Alaska Mini-Split Heat Pump Calculator

Thank you to our sponsors:

This calculator allows you to evaluate the possible energy and cost savings from use of a mini-split (ductless) heat pump in an Alaskan home or small building. Fill out the inputs listed below and then click the "Calculate" button at the bottom of the page to see the results on the analysis.

Where you see the question mark symbol ? additional help for the input is available. Hover your mouse over the symbol to see the pop-up help.

If you would like to reset all inputs to their default values and start over, click the Refresh button in your web browser.

The calculator was primarily built to evaluate retrofitting a mini-split heat pump into an existing home with an existing heating system. However, it can be used to compare use of a heat pump in a new home to use of a different heating fuel. To do a fair economic comparison in that situation, for the "Installed Cost of the Heat Pump" input, enter in the *extra* cost of the heat pump relative to the alternative heating system; this could be a negative number if the heat pump system is less expensive. This same approach should be used if you are in need of *replacing* your existing heating system; enter the additional cost of the heat pump install relative to replacing the existing system.

General

Building Name (optional)

123 Egan Dr

Enter in any Notes you want shown when you print this page (optional).

Location Info

City where Building is Located:

Juneau, City of

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Input method: ?

- (•) Select Utility Rate Schedule
- ( ) Manual Entry

○ Manual Entry (Advanced)

Select your Utility and Rate Schedule

AEL&P - Residential ×

Electric Rate Elements for this Utility:

Monthly Customer Charge: $9.22 /month
Demand Charge: $0.00 /kW/month
Power Cost Equalization: $0.0000 /kWh

kWh Energy Charges:
1 - all kWh: $0.1060 /kWh

▶ Click Here to change Advanced Utility Inputs

Building Info

Type of Building:

◉ Residential
○ Commercial Building
○ Community Building

Building Floor Area, excluding garage (square feet): 2000 ft2

Size of Garage:

◉ No Garage
○ 1-Car
○ 2-Car
○ 3-Car
○ 4-Car

Wall Construction:

◉ 2x4
○ 2x6
○ Better than 2x6

Select existing Space Heating Fuel type:

#1 Oil ×

Besides Space Heating, what other Appliances use this Fuel type?

☑ Domestic Water Heater
☐ Clothes Dryer
☐ Range or Oven

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Number of Occupants in Building using the above Appliances: 4 people

Fuel Price Per Unit: 2.70 $ / gallon

Efficiency of Existing Heating System:

- ○ Low 74%
- ◉ Standard 80%
- ○ High Efficiency (e.g. Toyostove) 84%
- ○ Manual Entry

Auxiliary electricity use (fans/pumps/controls) from existing heating system:

- ○ No Fans/Pumps (e.g. wood stove)
- ◉ Hydronic (boiler)
- ○ Fan-assisted Space Heater (e.g. Toyostove)
- ○ Forced Air Furnace, Efficient Fan
- ○ Forced Air Furnace, Standard Fan

Annual Fuel Use for the building including space heating and any other appliances that use that same fuel. (Optional, but very helpful for an accurate estimate of heat pump savings, particularly if your building is super-efficient or very inefficient.): gallon per year

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The following inputs asking for January and May electricity use are important in two situations:

- Your home or building is in Rural Alaska and receives Power Cost Equalization (PCE) limited to 500 kilowatt-hours per month.
- Your utility has a "block" rate structure where the electricity rate varies depending on how much you use.

If either one of those is true, review the Video Help below and take time to accurately fill out these inputs. Otherwise, these inputs have no effect on the financial payback of a heat pump (although they do affect some of the total energy cost graphs in the results section).

