

A Lifecycle Cost Analysis of Wood Pellet, Propane, and Heating Oil

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Introduction

This analysis compares the cost of three different heating technologies wood pellet, propane and heating oil over the lifetime of a wood pellet heating unit that provided central heating. Two different sized buildings are considered: a 2,000 square foot detached residence and a 30,000 square foot institution (church, school, etc.). Two scenarios will be considered, one with a 30 percent subsidy to offset the cost of the wood pellet heating unit and the second without this incentive. These units only generate heat, and as a result are not likely to be used for public/commercial buildings in most locations. The best locations are likely to be in the Upper Peninsula, parts of the Northern Lower Peninsula and perhaps selected locations along Lake Michigan and Lake Huron. These parts of the state tend to have cooler summers and therefore are in less need of a combined heating and cooling system.

Lowest Life Cycle Cost (LCC) will be used to compare the different technologies. It has the advantage of being relatively straightforward and easy to understand (Fuller). It allows comparisons between competing technologies that provide the same service, in this case heating. It should be noted that each project is different and that this analysis is designed to give a general idea of the relative cost of heating with wood pellets compared to propane, and heating oil. Actual costs will be different and in some cases could be considerably different depending on the actual building and vendors used.

The formula used for comparing wood pellets to propane and heating oil is shown in equation 1.

$$LCC = I + i + E + M \text{ (eq. 1)}$$

Where:

LCC = Life cycle cost

I = The cost of the investment including installation costs

i = Present value of the interest payments on the investment

E= Present value cost of the feedstock (wood or propane or oil)

M=Present value of the maintenance costs

The technology with the lowest life cycle cost is the preferred alternative from a purely economic perspective. Present values are used to estimate the current value of future costs; in this case energy and interest payments and maintenance costs.

The results of this analysis shows that heating with wood pellets is significantly less expensive than either propane or heating oil. In the case of the residence the cost savings vary from 12.2 percent for non-subsidized wood pellet heating compared to heating oil, to 35.7 percent for subsidized wood pellet heating compared to propane. In the case of the public building, the cost savings vary from 41.1 percent for non-subsidized wood pellet heating compared to heating oil, to 69.1 percent for subsidized wood pellet heating compared to propane.

Assumptions

In order to estimate the life cycle cost of the three technologies. The following assumptions are made, this is shown in Table 1. The life cycle is based on 30 years for the household unit and 40 years an institutional unit. A replacement unit is needed for the propane and heating oil and the discounted cost of the replacement unit is included in the analysis, prorated to the lifetime of the wood pellet unit.

Table 1: Assumptions Used in the Analysis

Variable	Pellets	Heating Oil	Propane	Source
Input Price	\$180 to \$220 a ton	\$1.38 to \$2.72 a gallon randomly generated	\$1.50 to \$2.21 a gallon randomly generated	EIA/Excel
Size of Residence	2,000 sq. ft.	2,000 sq. ft.	2,000 sq. ft.	
Size of Institution	30,000 sq. ft.	30,000 sq. ft.	30,000 sq. ft.	Mass. Div. of Energy Resources
Interest Rate Residence	6%	6%	6%	MSUFCU
Interest Rate Institution	2%	2%	2%	Bloomberg
Discount Rate	3%	3%	3%	30 Year Bond Yield
Conversion	1 to 1	120 gallons to 1 ton	170 gallons to 1 ton	
Inflation	2% a year	2% a year	2% a year	FED target
Lifespan Residential Unit	30 Years	18 Years	18 Years	National Assn. of Homebuilders
Lifespan Institution Unit	40 Years	25 Years	25 Years	
Installed Cost of Residence Unit	\$ 13,500	\$ 5,000	\$ 5,000	Fixr.com
Down Payment Residence	\$ 2,700	\$ 2,700	\$ 2,700	
Length of Loan Residence	5 Years	5 Years	5 Years	
Installed Cost of Institution Unit	\$ 75,000	\$ 30,000	\$ 30,000	Maine Energy Systems
Down Payment Institution	\$ 15,000	\$ 15,000	\$ 15,000	
Length of Loan Institution	5 Years	5 Years	5 Years	
Insurance	No difference			
Annual Maintenance	\$ 300	\$ 150	\$ 150	Green Building Mechanical

It is also assumed that the propane unit generates 89,768 btus a gallon, oil 126,000 btus a gallon, and 15,120,000 btus per ton of wood pellets (MDER). Also, it is assumed that the residence uses 1,100 gallons of propane, 785 gallons of heating oil and 6.5 tons of wood pellets. The institutional building uses 16,000 gallons of propane, 11,400 gallons of heating oil and 95 tons of wood pellets. These figures are based on using a high efficiency heating unit and consumption in the northern part of the state with long winters and reasonably easy access to wood pellets.

It is assumed that the maintenance costs for a wood system is \$300 a year and \$150 a year for an oil or propane system. It is assumed that the cost increases by two percent a year. The discounted cost of the maintenance payments are included in the analysis. A subsidy of 30 percent is relatively consistent with some of the subsidies offered in the Northeast especially Maine, Vermont and Massachusetts.

