CHBA led LEEP events coming to a region near you

WORKSHOPS PLANNED ACROSS CANADA

- **Fall 2024:** CHBA delivering 7 sessions in ON, 4 across the Prairies, 3 in BC, 4 in YK and 2 in the Maritimes
- Sessions on envelopes, mechanicals, windows, resilience and heat pumps offered through local HBAs
- Contact **Kay Parkes-Blanc** Program Coordinator for LEEP for more information!

LEEP RESPONDS TO MARKET NEEDS

- Your feedback today helps us adapt content and meet builder needs across the country!

Canadian Home Builders' Association

LEEP LOCAL ENERGY EFFICIENCY PARTNERSHIPS

QUESTIONS & CONTACT

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Khadijah.Parkes-Blanc@chba.ca

SCAN FOR WEBSITE

SCAN FOR MY INFO

Canadian Home Builders' Association

LEEP LOCAL ENERGY EFFICIENCY PARTNERSHIPS

Natural Resources Canada
Ressources naturelles Canada

CHBA's Net Zero Leadership Summit

Local Energy Efficiency Partnerships
Air Source Heat Pumps for High Performance Homes

June 10, 2024 - Vancouver

Canada

By the end of today's session, you will have:

LEEP LOCAL ENERGY EFFICIENCY PARTNERSHIPS

- ❑ **Learned** about best practices for successful heat pump integration into net zero new builds
- ❑ **Identified** new technologies and products to improve the performance of a local case study home
- ❑ **Accessed** new NRCan Tools for decision making in collaboration with your mechanical trades

Agenda for today

LEEP LOCAL ENERGY EFFICIENCY PARTNERSHIPS

7:30-8:30 BREAKFAST

20 min — **Welcome! Who & What is LEEP?**
NRCan

30 min — **PANEL: Builder challenges with heat pumps in high performance housing**
Panelists

30 min — **An Introduction to NRCan's NEW ASHP Sizing & Selection Tool**
NRCan

30 min — **Ductwork: best practices and solutions for new housing**
Rob Pope - Ecolighten

10:30-10:45 BREAK

30 min — **PANEL: Challenges with ductwork & distribution system design**
Panelists

60 min — **Sizing heat pumps: Equipment selection & optimization**
NRCan & Rob Pope - Ecolighten

12:15-1:15 LUNCH

30 min — **Controls systems: Best practices in operation for thermal comfort & performance**
Rob Pope - Ecolighten

75 min — **Manufacturer Presentations + Q&A**
Daikin, Mitsubishi & Panasonic

3:00-3:15 BREAK

30 min — **PANEL: Challenges with heat pump controls & operation**
Panelists

30 min — **Let's recap: System selection best practices**
NRCan

30 min — **Closing Remarks & What's next?**
NRCan

4:30 WRAP UP

What is LEEP?

Local Energy Efficiency Partnerships

We work with Canadian industry to make homes more **resilient, energy efficient and affordable** in the face of climate change.

LEEP reduces industry **time & risk** in adopting new technology and building innovations.

We've been in operation for
15 years

We've worked with
10 provinces
25+ municipalities
50+ manufacturers

We host
50–60 events per year

Integrated Design Process

Operational&. Embodied Carbon

J.n..l

Adaptatron & Resilience

Electrical Load Management

Cost Benefit Analysis

Envelopes

Windows & Fenestrations

Modular & Panelization

Heat Pumps

High Performance Mechanicals

Solar PV

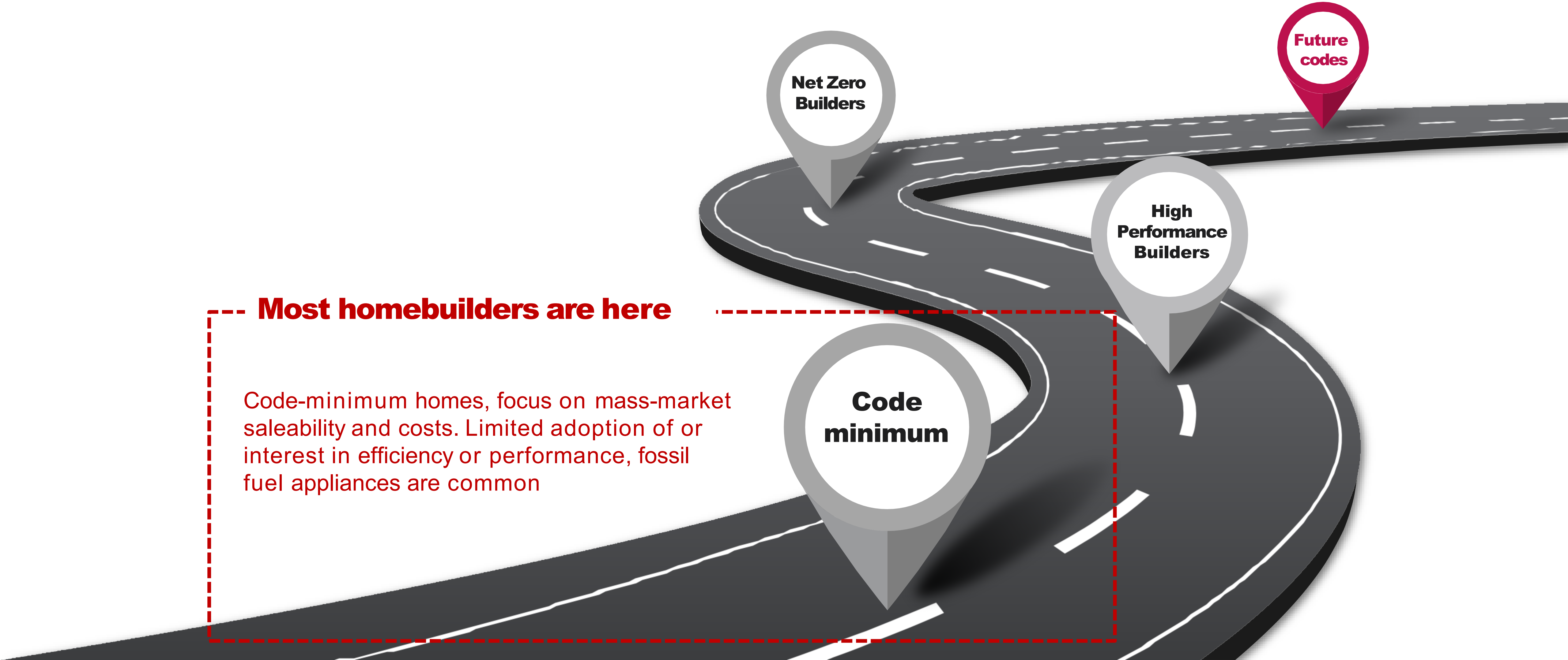
Case Studies & Field Trials

slido

Who is in the room today? Tell us what city you're from!

ⓘ Start presenting to display the poll results on this slide.

Where is the homebuilding industry heading?



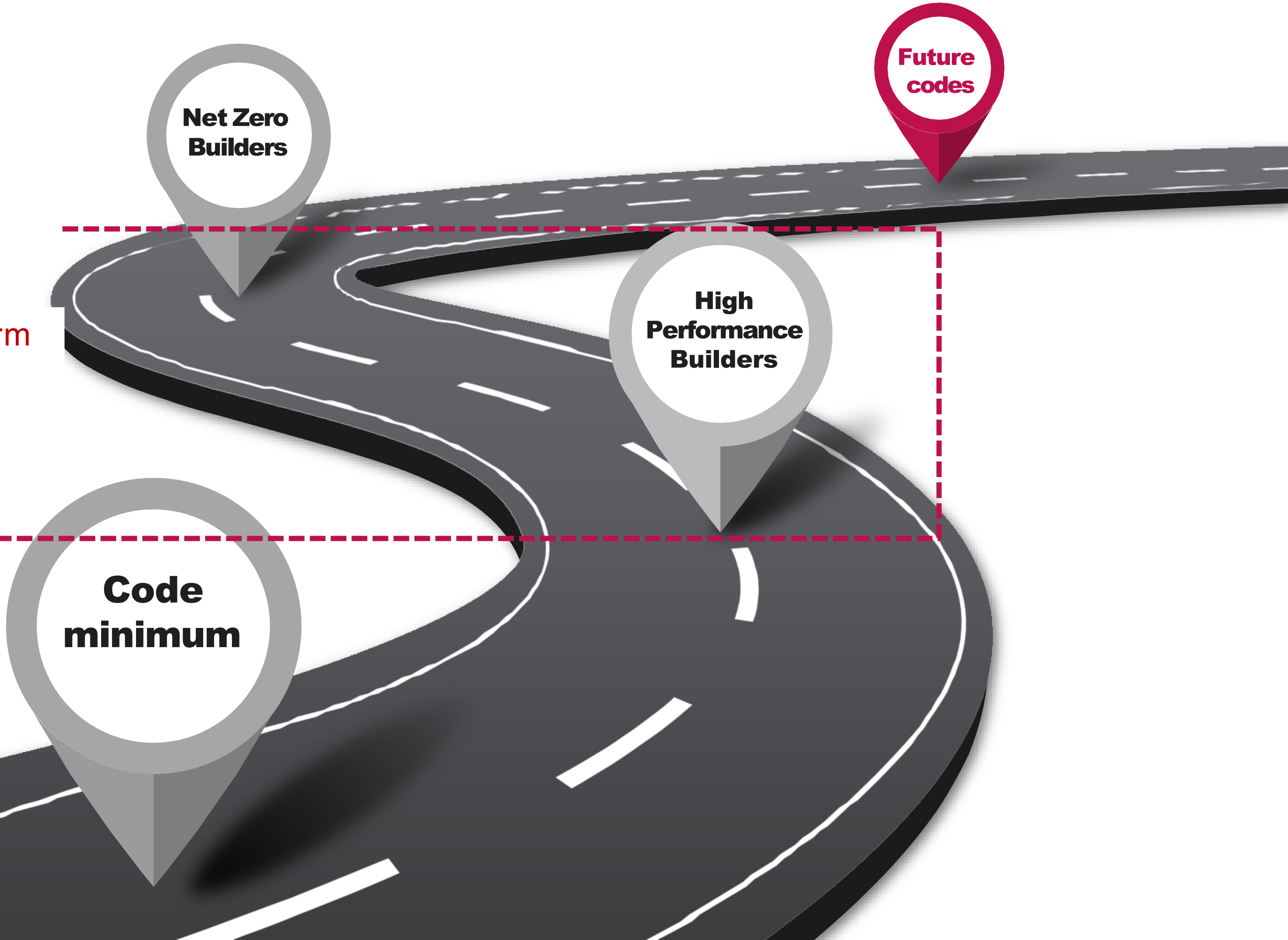
Most homebuilders are here

Code-minimum homes, focus on mass-market saleability and costs. Limited adoption of or interest in efficiency or performance, fossil fuel appliances are common

Where is the homebuilding industry heading?

Some homebuilders are here

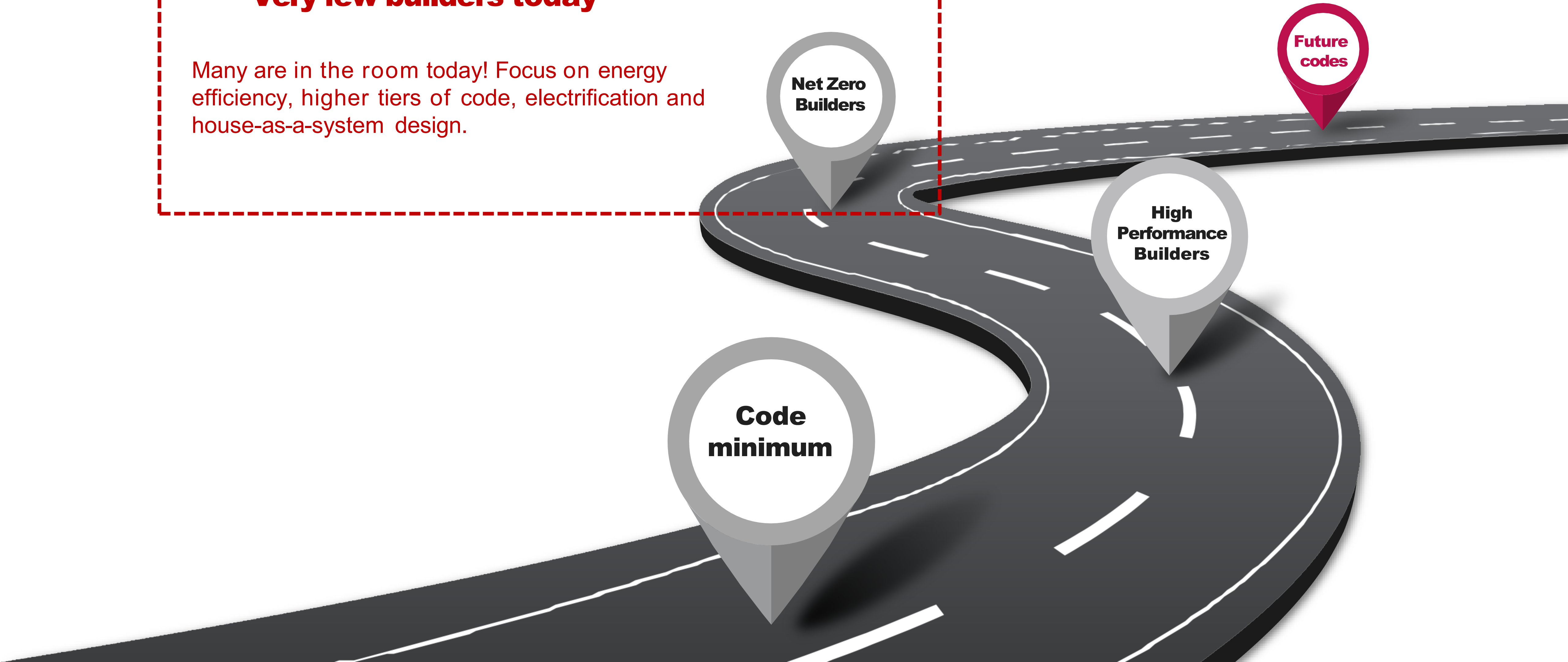
Programs, incentives and other short-term funding may lead to adoption of higher efficiency measures but limits long integration and “whole home” design.



Where is the homebuilding industry heading?

Very few builders today

Many are in the room today! Focus on energy efficiency, higher tiers of code, electrification and house-as-a-system design.



Heat pumps are a key component of the transition to net-zero, low-emission homes.

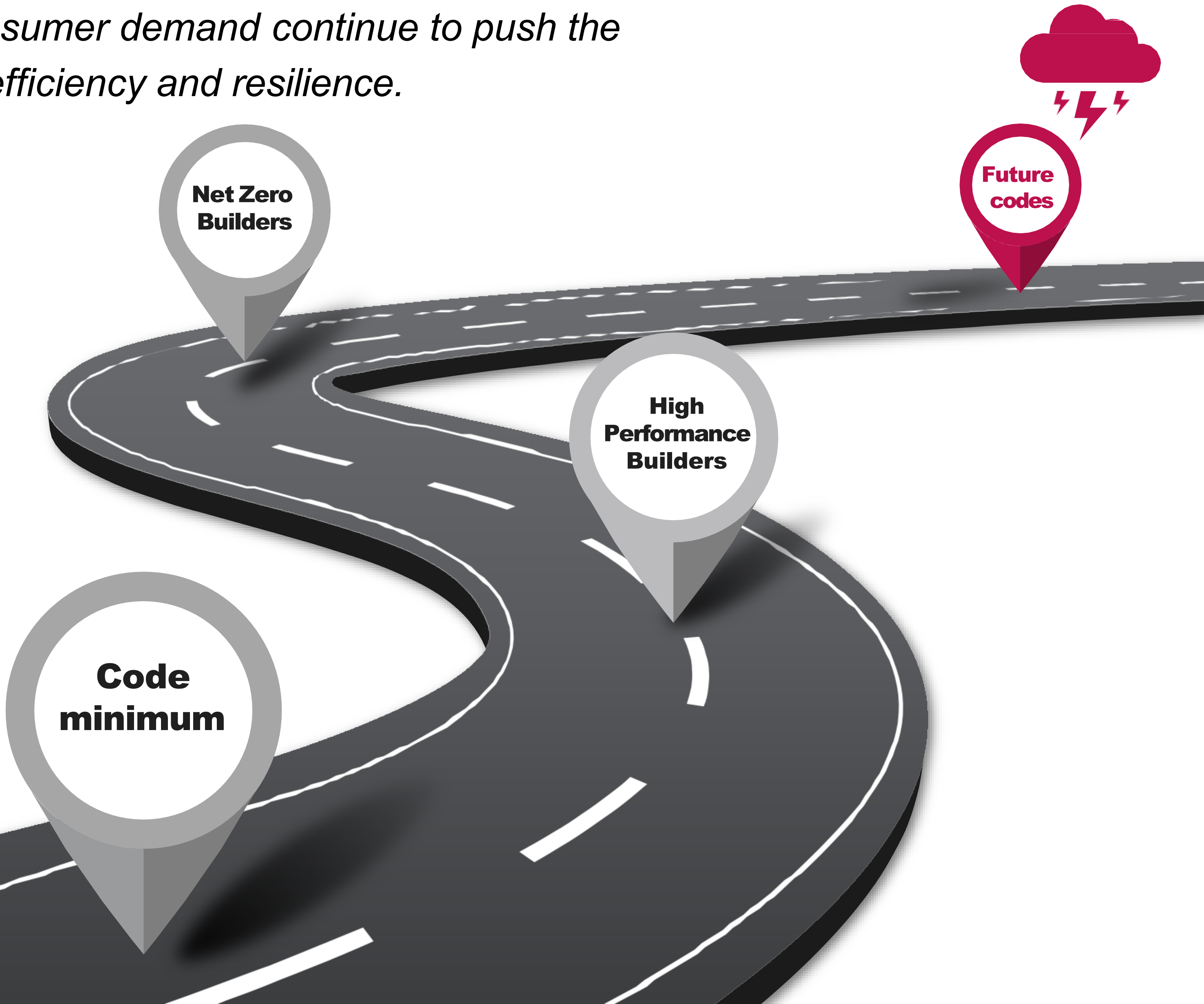
Pressures from future codes, programs and consumer demand continue to push the industry towards higher levels of performance, efficiency and resilience.

Growing pressure from utilities to manage peaks and electrical loads

Increasing efficiency and performance requirements with higher tiers of code

Growing focus on embodied and operational carbon

Integrate resiliency requirements to address extreme climate events



Design & Selection of Mechanical Systems is not a "once and done" step

ACTIVE LISTENING & IMPLEMENTATION EXERCISE NEEDED

A **PRESCRIPTIVE** approach leaves decisions in the hands of trades & distributors.

Limited opportunity for design thinking or consideration of long-term needs

Assumes that lowest upfront costs are lowest overall costs – but may pay more down the road for performance, callbacks, etc.

-VS-

A **COLLABORATIVE** approach brings together trades, mechanical designers and builders, right from the start.

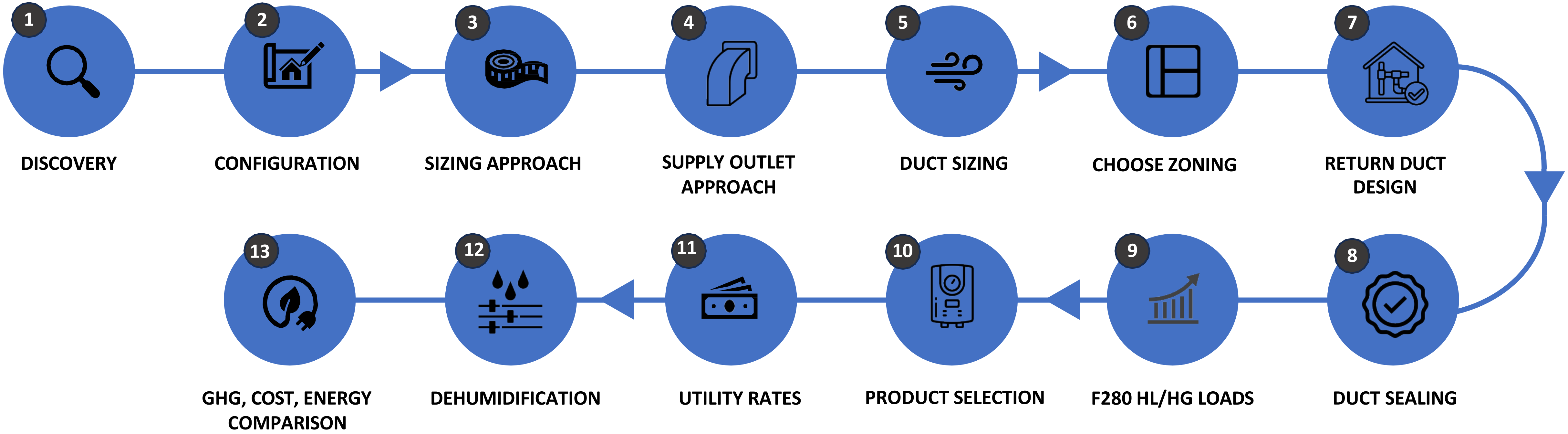
Whole-home approach considers both upfront costs as well as operating and emissions costs over time.

Focus on performance and long-term outcomes for builders, homeowners, grid, etc.

"The initial upfront cost of this system is slightly more than a traditional system – and I do mean slightly. But with the fewer customer comfort complaints on the backend, we are spending less time, less service calls, less cost, going out to address those concerns on the back end. So we do feel that that cost recovery is coming in the form of soft costs on the end."