Video Help for Finding Electricity Usage on Your Bill

Whole Building Electricity Use (without heat pump) in January: 674 kWh

Whole Building Electricity Use (without heat pump) in May: 503 kWh

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Heating Temperature Setpoint: Value = 70 °F

60 65 70 75 80

Heat Pump Info

Type of Heat Pump: Single- or Multi-zone

- (•) Single Zone
- ( ) Multi Zone: 2 zones installed
- ( ) Multi Zone: 3 zones installed
- ( ) Multi Zone: 4 zones installed

Heat Pump Selection Method

- (•) Simple (Heat Pump Model is Automatically Selected)
- ( ) Advanced (You select Manufacturer/Model)

Heat Pump Characteristics Used in Calculator:

HSPF (a Rating of Heating Efficiency): **14.0**
Maximum Heat Output at 5 °F: **16,500 BTUs per hour**

Installed Cost of Heat Pump (include applicable sales tax), $ 6000 $

Rebates Received for Heat Pump, $ 300 $

% of Heat Pump Purchase Financed with a Loan Value = 0 %

0 10 20 30 40 50 60 70 80 90 100

Heat Pump is Turned Off below this Outdoor Temperature: Value = 5 °F

-20 -15 -10 -5 0 5 10 15 20

Select Months when Heat Pump is Turned Off for Entire Month:

- [ ] October
- [ ] November
- [ ] December
- [ ] January
- [ ] February
- [ ] March

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These next questions will help determine how much of the building's heat load can actually be reached by the Heat Pump. Often the Heat Pump's indoor units

do not fully serve all of the spaces in the building.

Is All of the Building's Heat currently Provided by one Space Heater like a Toyostove or Wood Stove?

- ○ Yes
- ◉ No

Percentage of the Home that is Openly Exposed to the Heat Pump Indoor Units:

Value = 75 %

0 10 20 30 40 50 60 70 80 90 100

For those rooms that are not openly exposed to the heat pump indoor units, the following two questions help determine when the heat pump can successfully provide heat to those rooms.

What is your Tolerance for Cooler Bedroom and Back Room Temperatures?

- ○ Bedrooms must be kept at nearly the Same Temperature as Main Spaces
- ◉ Bedrooms can be as much as 5 degrees Cooler than Main Spaces
- ○ Bedrooms can be as much as 10 degrees Cooler than Main Spaces

Are Doors typically open to the Bedrooms and Back rooms that do not have a Heat Pump Indoor Unit?

◉ Open Doors ○ Closed Doors

Economic Inputs

Sales Tax (applies to heating fuel and electricity costs): Value = 5 %

0 1 2 3 4 5 6 7 8 9 10

▶ Click Here to change Advanced Economic Inputs

Results

Rate of Return: **22.3%**

The rate of return on the investment is estimated to be **22.3%**. Compare this *tax-free* return to the rate of return or interest of your other investment options. Usually a value greater than 4% indicates a cost-effective investment.

Net Present Value: **$8,770**

The Net Present Value of installing an air-source heat pump is estimated to be **$8,770**.

This means that over the life of the equipment you will earn a total of **$8,770** in today's dollars beyond your initial investment accounting for interest. Any value greater than zero indicates a cost-effective investment.

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You can change the default heat pump life of 14 years in the Advanced Economic Inputs section. If you are trying out different heat pumps or different operating procedures for the heat pump, you should try to pick the combination that maximizes this net present value figure. Note that this only includes economic costs and benefits and does not include any environmental or social benefits of the heat pump.

Annual Heating Fuel Savings: **706 gallon** of #1 Oil

This shows how much heating fuel is saved each year by use of the heat pump. The heat pump achieves these savings by **serving 93%** of the building's space heating load. The amount of load served by the heat pump is affected by:

- your choices concerning lower temperatures in the bedrooms and whether doors are open to those rooms,
- the Outdoor Temperature cutoff below which the heat pump doesn't run,
- the maximum heating capacity available for the heat pump selected.

Annual Increase in Electricity Use: **7,382 kWh**

Use of the heat pump adds to the electric use of the building. Shown here is the annual increase in electricity use.

Heat Pump Sizing

This energy model shows that the heat pump *did* deliver its maximum output capacity at some point during the year.

You might try larger heat pump sizes in the model to see if the Net Present Value benefit of the heat pump increases.

Seasonal Average Heat Pump COP: **3.0**

The Seasonal Average Heat Pump COP indicates the annual average efficiency of the heat pump. Conventional Electric Resistance heat (e.g. electric baseboard) would have a COP of 1.0 (100%). Heat Pumps generally have COPs in excess of 2.0 (200%).

