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How the Northern States can Heat with Renewable Energy and Create Jobs and Economic Growth while Significantly Lowering Carbon Emissions:

And Why Natural Gas is not an Option for Millions of Homes and Businesses

By William Strauss, PhD, President, FutureMetrics -- December, 2013

When people talk about energy, particularly at the federal level, they think of electricity and transportation. In the northern states, those two large sectors account for about 65% of energy use. The other 35% is often ignored in policy discussions. It is the need for heating homes and businesses over the long cold winters.

The reason this matters is that for many the heat is produced from burning imported petroleum-based fossil fuel in boilers or furnaces. As this white paper will show, the negative economic and environmental impacts of this dependency are significant. But this paper will also show that the positive benefits that accrue from the conversion of homes and businesses from fossil fueled heating systems to renewable premium pellet fueled systems are significant.

This analysis will also briefly look at a serious problem that challenges our social stability: The economic mandate for growth in output and profits pushes businesses to minimize costs. Much of this cost minimization is taking place from the replacement of low and unskilled labor with automation. This paper will show how this marginalization of working class labor can be, at least in part, reversed by growing our bioeconomy and in particular the premium wood pellet sector.

This paper will focus on those homes and businesses that use petroleum-based fuel for heating. The reason for this focus is threefold: (1) Most of the petroleum used to make heating oil and propane is imported; (2) Natural gas penetration into many rural areas along the northern tier states will never happen due to low density populations, and (3) Petroleum fuel (and natural gas) use generates net new carbon in the atmosphere.

Natural Gas, Heating Oil, Propane, Wood Pellet Fuel and the Demographics of Thermal Energy

The most common fuel used for heating varies by state. In some states natural gas dominates. In some states heating oil dominates. For example, 68.7% of Maine's homes and business use heating oil and only 5.0% are connected to natural gas. In Illinois 79.7% are on natural gas[1].

[1] EIA state data, 2013. The northwestern states have low cost renewable hydro-electric power which makes electric resistance heating competitive with fossil fueled combustion boilers and furnaces. The Midwest and Northeast states not on natural gas depend on primarily depend on heating oil or propane.

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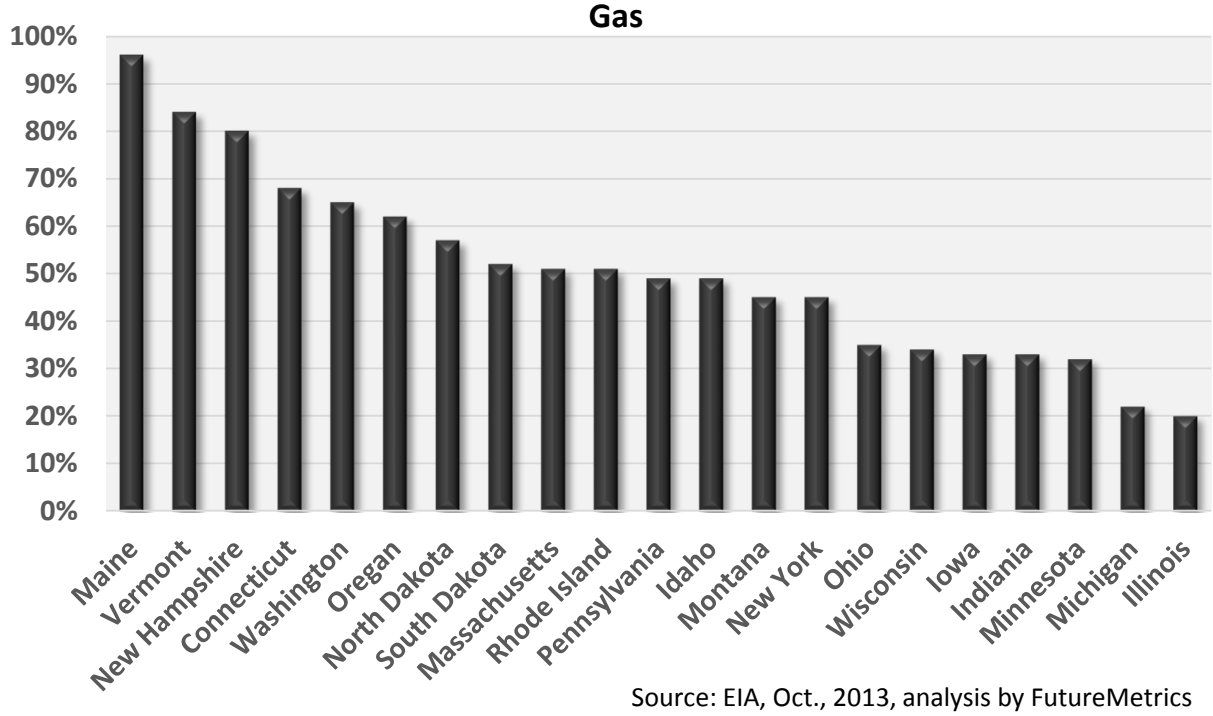
The states that will benefit the most from a conversion to premium wood pellet fuel[2] are those with the higher use of heating oil and the lack of natural gas infrastructure. The charts below show that in general the Northeastern states will benefit the most[3].



[2] Fully automatic high efficiency wood pellet boilers are common in Europe. They are beginning to penetrate the markets in the US. For an example of that see Maine Energy Systems at www.MaineEnergySystems.com.

[3] Note that wood fuel is used already in many states. The EIA is just beginning to quantify that in their Annual Energy Outlook. Much of that is cordwood used in somewhat inefficient wood stoves that have high particulate output levels. Premium pellet use in pellet stoves is significant in some northern states. However, this research is only using EIA data which does not, as yet, break out premium pellet use in boilers for central heating systems which is what will replace the fossil fuel used now.

