NEEP'S COLD CLIMATE AIR SOURCE Heat Pump List

Users Guide: Cold Climate Heat Pump Sizing Support Tools

The cold climate heat pump sizing support tools support users to select cold-climate air source heat pump (ccASHP) products that are sized to best match the peak and annual heating needs of a home or heating zone. The tools, functioning within the NEEP ccASHP Product List website, include a search function and a product-level analysis. The search function helps users compare multiple products to each other based on search criteria. The product view displays system and load-matching data, providing a visual for how a specific heat pump's capacity matches the heating load across the home's winter temperatures.

Considerations

This tool is for preliminary product selection planning only. It is necessary to conduct full engineering capacity assessments that take line-length, multi-head impacts, and other factors into consideration. Use manufacturer's data and tools to finalize product sizing and selection determinations

This tool is for use in heating-dominated climates. The tool, and users guide, presumes the reader has a basic understanding of heat pump terminology and home heating load concepts. If designing for regions that also have high humidity and summer cooling loads, the sizing decision needs to carefully balance heating, cooling, and humidity control needs*. In these climates, it is highly recommended to compare sensible cooling capacity to sensible load at the cooling design temperature and then select the equipment and system configurations that supports the higher of the two loads. This tool can provide information about the heating aspect of those systems, but it is insufficient for the ultimate system selection.

> ** **Note:** If cooling load or humidity control require a system that can provide over 140% of the heating load at design temperatures, consider other heat pump products or consider additional non-heat pump equipment such as energy recovery ventilators and dehumidifiers.*

Views

This tool has two views that support the user for different purposes.

1. A single **product view** that displays key data regarding how that product fulfills a home or zone's heating load.
2. A **search result list view** where a user can compare multiple products to each other based on search criteria. In this view, the tool limits users to viewing 300 products due to calculation speeds of the underlying data.

Product View Instructions

For the **Product View**, navigate to a specific product in the database and select the *Advanced Data - Sizing for Heating* button to open extra data fields:

- **Complete the follow data fields:** *State*, *Weather Station*, *Heating Design Load*

  - The tool will assign *Heating Design Temperature* based on the selected weather station as per American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) data.
  - Optionally: complete the *Apply Lockout Temperature*, and *Manually Set Low Temperature Capacity Rating* data fields

- After entering data, click the *Run Sizing for Heating Data* button.
  - Data, and a graphic visualization, of how the selected system's capacity matches the home or zone's annual heating needs will display. More details about the graphic and the data points are below.

Apply Lock-Out Temperature Field

If you intend on applying a compressor lockout or backup system switchover temperature, you can see the impact of that decision by using the optional *Apply Lock-Out Temperature* field. This temperature setting should be set on installer's experience or manufacturer guidance. The tool will zero out the heat pump's capacity for all hours that occur below the indicated temperature threshold, thus changing some of the load-fulfillment data points.

This tool does not presume what the backup, supplemental, or auxiliary heating system may be. The tools default display assumption is that the heat pump continues to run at its full capacity even below the capacity balance point, with a supplemental heating system providing the remainder of the heat load. Use the lock-out temperature field option if your system's controls will stop the heat pumps operation below a certain temperature, reverting entirely to the supplemental heating system.

Manually Set Low Temperature Capacity Rating

Some ccASHP products in the database *do* not include performance data below 5°F. If viewing a product for a particularly cold climate, where the design temperature is below 5°F, this tool will display a warning text below the graph to state that the tool assumes zero capacity below 5°F even though. ccASHPs will operate below 5°F. In these cases, the user has the option to self-enter a low-temperature maximum capacity rating to complete the data set. Please reference your manufacturer's expanded performance data to determine this input.

