Fairbanks: Net Zero Ready

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Energy Use Index (EUI)

Anchorage

Average Home: 141

5 star Home: 79

6 star Home: 40

kBtu/ft^2/year

Fairbanks

Average Home: 143

5 star Home: 90

6 star Home: 43

kBtu/ft^2/year

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Net Zero Ready – HERS Rating

Anchorage

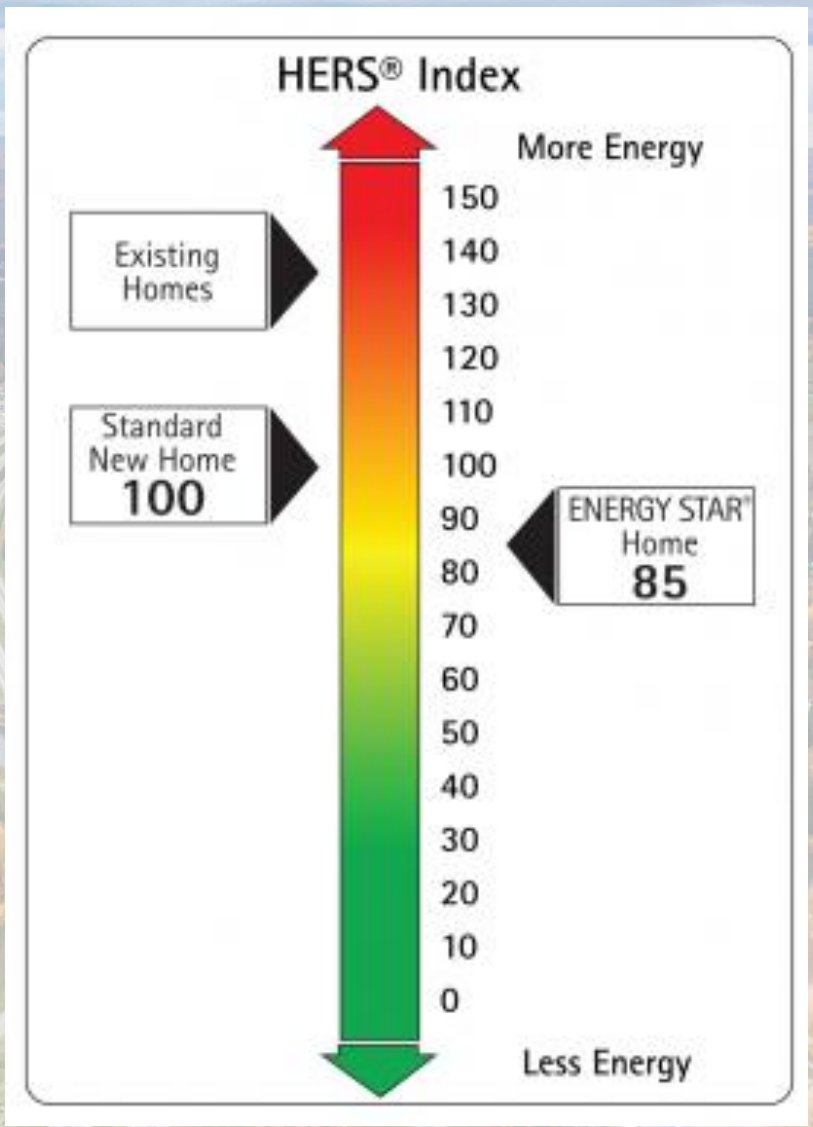
Average Home: 141

5 star Home: 79

6 star Home: 40

kBtu/ft²/year

Home Energy Rating System



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Annual Energy Cost

Anchorage	
Average Home:	$2,900
5 star Home:	$1,600
6 star Home:	$800
1,900 ft²	

Fairbanks	
Average Home:	$8,100
5 star Home:	$3,865
6 star Home:	$1,861
1,900 ft²	

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Fuel Types & Costs

Anchorage	
Electricity ($/kwh)	$0.18
Natural Gas ($/ccf)	$0.87
Oil ($/gal)	$2.61
Propane ($/gal)	$3.47
Coal ($/ton)	$175
Spruce ($/cord)	$345
Birch ($/cord)	$325
Pellets ($/ton)	$280

Fairbanks	
Electricity ($/kwh)	$0.24
Natural Gas ($/ccf)	$2.04
Oil ($/gal)	$2.66
Propane ($/gal)	$4.25
Coal ($/ton)	$250
Spruce ($/cord)	$250
Birch ($/cord)	$350
Pellets ($/ton)	$295

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Fuel Types & Costs Normalized

Anchorage ($/kWh)	
Natural Gas	$0.03
Coal	$0.05
Pellets	$0.07
Oil	$0.08
Birch	$0.09
Spruce	$0.13
Propane	$0.14
Electricity	$0.18

Fairbanks ($/kWh)	
Pellets	$0.07
Coal	$0.07
Natural Gas	$0.07
Oil	$0.08
Spruce	$0.09
Birch	$0.10
Propane	$0.18
Electricity	$0.24

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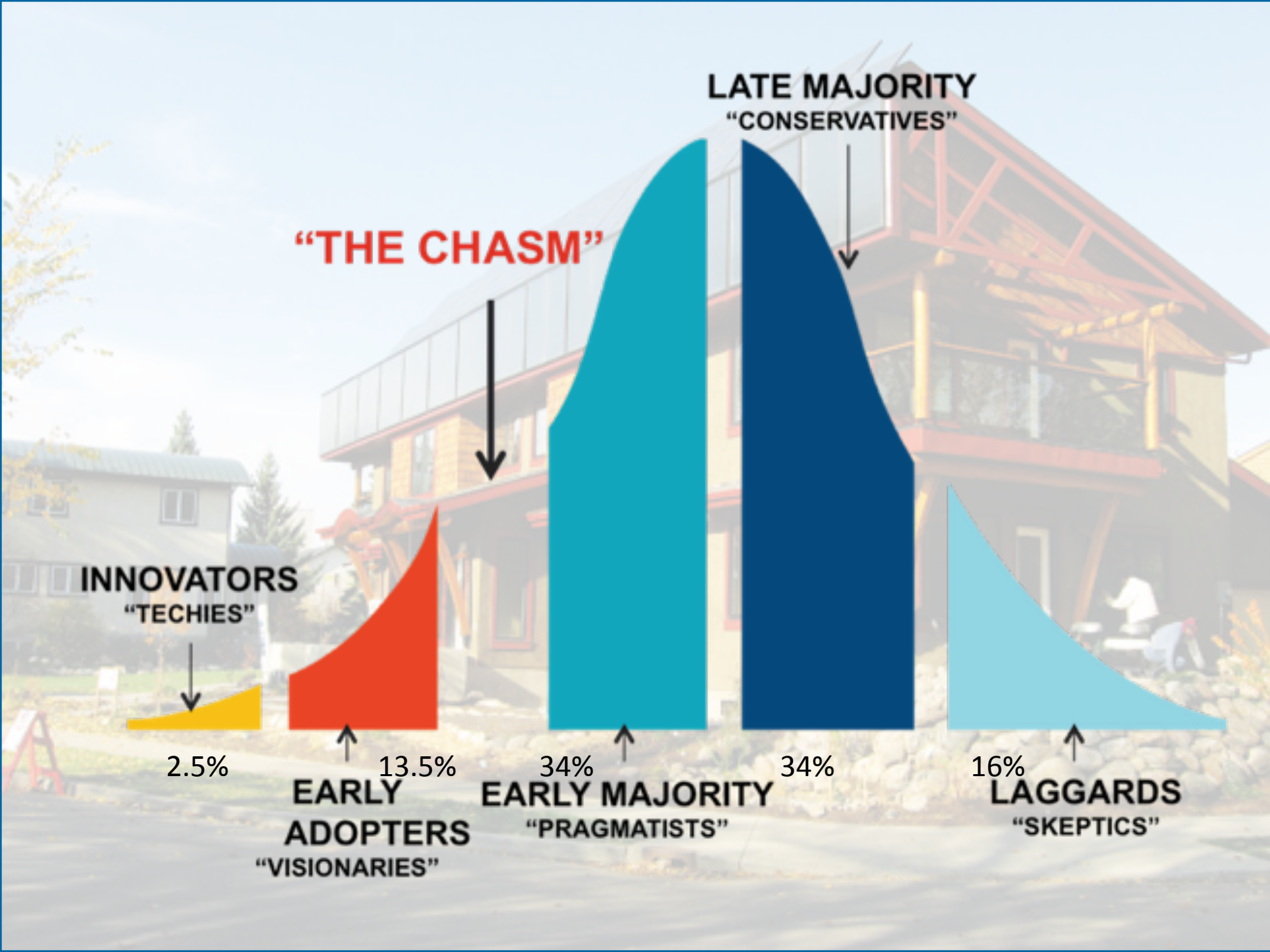

LATE MAJORITY
"CONSERVATIVES"
"THE CHASM"
INNOVATORS
"TECHIES"
2.5%
13.5%
34%
34%
16%
EARLY ADOPTERS
"VISIONARIES"
EARLY MAJORITY
"PRAGMATISTS"
LAGGARDS
"SKEPTICS"

