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Fuel Cost Comparison Chart

Vern Hofman
Extension Agricultural Engineer

Kenneth Hellevang, Ph.D.
Extension Engineer

A relative cost comparison chart showing heating values for fuels and biomass can be helpful in deciding what type of fuel to use. The chart is arranged so the equivalent prices of each fuel, the cost to deliver a given amount of heat based upon a specific heating efficiency, are located in the same column. For example, if the price of Number 2 fuel oil is $1.00 per gallon, the equivalent cost is 3.5 cents per kWh for electricity, $87.99 cents per ton for coal, $3.48 per bushel for hard red spring wheat, or $8.00 per cwt for sunflower seed.

Heating efficiencies vary depending on the type, quality and condition of the burner and the heat exchanger. Some of the newer natural gas and propane burners have heating efficiencies that are above 90 percent while others may have overall efficiencies of 75 percent or less. Also, if burners are not maintained properly, they may operate at 70 to 75 percent efficiency and the heat exchanger may have an efficiency of only 75 to 80 percent, reducing the overall heating efficiency to only 50 to 60 percent. Burner efficiency is controlled by adjusting the air-to-fuel ratio and the fuel injection system to allow for efficient combustion. If inefficient combustion occurs, soot may build up on the heat exchanger and insulate it, so more heat will go up the chimney and less will move through the heat exchanger. Inefficient combustion also produces more carbon monoxide.

For maximum efficiency, efficient combustion along with maximum heat transfer through the heat exchanger must occur. Heating contractors and service people have equipment to test combustion efficiency and to remove soot from heat exchangers. Heating equipment inspections by competent service people will help make heating equipment safer. Cracks in heat exchangers that allow carbon monoxide to escape from the burner into an inhabited area should be repaired or replaced immediately.

As energy costs rise, more efficient ways to provide heat become more attractive even though they may be more expensive to install. Heat pumps that extract heat from the air have been in use for a number of years. Extracting heat from the earth with heat pumps is a newer and more efficient method.

The efficiency of air source heat pumps varies widely. As the outside air temperature goes down, the efficiency of the heat pump decreases to less than 100 percent near 0 degrees F. Over the entire heating season the air source heat pump will usually show a significant cost advantage over electric resistance heating, and during the summer it will convert to an air conditioner.

Earth source heat pumps may show a 300 to 400 percent advantage in efficiency over electric resistance heating. These units circulate an antifreeze solution through pipes in the earth to transfer energy. Other earth source systems draw

