An Analysis of the Future of Natural Gas Prices and Wood Pellet Prices: Natural gas will become much more costly than wood pellets

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The growth of the bioenergy sector is challenged by what would appear to be an enduring era of low cost natural gas. This paper shows that this “era” will be temporary and that biomass thermal energy will be an important (and lowest cost) component in our energy future.

The following pages show how natural gas supply and demand dynamics will cause very significant natural gas price increases in the next 3 to 8 years. The paper also shows how wood pellets, a refined, low emission, low carbon, and renewable fuel, used in modern high efficiency heating systems, will always be a lowest cost solution for generating thermal energy.

The paper begins with our analysis of the future of natural gas prices and then looks at the expected prices for wood pellets.

Natural Gas – Cheap now but not for long

It is now common to hear that “the US is the Saudi Arabia of Natural Gas.” The quantity of gas that the US can theoretically produce in the next few decades is enormous. The US EIA estimate of total dry gas reserves went from about 1,950 trillion cubic feet (tcf) to about 2,550 tcf in just one year (2010 to 2011). Most of that increase was from shale gas reserves (more than doubling from 350 tcf in 2010 to 825 tcf in 2011). The expected growth in shale gas production suggests that gas prices will remain low for a long time. That at least is the conventional wisdom.

However, imagine that Saudi Arabia’s oil infrastructure stopped at its border. That is, imagine that they could not export a drop of petroleum. The combination of massive reserves and a limited demand would make petroleum prices in Saudi Arabia very low for a very long time. The cost of extracting Saudi oil is estimated to be between $3 and $6 a barrel (including capital cost). The price to users in this demand constrained scenario would not be much greater.

That hypothetical situation is exactly the current real situation in the US for natural gas. Natural gas produced in the US is essentially captive to our pipeline system which goes no farther than Canada and Mexico. Furthermore, natural gas is not easily stored and production has to more or less match demand. As production increases, prices drop and more gas is used or, in the worst case, the excess is flared. Because we are demand constrained, the current glut of natural gas has driven the price below the cost of extraction in some locations.

Based on our analysis, we expect that North American gas production could reach more than 75 tcf per year by 2020 (from the current 24 tcf) if there were a market for it. That forecast assumes that no major environmental or water resource issues slow the spread of shale gas wells. Given current reserves that extraction rate would give the United States 37 more years of production from 2012. However, the Saudi Arabia of gas will not be extracting 75 tcf per year if gas if restricted to the North American market.
Some of that potential growth in gas supply will be soaked up by increasing domestic demand. We expect that substitution from coal and nuclear for power production, and substitution from petroleum fuels in transportation and industrial processes will almost double domestic consumption from the current 24 tcf annually to about 45 tcf per year by 2020.

But even with these growth assumptions, as the chart below shows, supply could far exceed demand if there was a market for the natural gas.

We expect that there will be a market for the potential excess production because something else will happen concurrently with the substitution of transportation and generation into natural gas in the US: the rest of the world will also demand more natural gas for the same reasons; therefore natural gas imports by regions with limited domestic supply or inferior pipeline logistics will increase dramatically.

The pricing dynamics are already in place to motivate the “Saudi Arabia of natural gas” to open its borders. The most recent data on world natural gas prices from the EIA (see chart below) shows a median price for wholesale natural gas to be the equivalent of $11.46 per million BTU (MMBTU). Japan is already well down the road on conversion of its power generating fleet to natural gas (from nuclear) and is willing to pay around $16/MMBTU at current exchange rates. These rates are CIF (cost plus insurance plus freight) at the unloading facility for the shipped liquefied natural gas (LNG). The rates to the end users are substantially higher.
According to current EIA data (as of February 2012), for one million BTU of natural gas, the US average wellhead price was about $2.40, the industrial price was about $4.20, the commercial price was about $7.85, and the residential price was about $9.40. The LNG export price was $11.20 (very close to the median price in the chart above). LNG exports currently are only about 0.3% of the total US gas production.

Assuming that increasing shale gas production does not encounter environmental or water resource constraints, as global demand increases and as LNG export capacity grows, domestic gas will become exposed to world prices.