Brian Watters
Construction Manager, Daytona Homes

Key steps to facilitate best practices in HVAC Design & Installation



Let’s look at our case study home (Climate Zone 5)

HOME CHARACTERISTICS

	Heating load	Cooling Load
Zone 1 (Basement):	11,076 BTU/h	7,756 BTU/h
Zone 2 (Main floor):	9,535 BTU/h	9,983 BTU/h
Zone 3 (Second Floor):	9,383 BTU/h	10,002 BTU/h
	29,933 BTU/h (2.49 Ton)	27,441 BTU/h (2.29 Ton)

NET ZERO SPECIFICATIONS

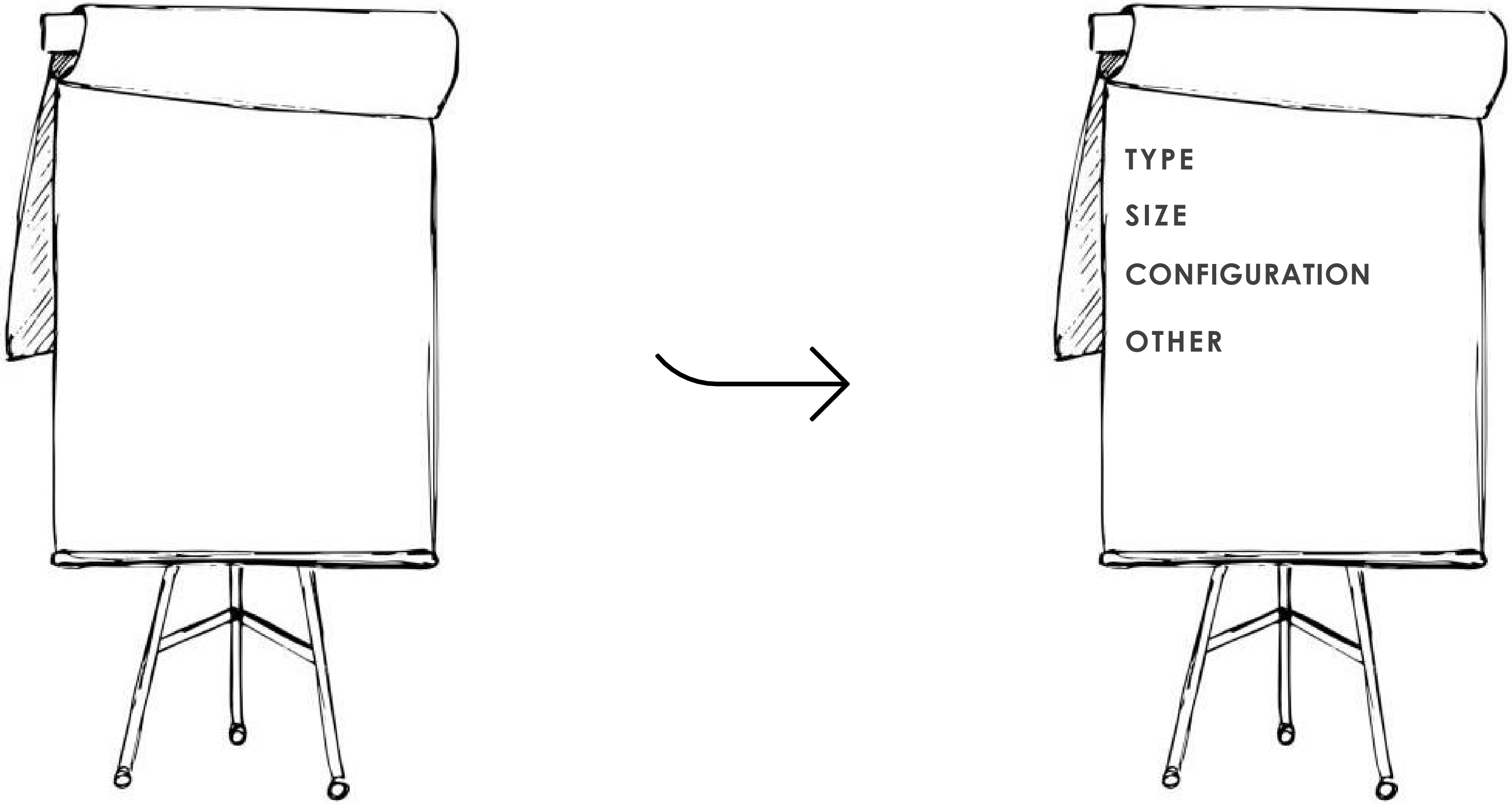
Air Tightness	1.5 ACH50
Attic	R60
Walls	R22+10continuous
Basement	R22+10continuous
Exposed Floor	R40
Windows	Double R4, 0.6 SHGC, 10.6% of wall area
Ventilation	75% Efficiency-HRV
Heating & Air Conditioning	??
Design Temperature	-23ºC

BUILDER GOALS:

- Achieve NZ standard
- Improve home thermal comfort
- Manage costs

Group Discussion

What type of heating system would you install in this home?



Coming up next: Panel discussion on Builder challenges with heat pumps in high performance housing

ANDY ODING

Vice President, Building Science
Building Knowledge Canada

ROB POPE

Co-founder, Mechanical Designer
Ecolighten Energy Solutions

NATHAN STONE

Managing Partner
Odessa Group

SHAY BULMER

Owner, General Manager
Northern Homecraft

THANK YOU

Panel Session: Industry Challenges

June 10, 2024 - Vancouver

New Air Source Heat Pump Sizing & Selection App

June 10, 2024 – Vancouver

Jérémie Léger – LEEP
Sneha Bernard – LEEP

NRCan's ASHP Sizing & Selection App

01 What is the ASHP Sizing & Selection App?

- Let's recap on the builder issues
- How can the app assist in selecting better systems

02 Demo of the New Web App

- Why should builders care?
- How to use it in IDP?
- Let's explore on today's case study home…
- Builder activity on the steps

03 Today's Agenda Through the Lense of the HP App

04 Key Takeaways

What is the ASHP Sizing & Selection App?

We heard from you…

Common issues with HVAC design and performance:

- Experiencing **overheating** on shoulder season in some rooms (room over garage, second floor rooms)
- **Placement of outdoor unit** is a challenge in urban environments with noise complaints and bylaws restricting locations
- **Wall space** for mechanicals and other trades is limited
- Keeping **cost** low to remain competitive
- Frequent **call backs** with underperforming systems

Leverage the NRCan ASHP Sizing & Selection App to resolve key issues on performance

Mechanical systems don't sell homes, but their outcomes can

Install + Operating Cost

Energy Use

Greenhouse Gas Emissions

Achieving comfort

slido

How do you typically make decision on selecting mechanical equipment, e.g. rely on HVAC contractor, rely on HVAC designer, seek advice from industry forums...?

ⓘ Start presenting to display the poll results on this slide.

The ASHP Sizing & Selection Tool allows you to select systems based on more than just lowest cost

Facilitate a step-by-step conversation with HVAC trades, designers, and builders to resolve challenges & communicate outcomes:

- ❑ **System sizing & product selection:** Access an extensive library of products including all leading brands to select equipment most appropriate for your new builds
- ❑ **Energy & GHG Savings:** Compare savings, costs and emissions across different products and configurations to better communicate with homeowners
- ❑ **Controls:** Optimize controls settings for ease of use, thermal comfort and cost-effectiveness

Does business as usual actual get you to optimal outcomes?

BUSINESS AS USUAL

- Save $$$ on upfront HVAC design
- Lowest cost equipment may win the bid
- Tried & true solutions reduce (perceived) risks
- Limits complications for operations & maintenance for buyers

COLLABORATIVE APPROACH

- Long term savings with reduced ductwork & labour costs
- Systems optimized for long term performance and costs
- New systems and product availability expand options for homeowners
- Optimize utility & GHG savings, limit reliance on back up systems

Selecting a heat pump without collaborative HVAC design is like…

Walking into a car dealership without specifying

… what you'll be using your car for

… where you'll be driving it

… how big your family is

… your fuel efficiency requirements

… what your price point is

… whether you even know how to drive it!

You could end up with…

-OR-

-OR-

Let’s look at our case study home (Climate Zone 5)

BUILDER GOALS:

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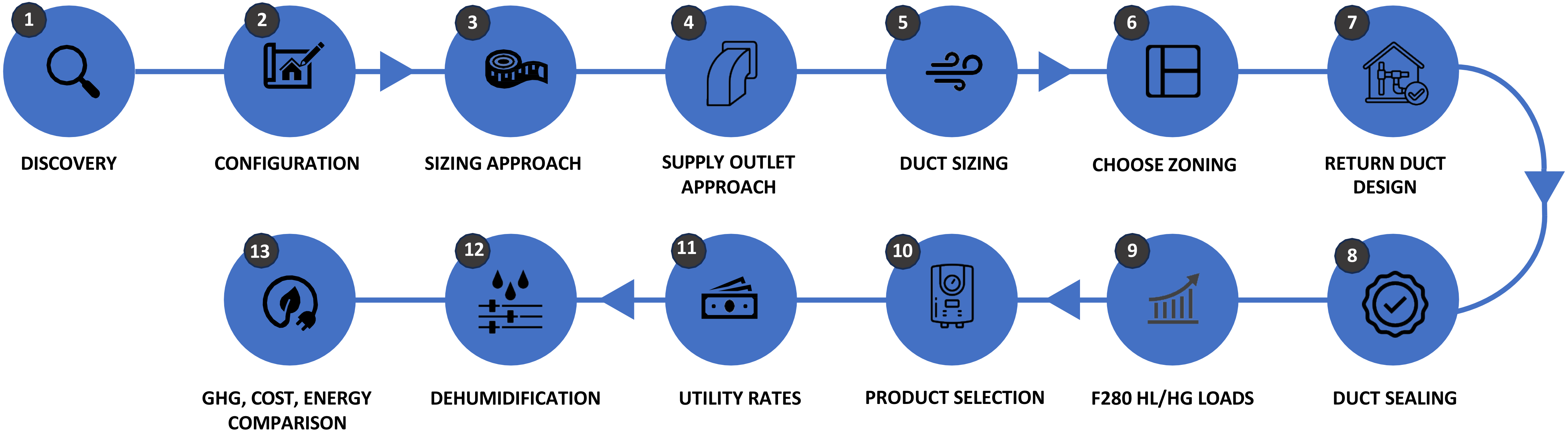
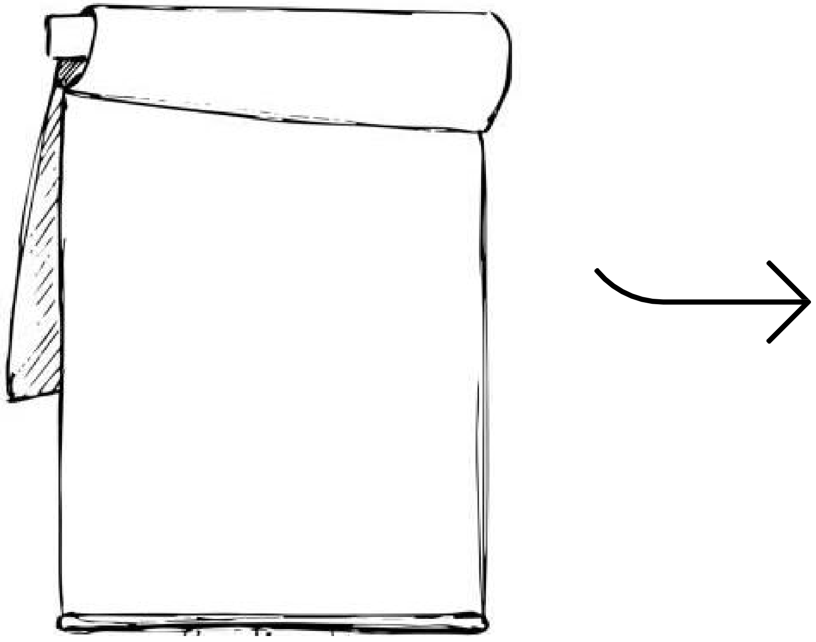
13 Steps to facilitate better HVAC design – we'll be working through these steps throughout the day



Group Discussion

Let's explore how we can modify our "business as usual" practices



Step	Current	Interested to explore
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

Demo: NRCan’s Air Source Heat Pump Sizing and Selection Tool

Before beginning, you will need:

- ✓ The whole home design heating and cooling load of the home
- ✓ Be ready to discuss past issues and goals for the project
- ✓ Understand market challenges and what is motivating sales

NRCan’s ASHP Sizing & Selection App

slido

How has a collaborative process with your trades affected your mechanical design?

ⓘ Start presenting to display the poll results on this slide.

Key takeaways

01 **NRCan's ASHP Sizing & Selection App provides data to support you selecting your mechanical systems.**

Better data - leads to effective communication of performance
Careful selection through discussion leads to better performance – and fewer callbacks

02 **Today we will walk through the steps of the app and explore how you can change your mechanicals to improve comfort, energy and cost performance**

Coming up next:

- Duct design option for improving comfort and reducing cost (step 4-8)
- Load calculation and selecting systems for heating and cooling best performance (step 2, 3, 9, 10)
- Selecting you control approach to optimize for your goals (Step 11-12)

Canada

Natural Resources Canada   Ressources naturelles Canada

Duct Design and Selection

Best practices to optimize for comfort

June 10, 2024 – Vancouver

Rob Pope – Ecolighten Energy Solutions

Canada

Presentation Outline

01 **Introduction to Current Industry Landscape**

- Current Industry Landscape and Practices

02 **HVAC Design with Forced Air Systems**

- Builder Collaboration with HVAC Design

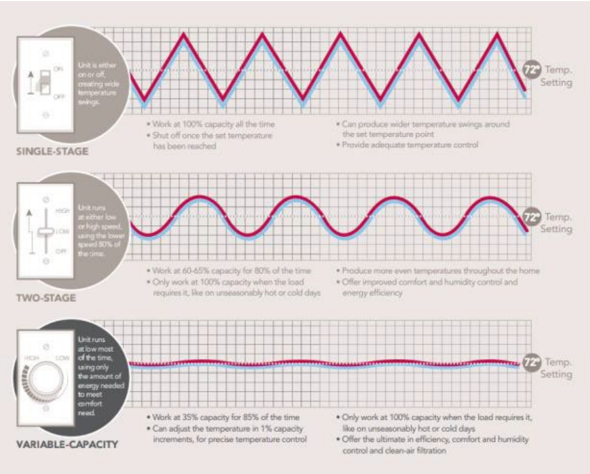
03 **Utilizing NRCan’s Decision Guide and Tools**

Current Industry Landscape

[Source: canada.ca]

Regulatory & Political

Net-Zero Emissions in Canada by 2050
2030 Emissions Reduction Plan: 40 - 45% Reduction from 2005 Levels by 2030



[Source: Fire & Ice Heating & Air Conditioning]

Changing Technology

VRF, Cold Climate Heat Pumps


LEADERSHIP

For Millennials And Gen Zs, Social Issues Are Top Of Mind —Here's How Organizations Can Drive Meaningful Change

Deloitte BRANDVOICE | Paid Program

Jul 22, 2021, 11:38am EDT

Millennials and Generation Zs have long pushed for social change, but the 10th annual Deloitte Global Millennial and Gen Z Survey reveals that they believe the world has reached a tipping point on issues such as racial justice, inequality and the environment.

[Source: Forbes]

Consumer Climate

Motivated Homeowners for GHG Reduction

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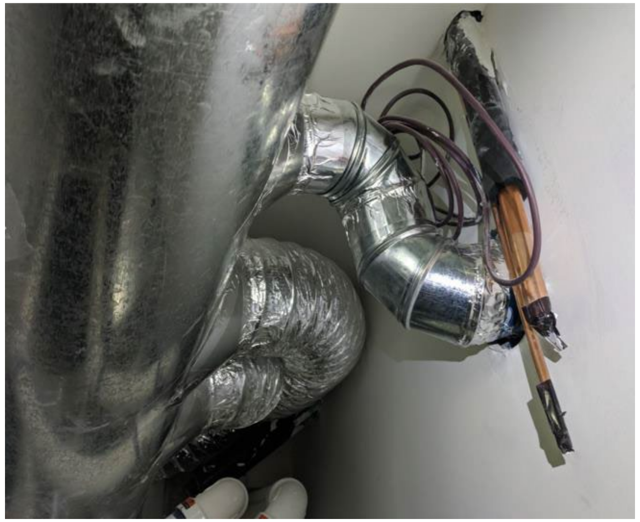
Who currently provides your duct design for your new construction homes?

ⓘ Start presenting to display the poll results on this slide.

Current Practices

Load Calculations:
Too often the
"rule of thumb"

Design:
More coincidental
than coordinated

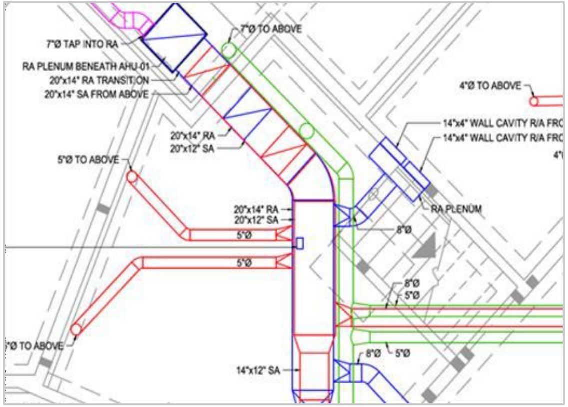


Verification:
Commissioning
is infrequent

Enhanced Practices

- Best practices in HVAC design start with code compliant F280-12 load calculations as the foundation on which all other HVAC decisions are dependent.
- Integrated and coordinated design between builders, architects/designers, mechanical designers and contractors will optimize the HVAC system performance within changes in housing form, style, design and construction that have impacted the mechanical needs of today's housing.

LOAD CALCULATIONS:
CSA F280-12 Compliant



HVAC DESIGN:
Integrated design practices

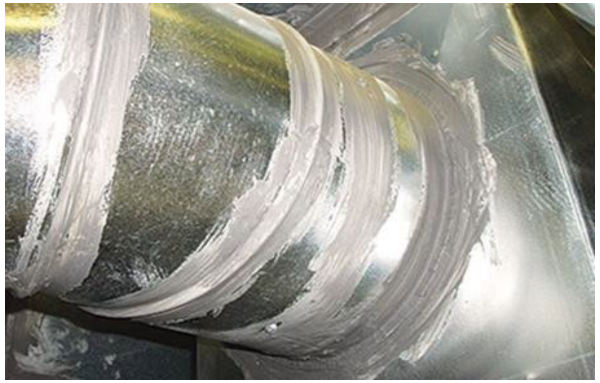
VERIFICATION:
Start-up performance documented

Evolving Practices

- HVAC design landscape is quickly evolving and driven by regulatory changes (e.g. Energy Step Code) and new technologies. Adapting to these changes requires better building/design processes.
- Standardizing HVAC design information for purposes of compliance will encourage better practices by industry, and result in improved energy performance required by performance-based codes.

MID-STAGE BLOWER DOOR TESTING:
Confirm air tightness targets

STANDARDIZING HVAC COMPLIANCE:
Harmonizing permitting requirements



INSPECTIONS:
Verifying installation practices

HVAC Design with Forced Air Systems

HVAC Design – Builder Considerations

Typical home design is done without anticipation or planning for the home's necessary HVAC system. It is imperative that builder/client needs, and project imperatives are established upfront. Consultation will help determine the most appropriate HVAC system for the project with respect to the following considerations:

- **Housing Type** – Low-rise attached houses and multi-level / single-storey houses.
- **Financial** – Budgets, value and costs/benefit.
- **Compliance Requirements** – Performance codes and HVAC design requirements unique to municipalities.
- **Comfort & Health** – Occupant expectations, indoor air quality and humidity controls.
- **Design/Construction Coordination** – Integrating HVAC with structural, architectural and interior design.
- **Fuel Source & Systems** – Gas, electric and geothermal. Forced air, radiant or hybrid.

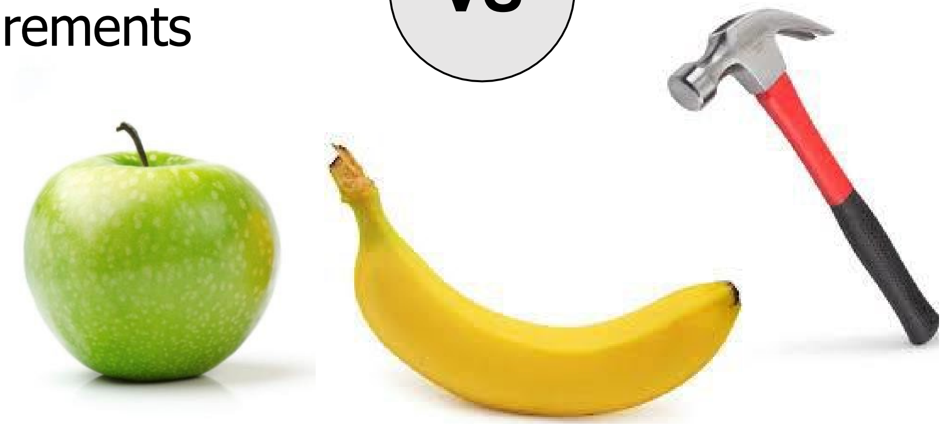
HVAC Design – Importance of Bid Specifications

As performance requirements in new construction become more complex requiring increased collaboration, it is crucial that the entire project team have the same basis of project requirements.

VS

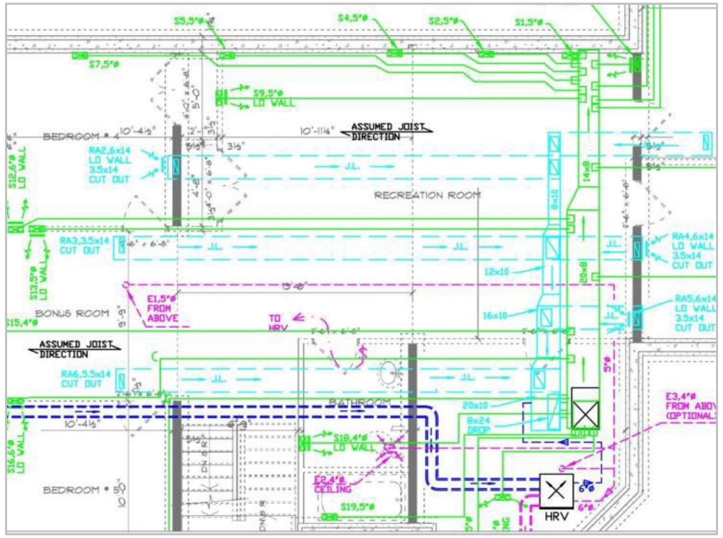
Bid Specifications

- Support a quality HVAC system installation by providing clear instructions on the intent, performance and installation requirements of the project.
- Key components include:
  - **Equipment Schedule**
  - **Standards of Practice**, and
  - **Mechanical Design**

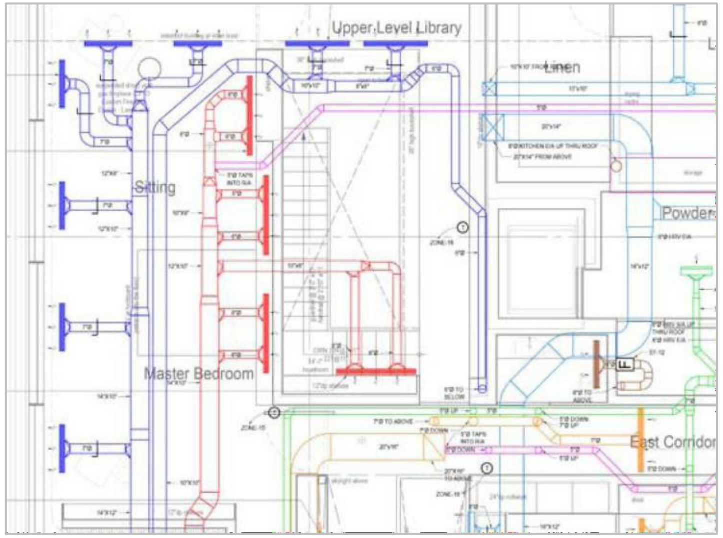


HVAC Design – Forced Air System: Ductwork Drawings

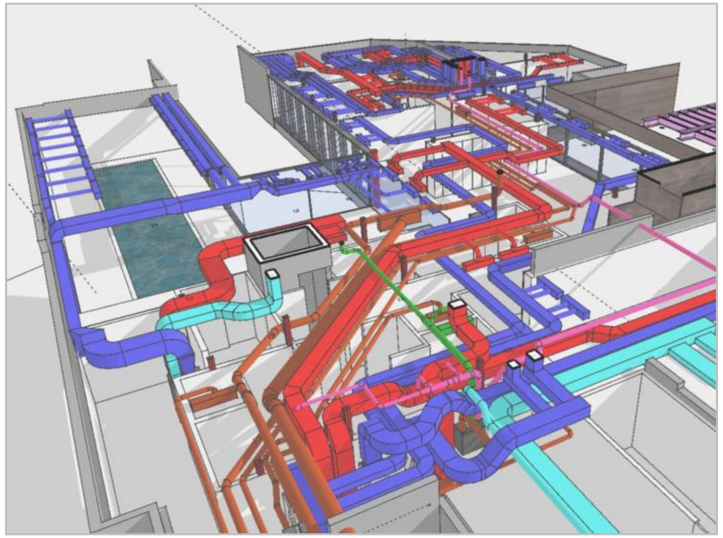
Forced air system duct designs are provided in single-line, two-line and 3D formats depending on project requirements that incorporate layouts into the architectural plans.



