Gulf of Mexico Offshore Oil and the Northeastern United States' Dependence on Heating Oil

Prepared for the Northeast Biomass Thermal Working Group by

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Executive Summary

The northeastern US consumes most of the heating oil used in the US. The New England states plus New York, Pennsylvania, and New Jersey consume 80.3% of all of the heating oil used in the US. These nine states consume on average more than 5.5 billion gallons per year of #2 oil for residential, commercial and industrial heating (that figure does not include diesel fuel for transportation).

About 77.5% of that heating oil is refined in US refineries (most of the rest is from Canada). Between 80% and 90% of the heating oil that is refined in the US and used in the northeast is refined in Gulf coast refineries and transported to terminals along the northeastern seaboard.

The crude oil that is refined into heating oil in the Gulf that is destined for the northeast comes either from domestic offshore wells or is imported. About 21% of the crude oil refined in the Gulf Coast area is from domestic offshore production in the Gulf of Mexico. The rest is imported. About 60% of the imports are from OPEC nations, about 19% are from Mexico, and the rest of the imports are from a variety of nations in South America, Europe, Africa, and also Canada. Of the OPEC imports, about half come almost equally from Venezuela and Saudi Arabia.

Because most of the money spent on heating oil does not stay in the northeast states' economies, those state economies are very sensitive to any increase in heating oil prices. Most of the money spent on heating oil is "exported" and therefore does not support the state economies and does not support jobs. For example, it is estimated that the economic harm from a $1.75 increase in heating oil prices would result in a loss of more than 370,000 jobs in the nine northeastern states.

The dependency of the northeastern states on #2 fuel oil for heat places these states in a uniquely vulnerable position. The heating needs of these states combined with their established high reliance on #2 oil makes them sitting ducks for extreme economic (and therefore social) harm if there is any disruption to the flow of #2 oil into the region.

That flow is almost entirely dependent upon only two sources: offshore oil from the Gulf and imported oil from OPEC nations. Any interruption to the flow of crude oil from those sources will have very negative impacts on the northeast.

Gulf of Mexico Offshore Oil and the Northeastern United States' Dependence on Heating Oil

This brief white paper illuminates the relationship between the northeastern states' dependence on heating oil and offshore crude oil production and heating oil refining in the Gulf coast area.

Most of the heating oil consumed in the United States is by the northeastern states; and a large proportion of that heating oil is produced in the Gulf coast area. A significant proportion of the crude that is refined into #2 fuels[1] for use in the northeast is extracted from offshore rigs in the Gulf of Mexico. Most of the remainder is imported from OPEC and Mexico.

Heating Oil and the Northeastern States

The northeastern US consumes most of the heating oil used in the US. The New England states[2] plus New York, Pennsylvania, and New Jersey consume 80.3%[3] of all of the heating oil used in the US.

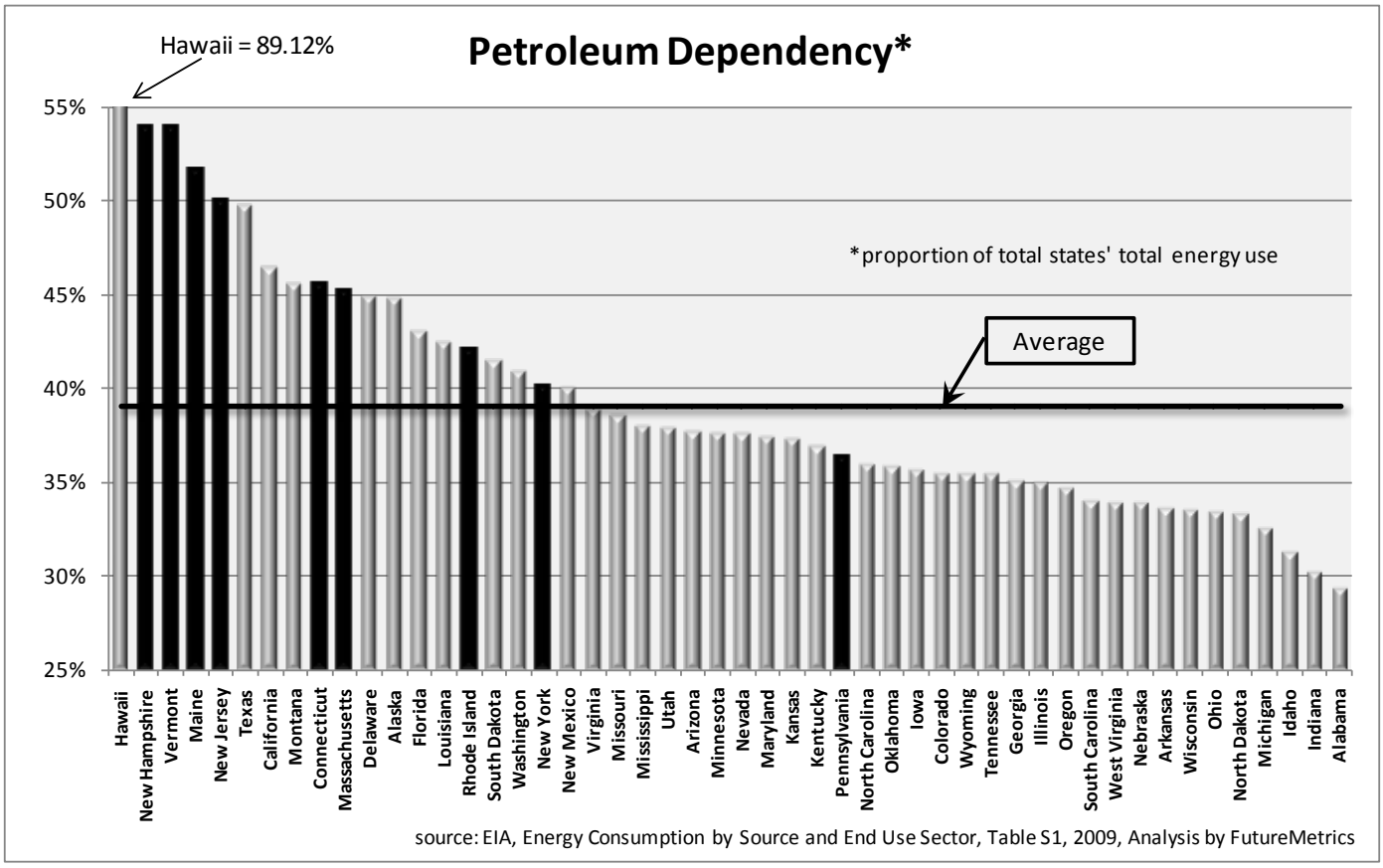
The proportions of homes that use heating oil in these states are show in the table below[4].