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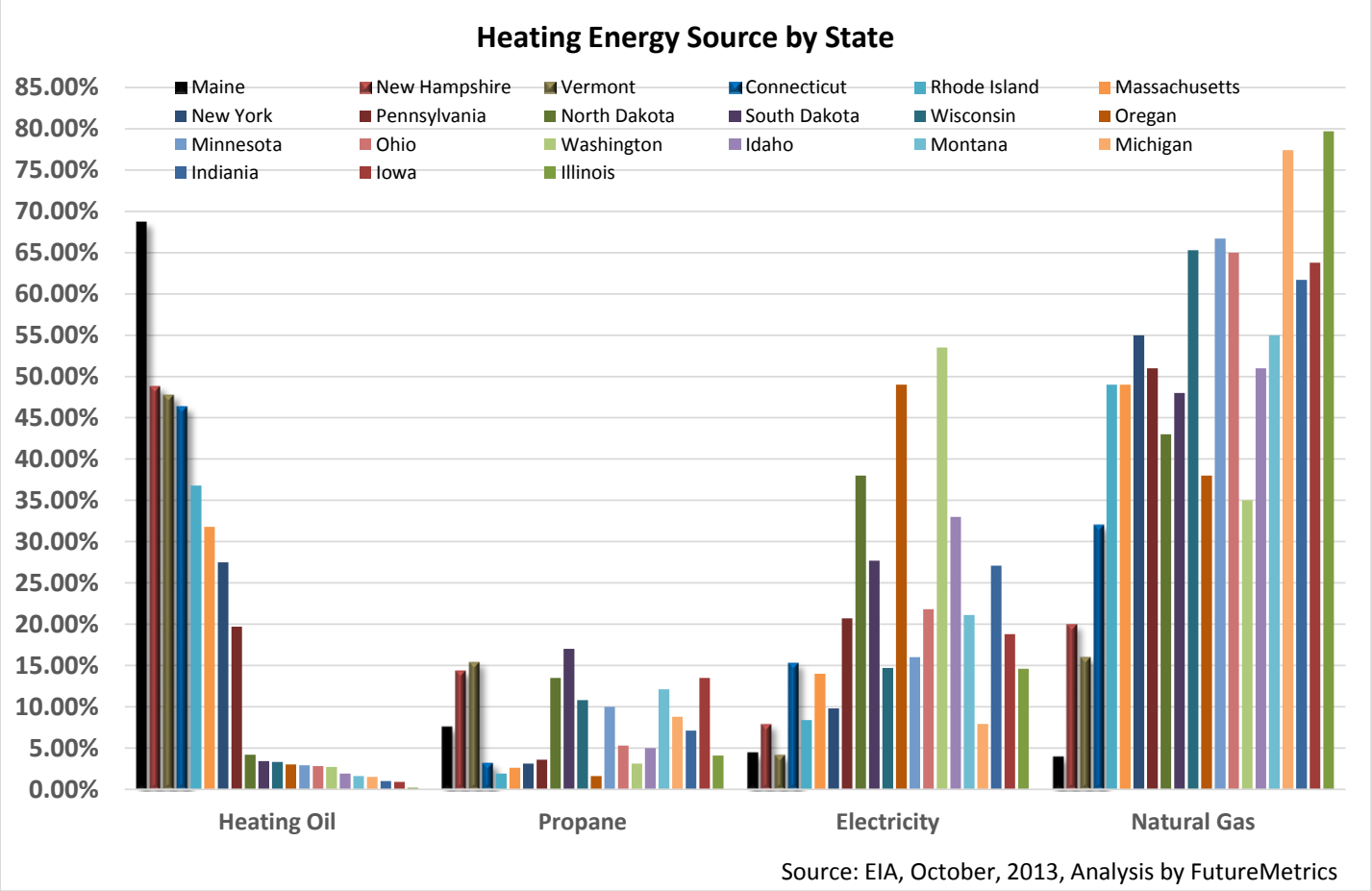

Source: EIA, October, 2013, Analysis by FutureMetrics

If heating oil were a product of US petroleum at least the money spent on heating would stay in the US. But most of the heating oil refined in the US for the Northeast markets is not made from US petroleum. Only about 19% of the Northeast's heating oil refined in the Gulf coast refineries comes from petroleum extracted from US wells[4].

Of that 81% imported into the US's Gulf of Mexico refineries, 52% is from OPEC. The rest comes from Mexico and a variety of countries including Columbia[5].

That OPEC oil comes from the countries in the chart below.

[4] EIA, Gulf of Mexico Fact Sheet, July, 2013.
[5] EIA, Total Crude Oil and Products, Gulf Coast, June, 2013.

