

**Scenario Analysis Project**  
**Long Term Forecast of**  
**Oil, Natural Gas and Coal Prices**  
**In New England**



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## ABSTRACT

In the fourth quarter of 2006, ISO New England Inc. (ISO-NE) began a process to examine different scenarios of future mixes of fuels and technologies for electric supply resources in New England. The goal of the process is the development of an information base on which multiple stakeholders can assess the implications for a number of reliability, economic and environmental outcomes of importance to New England. To facilitate the goals of the scenario analysis, ISO-NE asked Levitan & Associates, Inc. (LAI) to develop a long-term forecast of fossil fuel prices for New England. The forecast period is 2007 through 2022, a 15-year study horizon. In light of the uncertainty associated with long-term forecasting, LAI has conducted sensitivity analysis in order to predict other potential energy price futures. The other energy price futures mark the range of the probable with respect to oil, natural gas and coal prices in New England.

LAI's "*Conventional Wisdom*" is a reference case incorporating LAI's expectations about the future. LAI has also prepared a high price case and a low price case. While each of these cases is illustrated as a smooth long-term trend, in reality, the actual price for oil and natural gas is sure to whipsaw around average prices each and every year over the long-term forecast period. These three cases provide ISO-NE with both the central pricing tendency for each fuel as well as the reasonable bandwidth around expected fuel prices for electricity production in New England.

## EXECUTIVE SUMMARY

New England is heavily dependent on premium fossil fuels, in particular, natural gas, for the generation of electricity. This dependency is not likely to change over the 15-year planning horizon. While oil is much less important for purposes of electricity production, it is however, critical for home heating and all transportation fuels. Around the world -- here in New England, too -- the price of natural gas and oil are directly related. Hence, global developments affecting the price of crude oil have a direct bearing on the price of gasoline, other refined oil products, and natural gas. Every day the price of crude oil changes, pushing up or down the price of gasoline and other refined oil products such as the fuel used for jet planes, home heating, and power plants. Like the Dow Jones Average, it is impossible to predict where prices settle on any given day, much less many years from now. Sometimes the daily or seasonal price movements are extreme. Large changes in fuel prices reflect strong global demand for transportation fuels, underlying tight supplies from oil exporting nations, politics, even weather.

The outlook on oil and natural gas prices is uncertain. Uncertainties regarding the availability of adequate oil and natural gas supply have created a climate of fear and pessimism, thereby sustaining the pattern of gyrating prices or “volatility” characteristic of both fuels throughout the U.S. In the short-term, prices will be hypersensitive to weather, geopolitical events, gas storage inventory and perceived supply availability. Despite the vast amount of oil and natural gas around the world, “unlocking” the world’s fuel supply in hostile locations requires enormous capital, political brinkmanship, and break-thru technologies. The higher costs associated with oil and gas exploration and production in more remote and harsher operating environments, will tend to sustain upward pressure on these fuels. Over the long-term, LAI expects the pattern of price volatility, characteristic of premium fossil fuels, to remain the norm not the exception. Hence, global oil and natural gas prices are sure to whipsaw around a long-term trend line that reflects underlying tight commodity markets, periodic geopolitical upsets, production constraints, and the world’s unquenchable thirst for transportation fuels. Over the planning horizon, a new part of the world is becoming more dependent on oil. The soaring demand for gasoline and other transportation fuels in China, India and other developing nations, in competition with the U.S., Europe and Japan, is likely to sustain tight market fundamentals throughout global markets.

A large number of new natural gas wells are currently being drilled in supply basins throughout North America. Many producing fields in the U.S. and Canada are tired -- production has wound down in response to accelerated depletion trends across many parts of the continent. The maturation or fatigue observed in major natural gas producing basins can be counterbalanced by adding new sources of natural gas supply. Promising developments in Africa, the Caribbean and the Middle East will increase the amount of natural gas available from remote locations that can be transported via LNG tankers in the form of liquefied natural gas (LNG). The U.S., New England, in particular, is likely to dramatically increase the amount of LNG that is imported to help bridge the pending gap over the long-term between the amount of natural gas that is produced in North America and the amount of natural gas needed to satisfy overall consumer demand.

***Central to LAI’s forecast of oil and natural gas prices is the assumption that global trends will continue to reflect tight market fundamentals over the long-term. The price for imported LNG is likely to be consistent with trends in world oil prices.*** Prospects for increased global

cartelization of oil and LNG are likely. Under our *Conventional Wisdom* case, LAI assumes that world oil consumption grows at about 1% per year through 2022. LAI also assumes that OPEC pumps more oil into the global energy economy, increasing total production from around 30 million barrels per day to 35 million barrels per day in 2022, an increase of 17%. Other key assumptions incorporated in the *Conventional Wisdom* case reflect continuation of the pattern of fatigue observed across natural gas producing basins in the U.S. and Canada. Also central to LAI's forecast is the expectation that the decline in conventional natural gas production in the U.S. and Canada is directly offset by LNG imports through 2022. LAI projects the addition of 11 new LNG import terminals serving North America, including two earmarked for serving New England.

LAI's coal price forecasts were formulated to be consistent with the oil and gas price forecast cases. Delivered coal prices are projected to increase in nominal terms over the forecast horizon in each case driven primarily by mining productivity and inflation in the major basins that supply coal to New England. The price of imported coal delivered to New England is forecast to move with the prices projected for the Appalachian supply basins.

Two alternate price cases have also been formulated, a high and a low. The high price case is referred to as *Peak Oil*. Under our *Peak Oil* case, LAI assumes a higher growth in world oil demand, significantly lower OPEC production, and an even faster rate of decline in U.S. natural gas production relative to our perspective under *Conventional Wisdom*. LAI has made other adjustments regarding the number of new LNG import terminals and the amount of natural gas obtainable from those new LNG import terminals that are added to U.S., Canadian, and Mexican infrastructure. The low price case is referred to as *LNG Overbuild*. Under our *LNG Overbuild* case, LAI has assumed aggressive worldwide development of natural gas resources in Africa and the Middle East and a corresponding proliferation of new LNG import terminals serving North America.

Unless otherwise noted, all prices discussed in this report include inflation. Highlights of the long-term forecast are these:

- Under *Conventional Wisdom*, oil prices are forecast to change from around \$55 per barrel in 2007 to \$78 per barrel in 2022, an increase over 40%. Under *Peak Oil* and *LNG Overbuild*, oil prices in 2022 range from \$154 per barrel to \$49 per barrel, respectively. This equates roughly to expected gasoline prices in 2022 of \$3.00 per gallon, with an upside and downside of \$5.25 and \$2.10 per gallon.
- Under *Conventional Wisdom*, natural gas prices in New England are forecast to change from about \$7 per million BTU's (\$7/MMBtu) in 2007 to more than \$9/MMBtu in 2022, an increase of about 30%. Under *Peak Oil* and *LNG Overbuild*, natural gas prices in 2022 range from \$14/MMBtu to \$6/MMBtu.
- Relative to the price outlook for premium fossil fuels, the price of coal delivered to power plants in New England falls within a much narrower band over the forecast period. Coal prices vary based on many factors, in particular, where the coal is sourced. In New England, most of the coal that will be burned over the forecast period will likely originate in South America or Indonesia, where the chemical composition of the coal is less