Electricity and Fuel Prices

The average cost for the *additional* electricity needed for the heat pump is **$0.1113/kWh**. This accounts for any block rates and PCE (Rural Power Cost Assistance) limits that may be present. The fuel price for the fuel saved is **$2.835/gallon**. These values include sales taxes.

Greenhouse Gas Emissions

Installing a heat pump is predicted to save **15,642 pounds of CO2** emissions annually, or 218,994 pounds over the life of the equipment. This is equivalent to a reduction of **17,539 miles driven** by an average passenger vehicle annually, or 245,545 miles over the equipment's life.

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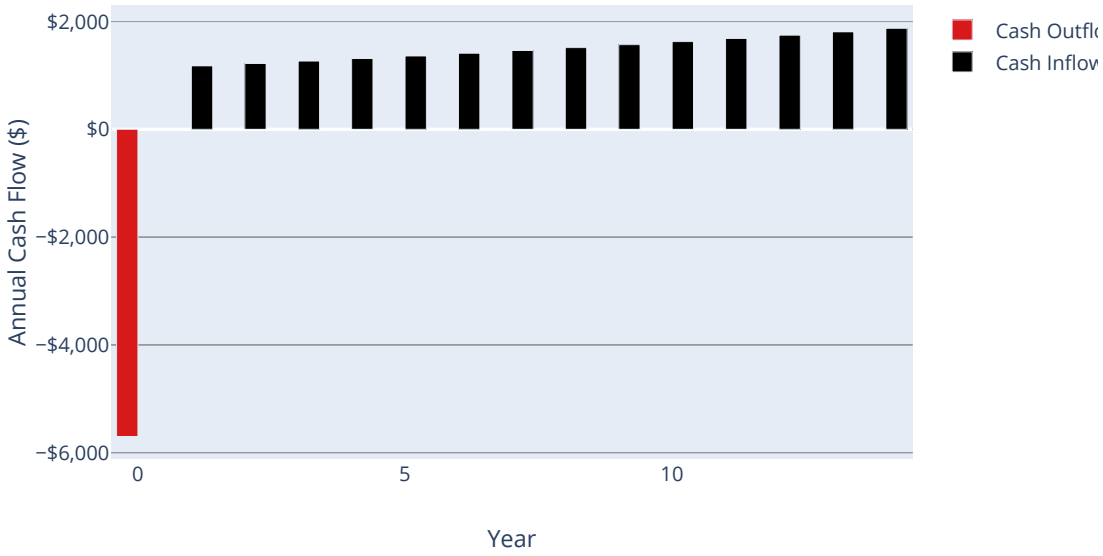
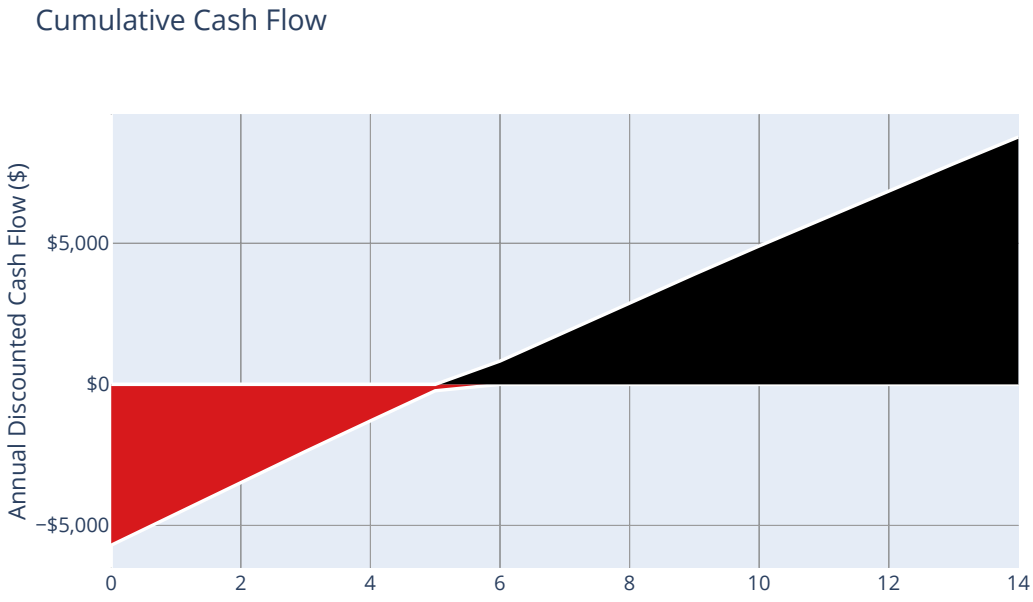
▼ Click Here for Year-by-Year Cash Flow Information

