FutureMetrics™ LLC
8 Airport Road
Bethel, ME 04217, USA

Heat Pumps

They are Great… Until they Aren't!

Comparing the cost of heat from heat pumps to the cost of heat from a modern wood pellet fueled central heating system.

September 17, 2023

By William Strauss, PhD

Heat pumps are everywhere. And for good reasons. Advances in design in recent years have improved the efficiency of air source heat pumps dramatically. They provide heat in the winter and cooling in the summer. They are relatively low cost to purchase, and they are easy to install.

Using only electricity, they do not require the end user to consume heating oil, propane, or natural gas for heat. Depending on how the electricity is generated, they may have a positive net impact on CO_2 emissions.

All good.? Not always!

For buildings that sit in colder climates, heat pumps will not deliver enough heat when needed and, depending on the cost of electricity, they may be a more costly heating solution on an annual basis than other options.

This white paper discusses these characteristics of heat pumps.

What Happens with Heat Pumps When it is Very Cold Outside?

Heat pumps are conceptually simple devices. When heating, they operate like a refrigerator or air conditioner, but in the opposite direction, performing the task of transferring the heat in the outside air into the building. Optimally designed systems are very good at this task as long as the outside air is not too cold. With moderately cold outside air, modern heat pumps can produce 4 to 5 kWh's of heat for every kWh of electricity used by the heat pump. This ratio is called the coefficient of performance (COP).

But as the outside air gets colder, the COP declines. It takes more work by the heat pump to extract a kWh of heat as the air temperature outside falls. As a result, the heat pump will produce less heat and use more power per kWh of heat it does produce.

At what temperature of the outside air the heat pump can no longer supply sufficient heat depends and many factors including how well the building is insulated. But there is a temperature below which the building will need supplemental heat.

Most residential sized heat pumps cease to operate when the temperature is below about -25 C (-13 F). Prior to that temperature, the COP degrades to nearly 1. That is, the cost of a kWh of electricity equals the cost of a kWh of heat.

In other words, when the building needs heat the most, the heat pump provides very little heat at a high cost; or when extremely cold, no heat at all.

Figure 1[1] below shows an example based on a typical COP schedule for a commercially available residential heat pump. The home's heating requirement profile versus the outside temperature is typical for many homes. In the model used to produce the chart, the heat pump can keep up with the heat losses down to around -10°C (14°F). But below that temperature, the heat losses of the home will outpace the heat pump's ability to produce heat and the house will begin to cool down unless there is supplemental heat.

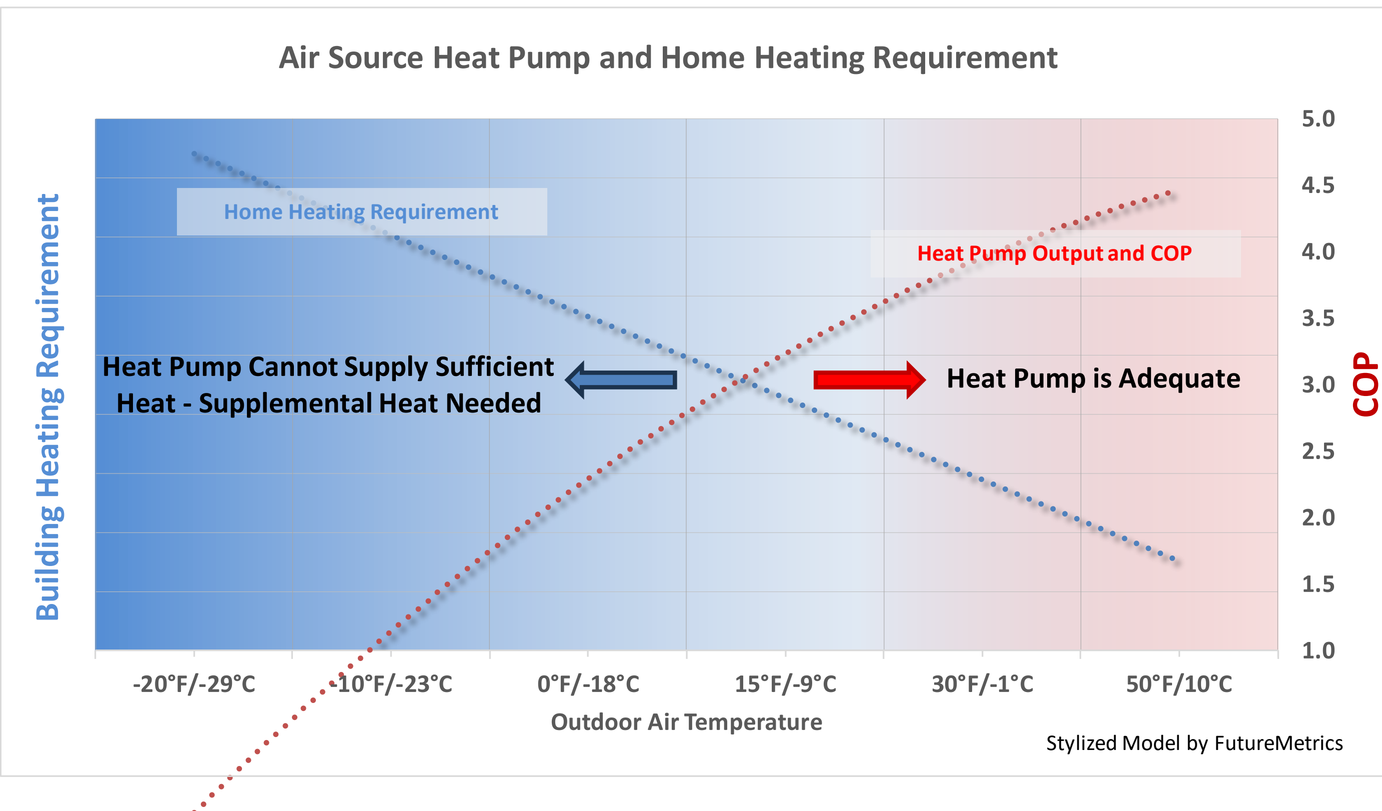

Figure 1 - Heat Pump, Building Heat Demand, and Outside Temperature

Some locations will rarely experience temperatures that cold. But some locations routinely have temperatures that drop below that threshold for extended periods of time.