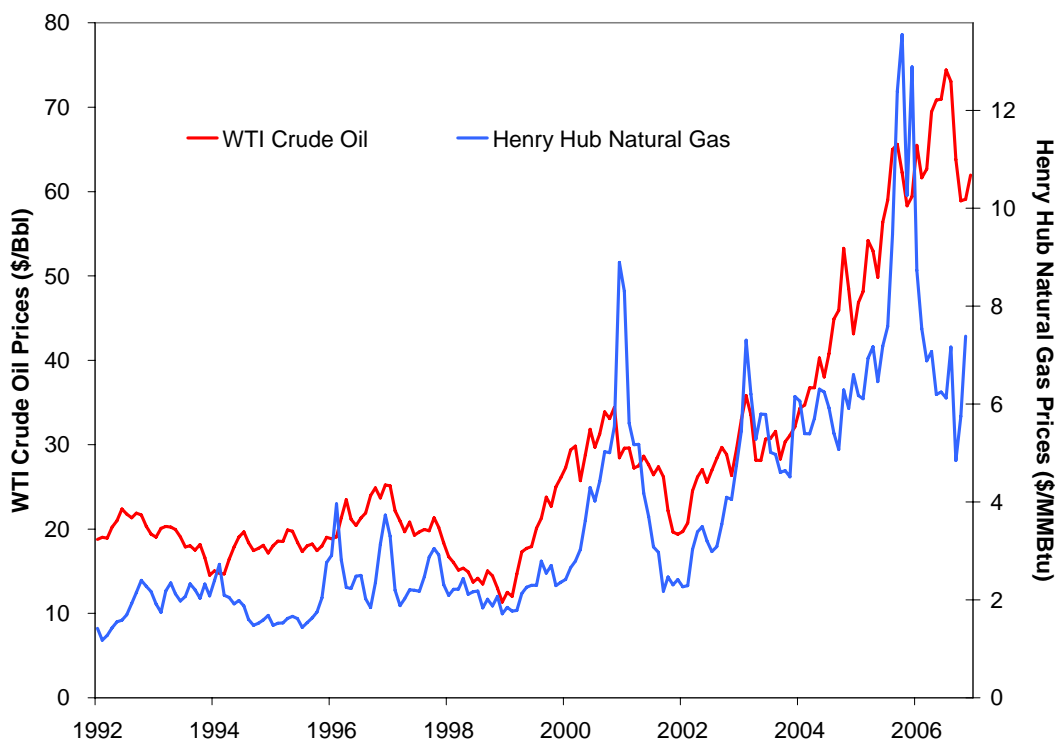
harmful to the environment. Western U.S. coals also have a favorable chemical composition, but it is currently too expensive to deliver coal from the Rocky Mountains to New England relative to foreign supplies. Under *Conventional Wisdom*, the cost of imported coal increases from \$59 per ton in 2007 to \$73 per ton in 2022, an increase of about 25%. This equates to \$3.06/MMBtu in 2022. Under *Peak Oil*, coal prices in 2022 increase to \$3.45/MMBtu. Coal prices in the *LNG Overbuild* case are insignificantly lower than those in *Conventional Wisdom*, however.

- The fuel price outlooks presented in this forecast consider a broad range of uncertainty relating to global energy supply and demand, as well as the geopolitics of moving oil and natural gas around the world. Events outside of the range of uncertainty have, by definition, a very low chance of occurrence. Nevertheless, if such events were to occur, then oil and natural gas prices may fall well outside the range of the probable as presented in this report. Conceivably, such events include war in the Middle East spreading to Iran, a radical change of leadership in Saudi Arabia, or a recurrence of the devastating hurricanes that struck the Gulf Coast in the summer of 2005. The impact on oil and natural gas prices associated with potential terrorist acts on U.S. soil is outside the scope of this inquiry.

## BACKGROUND

In recent years, oil and natural gas have shown substantial increases in price. Both fuels have demonstrated patterns of increased price volatility. Volatility is the relative change in price that occurs over time - highly volatile prices change dramatically over a short time period and vice versa. Relative to recent experience, prices throughout the 1990's did not bounce around – they were comparatively low, relatively stable and not particularly volatile. Over the last five years, prices have escalated substantially and have been erratic from season to season. Figure 1 displays the crude oil and natural gas prices over the past fifteen years. Crude oil prices are shown on the left-hand side in red and are expressed on a dollars per barrel basis. Natural gas prices are shown on the right-hand side in blue and are expressed on a dollars per MMBtu basis. The natural gas prices shown below represent the cost into-the-pipe in Louisiana rather than delivered to New England.<sup>1</sup>

**Figure 1 – Oil and Natural Gas Prices**



Oil and, increasingly, natural gas prices are driven by global events. Natural gas prices have been primarily influenced by the supply/demand balance across North America. Natural gas prices in New England reflect market dynamics across the continent, but also occasionally “spike” for brief intervals when the pipelines serving the region run full. This normally happens during winter cold snaps, but not during the spring, summer or fall. Geopolitical turmoil in the Middle East, hurricanes in the Gulf of Mexico and cold snaps in Europe all contribute to price levels and volatility in fossil fuel prices. A revolution or terrorist attack on oil facilities in a major oil producing country will cause oil prices to spike. For example, this happened in 1991 when Iraq invaded Kuwait and, to a much lesser extent, in 2003 when the war in Iraq began. In the summer of 2005 and throughout the remainder of the year, hurricanes Katrina and Rita

severely disrupted both oil and natural gas production and transportation operations in the Gulf of Mexico, causing natural gas prices to more than double in less than one month.

Since 2000, oil and natural gas prices have reflected the tightening conditions between global demand and supply, as surplus production capacity in major producing countries has dwindled. Since 2000, global oil demand increased almost 9%, while natural gas consumption increased 13%. Meanwhile proved oil reserves around the world increased approximately 8%. Natural gas reserves increased approximately 12%. At first blush, while these percentage differences between supply and demand seem small, LAI notes that the growth in both oil and natural gas reserves is significantly less than the growth in demand. Assuming China and India continue to grow economically, this gap is likely to compound over time, thereby sustaining upward pressure on both oil and natural gas prices. The addition of new oil and natural gas reserves is expected to increase at a slower rate over the forecast period than demand growth; hence, LAI projects continued high market prices and high volatility through 2022.

The world's oil, natural gas, and coal reserves are large and sufficient to meet current consumption levels for many decades – even longer in the case of coal. Current oil reserves amount to 40 years of consumption. Natural gas reserves amount to 65 years of consumption. Coal reserves amount to 155 years of consumption. Notwithstanding the known inventory of oil and gas reserves, finding and extracting these reserves from the ground or in deepwater will be more challenging and expensive. Notably, a large share of current oil and natural gas reserves are located in only a few countries in the Middle East, the Former Soviet Union (FSU), South America and Africa. The Middle East alone holds over 60% of total world oil reserves. The OPEC countries hold more than 75%.<sup>2</sup> Besides the Middle East, OPEC also includes a number of oil exporting countries in Africa as well as Venezuela. Middle Eastern countries and the FSU collectively have 75% of the world's natural gas reserves.<sup>3</sup> The heavy concentration of oil and natural gas reserves in only a few countries in politically unstable regions compounds the uncertainty associated with predicting long-term oil and natural gas prices.

Over the forecast period, LAI notes that the world, the U.S., and New England will continue to depend on fossil fuels, especially for cars, trucks, and planes. Currently the U.S. depends on foreign sources for more than 60% of total oil consumed each year. As global demand for transportation fuels continues to grow through 2022, there will be an increase in global energy trade, including natural gas. Over the last decade, it has become increasingly apparent that natural gas wells in most of North America's mature supply basins have experienced accelerated depletion effects. However, there is plenty of natural gas around the world that is "bottled up" in developing countries, ready to support the rapid expansion of global LNG trade. By "bottled up," LAI means that there is too much supply and too little local demand. Recently, the U.S. has had to compete with both Europe and the United Kingdom (UK) for LNG supply. This competition is likely to intensify over the forecast period as Europe and the United Kingdom likewise plan to step up reliance on imported LNG. Likewise, China and India plan to import LNG to meet their respective energy needs over the planning horizon. China has two LNG terminals under construction and by 2015 will have ten terminals in-service capable of importing 3,000 Bcf/year. India has two terminals that have started operations since 2004 and two more that are planned to go into service in 2009, which bring India's LNG import capacity to 730 Bcf/year.