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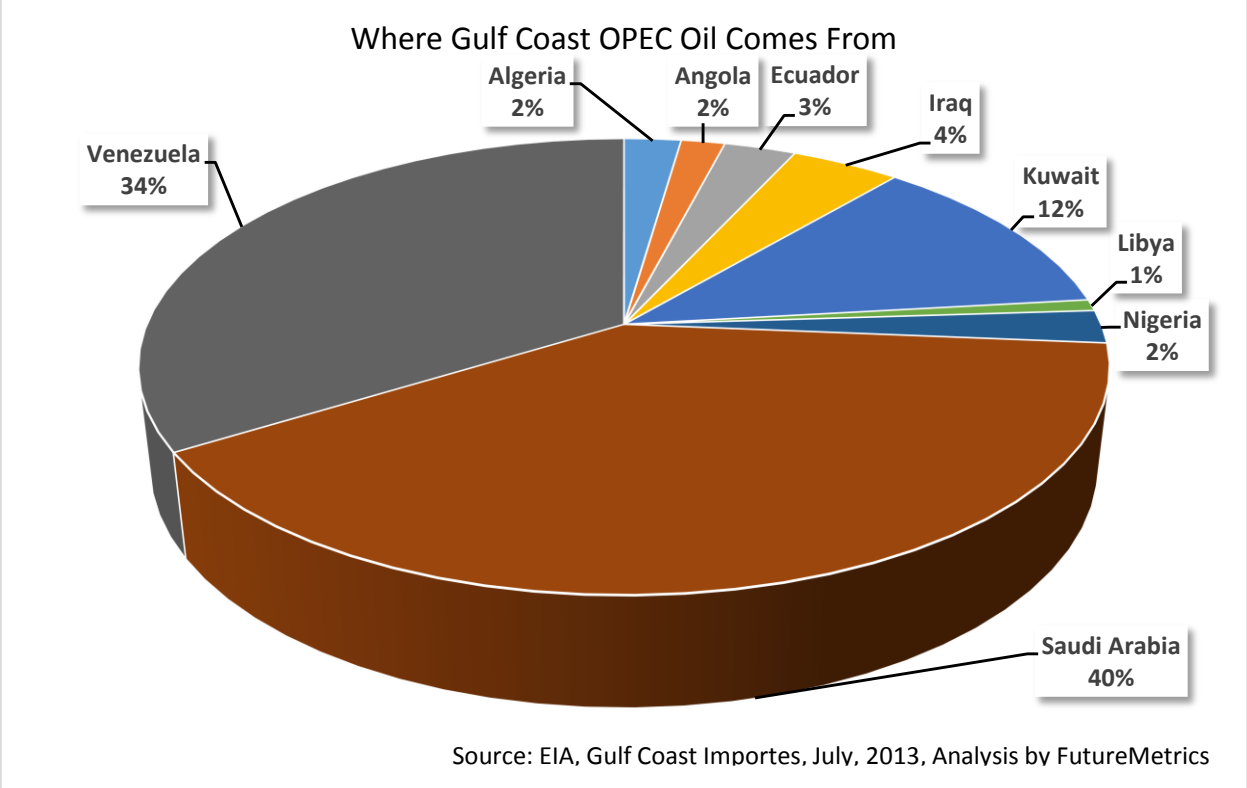
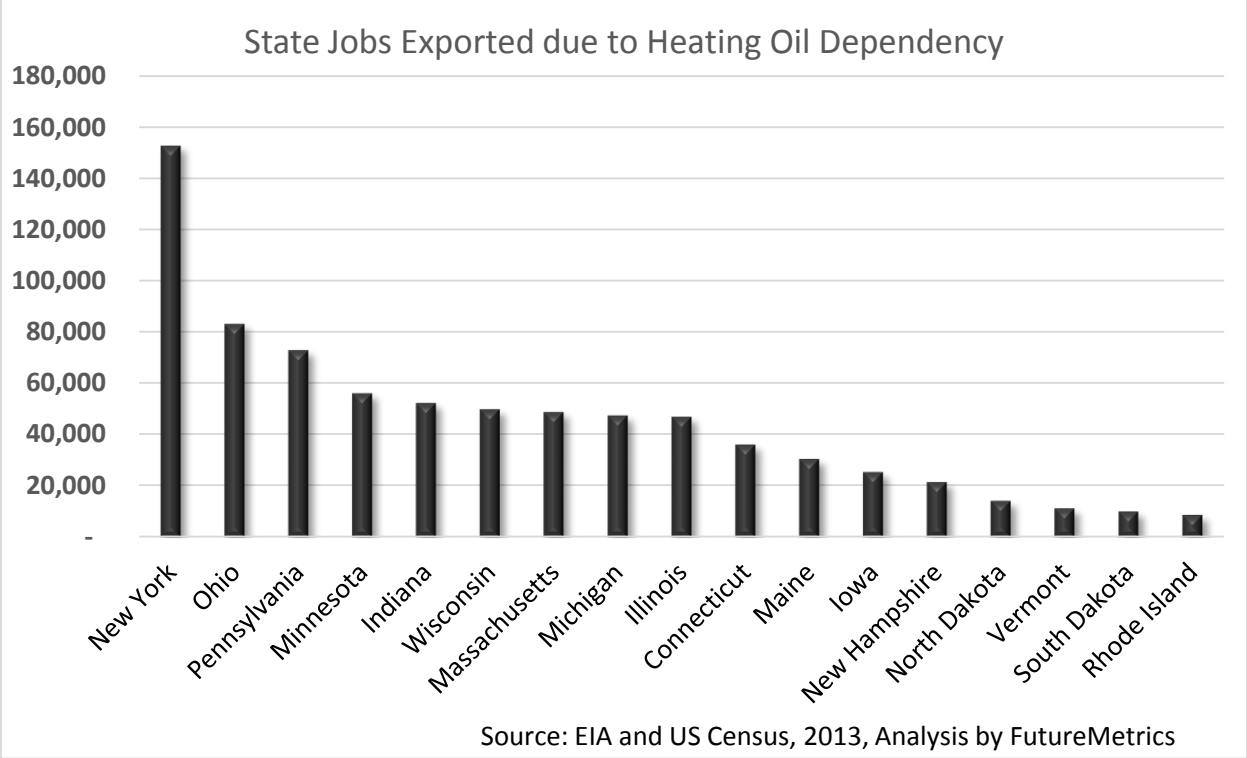


For those northern states that are heating oil dependent, the majority of every dollar spent on heating fuel leaves the local economy and much of that money spent on heating leaves the country. At a price of $3.80/gallon FutureMetrics estimates that about 770,000 jobs are exported to the other countries that supply the petroleum for the heating fuel used to keep the northern tier states' homes and business warm[6].

[6] This estimate excludes those areas that already heat with natural gas or electricity and those areas that are likely to get natural gas. The discussion below elaborates on potential natural gas penetration.



Domestically produced natural gas at least keeps the money from being exported. But how far can natural gas penetrate into the heating market?

A very optimistic scenario might suggest that by 2020 most urban centers will have natural gas. But that will leave a lot of homes and business on heating oil or propane. The chart below shows the relationship between natural gas penetration and the proportion of the population that lives in rural areas[7].

[7] Defined by the US Census as towns with populations of less than 2500 or not living in a town.