Photovoltaic vs. Solar Thermal

FAI: 5 – 15 yr Payback

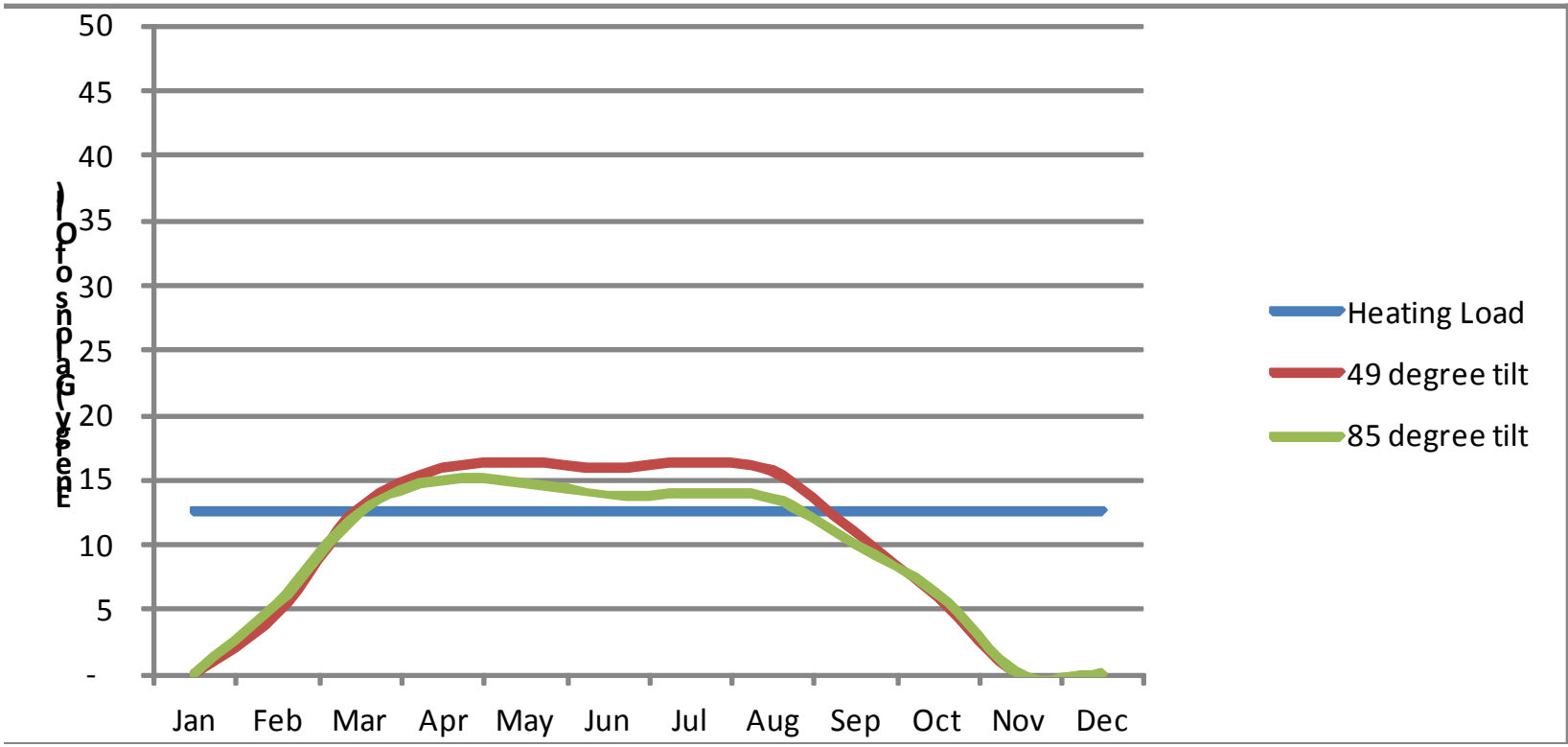
ANC: 7– 20 yr Payback

FAI: 3.5 – 7 yr Payback

ANC: 10 – 25 yr Payback

Domestic Hot Water Loads

Fairbanks, 3 collectors
Domestic Hot Water: 80



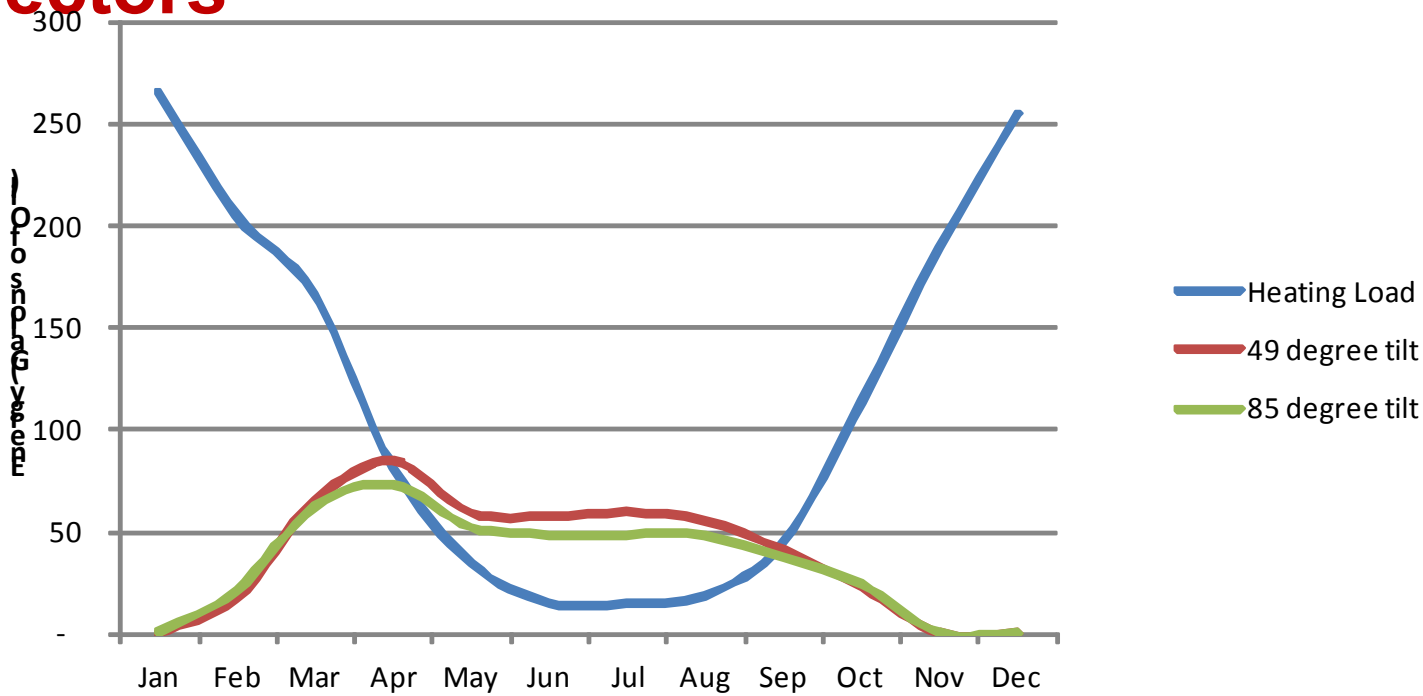
Base Heat Load: 152 gal/yr

Solar Savings: 115 gal/yr (49 degrees) 75%

106 gal/yr (85 degrees)

Space Heating Loads

Average House in Fairbanks, 10 collectors



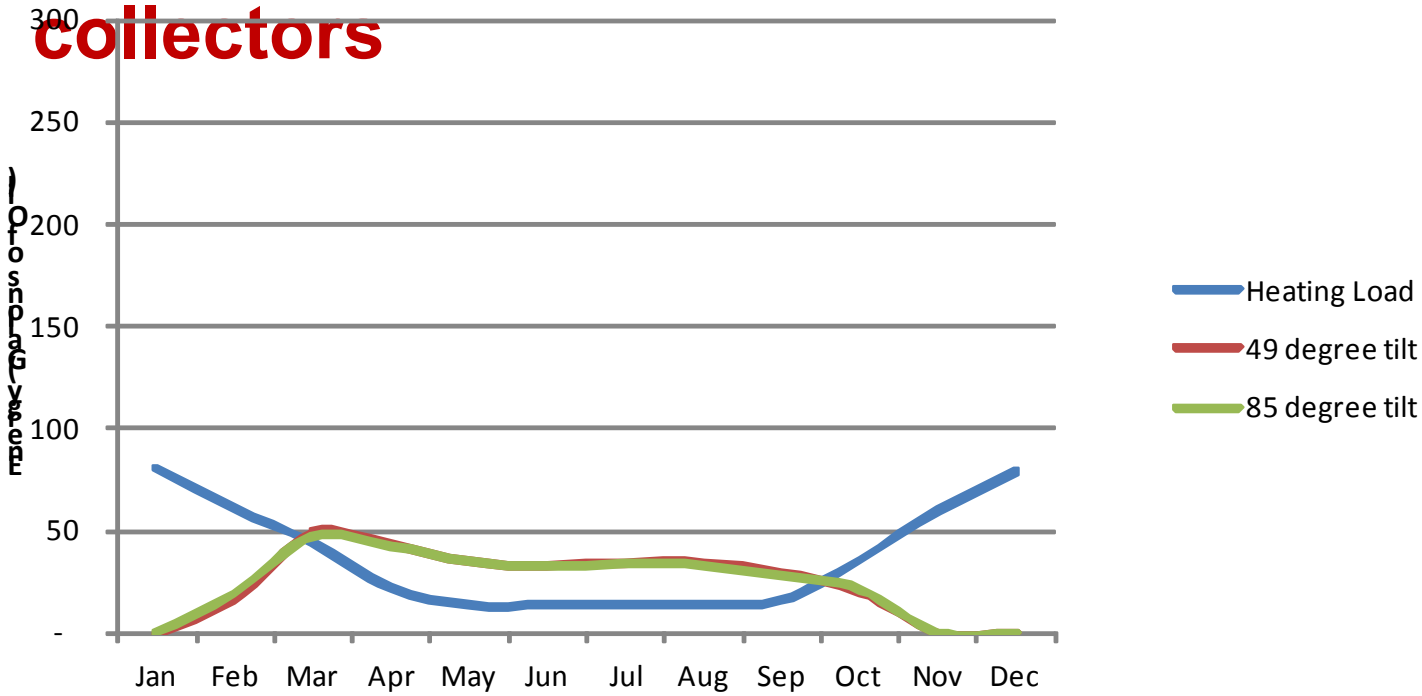
Base Heat Load: 1,400 gal/yr

Solar Savings: 462 gal/yr (49 degrees) 33%

413 gal/yr (85 degrees)