NDSU EXTENSION SERVICE
North Dakota State University
Fargo, North Dakota 58105

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Heating Efficiency	Equivalent Price of Each Fuel																	
100%	2	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	Electric Resistance kWh (3,413 Btu/kWh)
200%	4	5	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	Heat Pump (Air Source) kWh (3,413 Btu/kWh)
350%	7	8.75	10.5	12.3	14.0	15.8	17.5	19.3	21.0	22.8	24.5	26.3	28.0	29.7	31.5	33.2	35.0	Heat Pump (Earth Source) kWh (3,413 Btu/kWh)
92%	0.54	0.67	0.81	0.94	1.08	1.21	1.35	1.48	1.62	1.75	1.89	2.02	2.15	2.29	2.43	2.56	2.69	Natural Gas $/Therm High Efficiency (100,000 Btu/Therm)
75%	0.44	0.55	0.66	0.77	0.88	0.99	1.10	1.21	1.32	1.43	1.54	1.65	1.76	1.87	1.98	2.09	2.19	Natural Gas $/Therm Low Efficiency (100,000 Btu/Therm)
70%	0.55	0.69	0.83	0.97	1.11	1.25	1.38	1.52	1.66	1.80	1.94	2.08	2.21	2.35	2.49	2.63	2.76	#1 Fuel Oil (Diesel Fuel) $/Gal. (135,000 Btu/Gal.)
70%	0.57	0.72	0.86	1.00	1.15	1.29	1.43	1.58	1.72	1.87	2.01	2.15	2.30	2.44	2.58	2.73	2.87	#2 Fuel Oil and Diesel Fuel $/Gal. (140,000 Btu/Gal.)
75%	0.4	0.51	0.61	0.71	0.81	0.91	1.01	1.11	1.21	1.31	1.41	1.51	1.62	1.72	1.82	1.92	2.02	Propane $/Gal. (92,000 Btu/Gal.)
92%	0.5	0.62	0.74	0.87	0.99	1.12	1.24	1.37	1.49	1.62	1.74	1.87	1.98	2.11	2.23	2.35	2.48	Propane $/Gal. High Efficiency (92,000 Btu/Gal.)
75%	0.28	0.35	0.43	0.50	0.57	0.64	0.71	0.78	0.85	0.92	0.99	1.06	1.14	1.21	1.28	1.35	1.42	Methanol $/Gal. (64,700 Btu/Gal.)
75%	0.3	0.37	0.44	0.52	0.59	0.66	0.73	0.81	0.88	0.95	1.03	1.10	1.18	1.25	1.33	1.40	1.48	Ethyl Alcohol 160 Proof $/Gal. (67,200 Btu/Gal.)
75%	0.33	0.42	0.50	0.58	0.67	0.75	0.83	0.92	1.00	1.08	1.17	1.25	1.33	1.41	1.49	1.58	1.66	Ethyl Alcohol 180 Proof $/Gal. (75,600 Btu/Gal.)
75%	0.37	0.46	0.55	0.65	0.74	0.83	0.93	1.02	1.11	1.20	1.30	1.39	1.48	1.57	1.66	1.75	1.84	Ethyl Alcohol 200 Proof $/Gal. (84,000 Btu/Gal.)
75%	0.53	0.66	0.80	0.93	1.06	1.20	1.33	1.46	1.59	1.73	1.86	2.00	2.12	2.26	2.39	2.52	2.65	Gasohol (90/10) $/Gal. (120,900 Btu/Gal.)
75%	0.54	0.68	0.82	0.95	1.09	1.23	1.36	1.50	1.63	1.77	1.91	2.04	2.18	2.32	2.45	2.59	2.72	Gasoline Unleaded $/Gal. (124,000 Btu/Gal.)
70%	0.53	0.66	0.80	0.93	1.06	1.20	1.33	1.46	1.59	1.73	1.87	2.04	2.13	2.27	2.40	2.53	2.66	Vegetable Oil $/Gal. (130,000 Btu/Gal.)
65%	68.56	85.7	102.84	119.98	137.12	154.26	171.40	188.54	205.68	222.82	239.96	257.10	274.24	291.38	308.52	325.66	342.80	Sunflower Oil Meal $/Ton (9,000 Btu/lb)
65%	61.7	77.13	92.56	107.98	123.41	138.84	154.26	169.69	185.11	200.54	215.97	231.39	246.82	262.25	277.67	293.10	308.52	Sunflower Hulls $/Ton (8,100 Btu/lb @ 8% moisture)
65%	4.57	5.71	6.85	8.00	9.14	10.28	11.43	12.57	13.71	14.85	16.00	17.14	18.28	19.42	20.57	21.71	22.85	Sunflower Seeds $/Cwt. (12,000 Btu/lb @ 8% moisture)
65%	1.81	2.27	2.72	3.17	3.63	4.08	4.53	4.98	5.44	5.89	6.35	6.80	7.25	7.70	8.16	8.61	9.06	Shelled Corn $/Bushel (8,500 BTU/lb @ 15.5% moisture)
65%	1.99	2.49	2.98	3.48	3.98	4.47	4.97	5.47	5.96	6.46	6.96	7.46	7.95	8.45	8.95	9.44	9.94	HRS Wheat (Grain) $/Bushel (8,700 Btu/lb @ 13.5% moisture)
65%	1.5	1.87	2.25	2.62	3.00	3.37	3.75	4.12	4.50	4.87	5.25	5.62	5.99	6.37	6.75	7.12	7.49	Barley (Grain) $/Bushel (8,200 Btu/lb @ 12.5% moisture)
65%	57.13	71.42	85.70	99.98	114.27	128.55	142.84	157.12	171.40	185.69	199.97	214.25	228.53	242.82	257.10	271.39	285.67	Wheat and Barley Straw $/Ton (7,500 Btu/lb @ 8% moisture)
50%	30.23	37.78	45.34	52.90	60.45	68.01	75.57	83.13	90.68	98.24	105.79	113.35	120.91	128.67	136.02	143.58	151.14	Wood (Air Tight Stove) $/64 cft (½ standard cord) 65% Wood and 35% Air (6,200 Btu/lb @ 20% moisture) 40 lb/cft of Solid Wood
65%	50.27	62.85	75.42	87.99	100.56	113.13	125.70	138.27	150.84	163.40	175.97	188.54	201.11	213.68	226.25	238.82	251.39	Coal (Lignite) $/Ton (6,600 Btu/lb @ 12% moisture)

Example 1:
Compare the cost of electricity at $.04/kWh, 100% efficiency, to the cost of propane at 92,000 Btu/Gal in a 75% efficient furnace.