[1] The chart is based on a stylized model. Actual home heat losses will depend on location and how well the home is insulated. Actual heat pump performance will vary by brand and design. However, the illustration is conceptually accurate. As some point as temperatures fall, the output of the heat pump will not be sufficient to match the building's heat losses.

Buildings in colder climates must have a secondary source of heat.

Case Study: Cost of Heating in Maine

There are plenty of examples of locations in which the winter delivers cold days. The locations used in this analysis are Old Town and Limestone, Maine[2]. Old Town has a winter profile that is similar to many northern cities. Limestone is an example of a location that experiences periods of very cold winter temperatures not unlike many cities along the northern border of the US, across Canada, and in northern Europe.

Figure 2 shows the hourly temperatures in Old Town and Limestone. Note that the average temperature in the mid-winter months in Limestone is about 6° C colder than in Old Town. However, Limestone experiences many more extreme cold weather days than Old Town.

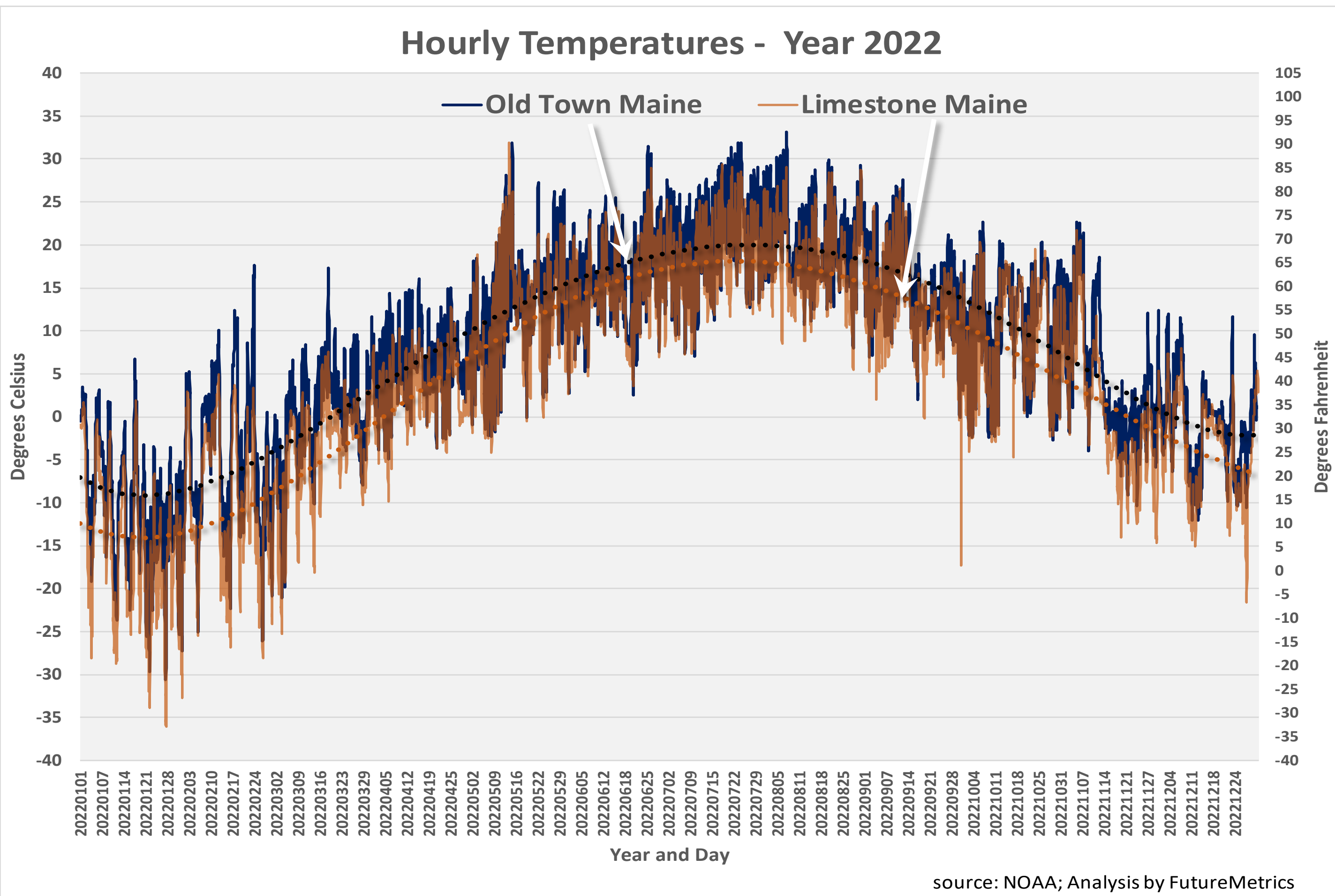

Figure 2 - Daily Temperatures in Old Town and Limestone Maine for the Year 2022

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[2] Google map of Old Town is HERE and Limestone is HERE. Datasets of hourly data from NOAA at THIS FTP site. Documentation HERE.

Maine is also a good example for a case study because the state is highly rural with very limited natural gas infrastructure. Maine has the highest proportion of heating oil used for heat of any US state. Figure 3 shows the top seven states in the US in terms of their use of heating oil.