Cash Flow Results

The graph below shows how the heat pump project impacts cash flow in each of the years during the life of the heat pump. Negative, red, values indicate a net outflow of cash, and positive, black, values indicate an net inflow of cash. Sales taxes are included where applicable.



The graph below shows the running total of cash flow over the life of the heat pump. If the total cash flow exceeds zero (turns black), your portion of the heat pump investment has paid itself back with interest. (The graph technically shows cumulative, discounted cash flow).



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Year

The table below breakdowns the cash flow impacts into categories. All values are dollars. Positive numbers indicate a beneficial impact (inflow of cash); negative values indicate a detrimental impact (outflow of cash).

Year	Initial Cost	Loan Payments	Operating Cost	Heating Fuel Cost	Electricity Cost	Net Cash Flow	Cumulative Discounted Cash Flow
0	-5,700	0	0	0	-0	-5,700	-5,700
1	0	0	0	2,000	-822	1,179	-4,578
2	0	0	0	2,060	-838	1,222	-3,469
3	0	0	0	2,122	-855	1,267	-2,375
4	0	0	0	2,186	-872	1,314	-1,294
5	0	0	0	2,251	-889	1,362	-227
6	0	0	0	2,319	-907	1,412	827
7	0	0	0	2,388	-925	1,463	1,866
8	0	0	0	2,460	-944	1,516	2,892
9	0	0	0	2,534	-963	1,571	3,905
10	0	0	0	2,610	-982	1,628	4,904
11	0	0	0	2,688	-1,002	1,686	5,890
12	0	0	0	2,769	-1,022	1,747	6,863
13	0	0	0	2,852	-1,042	1,810	7,823
14	0	0	0	2,937	-1,063	1,874	8,770

Results by Month

Monthly Space Heating Load

This graph shows how the space heating load of the building varies across the months, and it shows what portion of that load is served by the heat pump versus the existing heating system. The units are total MMBtu of heating load placed on the building's heating system. Not all of this load may be served by the heat pump, due to heat distribution, low-temperature cut-off, and capacity limitations of the heat pump. This figure does *not* include Domestic Hot Water or any other uses of the fuel.