Example 2:
Compare the cost of natural gas at $.81/CCF in a 92% efficient furnace to the cost of propane at 92,000 Btu/Gal in a 75% efficient furnace.

Comparative Cost Equation:

$$\text{Comparative Cost Fuel A} = \left[\frac{\text{Heat Value Fuel A} \times \text{Heating Efficiency Fuel A}}{\text{Heat Value Fuel B} \times \text{Heating Efficiency Fuel B}}\right] \times \text{Cost of Fuel B}$$

$$\text{Example 1: Propane Cost} = \left[\frac{92{,}000\ \text{Btu/Gal.} \times .75\ \text{Heating Efficiency}}{3{,}413\ \text{Btu/kWh} \times 1.00\ \text{Heating Efficiency}}\right] \times .04\ \text{Electricity Cost/kWh} = \$.81\ \text{per Gal. Propane}$$

$$\text{Example 2: Propane Cost} = \left[\frac{92{,}000\ \text{Btu/Gal.} \times .75}{100{,}00\ \text{Btu/CCF} \times .92}\right] \times \$.81/\text{CCF} = \$.61/\text{gallon}$$

water from one well, circulate it through a heat exchanger and discharge the water to another well. Since the heat source, earth or groundwater, is normally warmer than air, and doesn't vary as much as air temperature, these units have a higher efficiency, but burying pipes in the earth or digging wells is an added expense.

Several other materials that occasionally may be considered and used as alternate fuels are listed. These are included so their economic value may be compared. These include feed grains, alcohols, vegetable oil, gasoline and diesel fuel.

A comparison of heating cost needs to include capital and labor costs in addition to the cost of the energy or fuel.

If a homeowner wants to estimate annual home heating cost, the following chart may give some help. A well-insulated, 1,500 square foot home in North Dakota will require about 80 million Btus of heat during a year's time. A 3,000 square foot well-insulated home will require about two times as much energy. An older, poorly insulated 1,500 square foot home may require up to five times as much heat as compared to a well-insulated home. With fluctuating fuel costs, it is important for homeowners to insulate walls and ceilings and seal cracks around doors and windows along with selecting a new heat source.

Estimated Annual Heating Cost for Selected Fuels*

Fuel Type	Heating Efficiency	Fuel Cost	Energy use per year for a 1,500 square foot home	Energy cost for a well insulated 1,500 square foot home
Elec. Res. .... 3413 Btu/kWh	100%	$0.03/kWh	23440 kWh	$703.20
Propane .... 92,000 Btu/gal	92%	$0.90/gal	945 gal	$850.50
Natural Gas .... 100,000 Btu/therm	92%	$0.70/therm	870 therms	$609.00
Fuel Oil .... 140,000 Btu/gal	70%	$1.00/gal	816 gal	$816.00
Coal .... 6,600 Btu/lb	65%	$60.00/ton	9.32 tons	$559.20
Vegetable Oil .... 130,000 Btu/gal	70%	$1.50/gal	879 gal	$1318.50
Shelled Corn .... 8,500 Btu/lb	65%	$2.00/bu	258 bushels	$516.00
Wheat Straw .... 7,500 Btu/lb	65%	$30.00/ton	8.20 tons	$246.00
Wheat (Grain) .... 8,700 Btu/lb	65%	$3.00/bu	236 bushels	$708.00

Note: The chart includes only an estimate for fuel cost. It does not include costs for furnace equipment, installation of the equipment and fuel handling equipment.

* This chart is based on 9000 heating degree days (HDD) for North Dakota. The estimated annual heat use for a 1500 sq. ft. well-insulated home is 80 Million BTU for a heating season. This is determined from a home with the following R-values: Walls R-19, Ceiling R-38, Basement walls R-10 and including an air infiltration rate of 0.5 air changes per hour.

Heating Unit Relationships

Natural Gas

- 1 cubic foot = 1000 Btu
- 100 cubic feet = 100,000 Btu = 1 Therm

Electric

- 3413 Btu = 1 kWh = 1000 watts used for 1 hour
- 1 Btu is the energy needed to raise the temperature of 1 pound of water 1 degree Fahrenheit

For more information on this and other topics, see: www.ag.ndsu.nodak.edu

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