Single-Line Design



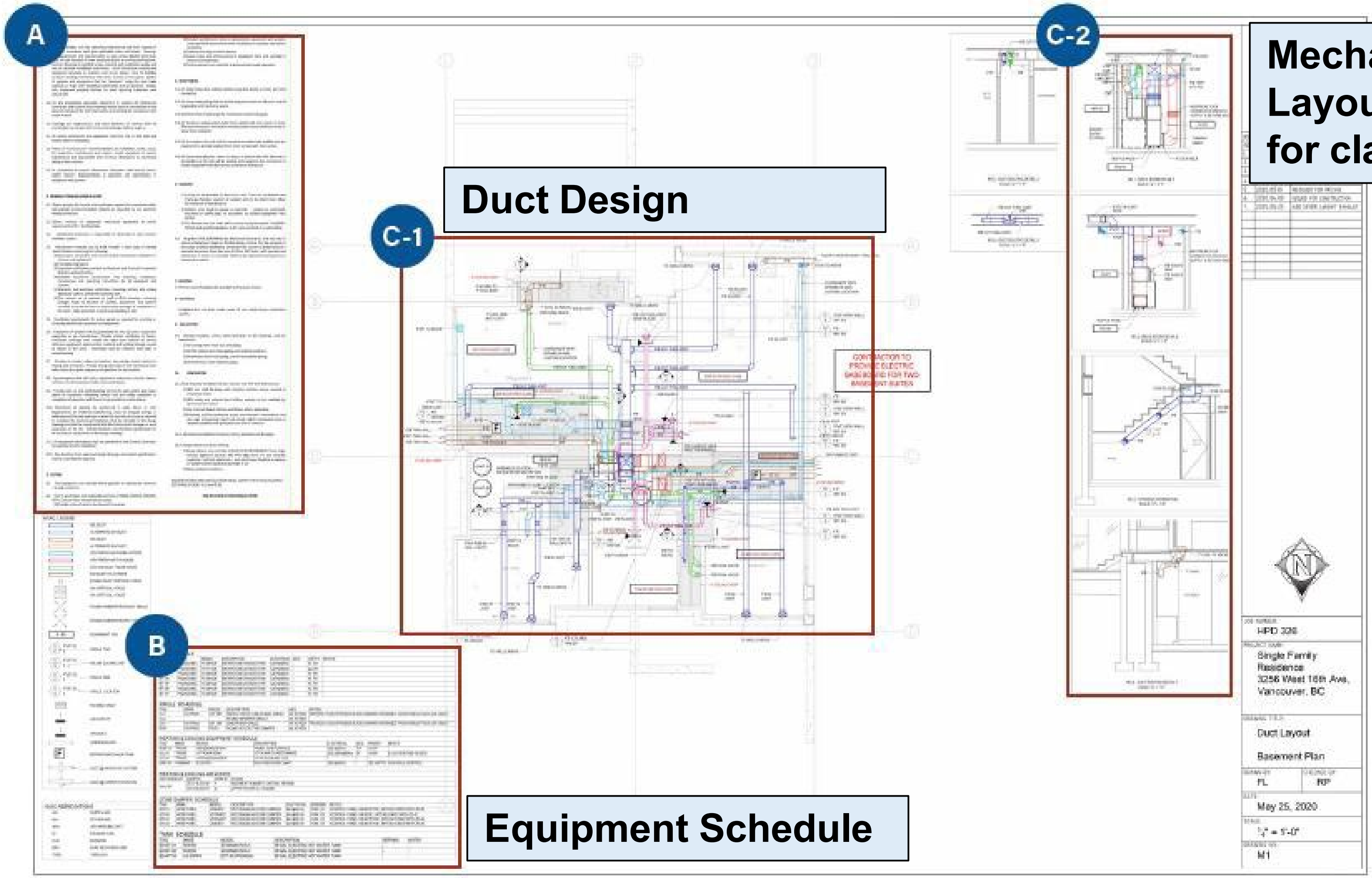
Two-Line Design



3-Dimensional Design

HVAC Design – Forced Air System: Drawing Example

Design Intent & Standards of Practice



Duct Design

Mechanical Room Layout & Sections for clarity

Equipment Schedule

HVAC Design – Field Reviews

HVAC field reviews should take place at **Start of Construction**, **During Construction (Mid-Stage)** and at **Completion**.

- **Prior to construction:** Review HVAC design with the designer, installer and builder to check and make timely adjustments to the design if required.
- **At mid-stage:** Review & verify that the design and installation is coordinated with electrical, hydraulic, structural, and architectural design, and correctly installed as per the design directions. This should occur after rough-in ductwork and piping for HVAC system is in place and prior to covering walls and ceilings.
- **Post-installation:** Review & verify all installed equipment is properly commissioned, balanced and ready to use. This should occur at project completion but prior to occupancy.

HVAC Design – Verification of Performance

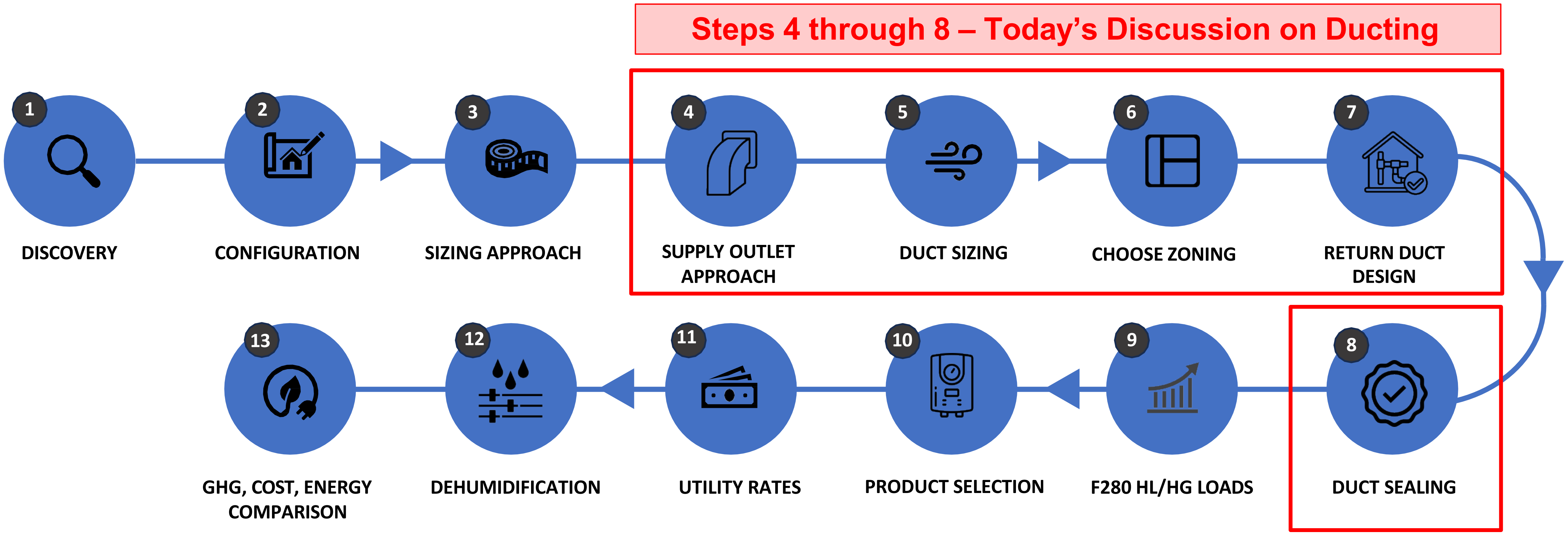
Verifying in field HVAC system performance provides builders peace of mind knowing that industry regulations and standards of excellence will be met.

STEP 1
Mid-stage blower door testing to confirm air tightness targets will be met.

STEP 2
Duct sealing and visual inspection to confirm equipment installation meets design intent with appropriate standard of practice

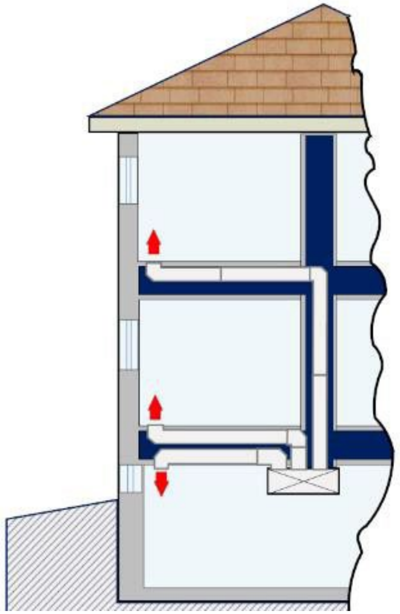
STEP 3
Ensure start-up equipment procedures are followed and commissioning documented for homeowner.

13 Steps to Facilitate Best Practices in HVAC Design & Installation

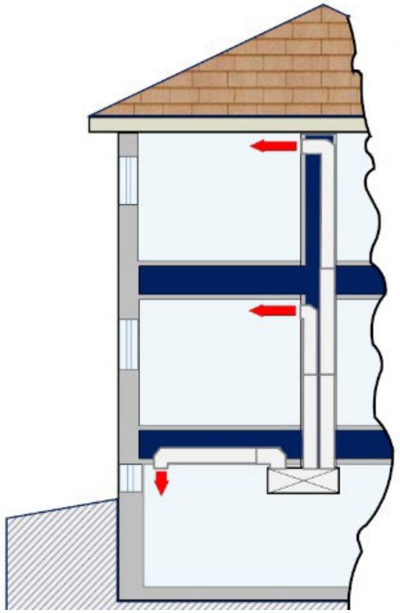


Supply Outlet Approach

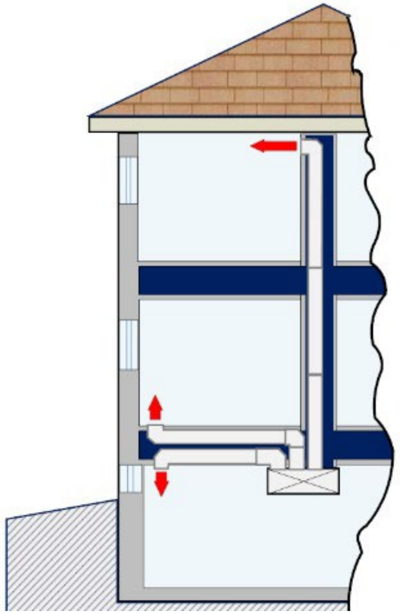
Various duct distribution methods are all acceptable to achieve performance and depend typically on style of structure, aesthetics, and loads.



Option A:
Perimeter Supply



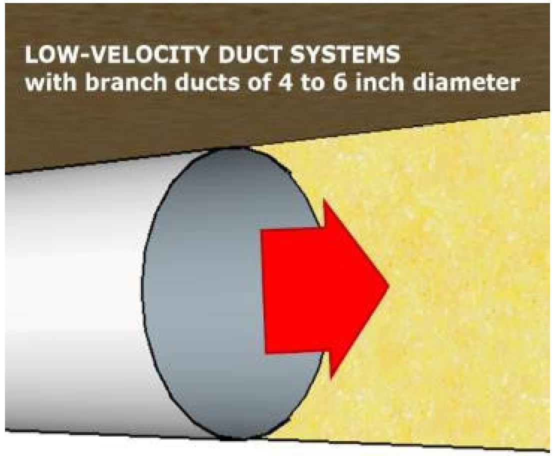
Option B:
Central Supply



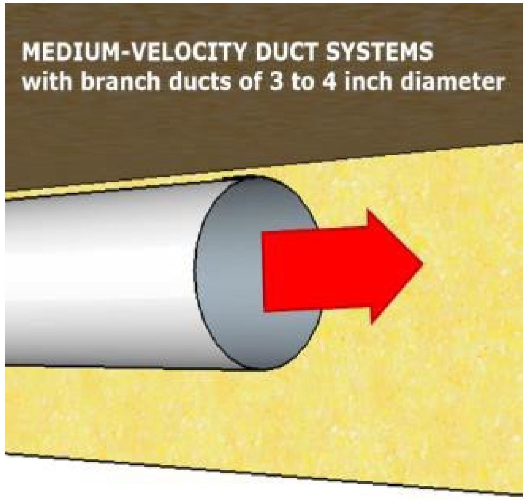
Option C:
Hybrid Supply

Duct Sizing

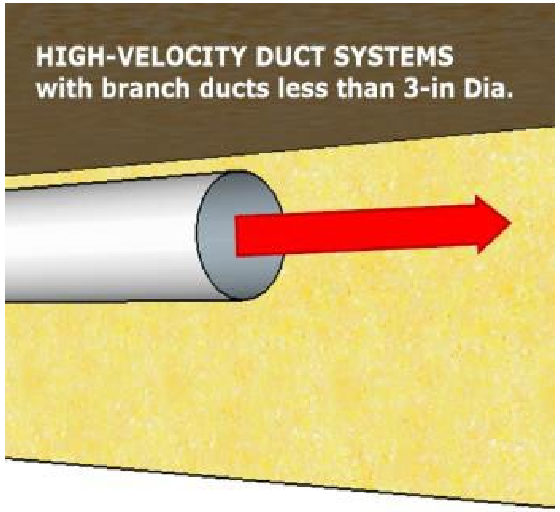
System style include low, medium and high velocities, each with their own set of benefits and compromises. The style of system should be discussed and determined before duct design.



Option A:
Low



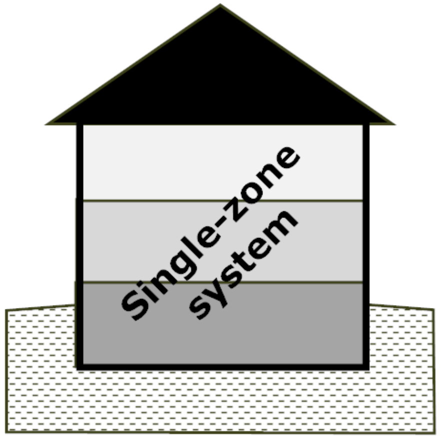
Option B:
Medium



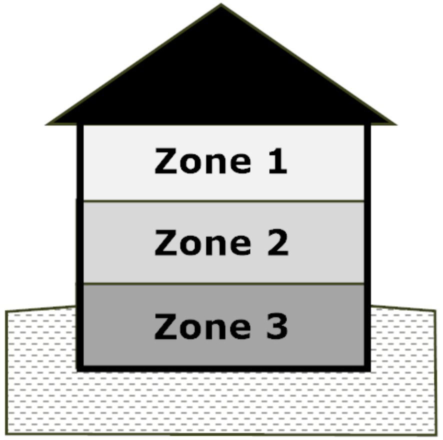
Option C:
High

Choose Zoning

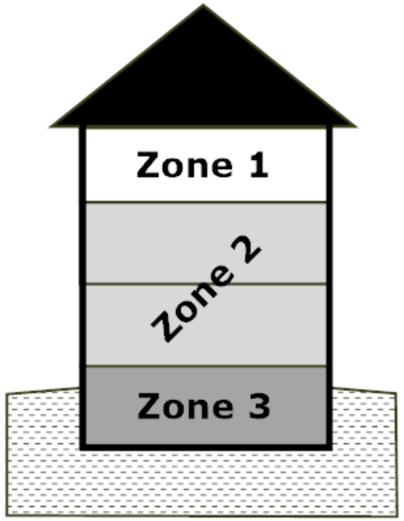
Forced-air zoning is common, but does have limitations related to equipment fan modulating range and external static pressures. Zoning can be accomplished by zone damper controls, or multiple fan coils and or heads (such as wall cassettes). Zones can be delineated by floor, load, or area/room usage.



Option A:
Single-zone supply



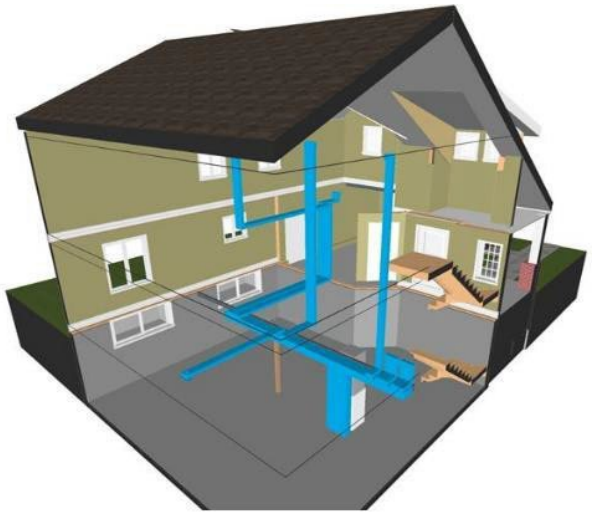
Option B:
One-zone per floor



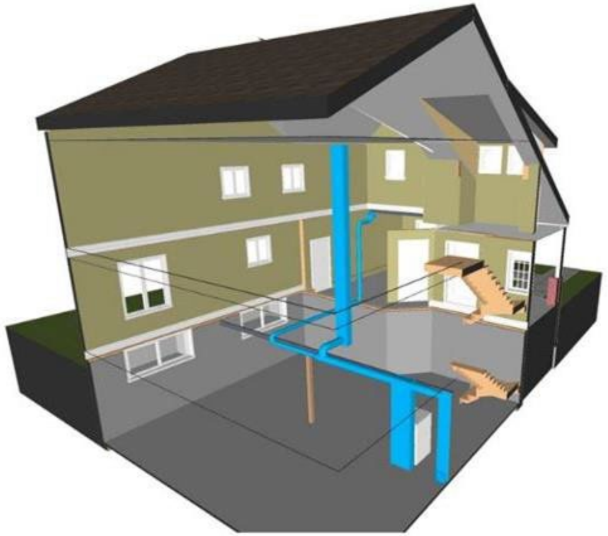
Option C:
Other zoning approach

Return Duct Design

It is ideal to have return grilles in every room. However, this is not always possible due restraints such as budgets, structural restrictions, or aesthetic impact. A simplified return layout with fewer centralized grilles is the most common system, utilizing interior door undercuts, and transfer grilles when necessary. At the very least, there should be one return at each level.



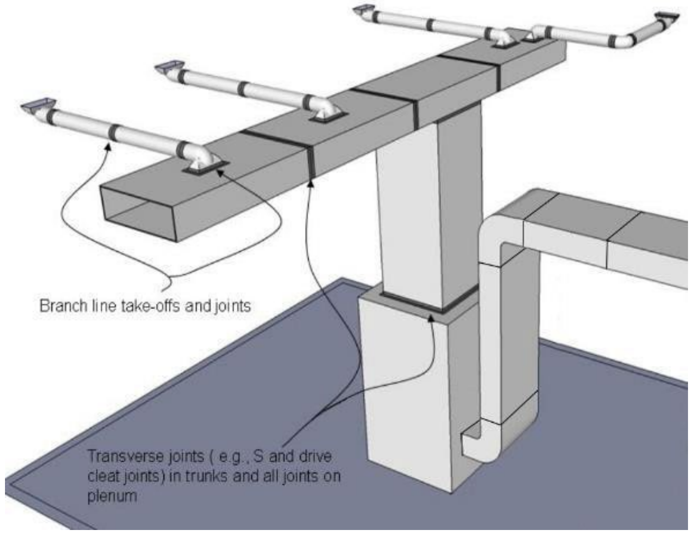
Option A:
Traditional return



Option B:
Simplified return

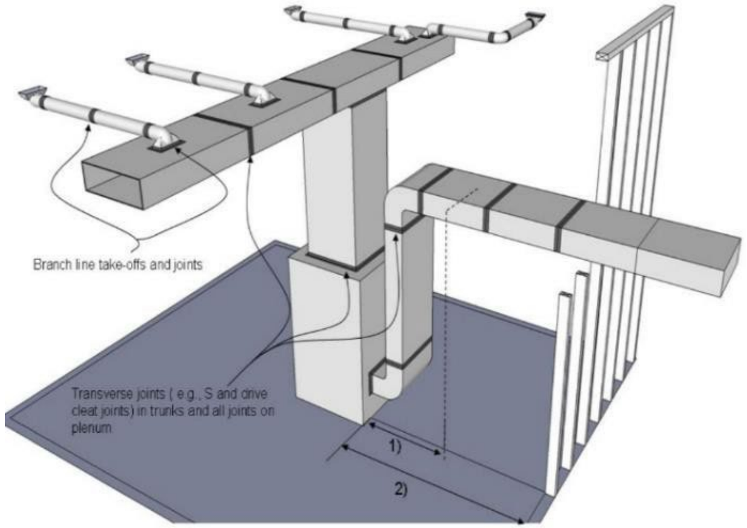
Duct Sealing

Sealing of all seams, elbow gourds, and joints ensures the air designed to reach of the registers will actually occur. Not sealing tends to over-condition the lowest levels and areas closest to the equipment, and under-conditions the highest levels and areas farthest away.



