New Installer Guides for Sizing, Selecting and Installing Air-Source Heat Pumps in Cold Climates

Presented by:

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Today's Presenters

- Dave Lis, Northeast Energy Efficiency Partnerships (NEEP)

- Bruce Harley, Bruce Harley Energy Consulting

Webinar logistics

- Today's Webinar is being recorded
- These Slides and the Guides can be downloaded from sidebar
- Everyone will be muted for duration of webinar
- Q&A
  - Please type any questions into "Questions" box on sidebar. We'll try to take clarifying questions in real time, but otherwise take them in order during Q&A session
- Recording/Slides will be sent to everyone after presentation

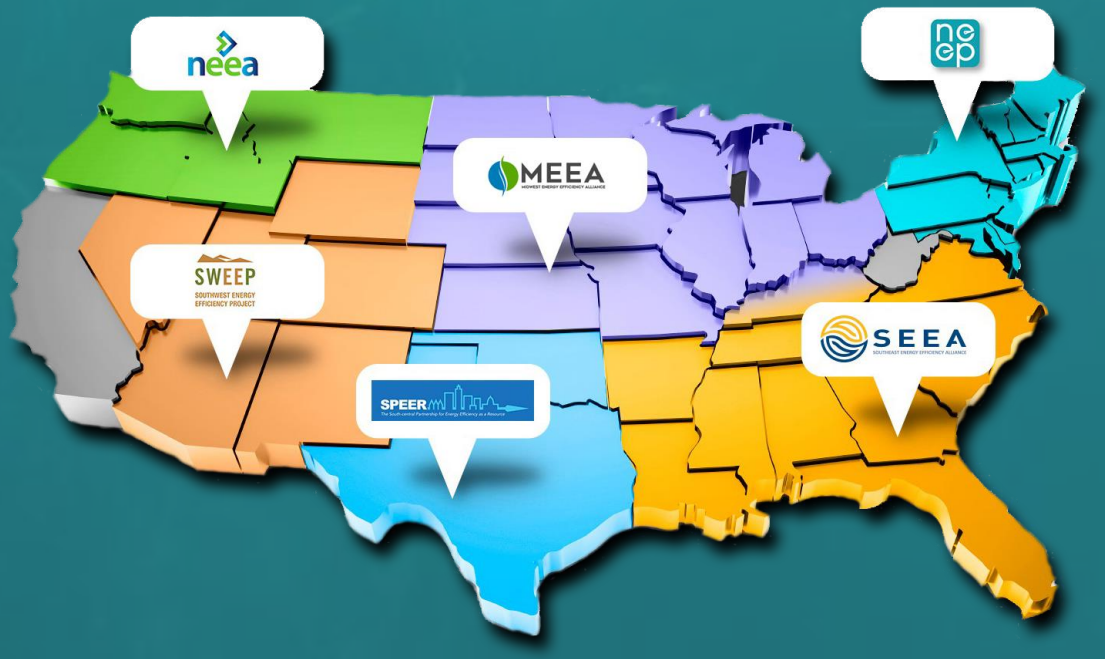
Webinar Agenda

- Putting the Guides in Context
- Present Sizing/Selecting ASHPs in Cold Climates Guide
- Present Installing ASHPs in Cold Climates Guide
- Q&A
- Wrap up/Next steps

*Audience POLL

About NEEP

A Regional Energy Efficiency Organization



One of six REEOs funded in-part by U.S. DOE to support state and local efficiency policies and programs.

Northeast Energy Efficiency Partnerships

- Long-term shared goal
  - To assist the Northeast and Mid-Atlantic region in reducing carbon emissions 80% by 2050 (relative to 2001)
- Mission
  - Accelerate energy efficiency as an essential part of demand-side solutions that enable a sustainable regional energy system
- Approach
  - Overcome barriers and transform markets through *Collaboration, Education, and Enterprise*

NEEP's Regional ASHP Initiative

- 2016 ASHP Market Transformation Strategy Report
- Cold Climate ASHP Specification
- Regional Working Group
- Annual In-person Workshop

Key Market Barrier/Opportunities

- Sizing/Installation crucial to system performance.
- New systems, new applications challenge longstanding tools and practices.
- Leverage NEEP's ccASHP Specification?

Could NEEP be part of the SOLUTION?

- Develop clear guidance resources to growing group of ASHP installers
- Ensure best practices when sizing/selecting and installing ASHPs in cold climates.

Process check

2016

- NEEP partnered w U.S. DOE
- Conducted Assessment of current practices (to be published soon)
- Developed two Draft “Best Practice” Guides

2017

- Sought market actor feedback (i.e. Manufacturers, installers, program administrators)
- Finalized/Posted Guides
- Presenting Guides via webinar today