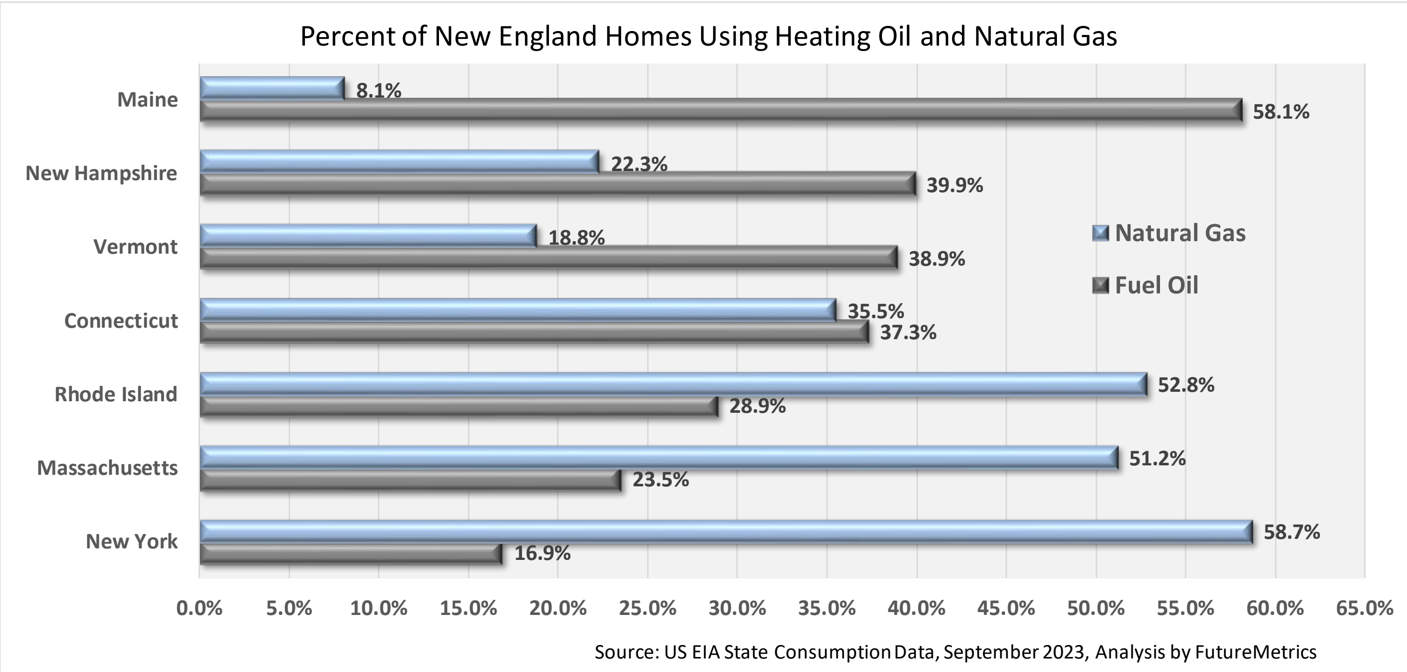

Figure 3 – Use of Natural Gas and Heating Oil in the NE States

Natural gas is currently the most economical heating fuel. But it is not an option for tens of millions of homes and businesses that are not connected to a pipeline. In many of those jurisdictions, there is both private sector and public sector advocacy for the installation of heat pumps as a lower cost option to heating oil (and propane).

What is almost universally not considered by policymakers and the public in North America is the value of using modern high efficiency, fully automatic, and very low emissions, wood pellet fueled central heating systems[3]. These appliances are common in many European countries but are not common in the US and Canada.

In some of those relatively milder locations heat pumps may be the best option. But, as shown in Figure 1, there are days and nights in cold locations during which heat pumps cannot supply sufficient heat.

Compounding the issue of supplying insufficient heat, the cost of that heat over the span of the winter cannot be based on a COP of 4 or 5. As it gets colder, the COP falls and the kWh's of electricity needed to produce a kWh of heat converges from perhaps 0.25 (COP of 4) to one-to-one (COP of 1) at extremely cold temperatures (at a COP of 1 the cost of a kWh of heat is the same as the cost of a kWh of electricity). The colder it gets, the higher the cost of heat from a heat pump.

[3] See HERE for information on pellet boilers.

Further compounding the issue of supplying insufficient heat is that, as noted above, many popular brands of residential heat pumps cease to operate below about -25°C (-13°F)[4].

When the building needs the heat the most, the heat pumps will not deliver.

As it turns out, and as will be shown below, there is a significant cost savings in heating buildings with pellet fueled central heating systems versus heat pumps in locations in which the winter delivers very cold temperatures.

The analysis below compares the overall operating cost of heat pumps and pellet fueled boilers.

Estimating the Annual Cost of Heating a Home

FutureMetrics has modeled the demand for heat based on the temperature profile of the location (in this case, Old Town and Limestone Maine). The size of the building (in square feet or square meters) and how well it is insulated sets the basis for the heat demand.

The heat losses of the building are based on tables used by contractors showing the needed energy per square foot or square meter across a span of temperatures and R factors[5]. Obviously as the outside temperature falls, the energy required by the building to stay warm increases. The model does not consider wind chill. The results therefore are "best case" because on those cold days with the wind is blowing, heat losses are greater than the baseline.

The COP of the heat pump is based on the outside temperature and is derived from tables produced by a major heat pump manufacturer.

For the Maine case study, the model uses the delivered cost of residential electricity. Figure 4 shows the most recent data from the Maine Public Utilities Commission.

RESIDENTIAL ELECTRICITY RATES IN MAINE

As of July 1, 2023*

	% of State Residential Load (4)	kWh	Delivery Rate				Standard Offer Rate ¢/kWh	Total Rate ¢/kWh
			Distribution ¢/kWh	Transmission ¢/kWh	Stranded Cost ¢/kWh	Total Delivery ¢/kWh		
INVESTOR-OWNED UTILITIES								
Central Maine Power	80.0%	4,053,651,315	6.6	3.8	1.0	11.4	16.6 (1)	28.0 ¢/kWh
Versant Power - BHD	12.6%	639,905,091	8.7	4.4	1.7	14.8	15.4 (1)	30.2 ¢/kWh
Versant Power - MPD	3.8%	194,466,683	8.5	2.6	1.1	12.2	14.9	27.1 ¢/kWh

Table 1 - Residential Power Rates in Maine

[4] See HERE.
[5] See HERE.

The weighed average cost of delivered residential power in Maine is $0.2724/kWh. Power prices have not fluctuated much. A sensitivity analysis later in the paper shows the impact that higher or lower power prices have on the comparison between heat pump heat costs and pellet fueled central heating system heat costs.