Just as the real Saudi Arabia has a strong interest in seeing shiploads of petroleum transit the Atlantic, domestic producers of natural gas have a very strong interest in opening up to the world market and seeing shiploads of LNG heading to hungry markets like Japan, India, China, South Korea, and Brazil. Exporting LNG will multiply profits. It will remove the constraint that production has to more or less match real time domestic demand and it will allow producers to seek the best (and much higher) price for their product.

It is difficult to forecast what that global market-clearing price will be and how quickly domestic prices will adjust. However, we can look at some of the pressures that will move prices as global demand increases and the US opens its natural gas market into the world LNG market.

We expect that by 2020, a significant proportion of the world’s rolling fleet will have converted to natural gas. At a price of $3.80 per gallon, people in the US are willing to pay the equivalent of $30.40 per MMBTU for gasoline or $27.15/MMBTU for diesel. In Europe and Japan, transportation fuel prices are much higher suggesting support for much higher natural gas prices as it becomes the transportation fuel of choice. Current residential natural gas prices in the US are close to $10/MMBTU or the equivalent of about...
$1.20/gallon gasoline. We expect that the demand for natural gas as a transportation fuel will push prices significantly higher.

We also expect that most new generation capacity, both for growth in demand and for replacing coal and nuclear plants in the developed world, will be gas fired. The gas price that would provide power at kWh rates equivalent to the cost of generating at a nuclear plant would be $18.50/MMBTU. This is only a few dollars higher than the current CIF price that Japan is paying for LNG.

We believe that well before 2020 we will see the end of cheap natural gas. Rapidly increasing global demand in the transportation and power sectors and the rapid growth of LNG export capacity will force domestic users to bid for gas against users in sectors and locations that are willing to pay much higher prices than we pay today.

**Wood Pellet Fuel – Clean and sustainable; but will it be cost competitive.**

Natural gas will be an important part of our energy portfolio and may dominate as a transportation fuel by 2020. However, in many locations and in many applications, renewable bioenergy for heating in the form of wood pellets will be the low cost choice that also, like domestic natural gas, brings the benefits of energy independence and energy security. Unlike natural gas, sustainably produced bioenergy also provides substantial environmental benefits.

Some areas of the US are already in need of low cost biomass thermal solutions because natural gas for heating is not an option for a significant proportion of homes and businesses. For example, two of the three states with the largest gap between heating oil reliance and the non-availability of natural gas (see chart below) are also states with abundant biomass resources. In those states, natural gas prices do not affect many homes and businesses since it is simply not available in many locations. In addition, it probably never will be due to the low density of population versus the cost of building transportation and distribution systems. In fact, low natural gas prices and thus lower margins for natural gas providers will inhibit the costly build out into marginal population density areas. Those states, in part due to limited natural gas availability, are also the most reliant on expensive heating oil.
For a shift in reliance from heating oil (and, in some locations, from natural gas) to biomass-based wood pellet fuel to make economic sense it will require that wood pellet prices are expected to remain relatively less expensive per unit of useful energy than the alternatives. Note that this analysis is focused on wood pellet fuel because that will be the solution for homes and small businesses. Larger demanders of heat such as factories, schools, apartment building, office buildings, etc., may use other forms of biomass fuels.

The necessary condition that precedes any discussion of intensity of the use of wood for energy is the sustainability of the resource. That is, what level of use will not deplete the resource? The whole idea of a “renewable” energy is that it renews and is useable forever. Based on the existing biomass resources, there is a limit to the volume of energy that can be annually derived from biomass. The binding constraint for the size of the bioenergy sector has to be the sustainability of the feedstock. The net stock of biomass has to remain constant (or grow through better forest management practices). In simple terms, the quantity harvested each year cannot exceed the quantity that grows each year.