* “Living Guides”- Plan to improve these resource as “best practices” evolve

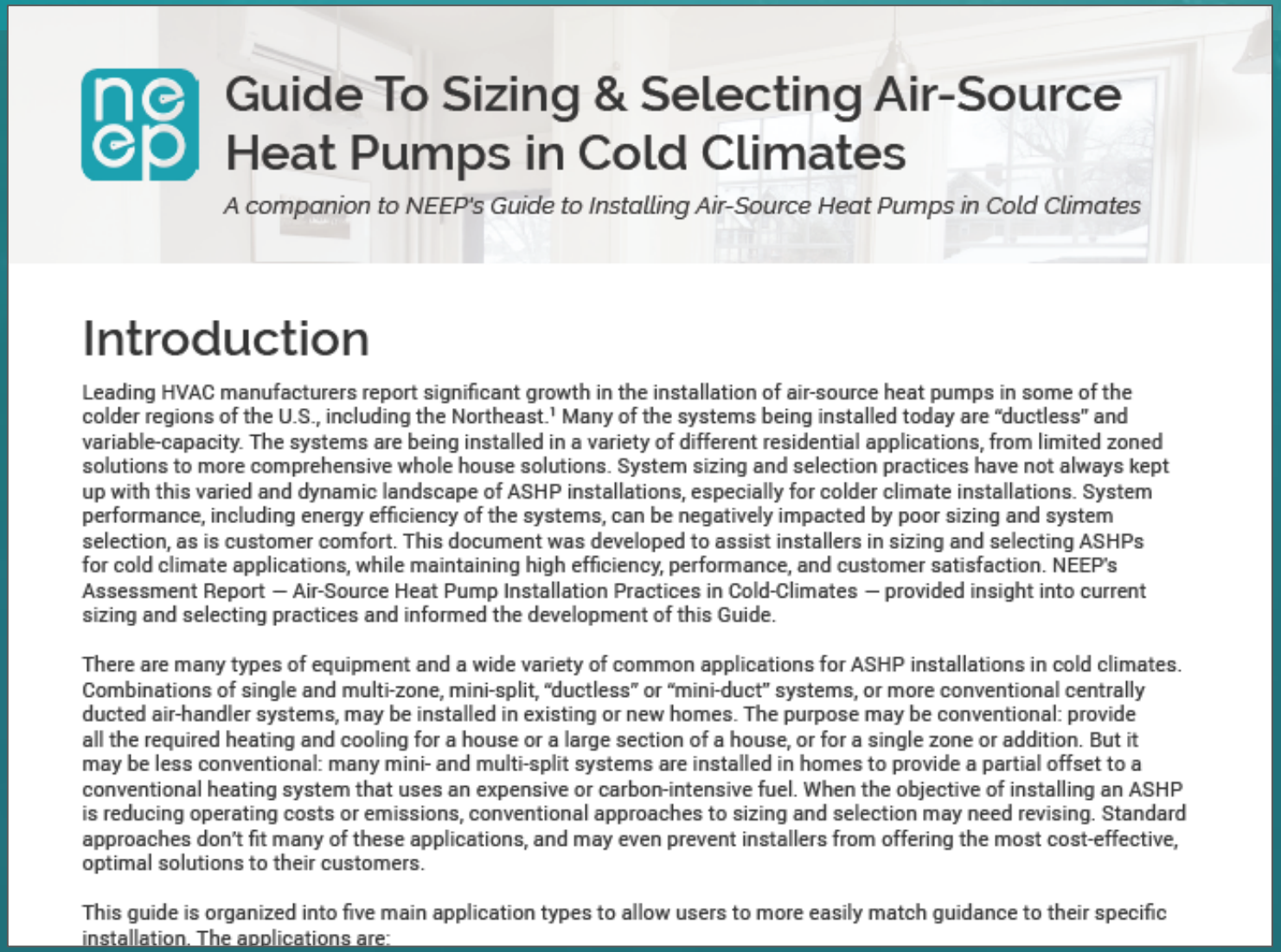
Group Effort

- These resources leverage a wealth of existing guidance
- Many regional/national stakeholders provided invaluable input in the development of the guides.
- Special thanks to Steve Dunn (U.S. DOE) and Courtney Moriarta, Cory Fox and Caroline Hazard (CSRA Inc.)

Access/Use of Guides

- Guides developed to be shared/used broadly
- Guides posted on NEEP's public website, available to download
- Guides available to co-brand
- Seeking opportunities to disseminate resource
- Please send ideas about key venues to share the Guides

Sizing and Selecting Guide



Guide To Sizing & Selecting Air-Source Heat Pumps in Cold Climates

A companion to NEEP's Guide to Installing Air-Source Heat Pumps in Cold Climates

Introduction

Leading HVAC manufacturers report significant growth in the installation of air-source heat pumps in some of the colder regions of the U.S., including the Northeast.[1] Many of the systems being installed today are "ductless" and variable-capacity. The systems are being installed in a variety of different residential applications, from limited zoned solutions to more comprehensive whole house solutions. System sizing and selection practices have not always kept up with this varied and dynamic landscape of ASHP installations, especially for colder climate installations. System performance, including energy efficiency of the systems, can be negatively impacted by poor sizing and system selection, as is customer comfort. This document was developed to assist installers in sizing and selecting ASHPs for cold climate applications, while maintaining high efficiency, performance, and customer satisfaction. NEEP's Assessment Report — Air-Source Heat Pump Installation Practices in Cold-Climates — provided insight into current sizing and selecting practices and informed the development of this Guide.