Space Heating Loads

6-Star House in Fairbanks, 10 collectors



Base Heat Load: 442 gal/yr

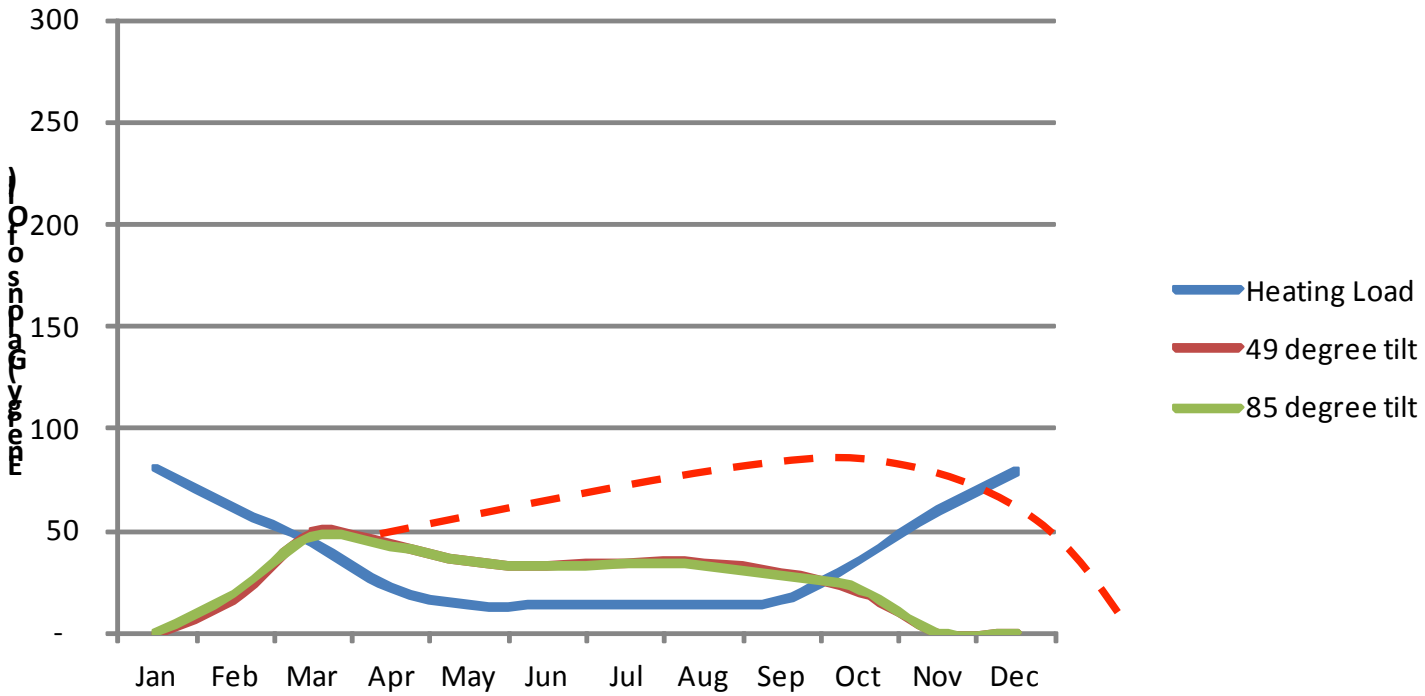
Solar Savings: 294 gal/yr (49 degrees) 67%

291 gal/yr (85 degrees)

66%

Space Heating Loads

6-Star House in Fairbanks

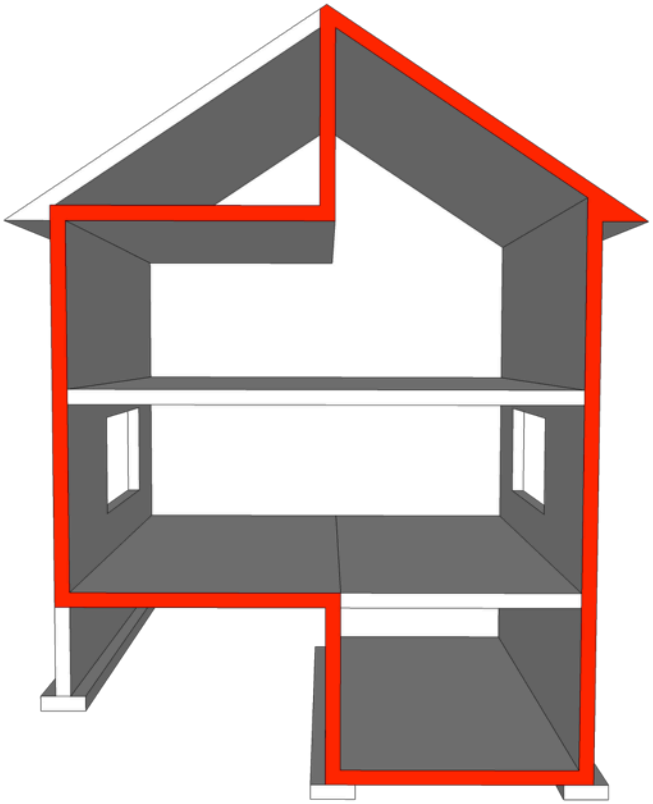


Seasonal Thermal Storage

Base Heat Load: 442 gal/yr

Solar Savings: 385 gal/yr (49 degrees) 87%

Perspective



Basic Info

- Work at CCHRC
- Ordinary Guy
- South facing lot
- Goal was $250,000

Basic Info

- Insulation
  - Walls: R-60
  - Floor: R-70
  - Ceiling: R-115
- Airtightness: 0.45 ACH_{50}
- Solar Thermal & Masonry Heater
- Seasonal Thermal Storage
- Energy Design Aspects Influenced by Thorsten Chlupp
- Cost: $268k

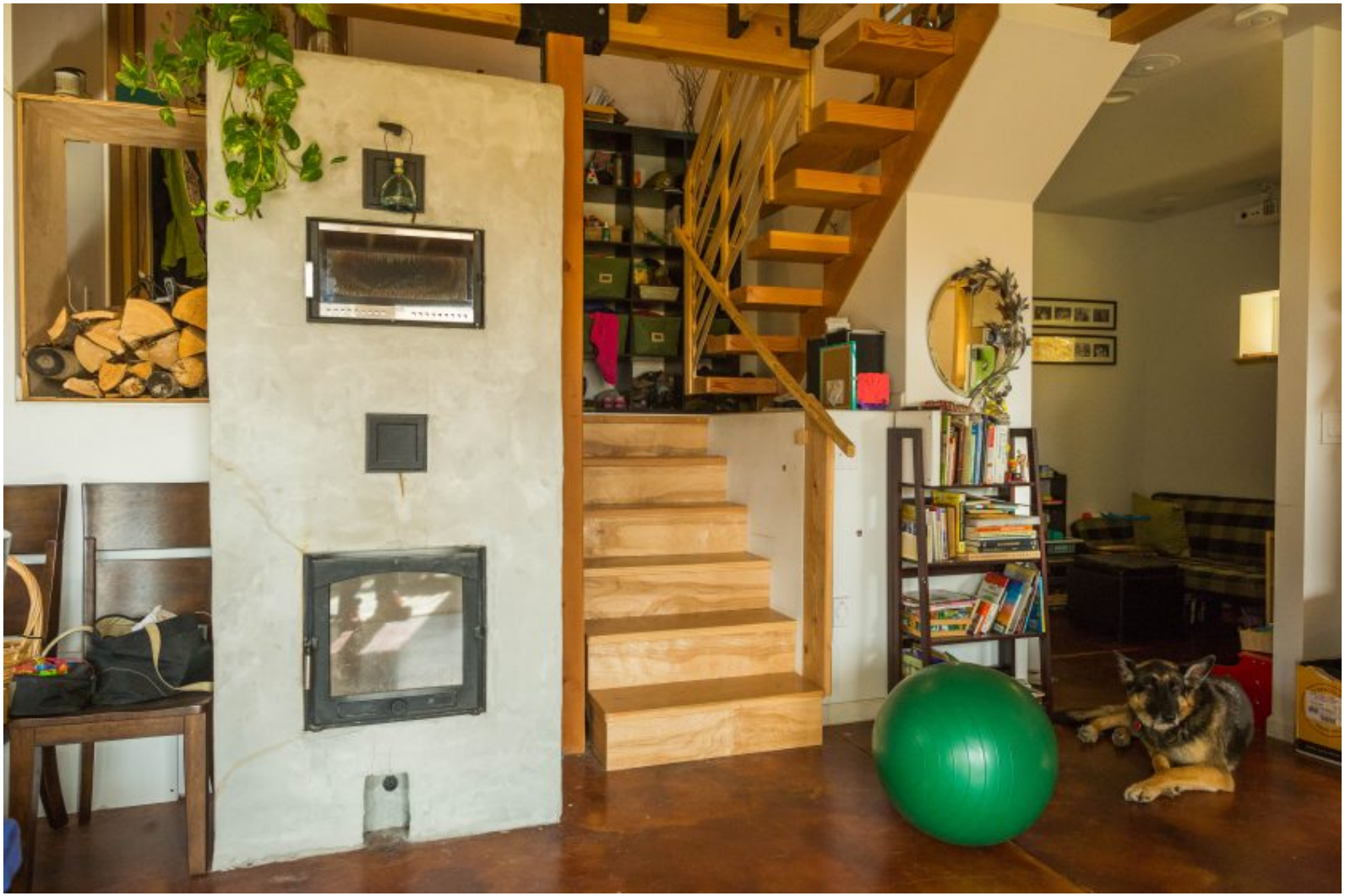
Land Clearing – Facing South

Subterranean Storage

Seasonal Thermal Storage

ADN Article (Oct 2015)

ADN Article (Oct 2015)