Such a constraint should eventually cause upward pressure on prices if demand exceeds the upper limit of supply. That is possible if the demand for biomass fuel exceeds the supply of the feedstock for the fuel. We think that the by 2020 a significant proportion of the current uses of wood from the annual harvest will shift to wood-to-energy and will expand the forest resources available for energy. We think that the traditional use of wood for pulp and paper making in the US will significantly decline over the next decade and the wood-to-energy sector will fill the space. The sustainable supply in those northern states that are forested and cold will then be sufficient for most of the locations that do not have natural gas and even for some areas that do. We do not consider dedicated short rotation woody crops in this analysis. But the use of fallow non-forested lands for energy crops will add to the sustainable feedstock available.
However, even without any decline in pulpwood demand for the paper industry, a significant number of northern tier homes could be converted to bioenergy. The table below shows our high-level analysis of current sustainable wood supply (these numbers exclude current demand for pulpwood and saw timber) for use in wood pellet production for the Northeast and the Midwest. The Northwestern states and some of the Rocky Mountain States also have the right combination of forest resources and heating demand but they are not included in this analysis. Based on this analysis about 3 million homes and businesses in the Northeast and Midwest states could convert to pellets now without exceeding the sustainable supply of biomass. There could be about 23 million tons per year of pellets sustainably produced in those states now. The table is set up as if wood and pellets do not cross state lines. That is unrealistic. But the table does illustrate how some states are better positioned to leverage the natural resources they have now to replace heating oil now and perhaps natural gas in the future with regionally produced low carbon biofuel. Maine could convert the highest proportion of its homes and businesses and New York could convert the highest number of homes and businesses.

<table>
<thead>
<tr>
<th>Occupied Households</th>
<th>Estimated Number of Small Businesses</th>
<th>Total Number of Homes and Businesses</th>
<th>Total Biomass for Pellets Production per Year (green tons)</th>
<th>Total Number Converting in each State if there is NO Interstate Transport of Pellets (based on 8 tons per user per year average)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Northeast</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connecticut</td>
<td>1,323,000</td>
<td>394,651</td>
<td>1,717,651</td>
<td>454,000 [1.65%]</td>
</tr>
<tr>
<td>Maine</td>
<td>542,000</td>
<td>161,679</td>
<td>703,679</td>
<td>3,640,000 [32.33%]</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>2,449,000</td>
<td>730,537</td>
<td>3,179,537</td>
<td>608,000 [1.20%]</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>501,000</td>
<td>149,448</td>
<td>650,448</td>
<td>694,000 [6.67%]</td>
</tr>
<tr>
<td>New York</td>
<td>7,907,420</td>
<td>2,358,783</td>
<td>10,266,203</td>
<td>12,096,000 [7.36%]</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>4,877,735</td>
<td>1,455,028</td>
<td>6,332,763</td>
<td>6,694,000 [6.61%]</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>405,000</td>
<td>120,812</td>
<td>525,812</td>
<td>166,000 [1.97%]</td>
</tr>
<tr>
<td>Vermont</td>
<td>251,000</td>
<td>74,873</td>
<td>325,873</td>
<td>1,434,000 [27.50%]</td>
</tr>
<tr>
<td>TOTAL</td>
<td>18,256,155</td>
<td>5,445,811</td>
<td>23,701,966</td>
<td>25,786,000 [1.61%]</td>
</tr>
<tr>
<td><strong>Midwest</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>2,624,358</td>
<td>782,846</td>
<td>3,407,204</td>
<td>4,964,000 [10.12%]</td>
</tr>
<tr>
<td>Minnesota</td>
<td>2,347,201</td>
<td>700,170</td>
<td>3,047,371</td>
<td>2,494,000 [5.68%]</td>
</tr>
<tr>
<td>Michigan</td>
<td>4,532,233</td>
<td>1,351,965</td>
<td>5,884,198</td>
<td>6,112,000 [7.21%]</td>
</tr>
<tr>
<td>North Dakota</td>
<td>317,498</td>
<td>94,710</td>
<td>412,208</td>
<td>155,000 [2.61%]</td>
</tr>
<tr>
<td>South Dakota</td>
<td>363,438</td>
<td>108,414</td>
<td>471,852</td>
<td>135,000 [1.99%]</td>
</tr>
<tr>
<td>Iowa</td>
<td>1,336,417</td>
<td>398,653</td>
<td>1,735,070</td>
<td>1,195,000 [4.78%]</td>
</tr>
<tr>
<td>Illinois</td>
<td>5,296,715</td>
<td>1,580,010</td>
<td>6,876,725</td>
<td>2,393,000 [2.42%]</td>
</tr>
<tr>
<td>Indiana</td>
<td>2,795,541</td>
<td>833,910</td>
<td>3,629,451</td>
<td>2,675,000 [5.12%]</td>
</tr>
<tr>
<td>TOTAL</td>
<td>19,613,401</td>
<td>5,850,678</td>
<td>25,464,079</td>
<td>20,123,000 [1.01%]</td>
</tr>
</tbody>
</table>

analysis by FutureMetrics
We have shown why we expect that natural gas prices will increase significantly. Can we rely on wood pellet prices to remain competitive particularly given the upper limit to the amount of wood that can be used for energy as illustrated by the table above?