There are many types of equipment and a wide variety of common applications for ASHP installations in cold climates. Combinations of single and multi-zone, mini-split, "ductless" or "mini-duct" systems, or more conventional centrally ducted air-handler systems, may be installed in existing or new homes. The purpose may be conventional: provide all the required heating and cooling for a house or a large section of a house, or for a single zone or addition. But it may be less conventional: many mini- and multi-split systems are installed in homes to provide a partial offset to a conventional heating system that uses an expensive or carbon-intensive fuel. When the objective of installing an ASHP is reducing operating costs or emissions, conventional approaches to sizing and selection may need revising. Standard approaches don't fit many of these applications, and may even prevent installers from offering the most cost-effective, optimal solutions to their customers.

This guide is organized into five main application types to allow users to more easily match guidance to their specific installation. The applications are:

Some Highlights

This guide is organized into five main application types to allow users to more easily match guidance to their specific installation. The applications are:

- Heating (or heating & cooling) displacement
- Full HVAC replacement
- Isolated zone
- New construction
- Targeted cooling solution

Each category suggests the relevant information on sizing and equipment selection, system configurations, the use of pre-existing HVAC, and tips on key issues to look out for. Note: this guide assumes the appropriate application type has already been chosen, or is driven conclusively by customer needs. Information provided offers substantial direction on how to properly size and select ASHP system(s).

Unless systems are focused entirely on cooling, it is strongly recommended to select products that appear on the Cold Climate Air Source Heat Pump (ccASHP) Specification. Therefore, variable-speed systems are also recommended and assumed in this guidance. High Heating Seasonal Performance Factor (HSPF) ratings and high efficiency (measured by Coefficient of Performance or COP) in cold outdoor conditions (required for listing in the Specification) are generally the most efficient for cold climate installations. (Cold climates may be considered to be International Energy Conservation Code (IECC) climate zone 4 and higher.) High Seasonal Energy Efficiency Rating (SEER) values are also desirable to reduce cooling costs. The following sections provide additional general guidance for all applications on building efficiency, load calculations, and equipment selection.

Heat pumps should always be installed by licensed, trained professionals. Always follow manufacturer's specifications and installation instructions, and all applicable building codes and regulations.

NEEP ccASHP Listings

DISCLAIMER- Some of the performance values reported as part of the Cold-Climate ASHP Specification are NOT derived from industry standard test procedures or third-party tested/verified (i.e. performance values at 5°F).

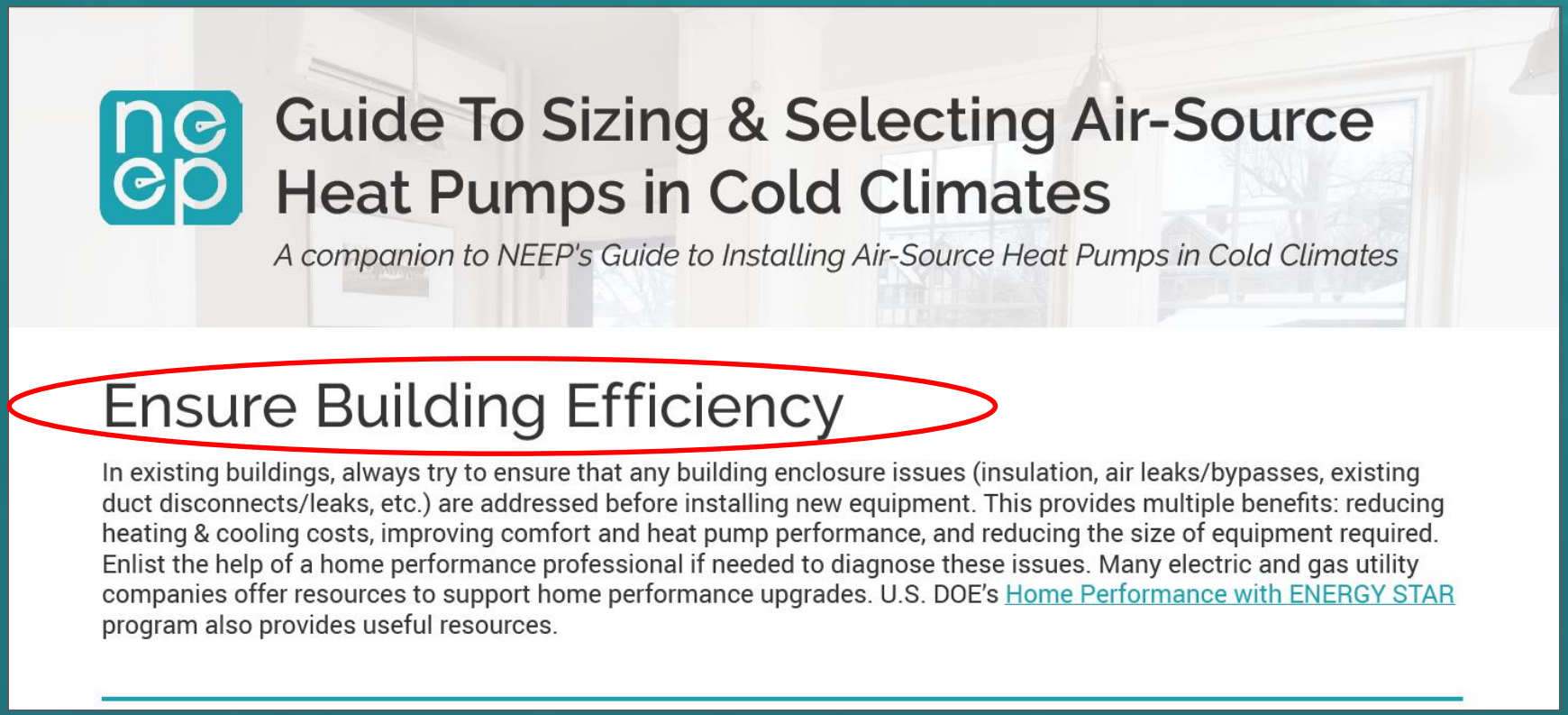
Products added to list since previous update highlighted in pink