Determining what price per short ton to use in this analysis requires looking at the longer-term trend. Figure 5 below shows the price of pellets per short ton from 1995 to the present (28 years). As would be expected just from basic inflation, the price has trended upward. The recent spike in price is unusual. It is likely that market forces will change that trajectory and that prices will trend back toward the long-term average. However, just as with power prices, the sensitivity analysis later in this paper will show the impact on the advantage or disadvantage of pellet heat over heat pump heat from different per ton pellet costs. For the analysis that follows, the baseline input is $300 per short ton.

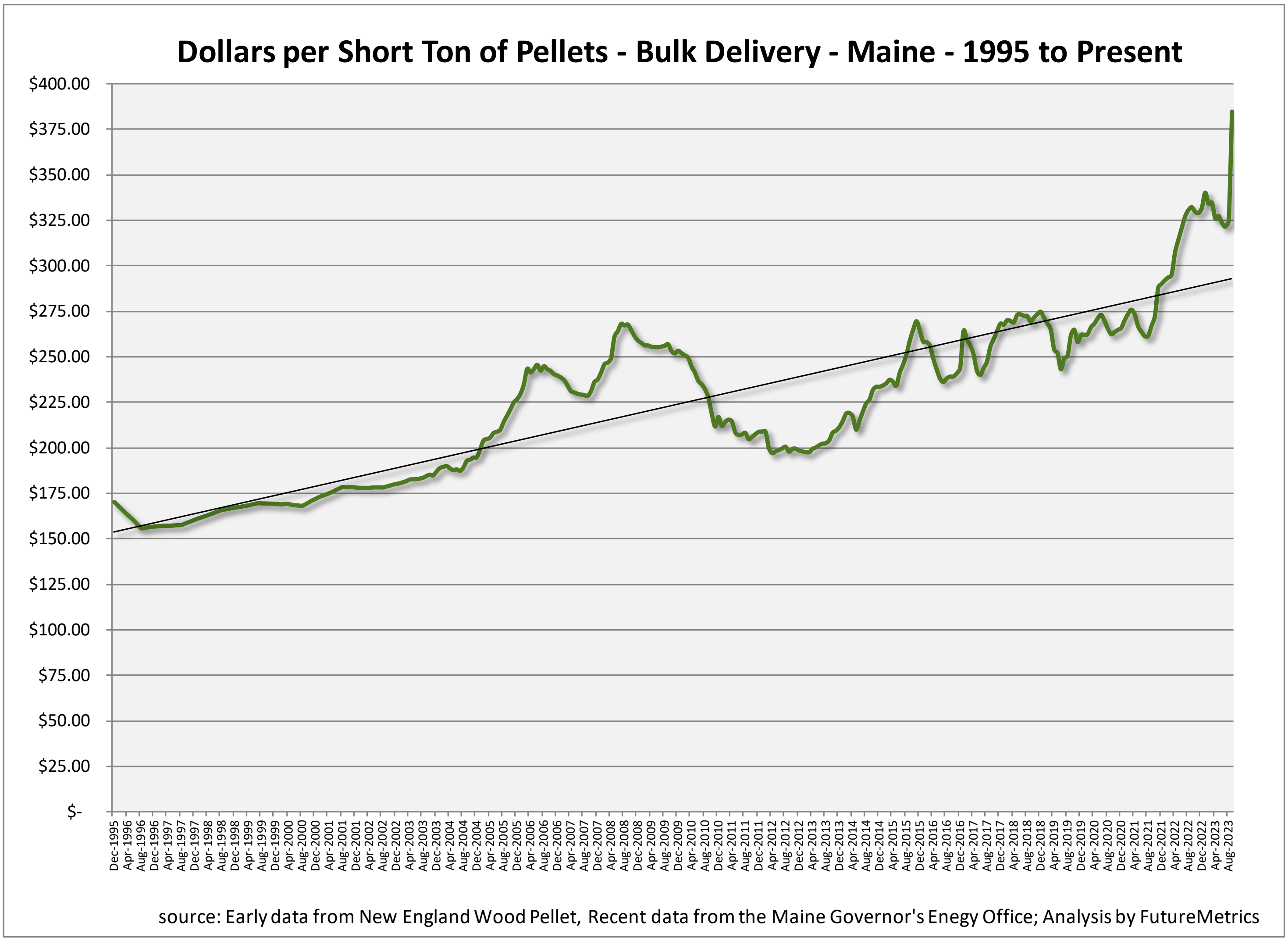

Figure 4 - Price of Bulk Delivered Wood Pellets in Maine - 1995 to Present

Maine is one of only a few states that have so-called thermal RECs[6]. RECs are renewable energy credits that are part of the state's renewable portfolio standards (RPS). RECs have traditionally only been awarded to the MWh's of electricity (not heat) generated from renewable sources. Recognizing that pellet fuel is renewable, in Maine, high efficiency pellet fueled heating systems that are independently audited for pellet fuel consumption can receive one thermal REC (TREC) for every MWh of useful heat produced (after adjusting for the efficiency of the heating system). Later this analysis will show the significant benefit that TRECs bring to the cost of heating with pellets in Maine.

But first the more general analysis that will be applicable to any jurisdiction.

The inputs to the analysis can be changed to any combination of real-world values. What follows is just one potential set of input parameters.

The tables below are from the Excel model. The yellow shaded cells are inputs that can be changed.

	Max Heat Pump Output		House size (ft^2)	House size (m^2)
	28,000	BTU/hour	**1,800**	**167.2**
	8.2	kW	Electricity Cost per kWh	
Number of heat pumps ==>	**1**		**$0.2724**	

Table 2 - Basic Model Input Parameters

For this example, we are assuming a home that is 167.2 square meters (1,800 square feet). The cost for power is from Table 1. The home has one 8.2 kW (28,000 BTU/hour) heat pump. The impact of adding an additional heat pump is shown in the analysis below.

The cost of heating oil and pellets are as shown in Table 3.

		kWh per gallon and ton	BTU per gallon and ton	Cost per kWh
Price of Heating Oil (gallon)	**$3.70**	**41.0**	**139,898**	**$0.104**
Price of Bulk Pellets (short ton)	**$300**	**4,850**	**16,548,879**	**$0.071**
Heating System Efficiency	**87%**			

Table 3 - Fuel Input Parameters

For the Old Town location with the inputs shown above, the result of the analysis (Table 4 below) shows that the home will need to supplement about 13.4% of its annual heat demand with other fuels. In colder climates, supplemental heat will always be needed.

