Comparing the Energy Consumption and Operating Costs of a typical NH Home using Different Fuels

Step 1 - Determine the Design Heating Load (Btuh) (Energy Output required):

A typical 2,000 ft^2 NH home has a heating load of: **38,722** Btu / hour

For detailed calc.s See "**2) Heating Load Calc.s**" tab **2,000** ft^2

Step 2 - Calculate Energy Input required based on Design Heating Load (Btuh):

The **Energy Input** is the required annual fuel consumption, adjusted upward to account for system efficiency losses (heating and distribution system losses).

$$F_{consump.} = \frac{(HL \times 24 \times HDD)}{((Eff._{heating} * Eff._{dist.}) \times Fuel\ factor \times \Delta T)}$$

Where:

F = the annual fuel consumption [units of respective fuel]
HL = is the design heating load [Btus]
24 = conversion factor to get units in per hour format … 24 hr/day
HDD = Heating Degree Days based on 65 degrees F in units of: [degree F * days]
Eff. $_{heating}$ = seasonal efficiency of the heating system [%]
Eff. $_{dist.}$ = is the efficiency of the distribution system (i.e. ducts, hydronic) [%]
Fuel Factor = is the heating value of the fuel [kWh, gallons, therms]
Δ**T** = is the delta T or temp. difference of Balance Point 70 F minus design temp. -15 F [degree F]

Step 2a - Add Ancillary Electric Usage to Energy Input Figures

Ancillary electric usage must be added to the Energy Input figures to account for the additional energy required by the furnace fan blower motors and hot water circ. pumps and burner. These kWh usage figures are added to the fossil fuel consumption figures to yield Total Costs for the system.

Step 3 - Apply Fuel Costs to Energy Input required:

See "**4) Fuel Cost Data**" tab

Assumptions:

1) Heating Degree Days - Concord, NH with base of 65 degree F = **7,478**

2) System Efficiencies and MMBTU Fuel Conversion Factors

Fuel Source	Fuel Units	BTUs per Fuel Unit	Seasonal Efficiency	Distribution Efficiency
Electric Heat - Rate R	kWh	3,413	100%	100%
Electric Heat w/ HEAT SMART	kWh	3,413	100%	100%
#2 Fuel Oil	gallon	139,000	80%	90%
Liquid Propane	gallon	91,600	80%	90%
Natural Gas	therms	100,000	80%	90%
Air-to-Air Heat Pump	kWh	3,413	200%	90%
Geo-thermal Heat Pump	kWh	3,413	350%	95%

Heating system efficiency depends upon age, condition, fuel type, etc...

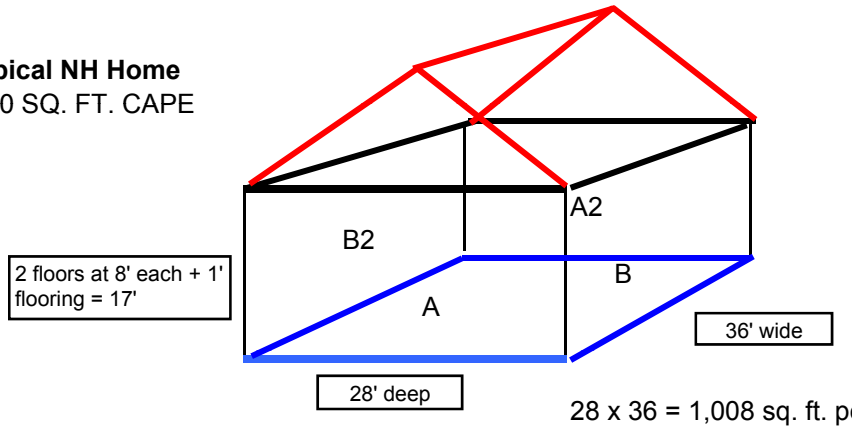
Distribution system depends upon type (hot air, hydronic, etc…) age, condition, location, etc…

3) ΔT Calc. Assumptions: Balance Point temp. = 70 F, the Design temp. = -15 F yielding a ΔT = 85 F

Footnotes:

1) Heating Degree Days (HDD) taken from NOAA for Concord, NH see www.noaa.gov
2) MMBTU Fuel conversion Factors taken from generally accepted figures (ASHRAE, RESNET etc…)
3) Heating / Dist.System efficiencies from Bruce Harley of CSG (9/05) and Bob Kahabka through field experience (11/05)
4) Ancillary Electric Usage: PSNH Tariff Form 3010 10/01/02. Took 50/50 avg. & 6 months heating (144+122)/2 = 133 kWh/mo.
Heat Sys-Hot Air 1/2HP Motor (<2000SF) = 144 kWh / month & Heat Sys-Hot Water (>1 Zone Circ+Burner) = 122 kWh / month