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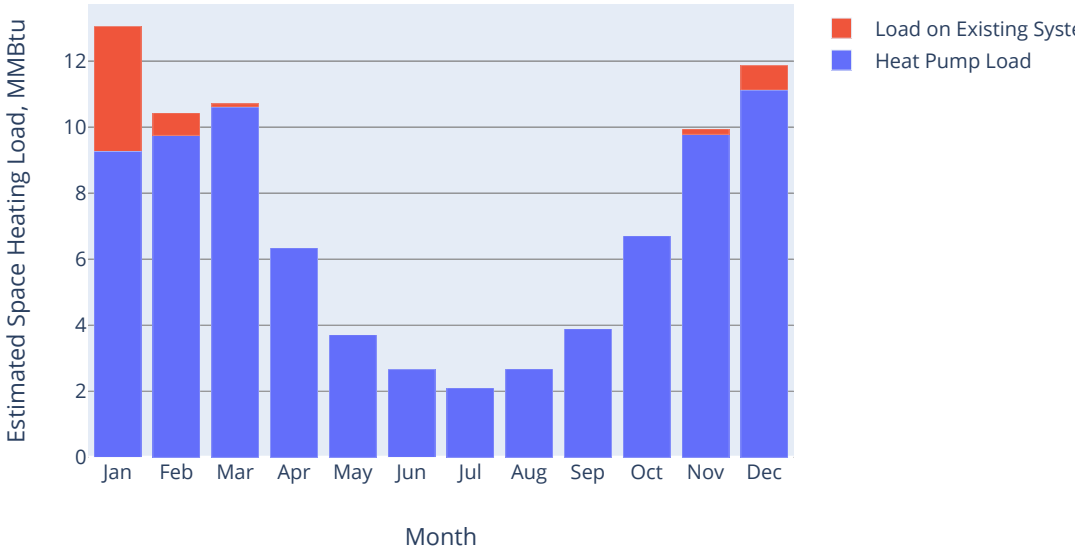
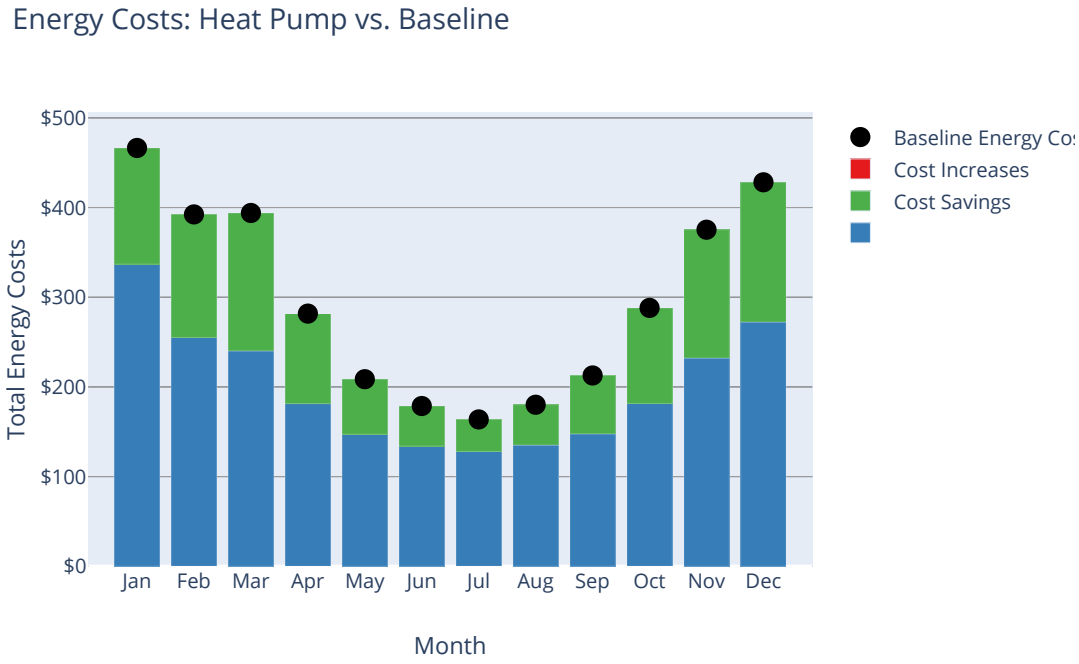
Monthly Space Heating Load



Monthly Energy Cost Impacts

This graph shows how the building's monthly energy costs in the first year change due to the heat pump. Both electricity costs and fuel costs are included. The dots show the current level of energy cost prior to installing the heat pump. If the heat pump lowers energy cost in the month, a green bar drops from the dot down to the new level of energy cost for the month. If the heat pump raises costs in the month (e.g. the added electricity cost is more than the fuel cost savings), a red bar extends from the current cost dot to the new, higher, energy cost level. It could be more economical to shut off the heat pump in these months, although red bars (cost increases) can turn into green bars (savings) in future years if heating fuel costs are projected to increase in price faster than electricity (see Advanced Economic Inputs for price escalation inputs). This graph shows monthly energy costs in the *first year* after installing the heat pump.

All energy uses are included in the costs, not just space heating.