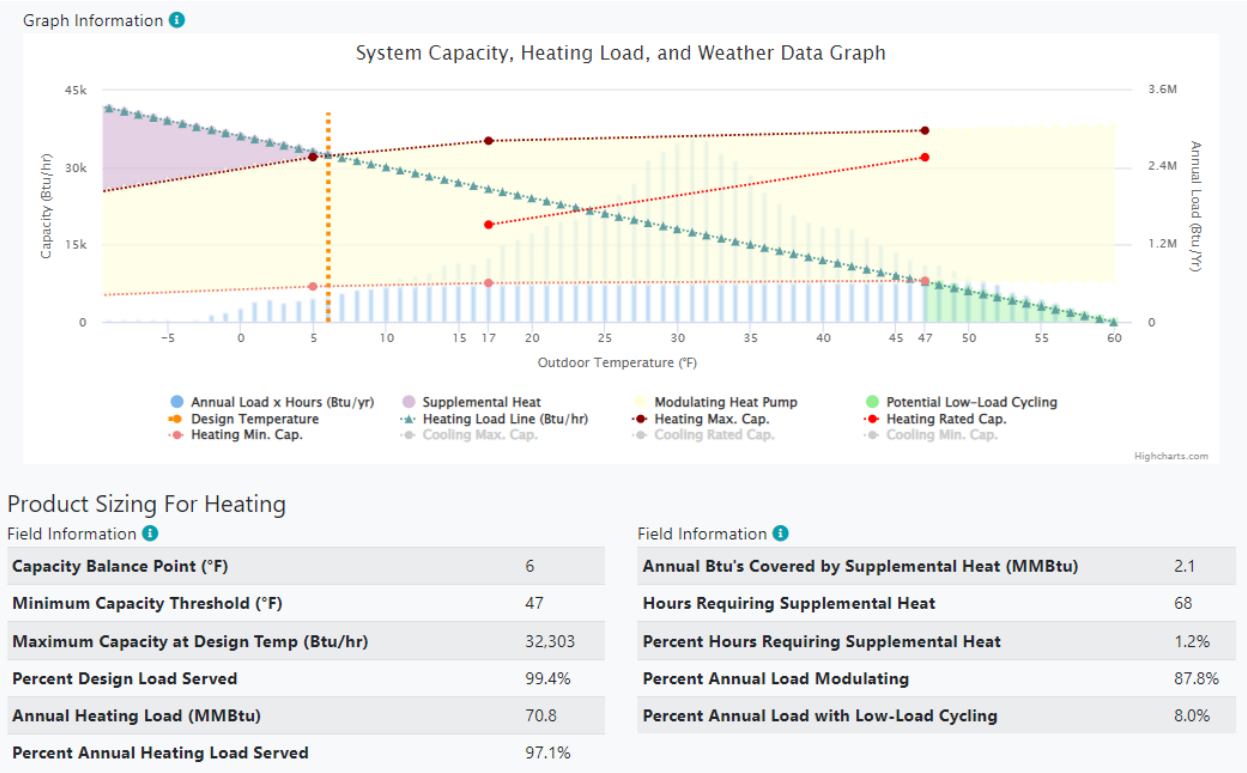

Figure 1: Product View Results Example

Manage the product view visualization chart

Clicking on any element in the chart's key will toggle it between being displayed or hidden. You can remove the load x hours histogram and view cooling capacities on the chart at your discretion.

> ***Note:*** *The annual load x hours histogram is only indirectly related to the system capacity and load lines. It is on its own scale shown on the right axis. The largest bars represent temperatures with the highest overall impact on the heat pump's performance. Selecting a heat pump that will be modulating with particularly high efficiency at those temperature points will lead to lower energy bills and best performance.*

Product View Quick-Guide

The product view visualization and associated data provide a wealth of useful information to help you determine if this heat pump is a good fit for the load. A detailed description of each data point and visual element is provided later in this user's guide. For a quick-assessment, here are the most important aspects to consider:

1. Look at the heat pump's max capacity at the design condition. Does it match your intentions?
    a. If you are planning for the heat pump to provide the full load, check that *Percent Design Load* Served is between 90%-120%. Avoid oversizing.

   b. If you're planning for the heat pump to provide partial load, recognize you will need supplemental heat to cover the difference. Is that being provided by a separate heating system?

2. Maximize time spent modulating. Will this heat pump spend its run-hours efficiently providing heat?
   a. Look at *Percent Annual Load Modulating* and pick a product that maximizes this value.
   b. Observe the overlap between the load x hours histogram, the load line, and the modulating zone. Pick a product with the load-line passing through the heat pump's modulating zone coincident with the weather station's highest load x hours. These are the conditions with best operational efficiency, providing the home's full heating need.
   c. Confirm that the min-capacity threshold is not crossed too early. The ideal unit should only be at risk of low-load compressor cycling for particularly mild days, with low overall load.

Maximize your annual use of heat-pump heating. View the *Percent Annual Heating Load Served* to gauge how much of the home's heating need is provided by the heat pump. It is common and appropriate for a small percent (<3) of the annual load to not be fully covered below the design temperature.

Search Result List View Instructions

For the **search result list view,** from the main page click the *Advanced Search - Sizing for Heating* button. This will open extra data fields to allow product listing relative to load-matching. Complete any known standard search data fields before entering the sizing data fields.

- **Complete the follow data fields:** *State*, *Weather Station*, *Heating Design Load*
  - The tool will assign *Heating Design Temperature* based on the selected weather station using ASHRAE data.
- After entering data, click the *Search the List* button.
  - Returns from your advanced search will be available in both *List View* and *Grid View*. Within *List View*, you can sort results for any column in either ascending or descending order. *Grid View* will present products in the same order as sorted and filtered in the *List View*. From either view, you can navigate to a specific heat pump's *Product View* for additional data visualization. Use multiple browser windows to compare the visualizations of multiple heat pumps.