	Heating Oil use by Households
Maine	**80%**
Vermont	**59%**
New Hampshire	**58%**
Connecticut	**52%**
Rhode Island	**42%**
Massachusetts	**39%**
New York	**33%**
Pennsylvania	**26%**
New Jersey	**19%**

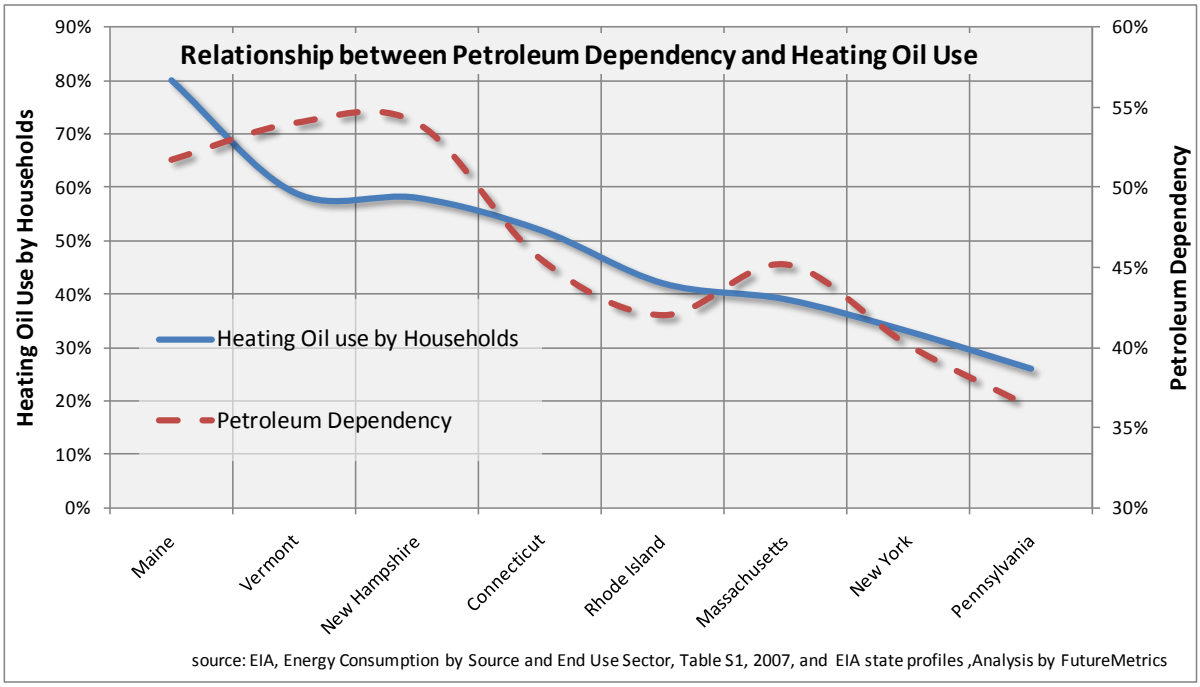
The top seven states are highly dependent on petroleum due to their heavy dependence on #2 heating oil for the primary source of thermal energy for homes and businesses.

[1] #2 fuels include heating oil and diesel fuel.
[2] Maine, Massachusetts, New Hampshire, Vermont, Rhode Island, Connecticut.
[3] EIA, Table S4. Residential Sector Energy Consumption Estimates, 2007.
[4] EIA, State Energy Profiles, 2010, US Census.

The chart below shows the states' petroleum dependency[5].



In the northeast states, there is a strong correlation between heating oil use and petroleum dependency. The only exception is New Jersey which has a high petroleum dependency but is relatively low in per capita heating oil dependency.



[5] Petroleum dependency is defined as the proportion of the total state's primary energy use that is derived from petroleum.

The table below[6] shows the number of gallons of #2 fuel used in the northeastern states by all users in the most recent year for data collection.

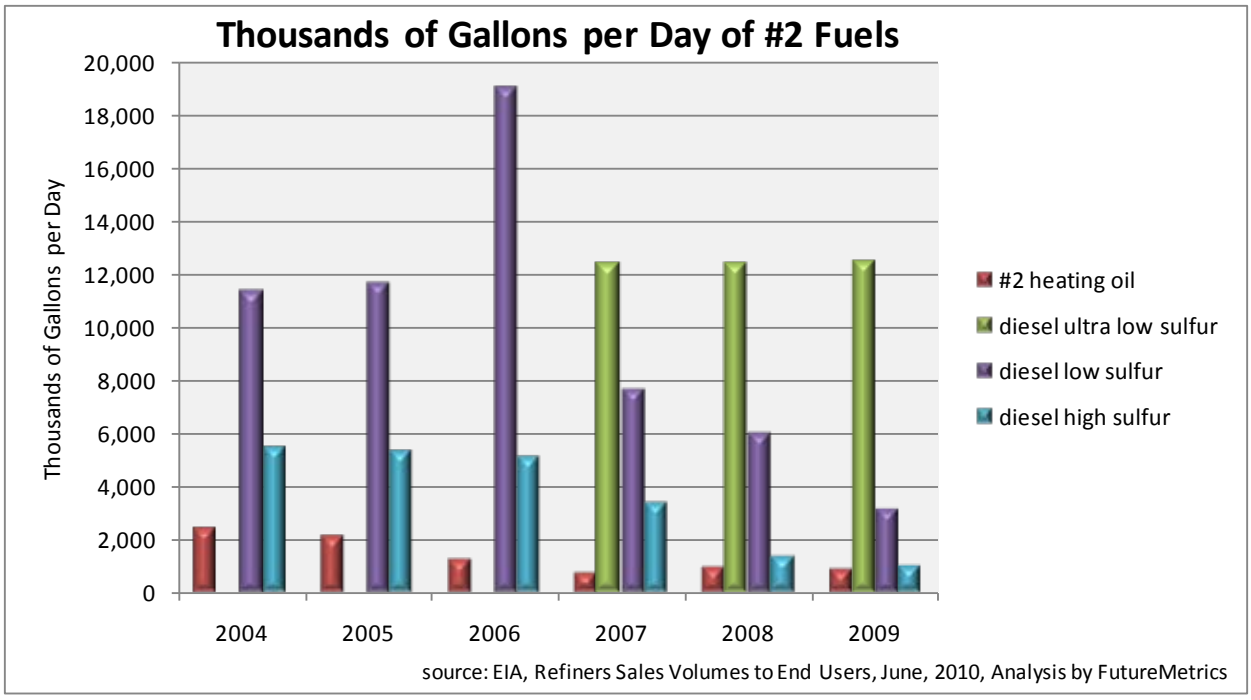
#2 Distillate Fuel use in Residential, Commercial, and Industrial (not Transportation)	Average Gallons per Year
Maine	414,493,000
Vermont	130,435,000
New Hampshire	242,029,000
Connecticut	672,464,000
Rhode Island	148,551,000
Massachusetts	818,841,000
New York	1,818,841,000
Pennsylvania	840,580,000
New Jersey	459,420,000
	5,545,654,000