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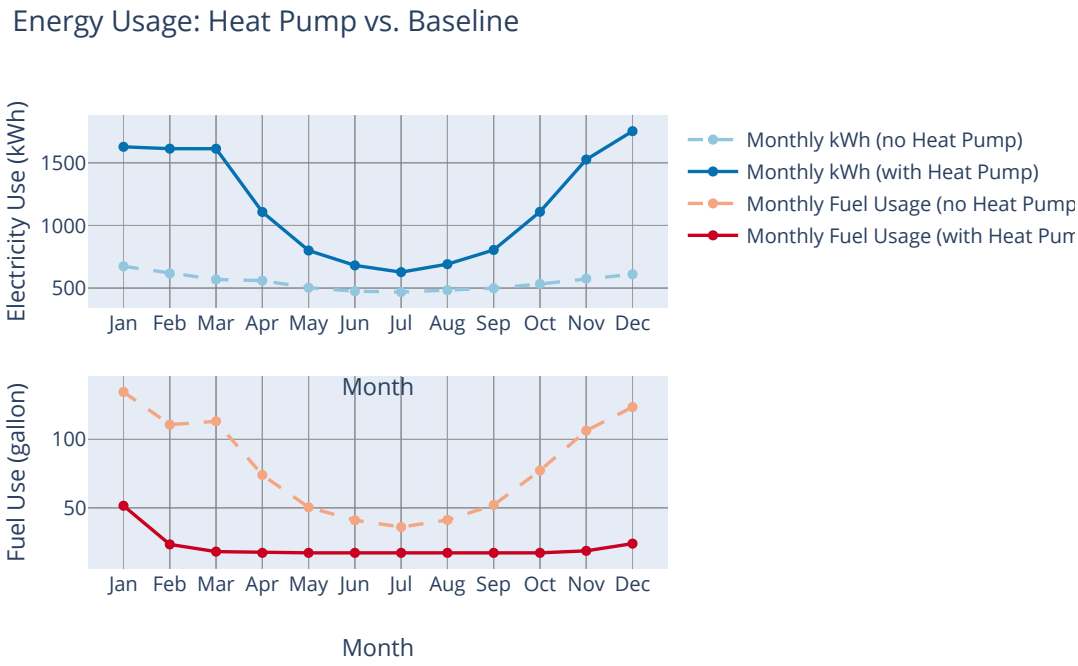
▼ Click Here for More Detailed Monthly Information

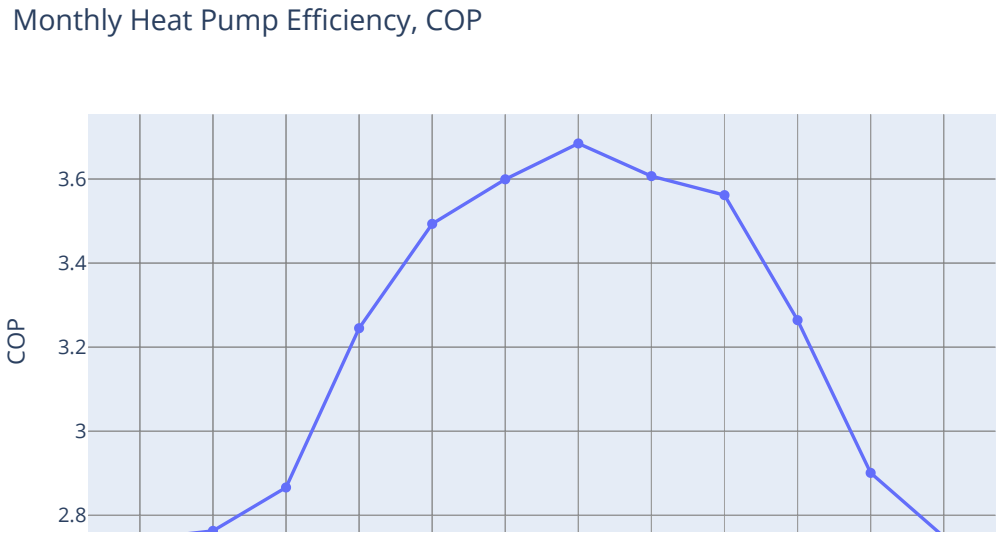
Monthly Electricity and Fuel, Before/After

This graph shows electricity use and fuel use before and after installation of the heat pump. This is total electricity and fuel use, including energy uses beyond just space heating.