Note: *Some ccASHP products in the database may not include performance data below 5°F. If searching for a weather station where the design temperature is below 5°F, this tool will not display design-load related data for such products. In these cases, the user has the option to self-enter a low-temperature maximum capacity rating on the* ***Product View****.*

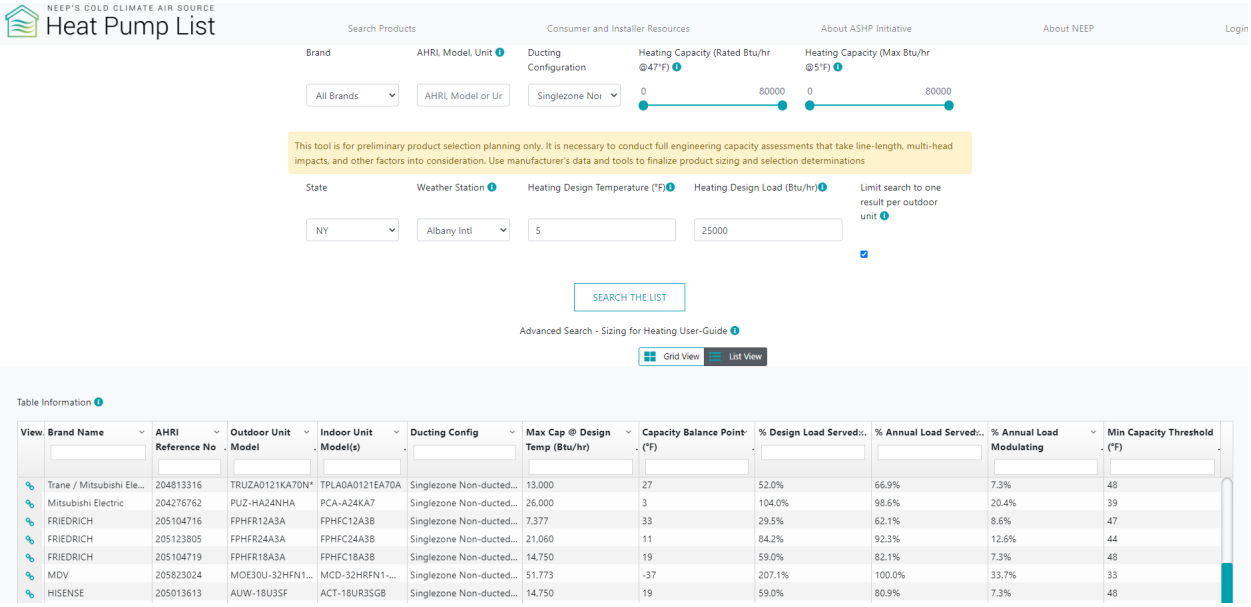

Figure 2: List View Results Example

To run the calculations, the user must apply filters to reduce the search returns to 300 results or fewer. If your search is over the limit, use a combination of the following five filters.

1. *Brand*
2. *Ducting Configuration*
3. Heating Capacity ranges (either/both @47°F and @5°F)
4. *Limit search to one result per unique outdoor unit* checkbox*
5. *AHRI, Model, Unit*

> ** **Note:** Some manufacturers, particularly those with ducted systems, have listed many relatively similar heat pump systems in the database. Each individual listing is its own AHRI certificate number representing a unique combination of outdoor unit, indoor unit, and in some cases paired indoor gas-furnace. For the heat pump's heating capacity variations, the dominant variable is the outdoor unit. Selecting the **Limit Search to One Result per Unique Outdoor Unit** checkbox sets the search to pick the first instance of each outdoor unit as representative, significantly reducing the search results. This is checked by default when you start a new search.*
>
> *Once chosen, users can list-view other systems that have the same outdoor unit by entering the selected outdoor unit number into the **AHRI, Model, Unit** input box and de-selecting the **Limit Search to One Result per Unique Outdoor Unit** checkbox.*

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Heat Pump List

Detailed Descriptions for Data Fields and Calculation Methods and Sources

Weather station selection*: This selection will auto populate the *Heating Design Temperature* field from the 99% dry bulb heating design temperature listed in the 2021 ASHRAE Handbook of Fundamentals.

> **** Note:** The tool does not have weather data for all weather stations. If you do not see yours, select the closest. Be sure to consider stations in neighboring states if near a state border.*

Heating design load*: This tool can only show results for a single heat pump at a time. If your home will use multiple heat pumps to fulfill a home's total load, enter a zonal design load and repeat for each zone. For the heating design load, use your preferred method. This could be by Air Conditioning Contractors of America (ACCA) Manual J software, block-load calculators, historic-fuel use load estimators, or rules of thumb. An accurate design load is critical to proper sizing. Resist adding in extraneous safety factors to avoid oversizing.