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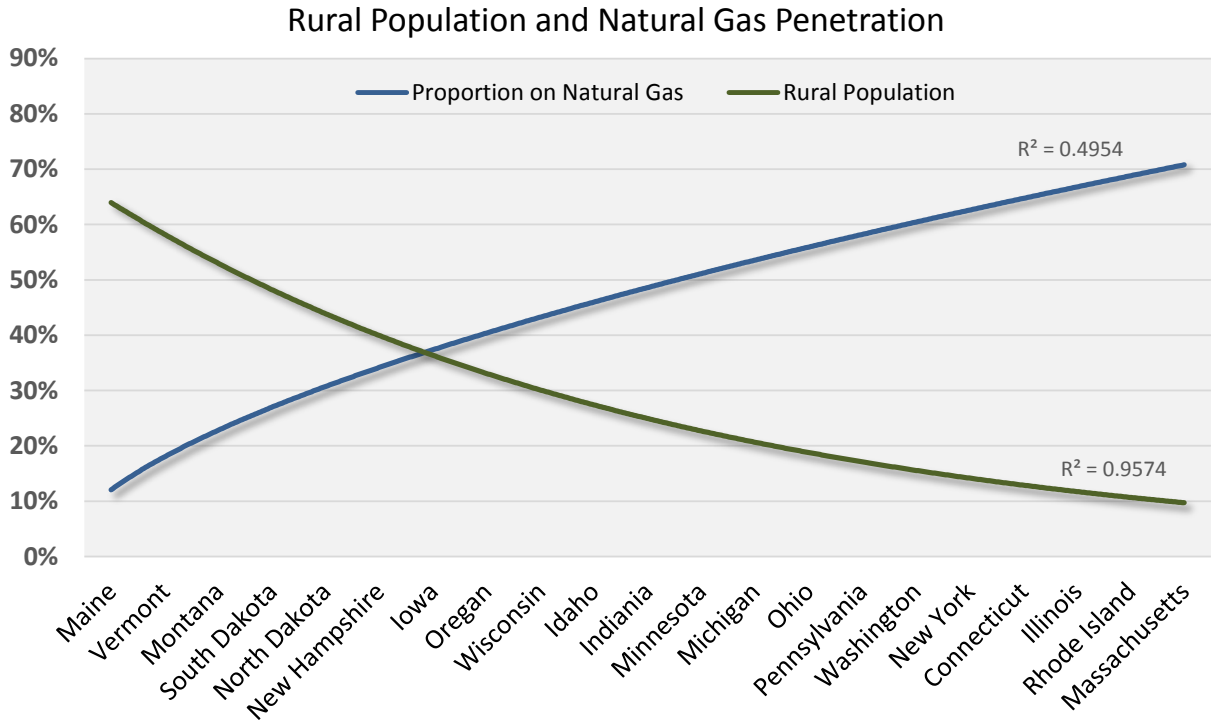

Source: EIA and US Census, 2013, Analysis by FutureMetrics (curves are fitted to the data)

The next chart shows the number of households (not including businesses) in the northern tier states that are in rural areas that are not on natural gas. Most of those households will never see a natural gas connection. Running natural gas pipes to low density rural populations is highly unlikely. There is no business case for spending millions on pipelines for a few homes per square mile. These chart below assumes that 80% of rural areas will not be connected to natural gas. It also excludes those already using electricity.

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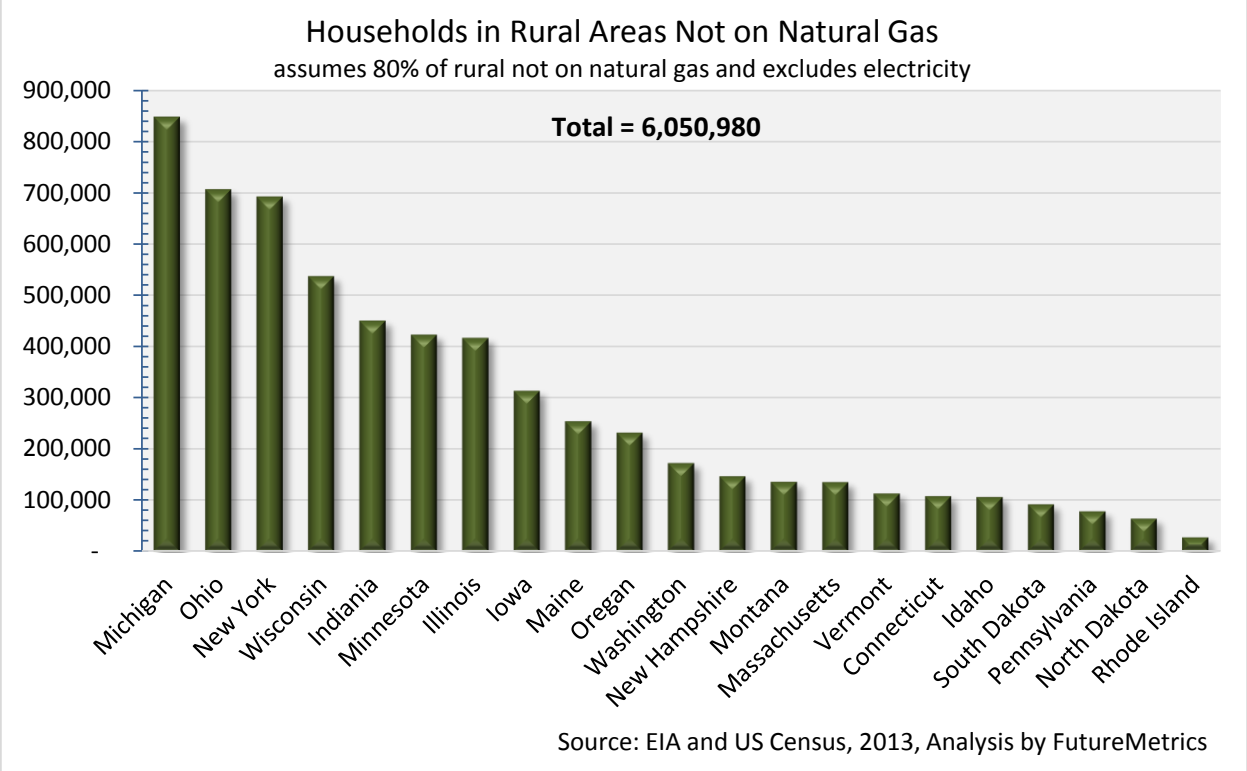

Many of the states on the chart above also have robust forest products industries and long histories of responsible working forest stewardship.

The state of Maine alone has sufficient sustainable wood supply in excess of current demand to heat nearly every Maine home represented in the chart above[8].

It would be irresponsible, given the demands by pulp and paper and lumber manufacturers, to suggest that there is sufficient sustainable forest feedstock today to heat 6 million homes[9]. But the world is changing and the primary demand for fiber from our working forests, paper making, will change dramatically in the coming decade.