Characteristics of Heating Oil Production and Distribution

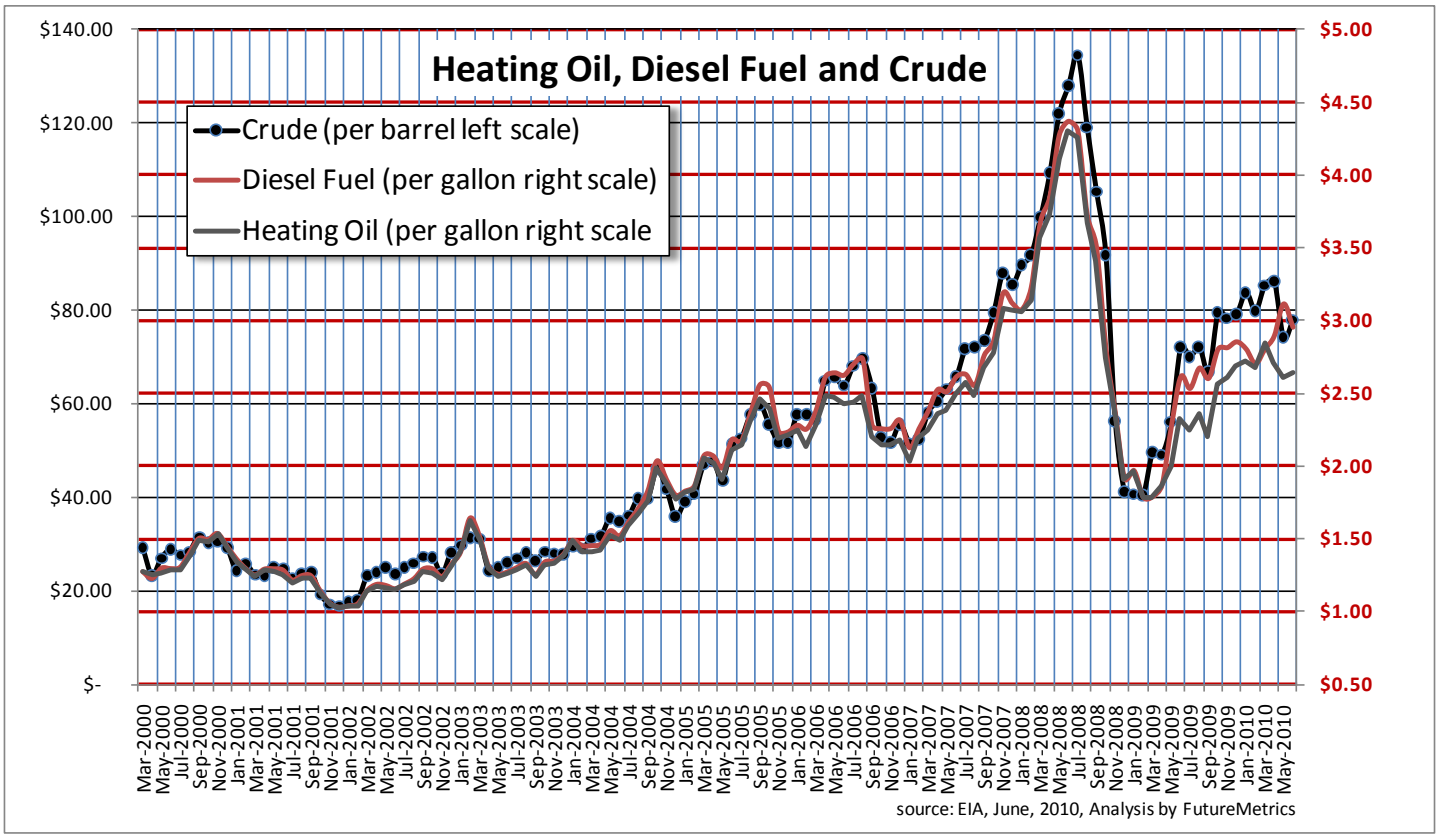
As the table above shows, the nine states use on average 5.5 billion gallons of heating oil per year. About one third of that is imported from other countries. The average annual imports from foreign refiners of low sulfur heating oil into the northeast US since 2006 has been approximately 1.6 billion gallons per year (most of which is from Canada)[7]. That is, about 77.5% of all low sulfur heating oil used in the northeastern states is domestically produced[8].

Heating oil does not command a large role in the aggregate production of #2 fuels when diesel fuel is included. The next chart shows the production, in gallons per day, of the #2 fuels.

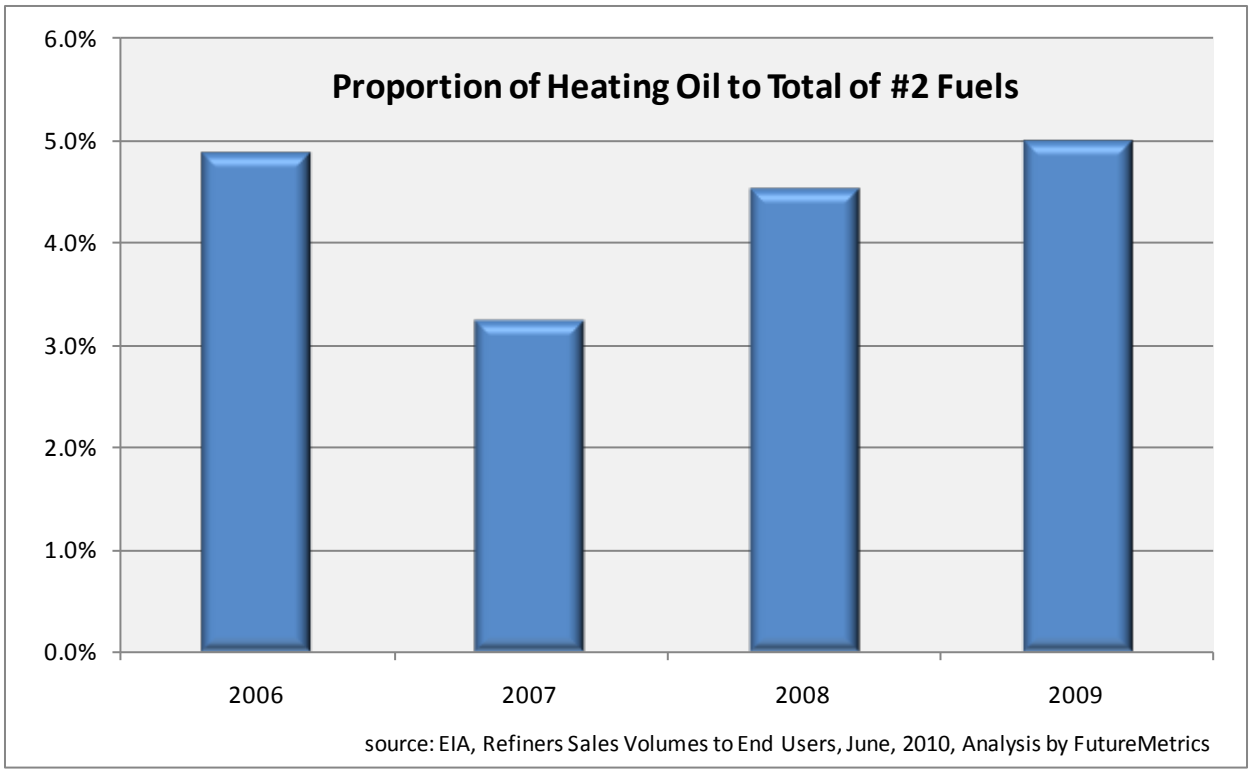
[6] EIA, State Profile Data, June, 2010 release of data from 2008; using total BTUs consumed with the assumption of 138,000 BTU per gallon.
[7] EIA, PADD District Imports by Country of Origin, June, 2010.
[8] However, as this report will show, much of the crude oil that is used to produce heating oil in US refineries is not domestically produced.