The answer relies on the same factors that drive all prices: supply and demand. If the supply of wood pellet fuel more or less matches demand, then the price of wood pellets in a competitive market should reflect the cost of production plus a competitive market mark-up. Obviously if demand exceeds supply, prices will rise. However, as long as there is sufficient feedstock, production capacity will come online to capture those windfall profits; and as supply returns to the market clearing equilibrium, prices will also return to the competitive equilibrium.

In Maine for example if all the currently operating Maine pellet mills were to run at capacity, production would be about 300,000 tons per year. Given our analysis that Maine could supply 3.6 million tons per year of wood to pellet mills and thus produce about 1.8 million tons per year of pellets, there is plenty of room for pellet demand growth at least in the near-term.

The chart below shows that while Maine is an intensive user of wood for many uses, the annual harvest is still below the maximum sustainable harvest. Of the 15.5 million tons harvested in Maine in 2010 about half (7.2 million tons) was for the pulp and paper industry. Other states in the northern tier have much more “slack” capacity for use in wood pellet production.

![Total Potential Sustainable and Actual Maine Harvest in Green Tons](chart.png)

Given equilibrium in pellet supply and demand, wood prices are the most important and most volatile input to the cost of wood pellets. Electricity and labor are the other major variable inputs but they remain

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relatively stable over time. Based on our detailed models of pellet manufacturing, the median of what wood prices contribute to the cost of pellets is about 55% of the total cost (electricity is about 15%, dryer heat cost is about 20%, labor about 5%).

The factor that most effects wood prices is the cost of the diesel fuel used for harvesting and transport. Weather and the demand for other grades of wood also influence pellet grade wood prices but the primary factor is diesel fuel cost. Based on our analysis of wood prices, diesel fuel contributes to about 60% of the price variation of wood.

Diesel fuel and heating oil prices are highly correlated. The chart below shows this relationship.

Thus, changes in heating oil prices (and therefore diesel fuel prices) map to changes in wood pellet prices (via wood prices). Since each influence is only 55% or 60% of the variation, pellet prices will increase as heating oil prices but will increase at a slower rate. The chart below shows this relationship beginning with current prices per MMBTU for pellets and heating oil. (Note that heating oil prices have actually appreciated at an annualized rate of 8.21% since 2001 and the chart below uses 4% for the next 10 years.)
As noted above, this analysis assumes that supply is sufficient to meet demand. We have a few final comments on that below.

But it is important to highlight that by 2020, assuming oil prices increase at 4% per year, our analysis suggests that the market clearing pellet fuel cost will be about $17.50/MMBTU. If natural gas does dominate the transportation sector by 2020, we would expect that the market would be willing to pay a significant proportion of what they pay today for the equivalent energy from gasoline: about $30/MMBTU at $3.80/gallon.

In other words, pellet fuel in 2020 could be about half the cost per unit of energy of natural gas if it is priced at today’s transportation fuel cost.

Of course there is a growing pellet export market. We have made a case that the opening up of the natural gas market to global prices will increase gas prices; won’t pellets follow the same path and see prices rise as the export business grows?

It is possible and it depends on how carbon emissions are penalized. Right now, some European coal power plants can lower the cost of generation by co-firing coal and pellets. This is because the higher cost of imported pellet fuel over relatively low cost coal is offset by the lower carbon emissions costs. For those economics to work, the pellets cannot be too costly even after being shipped from the US.

The price that US export manufacturers get for exported pellets are below the domestic market prices for pellets. Furthermore, domestic premium pellets for home heating systems are actually less costly to produce than utility pellets for co-firing. This is because the finer particle size specifications needed for pulverizing pellets for injection into pulverized coal burners requires more horsepower and thus higher electricity costs to mill the wood to the finer specification. So given a choice, pellet producers will make higher profits selling into the domestic market; to the extent that it exists. Right now, 2,400,000 tons per
year of the pellets manufactured in the US are exported to Europe\(^1\). That number is expected to increase to the tens of millions of tons per year by 2020. Millions more tons per year of capacity is coming online or is in advanced development in 2012 in the US.