Updated: March 9, 2017

General Information												Capacity (btu/hr)		
Manufacturer	Brand (if applicable)	AHRI Certificate No.	Outdoor Unit Model	Indoor Unit Model(s)	HSPF (Region IV):	SEER	EER (@ 95°F)	ENERGY STAR Certifie	Ductless or Ducted	If Ductless, Multi-zone or Single-zone		Minimum Capacity 47°F	Rated Capacity 47°F	Maxim Capac 47°F
Daikin		3208521	RXG09HVJU	FTXG09HVJU	11	26.1	15.8	Yes	Ductless	Single-zone		4,668	12,000	18,670
Daikin		3208522	RXG12HVJU	FTXG12HVJU	10.55	24.2	14	Yes	Ductless	Single-zone		4,668	16,000	19,130
Daikin		3208523	RXG15HVJU	FTXG15HVJU	10	21	12.9	Yes	Ductless	Single-zone		4,668	18,000	21,280
Mitsubishi		4217888	MUZ-FE18NA	MSZ-FE18NA	10.3	20.2	14.2	Yes	Ductless	Single-zone		7,500	21,600	29,700
Mitsubishi		4908219	MUZ-FE09NA	MSZ-FE09NA	10	26	15.5	Yes	Ductless	Single-zone		3,000	10,900	18,000
Mitsubishi		4934170	MUZ-FE12NA	MSZ-FE12NA	10.5	23	12.9	Yes	Ductless	Single-zone		3,000	13,600	21,000
Fujitsu		5063325	AOU9RLS2	ASU9RLS2	12.5	27.2	16.1	Yes	Ductless	Single-zone		3,100	12,000	22,000
Fujitsu		5063326	AOU12RLS2	ASU12RLS2	12	25	13.8	Yes	Ductless	Single-zone		3,100	16,000	22,110
Daikin		5265753	RXS09LVJU	FTXS09LVJU	12.5	24.5	15.3	Yes	Ductless	Single-zone		4,400	12,000	15,600
Daikin		5265755	RXS12LVJU	FTXS12LVJU	12.5	23	12.8	Yes	Ductless	Single-zone		4,800	14,400	18,000
Daikin		5265756	RXS15LVJU	FTXS15LVJU	11.6	20.6	14.4	Yes	Ductless	Single-zone		5,800	18,000	22,300
Daikin		5265757	RXS18LVJU	FTXS18LVJU	11	20.3	12.7	Yes	Ductless	Single-zone		5,800	21,600	26,700
Daikin		5265758	RXS24LVJU	FTXS24LVJU	10.6	20	12.5	Yes	Ductless	Single-zone		7,800	25,400	31,400
Nortek Global	Maytag	5597453	PSH4BG024K	B6VMAX024K-B	10	19	13.9	Yes	Ducted	N/A		10,200	22,400	24,700
Nortek Global	Maytag	5597457	PSH4BG036K	B6VMAX036K-B	10	19	12.9	Yes	Ducted	N/A		16,500	34,400	36,800
Fujitsu		5751311	AOU9RLFC	AUU9RLF	13	24	14.5	Yes	Ductless	Single-zone		3,100	12,000	18,000
Fujitsu		5751312	AOU9RLFC	ARU9RLF	12.2	21.5	14.5	Yes	Ductless	Single-zone		3,100	12,000	18,000
Fujitsu		5751313	AOU12RLFC	AUU12RLF	12.2	21.9	12.8	Yes	Ductless	Single-zone		3,100	16,000	19,400
Fujitsu		5751314	AOU12RLFC	ARU12RLF	11.5	20	12.8	Yes	Ductless	Single-zone		3,100	16,000	19,400
LG		5859619	LUU187HV	LCN187HV	10.1	20	15	Yes	Ductless	Single-zone		9,300	20,000	22,000
LG		6236101	LSU240HSV3	LSN240HSV3	10.2	20	12.5	Yes	Ductless	Single-zone		3,070	27,600	38,900
American Standard		6749789	4A6V0024A1	*AM8C0B30V21	10	19.25	13.75	Yes	Ducted	N/A		7,800	20,200	21,900
American Standard		6749791	4A6V0048A1	*AM8C0C48V41	10	19.25	12.5	Yes	Ducted	N/A		11,800	42,500	42,600
Trane		6749942	4TWV0024A1	*AM8C0B30V21	10	19.25	13.75	Yes	Ducted	N/A		7,800	20,200	21,900
Trane		6749944	4TWV0048A1	*AM8C0C48V41	10	19.25	12.5	Yes	Ducted	N/A		11,800	42,500	42,600
American Standard		6750232	4A6V8036A1	*AM8C0C36V31	10	18	13	Yes	Ducted	N/A		8,200	32,200	32,200
American Standard		6750233	4A6V8048A1	*AM8C0C48V41	10	18	12.5	Yes	Ducted	N/A		11,800	41,000	43,000