Most natural gas used in the U.S. has been home grown. Over 80% of the natural gas used in the U.S. comes from domestic sources. Most of the rest is imported from Canada. Less than 3% of total U.S. natural gas demand is met via LNG imports. Most of the LNG comes from the Caribbean. Some LNG also comes from Africa and the Middle East. However, as domestic producing fields get older, the level of LNG imports will likely increase to keep pace with demand. In New England, 70% of the total energy consumed is derived from oil and natural gas. ISO-NE depends on natural gas as a major fuel for electricity generation. In 2005, over 40% of the total electricity generated in New England was produced by gas-fired and gas/oil-fired plants.

## FORECAST

LAI produced forecasts of the delivered prices of oil, natural gas and coal in New England through 2022. There are three cases for each fuel: *Conventional Wisdom*, *Peak Oil*, and *LNG Overbuild*. LAI did not directly consider the implementation of a carbon tax or greenhouse gas emissions restrictions that would impact the use of fossil fuels, particularly coal.<sup>4</sup> ***The prices forecasted in this report represent projected annual averages.*** Historical crude oil prices, represented in Figure 2, depict the pattern of price volatility by comparing the annual average price with the daily price over the last three years.

Figure 2 – Crude Oil Daily and Average Annual Prices



### ***CONVENTIONAL WISDOM***

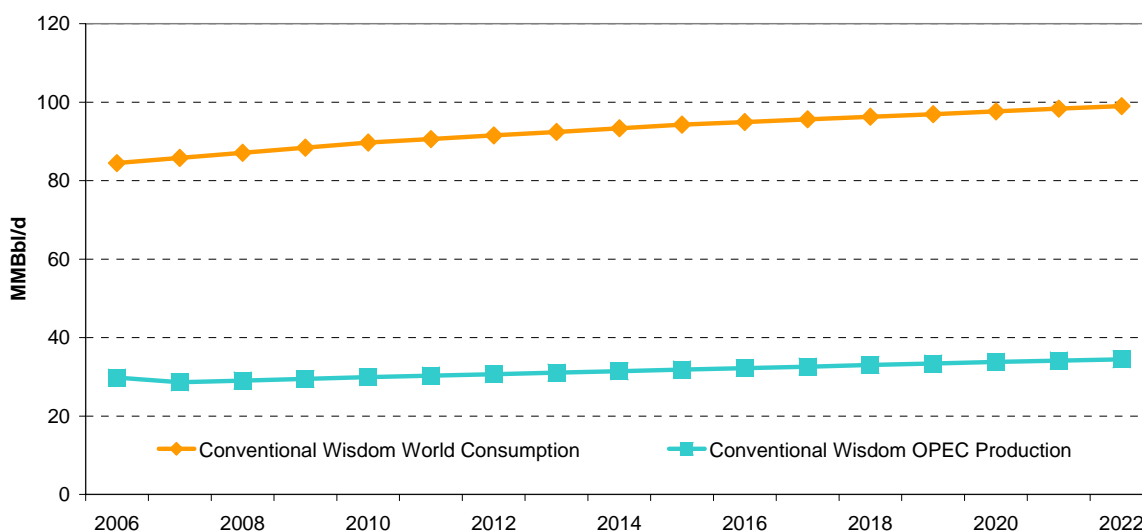
#### Oil

LAI's forecasts of crude oil prices are based on the relationships between world oil consumption, world proved oil reserves, and OPEC production. OPEC production is the key driver of crude oil prices because OPEC producers control most of the spare production capacity around the world.

To support the scenario planning analysis undertaken by ISO-NE, LAI forecasts the price of crude oil. LAI also forecast the price of two oil products of relevance for electricity production in New England: first, “No. 2 fuel oil” which is a valuable fuel used sparingly either as a back-up fuel for natural gas or as the primary fuel in peaking generation plants;<sup>5</sup> and, second, “low-sulfur residual fuel oil” which is a much less valuable fuel, but widely used in older, steam-based power plants and industrial boilers.

Our *Conventional Wisdom* assumes relative stability in the Middle East, Nigeria and Venezuela, steady investment in exploration and production, and gradual development of new reserves such as ethanol, oil sands, gas-to-liquids and even some coal-to-liquids. Relative to recent trends, LAI projects a slightly more moderate growth in oil demand around the world. Overall world consumption in the *Conventional Wisdom* is forecast to increase by an average of 1.0% per year, while OPEC production increases by an average of 0.9% per year, as shown in Figure 3. World proved oil reserves are projected to grow at an average annual rate just under 1%. However, this rate of reflects a gradual slowing in the growth of reserves from about 1.2% in the early years to 0.5% by 2022.

**Figure 3 – World Consumption and OPEC Production (Conventional Wisdom)**

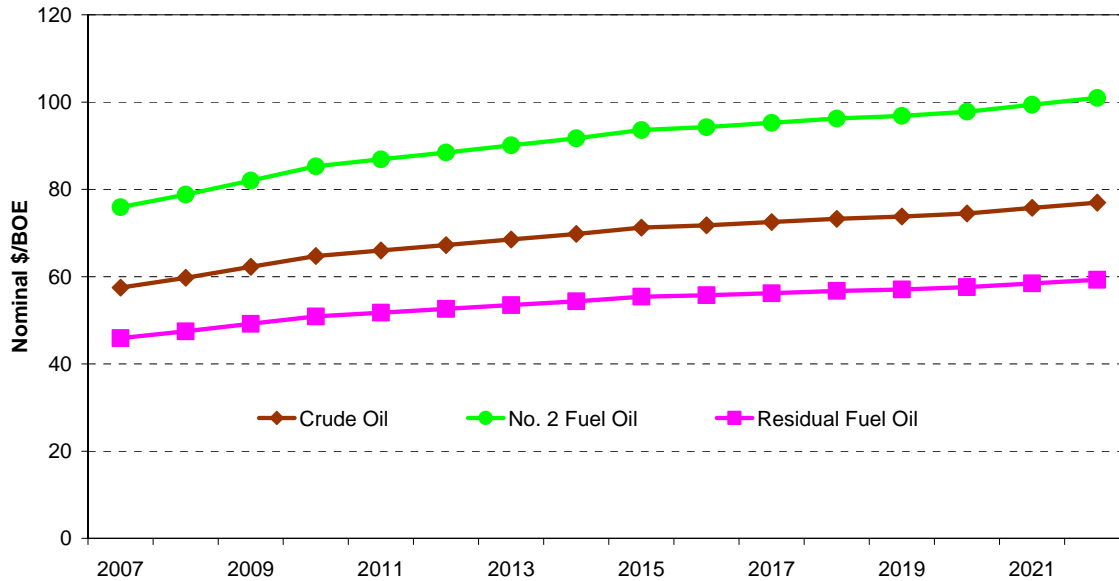


As world oil demand moves at a faster pace than OPEC production, other sources of supply will likely take up the slack. These other sources of supply are much more expensive to produce than typical production from conventional fields in the Middle East, Africa, or Venezuela. Anticipated new supply sources are from Canadian oil sands in Alberta, new fields in the FSU and in ultra deepwater in the Gulf of Mexico.<sup>6</sup>

In this case, the price of oil is projected to increase by approximately 2% per year, from \$57 per barrel in 2007 to \$78 per barrel in 2022. This case incorporates an overall inflation rate of 2.5%. Oil markets will undoubtedly remain volatile. As shown in Figure 4, the price of No. 2 fuel oil and residual fuel oil will remain strongly correlated with crude oil. For consistency sake, the prices shown below are expressed on a common basis. The measurement convention is referred to as barrel of oil equivalent or “\$/BOE” in order to adjust for the different heat content of crude

oil, No. 2 fuel oil and residual fuel oil. Prices for the benchmark crude oil in the U.S. – West Texas Intermediate or “WTI” – represent delivery at Cushing, Oklahoma. Prices for No. 2 fuel oil and 0.3% sulfur residual fuel oil are for delivery at New York Harbor. Fuel use differentiation by power plant in New England is not part of this forecast.