If the domestic market demand matures sufficiently and the European utility offtake contracts are flexible enough, we would expect that as much of that export capacity as possible would remain in the US. Of course that assumes that the price on carbon in those foreign markets does not increase significantly. If it does, then the effective cost of using coal increases and those markets can afford a higher price for pellets. However, prices in the US are before the costs of storage and shipping to Europe and thus will always have that advantage on margins.

Whether exported or not, the key question is: will there be sufficient wood supply to keep pellet prices stable as demand increases?

Just like any other energy sector, it is likely that mistakes will be made in matching supply and demand. At the local level, inferior wood studies misjudging the capacity of wood baskets and the cost to the mill of getting the feedstock over the scales will either make production costs higher than expected or will cause the facility to operate below nameplate capacity; both, or a combination of both, will result in the need for higher pellet prices. Overlapping demand arising from poorly analyzed siting decisions (two or more facilities drawing upon the same wood basket) will distort wood prices and lead to higher pellet prices.

But in the aggregate and over time in a competitive market, we think that prices will remain stable as we would expect most new capacity to be professionally analyzed for optimal location and sizing to minimize the exposure to market risk and to maximize profits.

Pellet fuel cannot become more expensive than the alternatives or demand will fade. In the heating oil dependent and natural gas deficient states, that sets a very high benchmark. At current heating oil prices, pellets would have to cost $445/ton to reach cost per unit of energy equivalency with heating oil. The current price for bulk pellet delivery is about $220/ton and for bagged pellets is about $190/ton. Furthermore, if excess wood demand drives up prices for pellets, in a competitive market, high priced suppliers will lose market share and will close. That will lower the stress on the wood supply and bring prices back toward the market equilibrium.

The chart below shows that pellet prices have been quite stable even as other heating fuel prices have fluctuated significantly.

Finally, with regards to the amount of wood available for the biomass thermal sector, there is the uncertain future of the pulp and paper sector in the US. Recently pulp exports have been strong. But in general paper demand for printed media is declining and will decline at an increasing rate. The current big exception to this trend is China whose demand for wood by 2015 is expected to be twice its domestic production. China is why pulp exports are strong. But the future of US pulp and paper, at least for printed media, is uncertain. Lower cost producers of pulp and paper in the developing world will fill some of that Chinese demand. In addition, the strengthening dollar is not good news to the domestic pulp exporters. And China, like most of the world, will also turn to screens as replacements for books, newspapers, most of what passes in the mail, and even office paper.

We cannot be sure of the future for the pulp and paper sector and we do not wish ill upon such an important part of the forest products industry; but we strongly believe that the wood-to-energy sector should be ready to fill any space left by the domestic pulp sector.

The landowners, the loggers, and the truckers just want an end user for pulp grade logs and some certainty for demand going forward. If that space currently occupied by the pulpwood demanders opens up, pellet fuel producers in states like Maine could still pay pulpwood prices, support the wood supply chain with the certainty of annual demand for heating fuel, and offer heating fuel to almost all of its homes and businesses for a price that will be less than all the alternatives including, we believe, natural gas.

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Conclusion

No one knows the future. But in this paper we have tried to tell a story of a future that is logically consistent and plausible. The chart below distills our expectations into an illustration of commercial rates for natural gas and for wood pellet fuel.

If we are correct, then a significant proportion of the heating demands of the northern forested states’ homes and businesses will be satisfied by domestically produced renewable low carbon biomass derived fuels. The switch from using heating oil refined from a significant proportion of imported petroleum to a renewable fuel manufactured regionally will have huge positive economic and environmental impacts. We have a number of papers and presentations on that subject. In some locations where residential natural gas prices are already high, the switch will be from natural gas to bioenergy.

But the economic story is even better. We will be driving natural gas powered vehicles with fuel costs per mile traveled that will probably be lower than gasoline or diesel fuel in 2020. The lower carbon output of natural gas vehicles and the switch from importing petroleum for gasoline and diesel refining will also have positive economic and environmental impacts. Of course the assumption behind the growth in natural gas production is that negative environmental impacts from hydraulic fracturing will be contained. The costs of compliance, assuming regulation and enforcement, will also add to the cost of the natural gas.

Finally, the world is rapidly moving to screens and away from the printed page. The future of a large segment of the forest products industry and the health of our working forests lies in a complimentary growth of wood-to-energy as the traditional sectors decline.