The single biggest cost item is the cost of the fuel, and this is the item that is the most difficult to estimate, because these are commodities, whose prices vary from year to year, traditional measures of inflation are not likely to yield accurate estimates. The estimates used in this analysis are based on the cost of propane and heating oil in Michigan from the mid-1990s to 2018. The price of propane varied from \$1.76 to \$2.52 a gallon and for heating oil from \$1.75 to \$3.73 a gallon. The price of wood pellets does not vary as much. Wood pellet prices vary from \$180 a ton to \$220 a ton. To generate annual estimates, random prices were generated via Excel. A price from within each of these ranges was randomly generated by the software for each year, to prevent bias from the analyst.

Results

The lifecycle costs of different residential heating units is shown in table 2.

Table 2: Residential Heating Costs: 30 Years

Item	Wood Pellets		Propane	Heating Oil
	Without Subsidy	With Subsidy		
Cost of Heating Unit	13,500	10,800	5,000	5,000
Discounted Cost of Replacement	0	0	2,856	2,856
Discounted Interest Expense	1,869	1,171	723	723
Replacement Discounted Interest Expense	0	0	332	332
Discounted Disposal Cost	0	0	352	352
Discounted Fuel Costs	26,505	26,505	48,722	41,925
Discounted Maintenance Costs	6,688	6,688	3,315	3,315
Total Costs	48,562	45,164	61,300	54,503

Without the subsidy the estimated cost of the wood pellet heating unit is approximately \$48,500 and with a 30 percent slightly more than \$45,000. This is considerably less than the roughly \$61,000 for propane and \$54,500 for heating oil. Propane is 26.2 percent more expensive than non-subsidized wood pellets and 35.7 percent more expensive than the subsidized wood pellet heating unit. Heating oil is 12.2 percent more expensive than the non-subsidized wood unit and 20.7 percent more expensive than the subsidized wood heating unit. While heating oil is more expensive on average than propane, its higher energy content allows heating oil to be less expensive than propane. Also, the greater price variation of heating oil may make it less desirable compared to propane. While wood pellets are clearly less expensive than either heating oil or propane; the initial cost of the heating unit is higher. Nonetheless, there is clearly an opportunity to expand the use of wood pellet heating units.

Table 3 shows the lifecycle cost of an institutional building.

Table 3: Institution Building Heating Costs: 40 Years

Item	Wood Pellets		Propane	Heating Oil
	Without Subsidy	With Subsidy		
Cost of Heating Unit	75,000	52,500	30,000	30,000
Discounted Cost of Replacement	0	0	14,103	14,103
Discounted Interest Expense	3,469	2,165	865	865
Replacement Discounted Interest Expense	0	0	323	323
Discounted Disposal Cost	0	0	352	352
Discounted Fuel Costs	457,862	457,862	833,314	720,608
Discounted Maintenance Costs	9,984	9,984	4,868	4,868
Total Costs	546,315	522,511	883,825	771,119

In the case of a public building the cost of the wood pellet heating unit is approximately \$546,000 and the cost with the subsidy is approximately \$522,500. The cost of the propane unit is almost \$884,000 and is more than \$777,000 for heating oil. The cost of propane is 61.8 percent more than wood pellets without the subsidy and 69.1 percent more than the subsidized cost of heating with wood pellets. Heating oil is 41.1 percent higher than unsubsidized wood pellets, and 47.6 percent higher with the subsidy. Again, wood pellets have the potential for substantial cost savings compared to propane and heating oil. However, the initial costs are much higher for the wood pellet heating unit. Also, some building owners may prefer an integrated heating and air conditioning unit which could limit the application of wood pellet heating units. Buildings that are used on a more limited or seasonal basis such as churches and schools may be a better fit for wood pellet heating.

Given the substantial potential cost savings of wood pellet heating units raises the question as to why these units aren't more widely used. Lack of knowledge about the potential for wood pellets is likely one reason. This extends not only to potential consumers but to marketers and installers of heating units. Since this technology is less well known obtaining insurance for a building that uses wood pellets may be difficult. The supply chain may also be underdeveloped; the lack of distributors of bulk wood pellets in automated pneumatic trucks may be limiting the growth of the wood pellet industry. The few number of wood pellet heating units also makes the transport of pellets from one customer to another more expensive. Disposing of the ash may be an inconvenience that some consumers are unwilling to bear.

Conclusion

This study analyzes the life cycle costs of wood pellets compared to propane and heating oil. A house and an institutional building were both considered as were subsidized and unsubsidized wood pellet heating units. In the case of the residence, a life span of 30 years was considered; a 40 year lifespan was analyzed in the case of an institutional building. In all cases the wood pellet heating units are less expensive than propane and heating oil. The lower costs of the heating fuel more than offsets the higher costs of the boilers. Wood pellet boilers also have the advantage of having a longer life span than oil and propane units.

Despite these costs savings wood pellets are not widely used for central heating. Lack of knowledge about the potential cost saving is one possible reason wood pellets are not most widely used. The potential underdeveloped supply chain, especially with respect to distribution, is another barrier to the increased used for central wood pellet heating units. The inability to obtain insurance and the inconvenience of disposing of the ash may be additional barriers to the use of wood pellets.

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