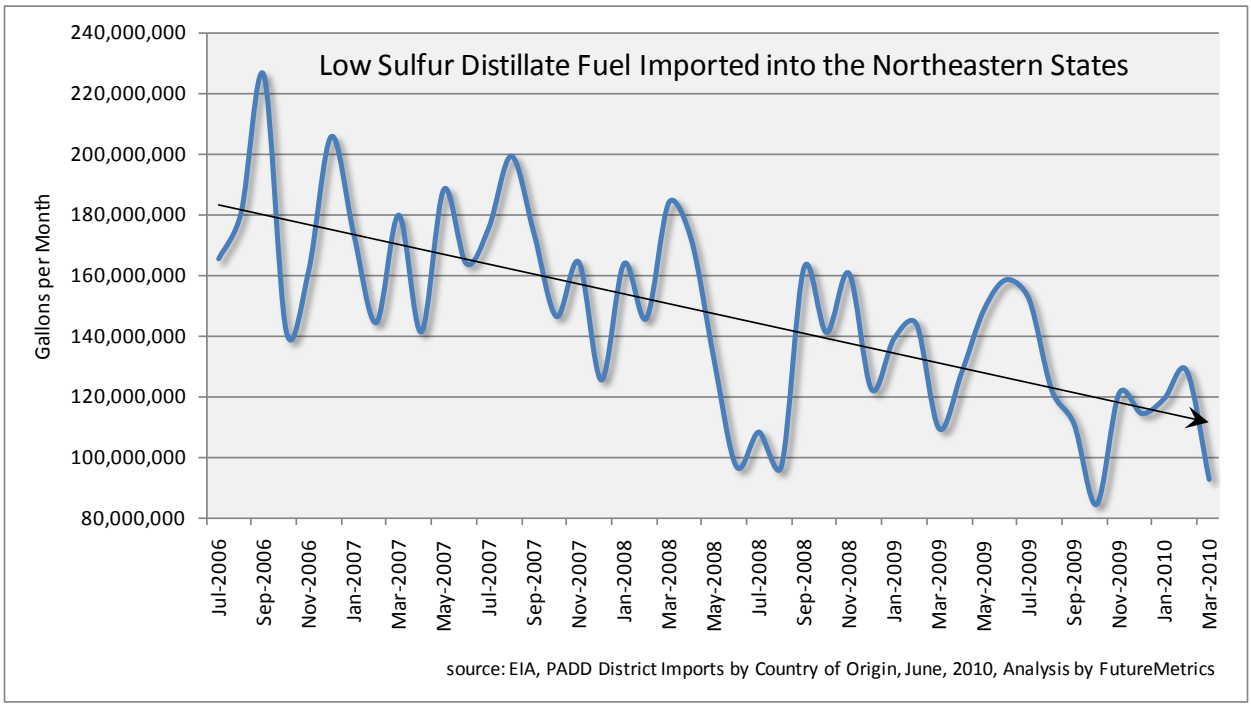
Diesel fuel and #2 heating oil share almost identical characteristics. Their prices also track very closely as the next chart shows.



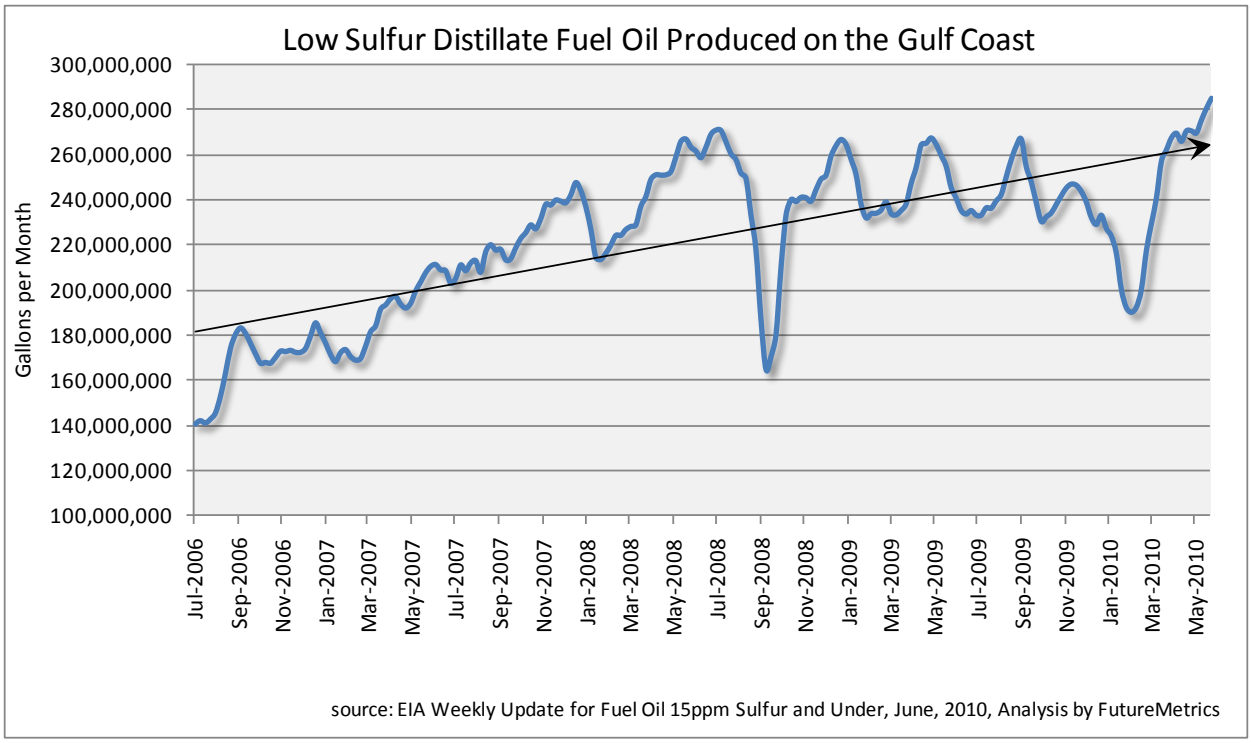
Heating oil is a small proportion of the total of the #2 fuels.