**Figure 4 – Crude Oil and Oil Product Prices (Conventional Wisdom)**

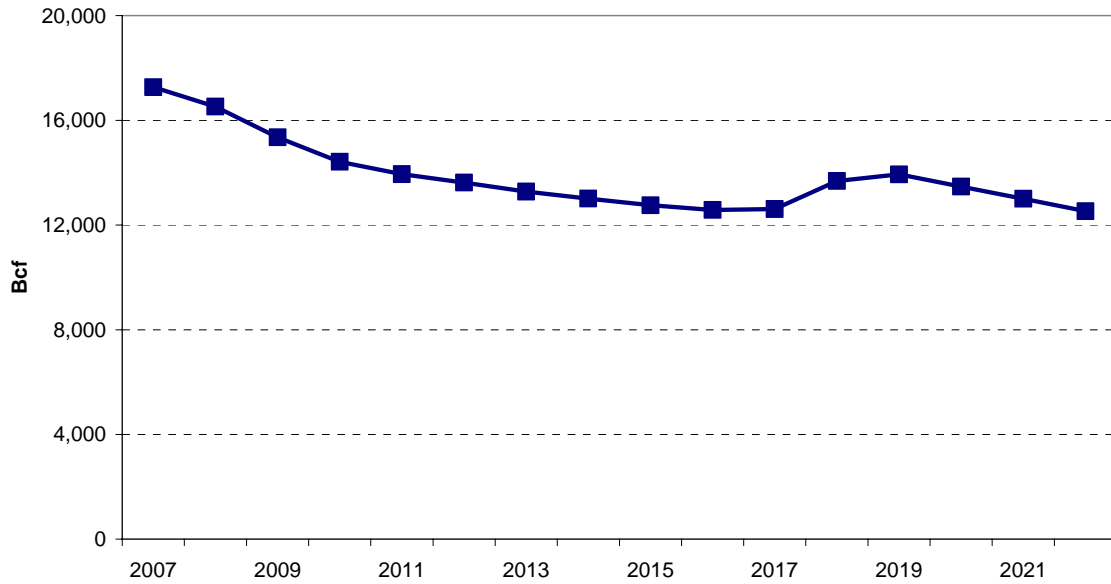


Natural Gas

North American natural gas production is undergoing a transition from production centered in traditional fields located in Texas, Louisiana, Kansas, Oklahoma, the plains of eastern Alberta in Canada and the shallow waters of the Outer Continental Shelf (OCS) in the Gulf of Mexico. More production than ever before is happening in the Rocky Mountains, western Alberta and British Columbia, and the deep waters in the Gulf of Mexico. There are also other unconventional reservoirs throughout the continent.<sup>7</sup> The increase in production from Rocky Mountain and unconventional reservoirs will take up the slack as traditional basins continue to age.

Historically, natural gas prices have been tied to the Henry Hub index, a major trading point in Louisiana that is at the nexus of several major interstate pipelines. LAI has forecast natural gas prices using a computer modeling system.<sup>8</sup> The primary drivers of the natural gas forecast for each case are U.S. gas production, the size and location of new LNG facilities and oil prices. Total U.S. natural gas supplies, excluding LNG, are projected to decrease by 2.1% per year in Conventional Wisdom. This decline is not constant. As shown in Figure 5, supplies decline by 3.4% per year through 2016, but then increase for a short while once natural gas is produced from Alaska.

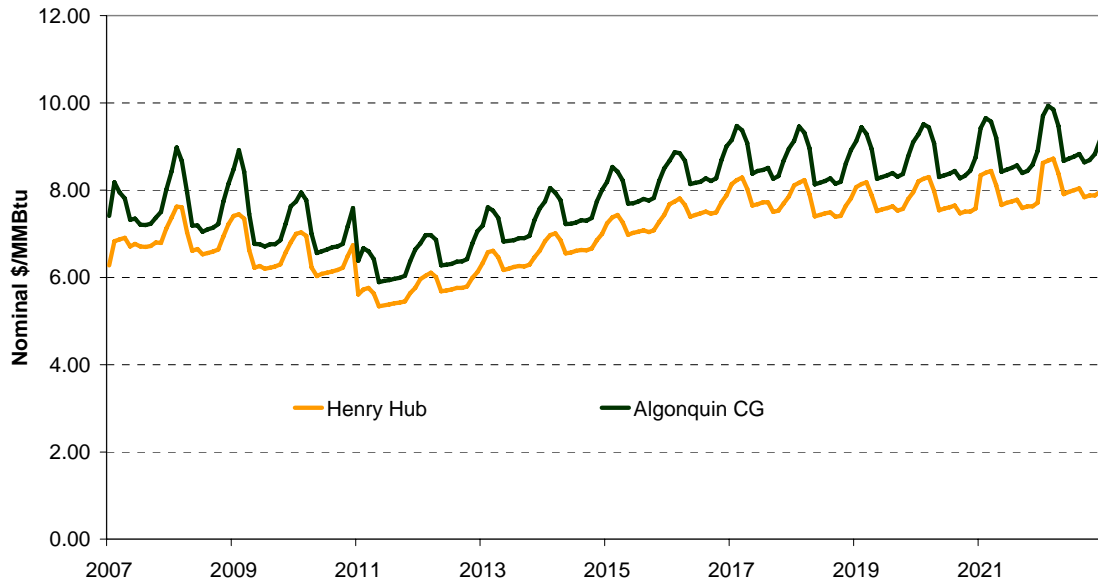
**Figure 5 – Total U.S. Production, excluding LNG (Conventional Wisdom)**



The gap between production and consumption needs to be met by LNG imports. In *Conventional Wisdom*, LAI forecasts the addition of 11 LNG import terminals through 2022. This equates to the addition of 16.6 billion cubic feet per day (Bcf/d) of capacity. There is also 5.8 Bcf/d of potential supply injection from the five existing import LNG terminals.<sup>9</sup> Among the 11 new LNG import terminals, LAI has assumed the addition of the Canaport terminal in New Brunswick and one offshore terminal in Massachusetts Bay.<sup>10</sup>

Under *Conventional Wisdom*, natural gas prices at the Henry Hub decline from current levels of around \$7/million Btus (MMBtu) in 2007 to around \$6/MMBtu in 2012, then rise to more than \$8/MMBtu in 2022.<sup>11</sup> To capture the value of natural gas delivered to New England, LAI has projected the typical benchmark price, *i.e.*, Algonquin Citygates. In Figure 6, LAI shows the forecast of natural gas prices at the Henry Hub in Louisiana and New England.