Option A:

Seal supply ducts only



Option B:

Seal supply and return ducts

HVAC Design – What Have We Learned

01 Changing Landscape

- HVAC design landscape is quickly evolving and driven by changes to regulation (e.g. Energy Step Code), homeowner demand and new technologies. Adapting to these changes requires better building/design processes.
- Improved collaboration and verification between builders and mechanical designers will optimize the HVAC system within the project requirements.

02 NRCan Tool Kit for Air Source Heat Pump Sizing and Selection

- NRCan's "Tool Kit for Air Source Heat Pump Sizing and Selection" is a fundamental resource supporting a more effective approach to HVAC decision-making between builders and mechanical designers.

Let's take a look at your design decision for the case study home…

Step	Current	Interested to explore
1	**Discovery:** barriers, challenges & pain points	
2	**Configuration**: centrally ducted system, hybrid install	
3	**Sizing approach**: Emphasis on cooling	
4	**Supply outlet approach:** perimeter supply	
5	**Duct Sizing**: low velocity	
6	**Choose Zoning**: single zone	
7	**Return Duct design:** traditional return design	
8	**Duct Sealing**: base level sealing	
9	**F280 HL/HG:** Work with HVAC contractor to complete F280 calculations	
10	**Heat pump selection**: HP does not meet full load, furnace backup	
11	**Utility rates/controls**: Backup only below TBP	
12	**Dehumidification controls**: not implemented/not designed	
13	GHG, cost, energy outcomes	

Natural Resources Canada | Ressources naturelles Canada

Panel Session: Duct Design

June 10, 2024 – Vancouver

Canada

Canada

Natural Resources Canada   Ressources naturelles Canada

Load Calculations for Heat Pumps

Best practices in right sizing systems

June 10, 2024 – Vancouver

Rob Pope – Ecolighten Energy Solutions

Canada

Presentation Outline

01 Importance of Load Calculations

- Right-Sizing with CSA F280-12
- Equipment Selection

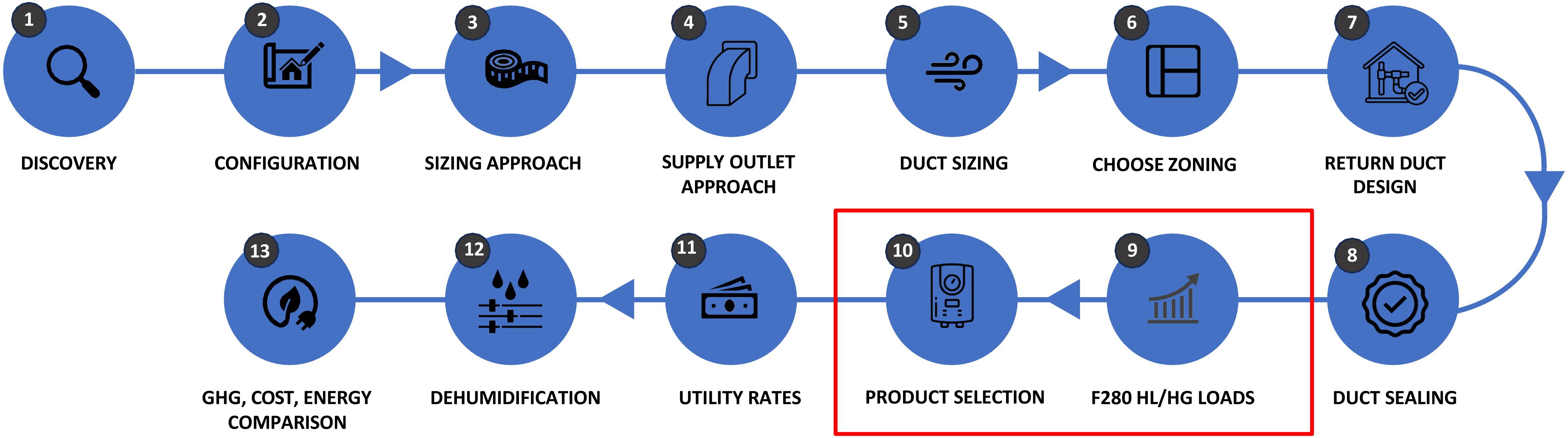
02 Industry transition to low-GWP refrigerants

- Showcasing new research from Canmet Energy labs

03 Envelopes and product availability

- How do heating & cooling loads affect available heat pump options?

13 Steps to Facilitate Best Practices in HVAC Design & Installation

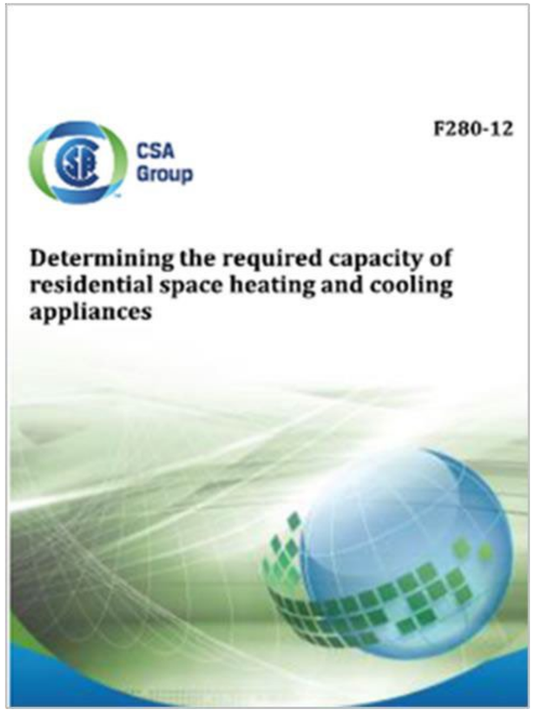


Steps 9 and 10 – Today's Discussion on Sizing

Load Calculations – CSA F280-12

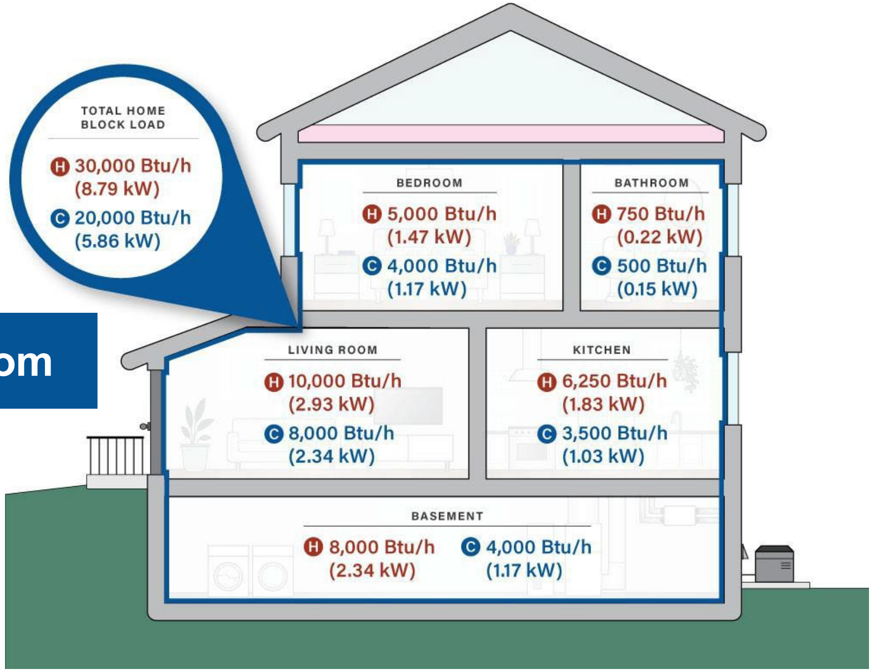
CAN/CSA F280-12: Canadian Standards Association (CSA) standard on how to properly size residential space heating and cooling equipment.

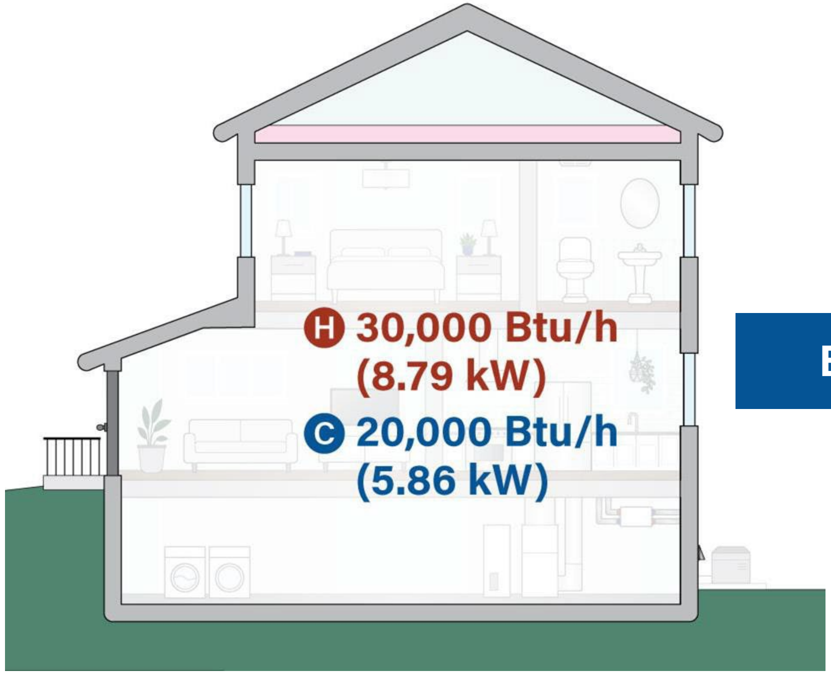
- This standard is nationally recognized and **required** in the National and BC Building Code (Section 9.33)
- It's imperative that residential space heating and cooling systems have the proper output capacity.
- Too little or too much capacity can create a dangerous and uncomfortable living environment.



Load Calculations – Room-by-Room vs. Block Loads

Room-by-Room





Block Load

Calculation Method/Tool Examples

- **CAN/CSA F280:** Typically Room-by-Room for new construction and Block Load for retrofits
- **HOT2000:** Step Code energy modelling software. Not CSA F280 compliant. Typically Block Load.

slido

How do your contractors/designers size mechanical systems?

ⓘ Start presenting to display the poll results on this slide.

Consequences of Oversizing

Consequences of Improper Sizing of Equipment

- As homes become more energy-efficient, improper sizing of HVAC equipment is emerging as one of the more serious performance issues in residential construction.
- The consequences of poorly sized HVAC equipment include:

Reduced Efficiency

Increased Costs & Liability

Shorter Equipment Life Cycle

Poor Comfort and Indoor Air Quality

slido

What are some other challenges you have seen with oversized systems

ⓘ Start presenting to display the poll results on this slide.

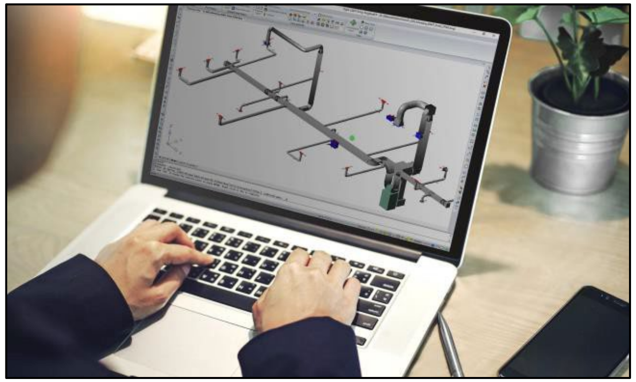
Load Calculations – Industry Practices

- **Most common practice -** Rule of thumb.
- **Too common practice -** Look at rating plate of existing system, then just match it.

- **Less common practice** is Mechanical Contractors utilizing TECA (*BC's Thermal Energy Comfort Association*) CSA F280 compliant software
- **Least common practice** is full consultation with CSA-F280-12 load calculations, cost/benefit analysis & range of options presented, full commissioning with associated reports, and follow up with occupant after commissioning.

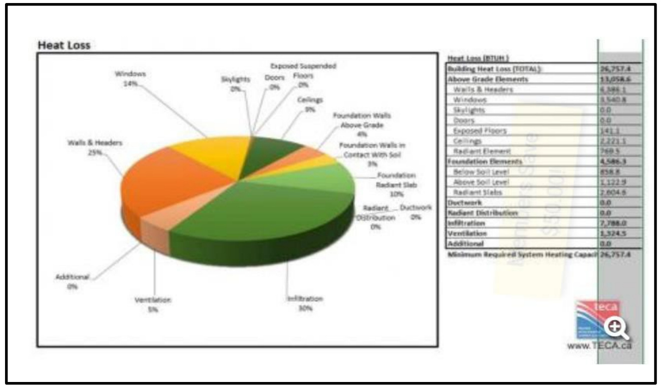
Best Practices

Load Calculations – Industry Trends



Mechanical Designers
use sophisticated programs for load calculations and distribution system design.

Example: Wrightsoft



Mechanical Contractors
use spreadsheet programs for load calculations.

Example: TECA Quality First™ Companion Software

Energy Modellers
can transfer inputs from HOT2000 to **Volta Snap** for CSA F280 compliant load calculations.

Load Calculations – F280-12 Verified Software

- HVAC Designers of Canada has published a list of verified software tools that are compliant with CSA F280-12.

- Using verified software gives both the HVAC contractor and those who rely on the outputs from the software confidence that the tool can generate correct results in line with the CSA standard.

HVAC DESIGNERS OF CANADA
VERIFIED F280 SOFTWARE

teca
thermal environmental comfort association

wrightsoft®

HeatCAD®

volta SNAP

F280 compliant software listing

F280-12 Software Verified according to the procedure set out in F280-12, Section 8.

COMPANY NAME	SOFTWARE NAME	ROOM BY ROOM	WHOLE HOUSE	CONDITIONS	WEBSITE
Building Technology Services	Building Tech F280	✓	✓	Click Here	BuildingTech
Avenir Software Inc	HeatCAD/LoopCAD	✓	✓	Click Here	HeatCAD LoopCAD
Thermal Environmental Comfort Association	Teca Heat Loss & Heat Gain Calculator	✓	✓	Click Here	teca
Volta Research Inc	Volta Snap		✓	Click Here	volta SNAP
MiTek Inc	Right-Suite Universal	✓	✓	Click Here	MiTek WRIGHTSOFT
Sustainable HVAC Design Inc	Sustainable HVAC F280	✓	✓	Click Here	
McCallum HVAC Design Inc	Mecha F280	✓	✓	Click Here	MCCALLUM HVAC DESIGN INC design excellence with on time delivery

Let’s look at our case study home (Climate Zone 5)

BUILDER GOALS:

- Achieve NZ standard
- Improve home thermal comfort
- Manage costs

HOME CHARACTERISTICS

	Heating load	Cooling Load
Zone 1 (Basement):	11,076 BTU/h	7,756 BTU/h
Zone 2 (Main floor):	9,535 BTU/h	9,983 BTU/h
Zone 3 (Second Floor):	9,383 BTU/h	10,002 BTU/h
	29,933 BTU/h (2.49 Ton)	27,441 BTU/h (2.29 Ton)

NET ZERO SPECIFICATIONS

Air Tightness	1.5 ACH50
Attic	R60
Walls	R22+10continuous
Basement	R22+10continuous
Exposed Floor	R40
Windows	Double R4, 0.6 SHGC, 10.6% of wall area
Ventilation	75% Efficiency-HRV
Heating & Air Conditioning	Cold Climate Air Source Heat Pump
Design Temperature	-23°C

Load Calculations – Rule-Of-Thumb vs. F280-12

RULES OF THUMB?

From Google searched websites for BC interior

*"The generally accepted BTU per square foot heating rule of thumb ranges from **30 BTU to 60 BTU per square foot**. That's a wide difference, essential one furnace being twice as large as the other, so the size factors are discussed to help you narrow down the right BTUs needed for your home…"*

"… a 400 to 550 square foot room is best served by an air conditioner with between 10,000 BTU and 12,000 BTU, while a room that's only 250 square feet would probably be fine with an 8,000 BTU unit."

(28 BTU per square foot)

Heat pump size guide

Home size (in square feet)	Heat pump size (in tons)	Heat pump size (in BTUs)
500 sq. ft	1 ton	12,000 BTUs
1,000 sq. ft	2 tons	24,000 BTUs
1,500 sq. ft	3 tons	36,000 BTUs
2,000 sq. ft	4 tons	48,000 BTUs
2,500 sq. ft	5 tons	60,000 BTUs

(22 BTU per square foot)

*"If you had to calculate the size of the HVAC system on the size of the space, you'd have to assign around **25 BTU per square foot** of living area. Room height, windows, shade, and insulation are other factors that dictate what BTU rating you require for your home."*

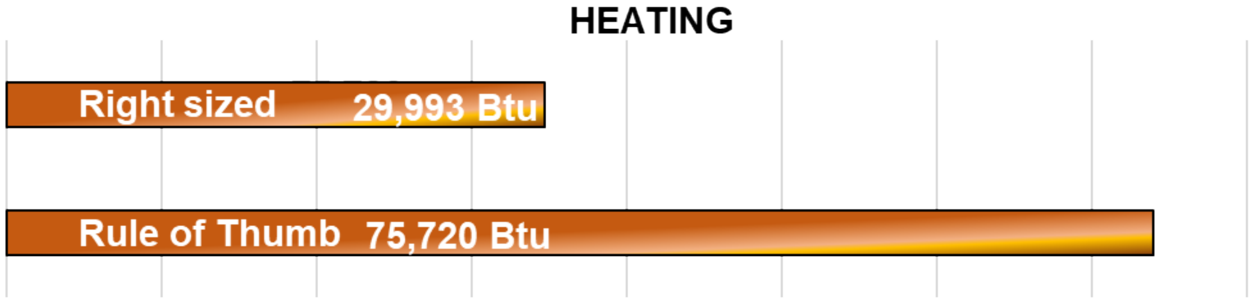
Load Calculations – Rule-Of-Thumb vs. F280-12

Example

3,786 ft² house
Kamloops, Climate Zone 5

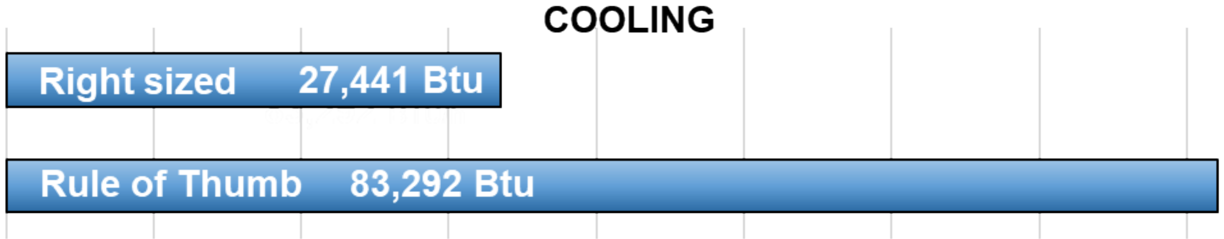
Space Heating Design Loads

- Applying a 'rule of thumb' @ 20 Btu/h per sq. ft.
- CSA F280



Space Cooling Design Loads

- Applying a 'rule of thumb' @ 22 Btu/h per sq. ft.
- CSA F280



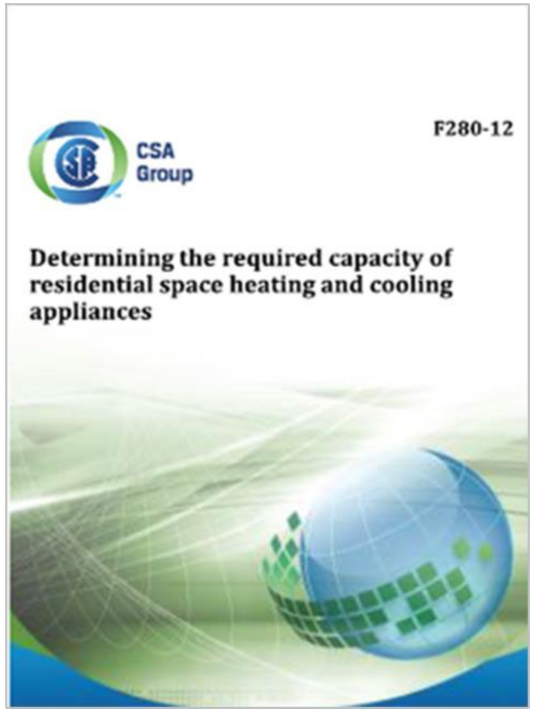
Load Calculations – Importance of Right-Sizing

CALCULATE… DON'T GUESS

CAN/CSA F280-12: BC Building Code (Section 9.33.5)

Making sure this standard is used will:

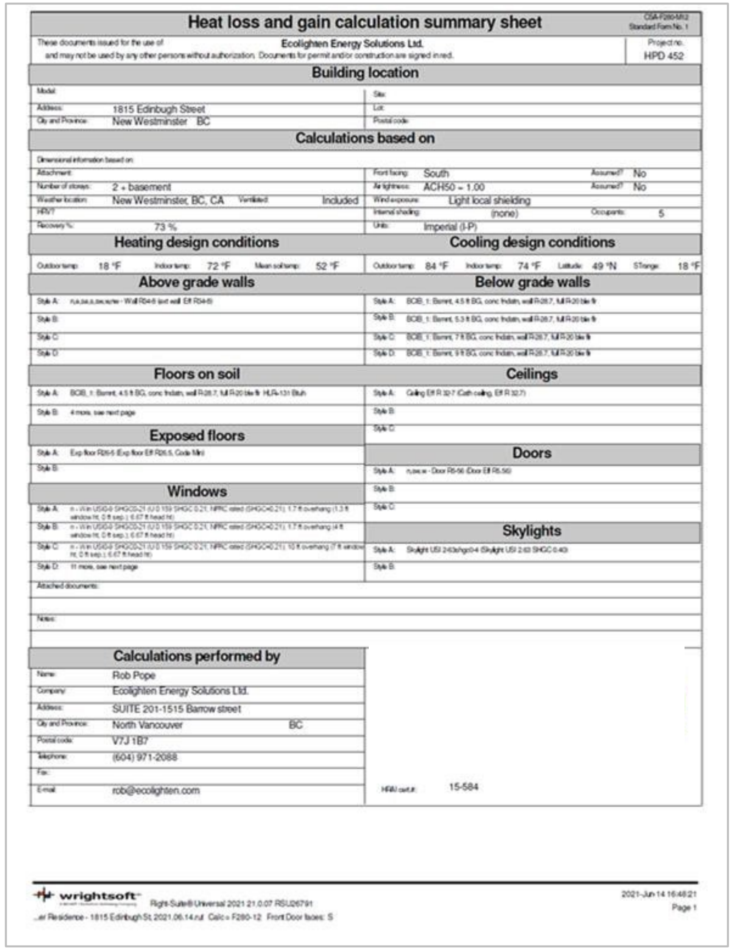
- ✓ Ensure comfort & Indoor Air Quality
- ✓ Optimize equipment efficiency & longevity
- ✓ Reduce HVAC system upfront and operating costs
- ✓ Ensure compliance with code
- ✓ **Reduce liability risks**



Load Calculations – Builder Checklist

HVAC Designer will require the following to ensure a thorough and accurate Load Calculation.

