Global Warming Reduction Benefits From the Use of Pellet Fuel for Residential Heating

Jim Houck and Paul Tiegs
OMNI Environmental Services

For Presentation At:

The 2007 Annual Conference
Of The Pellet Fuels Institute

Myth #1

Biomass Fuels are Greenhouse Gas Neutral

They are not.

A more accurate statement is:

"Carbon dioxide produced by biomass combustion is not considered a greenhouse gas."

The U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks

"The combustion of biomass fuels such as wood, charcoal, wood waste, and biomass-based fuels such as ethanol from corn and woody crops generates CO_2. Assuming the biogenic carbon emitted from biomass combustion as CO2 is offset or exactly balanced by the uptake of the CO_2 by the growth of new biomass, the total amount of bio-derived CO2 in the atmosphere will not increase over time. This has been officially recognized in that CO_2 emissions from biomass combustion have been estimated separately from fossil fuel-based CO2 emissions and are not included in the official inventories of CO2 sources in the U.S. or Canada."

Reasons for Greenhouse Impacts from Biomass Combustion

1. Methane produced as a product of incomplete wood combustion (PIwC) is a greenhouse gas and it has a ***Greenhouse Warming Potential*** (GWP) 21 times larger than carbon dioxide.
2. ***Energy Return on Energy Investment*** (EROEI) is approximately 13:1 for pellet fuels. Most of the energy invested in pellet fuels is the fossil fuels that power the manufacturing, drying, and transportation of pellet fuels.

Myth #2

Greenhouse Gas (GHG) Uptake by Photosynthesizing Plants and Their Release Rates from Biomass Fuel Combustion are Significant

For example, it has been stated:

- By replacing harvested mature trees with more rapidly photosynthesizing juvenile trees removes carbon dioxide more rapidly from the atmosphere thereby producing a global warming benefit.

- Burning biomass rather than using it structurally or land-filling it increases global warming impacts due to fast release rather than slow release through decay.

These factors have only very small impacts on the bio/atmospheric carbon cycle and are even then only realized over a long periods of time compared to introducing fossil fuel carbon (tens of millions of years old) into the modern carbon cycle. (Note: the bio-productivity of the oceans dwarfs the bio-productivity of terrestrial woody plants)

Bottom Line #1

There is a large greenhouse gas benefit realized by using pellet fuel in lieu of fossil fuel for residential heating. This is primarily due to its carbon dioxide being excluded as being counted as a GHG. However, don't forget that the methane produced by PIwC and the CO_2 generated by the energy invested in pellet fuel production are still significant enough to be included.

Net GHG benefit from replacing fossil fuel heating appliances with pellet fuel heating appliances =

- (CO_2 from fossil fuel combustion)
- (CO_2 from invested energy for fossil fuels)
- (CH_4 from incomplete fossil fuel combustion)
+ (CO_2 from invested energy for pellet fuel)
+ (CH_4 from pellet fuel combustion)

Bottom Line # 2

There is an additional GHG benefit realized by using pellet fuel in lieu of natural gas. Since North American natural gas averages about 90% methane, the loss of 1.75% of the amount of natural gas that reaches homes from leaking valves, flanges, pumping stations, etc., results in an additional and significant contribution to GHG emissions.

GHG benefit of replacing natural gas heating appliances with pellet fuel heating appliances =

- (CO_2 from natural gas combustion)
- (CO_2 from invested energy for natural gas recovery and transport)
- (unburned CH_4 from natural gas burners)
- (fugitive CH_4 loss)
+ (CO_2 from invested energy for pellet fuel)
+ (CH_4 from pellet fuel combustion)]

Bottom Line #3

There are differences in GHGs between cordwood and pellets. The magnitude and direction of the net effect of the differences is not known but needs to be resolved. Two difference factors favor pellets one favors cordwood.

EROEI for pellets is about 13:1, EROEI.

For cordwood EROEI is greater but there are no data.

Methane emissions from cordwood are greater than for pellets but there is only limited data.

Pellet stoves are more efficient than cordwood stoves (~75% vs. ~ 65%). Therefore, less biomass is burned in a pellet stove and can be easily quantified.