**Figure 6 – Henry Hub and Algonquin Citygates Prices (Conventional Wisdom)**



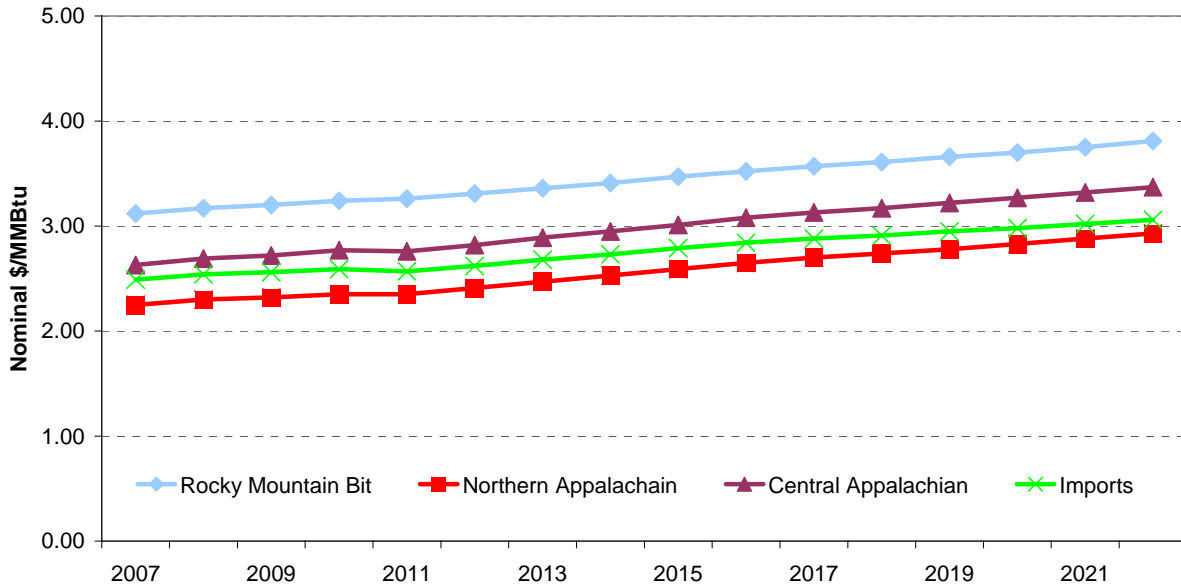
## Coal

Coal price forecasts were prepared for three U.S. supply basins: the Central Appalachian Basin, Northern Appalachian Basin, and the Rocky Mountain bituminous region as well as for imported coal delivered to New England.<sup>12</sup> The Central Appalachian Basin includes mines in Eastern Kentucky, the southern section of West Virginia, and Virginia. The Northern Appalachian Basin includes mines in Pennsylvania, Eastern Ohio, and northern West Virginia. The Rocky Mountain region included mines in Colorado and Utah. Powder River Basin (Wyoming) coal has not been considered an appropriate fuel for New England power generators because of distance, transportation costs, and its low heat content.

The key parameters for the forecast of coal prices include: mining productivity, total production, the price of natural gas, and inflation. Transportation costs were added to the basin price of coal to reflect delivery to New England. Imported coal burned by generating plants in New England is primarily from Columbia, Venezuela, Indonesia and Russia.

Delivered coal prices to New England are shown in Figure 7.

**Figure 7 – Coal Price Forecast (Conventional Wisdom)**

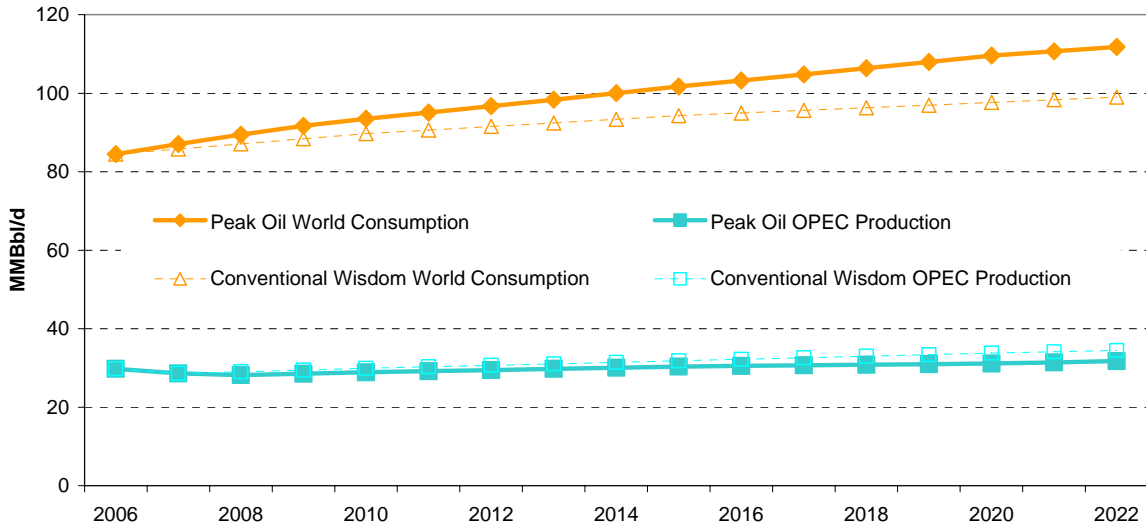


***PEAK OIL CASE***

Oil

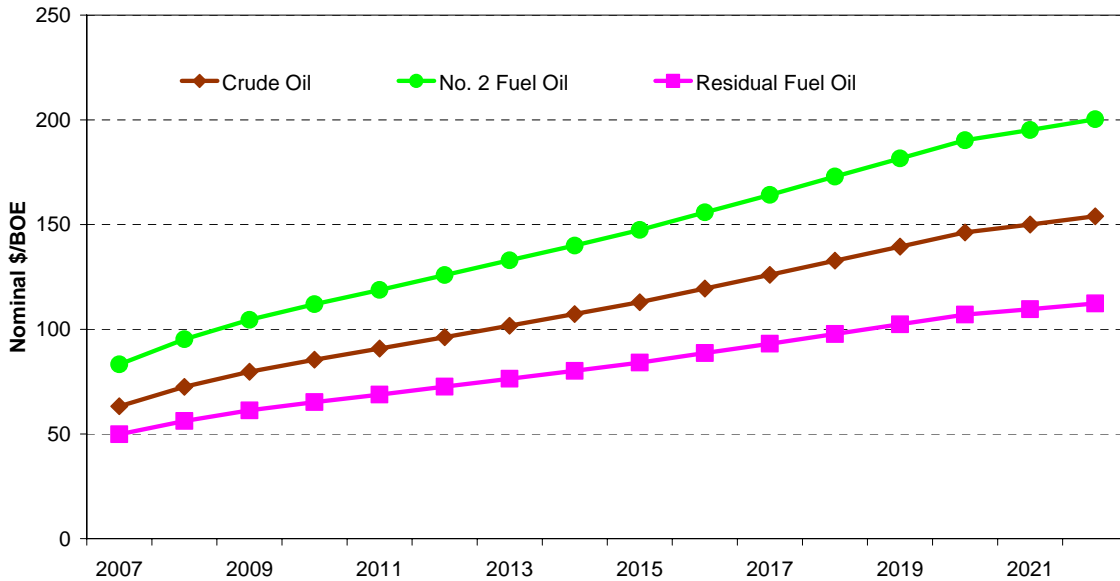
In the *Peak Oil* case, world demand is projected to grow at a more rapid rate, increasing on average by 1.8% per year. Relative to production in *Conventional Wisdom*, LAI projects a decline in global production in *Peak Oil*. Underlying this case are geopolitical tensions in the Middle East, Venezuela and Nigeria, thus dampening growth in OPEC production. Increases in oil production elsewhere in the world do not compensate. In *Peak Oil*, demand growth continues in the developing world, in particular, China and India. OPEC production declines through 2008 then increases slowly as OPEC struggles to bring on enough new production to replace depletion at existing fields.<sup>13</sup> ***World oil production peaks in 2010.*** World proved reserves grow more slowly than in *Conventional Wisdom*, reaching a peak in 2015 and declining thereafter.

**Figure 8 – World Consumption and OPEC Production (Peak Oil)**



The price of crude oil is projected to increase over 6% per year, from \$63 per barrel in 2007 to \$154 per barrel in 2022. The *Peak Oil* case assumes an inflation rate of 3.25% per year. The prices of refined oil products follow similar price trajectories as depicted in Figure 9.