> **** Note:** A home's load is principally determined by outdoor air temperature relative to thermal envelope quality. But it is also impacted by solar gains, internal gains, and wind. Design load calculations assume low solar gains, moderate internal gains, and moderate wind impacts.*
>
> *This tool applies a linear load line from the designated heating design load at design temperature, to zero load at 60°F. In reality, the load at any given temperature is impacted by other variables, particularly solar gains that will reduce load. This tool's load line and annual load assumptions can therefore be considered conservative.*

> ***Note:** For particularly cold climates, there will be some load-hours at temperatures for which there is no manufacturer's capacity data. In these cases, the tool will use a capacity of 0 Btu/hr for those hours. This calculation approach only has a small impact on annual load-served results.*

NEEP'S COLD CLIMATE AIR SOURCE
Heat Pump List

List Search Data Fields Definitions

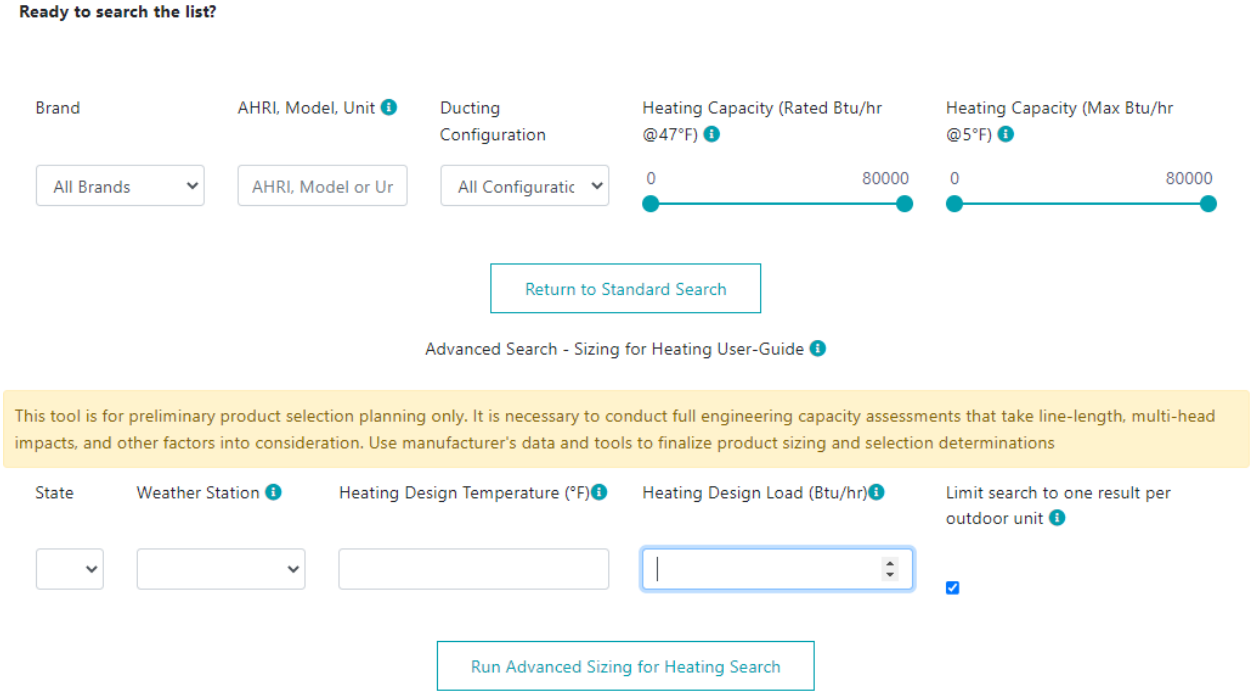

Figure 3: Data Fields for List Search

Filters/Data Points	*Definition/Use Case*
Brand	The product's manufacturer as listed within the NEEP database. This field can be used to limit search results. Note, some manufacturers list products using a variety of tradenames.
AHRI, Model, Unit	Identifiers used to label equipment. AHRI tests and certifies equipment ratings. This field can be used to limit search results.
Ducting Configuration	A drop-down of different system configurations as listed by the manufacture within NEEP's database. This field can be used to limit search results.
Heating Capacity @ 47°F	Often listed as the *rated capacity*. Unlike *max capacity* @5°F, this is a standardized capacity at 47°F used for standard comparison amongst all heat pumps.
Heating Capacity @ 5°F	Often listed as the maximum heating capacity @ 5°F, this is the amount of Btu/hr the device is capable of producing at the outdoor temperature.
Weather Station	Location that collects weather data. The design temperature and temperature-bin climate information used by the tool calculations are specific to the weather station's data. This tool only has temperature bin data for a subset of all weather stations listed in the ASHRAE Handbook of Fundamentals or used by ACCA Manual J 8th Edition Version 2.5
Heating Design Temp	This is also referred to as the *winter design temperature*. This tool follows best practices and assigns the 99% heating dry-bulb temperature as listed by the 2021 ASHRAE Handbook of Fundamental for the selected weather station. For heating, 99% of the region's hours are above this temperature.
Heating Design Load	This is the heating need of the home (or zone), at the heating design temperature, to maintain a 70°F indoor air temperature.
Limit Search to one result per outdoor unit	Some manufacturers, particularly those with ducted systems, have listed many relatively similar heat pump systems in the database. Each individual listing is its own AHRI certificate number representing a unique combination of outdoor unit, indoor unit, and in some cases paired indoor gas-furnace. For the heat pump's heating capacity variations, the dominant variable is the outdoor unit. Selecting this checkbox sets the search to pick the first instance of each outdoor unit as representative, significantly reducing the search results. This is checked by default when you start a new search.