Current Product List (3.9.17) | Delisted (on 1.1.17)

Other General Concepts



Guide To Sizing & Selecting Air-Source Heat Pumps in Cold Climates

A companion to NEEP's Guide to Installing Air-Source Heat Pumps in Cold Climates

Ensure Building Efficiency

In existing buildings, always try to ensure that any building enclosure issues (insulation, air leaks/bypasses, existing duct disconnects/leaks, etc.) are addressed before installing new equipment. This provides multiple benefits: reducing heating & cooling costs, improving comfort and heat pump performance, and reducing the size of equipment required. Enlist the help of a home performance professional if needed to diagnose these issues. Many electric and gas utility companies offer resources to support home performance upgrades. U.S. DOE's Home Performance with ENERGY STAR program also provides useful resources.

General – Load Calculations

Getting Load Calculations Right

Grossly oversizing equipment, whether individual zones or a whole house, can lead to excessive cycling, low efficiency and ineffective summer dehumidification. Right-sizing is important. ACCA Manual J[2] (or equivalent), when combined with the recommendations in this guide, is always an acceptable method for calculating heating and cooling loads for an ASHP installation. In some cases, contractors will utilize other, more simplified load calculation methods. Regardless of the method used, the following recommendations will help ensure accurate and appropriate results for cold climate heat pumps.

- The load calculation method must account for:
  - surface areas and thermal properties of building enclosure (walls, roofs, windows, floors, foundations, etc.);
  - air leakage in the building, including latent load for cooling;
  - duct losses, only when ducts are present or planned; and
  - solar gains from roof and windows, as well as internal sensible and latent gains for cooling.
- Load calculations have safety factors built in. Always follow the procedure accurately, without "padding" the estimates with additional safety factors.
- Represent actual conditions accurately. For example, don't use duct loss factors for ductless distribution or for ducts that are internal to the conditioned space.
- Be cautious when applying infiltration estimates, which are often overstated. Blower door testing is recommended.

More on Load Calculations

- When a single zone system (typically ductless) is installed in an “open floor plan” house, it is acceptable to include “connected” open spaces in the load estimates for that zone. When rooms are open to each other, a single ductless unit may reasonably heat and cool that space — particularly if the home is weatherized. This may also include a significant part of second-floor heating loads, when an open stairway exists.
- When existing equipment is left in place to handle heating in the coldest weather, the risk of undersizing is largely mitigated: a conservative estimate of the heating load is safe.
- Whole-house, room-by-room calculations may not be necessary for many retrofit applications where existing / alternate heating systems will remain in place.
- Individual (bedroom or bedroom-sized) room loads can be smaller, sometimes much smaller, than available ductless indoor unit capacities. Try to use mini-duct systems instead of separate ductless units to serve multiple small rooms.