Typical NH Home
2,000 SQ. FT. CAPE



28 x 36 = 1,008 sq. ft. per floor or 2,016 sq. ft.
Volume = 16,128 cu. Ft.
(V = 1,008 x 2 x 8)

1) Walls A,A2,B,B2 surface area = 2,176

	% of Area	Effective Avg. R-value	Weighted R Value	
Windows/doors	18%	2	0.36	
Studs	13%	5	0.65	
Wall Cavity	69%	13	8.97	(2x4 16" OC)
Weighted R-value			**9.98**	
Weighted U-factor			0.1002	

2) Ground floor, attic ceiling = 2,016

	% of Area	Avg. R-value	Weighted R Value
Studs	13%	6	0.78
Joist Cavity	87%	19	16.53
Weighted R-value			17.31
Weighted U-factor			0.0578

3) Combined

	Weighted R-value	Sq. Ft.
1)	9.98	2,176
2)	17.31	2,016
Weighted R-value	**13.51**	**4,192**
Weighted U-factor	**0.0740**	

Transmission Heating Load

U	A	Delta T	q - Transmissive Heat Load
0.0740	4,192	85	26,384 Btuh

Air Exchange Heating Load

Air's Heat Capacity	Air Flow Rate	Delta T	q - Air Exchange Heating Load
0.018	8,064	85	12,338 Btuh

Total Heating Load (output)

q (transmis.)	+	q (air)	=	q (total)
26,384		12,338		**38,722 Btuh**

Conversion of Base Heating Load (Output) into Adjusted Heating Load (Required Input) by Fuel Type

$$F_{consump.} = \frac{(HL \times 24 \times HDD)}{((Eff._{heating} * Eff._{dist.}) \times Fuel\ factor \times \Delta T)} + ((144+122)/2) * 6 \text{ kWh of ancillary electric usage (798 kWh / heating season)}$$

Where:	HL =	38,722	Design heating load Btuh	Eff.heating =	see below
	HDD =	7,478	Heating degree Days (Concord, NH)	Eff.dist. =	see below
	ΔT =	85	Design Temp. Difference	Fuel Factor =	heating value of the fuel - see below

Sample

$$F_{consump.\ oil} = \left(\frac{38{,}722\ \#\ Btuh \times 24 \times 7{,}478}{(80\% \times 85\%) \times 139{,}000 \times (70 - -15)} \right) = 817 \text{ gallons}$$

$$F_{consump.\ Electric\ Ancillary} = + 798 \text{ kWh/yr}$$

$F_{consump.\ Total}$ = 817 gallons oil plus 798 kWh

Fuel Source	Fuel Units	Fuel Factor #of BTUs per Fuel Unit	Eff.heating Heating System Efficiency	Eff.dist. Heating Distribution Efficiency	Adjusted (Input) Heating Load in Fuel Units		Additional Ancillary Electric	Fuel Units
Electric Heat - Rate R	kWh	3,413	100%	100%	23,955	kWh	0	kWh
Electric Heat w/ HEATSMART	kWh	3,413	100%	100%	23,955	kWh	0	kWh
#2 Fuel Oil	gallons	139,000	80%	90%	817	gal	798	kWh
Liquid Propane	gallons	91,600	80%	90%	1,240	gal	798	kWh
Natural Gas	therms	100,000	80%	90%	1,136	therms	798	kWh
Geo-thermal Heat Pump	kWh	3,413	350%	90%	7,605	kWh	0	kWh

Fuel Costs per Unit of Fuel - sourced at:

1) PSNH's current Residentail Rate R & LCS aas of 01/01/2008

2) Fossil Fuel pricing from NH PUC Office of energy & Planning (www.nh.goc/oep)

Fuel Source	Fuel Units	*	Pricing as of: 4/28/2008
Electric Heat - Rate R	kWh	*	$0.13694
Electric Heat w/ HEATSMART	kWh	*	$0.10379
#2 Fuel Oil	gallons	*	$4.03100
Liquid Propane	gallons	*	$3.20300
Natural Gas * second tier	therms	*	$1.46950
Air-to-Air Heat Pump on HEATSMART	kWh	*	$0.10379
Geo-thermal Heat Pump on HEATSMART	kWh	*	$0.10379