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List Results Data Fields Definitions

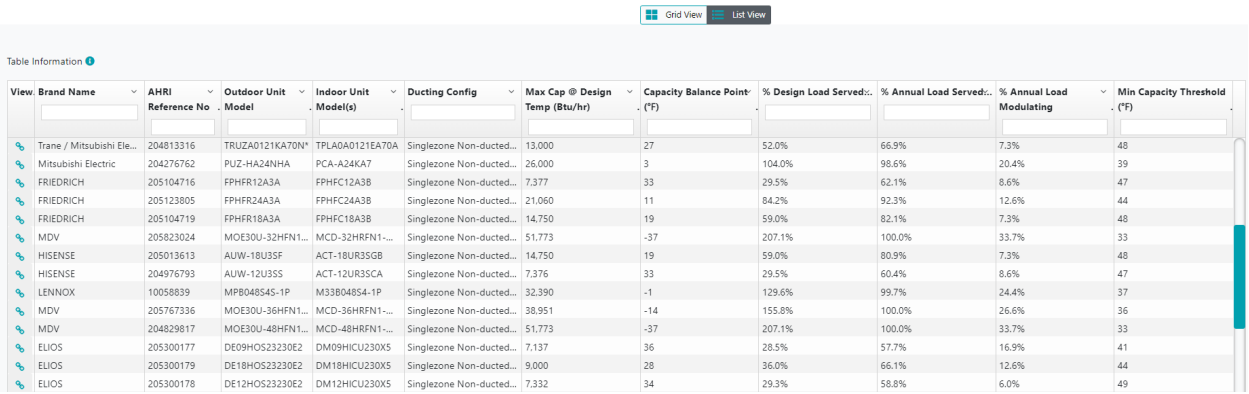
Grid View | List View

Table Information

View	Brand Name	AHRI Reference No	Outdoor Unit Model	Indoor Unit Model(s)	Ducting Config	Max Cap @ Design Temp (Btu/hr)	Capacity Balance Point (°F)	% Design Load Served	% Annual Load Served	% Annual Load Modulating	Min Capacity Threshold (°F)
	Trane / Mitsubishi Ele...	204813316	TRUZA0121KA70N*	TPLA0A0121EA70A	Singlezone Non-ducted...	13,000	27	52.0%	66.9%	7.3%	48
	Mitsubishi Electric	204276762	PUZ-HA24NHA	PCA-A24KA7	Singlezone Non-ducted...	26,000	3	104.0%	98.6%	20.4%	39
	FRIEDRICH	205104716	FPHFR12A3A	FPHFC12A3B	Singlezone Non-ducted...	7,377	33	29.5%	62.1%	8.6%	47
	FRIEDRICH	205123805	FPHFR24A3A	FPHFC24A3B	Singlezone Non-ducted...	21,060	11	84.2%	92.3%	12.6%	44
	FRIEDRICH	205104719	FPHFR18A3A	FPHFC18A3B	Singlezone Non-ducted...	14,750	19	59.0%	82.1%	7.3%	48
	MDV	205823024	MOE30U-32HFN1...	MCD-32HRFN1-...	Singlezone Non-ducted...	51,773	-37	207.1%	100.0%	33.7%	33
	HISENSE	205013613	AUW-18U3SF	ACT-18UR3SGB	Singlezone Non-ducted...	14,750	19	59.0%	80.9%	7.3%	48
	HISENSE	204976793	AUW-12U3SS	ACT-12UR3SCA	Singlezone Non-ducted...	7,376	33	29.5%	60.4%	8.6%	47
	LENNOX	10058839	MPB048S4S-1P	M33B048S4-1P	Singlezone Non-ducted...	32,390	-1	129.6%	99.7%	24.4%	37
	MDV	205767336	MOE30U-36HFN1...	MCD-36HRFN1-...	Singlezone Non-ducted...	38,951	-14	155.8%	100.0%	26.6%	36
	MDV	204829817	MOE30U-48HFN1...	MCD-48HRFN1-...	Singlezone Non-ducted...	51,773	-37	207.1%	100.0%	33.7%	33
	ELIOS	205300177	DE09HOS23230E2	DM09HICU230X5	Singlezone Non-ducted...	7,137	36	28.5%	57.7%	16.9%	41
	ELIOS	205300179	DE18HOS23230E2	DM18HICU230X5	Singlezone Non-ducted...	9,000	28	36.0%	66.1%	12.6%	44
	ELIOS	205300178	DE12HOS23230E2	DM12HICU230X5	Singlezone Non-ducted...	7,332	34	29.3%	58.8%	6.0%	49