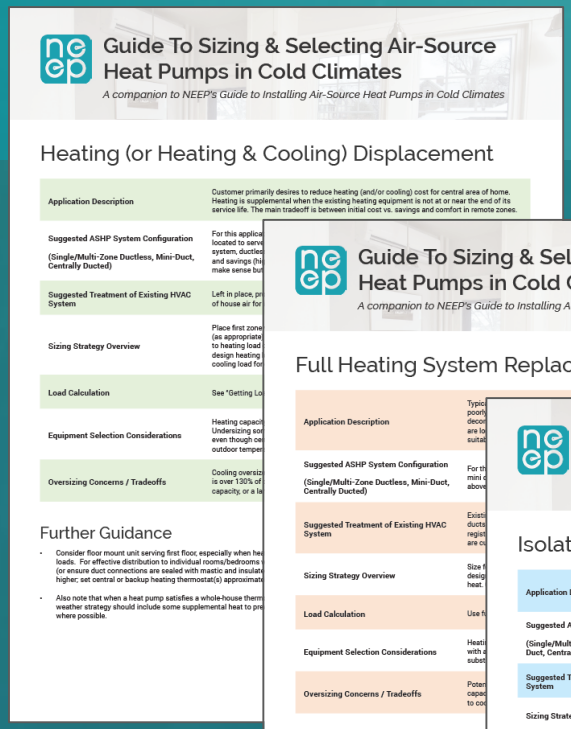
Installing ASHPs in Cold Climates

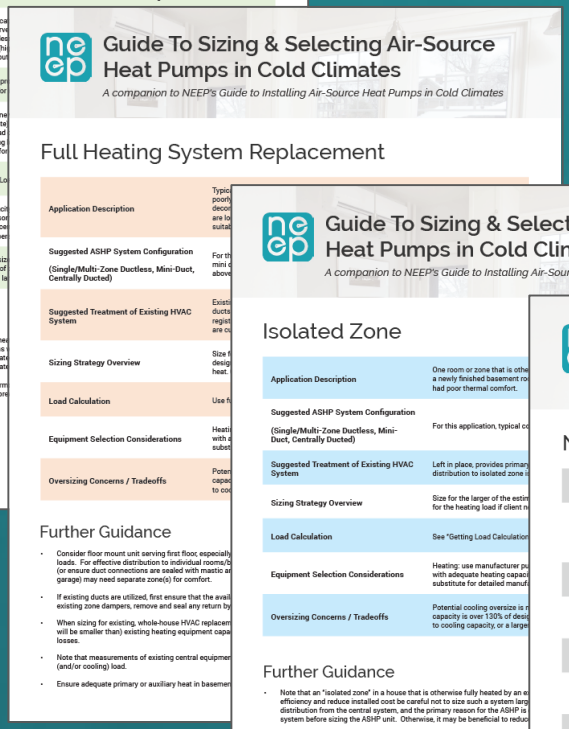
General Equipment Selection Guidance

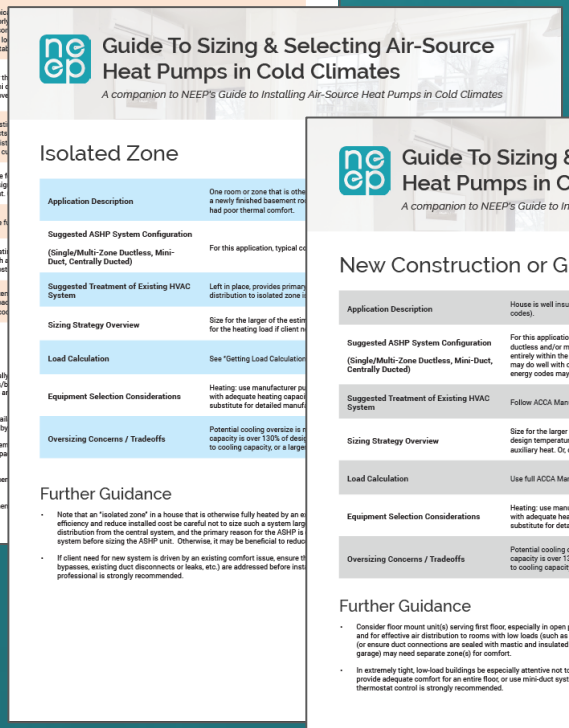
ACCA Manual S[3] (or equivalent), when combined with the recommendations in this guide, is an acceptable method to ensure equipment meets the heating and cooling load requirements. The general guidance below may be combined with the application-specific recommendations to inform the selection process:

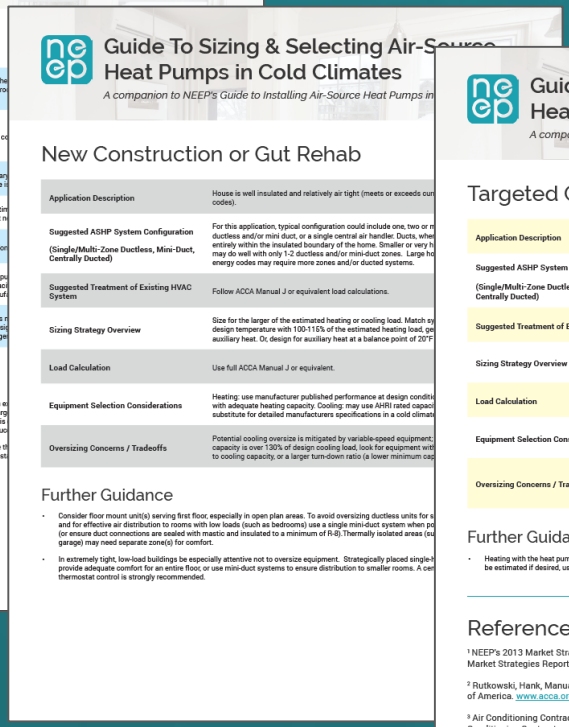
- Generally, use manufacturer's extended performance tables to determine heating and cooling capacity as applicable, at the actual design conditions for the local climate.
- Although extended performance tables are recommended for sizing equipment to heating loads (whether 100% of load, or based on some use of available backup heat source), be cautious because not all published performance data is consistent. Some tables may not show maximum capacity at colder temperatures, when variable-speed equipment may reasonably be expected to operate at high speeds. The information in the Cold Climate Air Source Heat Pump (ccASHP) Specification tables (minimum and maximum heating capacities reported at 5°F) may be used to corroborate extended performance tables and help ensure the right equipment selection.
- For homes where systems are installed with a heating focus, cooling capacity may be estimated for sizing purposes as allowed in the various application sections below, as an alternate to manufacturer's performance tables.
- The step of adding the heating and cooling air flow needed for each room to estimate total system air flow applies to centrally ducted heat pump systems, and may be omitted for single- or multi-zone ductless distribution systems.