1. **Construction documents that include:**
    - Plans with orientation, sections & elevations
    - Assemblies with effective R-Values
    - Window sizes, USI-values, and SHGC values
2. **Airtightness requirement** (2.5 ACH_{50}, 1.5 ACH_{50}, etc.)
3. **Energy Model documents**
4. **Any desired iterations and alternatives to explore**


Heat loss and gain calculation summary sheet

Ecolighten Energy Solutions Ltd.

Project no. HPD 452

Building location

Address:	1815 Edinbugh Street	Lot:	
City and Province:	New Westminster BC	Postal code:	

Calculations based on

Number of storeys:	2 + basement	Front facing:	South
Weather location:	New Westminster, BC, CA	Airtightness:	ACH50 = 1.00
HRV?	Included	Wind exposure:	Light local shielding
Recovery %:	73 %	Internal shading:	(none)
		Occupants:	5
		Units:	Imperial (I-P)

Heating design conditions: Outdoor temp: 18 °F; Indoor temp: 72 °F; Mean soil temp: 52 °F

Cooling design conditions: Outdoor temp: 84 °F; Indoor temp: 74 °F; Latitude: 49 °N; ST range: 18 °F

Above grade walls · Below grade walls · Floors on soil · Ceilings · Exposed floors · Doors · Windows · Skylights

Calculations performed by

Name:	Rob Pope
Company:	Ecolighten Energy Solutions Ltd.
Address:	SUITE 201-1515 Barrow street
City and Province:	North Vancouver BC
Postal code:	V7J 1B7
Telephone:	(604) 971-2088
E-mail:	rob@ecolighten.com

HRAI cert #: 15-584

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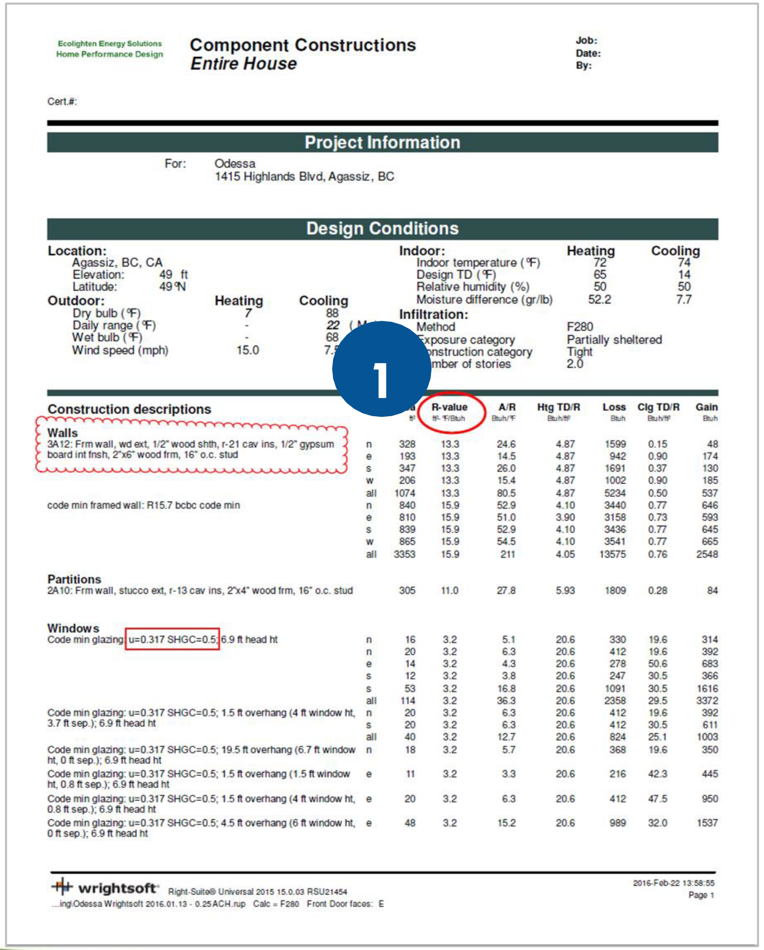
Load Calculations – Builder Checklist



Ecolighten Energy Solutions
Home Performance Design

Component Constructions
Entire House

Job:
Date:
By:

Cert.#:

Project Information

For: Odessa
1415 Highlands Blvd, Agassiz, BC

Design Conditions

Location:		
Agassiz, BC, CA		
Elevation:	49 ft	
Latitude:	49 °N	
Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	*7*	88
Daily range (°F)	-	*22* (M
Wet bulb (°F)	-	68
Wind speed (mph)	15.0	7.5

Indoor:	Heating	Cooling
Indoor temperature (°F)	72	74
Design TD (°F)	65	14
Relative humidity (%)	50	50
Moisture difference (gr/lb)	52.2	7.7
Infiltration:		
Method	F280	
Exposure category	Partially sheltered	
onstruction category	Tight	
mber of stories	2.0	

1

Construction descriptions		a (ft²)	R-value (ft²·°F/Btuh)	A/R (Btuh/°F)	Htg TD/R (Btuh/ft²)	Loss (Btuh)	Clg TD/R (Btuh/ft²)	Gain (Btuh)
Walls								
3A12: Frm wall, wd ext, 1/2" wood shth, r-21 cav ins, 1/2" gypsum board int fnsh, 2"x6" wood frm, 16" o.c. stud	n	328	13.3	24.6	4.87	1599	0.15	48
	e	193	13.3	14.5	4.87	942	0.90	174
	s	347	13.3	26.0	4.87	1691	0.37	130
	w	206	13.3	15.4	4.87	1002	0.90	185
	all	1074	13.3	80.5	4.87	5234	0.50	537
code min framed wall: R15.7 bcbc code min	n	840	15.9	52.9	4.10	3440	0.77	646
	e	810	15.9	51.0	3.90	3158	0.73	593
	s	839	15.9	52.9	4.10	3436	0.77	645
	w	865	15.9	54.5	4.10	3541	0.77	665
	all	3353	15.9	211	4.05	13575	0.76	2548
Partitions								
2A10: Frm wall, stucco ext, r-13 cav ins, 2"x4" wood frm, 16" o.c. stud		305	11.0	27.8	5.93	1809	0.28	84
Windows								
Code min glazing: u=0.317 SHGC=0.5; 6.9 ft head ht	n	16	3.2	5.1	20.6	330	19.6	314
	n	20	3.2	6.3	20.6	412	19.6	392
	e	14	3.2	4.3	20.6	278	50.6	683
	s	12	3.2	3.8	20.6	247	30.5	366
	s	53	3.2	16.8	20.6	1091	30.5	1616
	all	114	3.2	36.3	20.6	2358	29.5	3372
Code min glazing: u=0.317 SHGC=0.5; 1.5 ft overhang (4 ft window ht, 3.7 ft sep.); 6.9 ft head ht	n	20	3.2	6.3	20.6	412	19.6	392
	s	20	3.2	6.3	20.6	412	30.5	611
	all	40	3.2	12.7	20.6	824	25.1	1003
Code min glazing: u=0.317 SHGC=0.5; 19.5 ft overhang (6.7 ft window ht, 0 ft sep.); 6.9 ft head ht	n	18	3.2	5.7	20.6	368	19.6	350
Code min glazing: u=0.317 SHGC=0.5; 1.5 ft overhang (1.5 ft window ht, 0.8 ft sep.); 6.9 ft head ht	e	11	3.2	3.3	20.6	216	42.3	445
Code min glazing: u=0.317 SHGC=0.5; 1.5 ft overhang (4 ft window ht, 0.8 ft sep.); 6.9 ft head ht	e	20	3.2	6.3	20.6	412	47.5	950
Code min glazing: u=0.317 SHGC=0.5; 4.5 ft overhang (6 ft window ht, 0 ft sep.); 6.9 ft head ht	e	48	3.2	15.2	20.6	989	32.0	1537

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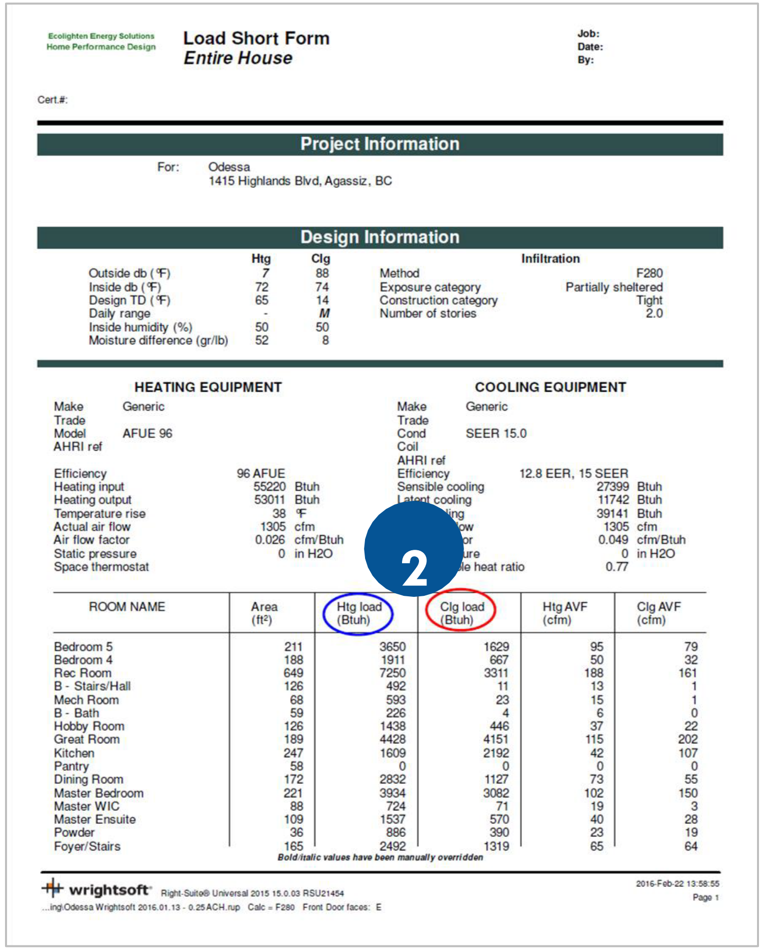

Ecolighten Energy Solutions
Home Performance Design

Load Short Form
Entire House

Job:
Date:
By:

Cert.#:

Project Information

For: Odessa
1415 Highlands Blvd, Agassiz, BC

Design Information

	Htg	Clg
Outside db (°F)	*7*	88
Inside db (°F)	72	74
Design TD (°F)	65	14
Daily range	-	*M*
Inside humidity (%)	50	50
Moisture difference (gr/lb)	52	8

Infiltration	
Method	F280
Exposure category	Partially sheltered
Construction category	Tight
Number of stories	2.0

HEATING EQUIPMENT

Make	Generic
Trade	
Model	AFUE 96
AHRI ref	
Efficiency	96 AFUE
Heating input	55220 Btuh
Heating output	53011 Btuh
Temperature rise	38 °F
Actual air flow	1305 cfm
Air flow factor	0.026 cfm/Btuh
Static pressure	0 in H2O
Space thermostat	

COOLING EQUIPMENT

Make	Generic
Trade	
Cond	SEER 15.0
Coil	
AHRI ref	
Efficiency	12.8 EER, 15 SEER
Sensible cooling	27399 Btuh
Latent cooling	11742 Btuh
ling	39141 Btuh
ow	1305 cfm
or	0.049 cfm/Btuh
ure	0 in H2O
le heat ratio	0.77

2

ROOM NAME	Area (ft²)	Htg load (Btuh)	Clg load (Btuh)	Htg AVF (cfm)	Clg AVF (cfm)
Bedroom 5	211	3650	1629	95	79
Bedroom 4	188	1911	667	50	32
Rec Room	649	7250	3311	188	161
B - Stairs/Hall	126	492	11	13	1
Mech Room	68	593	23	15	1
B - Bath	59	226	4	6	0
Hobby Room	126	1438	446	37	22
Great Room	189	4428	4151	115	202
Kitchen	247	1609	2192	42	107
Pantry	58	0	0	0	0
Dining Room	172	2832	1127	73	55
Master Bedroom	221	3934	3082	102	150
Master WIC	88	724	71	19	3
Master Ensuite	109	1537	570	40	28
Powder	36	886	390	23	19
Foyer/Stairs	165	2492	1319	65	64

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Page 1

What to review and check once calculations are completed:

1. **Check** that building assemblies and related R-values & USI-values make sense.

2. **Review** Total Heat Loss & Total Heat Gain.

Load Calculations – Builder Checklist

Ecolighten Energy Solutions
Home Performance Design

Building Analysis
Entire House

Job:
Date:
By:

Cert.#:

Project Information

For: Odessa
1415 Highlands Blvd, Agassiz, BC

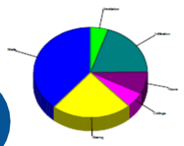
Design Conditions

Location:	Heating	Cooling	Indoor:	Heating	Cooling
Agassiz, BC, CA			Indoor temperature (°F)	72	74
Elevation: 49 ft			Design TD (°F)	65	14
Latitude: 49°N			Relative humidity (%)	50	50
Outdoor:			Moisture difference (gr/lb)	52.2	7.7
Dry bulb (°F)	7	88	**Infiltration:**		
Daily range (°F)	-	22 (M)	Method	F280	
Wet bulb (°F)	-	68	Exposure category	Partially sheltered	
Wind speed (mph)	15.0	7.5	Construction category	Tight	
			Number of stories	2.0	

Heating

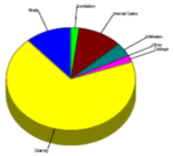
Component	Btuh/ft²	Btuh	% of load
Walls	1.6	20618	38.9
Glazing	20.6	12089	22.8
Doors	0	0	0
Ceilings	1.6	2949	5.6
Floors	2.3	4175	7.9
Infiltration	17.9	10510	19.8
Ducts		0	
Hydronic		0	
Humidification		0	
Ventilation		2671	
Adjustments		0	
Total		53011	100.

3



Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	0.2	3169	11.6
Glazing	32.1	18843	68.8
Doors	0	0	0
Ceilings	0.3	583	2.1
Floors	0.0	8	0.0
Infiltration	2.0	1177	4.3
Ducts		0	0
Ventilation		575	2.1
Internal gains		3044	11.1
Blower		0	0
Adjustments		0	
Total		27399	100.0



Latent Cooling Load = 8220 Btuh
Overall U-value = 0.033 Btuh/ft²-°F

Data entries checked.

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What to review and check once calculations are completed:

1. **<u>Look</u>** at what has most impact on your Design Heat Loss/Gain.
2. **<u>Review</u>** your upgrade options
3. **<u>Select</u>** your final specifications

A brief summary report will be provided with your chosen specifications.

Equipment Selection

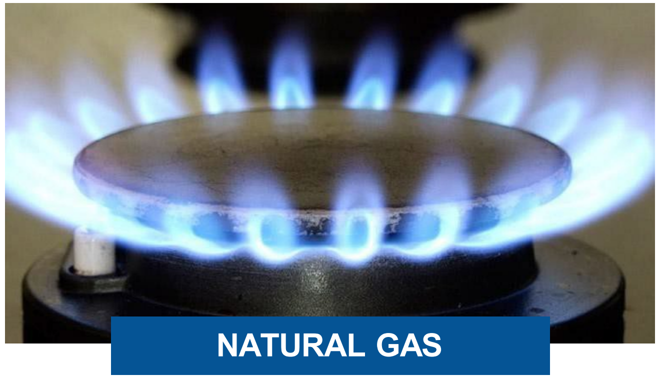
Energy Performance/Climate Targets

Energy performance/climate targets need to be confirmed upfront as it may limit the energy source and equipment selection options.

Energy Sources

Before deciding on an energy source, consider the following:

- Availability and suitability of the energy source
- Operating costs and benefits
- Homeowner interests and motivations
- Accelerating climate change policies and environmental impacts



Equipment Selection

When Discovery, Energy Evaluation & Load Calculations are completed, equipment can then be selected based on the following criteria:

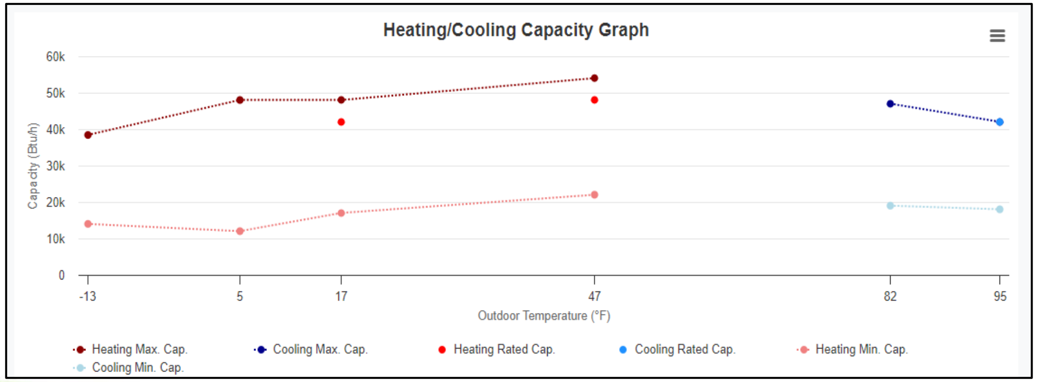
- Budget
- Supply chain and product support from suppliers and installers for the project location
- Space Restrictions, Noise Level, Electrical Service Requirements, etc.
- **Efficiency & Capacity from equipment specifications (e.g., efficiency, capacity & fan performance curves)**

Equipment Selection

Selecting the appropriate equipment requires technical competence beyond sales convenience.

MITSUBISHI ELECTRIC P-Series

Central Air Conditioning Heat Pump (HP)
Singlezone Ducted, Centrally Ducted
AHRI Cert #*: **211259282**
Outdoor Unit Model #*: **PUZ-HA42NKA1**
Indoor Model #*: **PVA-A42AA***
Maximum Heating Capacity (Btu/h) @5°F: **48,000**
Rated Heating Capacity (Btu/h) @47°F*: **48,000**
Rated Cooling Capacity (Btu/h) @95°F*: **42,000**



Performance Specs

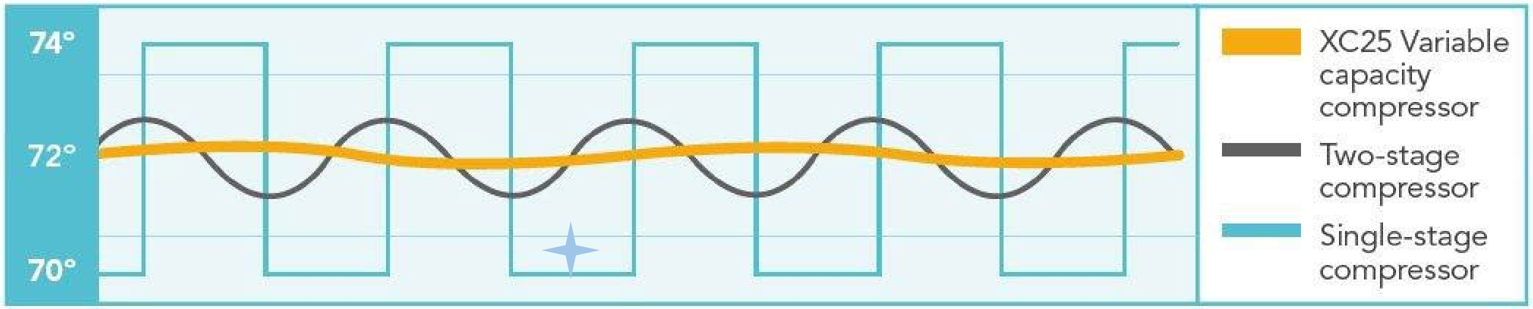
Heating / Cooling	Outdoor Dry Bulb	Indoor Dry Bulb	Unit	Min	Rated*	Max
Cooling	95°F	80°F	Btu/h*	18,000	42,000	42,000
			kW	1.78	4.27	4.27
			COP	2.96	2.88	2.88
Cooling	82°F	80°F	Btu/h*	19,000	-	47,000
			kW	1.3	-	4.2
			COP	4.28	-	3.28
Heating	47°F	70°F	Btu/h*	22,000	48,000	54,000
			kW	1.59	4.01	4.87
			COP	4.06	3.51	3.25
Heating	17°F	70°F	Btu/h*	17,000	42,000	48,000
			kW	1.85	4.99	6.7
			COP	2.69	2.47	2.1
Heating	5°F	70°F	Btu/h*	12,000	-	48,000
			kW	3.06	-	7.36
			COP	1.15	-	1.91
Heating	-13°F	70°F	Btu/h*	14,000	-	38,400
			kW	0.99	-	7.24
			COP	4.14	-	1.55

Information Tables

Brand	MITSUBISHI ELECTRIC
Series	P-Series
Ducting Configuration	Singlezone Ducted, Centrally Ducted
AHRI Certificate #*	211259282
Outdoor Unit Model #*	PUZ-HA42NKA1
Indoor Model #*	PVA-A42AA*
Indoor Unit Type*	Mini-Splits
Furnace Model* #	
EER*	10.6
SEER*	15.3
HSPF (Region IV)*	11
EER2*	9.8
SEER2*	15.4
HSPF2 (Region IV)*	9.3
HSPF2 (Region V)	7.9
ENERGY STAR V6.1	✔
ENERGY STAR V6.1 Cold Climate	✔

Equipment Selection

Conventional Equipment



[Source: PickHVAC]

Single-Stage:

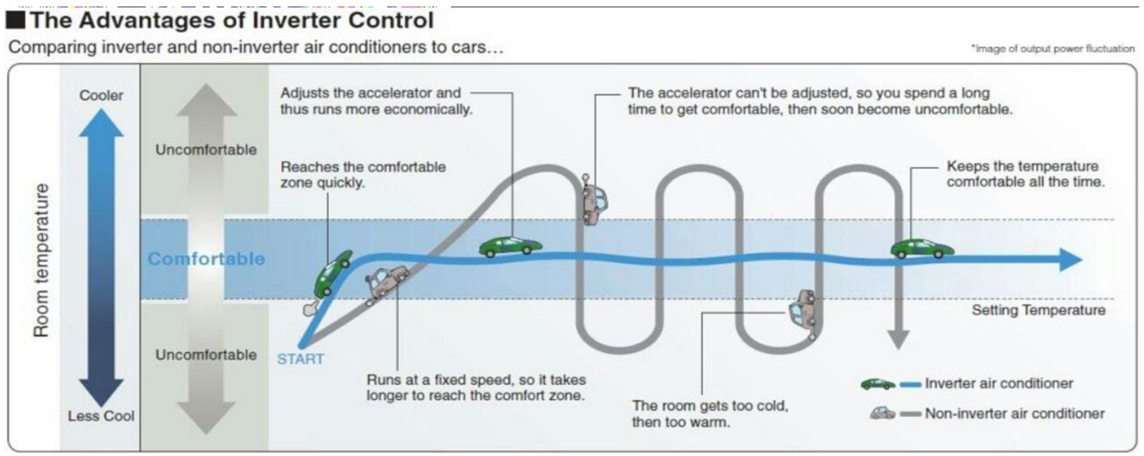
- Operates on a full-on or full-off schedule and works at 100% capacity all the time.
- Most affordable option but efficiency is the lowest.