Figure 4: List View from Advanced Search - Sizing for Heating

Search View Results Fields	*Definition*
Maximum Capacity at Design Temp (Btu/hr)	The heat pump's maximum capacity output at the design temperature.
Capacity Balance Point (°F)	Temperature at which the capacity of the heat pump equals the heating load in the house (i.e., The point of intersection of the load line and max capacity line). Note, the term balance point is also used to convey other concepts in the building science and HVAC) fields.
Percent Design Load Served	The percent of the home's design load met by the heat pump operating at maximum capacity at the design temperature. For whole-home heating, this should be between 90% and 120%.
Percent Annual Heating Load Served	The percent of the annual heating load satisfied by the heat pump. This includes load hours at which the heat pump may be low-load cycling (warmer weather), as well as load-hours where the heat only fulfills a portion of the home or zone's heating load (colder weather). It is expected, as with most heating systems sized to the design load, that a small percent of annual load during the coldest hours will not be served by the heating system. Those hours are few, and the home's internal temperature will not drift substantially during them.
Percent Annual load Modulating	The percent of the annual heating load supplied by the heat pump in its modulating zone—between minimum and maximum capacities.
Minimum Capacity Threshold (°F)	Temperature at which the home's load is lower than the heat pump's minimum capacity. Below this point, the heat pump's compressor will cycle.

NEEP'S COLD CLIMATE AIR SOURCE
Heat Pump List

Product View Data-Entry Field Definitions

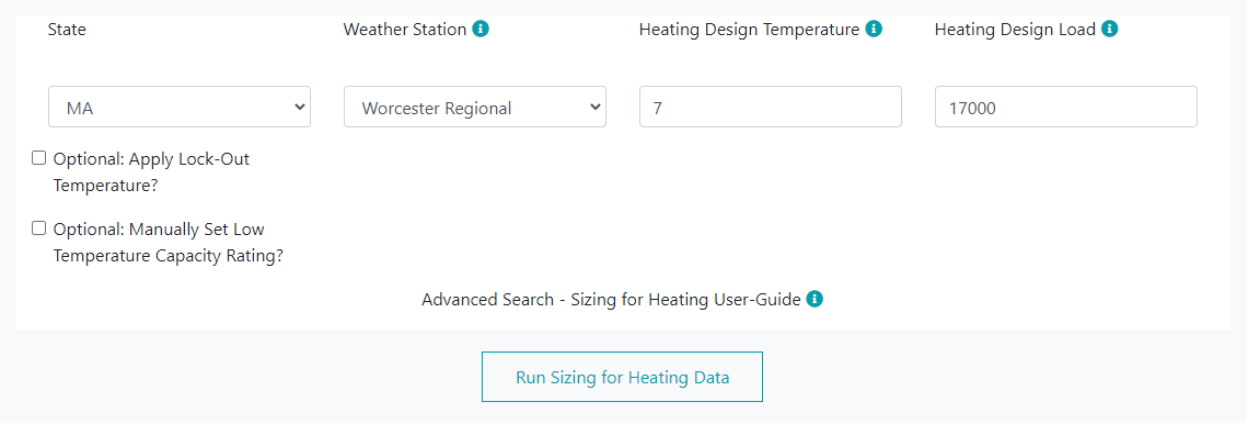

Figure 5: Data Fields for Sizing for Heating Product View

Filters/Data Points	*Definition/Use Case*
Weather Station	Location that collects weather data. The design temperature and temperature-bin climate information used by the tool calculations are specific to the weather station's data. This tool only has temperature bin data for a subset of all weather stations listed in the ASHRAE Handbook of Fundamentals or used by ACCA Manual J 8th Edition Version 2.5
Heating Design Temp (°F)	This is also referred to as the *winter design temperature*. This tool follows best practices and assigns the 99% heating dry-bulb temperature as listed by the 2021 ASHRAE Handbook of Fundamental for the selected weather station. For heating, 99% of the region's hours are above this temperature.
Heating Design Load (Btu/hr)	This is the heating need of the home (or zone), at the heating design temperature, to maintain a 70°F indoor air temperature.
Optional: Apply Lock-Out Temperature (°F)	If you intend on applying a compressor lockout or backup system switchover temperature, you can see the impact of that decision by using this field. The tool will zero out the heat pump's capacity for all hours that occur below the indicated temperature threshold, thus changing some of the load-fulfillment data points.
Optional: Set Low Temperature Capacity Rating (°F), (Btu/hr)	Some ccASHP products in the database do not include performance data below 5°F. In these cases, the user has the option to self-enter a low-temperature maximum capacity rating to complete the data set using this field. Please reference your manufacturer's expanded performance data to determine this input. Typically, this is near the balance point, or based on fuel and efficiency economics for lowest cost operation.