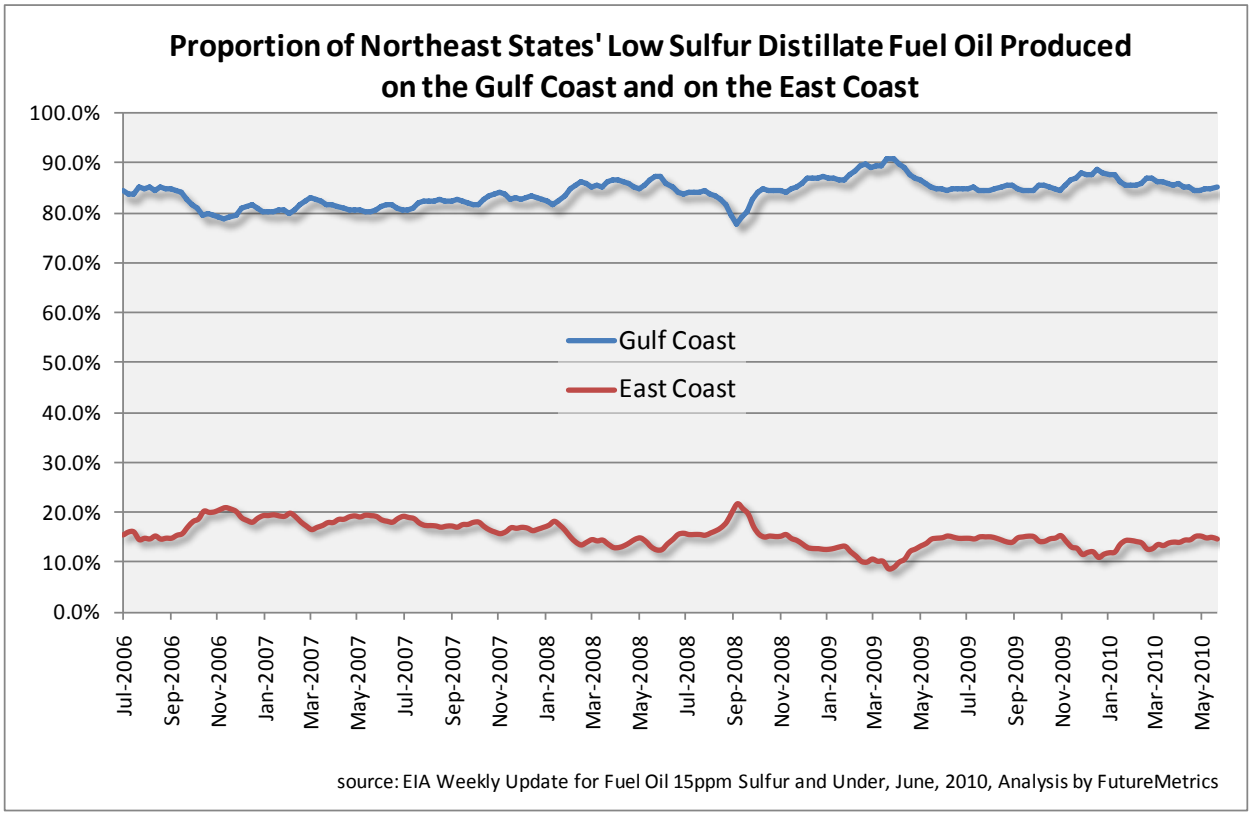
As the chart below shows, the average imports of distillate fuel oil into the northeast from foreign nations (most of which is from Canada) are declining.



The chart below shows that this decline in imported distillate fuel is being supplemented by Gulf Coast production.



Most of that domestic production of low sulfur fuel oil that is used in the northeast comes from the Gulf coast as the chart below shows.



The table below shows that offshore extraction in the Gulf of Mexico accounts for 8% of the total US crude oil production and almost all of the domestic offshore production[9]. The table also shows that about 21% of the crude oil refined in the Gulf Coast area is from domestic offshore production in the Gulf of Mexico (48 million barrels per month of a total of 228 million barrels per month entering Gulf

[9] EIA, Special Report, Gulf of Mexico Fact Sheet, June 15, 2010.

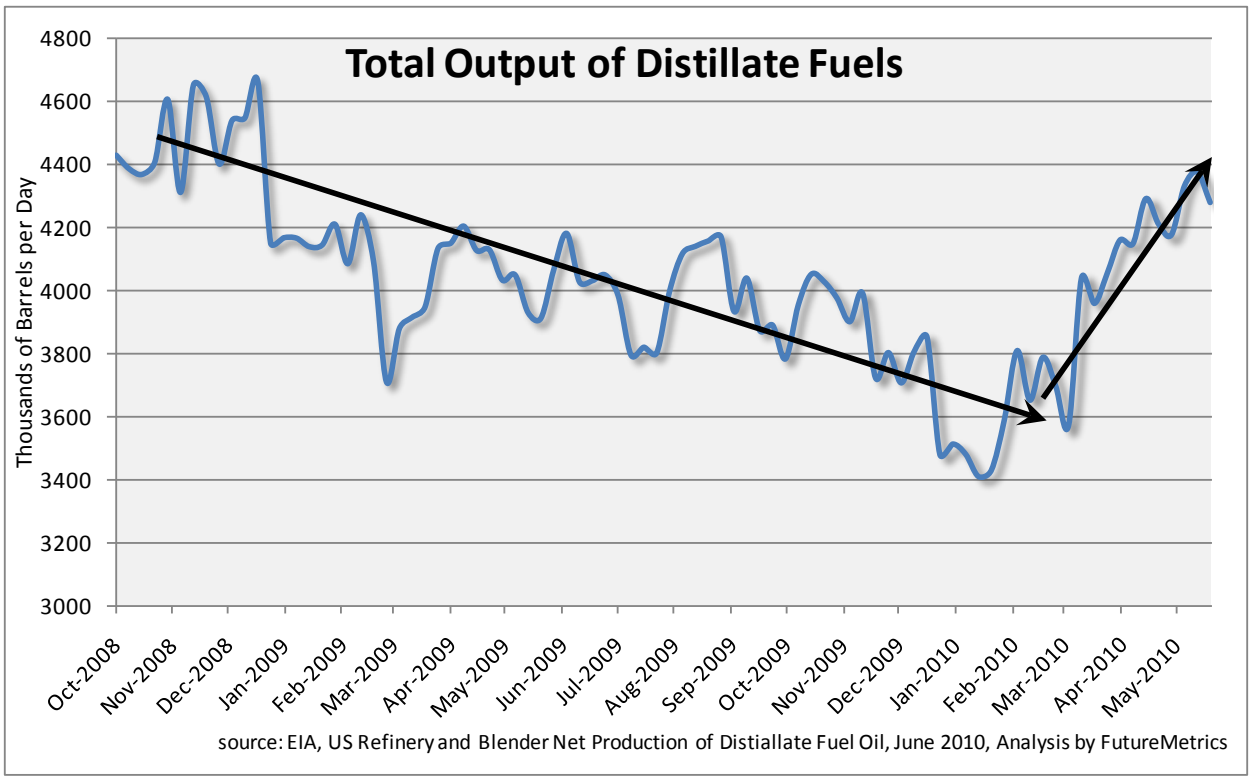
coast refineries). The rest is imported. About 60% of the imports are from OPEC nations, about 19% are from Mexico, and the rest of the imports are from a variety of nations in South America, Europe, Africa, and also Canada.