[6] See HERE.

1,800 sq ft (167.2 sq m) Home with One 28,000 BTU/hour (8.2kW) Heat Pump in Old Town Maine						
Assumes Buiding Insulaton is Average	Heat Pump Operating Cost	Cost of Needed Supplemental Fuel	Subtract TREC Benefit for Maine? No	Total Heating Cost per Year	Advantage Disadvantage	Percent Improvement
Total Cost with Heat Pump and Oil	$2,564	$551	$0	$3,115		
Total Cost with Heat Pump and Pellets	$2,564	$377	$0	$2,941	$173	5.6%
Total Cost with 100% Pellets	$0	$2,823	$0	$2,823	$291	9.3%
Supplemental heat needed as Percent of Total Heat Required ==> 13.4%						
Cost per Year if 100% Heating Oil ==>		$4,119	<== $1,296 More costly than 100% pellets			

Analysis by FutureMetrics

Table 4 - Results for 1,800 sq ft (167.2 sq m) Home with One 28,000 BTU/hour (8.2kW) Heat Pump in Old Town Maine

If the home were heated solely with a pellet fueled central heating system, it would cost about $291 per year less than the heat pump and heating oil option (about a 9.3% annual savings). Note that the annual cost to heat that same home with 100% heating oil would be about $4,120; almost $1,300 per year more costly than with a pellet fueled central heating system.

The advantage or disadvantage of using a heat pump is sensitive to the cost of the pellets and the electricity. Table 5 shows those combinations that result in annual savings (green) from 100% pellet heating and those that do not.

Pellet Central Heating System Advantage or Disadvantage at Different Costs for Pellets and Power - Old Town Maine - Average Insulation

No TREC Benefit		Price of Pellets						
Per Metric Tonne =>		$242	$275	$308	$341	$374	$407	$440
Per Short Ton =>		$220	$250	$280	$310	$340	$370	$400
Power Cost per kWh	$0.34	$1,680	$1,398	$1,116	$833	$551	$269	-$14
	$0.30	$1,304	$1,021	$739	$457	$174	-$108	-$390
	$0.26	$927	$645	$363	$80	-$202	-$484	-$767
	$0.22	$551	$268	-$14	-$296	-$579	-$861	-$1,143
	$0.18	$174	-$108	-$390	-$673	-$955	-$1,237	-$1,520
	$0.14	-$202	-$485	-$767	-$1,049	-$1,332	-$1,614	-$1,896
	$0.10	-$579	-$861	-$1,143	-$1,426	-$1,708	-$1,990	-$2,273
		1,800sq. ft. Home with One 28,000 BTU/hour Heat Pump						
Green cells = Pellet fueled central heating system is lower cost								

Analysis by FutureMetrics

Table 5 - Sensitivity to changes in pellet cost and power cost - Old Town

As the winter temperatures in a location becomes more harsh, the metrics shift more in favor of pellet heat. Table 6 below shows the results of the analysis for the Limestone Maine location.

1,800 sq ft (167.2 sq m) Home with One 28,000 BTU/hour (8.2kW) Heat Pump in Limestone Maine						
Assumes Buiding Insulaton is Average	Heat Pump Operating Cost	Cost of Needed Supplemental Fuel	Subtract TREC Benefit for Maine? No	Total Heating Cost per Year	Advantage Disadvantage	Percent Improvement
Total Cost with Heat Pump and Oil	**$2,880**	**$973**	**$0**	**$3,853**		
Total Cost with Heat Pump and Pellets	**$2,880**	**$667**	**$0**	**$3,547**	**$306**	**7.9%**
Total Cost with 100% Pellets	**$0**	**$3,270**	**$0**	**$3,270**	**$583**	**15.1%**
Supplemental heat needed as Percent of Total Heat Required ==> 20.4%						
Cost per Year if 100% Heating Oil ==>		**$4,771**	**<== $1,501 More costly than 100% pellets**			

Analysis by FutureMetrics

Table 6 - Results for 1,800 sq ft (167.2 sq m) Home with One 28,000 BTU/hour (8.2kW) Heat Pump in Limestone Maine

The supplemental heat requirement increases to over 20%. The annual savings with 100% pellet heat versus the heat pump and heating oil option increase to nearly $600 per year. If power costs are high and pellet costs are low, the annual savings under the 100% pellet option are substantial.

Pellet Central Heating System Advantage or Disadvantage at Different Costs for Pellets and Power - Limestone Maine - Average Insulation

No TREC Benefit		Price of Pellets						
Per Metric Tonne =>		**$242**	**$275**	**$308**	**$341**	**$374**	**$407**	**$440**
Per Short Ton =>		**$220**	**$250**	**$280**	**$310**	**$340**	**$370**	**$400**
Power Cost per kWh	**$0.34**	$2,170	$1,843	$1,516	$1,189	$862	$535	$208
	$0.30	$1,747	$1,420	$1,093	$766	$439	$112	-$215
	$0.26	$1,324	$997	$670	$343	$16	-$311	-$638
	$0.22	$901	$574	$247	-$80	-$407	-$734	-$1,061
	$0.18	$478	$151	-$176	-$503	-$830	-$1,157	-$1,484
	$0.14	$56	-$271	-$598	-$925	-$1,252	-$1,579	-$1,906
	$0.10	-$367	-$694	-$1,021	-$1,348	-$1,675	-$2,002	-$2,329
		1,800sq. ft. Home with One 28,000 BTU/hour Heat Pump						
Green cells = Pellet fueled central heating system is lower cost								

Analysis by FutureMetrics

Table 7 - Sensitivity to changes in pellet cost and power cost - Limestone

What if two heat pumps were used in the Limestone house? Table 8 below shows that the need for supplemental heat declines from about 20.4% to 7.9%. But the annual cost to heat the home increases!