[8] Sustainable is defined as never harvesting more in a given year than the growth rate. For example, the working forests in Maine produce about 20 million tons per year of new growth. The state harvests about 16 million tons per year for pulp and paper production, sawlogs for lumber production, and other uses. The Maine working forests are growing faster than they are being harvested. The average home in Maine, based on heating oil consumption, would use about 8 tons per year of pellet fuel for its central heating system. That works out to about 2 million tons per year of pellets for all 253,700 households in rural areas that currently use heating oil or propane. Producing 2 million tons per year of pellets requires about 4 million tons per year of harvest. Furthermore, as demands for paper change in the future, the traditional pulp and paper industry, which currently uses about 10.8 million tons per year in Maine, will likely see declines in their use of wood. (Data from EIA and Maine Forest Service. Analysis by FutureMetrics)

[9] An analysis by the Biomass Thermal Energy Council in 2010 determined that there was an excess of about 14 million green tons of wood in the New England states. That would be sufficient to heat about 1,000,000 homes. Demand by pulp and paper mills in those states exceeds 15 million green tons per year.

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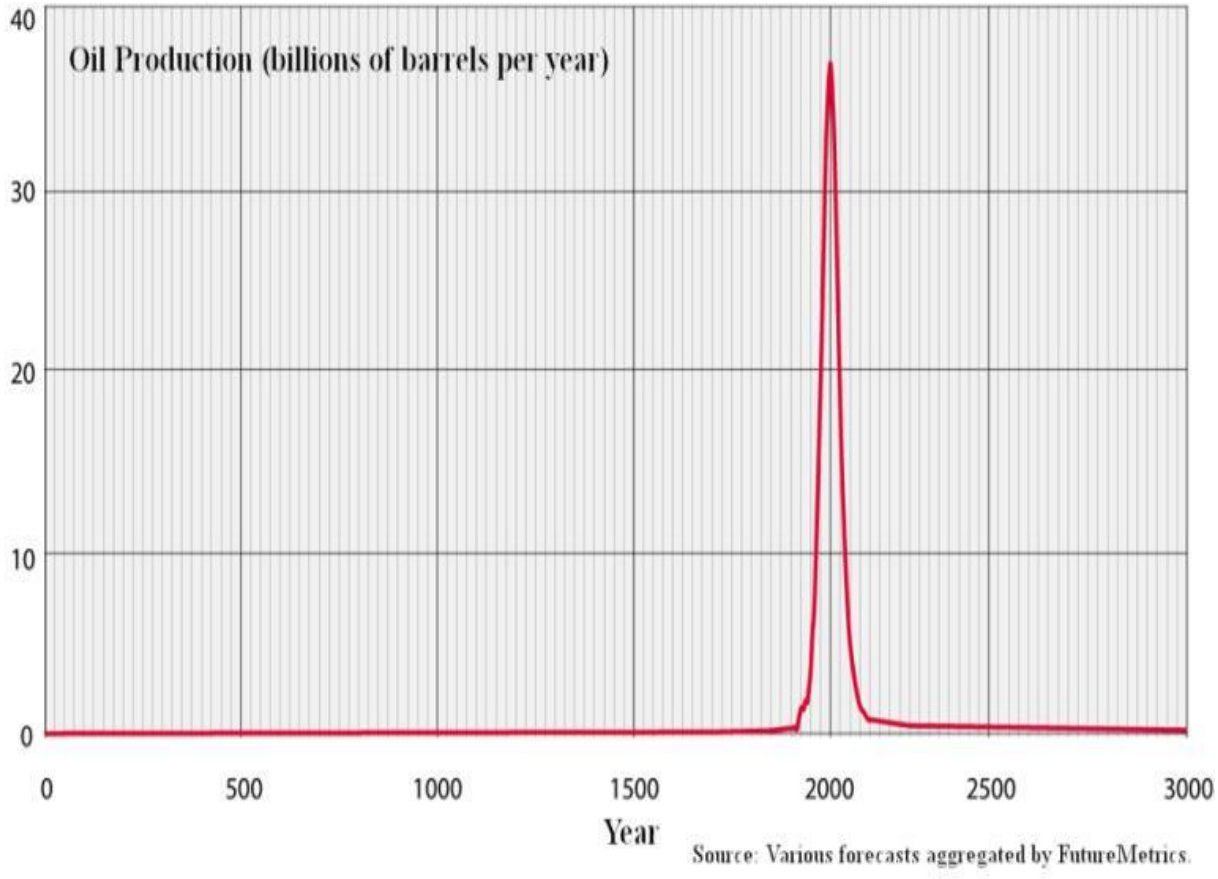
No one can accurately predict how fast and how far the drop on demand for paper will go but there is no doubt that it will drop.

Dependence on fossil fuels is a dead end policy; but responsible sustainable use of our working forests for energy is good for the economy and the environment

The following chart illustrates the history and the future of petroleum based fuels (note the time line is the year zero to the year 3000!). We cannot be sure if the return to the bottom is the year 2060 or 2080 or later, but unlike sustainably managed bioenergy feedstocks, it is a finite non-renewing source of energy that will deplete.



The conversion of homes from heating oil to locally-made premium wood pellet fuel has many benefits. The benefits accrue from three key pathways: (1) More than 75% of each dollar spent on heating oil does not stay in the local economy. Jobs are exported along with that money. Locally produced pellet fuel keeps almost 100% of every dollar spent circulating locally; (2) Pellet fuel is about half the price of heating oil for the same heating energy. Those savings increase the income that households and businesses have for spending in the local economy. The increased disposable income that homes and businesses have after conversion is money that stays in the local economy and creates commerce and

jobs. (3) The supply chain for harvesting sustainable biomass and for manufacturing and distributing the fuel creates jobs. All of these pathways have significant positive multiplier effects[10].

The environmental benefits are also significant. Particulate emissions from modern fully automatic pellet boilers are about the same as heating oil boilers. And carbon emissions are much lower. Every pound of carbon dioxide produced in the combustion of pellet fuel is reabsorbed by the new growth in the sustainably managed forests from which the fuel originated. Accounting for the fossil fuel used in logging and trucking and electricity production for running the pellet refinery, pellet fuel has 87% lower carbon emission than heating oil and 80% lower carbon emissions than natural gas[11].