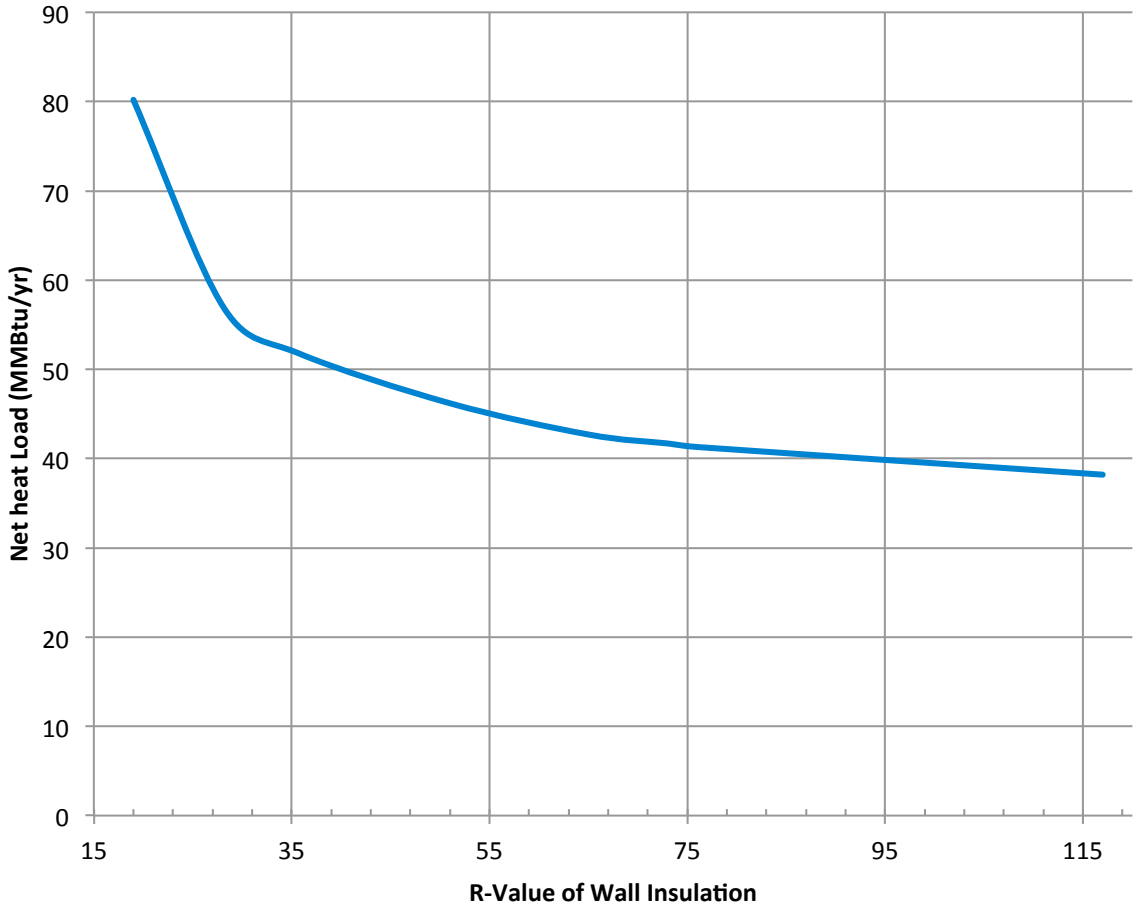
ADN Article (Oct 2015)

Insulation

- 42 MMBtu/yr savings over R-19 Wall (323 gallons oil)

R-Value	MMBTU/Yr
117	38
76	41.3
73	41.7
65	43
51	46
35.7	51.8
28.2	56.8
19	80.2

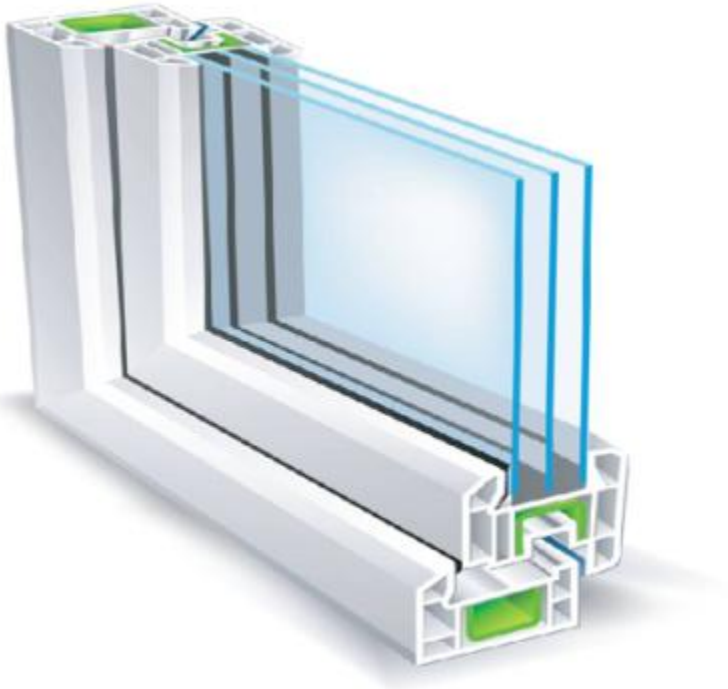
How Much Insulation?



R-Value	MMBTU/Yr
117	38
76	41.3
73	41.7
65	43
51	46
35.7	51.8
28.2	56.8
19	80.2

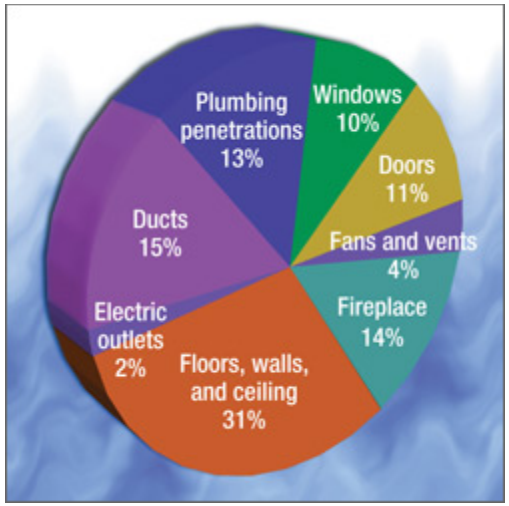
Triple Pane Windows

- 10 MMBtu/yr savings over Double Pane (77 gallons oil)



Air Sealing

- 3 ACH_{50} → 0.45 ACH_{50}
- 18 MMBtu/yr savings (138 gallons oil)

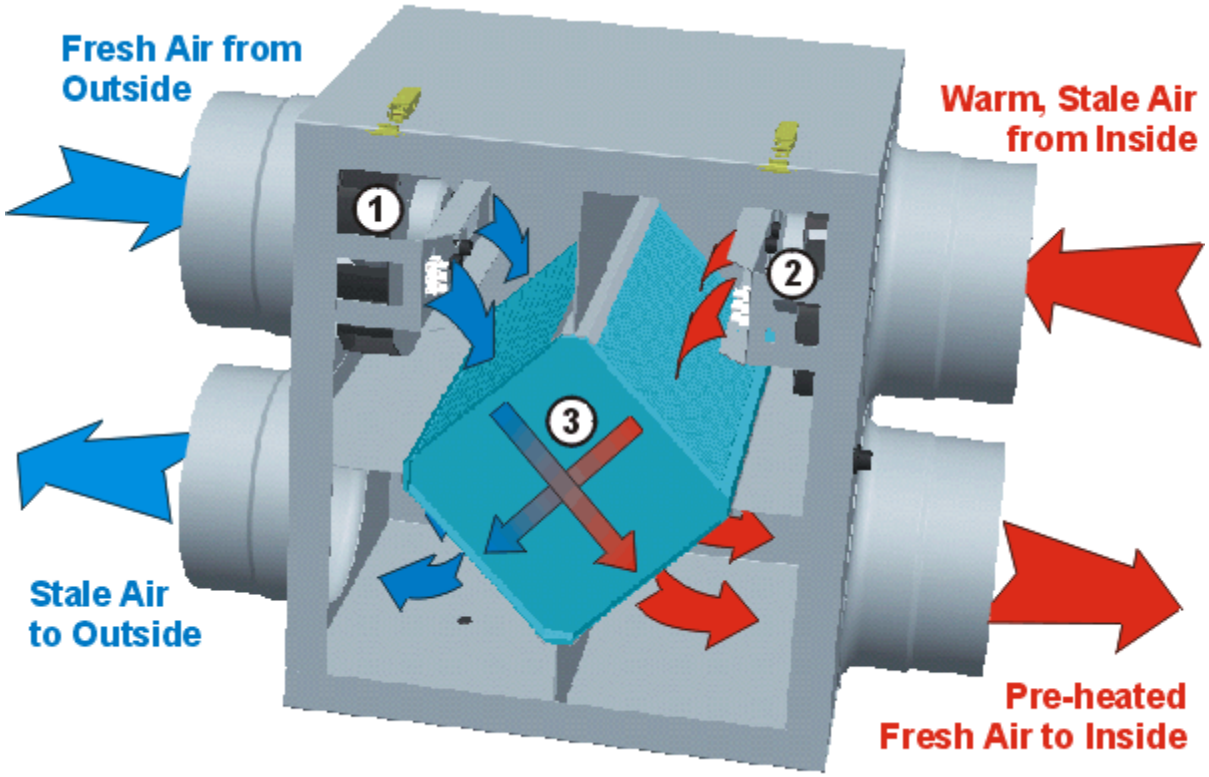


Roof Insulation

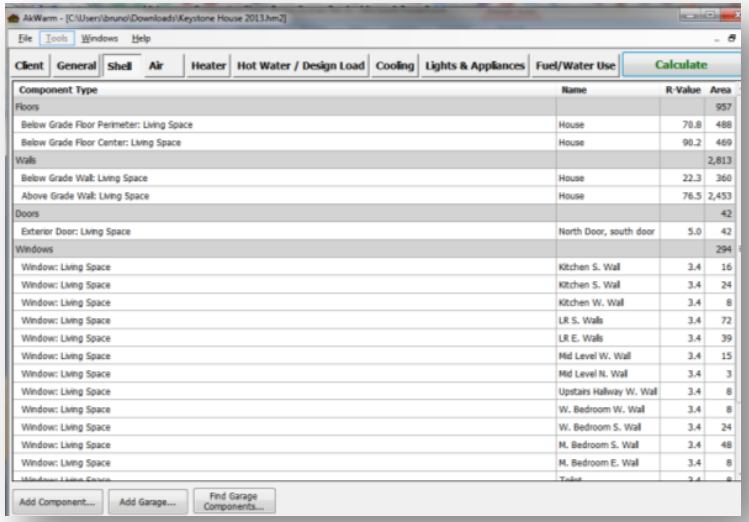
- 12 inches → 30 inches
- 4 MMBtu/yr savings (30 gallons oil)

Heat Recovery

- Savings: 20 MMBtu/yr (153 gallons oil)