NEEP'S COLD CLIMATE AIR SOURCE
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Product View Visualization Chart Data Definitions

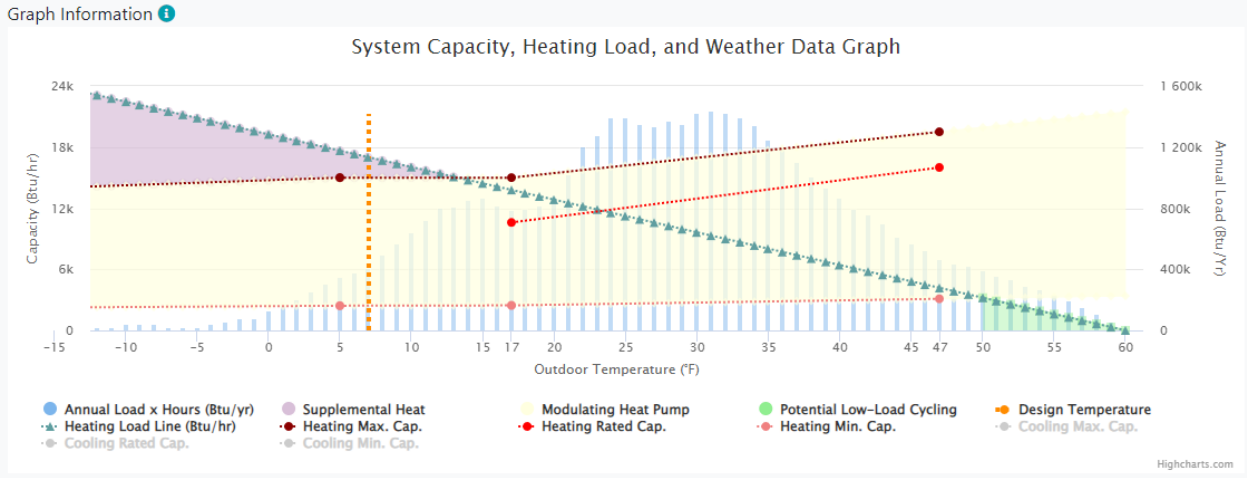

Figure 6: Product View Data Visualization Chart Example

Visualization Chart Legend	*Definition/Importance*
Annual Load x Hours (Btu/yr)	On the graph, there is a bar chart in the background indicating the number of load-hours a home spends at each outdoor temperature range or "bin." For each bin, this is the home's load (in Btu/hr) ***times*** the number of hours. It is an indication of how much heating energy is needed each year at various outdoor temperatures. This can help users understand relative impacts of short cycling and backup heating for a given heat pump and home heating load. Generally, the more this bar chart is covered by the modulating zone, the better the heat pump fits the heating load.
Supplemental Heat	Shaded zone on the left side of the graph, which shows the amount of heating load served by a supplemental or backup heating system at each temperature point.
Modulating Heat Pump	The temperature range within which the heat pump is operating between its minimum and maximum capacity as it responds to the home or zone's heating load. The system is most efficient when within this zone. This is sometimes referenced as the *Goldilocks zone*.
Potential Lod-Load Cycling	Indicating a heat pump that turns on but does not complete its normal cycle. Instead, the system shuts down briefly, then restarts again. This may happen over and over in a cycle. On this graph, this is represented by the shaded triangle on the lower right of the page. This occurs when the heat pump's minimum capacity is higher than the heating load. It is common and expected at low-load situations on warmer days, but it can be problematic for efficiency and comfort if it occurs for a large portion of the year's load-hours. In this tool, a green short-cycling triangle indicated a system where the crossover temperature is high enough to not lead to any significant efficiency penalties. A yellow short-cycling triangle indicates a system that may short cycle with medium frequency for a more substantial portion of the year's heating season, and it will result in a minor efficiency penalty. A red short-cycling triangle indicates a system that will short cycle considerably with a significant impact in annual efficiency.
Design Temperature (°F)	A vertical line indicating the selected weather station's 99% heating dry-bulb temperature as listed by the 2021 ASHRAE Handbook of Fundamentals
Heating Load Line (Btu/hr)	The home (or zone's) heating load at each temperature point. The *heating load line* starts at the user's indicated *heat design load* and reduces linearly to zero load at an outdoor temperature of 60°F. In reality, the heating load is not perfectly linear, but is also impacted by solar gains, internal gains, and wind. The choice of zero load at 60°F represents the *building* balance point of a moderately well insulated and air-sealed home. A higher-quality envelope will lead mean a lower temperature building balance point and vice-versa.
Heating Max Capacity (Btu/hr)	The heat pump's maximum heat output, in Btu/hr, at the specific temperature. This tool extrapolates *max capacity* between discreet temperature data points provided by the manufacturer at 47°F, 17°F, 5°F, and in some cases an optional temperature point below 5°F.