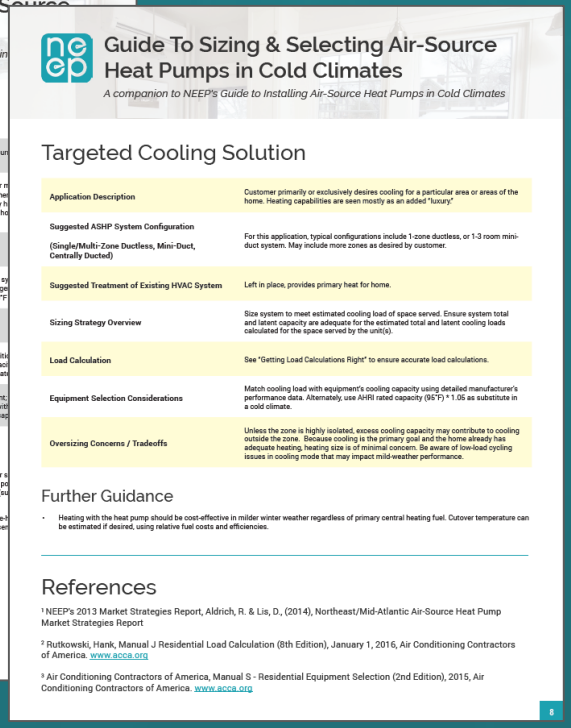
Application Sheets











Guide To Sizing & Selecting Air-Source Heat Pumps in Cold Climates

A companion to NEEP's Guide to Installing Air-Source Heat Pumps in Cold Climates

Heating (or Heating & Cooling) Displacement

Application Description	Customer primarily desires to reduce heating (and/or cooling) cost for central area of home. Heating is supplemental when the existing heating equipment is not at or near the end of its service life. The main tradeoff is between initial cost vs. savings and comfort in remote zones.
Suggested ASHP System Configuration **(Single/Multi-Zone Ductless, Mini-Duct, Centrally Ducted)**	For this applicat located to serve system, ductless and savings (hig make sense but
Suggested Treatment of Existing HVAC System	Left in place, pro of house air for
Sizing Strategy Overview	Place first zone (as appropriate) to heating load design heating l cooling load for
Load Calculation	See "Getting Lo
Equipment Selection Considerations	Heating capacit Undersizing son even though cer outdoor temper
Oversizing Concerns / Tradeoffs	Cooling oversize is over 130% of capacity, or a la

Further Guidance

- Consider floor mount unit serving first floor, especially when hea loads. For effective distribution to individual rooms/bedrooms v (or ensure duct connections are sealed with mastic and insulate higher; set central or backup heating thermostat(s) approximate
- Also note that when a heat pump satisfies a whole-house therm weather strategy should include some supplemental heat to pre where possible.

Guide To Sizing & Selecting Air-Source Heat Pumps in Cold Climates

A companion to NEEP's Guide to Installing Air-Source Heat Pumps in Cold Climates

Full Heating System Replacement

Application Description	Typica poorly decon are lo suitab
Suggested ASHP System Configuration **(Single/Multi-Zone Ductless, Mini-Duct, Centrally Ducted)**	For th mini d above
Suggested Treatment of Existing HVAC System	Existi ducts regist are cu
Sizing Strategy Overview	Size f desig heat.
Load Calculation	Use fu

Guide To Sizing & Selecting Heat Pumps in Cold Climate

A companion to NEEP's Guide to Installing Air-Source Heat

Isolated Zone

Application Description	One room or zone that is otherwise thermally isolated a newly finished basement room, build out above gara had poor thermal comfort.
Suggested ASHP System Configuration	

Heating (or Heating & Cooling) Displacement

Application Description	Customer primarily desires to reduce heating (and/or cooling) cost for central area of home. Heating is supplemental when the existing heating equipment is not at or near the end of its service life. The main tradeoff is between initial cost vs. savings and comfort in remote zones.
Suggested ASHP System Configuration **(Single/Multi-Zone Ductless, Mini-Duct, Centrally Ducted)**	For this application, typical configurations include 1-zone ductless, or 1-3 room mini-duct located to serve central living space (for reduced installed cost). Alternatively, larger 2-5 zone system, ductless and/or mini duct, can be configured to serve home widely for better comfort and savings (higher installed cost). In some cases, a new single-zone central heat pump may make sense but that is more likely a whole-house replacement.
Suggested Treatment of Existing HVAC System	Left in place, provides heat only as needed. A centrally ducted system may also provide mixing of house air for improved comfort.
Sizing Strategy Overview	Place first zone where heat will cover most central living area. Establish any additional zones (as appropriate) to strategically cover key living areas per customer needs. Size each zone to heating load of area(s) to be served (block load): total will be undersized for whole-house design heating load. If cooling comfort is desired by customer, size to larger of heating or cooling load for each zone.
Load Calculation	See “Getting Load Calculations Right” to ensure accurate load calculations.
Equipment Selection Considerations	Heating capacity of system at or near outdoor design temperature is a secondary concern. Undersizing somewhat for heating should improve efficiency and reduce overall heating costs, even though central system may be used slightly more. High efficiency at predominant winter outdoor temperatures will reduce operating cost.
Oversizing Concerns / Tradeoffs	Cooling oversize is mitigated by variable-speed equipment; if minimum speed cooling capacity is over 130% of design cooling load, look for equipment with a higher ratio of heating to cooling capacity, or a larger turn-down ratio (a lower minimum capacity), or both.