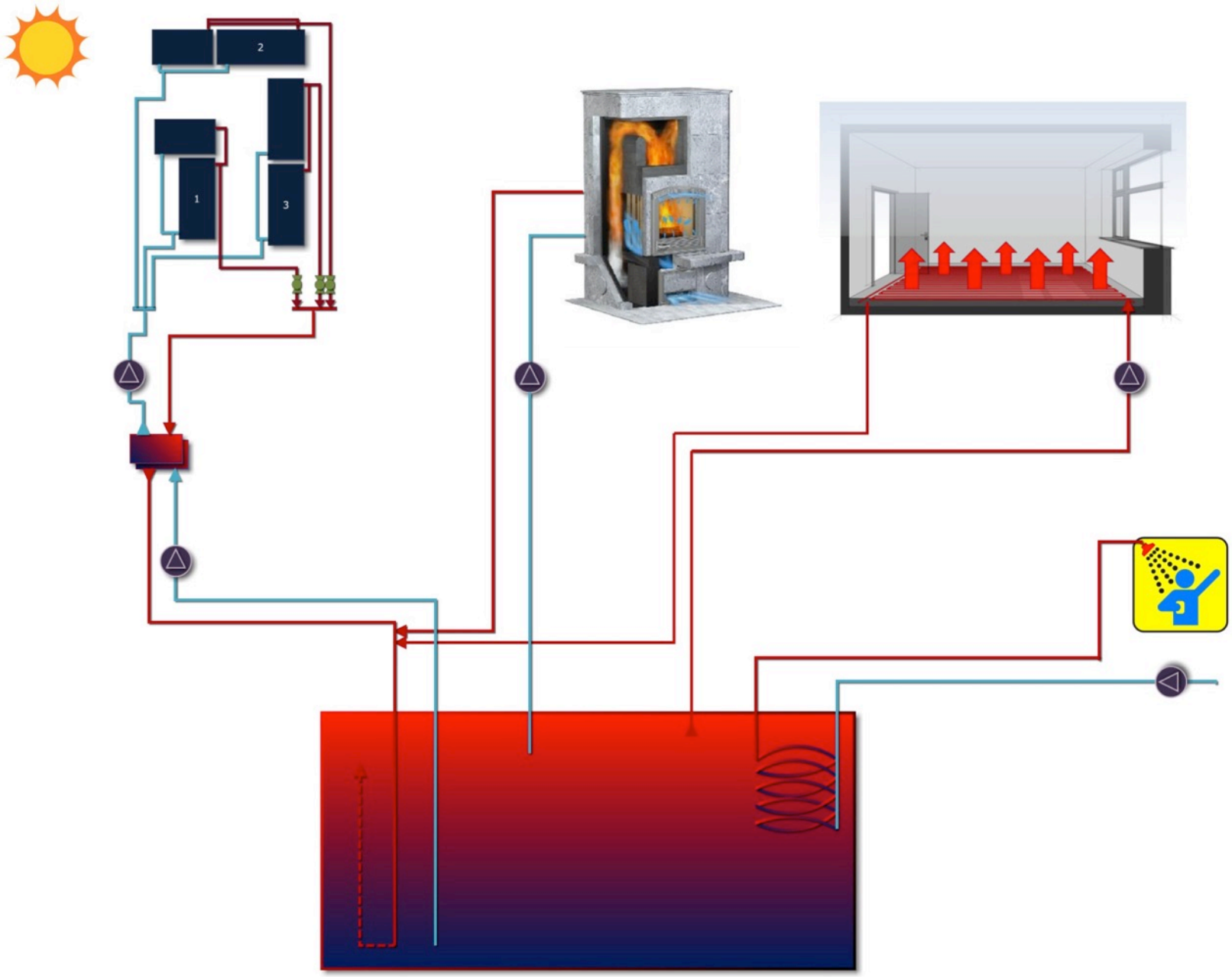
Energy Modeling: AkWarm

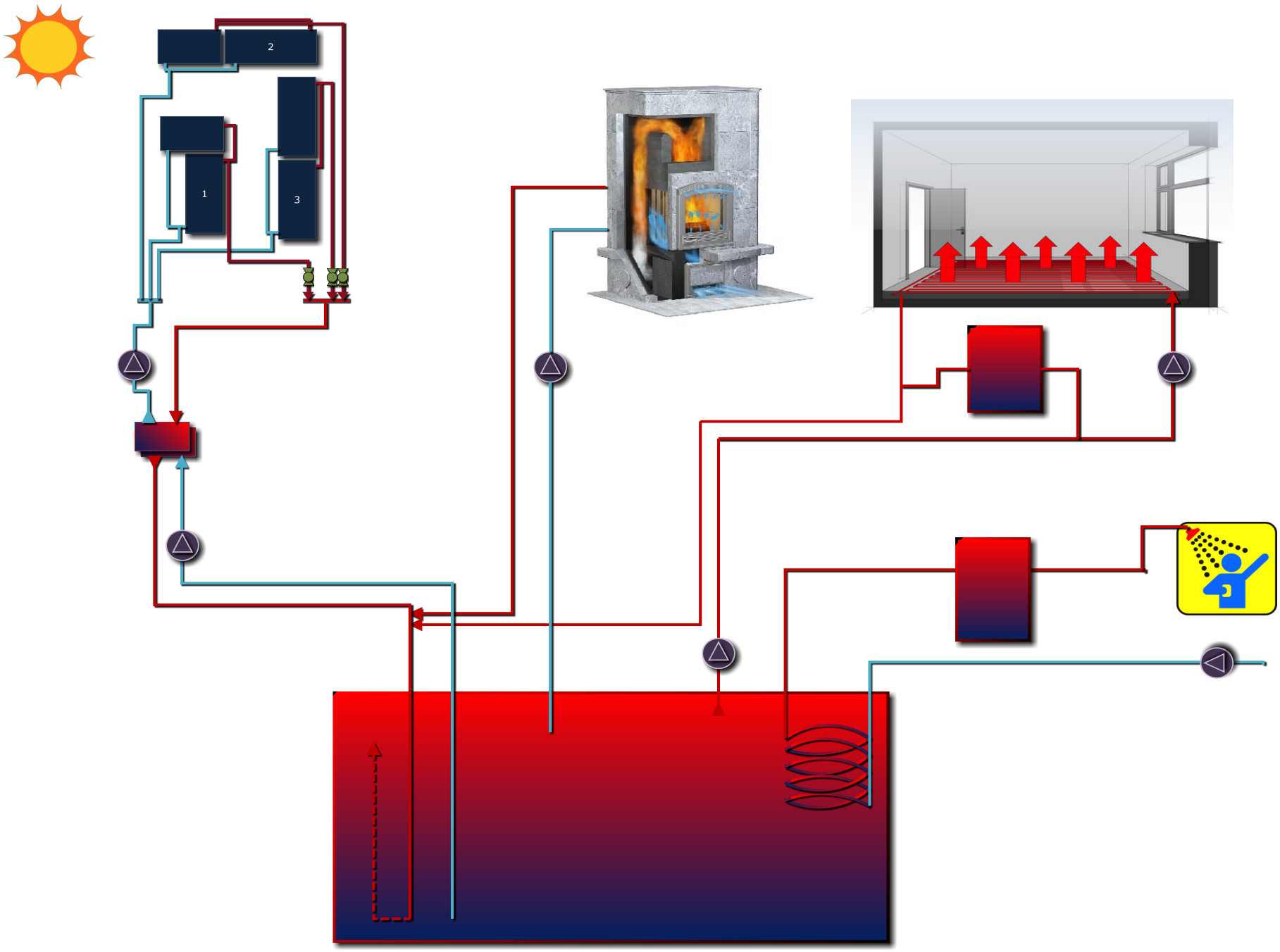


Component Type	Name	R-Value	Area
Floors			957
Below Grade Floor Perimeter: Living Space	House	70.8	488
Below Grade Floor Center: Living Space	House	90.2	469
Walls			2,813
Below Grade Wall: Living Space	House	22.3	360
Above Grade Wall: Living Space	House	76.5	2,453
Doors			42
Exterior Door: Living Space	North Door, south door	5.0	42
Windows			294
Window: Living Space	Kitchen S. Wall	3.4	16
Window: Living Space	Kitchen S. Wall	3.4	24
Window: Living Space	Kitchen W. Wall	3.4	8
Window: Living Space	LR S. Walls	3.4	72
Window: Living Space	LR E. Walls	3.4	39
Window: Living Space	Mid Level W. Wall	3.4	15
Window: Living Space	Mid Level N. Wall	3.4	3
Window: Living Space	Upstairs Hallway W. Wall	3.4	8
Window: Living Space	W. Bedroom W. Wall	3.4	8
Window: Living Space	W. Bedroom S. Wall	3.4	24
Window: Living Space	M. Bedroom S. Wall	3.4	48
Window: Living Space	M. Bedroom E. Wall	3.4	8

- 6 Star, 98 points
- Net Heat Load: 34 MMBtu (246 gal oil)
- Solar Offset: 21 MMBtu (152 gal oil)
- Wood Offset: 13 MMBtu (under 1 cord)