Two-Stage:

- Offers better control and performance with higher efficiency than single-stage equipment.
- Works at 60% – 65% capacity for 80% of the time.

Equipment Selection

High-Performance Equipment



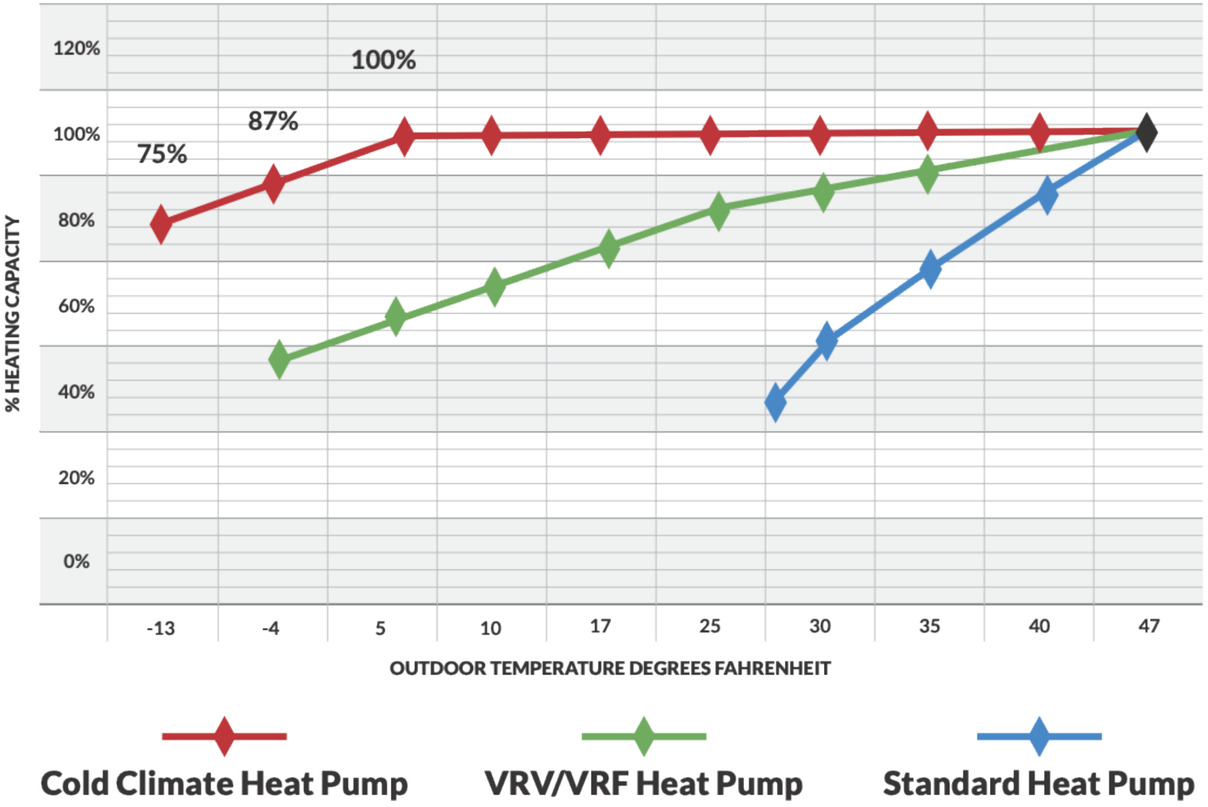
[Source: Bijli Bachao]

Variable Refrigerant Flow (VRF)/Variable Refrigerant Volume (VRV)

- Can modulate and operates at the speed necessary to meet demand.
- 40% - 50% higher efficiency than conventional equipment.
- Capable of serving multiple zones with a single outdoor unit.

Equipment Selection

High-Performance Equipment



Cold Climate Heat Pump (CCHP):

- Combines inverter-driven variable-speed compressor with newer technologies.
- CCHPs can operate down to -15°C or even as low as -30°C without significantly losing its capacity.
- CCHPs can meet higher heating demand, but they also come with higher installation costs.

Equipment Selection

All Electric Option and Dual Fuel/Hybrid Technologies

What are the main differences?

	All Electric	Dual Fuel/Hybrid
Primary Heat	Heat Pump	Heat Pump
Auxiliary Heat	Electric (COP 1 – 100% efficient)	Gas Backup (efficiency less than 100%)
Costs	Dependent on regional energy costs, equipment quality, capacity & efficiency	Dependent on regional energy costs, equipment quality, capacity & efficiency
GHG Emissions	Minimal (Depending on source, ie. Nuclear, Hydro, Natural Gas, Coal, etc.)	Can be significant depending on the amount of gas backup used.
Other Considerations	May require larger electric panel/service capacity	As auxiliary it is sized to full load, therefore can function as back-up heat if heat pump fails. Easier to connect to back-up generator

F280– What Have We Learned

01 F280 Load Calculations

- CSA F280 heat loss/gain analysis will right-size heating and cooling systems, improve comfort, and can reduce build cost. Getting accurate information in construction documents is critical to avoiding issues with improper equipment sizing.
- Code compliant F280-12 load calculations is the foundation on which all other HVAC decisions are dependent. Builders need to take ownership of their load calculations.

02 Equipment Selection

- Selecting appropriate equipment is a critical step in its own right and requires technical competence from an HVAC designer.
- Criteria for equipment options will include considerations for budget, product support, equipment performance specifications.

Industry transition to low-GWP refrigerants

Presented by: Jérémie Léger – Local Energy Efficiency Partnerships

CE-O's Low Global Warming Potential (GWP) Cold Climate Heat Pumps R&D Project

Technology development

Lifecycle analysis

Guides, tools, resource development

Contacts for more information:

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jeremie.sager@nrcan-rncan.gc.ca

Charles Mougeot
Charles.Mougeot@nrcan-rncan.gc.ca

What you need to know

2025 transition to new, lower-GWP refrigerants for heat pumps is coming

We are here

transitioning here

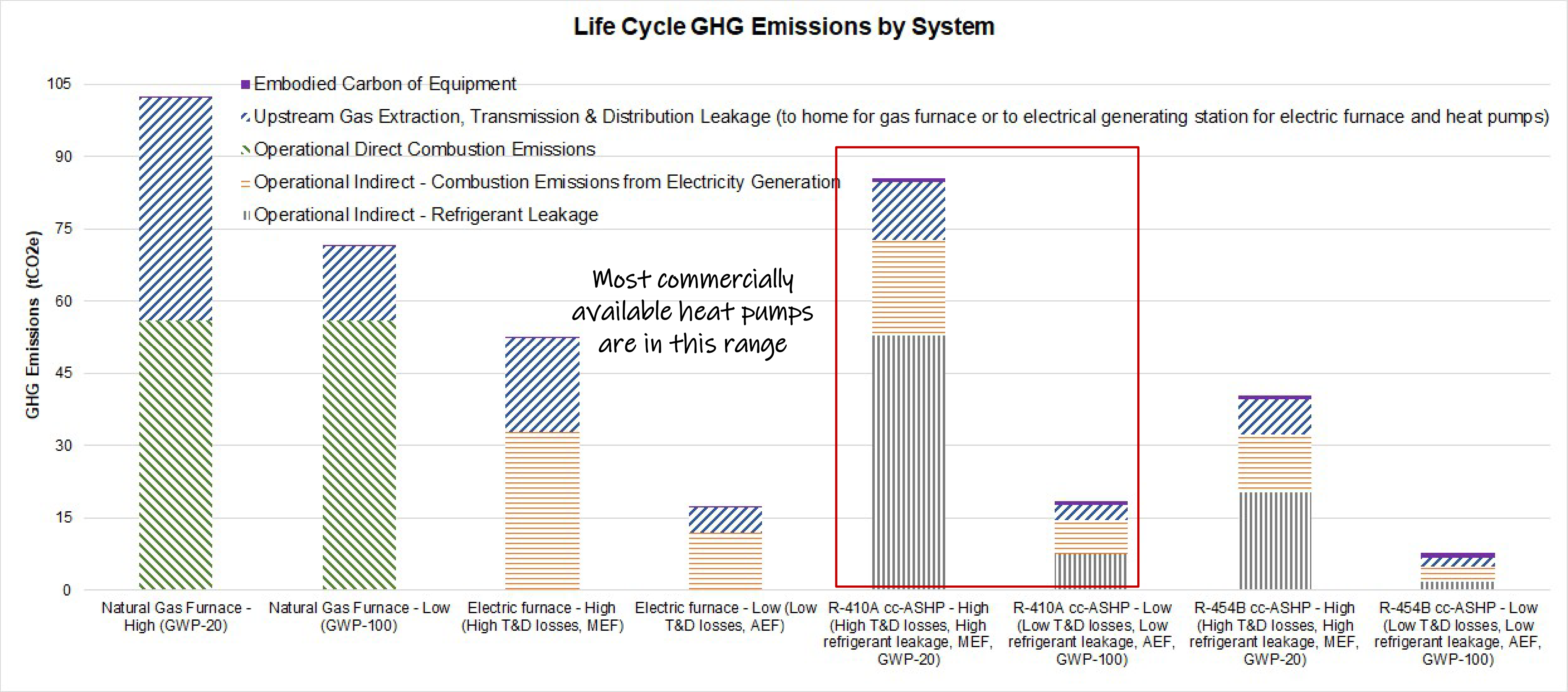
And eventually moving here

	GWP20	GWP100
R134a	3810	1360
R410A	4400	2100
R32	2530	704
R454B	1700	490
R290	1	1
R717	0	0
R744	1	1
R1234ze	4	1
R1234yf	1	1

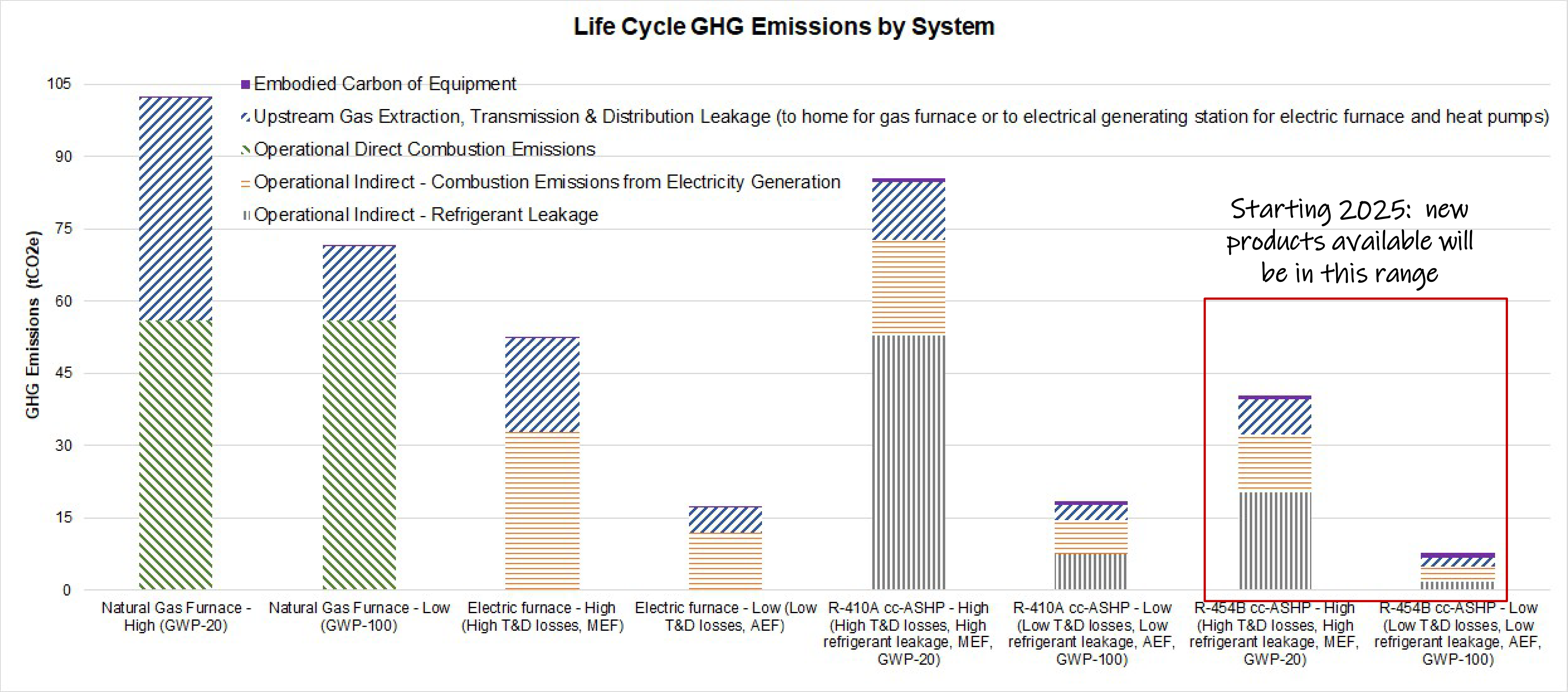
United Nations Environment Programme. *Montreal Protocol on the Substances That Deplete the Ozone Layer: 2018 Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Comittee*; United Nations: Geneva, Swietzerland, 2018.

The carbon footprint of most mechanical systems is operational carbon – leakage or combustion.

Note: Modeled using an archetype home at the CCHT Research Facility using Ottawa climate data

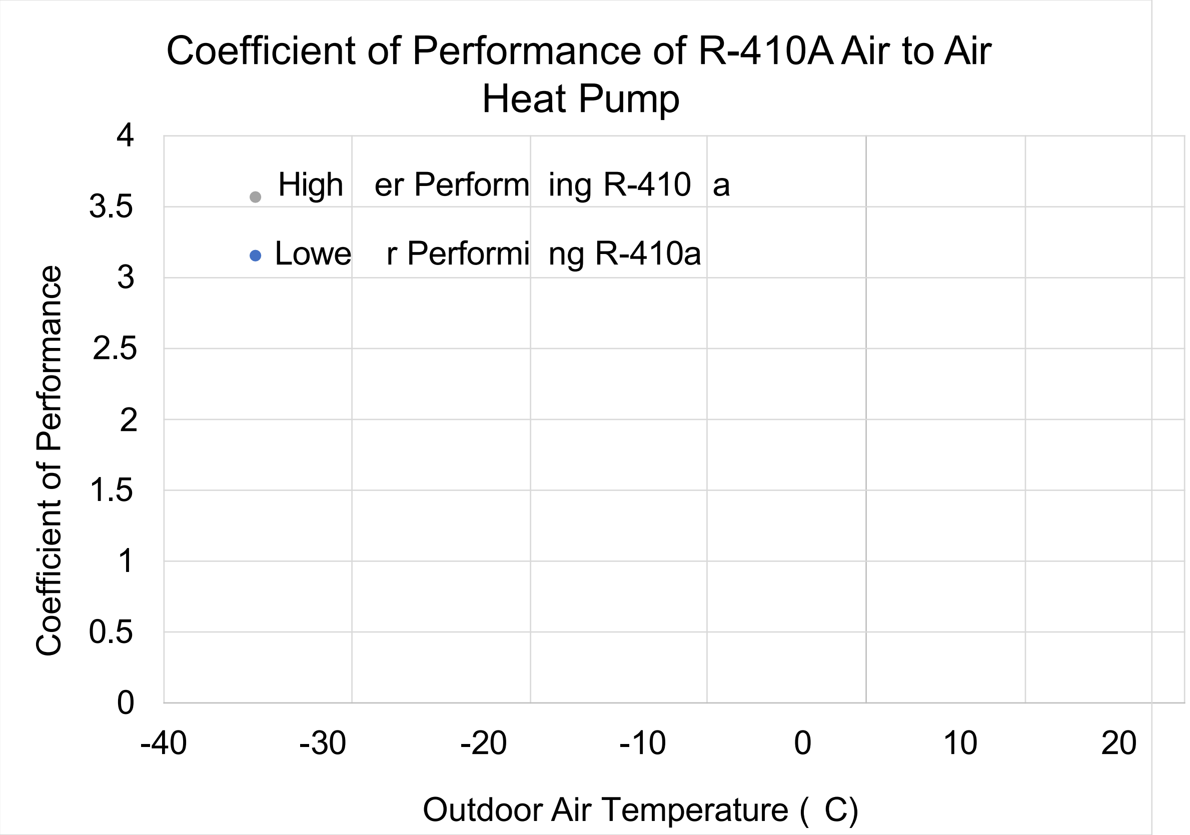


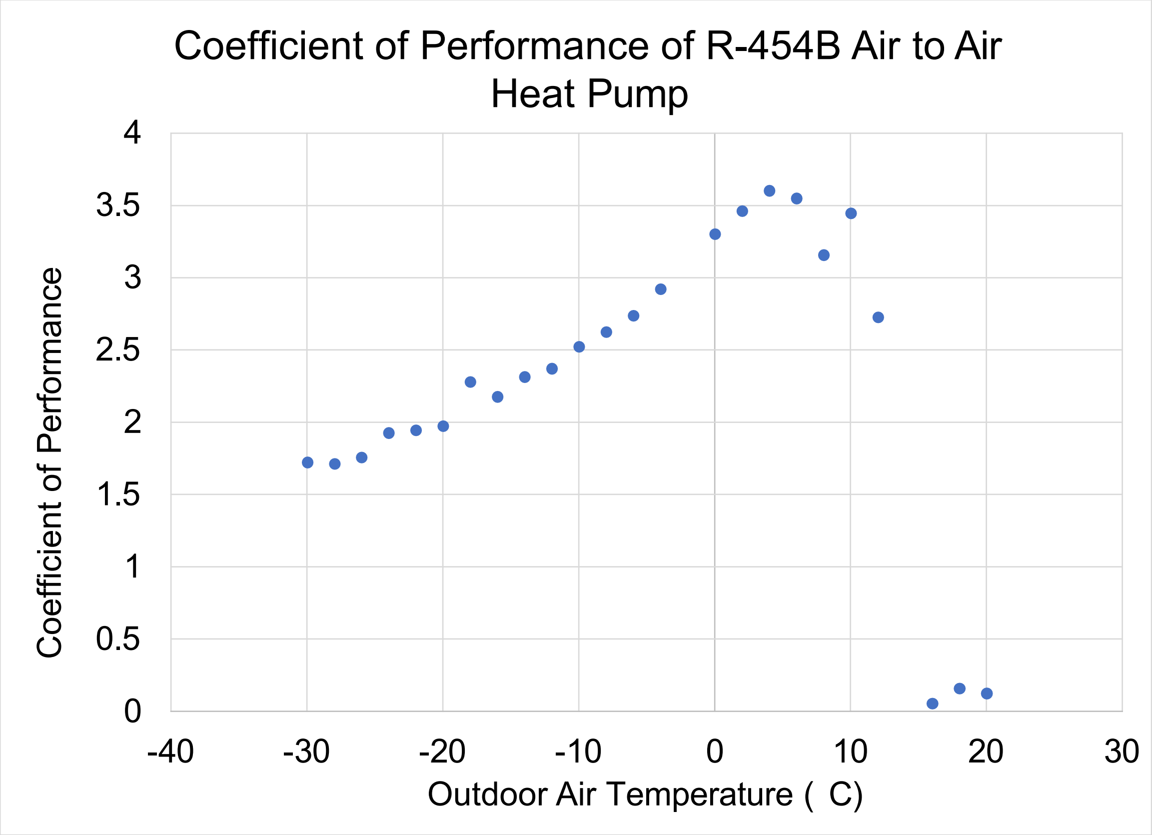
The transition to lower GWP refrigerants halves the operational carbon emissions of heat pumps



New refrigerant products demonstrated higher COPs in lab testing results

- Performance of two 10.6 kW (3 ton) cc-ASHPs evaluated during controlled field trial
- Developed detailed performance maps for systems that used R-410A and R-454B refrigerants





New Refrigerants is Good News!

1. CE-O labs have measured **higher COP**
2. **Colder operating temperature**
3. **Lower GWP** from leakage

Contacts for more information:

Jeremy Sager
jeremie.sager@nrcan-rncan.gc.ca

Charles Mougeot
Charles.Mougeot@nrcan-rncan.gc.ca

Envelopes and product availability

How do heating & cooling loads affect available heat pump options?

Knowing your Loads is Important for Design, but What About the Impact on Available Systems?