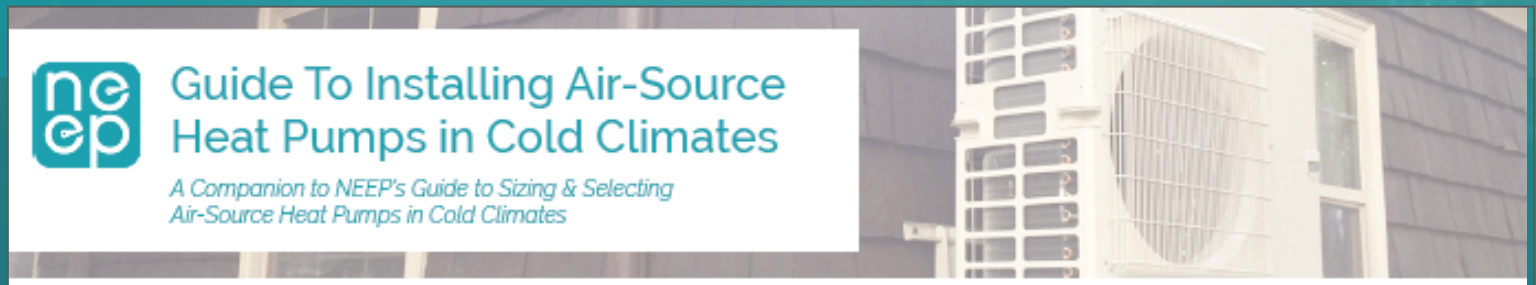
Further Guidance

Further Guidance

- Consider floor mount unit serving first floor, especially when heating is the customer priority. Avoid oversizing ductless units for individual room loads. For effective distribution to individual rooms/bedrooms with low loads, use a single mini-duct system when possible; avoid using the attic (or ensure duct connections are sealed with mastic and insulated to a minimum of R-8). Set ASHP heating thermostat to comfort level or slightly higher; set central or backup heating thermostat(s) approximately 4°F lower whenever possible to maximize heat pump utilization.

- Also note that when a heat pump satisfies a whole-house thermostat in very cold weather, pipes may freeze in basement or remote areas. Cold-weather strategy should include some supplemental heat to prevent this; air seal and insulate exterior sill plates in basements and crawlspaces where possible.

Installation Guide



Guide To Installing Air-Source Heat Pumps in Cold Climates

A Companion to NEEP's Guide to Sizing & Selecting Air-Source Heat Pumps in Cold Climates

Introduction

High-quality installations of air-source heat pump (ASHP) systems generate referrals, increase sales, reduce callbacks and improve customer comfort and satisfaction. Installation practices also have a major impact on efficiency and performance of an ASHP system. Efficient ASHPs have seen significant sales growth in colder climates in recent years. The recent generation of cold-climate ASHPs, combined with insights from large-scale installation programs and installers, has led to a better understanding of the full range of practices to ensure maximum system performance and customer satisfaction. This guide provides a list of these best practices, as well as homeowner education and system setup guidance, to help ensure efficient air-source heat pumps and happy customers in cold climates.

Heat pumps should always be installed by licensed, trained professionals. Always follow manufacturer's specification and installation instructions, and all applicable building codes and regulations. All installers should attend a manufacturer's training or preferred installer program.

ASHPs come in a number of configurations, and in some cases the following guidance may be specific to one or more of those system types. There are many variations and terms used, but these guidelines will focus on the following broad categories: "ductless ASHP" refers to any non-ducted cassette type indoor unit (including wall-mount air handlers, floor mounted consoles, in-ceiling cassettes, etc.); "mini-duct ASHP" refers to remote air handlers that are typically designed for compact, concealed-ceiling or short-duct configurations; and "centrally ducted ASHP" refers to whole-house systems with central air handlers. The icons shown here are used below to indicate when guidance is specific to a certain system type. All items without icons are generally applicable to all ASHP configurations.

Applies to: Ductless ASHP Mini-Duct ASHP Centrally ducted ASHP

Installation Best Practices: Categories

- Line Set
- Recommended Tools
- Refrigerant Tubing
- Refrigerant Charge
- Condensate Drain
- Outdoor Unit Installation
- Indoor Unit Installation
- Placement of Indoor Unit
- Ducting Considerations

Installation Best Practices: Notable / New

- Protecting line set entry point from rodents
- Focus on protecting outdoor unit from eaves/drip/snow
  - De-emphasis on pan heaters
- Installation of surge suppressors
- Recommendation of floor-mount / console units
  - For heating-focused applications, lower floors

Setup: Categories

- Thermostat – Installer Setup
- Control Settings – Installer Controls
- Homeowner Education

- Also, links to Additional Resources

Installer Setup: Notable / New

- Use wall-mounted control (except for small rooms)
- Integrated controls for heat pump + central HVAC
- Use “efficient home” or other settings to minimize cycling in low load conditions
- Avoid continuous fan operation for temperature sensing

Time for Questions and Comments

- Please type questions and/or comments into “Questions” box on sidebar.

2017 Regional ASHP Workshop

- Purpose- Coordinate implementation of market strategies
- Timing- June 27-28 (1.5 days)
- Location- Schneider Electric, (Andover, MA)
- Registration now open on NEEP website
- Sponsorship opportunities available

Contact

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  - **781-860-9177 (x127)**
- **Bruce Harley, Bruce Harley Energy Consulting**
  - **bruceharleyenergy@gmail.com**
  - **802-694-1719**
- Link to NEEP's ASHP Website/Resources

  http://www.neep.org/initiatives/high-efficiency-products/emerging-technologies/ashp

*Please complete brief Survey when Webinar ends