Seasonal Thermal Storage



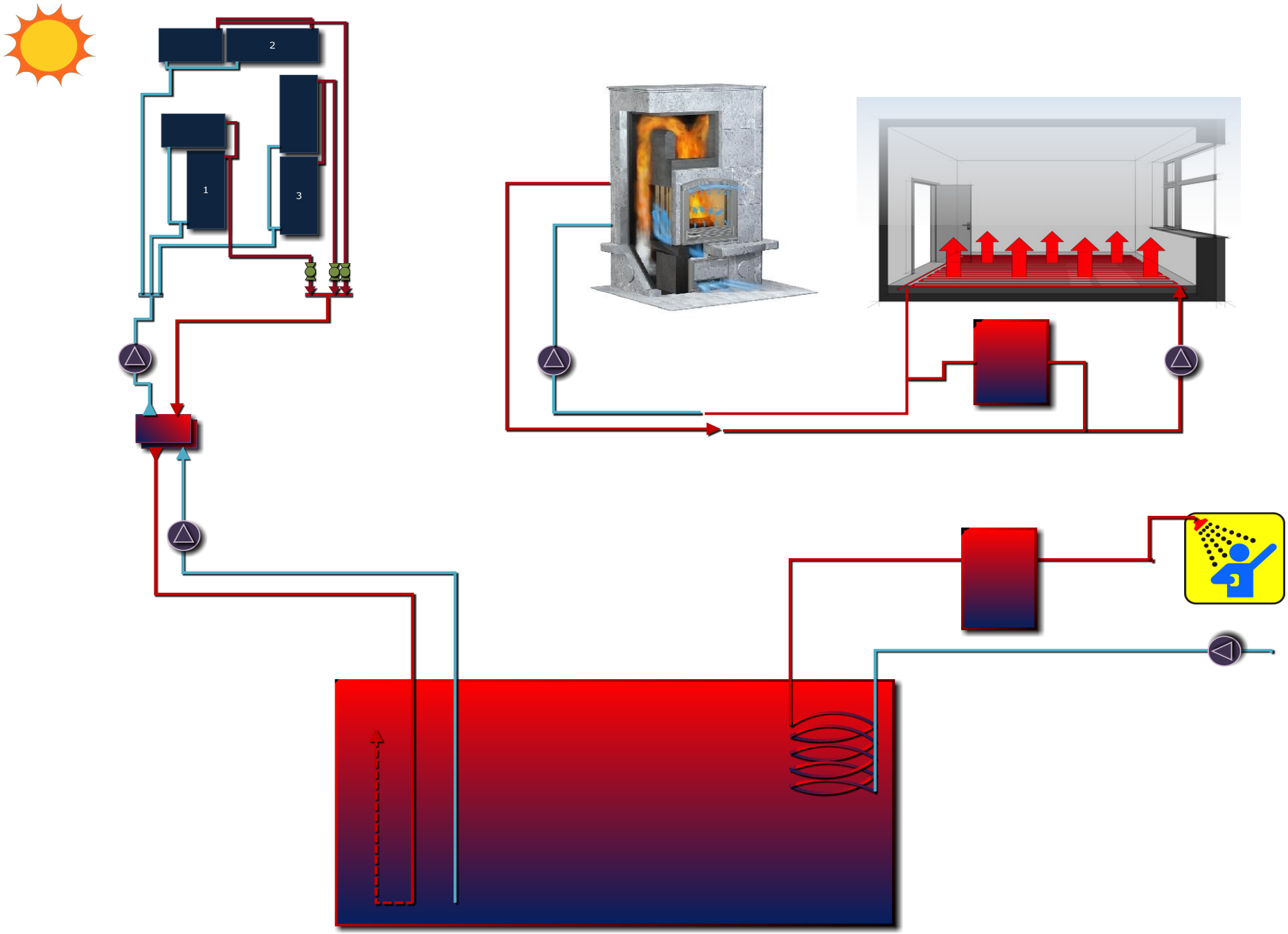

2
1
3

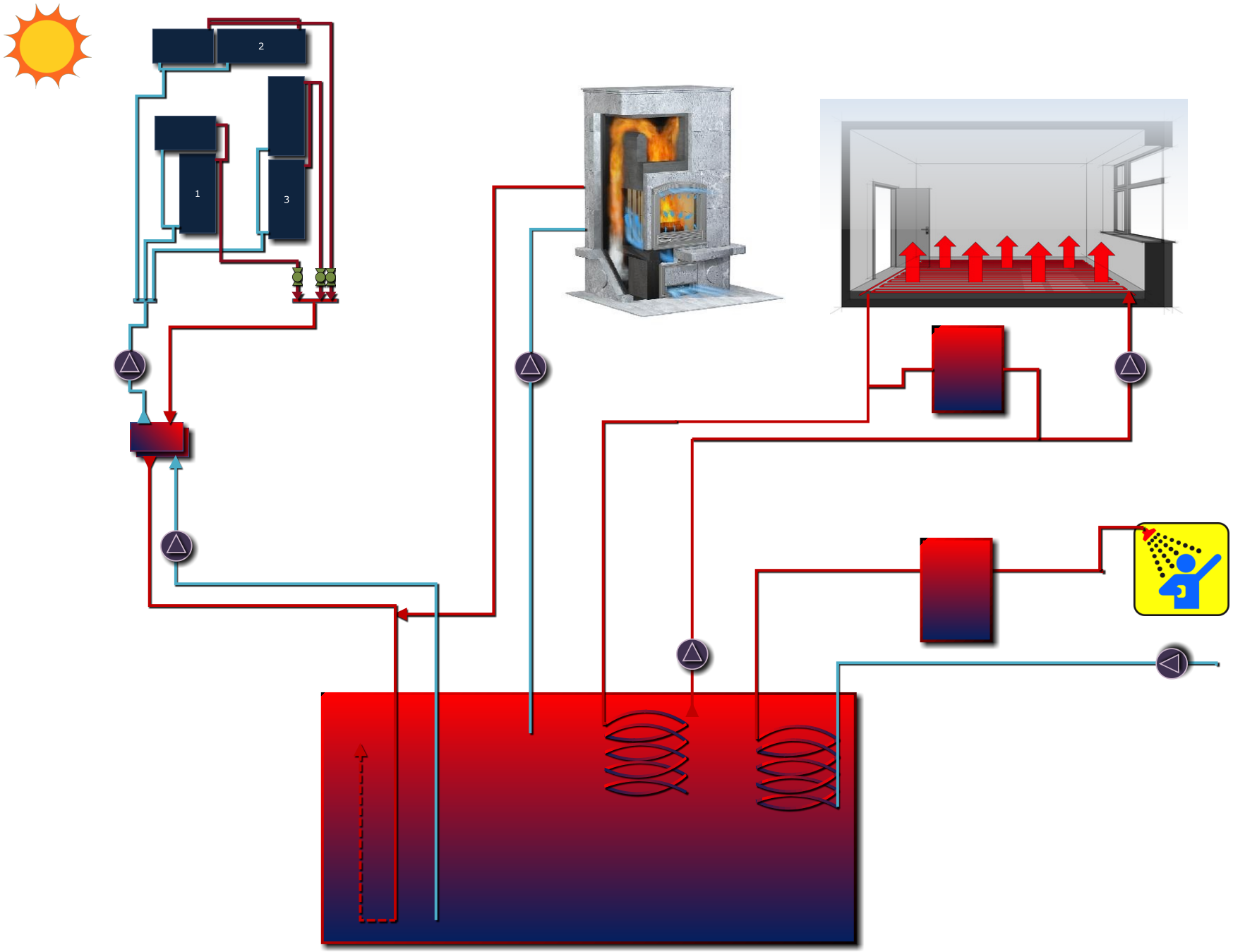
November 2014

Sun	Mon	Tue	Wed	Thu	Fri	Sat
2 25# 115°F	3	4	5 28# 108°F	6 21# 113°F	7 25# 116°F	8
9 30# 118°F	10 25# 120°F	11	12	13 31# 116°F	14	15
16 35# 108°F	17	18	19	20	21	22 38# 105°F
23 35# 113°F	24 25# 119°F	25 21# 123°F	26	27	28	29
30 37# 109°F	1	2	3	4	5	6 30# 104°F

Modeled Vs Actual

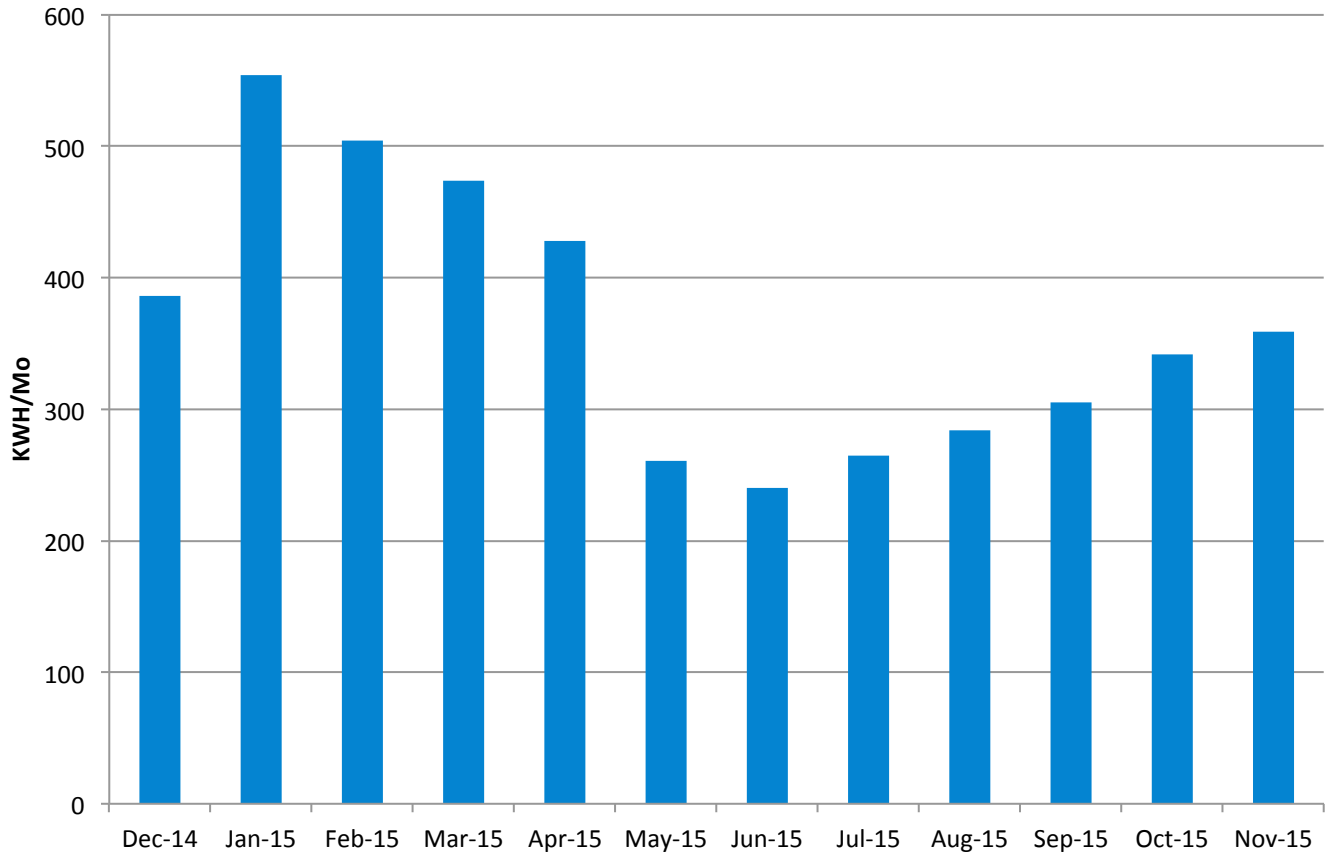
- 6 Star, 98 points
- Net Heat Load: 34 MMBtu (246 gal oil)
- Solar Offset: 21 MMBtu (152 gal oil)
- Wood Offset: 13 MMBtu (under 1 cord)
- Wood Burned:
  - 2013-2014: 0.75 Cords
  - 2014-2015: 1 Cord
  - 2015-2016: 1 Cord
  - 2016-2017: 1.5 Cords