The job creation effects from the conversion from heating oil and propane to premium regionally produces wood pellet fuel are significant.

Creating need jobs for low and moderately skilled workers should be a major component of an energy policy; and the premium pellet market delivers on that.

The Importance of the Domestic Premium Pellet Sector: Job Creation that also Yields Aggregate Economic Gain

Our economic system rewards higher productivity. That incentive has a negative effect on the demand for labor: If profit margins can be improved by lowering the unit cost of labor per unit of output (either with lower wages or fewer workers, or both), a strategy to do so will by followed.

The US, in its quest for maximizing profits, has improved labor productivity dramatically. But the impact on aggregate employment in the US is troubling.

The chart below shows how, from 1990 to Q3 of 2013, our GDP, measured in real 2009 dollars, has grown by about 76% while the number of workers employed has grown by about 22%.

The chart also shows how output, after the great recession of 2008, returned to the 2007 level in 2012; but about 6 million fewer people were employed to get the same level of GDP. In other words, from a purely economic perspective, those 6 million workers were no longer needed.

[10] The positive multiplier effects are counter to the negative multiplier effects that are the result of money being drained from the economy when homes and business's purchase heating oil or petroleum-based heating oil. FutureMetrics uses IMPLAN modeling for calculating the multiplier effects.
[11] Life Cycle Assessment of Pellet Burning Technologies, Thomas Willem de Haan, University of Amsterdam, June 2010.

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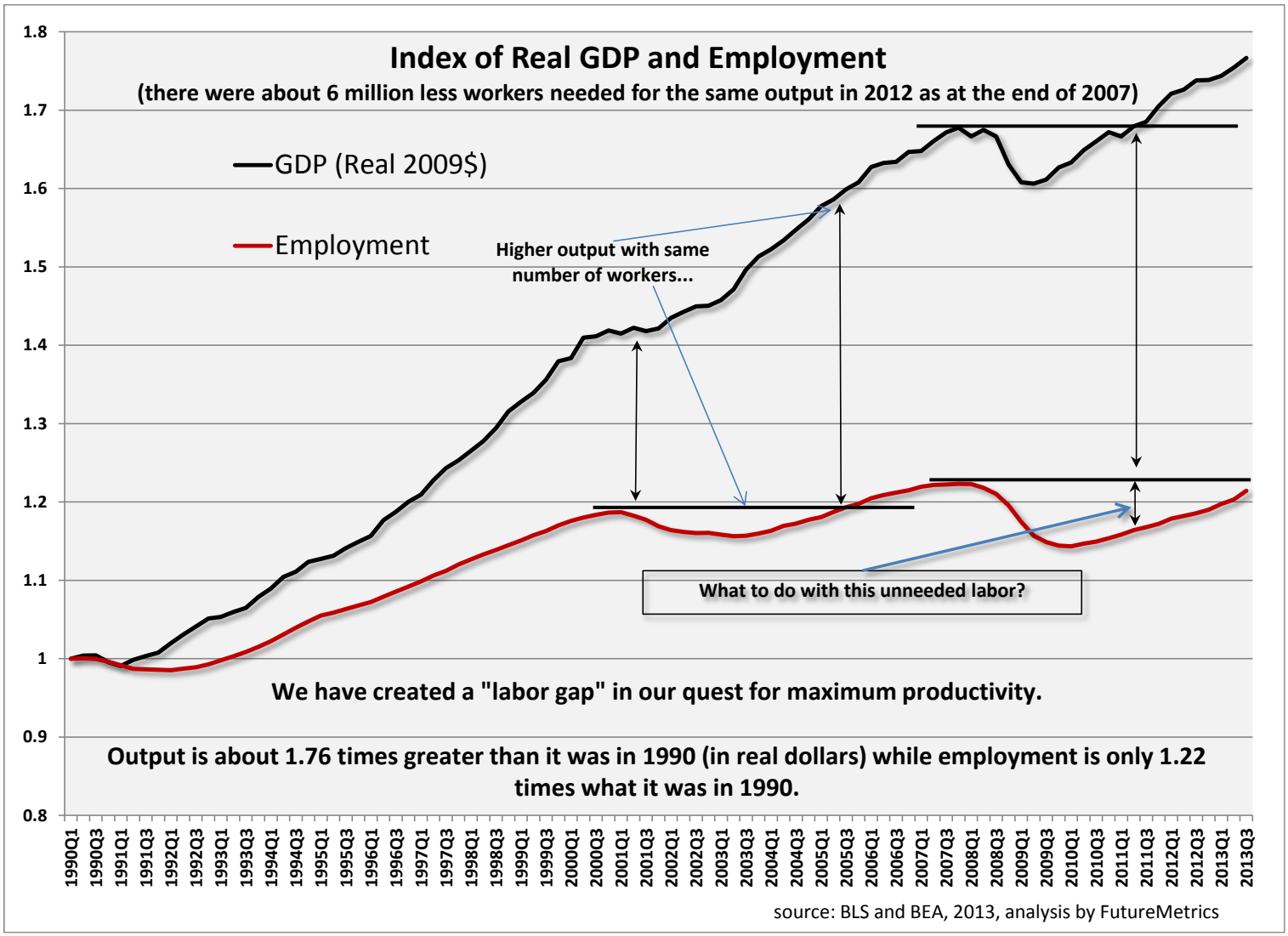

source: BLS and BEA, 2013, analysis by FutureMetrics

This labor gap has serious implications for social stability as a growing segment of the US population is marginalized from the labor market.

The solution to that issue is a challenge for policymakers in the US and for the global economic system in general[12].

But there is one solution that exists now that can contribute to a socially, economically, and environmentally positive outcome: The pellet heating market not only creates jobs but also has strong positive environmental effects.

[12] For a comprehensive view of this issue read "The Myth of Endless Growth". A book by Dr. William Strauss, the author of this white paper.