1,800 sq ft (167.2 sq m) Home with Two 28,000 BTU/hour (8.2kW) Heat Pumps in Limestone Maine						
Assumes Buiding Insulaton is Average	Heat Pump Operating Cost	Cost of Needed Supplemental Fuel	Subtract TREC Benefit for Maine? No	Total Heating Cost per Year	Advantage Disadvantage	Percent Improvement
Total Cost with Heat Pump and Oil	$3,601	$375	$0	$3,976		
Total Cost with Heat Pump and Pellets	$3,601	$257	$0	$3,858	$118	3.0%
Total Cost with 100% Pellets	$0	$3,270	$0	$3,270	$706	17.8%
Supplemental heat needed as Percent of Total Heat Required ==> 7.9%						
Cost per Year if 100% Heating Oil ==>		$4,771	<== $1,501 More costly than 100% pellets			
						Analysis by FutureMetrics

Table 8 – Results for 1,800 sq ft (167.2 sq m) Home with Two 28,000 BTU/hour (8.2kW) Heat Pumps in Limestone Maine

More heat is produced from the two heat pumps, but it is costly heat when the temperatures are very low. And they still do not produce any heat during very cold periods. Depending on the size of the building, adding more heat pumps in a cold climate will increase the total annual heating cost versus using supplemental fuel when the temperatures are very low.

Some homes in rural locations are poorly insulated. This is particularly the case for lower income homeowners.

1,800 sq ft (167.2 sq m) Home with One 28,000 BTU/hour (8.2kW) Heat Pump in Limestone Maine						
Assumes Buiding Insulaton is Below Average	Heat Pump Operating Cost	Cost of Needed Supplemental Fuel	Subtract TREC Benefit for Maine? No	Total Heating Cost per Year	Advantage Disadvantage	Percent Improvement
Total Cost with Heat Pump and Oil	$3,223	$2,309	$0	$5,531		
Total Cost with Heat Pump and Pellets	$3,223	$1,582	$0	$4,805	$726	13.1%
Total Cost with 100% Pellets	$0	$4,578	$0	$4,578	$954	17.2%
Supplemental heat needed as Percent of Total Heat Required ==> 34.6%						
Cost per Year if 100% Heating Oil ==>		$6,679	<== $2,101 More costly than 100% pellets			
						Analysis by FutureMetrics

Table 9 - Results for Poorly insulated 1,800 sq ft (167.2 sq m) Home with One 28,000 BTU/hour (8.2kW) Heat Pump in Limestone Maine

In the case shown in Table 9 assuming that the heat losses are 40% higher than the average home, supplemental heat is needed more frequently and the total heating cost with the heat pump supplemented with heating oil option is almost $2,000 per year higher than with 100% pellets.

Clearly insulating homes should be a priority.

But putting heat pumps in poorly insulated homes occupied by lower income families in cold climates will increase their economic hardship versus the use of 100% pellets for heating fuel.

A heat pump combined with the use of a heating oil boiler or furnace will save the homeowner about $1,150 per year versus 100% heating oil. A heat pump combined with a pellet fueled heating appliance will save the homeowner about $1,875 per year versus 100% heating oil.

What about TRECs in Maine?

The reader will have noticed that the tables above have zeros in the column for TRECs. If the homeowner is in Limestone Maine, they can benefit from the state of Maine's RPS. The bulk pellet fuel suppliers' records on the quantities of pellets delivered to each heating system combined with the known energy content of the pellet fuel and efficiency of the central heating system allows a homeowner to be rewarded for generating renewable heat.

TRECs have recently traded between $22/MWh and $25/MWh. Using $22/MWh, the Limestone homeowner will cut their effective cost of heating with pellet fuel by about 31%.

1,800 sq ft (167.2 sq m) Home with One 28,000 BTU/hour (8.2kW) Heat Pump in Limestone Maine						
Assumes Buiding Insulaton is Average	Heat Pump Operating Cost	Cost of Needed Supplemental Fuel	Subtract TREC Benefit for Maine? Yes	Total Heating Cost per Year	Advantage Disadvantage	Percent Improvement
Total Cost with Heat Pump and Oil	**$2,880**	**$973**	**$0**	**$3,853**		
Total Cost with Heat Pump and Pellets	**$2,880**	**$667**	**$206**	**$3,341**	**$513**	**13.3%**
Total Cost with 100% Pellets	**$0**	**$3,270**	**$1,012**	**$2,258**	**$1,595**	**41.4%**
Supplemental heat needed as Percent of Total Heat Required ==> 20.4%						
Cost per Year if 100% Heating Oil ==>		**$4,771**	**<== $2,513 More costly than 100% pellets**			

Analysis by FutureMetrics

Table 10 - Results WITH TRECs for 1,800 sq ft (167.2 sq m) Home with One 28,000 BTU/hour (8.2kW) Heat Pump in Limestone Maine

Under most power cost and pellet cost combinations, 100% pellet heating is better than a heat pump in Limestone.

Pellet Central Heating System Advantage or Disadvantage at Different Costs for Pellets and Power - Limestone Maine - Average Insulation

With TREC Benefit		Price of Pellets						
Per Metric Tonne =>		$242	$275	$308	$341	$374	$407	$440
Per Short Ton =>		$220	$250	$280	$310	$340	$370	$400
Power Cost per kWh	$0.34	$3,182	$2,855	$2,528	$2,201	$1,874	$1,547	$1,220
	$0.30	$2,759	$2,432	$2,105	$1,778	$1,451	$1,124	$797
	$0.26	$2,336	$2,009	$1,682	$1,355	$1,028	$701	$374
	$0.22	$1,913	$1,586	$1,259	$932	$605	$278	-$49
	$0.18	$1,490	$1,163	$836	$509	$182	-$145	-$472
	$0.14	$1,067	$740	$413	$86	-$241	-$568	-$895
	$0.10	$644	$317	-$10	-$337	-$663	-$990	-$1,317
		1,800sq. ft. Home with One 28,000 BTU/hour Heat Pump						
Green cells = Pellet fueled central heating system is lower cost								

Analysis by FutureMetrics

Table 11 - Sensitivity to changes in pellet cost and power cost – WITH TRECs and AVERAGE Insulation Limestone

And for poorly insulated homes the case for 100% pellet fueled central heating system is very strong.