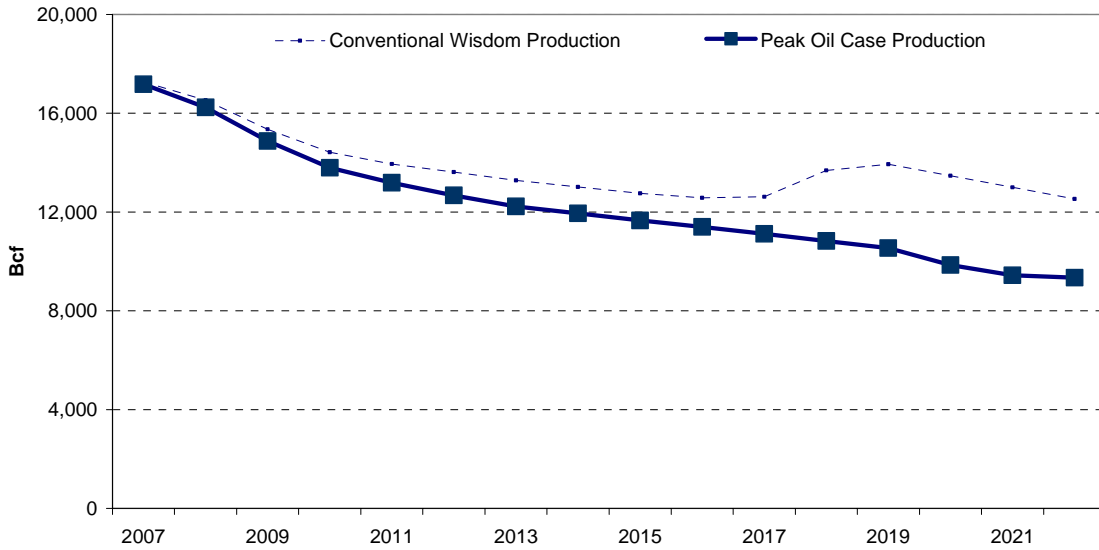
**Figure 9 – Crude Oil and Oil Product Prices (Peak Oil)**



Natural Gas

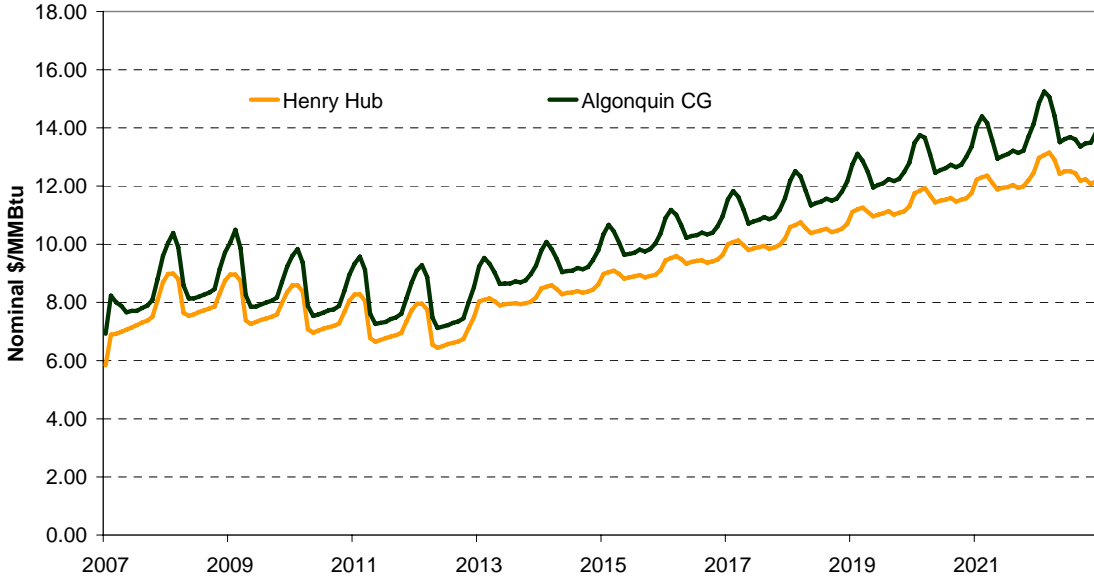
Total U.S. natural gas supplies, excluding LNG, are projected to decrease by 4% per year under the *Peak Oil* case. Alaska North Slope gas production does not arrive in the Lower 48 until after 2022, beyond the study horizon. Thus, a significant divergence in total production after 2017 arises relative to the assumptions used in *Conventional Wisdom*.<sup>14</sup> Projected domestic natural gas production is shown in Figure 10 – the light, dashed line depicting base production in *Conventional Wisdom* is included for easy reference:

**Figure 10 – Total U.S. Production (Peak Oil)**



Lower domestic gas production coupled with increased reliance on higher priced LNG puts upward pressure on Henry Hub prices, increasing from about \$7/MMBtu in 2007 to \$13/MMBtu in 2022. In New England, the price of natural gas increases from an average of about \$8/MMBtu in 2007 to an average of \$14/MMBtu in 2022.

**Figure 11 – Henry Hub and Algonquin Citygates Prices (Peak Oil)**

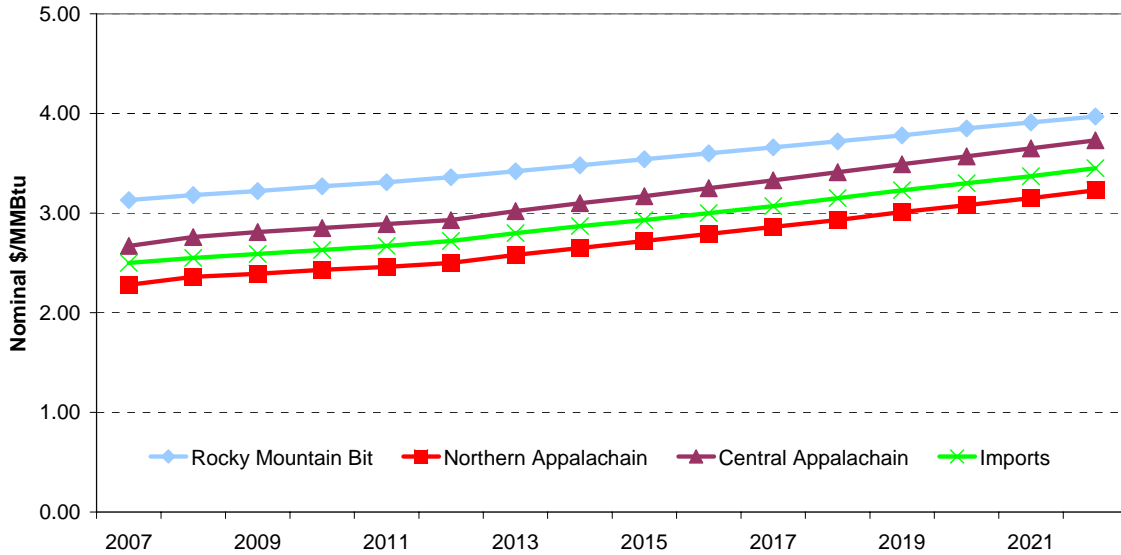


Coal

Coal prices are projected to increase somewhat relative to the *Conventional Wisdom* as a result of higher inflation. However, the rate of increase in coal prices under the *Peak Oil* case is much lower than oil or natural gas. Mining productivity is less sensitive to higher oil and gas prices.

Also, good productivity in western coal mines over the forecast period will tend to hold down the increases in coals prices from Appalachia as well as imports.