	Millions of Barrels Per Month	Share of Total U.S. Liquid Fuels Consumed
Domestic Liquid Fuels Production	273	49%
U.S. Crude Oil Production	159	28%
Total Offshore Production	51	9%
Gulf of Mexico Offshore Production	**48**	**8%**
Natural Gas Plant Liquids	57	10%
Refinery Processing Gain	30	5%
Biofuels	21	4%
Other	6	1%
Stocks Withdrawn	-3	-1%
Net Imports	291	52%
Gross Imports into Gulf Coast	**180**	**32%**
Total U.S. Liquid Fuels Consumed	561	100%

The Economic Vulnerability of the Northeastern State's Economies due to Heating Oil Dependency

Since most of the northeast's heating oil is refined in the Gulf area and the flow of crude into these refineries is strongly dependent on offshore production in the Gulf of Mexico, the price of heating oil in the northeast would be adversely affected by a disruption in domestic offshore crude oil flows.

Another price risk is due to the essentially identical characteristics of low sulfur diesel fuel and heating oil. #2 heating oil production and diesel fuel production come from the same fraction in the crude oil cracking process. The quantities of heating oil, diesel fuel, jet fuel (kerosene), and gasoline made from a barrel of crude are determined by the refiner responding to market pressures (see the appendix for a brief on cracking crude oil and how refiners can vary the output). As the US economy rebounds from the recession, demand for transportation fuels (gasoline, jet fuel and diesel fuel) will increase as the chart below suggests is already occurring. This will also put upward pressure on heating oil prices.

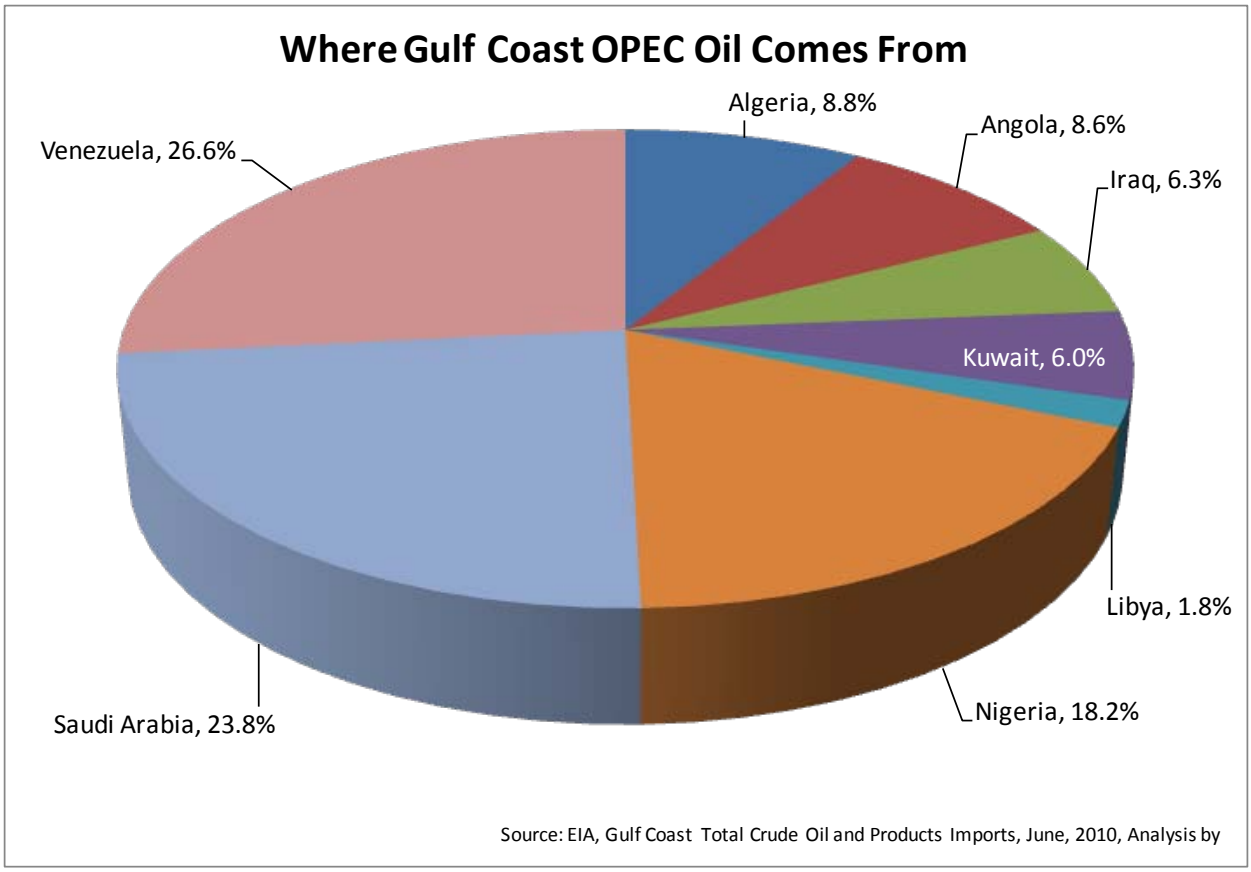


Also, as a result of the recent oil spill disaster in the Gulf, it is likely that increased safety requirements in the Gulf and in other offshore locations will also increase the cost of extraction. This will also put upward pressure on heating oil prices.

Heating oil prices in the northeastern states are connected to the flows of the offshore wells in the Gulf of Mexico. But the northeastern states are also directly and indirectly heavily dependent on imported oil. They are directly dependent due to already refined distillate imports from Canada and indirectly dependent due to the reliance of Gulf coast refineries on foreign crude.

The majority of the heating oil refined in the Gulf refineries is from crude imported from overseas. Of all of the Gulf coast imports, 56.9% are from OPEC nations[10]. The breakdown of the sources of the OPEC crude oil is shown on the chart below. Note that Venezuela's "heavy" oil is more than ¼ of the total OPEC imports. Nearly half of the non-OPEC imports are from Mexico and the rest are from a variety of nations in South America, Europe, and Africa.

[10] EIA, Gulf Coast Total Crude Oil and Products Imports, June, 2010.



If either the domestic or the foreign flow rates were to be disrupted, the economic effects on the northeastern states would be dire.

The northeastern states already suffer economic harm due to their dependency on #2 oil for heat. The table below shows how much money is lost to the state's economies due to heating oil dependency[11].

#2 Distillate Fuel use in Residential, Commercial, and Industrial (not Transportation)	Average Gallons per Year	Money Exported from Regional Economy at $2.75/gal	Money Exported from Regional Economy at $4.50/gal	Annual Increased Loss of Money if Heating Oil goes to $4.50/gal	Permanent Increase in Jobs Lost
Maine	414,493,000	$889,087,485	$1,454,870,430	($565,782,945)	-32,777
Vermont	130,435,000	$279,783,075	$457,826,850	($178,043,775)	-10,091
New Hampshire	242,029,000	$519,152,205	$849,521,790	($330,369,585)	-17,867
Connecticut	672,464,000	$1,442,435,280	$2,360,348,640	($917,913,360)	-43,842
Rhode Island	148,551,000	$318,641,895	$521,414,010	($202,772,115)	-9,685
Massachusetts	818,841,000	$1,756,413,945	$2,874,131,910	($1,117,717,965)	-54,867
New York	1,818,841,000	$3,901,413,945	$6,384,131,910	($2,482,717,965)	-117,823
Pennsylvania	840,580,000	$1,803,044,100	$2,950,435,800	($1,147,391,700)	-54,452
New Jersey	459,420,000	$985,455,900	$1,612,564,200	($627,108,300)	-29,761
	5,545,654,000	$11,895,427,830	$19,465,245,540	($7,569,817,710)	**-371,165**

[11] EIA, Residential Heating Oil Prices: What Consumers Should Know, 2010, shows that 78% of every dollar spent on heating oil does not stay in the regional economy. It pays for the crude oil and the refining.