01 Does the heat loss and heat gain effect availability of heat pump?

02 Can we size smaller heat pumps to meet the full load?

03 How can the envelope packages be optimized to increase comfort and energy performance in relation with the available heat pumps

Why this is Important

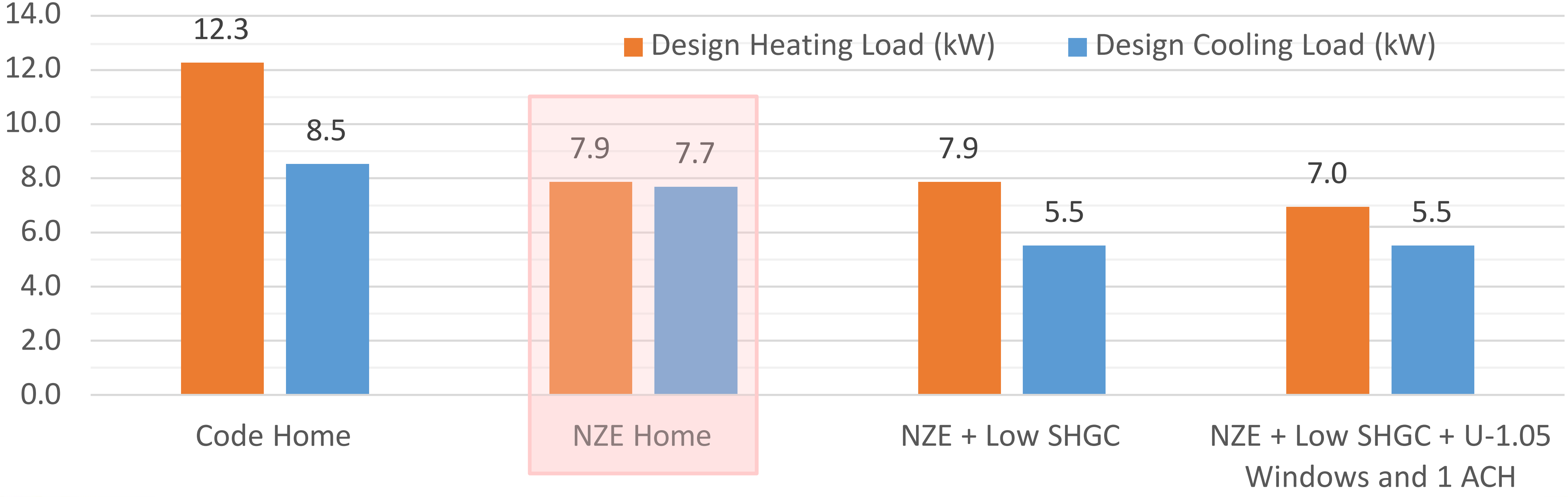
Install + Operating Cost

Energy Use

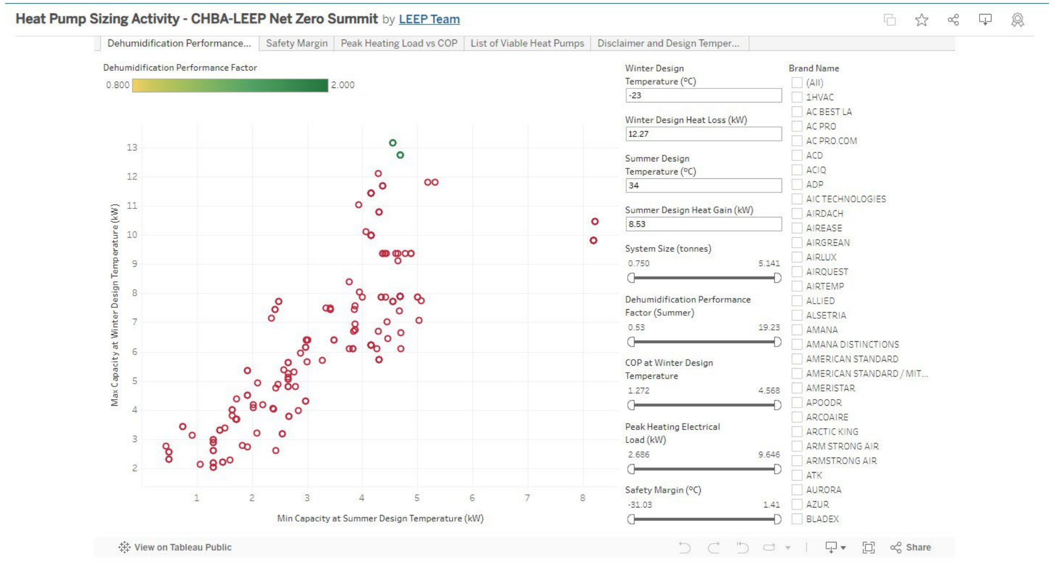
Greenhouse Gas Emissions

Achieving comfort

Using the Following Envelope Choices



Let’s use Newly Developed Heat Pump Tool to Navigate the NEEP Database



NEEP'S COLD CLIMATE AIR SOURCE
Heat Pump List

Can follow along using this tool (better on laptop or tablet)

For each envelope package we will…

- Model the packages by **updating the design heat loss and heat gain** in the tool
- Look at the following:
  - Number of **systems available**
  - **System size** (Tons)
  - Efficiency (**COP** at design temperature)
  - **Dehumidification performance** factor (ratio of cooling load to min cooling capacity)
- Use the tool filters to **find a good heat pump** for each case

slido

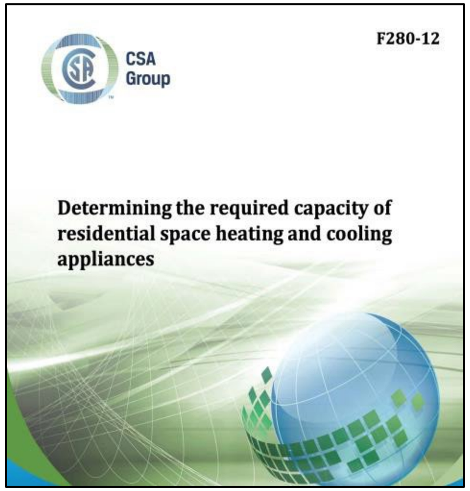
What typically limits your heat pump product selection and suitability?

ⓘ Start presenting to display the poll results on this slide.

Dehumidification Performance Factor

Ratio of Minimum Cooling Capacity to Design Heat Gain

Recommended range of sizing AC 80% to 125% of DHG

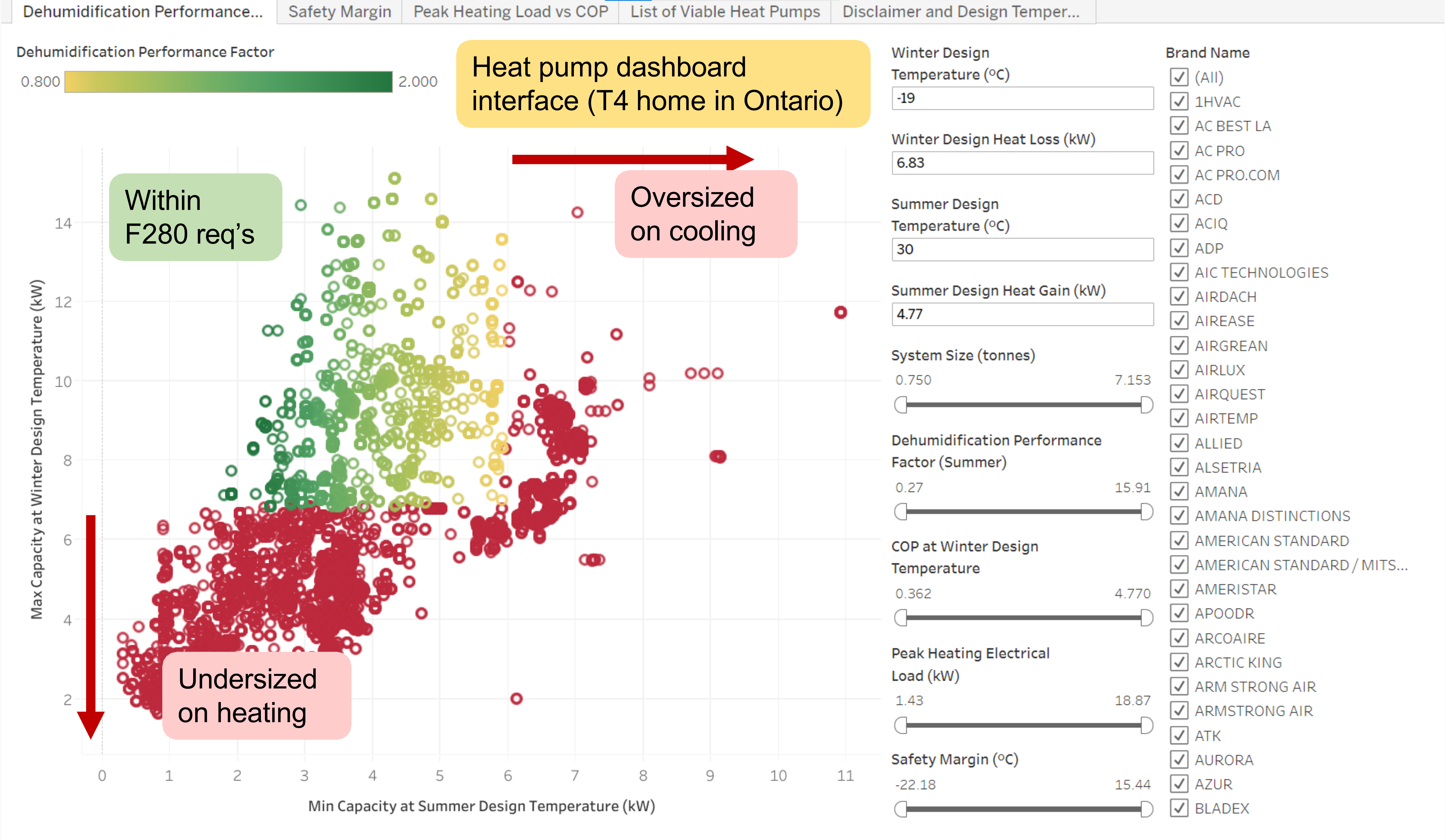

F280-12

CSA Group

Determining the required capacity of residential space heating and cooling appliances

Reminder: What happens if we oversize cooling

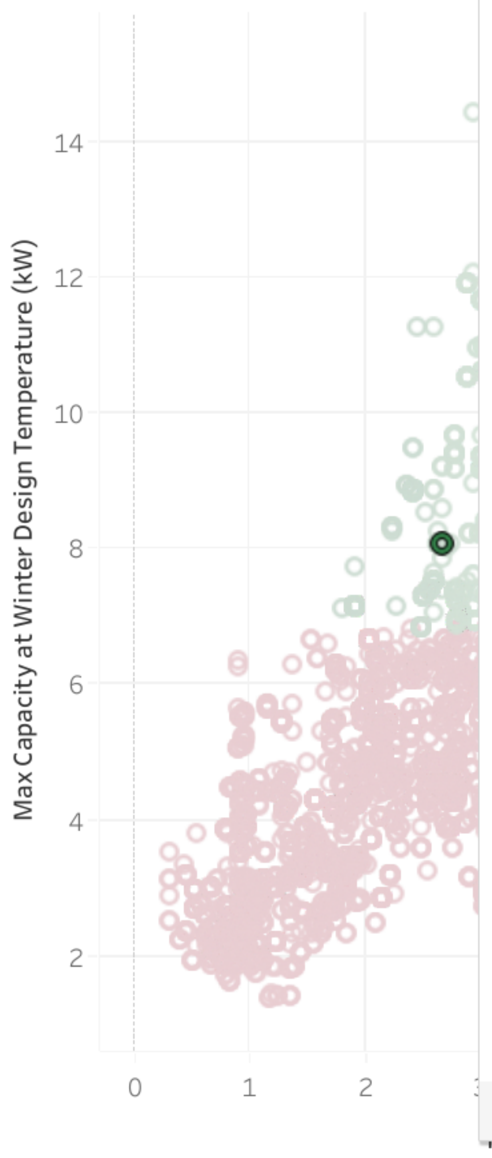
The higher DPF the better the dehumidification performance


Dehumidification Performance...
Safety Margin
Peak Heating Load vs COP
List of Viable Heat Pumps
Disclaimer and Design Temper...
Dehumidification Performance Factor
0.800
2.000
Heat pump dashboard interface (T4 home in Ontario)
Within F280 req's
Oversized on cooling
Undersized on heating
Max Capacity at Winter Design Temperature (kW)
Min Capacity at Summer Design Temperature (kW)
0
1
2
3
4
5
6
7
8
9
10
11
2
4
6
8
10
12
14
Winter Design Temperature (ºC)
-19
Winter Design Heat Loss (kW)
6.83
Summer Design Temperature (ºC)
30
Summer Design Heat Gain (kW)
4.77
System Size (tonnes)
0.750
7.153
Dehumidification Performance Factor (Summer)
0.27
15.91
COP at Winter Design Temperature
0.362
4.770
Peak Heating Electrical Load (kW)
1.43
18.87
Safety Margin (ºC)
-22.18
15.44
Brand Name
(All)
1HVAC
AC BEST LA
AC PRO
AC PRO.COM
ACD
ACIQ
ADP
AIC TECHNOLOGIES
AIRDACH
AIREASE
AIRGREAN
AIRLUX
AIRQUEST
AIRTEMP
ALLIED
ALSETRIA
AMANA
AMANA DISTINCTIONS
AMERICAN STANDARD
AMERICAN STANDARD / MITS...
AMERISTAR
APOODR
ARCOAIRE
ARCTIC KING
ARM STRONG AIR
ARMSTRONG AIR
ATK
AURORA
AZUR
BLADEX

Dehumidification Performance... | Sa... | ...sign Temper...

Dehumidification Performance Factor

0.800



AHRI Certified Reference Number: 207465458
Search here: https://ashp.neep.org/#!/product_list/

Specified Design Loads and Temperatures:

Winter Design Temperature (ºC):	-19
Winter Design Heat Loss (kW):	6.83
Summer Design Temperature (ºC):	30
Summer Design Heat Gain (kW):	4.77

Attributes (general):

HSPF (Region IV):	11.000
HSPF2 (Region IV):	8.40
HSPF2 (Region V):	7.00
SEER:	17.70
SEER2:	18.20
System Size (tons):	**2.833**
Minimum Duct Capacity (CFM at 0.8 in WC)*:	**1,133**

*(System size multiplied by 400 CFM/ton)

Attributes (function of design loads and temperatures):

Max Capacity at Winter Design Temperature (kW):	8.08
Min Capacity at Summer Design Temperature (kW):	2.66
Max Capacity at Summer Design Temperature (kW):	10.47
Dehumidification Performance Factor (Summer):	**1.79**
COP at Winter Design Temperature and Design Heat Loss:	**1.849**
Peak Heating Electrical Load at Winter Design Temperature and Design Heat Loss (kW):	**3.69**
Safety Margin (ºC)*:	**1.00**

***(Degrees below design temperature where supplemental heating is not needed)**

Safety Margin 2 (ºC)**: 1.00
**(Degrees below design temperature where heat pump will still operate)

Flags:

Outside of F280 or Minimum Temperature Constraints:	OK
Heating Capacity Flag:	OK
Cooling Min Capacity Flag:	OK
Cooling Max Capacity Flag:	OK
Minimum Temperature Flag:	OK

✓ Keep Only ⊘ Exclude

Each point is (at least one) HP, can hover to see specs and performance

...gn
...e (ºC)
...oss (kW)
...e (ºC)
...sign Heat Gain (kW)
... (tonnes)
7.153
...ation Performance
...mer)
15.91
...er Design
...e
4.770
...g Electrical
18.87
...in (ºC)
15.44

Brand Name

- ☑ (All)
- ☑ 1HVAC
- ☑ AC BEST LA
- ☑ AC PRO
- ☑ AC PRO.COM
- ☑ ACD
- ☑ ACIQ
- ☑ ADP
- ☑ AIC TECHNOLOGIES
- ☑ AIRDACH
- ☑ AIREASE
- ☑ AIRGREAN
- ☑ AIRLUX
- ☑ AIRQUEST
- ☑ AIRTEMP
- ☑ ALLIED
- ☑ ALSETRIA
- ☑ AMANA
- ☑ AMANA DISTINCTIONS
- ☑ AMERICAN STANDARD
- ☑ AMERICAN STANDARD / MITS...
- ☑ AMERISTAR
- ☑ APOODR
- ☑ ARCOAIRE
- ☑ ARCTIC KING
- ☑ ARM STRONG AIR
- ☑ ARMSTRONG AIR
- ☑ ATK
- ☑ AURORA
- ☑ AZUR
- ☑ BLADEX

Dehumidification Performance... | Safety Margin | Peak Heating Load vs COP | List of Viable Heat Pumps | Disclaimer and Design Temper...

Viable Heat Pumps

AHRI Certified Reference Number	Info Box
8654212	■
8693473	■
8693475	■
8693476	■
8693478	■
8693479	■
8693480	■
8693481	■
8796414	■
8908615	■
8908616	■
8912450	■
8912454	■
9962519	■
9962520	■
9962521	■
9962522	■
9962523	■
9962524	■
10070561	■
10147096	■
10147097	■
10271657	■
10271659	■
10445374	■
10445376	■
10445377	■
10514710	■
10514711	■

After filtering, can go to list of viable heat pumps (that can meet 100% of the loads) tab

Can compare all applicable systems, and/or do more filtering

Winter Design Temperature (ºC)
-19

Winter Design Heat Loss (kW)
6.83

Summer Design Temperature (ºC)
30

Summer Design Heat Gain (kW)
4.77

System Size (tonnes)
1.833 – 7.153

Dehumidification Performance Factor (Summer)
0.806 – 2.642

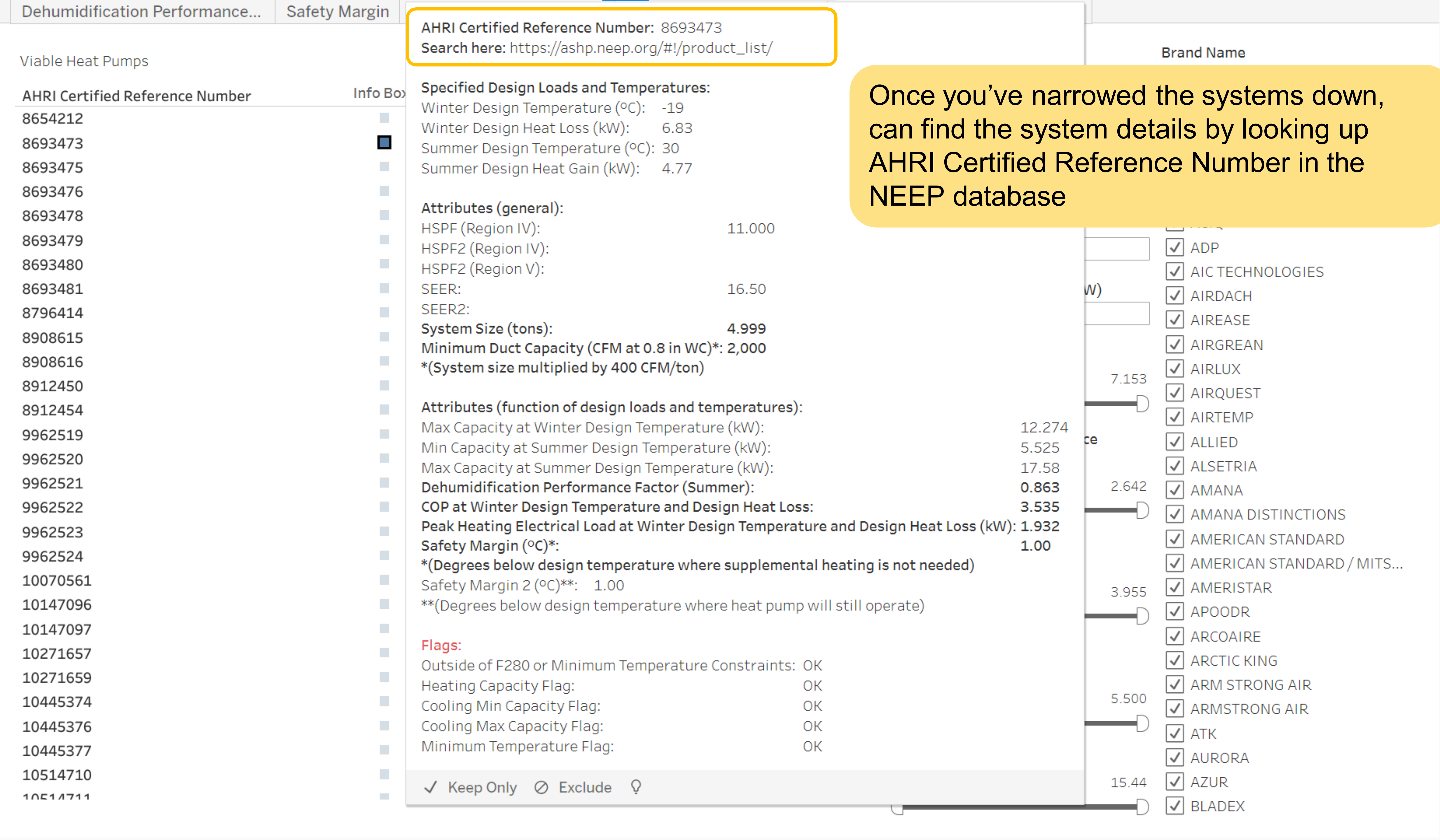
COP at Winter Design Temperature
1.242 – 3.955

Peak Heating Electrical Load (kW)
1.727 – 5.500

Safety Margin (ºC)
0.01 – 15.44

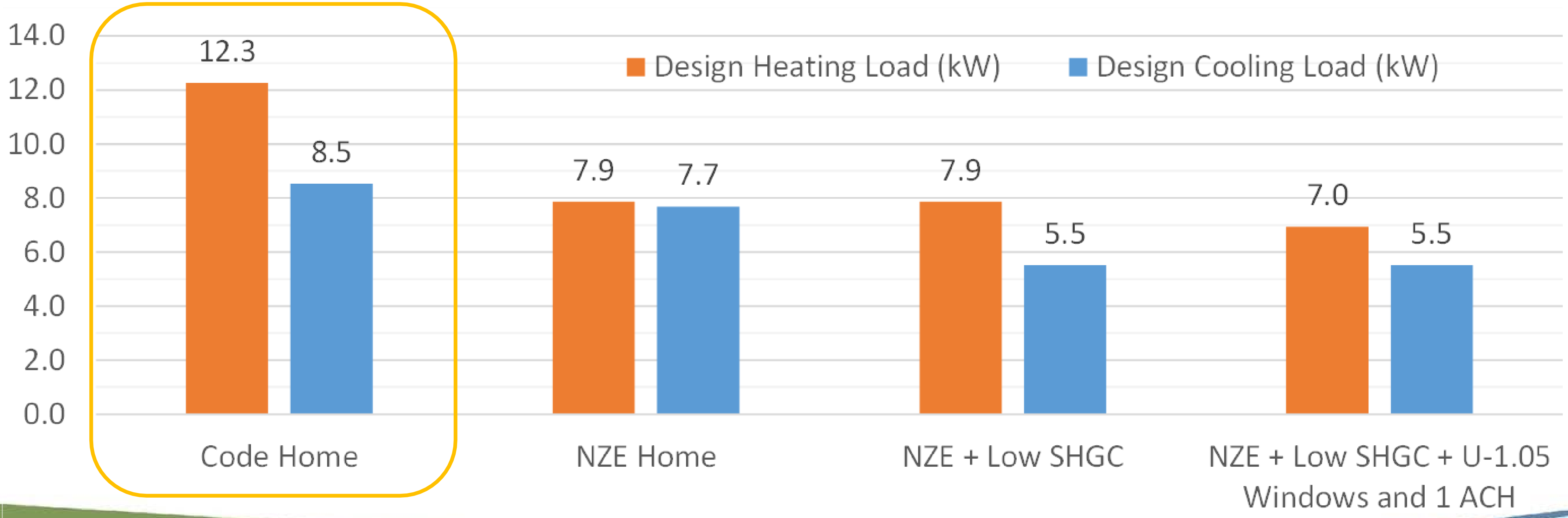
Brand Name
- ☑ (All)
- ☑ 1HVAC
- ☑ AC BEST LA
- ☑ AC PRO
- ☑ AC PRO.COM
- ☑ ACD
- ☑ ACIQ
- ☑ ADP
- ☑ AIC TECHNOLOGIES
- ☑ AIRDACH
- ☑ AIREASE
- ☑ AIRGREAN
- ☑ AIRLUX
- ☑ AIRQUEST
- ☑ AIRTEMP
- ☑ ALLIED
- ☑ ALSETRIA
- ☑ AMANA
- ☑ AMANA DISTINCTIONS
- ☑ AMERICAN STANDARD
- ☑ AMERICAN STANDARD / MITS...
- ☑ AMERISTAR
- ☑ APOODR
- ☑ ARCOAIRE
- ☑ ARCTIC KING
- ☑ ARM STRONG AIR
- ☑ ARMSTRONG AIR
- ☑ ATK
- ☑ AURORA
- ☑ AZUR
- ☑ BLADEX