**Figure 12 – Coal Price Forecast (Peak Oil)**



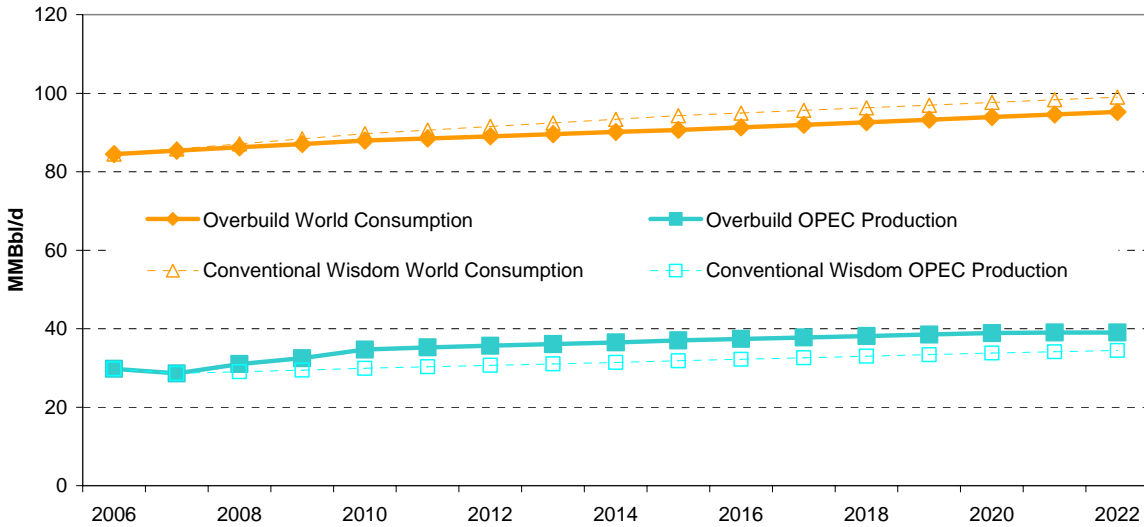
***LNG OVERBUILD CASE***

Oil

The background assumptions within the *LNG Overbuild* case include: stability in the major oil producing regions of the world resulting in strong growth in OPEC production and increased world proved reserves; aggressive worldwide development and trading of LNG; surplus LNG tanker capacity; and increased U.S. oil and natural gas production in deepwater as well as from unconventional gas reservoirs in Texas, the Rocky Mountains, and North Dakota.

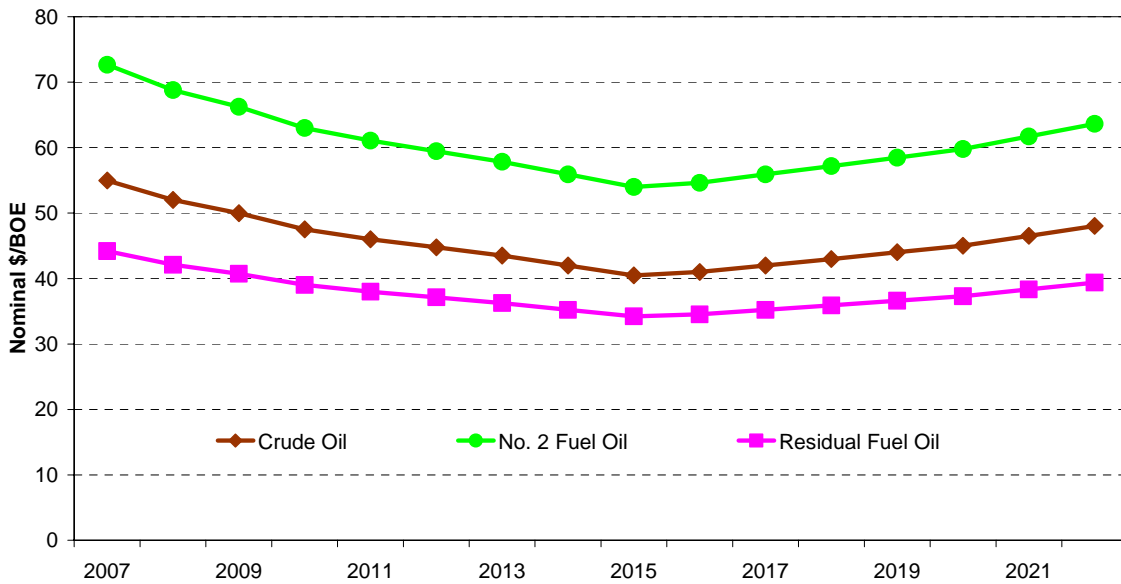
Under the *LNG Overbuild* case, world oil demand is expected to be about 4% less in 2022 relative to the *Conventional Wisdom*. Increased global natural gas supplies result in broad scale substitution effects for oil in power generation and industrial applications. A relaxation in geopolitical tensions helps boost future OPEC production.<sup>15</sup>

**Figure 13 – World Consumption and OPEC Production (LNG Overbuild)**



Under the *LNG Overbuild* case, the price of crude oil is projected to decrease by approximately 3.8% per year through 2015. Prices would then increase by 2.5% per year through the end of the forecast. The 2022 price of crude oil is under \$50 per barrel. With lower oil and natural gas prices, core inflation is assumed to be 2.0% per year. Refined product prices are expected to follow a similar pattern of decline as depicted in Figure 14.

**Figure 14 – Crude Oil and Oil Product Prices (LNG Overbuild)**

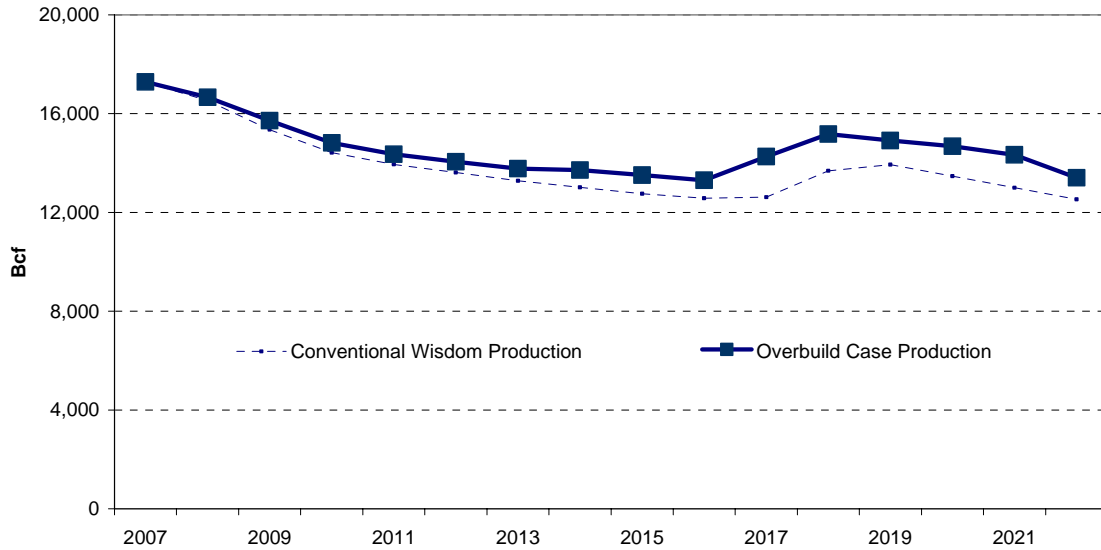


Natural Gas

Under the *LNG Overbuild* case, lower prices for oil drive U.S. natural gas prices lower. Prices are depressed by the postulated addition of additional LNG import terminals. Relative to *Conventional Wisdom*, total LNG capability is assumed to be 10% higher. Based on improved production performance from the deepwater Gulf of Mexico and unconventional gas fields, total