The nine states are already exporting almost $12 billion per year. That is money that is permanently lost to the regional economies. If a supply disruption occurs and/or global demand outpaces supply and heating oil prices were to rise to $4.50 per gallon (a rise of $1.75 from today's prices to where they were in mid-2008), the nine states will then export more than $19.4 billion per year; an increase of more than $7.5 billion per year that would be drained from those state economies.

Using detailed job multipliers[12] to estimate the effects of changes to jobs given changes in final demand, the estimated jobs that will be permanently lost are shown in the far right column of the table above. More than 371,000 jobs will be lost due to the reduction in gross state products as money is drained from the states' economies.

Conclusion

The dependency of the northeastern states on #2 fuel oil for heat places these states in a uniquely vulnerable position. The heating needs of these states combined with their established high reliance on #2 oil makes them sitting ducks for extreme economic (and therefore social) harm if there is any disruption to the flow of #2 oil into the region. Those states with very high residential heating oil use proportions are particularly at risk to direct and indirect economic harm if homeowners' disposable incomes are significantly reduced by higher heating oil prices.

As this analysis has shown, that flow of #2 heating fuel into the northeast region is dependent upon several sources that are subject to uncertainty. However, the preponderance of likely changes suggest that there will be continued upward pressure on heating oil prices with the risk of large price spikes if there are interruptions in the flows.

The supply side risks to prices are regulatory (in response to the BP disaster), geopolitical (due to our reliance on crude from unstable nations), and geological[13].

Domestic demand side risks arise from the competition for the highest and best use of the hydrocarbon compounds in the crude oil. As the recession recedes, the demand for transportation fuels will compete with the demand for heating oil.

Although this brief has not discussed demand side pressures on global oil supplies, two charts sum up the risk. The first chart below[14] shows the change in oil consumption from 1999 to 2009. China has more than doubled its demand in the past 10 years. America was the world's biggest consumer of primary energy in 2009. It used 2.18 billion tons of oil equivalent (TOE). That was 5% less than in 2008, and that drop in demand contributed to a recession-driven decline of 1.1% in the world's energy usage.

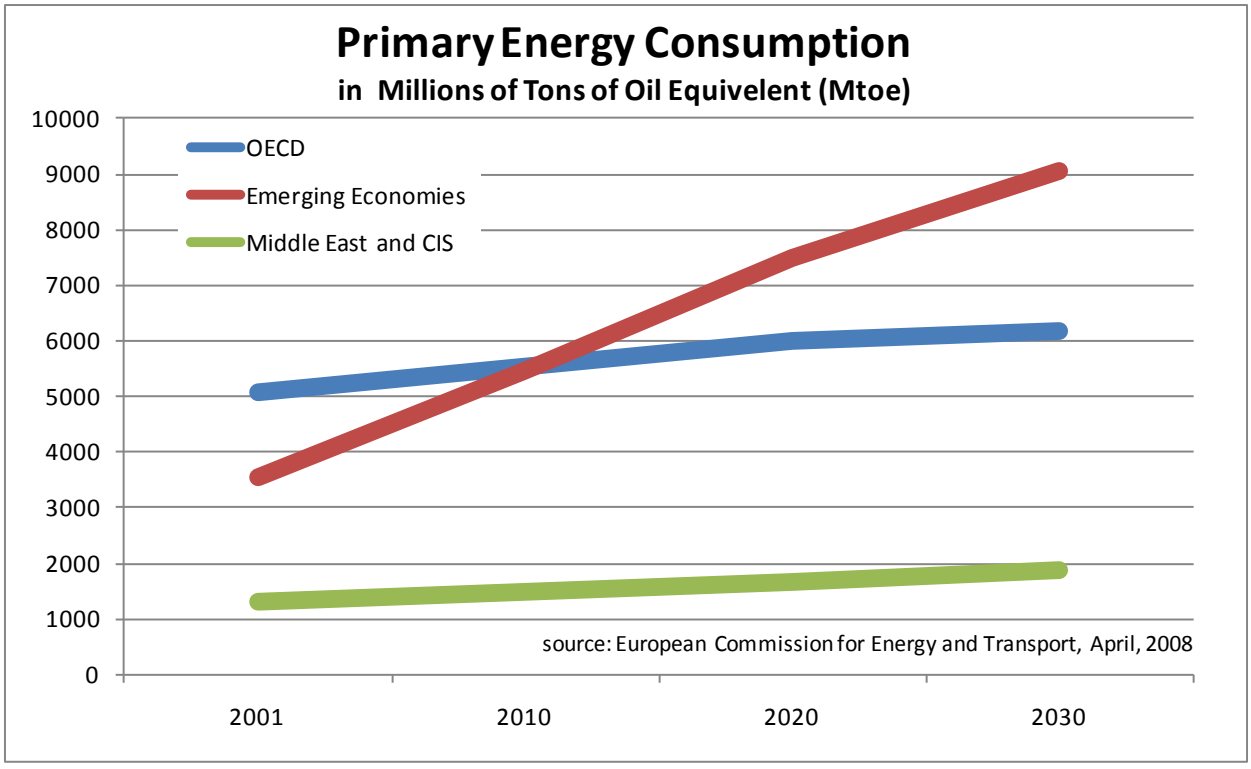
China's energy consumption however continued to grow last year, increasing by 8.7%. At the end of 2009 China was 5 million TOE less than America's (That was only 0.23% less than the US). When the data for 2010 comes in it will be clear that China will have become the world's largest consumer of primary energy.

[12] Job multipliers are based on detailed multiplier tables, by state, from the National Renewable Energy Laboratory, The Jobs and Economic Development Impact (JEDI) Model, revised in 2009.