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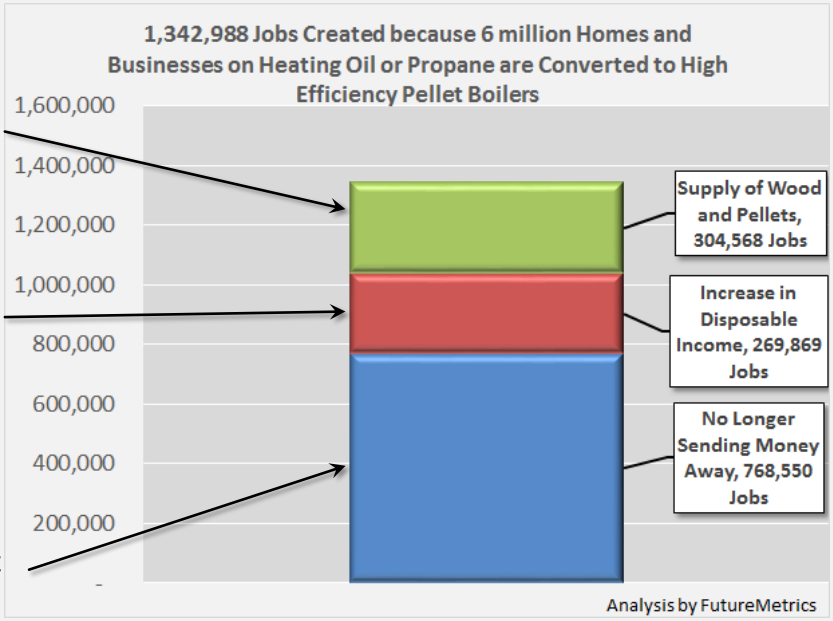
The ability to produce premium pellets for the domestic markets in large quantities already exists. But most of the pellet production in the US (and Canada) is going into the industrial utility pellet market[13]. However, even premium heating pellets that could be used in high efficiency wood pellet boilers in the US are being exported to Italy and other EU countries by the hundreds of thousands of tons per year.

To illustrate the very significant job creating benefits, assume that all 6 million homes in rural areas that use heating oil or propane were to convert to domestically produced premium wood pellets. The chart below shows the forecasted job effects.

There are Three Pathways for Job Creation

- ✓ The sustainable management, harvest, transport, and refining of wood into pellets creates jobs.
- ✓ The dramatic cut in heating costs leaves, on average, $1,500 per year in the pockets of homes and businesses. Most of that money is spent in the local economy and creates commerce and jobs.
- ✓ The money that is spent on domestically-made heating fuel stays here. The wealth and jobs that were "exported" to places like Venezuela and Saudi Arabia stays in the states.



That is 1.35 million more jobs that will otherwise not be created in the US if those homes and business remain on heating oil and propane.

Why Wood Pellets Produced from Sustainable Sources are Carbon Neutral in Combustion

Most of the developed world has moved past the debate on whether or not geologic carbon released from the combustion of fossil fuels is driving climate change and ocean acidification. There is uncertainty over how quickly and forcefully changes in atmospheric CO_2 levels will drive climate change and the lowering

[13] The US and Canada exported 5 to 6 million metric tons of industrial wood pellets to the UK and EU in the past year and is expected to export 12 to 20 million tons per year by 2017. Source: Hawkins Wright, US Industrial Pellet Association presentation, October, 2013.

of ocean PH levels, but there is nearly unanimous consent that dramatic changes are occurring now and will occur in the future as a result of fossil fuel combustion.

The net carbon emissions from burning pellet fuel depends on the fossil fuel used in the supply chain (which is also part of the carbon footprint of heating oil and propane). But the thesis that pellet combustion is worse than fossil fuels wrong.

The overarching necessary condition for reaping carbon benefits from wood-based fuels is that the wood must be from sustainable sources. "Renewable" energy is not renewable unless it renews! If there is any validity to a model that has carbon cycling from atmosphere into trees and back into the atmosphere, the stock of trees must remain constant or growing. Depleting the forests for energy is not renewable. A shrinking forest is a net carbon source.

Fortunately, the US forest products industry has a long history of managing forests for sustained yield. In some states the majority of the managed forests are certified sustainable by either FSC or SFI[14].

The most serious flaw in research that shows that carbon emissions for wood combustion adds to the stock of atmospheric carbon is the timing of their carbon cycle assumptions. Many of the models that show that wood combustion is worse than fossil fuel combustion begin the story at the moment the wood is harvested[15]. This perspective is flawed and does not represent the real world of pellet production[16].

Ignoring fossil fuel combustion and assuming a stable forest stock, the carbon in the trees is part of a net stock of non-geologic carbon on the planet that is in equilibrium. When sustainably managed and contemporaneously renewing forest crops are harvested, refined, and used as fuel, no new carbon from combustion is released[17]. What is released used to be in the atmosphere before the new growth captured it.

All of the studies that show that wood-to-energy adds to the carbon stock of the atmosphere assume a carbon debt is created that has to be repaid by new growth over 30 to 80 years (or more is some studies).

The chart below shows the correct frame of reference for a forest that is sustainably managed. The chart shows the carbon cycle for one harvest.

[14] FSC = Forest Stewardship Council; SFI = Sustainable Forestry Initiative.

[15] For example: Manomet Center for Conservation Sciences, "Massachusetts biomass sustainability and carbon policy study: report to the commonwealth of Massachusetts Department of energy resources", 2010. And, "The outcome is in the assumptions: analyzing the effects on atmospheric CO2 levels of increased use of bioenergy from forest biomass", from Global Change Biology Bioenergy, 2012.

[16] See the report by the US Industrial Pellet Association at http://www.theusipa.org/Documents/biomass_study_23092013.pdf

[17] The harvest, refinement, and transport of wood base fuels does require fossil fuel (diesel for trucking, heavy oil for shipping, and electricity from coal or gas for pelletizing. A life cycle analysis of pellets has a component of carbon emission from those activities. Fossil fuels also incur extraction, transportation, and refining carbon debts. But sustainably managed working forests used for premium wood pellet fuel do yield a carbon neutral outcome in combustion.