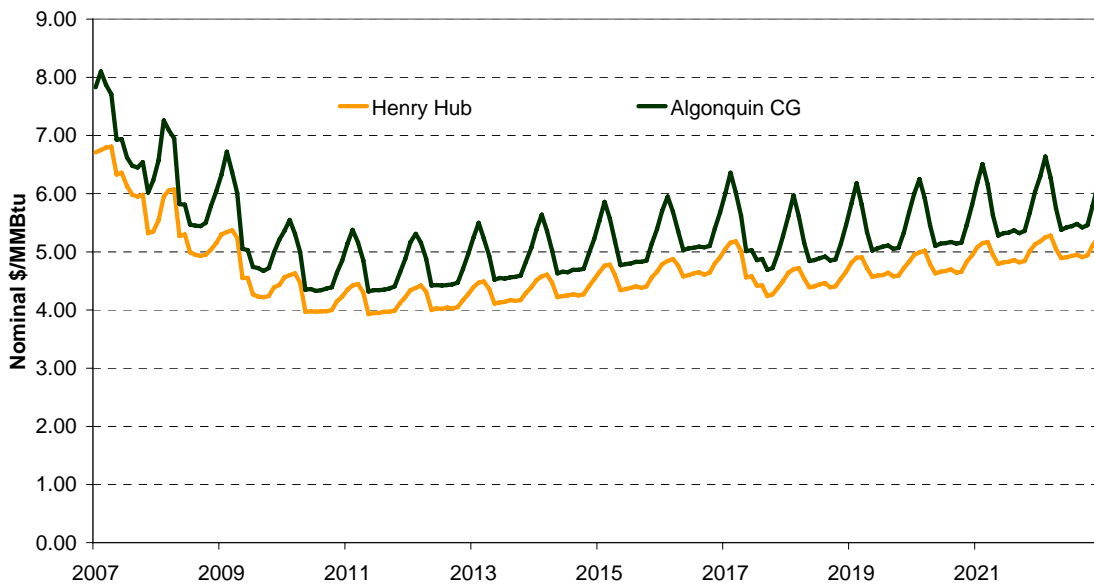
U.S. gas supplies, excluding LNG, are projected to decrease by only 1.6% per year. LAI assumes that gas from Alaska’s North Slope gas is available in 2017, temporarily reversing the U.S. decline trend. Total U.S. production for the *LNG Overbuild* case is shown in Figure 15.

**Figure 15 – Total U.S. Production (LNG Overbuild)**



The Henry Hub price decreases from an average of roughly \$7/MMBtu in 2007 to an average of \$5/MMBtu in 2022. Average annual prices in New England decrease from \$7/MMBtu in 2007 to under \$6/MMBtu in 2022.

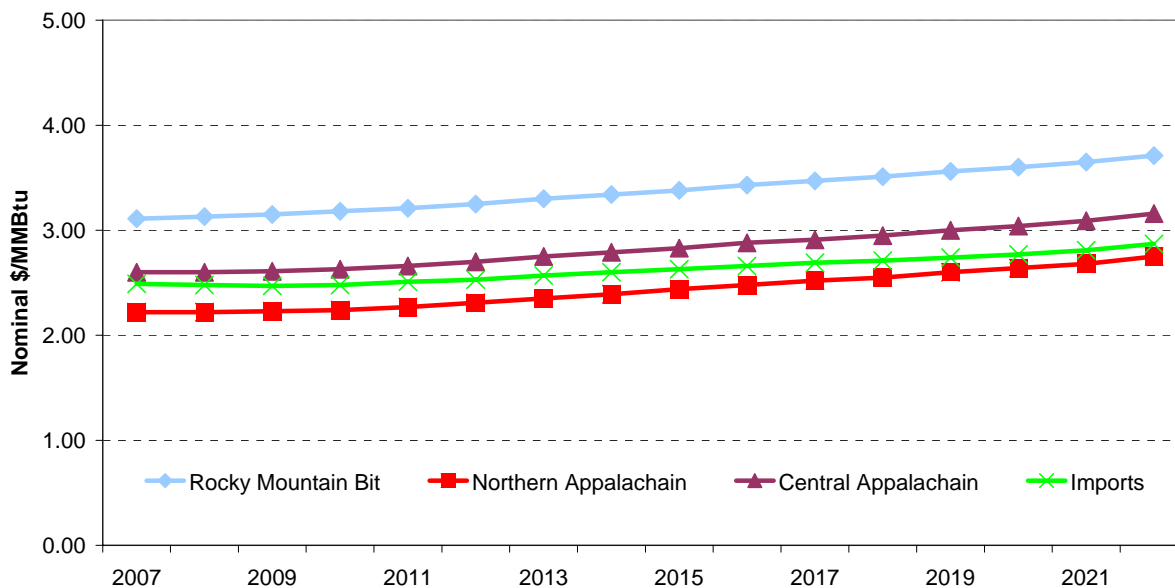
**Figure 16 – Henry Hub and Algonquin Citygates Prices (LNG Overbuild)**



## Coal

Lower natural gas prices and inflation exert insignificant downward pressure on coal prices in the *LNG Overbuild* case. Figure 17 presents the forecast of coal prices delivered to New England under the *LNG Overbuild* case.

**Figure 17 – Coal Price Forecast (LNG Overbuild)**



### ENDNOTES:

<sup>1</sup> Crude oil is priced using an index referred to as West Texas Intermediate, or WTI. Natural gas prices reflect in-the-pipe values at the Henry Hub, Louisiana, the center for gas trade in North America and for NYMEX futures contracts. Natural gas prices delivered to New England are consistently higher than Henry Hub, reflecting the cost of transporting natural gas from the Gulf Coast to New England.

<sup>2</sup> OPEC is the Organization of Petroleum Exporting Countries and currently includes: Algeria, Angola, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates (UAE), and Venezuela.

<sup>3</sup> Russia has recently made overtures of forming an LNG cartel in order to organize gas exporting nations, control benchmark prices, and coordinate global production levels.

<sup>4</sup> The most likely approach to modeling the impact of CO<sub>2</sub> emissions restrictions would be as a carbon tax that would not necessarily change the price of coal, but would change the cost of using coal at the power plant. Quantification of bid adders for tax effects are not part of this forecast.

<sup>5</sup> Peaking generation plants or “peakers” are combustion turbines that are capable of achieving full output in less than an hour.

<sup>6</sup> Our *Conventional Wisdom* projection reflects an increase in world oil reserves from 1,200 billion barrels in 2007 to 1,400 billion barrels in 2022.

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<sup>7</sup> Unconventional reservoirs include tight sands, coalbed methane and shale gas that require enhanced production techniques relative to conventional reservoirs. Production from unconventional reservoirs tends to be more expensive than production from conventional reservoirs.

<sup>8</sup> LAI is a licensee of GPCM, a linear optimization model from RBAC, Inc. LAI has customized the database. The optimization model simulates the natural gas market across North America, including gas supplies, imports, demand, pipeline and storage facilities by location. In total, the system model includes more than 140 existing and proposed pipelines, 100 storage areas, 60 production areas, and 450 demand centers.

<sup>9</sup> The five existing LNG terminals are at Everett, MA, Cove Point, MD, Elba Island, GA, Lake Charles, LA and the Gulf Gateway offshore terminal located in the Gulf of Mexico.

<sup>10</sup> There are a number of other potential LNG import terminals proposed in or around New England that are well along the permitting process, for example, Broadwater and Weaver's Cove. Either or both of these projects could be commercialized in addition to, or in lieu of, one offshore project in Massachusetts Bay. LAI's assumptions in *Conventional Wisdom* are solely for the purpose of forecasting fuel prices and do not represent a company view regarding long-term market requirements, timing, or location.

<sup>11</sup> GPCM forecasts prices on a monthly basis. The average annual prices indicated in the figures in this section of the report are a simple average of the twelve months in a given year.

<sup>12</sup> Rocky Mountain bituminous coal reflects coal produced in Colorado and Utah and does not include the sub-bituminous coal produced in the Powder River Basin of Wyoming.

<sup>13</sup> By 2022, OPEC production in *Peak Oil* amounts to 31.7 million barrels per day, a reduction of 2.8 million barrels per day from *Conventional Wisdom*.

<sup>14</sup> *Peak Oil* also reflects other changes in the number of new LNG import terminals, including no offshore development within Massachusetts Bay.

<sup>15</sup> The increase is an average of 1.7% year, reaching 39 million barrels per day by 2022.