Monthly Heat Pump Efficiency

This graph shows the efficiency of the heat pump in each month. Heat Pump efficiency is measured as "COP"(Coefficient of Performance). A COP of 2.5 means 250% efficient, as compared to electric resistance heat, which is 100% efficient. The heat pump's efficiency improves as the temperature outside warms.



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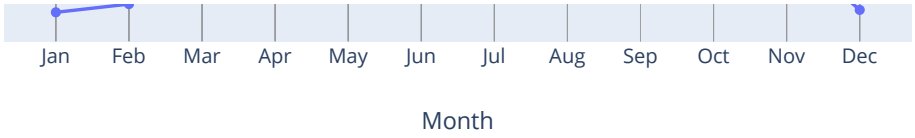
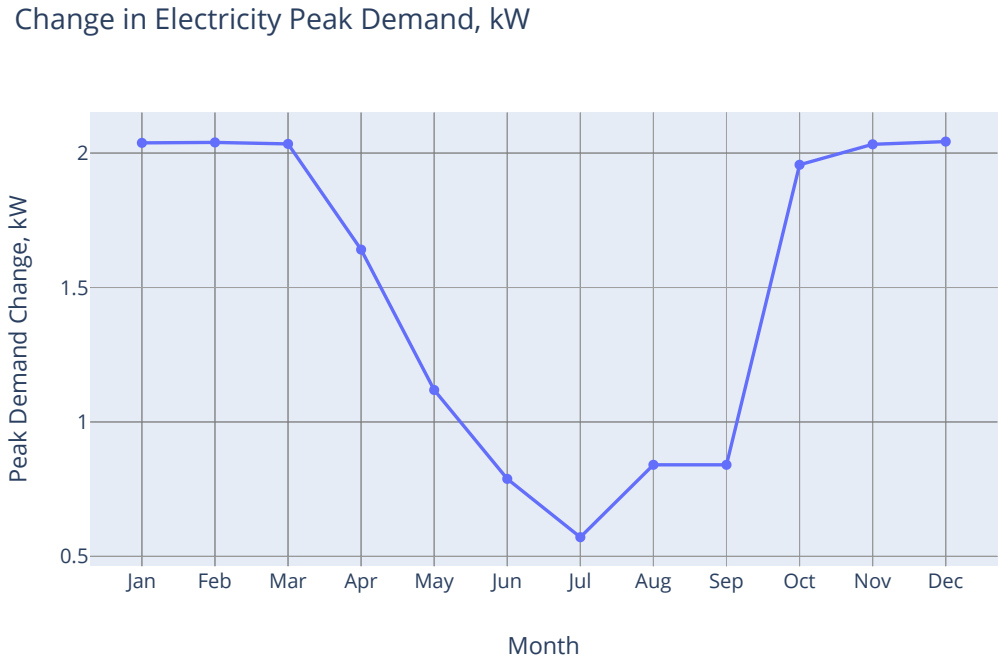


Month

Monthly Change in Electricity Peak Demand

This graph shows how much the peak electricity demand in each month is affected by the heat pump. The heat pump will normally increase the peak demand, except when the heat pump is used to avoid conventional electric heat; in that case peak demand will decrease and values in the graph below will be negative. Units are kilowatts.



Design Heating Load Information

An approximate estimate of the design space heating load of this building is **28,870 Btu/hour**, not including any domestic hot water load. This was based on a Design Outdoor Temperature of **8.9 °F**; approximately 1% of the hours in the year (88 hours) will be colder than this temperature. The design heating load figure does *not* include any safety margin and is measured at the output of the heating system.

The heat pump is estimated to have an output of **13,309 Btu/hour at a 5 °F** outdoor temperature. The heat pump will have different maximum output capacities at other outdoor temperatures, as the heat pump's efficiency varies with outdoor temperature. This energy model shows that the heat pump *did* deliver its maximum output capacity at some point during the year.

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▶ Click Here for Debug Output

This calculator was created by Analysis North, The Cold Climate Housing Research Center, and Arctic Energy Systems. The underlying code for this calculator is Open Source and available on Github. The calculator was built entirely in the Python programming language through use of the Dash by Plotly framework. Questions and comments may be sent to Alan Mitchell alan@analysisnorth.com.

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