Pellet Central Heating System Advantage or Disadvantage at Different Costs for Pellets and Power - Limestone Maine - Below Average

With TREC Benefit		Price of Pellets						
Per Metric Tonne =>		$242	$275	$308	$341	$374	$407	$440
Per Short Ton =>		$220	$250	$280	$310	$340	$370	$400
Power Cost per kWh	$0.34	$4,391	$3,933	$3,475	$3,017	$2,560	$2,102	$1,644
	$0.30	$3,917	$3,460	$3,002	$2,544	$2,086	$1,628	$1,171
	$0.26	$3,444	$2,986	$2,529	$2,071	$1,613	$1,155	$697
	$0.22	$2,971	$2,513	$2,055	$1,598	$1,140	$682	$224
	$0.18	$2,498	$2,040	$1,582	$1,124	$667	$209	-$249
	$0.14	$2,024	$1,567	$1,109	$651	$193	-$265	-$722
	$0.10	$1,551	$1,093	$636	$178	-$280	-$738	-$1,196
		1,800sq. ft. Home with One 28,000 BTU/hour Heat Pump						
Green cells = Pellet fueled central heating system is lower cost								

Analysis by FutureMetrics

Table 12 - Sensitivity to changes in pellet cost and power cost – WITH TRECs and BELOW AVERAGE Insulation Limestone

Conclusion

Policies that support decarbonization in the three energy sectors, transportation, power, and heating, are critical if CO_2 emissions targets are to be reached.

But the heating sector is often either overlooked or is under supported relative to the other two sectors. For any jurisdiction that experiences cold weather, heat is essential; and for some locations heat demand is the majority of the energy demand across all three major energy sectors.

Figure 5 on the next page[7] shows the energy sources and uses for the state of Maine. The data shows that transportation makes up about 28.3% of Maine's energy use, electricity makes up about 22.6%[8], and heat makes up the rest. In the residential sector, heat is 80% of the non-transportation energy used and electricity is 20%.

The state of Maine is one of the few states in the United States that explicitly recognizes the value of supporting the production of heat for homes and business produced from renewable sources. Thermal RECs move the heating sector into the same arena as the power generation sector in the RPS and thus provide support for using non-fossil fuels. This is policy that should be replicated across all northern tier jurisdictions.

[7] Based on US DOE/EIA data from August 2021. The Sankey chart is produced by the Lawrence Livermore National Laboratory and the Department of Energy.
[8] Note that 59.5% of the energy input into electricity generation is rejected. That is a result of how steam turbines require a condenser and a cooling solution for the condenser (often cooling towers).

FutureMetrics™ LLC
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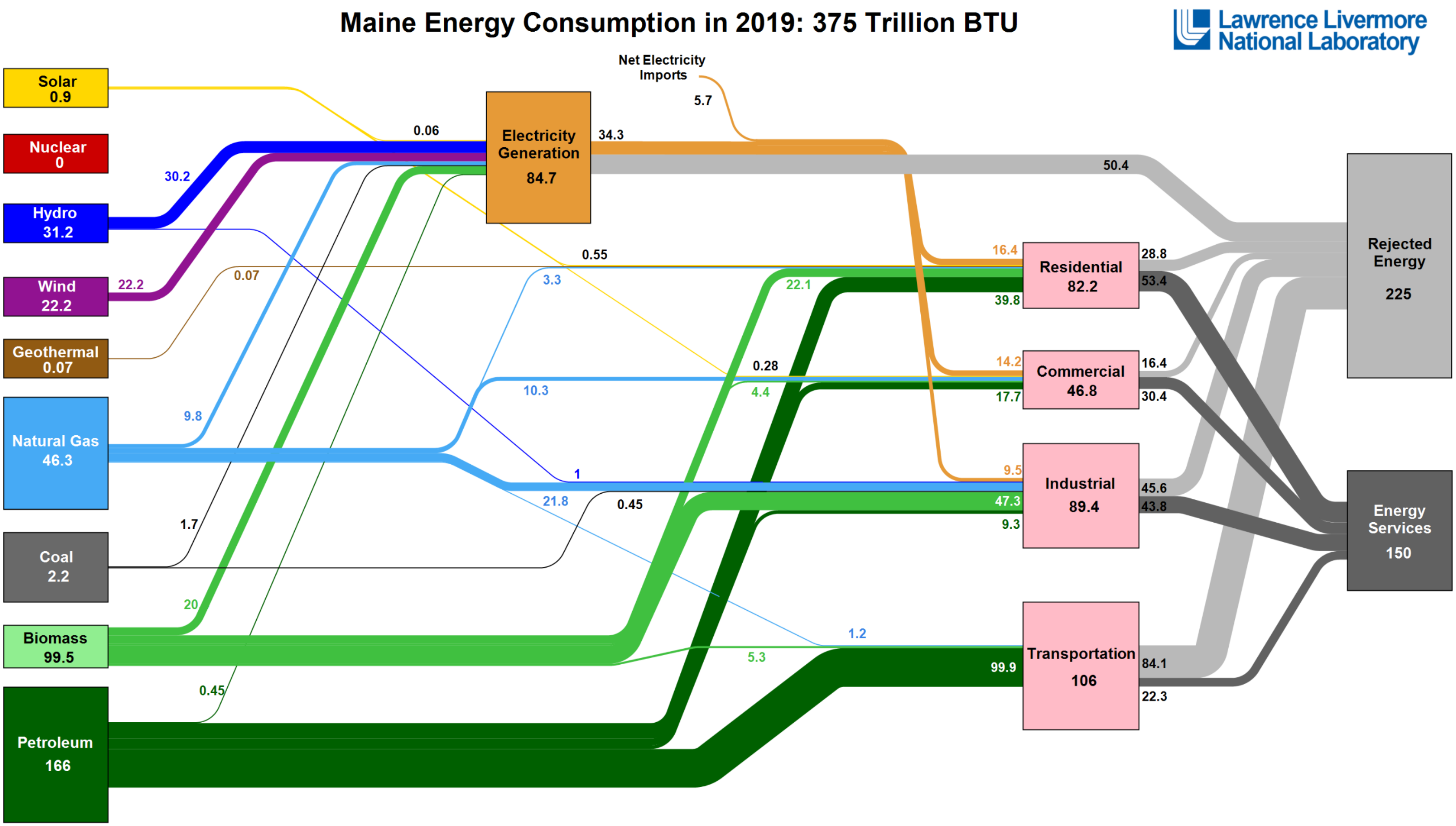

Figure 5 - Maine's Energy Flows

While the two example cities used in this analysis are in Maine, and the energy flow chart in Figure 5 is based on Maine, the results of the analysis are applicable to any location where there are harsh winter conditions.