Heating Costs by Fuel Type - Cost Per Square Foot

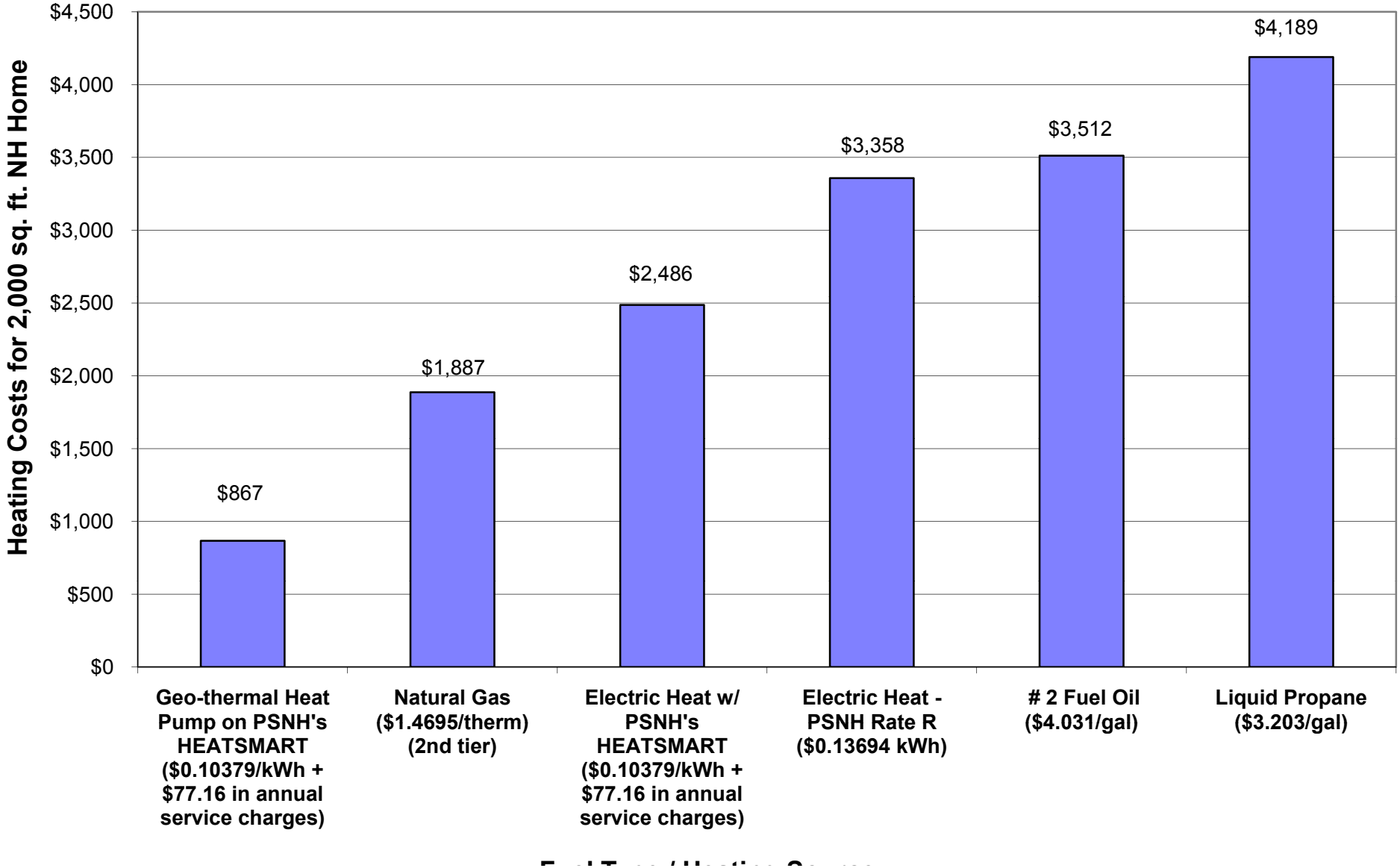
Fuel Source	Fuel Units	*	4/28/2008
Electric Heat - Rate R	kWh	*	$1.6402
Electric Heat w/ HEATSMART	kWh	*	$1.2432
#2 Fuel Oil	gallons	*	$1.7012
Liquid Propane	gallons	*	$2.0400
Natural Gas * second tier	therms	*	$0.8890
Air-to-Air Heat Pump on HEATSMART	kWh	*	$0.6906
Geo-thermal Heat Pump on HEATSMART	kWh	*	$0.3947

Sorted Heating Costs for Charts

Fuel Source	28-Apr-08 Heating Costs per Square Foot	28-Apr-08 Heating Costs for 2,000SF Home
Geo-thermal Heat Pump on PSNH's HEATSM	$0.39	$867
Natural Gas ($1.4695/therm) (2nd tier)	$0.89	$1,887
Electric Heat w/ PSNH's HEATSMART ($0.103	$1.24	$2,486
Electric Heat - PSNH Rate R ($0.13694 kWh	$1.64	$3,358
# 2 Fuel Oil ($4.031/gal)	$1.70	$3,512

Comparison of Heating Systems / Fuels

Estimated Annual Heating Costs for a Typical 2,000 sq. ft. NH Home
(using PSNH's current rates and fossil fuel prices as of April 28, 2008 at www.nh.gov/oep)



Comparison of Heating Systems / Fuels

Estimated Annual Heating Costs Per Square Foot for a Typical 2,000 sq. ft. NH Home
(using PSNH's current rates and fossil fuel prices as of April 28, 2008 at www.nh.gov/oep)