Home Heating in the United States

Fuel	Main Heating Fuel (2005 housing units, X 1000)	Secondary Heating Fuel (2005 housing units, X 1000)	Millions of Btu per Household (2001)
Electricity*	40,648	12,582	108.7 (36.4)**
Piped Gas	61,850	7194 (combined piped and bottled gas)	72.4
Bottled Gas	7551		40.2
Fuel Oil	10,260	829	81.7
Kerosene or Other Liquid Fuel	713	791	16.1
Coal or coke	114	104	-
Wood	1768	9361	25.9
Solar Energy	16	27	-
Total	123,257	27,345	92.2***

*72% of electricity is generated by fossil fuels, transmission line losses are 12%, and coal-fired power plants (ie, good ones) are 33% efficient
**108.7 is primary, 36.4 is site
***excludes primary electricity and wood

Global Warming Benefit Scenario

61,850,000 households use natural gas as main heating fuel (AHS, 2005)

72.4 million Btu natural gas/household (EIA, 2001)

Assume 0.1% of these households change 50% of their heating needs to pellet fuel

(0.001) X (0.5) X (61,850,000 households) X (72.4 million Btu/household) = 2.2 trillion Btu

GHG from the combustion of 2.2 trillion Btu of natural gas =

(133,000 tons CO_2-eq. from CO_2 emitted upon combustion)
+ (20,880 tons CO_2-eq. emitted from invested energy)
+ (61 tons CO_2-eq. from methane directly emitted upon combustion)
+ (14,900 tons CO_2-eq.from fugitive methane loss)
= **168,761 tons CO_2-eq.**

GHG from the combustion of 2.2 trillion Btu of pellet fuel =

(15,600 tons CO_2-eq. from CO_2 emitted from invested energy)
+ (19,500 tons CO_2-eq from methane directly emitted upon combustion
= **35,100 tons CO_2-eq.**

Net GHG benefit from pellet fuel = 168,761 - 35,100 = **133,661 tons CO_2-eq.**

Bonus Topic: Pellet Fuel vs Corrosion

The Players

Ash	Potassium, sodium, and other salts (namely, sulfates and chlorides)
Sulfur	Organic sulfur, sulfate sulfur and pyritic sulfur
Chlorine	Chlorides and organic chlorine
Nitrogen	Amino acids (protein, seed germ)

Common Sources of Corrosive Agents

- Demolition wood (high chloride and sulfate)
- Bark (high nitrogen and potassium)
- Coal dust (high sulfur and salts)
- Chlorinated plastics (PVC)
- Sea salt (logs transported in marine environment)
- Treated wood (preservatives, resins, pesticides, glues, paints, etc.)
- Agricultural byproducts (straw, stubble, stover, nut husks, etc.) have high potassium and chloride
- Seeds (high nitrogen)
- Log yard debris (plain dirt)

Chemistry

- Potassium salts, namely, potassium chloride (KCl) and potassium sulfate (K_2SO_4) are volatile, i.e., they reach the stack rather than remaining in the ash, have low melting points, ie, they facilitate clinker formation, and they are a major component of plant tissue as reflected in the need for potassium fertilizer

- Organic sulfur and pyritic sulfur (common in coal) form corrosive sulfate salts and sulfuric acid

- Organic chlorine forms corrosive hydrochloric acid and chloride salts

- The decomposition/combustion of amino acids produces corrosive nitric acid and ammonium salts

Typical Corrosive Content of Pellet Materials

Material	Ash (%)	Nitrogen (%)	Sulfur (ppm)	Chlorine (ppm)	Potassium (ppm)	Sodium (ppm)
Wood	0.51	0.22	278	48	493	17
Bark	4.85	0.34	403	221	1750	23
Straw	5.40	0.54	766	1150	7940	60
	PFI standard 1%	Sunflower 1.38%	low sulfur coal <10,000 ppm	PFI standard 300 ppm		sea salt, 306,000 ppm

Hardwood vs Softwood

Hardwood 1.0% to 1.3 % ash

Softwood 0.4% to 0.8% ash

Counter-intuitively, softwood pellets have more heat (Btu) per pound when made to the same size and density than hardwood pellets due to a typically higher resin (17,400 Btu/lb) and lignin content as compared to hardwood

Summary

For most pellet materials potassium salts (KCl and K_2SO_4) and the nitrogen content are most important in terms of corrosion