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Visualization Chart Legend	*Definition/Importance*
Heating Rated Capacity (Btu/hr)	Often listed as the *heating capacity* at 47°F. This is a standardized capacity at 47°F used for comparison amongst all heat pumps.
Heating Min Capacity (Btu/hr)	The heat pump's lowest heat output, in Btu/hr, at the specific temperature. This tool extrapolates *min capacity* between discreet temperature data points provided by the manufacturer at 47°F, 17°F, 5°F, and in some cases an optional temperature point below 5°F. A heat pump may short cycle below this threshold. This can impact efficiency and comfort if substantial.
Cooling Max Capacity (Btu/hr)	Highest possible cooling output at a given temperature, in Btu/hr.
Cooling Rated Capacity (Btu/hr)	Often listed as the *cooling capacity* at 95°F. This is a standardized capacity used for comparison among all heat pumps and central air conditioners.
Cooling Min Capacity (Btu/hr)	Lowest possible cooling output at a given temperature, in Btu/hr.

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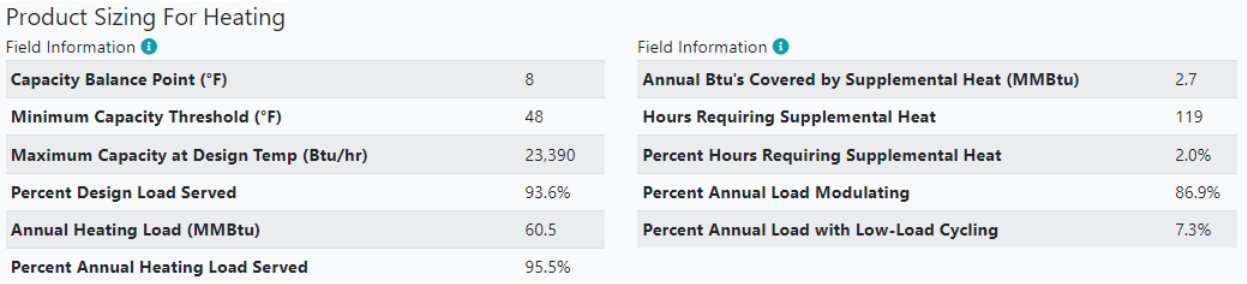
Product View Calculated Sizing for Heating Data Points Definitions



Product Sizing For Heating

Field Information	
Capacity Balance Point (°F)	8
Minimum Capacity Threshold (°F)	48
Maximum Capacity at Design Temp (Btu/hr)	23,390
Percent Design Load Served	93.6%
Annual Heating Load (MMBtu)	60.5
Percent Annual Heating Load Served	95.5%

Field Information	
Annual Btu's Covered by Supplemental Heat (MMBtu)	2.7
Hours Requiring Supplemental Heat	119
Percent Hours Requiring Supplemental Heat	2.0%
Percent Annual Load Modulating	86.9%
Percent Annual Load with Low-Load Cycling	7.3%

Figure 7: Product View Calculated Sizing for Heating Data Points Example

Product View Data Table Legend	*Definition/Importance*
Capacity Balance Point (°F)	Temperature at which the capacity of the heat pump equals the heating load in the house (i.e., The point of intersection of the load line and max capacity line). Note: the term balance point is also used to convey other concepts in the building science and HVAC fields.
Minimum Capacity Threshold (°F)	Temperature at which the home's load is lower than the heat pump's minimum capacity. Below this point, the heat pump's compressor will cycle.
Maximum Capacity at Design Temp (Btu/hr)	The heat pump's maximum capacity output at the design temperature.
Percent Design Load Served	The percent of the home's design load met by the heat pump operating at maximum capacity at the design temperature. For whole-home heating, this should be between 90% and 120%.
Annual Heating Load (MMBtu)	To total amount of annual heating energy needed to maintain home-comfort
Percent Annual Heating Load Served	The percent of the annual heating load satisfied by the heat pump. This includes load hours at which the heat pump may be low-load cycling (warmer weather) as well as load-hours where the heat only fulfills a portion of the home or zone's heating load (colder weather).
Annual Btu's Covered by Supplemental Heat (MMBtu)	The amount of annual home heating energy supplied by the supplemental heating system
Hours Requiring Supplemental Heat	The number of annual hours that require operation of supplemental heat to maintain home-comfort
Percent Hours Requiring Supplemental Heat	The percent of annual hours that require operation of supplemental heat to maintain home-comfort
Percent Annual load Modulating	The percent of the annual heating load supplied by the heat pump in its modulating zone—between minimum and maximum capacities.
Percent Annual Load with Low-Load Cycling	The percent of the annual load where the home's load is below the heat pump's minimum capacity thus potentially causing the compressor to cycle.