2
1
3


2
1
3

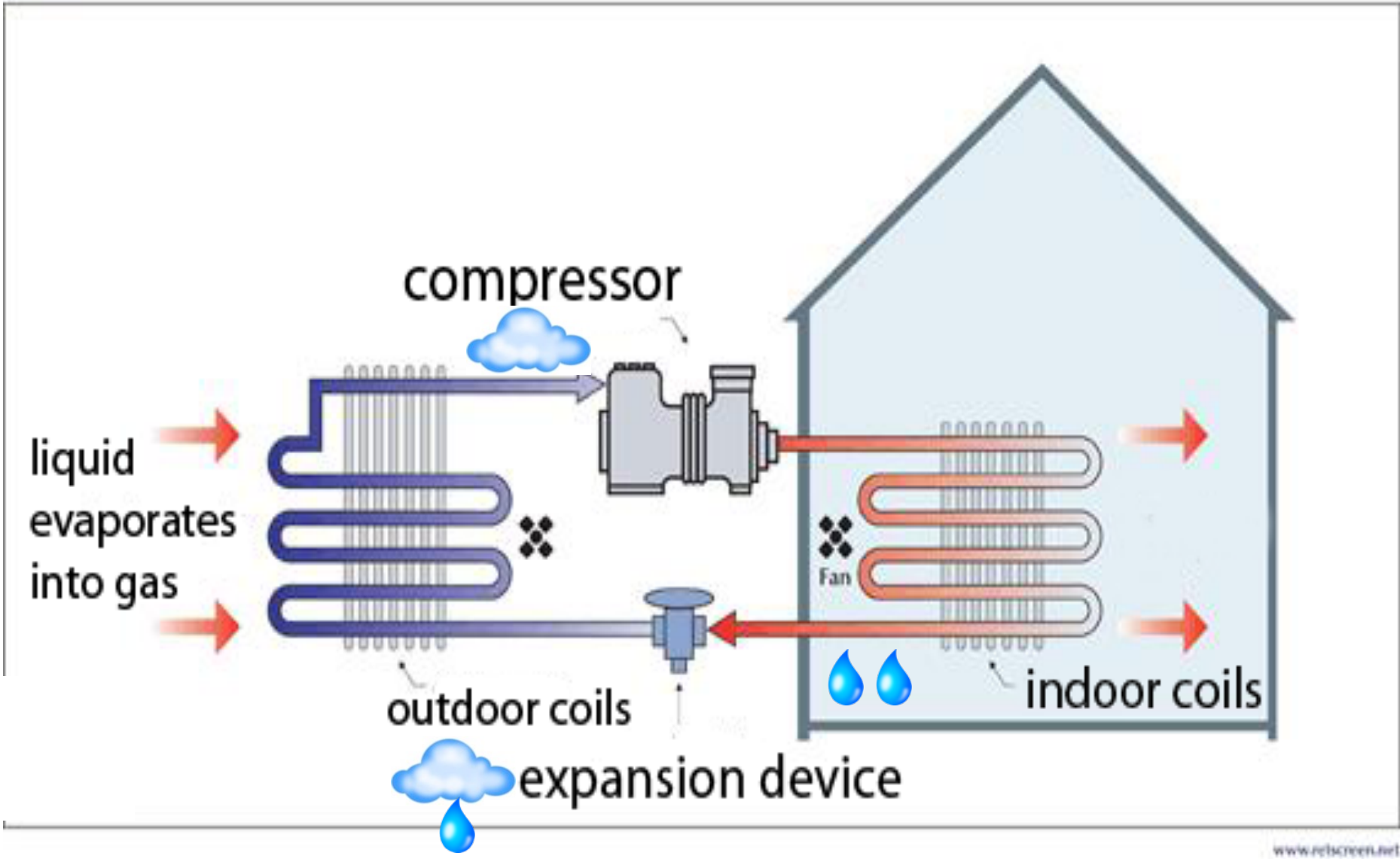
Getting to Net Zero

- Yearly Average: 4,400 kwh

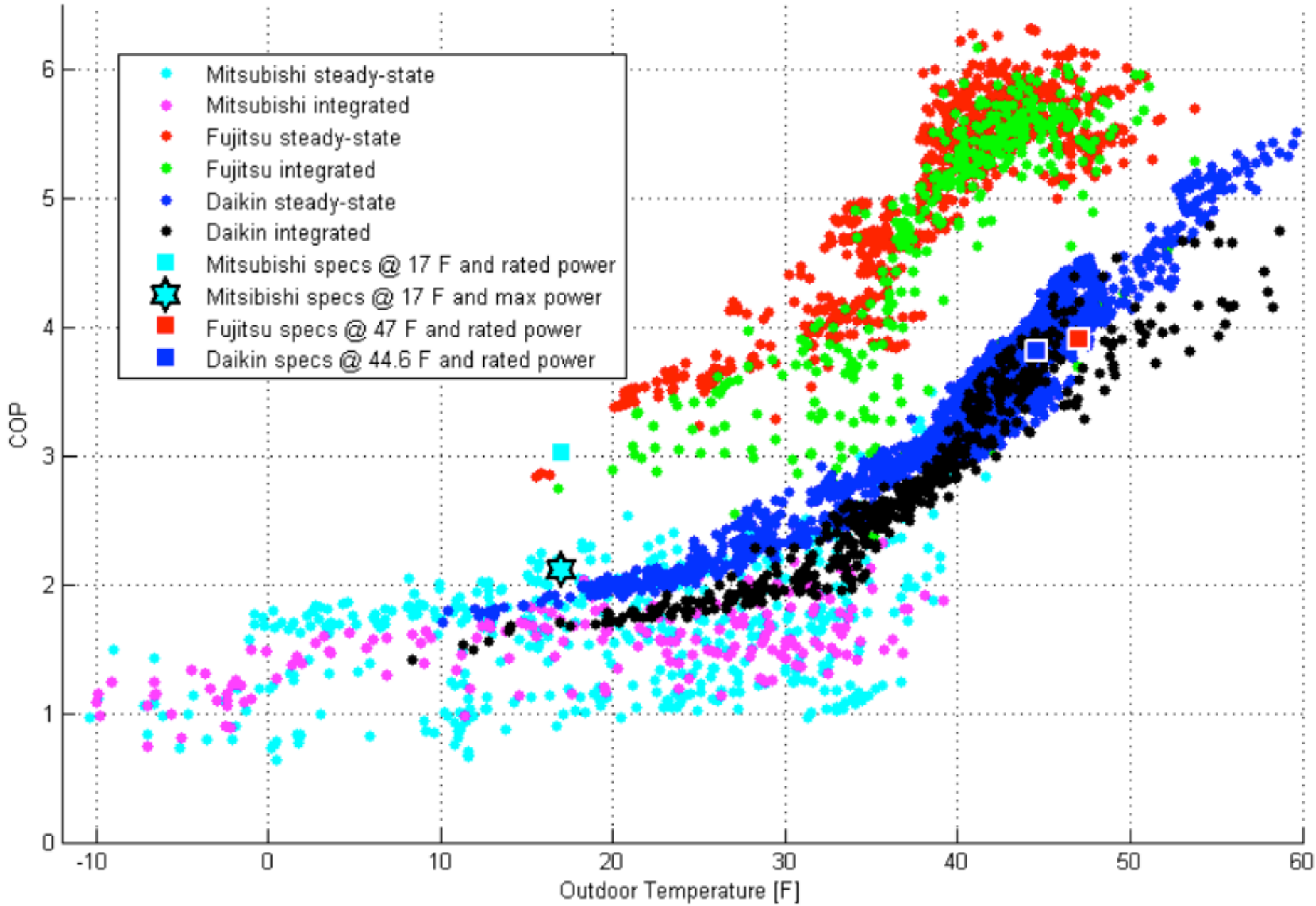


- Solar PV: 4,500 Watts

Panasonic
INVERTER


RETScreen
compressor
liquid
evaporates
into gas
Fan
outdoor coils
indoor coils
expansion device
www.retscreen.net

Panasonic


Mitsubishi steady-state
Mitsubishi integrated
Fujitsu steady-state
Fujitsu integrated
Daikin steady-state
Daikin integrated
Mitsubishi specs @ 17 F and rated power
Mitsibishi specs @ 17 F and max power
Fujitsu specs @ 47 F and rated power
Daikin specs @ 44.6 F and rated power
COP
0
1
2
3
4
5
6
-10
0
10
20
30
40
50
60
Outdoor Temperature [F]