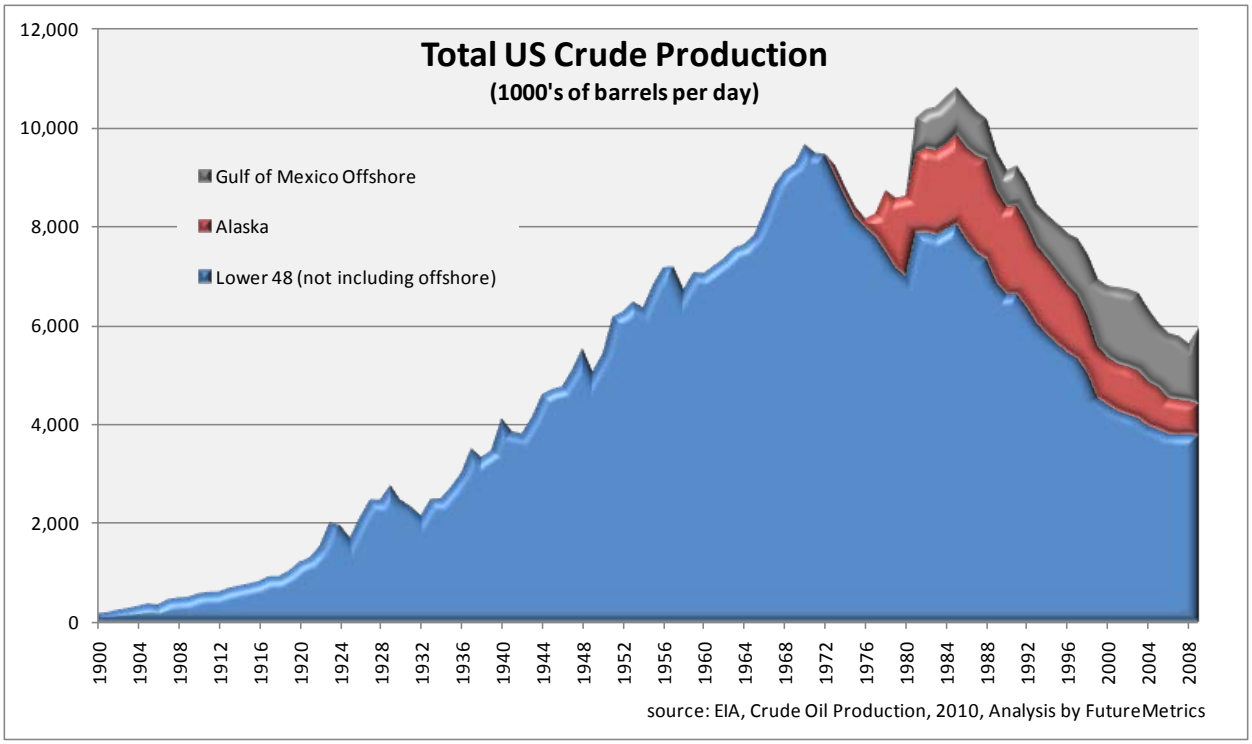
[13] A discussion of potential oil reserves and extraction flow rates is not within the scope of this brief. However, the risk over time is for both declining flows and increasing costs of extracting harder to reach reserves.

[14] Taken from the June 10, 2010 Economist Magazine.

The second chart shows the expected changes in energy demand for the next 20 years. The growing demand for energy will increase the prices for all non-renewable fuel sources.



Finally, the chart below shows that peak oil happened decades ago for the US. As a result, the US has become increasingly dependent on imported crude and therefore stability in the discovery, extraction, and transportation of crude from foreign nations. The northeast's economic well being is directly linked to that stability.



The northeastern states need to move quickly and decisively to lower and eventually eliminate their dependence on #2 heating oil. The consequences of inaction will be that an increasing proportion of the region's economic product will be siphoned away. This will depress growth and cause job loss.

The social effects will be most severe for the lower income residential segments. When heating oil was $4.50/gallon, almost 50% of the bottom deciles' household disposable income went to pay the heating bill.

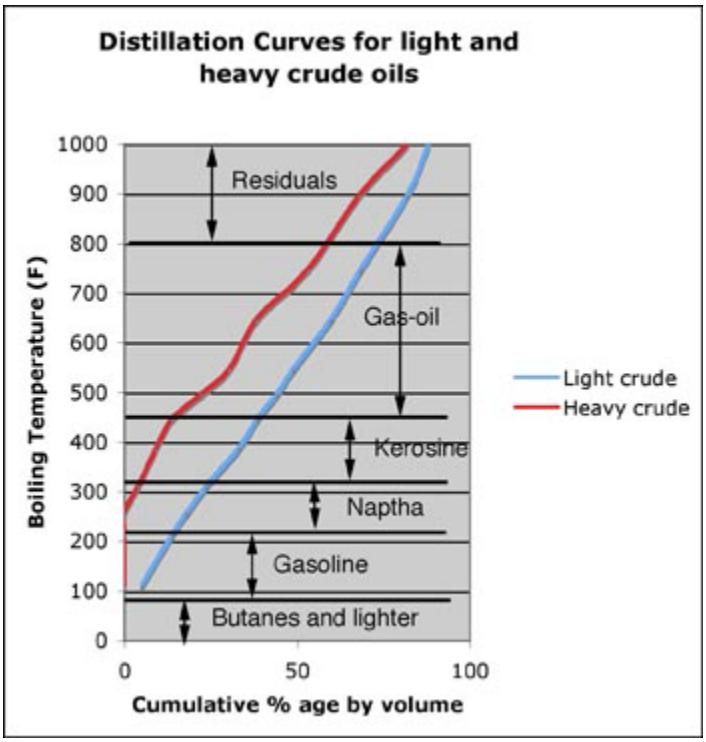
But the effects will be universally felt if nothing is done as the black hole of heating oil spending grows larger and more voracious; taking money and jobs away.

Appendix – How Crude is Made into Fuels

Crude oil is not made up of a single hydrocarbon. It is a mix of different hydrocarbons that have to be separated. Crude oils from different areas are formed as different combinations of these hydrocarbons.

As crude oil is heated, the lighter fractions boil off. By plotting the volumes emitted as the temperature increases, the make-up of that particular oil can be determined.

The blue line on the following graph[15] shows a typical light oil composition.



If the crude is a heavier version, then the fractions boil off at higher temperatures.

In the chart above there is no fraction boiled off until the temperature has passed 250 deg. In its untreated state, there is no natural gasoline in the oil. Heavy oil was close to the surface and those fractions evaporated away over millions of years (for example, the heavy oils in Alberta). So crude has to be further processed.

The processing is not only for heavy crude, but also for the heavier fractions of light crude, since in both cases the refiners would like to end up with about 45% gasoline. This requires that the refiner crack (or split) the higher "heavy" carbon molecules into lighter or lower carbon ones. For example a molecule of Cetane (16 carbon & 34 hydrogen atoms or C16H34) if heated to a high enough temperature will break down into Octane (C8H18), Hexane (C6H12) and Ethylene (C2H4).

After the crude oil has been separated into the different fractions by distillation, the heavier gas-oil fraction is then fed to a second heating process, where the fluid is brought back up to a high temperature (around 1400 deg F) and mixed with a catalyst. Steam is also added to help with the movement of the mix, and the combined mix is fed up a pipe (called a riser) into a tank and as it flows

[15] Chart from The Oil Drum, "Cracking Oil is not a Funny Business," March, 2006.

up and into the tank the gas-oil breaks down into the lower carbon molecules. Once the mix is in the tank, the heavy molecules have broken down, and so can be drawn off.

The hydrocarbons that flow out of the cracking process are then separated into different fractions, depending on the season more gasoline or distillate might be desired, but the process might yield about 8% coke, 55% gasoline, and 12% light gas oil with about 10% of the flow being a sufficiently heavy product that it is sent back to be run through the process again. Light gas oil becomes diesel and furnace fuel oil.

There are also contaminants such as sulfur which can be present in the crude oil. If the content is higher than 2.5% then the oil is called "sour". The sulfur must be removed.