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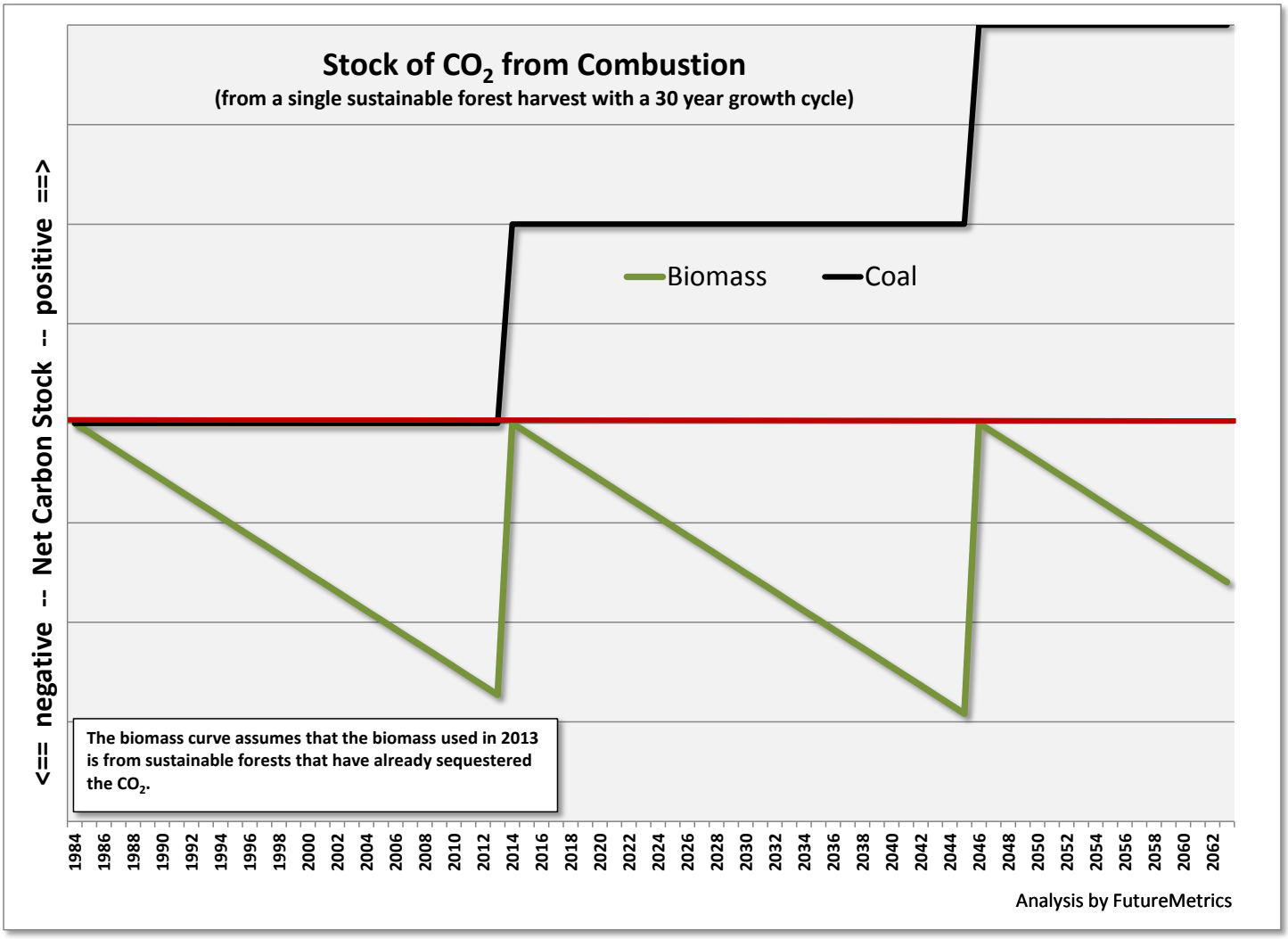

In the FutureMetrics model, the forest grows at a rate of one ton per acre per year[18]. Our model forest is 100,000 acres[19]. That means that each year there is 100,000 tons of new growth. The chart assumes that this year's 100,000 tons harvest started growing 30 years ago in 1984. Note that the net carbon stock of the atmosphere is reduced over those thirty years as the new growth absorbs carbon. This is shown by the downward sloping green line. In 2013 when this year's 100,000 ton harvest is combusted as fuel, the previously sequestered carbon is released. The cycle is repeated in 2045.

But the carbon does not have to wait until 2045 to be removed from the atmosphere. The new 100,000 tons that grows in 2013 captures all of the carbon released as long as the net stock of wood on the 100,000 acres of forest is not diminished.

[18] Northern forests grow a slightly above that rate. Southern forests grow at a significantly higher rate.
[19] The US and Canada have over 480 million acres of certified sustainable forestland. From "Sustainable Forestry in North America", Wood Products Council, April, 2012.

In contrast, if the same amount of energy is released from coal in 2013 and 2045, the net stock of atmospheric carbon is permanently increased. This is shown by the black line.

This white paper is focused on heating oil and propane. The CO_2 emissions profiles are different than coal but the underlying concept is identical. Premium wood pellets are carbon neutral in combustion while fossil fuels add to the net stock of CO_2 in the atmosphere and to the acidification of the oceans.

The conversion of 6 million homes and businesses from heating oil to premium wood pellet fuel would reduce net carbon emissions in the US by 81,600,000 tons per year[20].

Conclusion

This white paper has identified a significant market that will never be served by natural gas pipelines and which is dependent on heating oil primarily refined from foreign petroleum and propane. About 6 million homes in the US northern states are in rural locations (will not have natural gas) and use heating oil or propane.

The paper has also shown that the economic impacts that would accrue from the conversion of homes and businesses from heating oil or propane boilers to premium pellet fuel used in modern pellet boilers is very significant. About 1.34 million jobs will be created when those 6 million homes are fueled with domestically produced renewable premium wood pellet fuel. In an era when downsizing is viewed positively for its impact on the bottom line, the wood pellet sector delivers a better bottom line from producer to user, and generates sustainable economic benefits and higher energy independence.

Finally, even though the US currently does not explicitly have policies that incentivize lower carbon emissions, the wood pellet sector delivers anyway. The significant economic benefits are accompanied by significant environmental benefits.

The premium wood pellet sector can deliver lower end user heating costs, a higher degree of energy independence, needed jobs from three important pathways, and can reduce CO_2 emissions while doing so.

[20] Based on typical annual use of 8 tons of pellets offsetting 1000 gallons of heating oil for a net reduction of CO_2 of about 13.6 tons per year per user.