Anchorage:
COP = 5

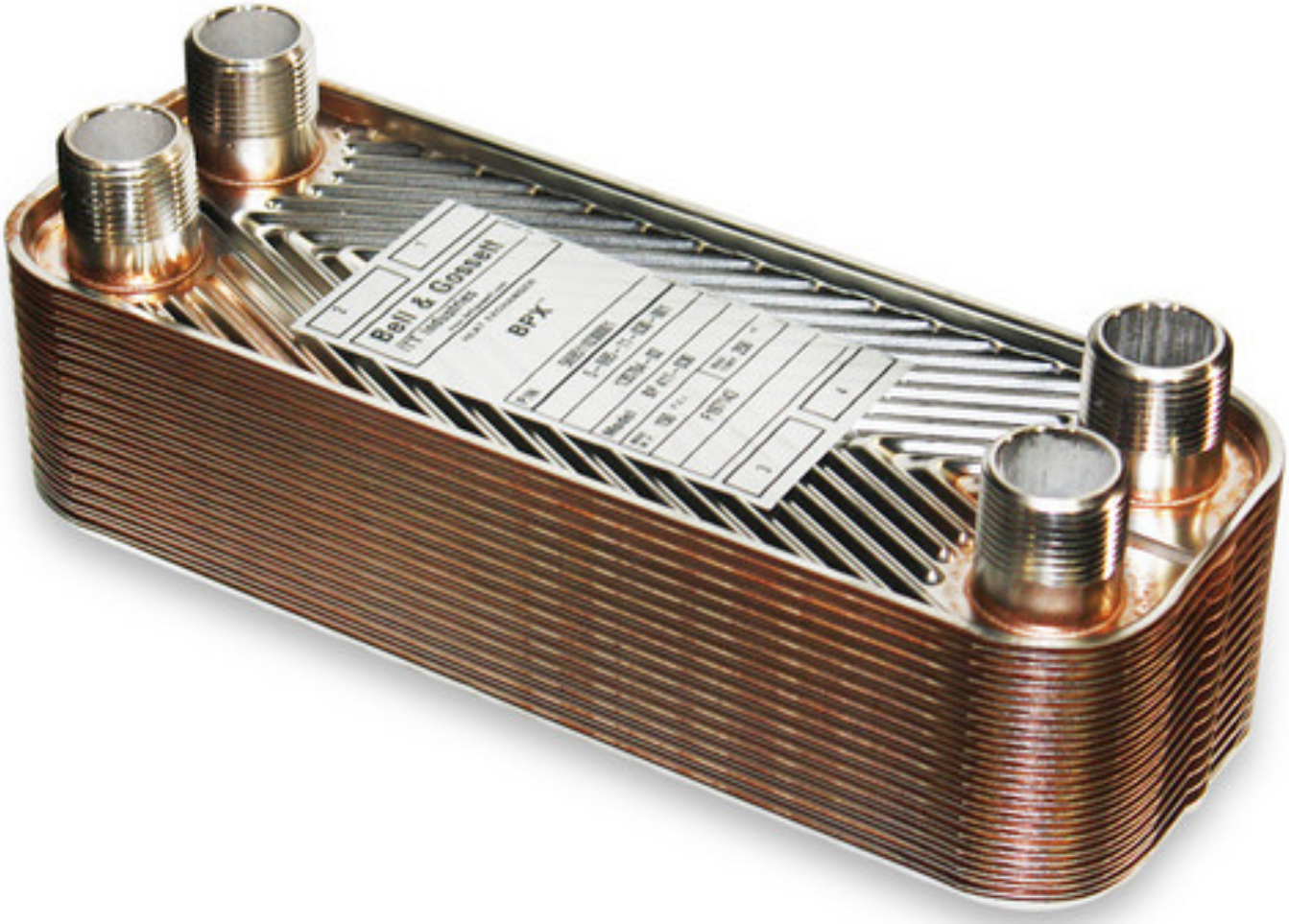
$0.036/kWh

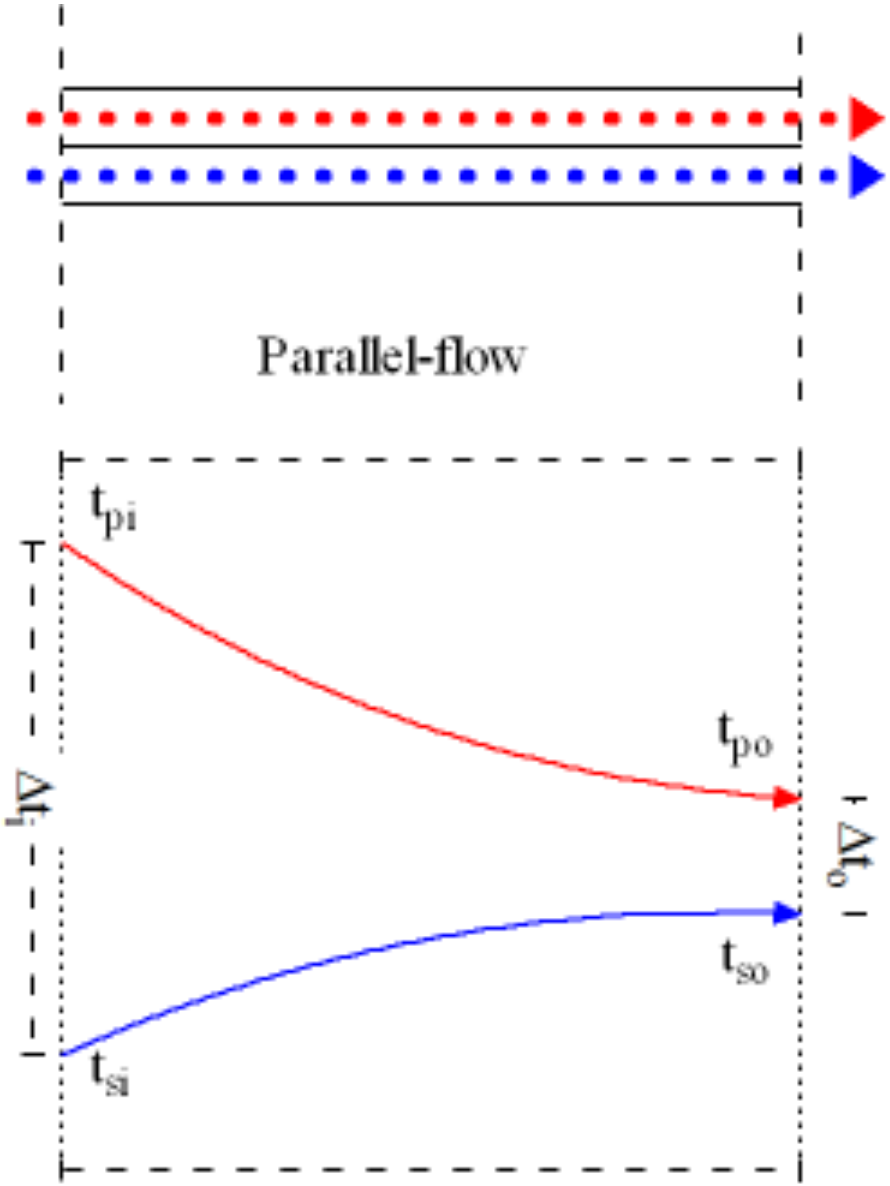
Fairbanks:
COP = 4

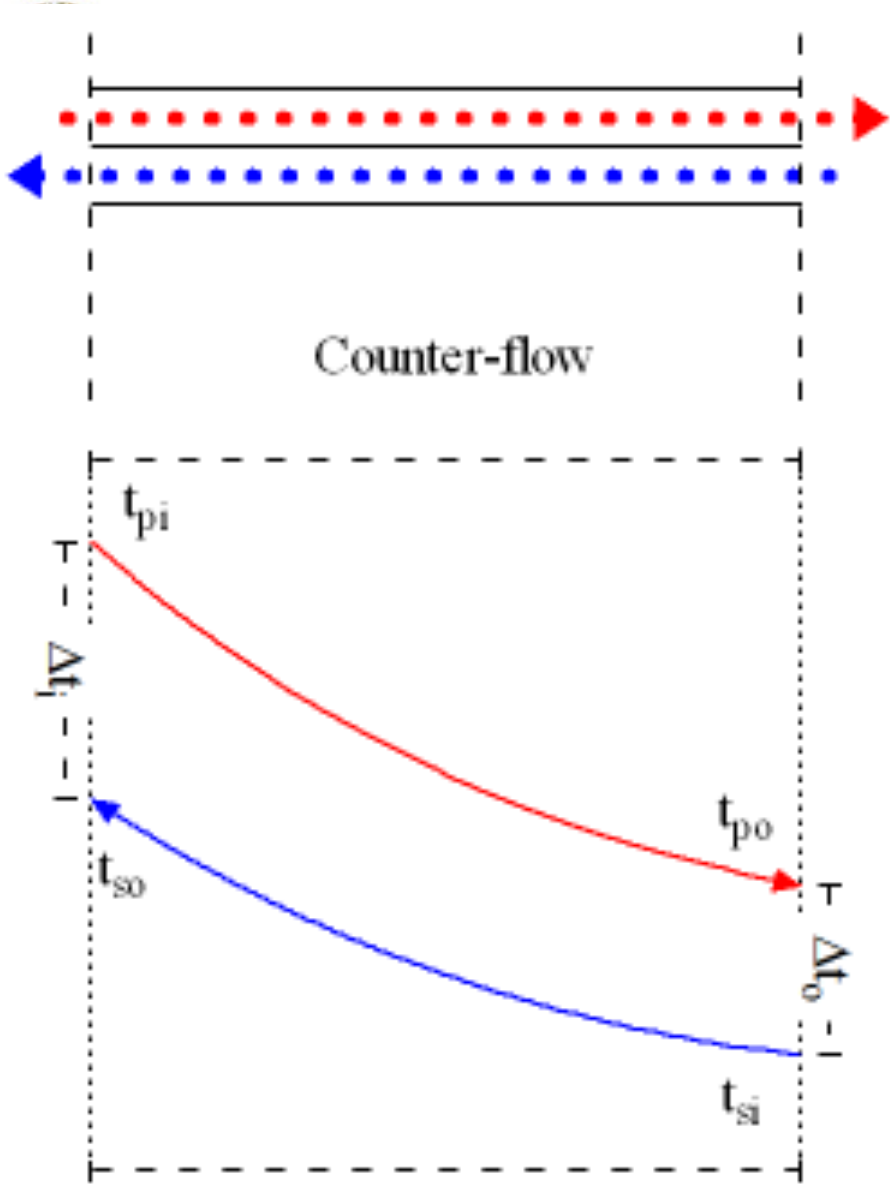
$0.06/kWh

Anchorage ($/kWh)	
Natural Gas	$0.03
Coal	$0.05
Pellets	$0.07
Oil	$0.08
Birch	$0.09
Spruce	$0.13
Propane	$0.14
Electricity	$0.18

Fairbanks ($/kWh)	
Pellets	$0.07
Coal	$0.07
Natural Gas	$0.07
Oil	$0.08
Spruce	$0.09
Birch	$0.10
Propane	$0.18
Electricity	$0.24


Bell & Gossett
BPX


Parallel-flow
t_{pi}
t_{po}
t_{so}
t_{si}
Δt_i
Δt_o


Counter-flow
t_{pi}
t_{po}
t_{so}
t_{si}
Δt_i
Δt_o

Thoughts

- Like having a dog team – Make a Manual
- More Coils in Fire Box!
- Financing Obstacles
- Equivalent Oil Use: 250 gal
- Once tank is depleted, dump heat to floors
- Air Source Heat Pump
- Good example
  - Building envelope influence
  - Energy system influence
- Net Zero
- PV vs Solar Thermal

"Promoting and advancing the development of healthy, durable, and sustainable shelter for Alaskans and other Circumpolar people ."
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