The model used in this analysis has been bult to take in data from any location that has hourly data over the span of a year (8,760 rows of data). The inputs in the yellow shaded cells can easily be changed.

If the winter temperatures are low enough, power costs are high enough, and pellet fuel cost is low enough, heat pumps may not be the best option.

Pellets prices have also traditionally been far less volatile than heating oil prices even with the price increases that began with the covid pandemic. Figure 6 shows the cost to heat a typical home with pellets and heating oil. Note that the standard deviation of the annual cost of heating oil is about three times greater than the standard deviation of the annual cost for pellets. The risk of unexpected punishing heating cost is almost entirely mitigated if the home or business uses locally produced renewable wood pellet fuel.

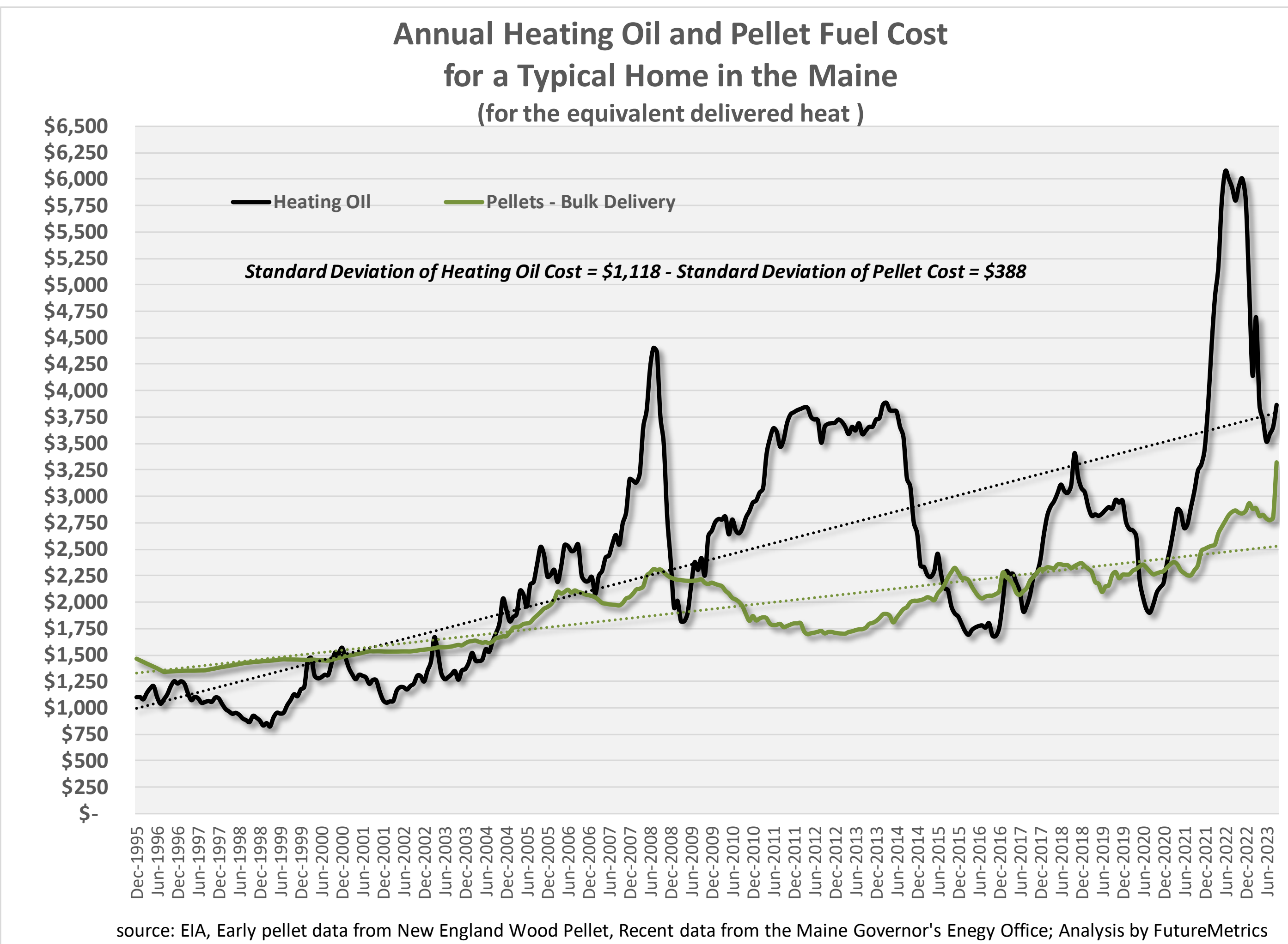

Figure 6 - Pellet and Heating Oil Cost in for a Typical Northern Home

This analysis has focused on the operating costs. The cost of purchasing and installing the heating systems matters as well. To view an interactive dashboard that shows the payback for a pellet heating system versus heating oil or propane, click HERE. The dashboard makes it clear that government policies matter in terms of tax credits and rebates[9].

But operating costs are what the homeowner is exposed to over the life of the heating system.

And the lower the homeowner is in the income distribution, the more critical it becomes to lower annual heating costs.

Heat pumps have a strong role to play and, in many locations, will be the best choice.

But across the northern tiers of the continents, heat pumps always need a source of supplemental heat; and often they are not the lowest cost option for heating buildings.

[9] FutureMetrics has produced several white papers that discuss the critical need for policies that address the need for a reduction in carbon emissions. The use of wood pellet heating should be in the portfolio of carbon emissions reduction strategies and policies in every jurisdiction that experiences cold winters.