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A Lifecycle Cost Analysis of Wood Pellet and Natural Gas

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Introduction

This analysis compares the cost of two different heating technologies wood pellet, and natural gas over the lifetime of a wood pellet heating unit that provides 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 select 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 natural gas. 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.

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

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 natural gas)
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 more expensive than heating with natural gas. In the case of the residence, heating with wood is estimated to be 57 percent more expensive than natural gas without the subsidy, and 46 percent more expensive with the subsidy. Heating an institutional building with wood is estimated to be 44 percent more expensive than natural gas without the subsidy, and 38 percent more expensive with a subsidy.

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 natural gas heater 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	Natural Gas	Source
Input Price	$180 to $220 a ton	$6 to $16 per 1,000 cubic ft. for the house $6 to $13 per 1,000 cubic feet for the insitution randomly generated	EIA/Excel
Size of Residence	2,000 sq. ft.	2,000 sq. ft.	
Size of Insitution	30,000 sq. ft.	30,000 sq. ft.	Mass. Div. of Energy Resources
Interest Rate Residence	6%	6%	MSUFCU
Interest Rate Institution	2%	2%	Bloomberg
Discount Rate	3%	3%	30 Year Bond Yield
Conversion	1 to 1	120 gallons to 1 ton	
Inflation	2% a year	2% a year	FED target
Lifespan Residential Unit	30 Years	18 Years	National Assn. of Homebuilders
Lifespan Institution Unit	40 Years	25 Years	
Installed Cost of Residence Unit	$ 13,500	$ 5,000	Fixr.com
Down Payment Residence	$ 2,700	$ 2,700	
Length of Loan Residence	5 Years	5 Years	
Installed Cost of Institution Unit	$ 75,000	$ 30,000	Maine Energy Systems
Down Payment Institution	$ 15,000	$ 15,000	
Length of Loan Institution	5 Years	5 Years	
Insurance	No difference		
Annual Maintenance	$ 300	$ 150	Green Building Mechanical

It is also assumed that natural gas generates 1,037,000 btus per 1,000 cubic feet and that wood pellets generate 15,120,000 btus per ton (MDER). Also, it is assumed that the residence uses 95,000 cubic feet of natural gas and 6.5 tons of wood pellets. The institutional building uses 1.385 million cubic feet of natural gas 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 a natural gas 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 subsides 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 natural gas in Michigan from the late 1990s to 2018. The price of natural gas for residential use in Michigan varied from approximately $6 to $16 per 1,000 cubic feet; and the commercial price for natural gas varied from approximately $6 to $13 per 1,000 cubic feet. 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

	Wood Pellets		Natural Gas	
Item	**Without Subsidy**	**With Subsidy**		
Cost of Heating Unit	13,500	10,800	5,000	
Discounted Cost of Replacement	0	0	2,856	
Discounted Interest Expense	1,869	1,171	723	
Replacement Discounted Interest Expense	0	0	332	
Discounted Disposal Cost	0	0	352	
Discounted Fuel Costs	26,505	26,505	18,265	
Discounted Maintenance Costs	6,688	6,688	3,315	
Total Costs	**48,562**	**45,164**	**30,843**	

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. The estimated cost of using natural gas is approximately $31,000. Heating with wood is approximately 57 percent higher than heating with natural gas without the subsidy and about 46 percent more expensive than natural gas with the subsidy.

Table 3 shows the lifecycle cost of an institutional building.

Table 3: Institution Building Heating Costs: 40 Years

	Wood Pellets		Natural Gas	
Item	**Without Subsidy**	**With Subsidy**		
Cost of Heating Unit	75,000	52,500	30,000	
Discounted Cost of Replacement	0	0	14,103	
Discounted Interest Expense	3,469	2,165	865	
Replacement Discounted Interest Expense	0	0	323	
Discounted Disposal Cost	0	0	352	
Discounted Fuel Costs	457,862	457,862	328,611	
Discounted Maintenance Costs	9,984	9,984	4,868	
Total Costs	**546,315**	**522,511**	**379,122**	

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 discounted cost of the natural gas unit is approximately $379,000 which is about 44 percent less than wood pellets without the subsidy and approximately 38 percent less than the subsidized cost of heating with wood pellets.

While heating with wood is cost competitive with heating oil and propane it is more expensive than heating with natural gas. This is especially this case at the household level.

Conclusion

This study analyzes the life cycle costs of wood pellets compared to natural gas. 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 more expensive than heating with natural gas. While wood boilers have a longer lifespan than gas heating units it does not offset the higher initial costs and higher fuel costs compared to natural gas.

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