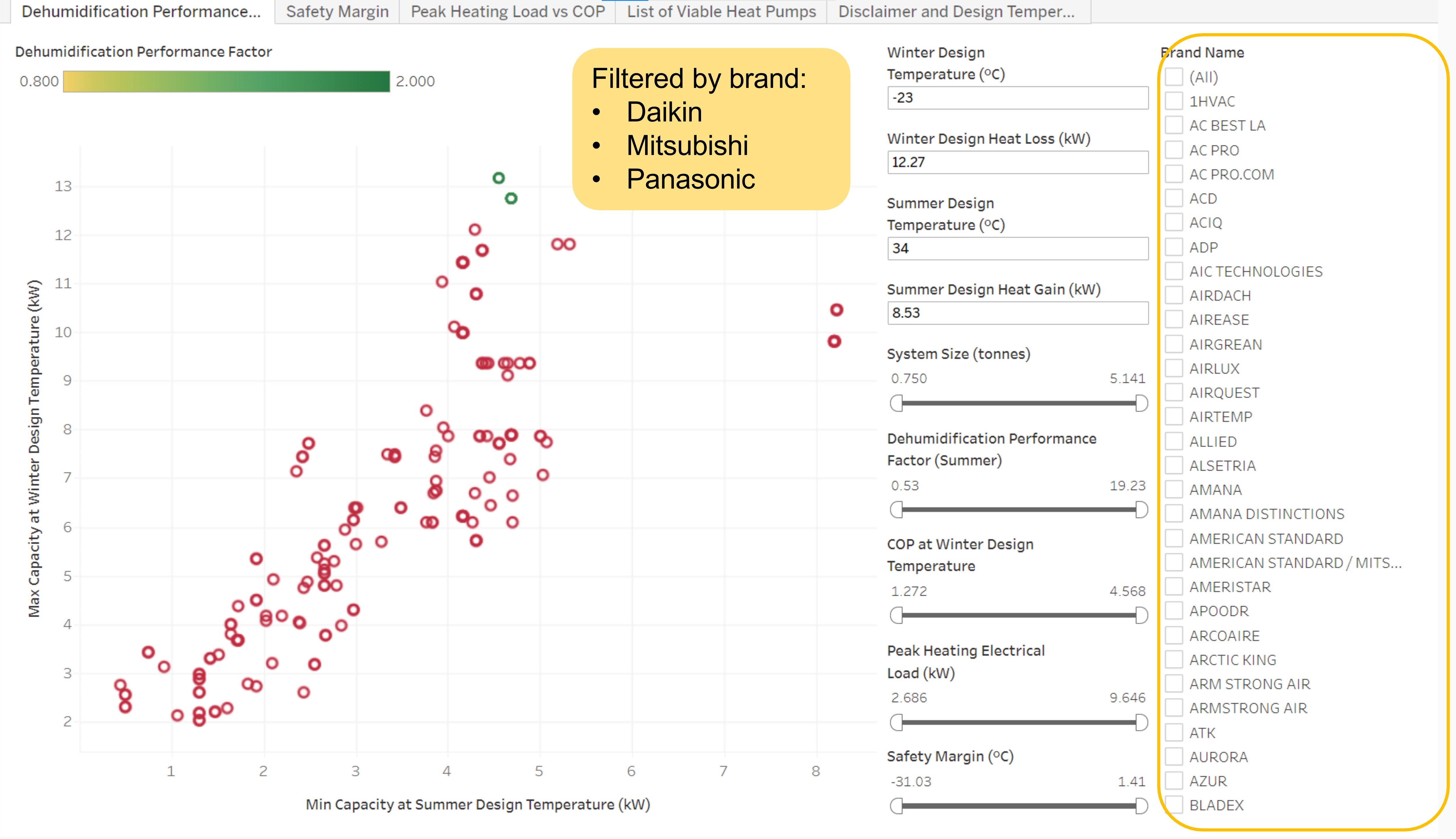
Once you've narrowed the systems down, can find the system details by looking up AHRI Certified Reference Number in the NEEP database



Case 1: Code home

- Heating Loads: 12.27 kW (41,900 BTU/h, 3.49 Tons)
- Cooling Loads: 8.53 kW (29,100 BTU/h, 2.42 Tons)





Dehumidification Performance...
Safety Margin
Peak Heating Load vs COP
List of Viable Heat Pumps
Disclaimer and Design Temper...
Dehumidification Performance Factor
0.800
2.000
Filtered by brand:
• Daikin
• Mitsubishi
• Panasonic
Max Capacity at Winter Design Temperature (kW)
13
12
11
10
9
8
7
6
5
4
3
2
1
2
3
4
5
6
7
8
Min Capacity at Summer Design Temperature (kW)
Winter Design Temperature (ºC)
-23
Winter Design Heat Loss (kW)
12.27
Summer Design Temperature (ºC)
34
Summer Design Heat Gain (kW)
8.53
System Size (tonnes)
0.750
5.141
Dehumidification Performance Factor (Summer)
0.53
19.23
COP at Winter Design Temperature
1.272
4.568
Peak Heating Electrical Load (kW)
2.686
9.646
Safety Margin (ºC)
-31.03
1.41
Brand Name
(All)
1HVAC
AC BEST LA
AC PRO
AC PRO.COM
ACD
ACIQ
ADP
AIC TECHNOLOGIES
AIRDACH
AIREASE
AIRGREAN
AIRLUX
AIRQUEST
AIRTEMP
ALLIED
ALSETRIA
AMANA
AMANA DISTINCTIONS
AMERICAN STANDARD
AMERICAN STANDARD / MITS...
AMERISTAR
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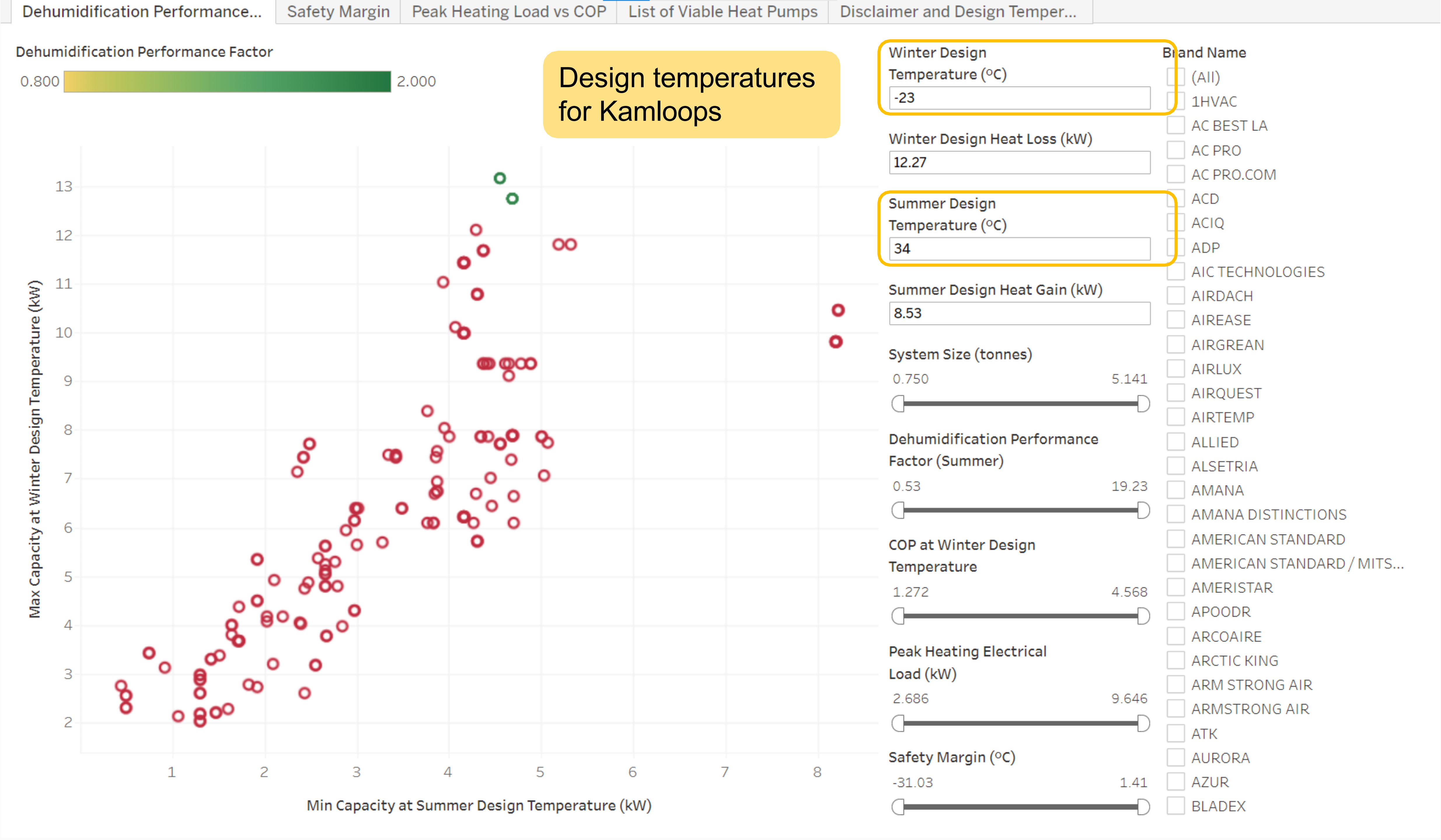
ARCOAIRE
ARCTIC KING
ARM STRONG AIR
ARMSTRONG AIR
ATK
AURORA
AZUR
BLADEX



Dehumidification Performance...
Safety Margin
Peak Heating Load vs COP
List of Viable Heat Pumps
Disclaimer and Design Temper...
Dehumidification Performance Factor
0.800
2.000
Design temperatures for Kamloops
Max Capacity at Winter Design Temperature (kW)
Min Capacity at Summer Design Temperature (kW)
13
12
11
10
9
8
7
6
5
4
3
2
1
2
3
4
5
6
7
8
Winter Design Temperature (ºC)
-23
Winter Design Heat Loss (kW)
12.27
Summer Design Temperature (ºC)
34
Summer Design Heat Gain (kW)
8.53
System Size (tonnes)
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Dehumidification Performance Factor (Summer)
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Brand Name
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AC BEST LA
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AIRLUX
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ALSETRIA
AMANA
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AMERICAN STANDARD
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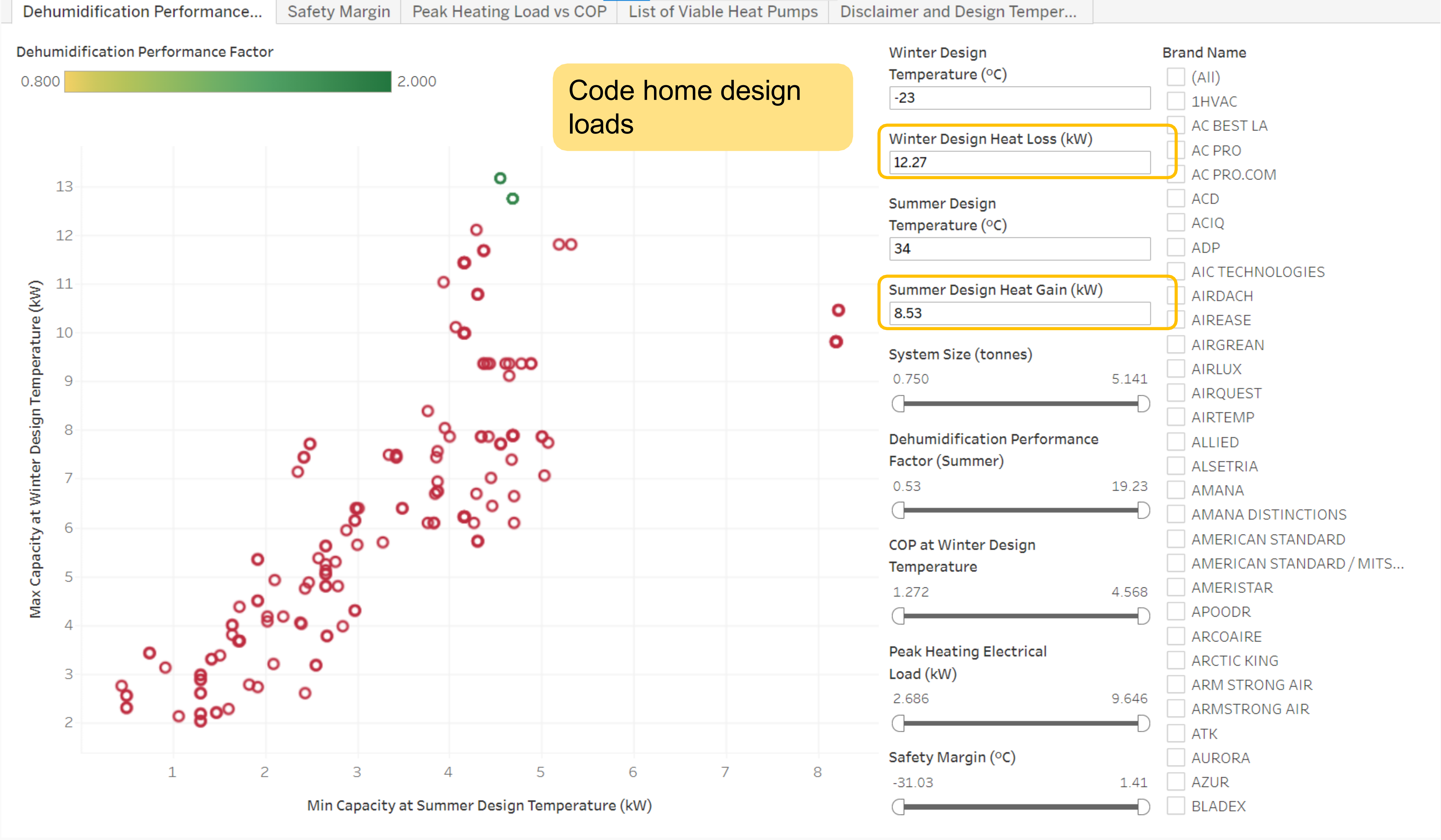
ARM STRONG AIR
ARMSTRONG AIR
ATK
AURORA
AZUR
BLADEX


Dehumidification Performance...
Safety Margin
Peak Heating Load vs COP
List of Viable Heat Pumps
Disclaimer and Design Temper...
Dehumidification Performance Factor
0.800
2.000
Code home design loads
Max Capacity at Winter Design Temperature (kW)
Min Capacity at Summer Design Temperature (kW)
Winter Design Temperature (ºC)
-23
Winter Design Heat Loss (kW)
12.27
Summer Design Temperature (ºC)
34
Summer Design Heat Gain (kW)
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5.141
Dehumidification Performance Factor (Summer)
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19.23
COP at Winter Design Temperature
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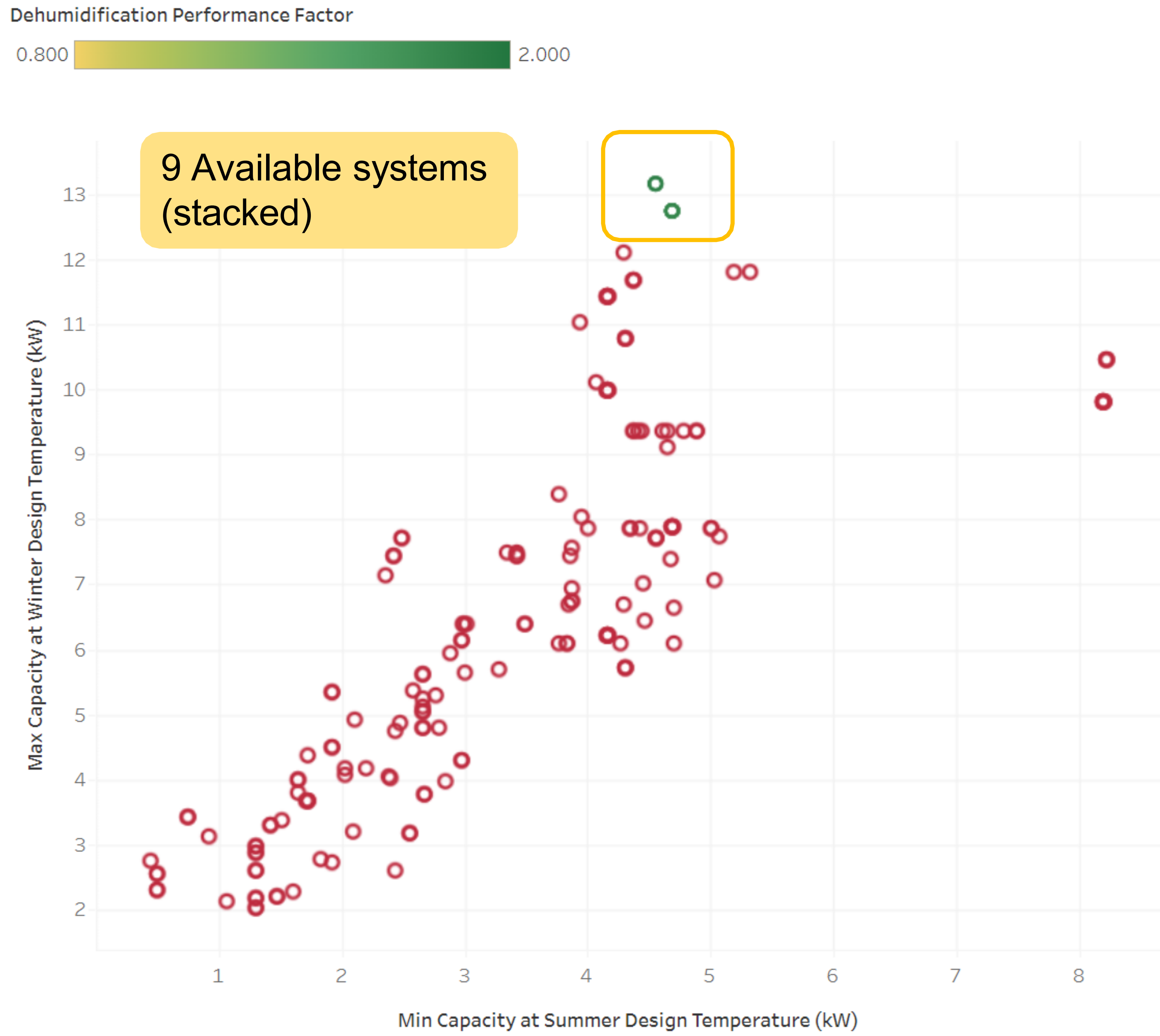
4.568
Peak Heating Electrical Load (kW)
2.686
9.646
Safety Margin (ºC)
-31.03
1.41
Brand Name
(All)
1HVAC
AC BEST LA
AC PRO
AC PRO.COM
ACD
ACIQ
ADP
AIC TECHNOLOGIES
AIRDACH
AIREASE
AIRGREAN
AIRLUX
AIRQUEST
AIRTEMP
ALLIED
ALSETRIA
AMANA
AMANA DISTINCTIONS
AMERICAN STANDARD
AMERICAN STANDARD / MITS...
AMERISTAR
APOODR
ARCOAIRE
ARCTIC KING
ARM STRONG AIR
ARMSTRONG AIR
ATK
AURORA
AZUR
BLADEX

Dehumidification Performance... | Safety Margin | Peak Heating Load vs COP | List of Viable Heat Pumps | Disclaimer and Design Temper...



Winter Design Temperature (ºC)
-23

Winter Design Heat Loss (kW)
12.27

Summer Design Temperature (ºC)
34

Summer Design Heat Gain (kW)
8.53

System Size (tonnes)
0.750 5.141

Dehumidification Performance Factor (Summer)
0.53 19.23

COP at Winter Design Temperature
1.272 4.568

Peak Heating Electrical Load (kW)
2.686 9.646

Safety Margin (ºC)
-31.03 1.41

Brand Name
- (All)
- 1HVAC
- AC BEST LA
- AC PRO
- AC PRO.COM
- ACD
- ACIQ
- ADP
- AIC TECHNOLOGIES
- AIRDACH
- AIREASE
- AIRGREAN
- AIRLUX
- AIRQUEST
- AIRTEMP
- ALLIED
- ALSETRIA
- AMANA
- AMANA DISTINCTIONS
- AMERICAN STANDARD
- AMERICAN STANDARD / MITS...
- AMERISTAR
- APOODR
- ARCOAIRE
- ARCTIC KING
- ARM STRONG AIR
- ARMSTRONG AIR
- ATK
- AURORA
- AZUR
- BLADEX

Dehumidification Performance... | Safety Margin | Peak Heating Load vs COP | List of Viable Heat Pumps | Disclaimer and Design Temper...

Viable Heat Pumps

AHRI Certified Reference Number	Info Box
207517158	■
207517159	■
207525858	■
211016458	■
211016459	■
211016460	■
211016654	■
211016655	■
211016662	■

- From the 9 similar systems available
  - No difference on system size
  - Minimal difference on dehumidification performance
  - Only significant difference is on COP
- Let's maximize the COP

Winter Design Temperature (ºC)
-23

Winter Design Heat Loss (kW)
12.27

Summer Design Temperature (ºC)
34

Summer Design Heat Gain (kW)
8.53

System Size (tonnes)
4.000 4.000

Dehumidification Performance Factor (Summer)
1.81902 1.87286

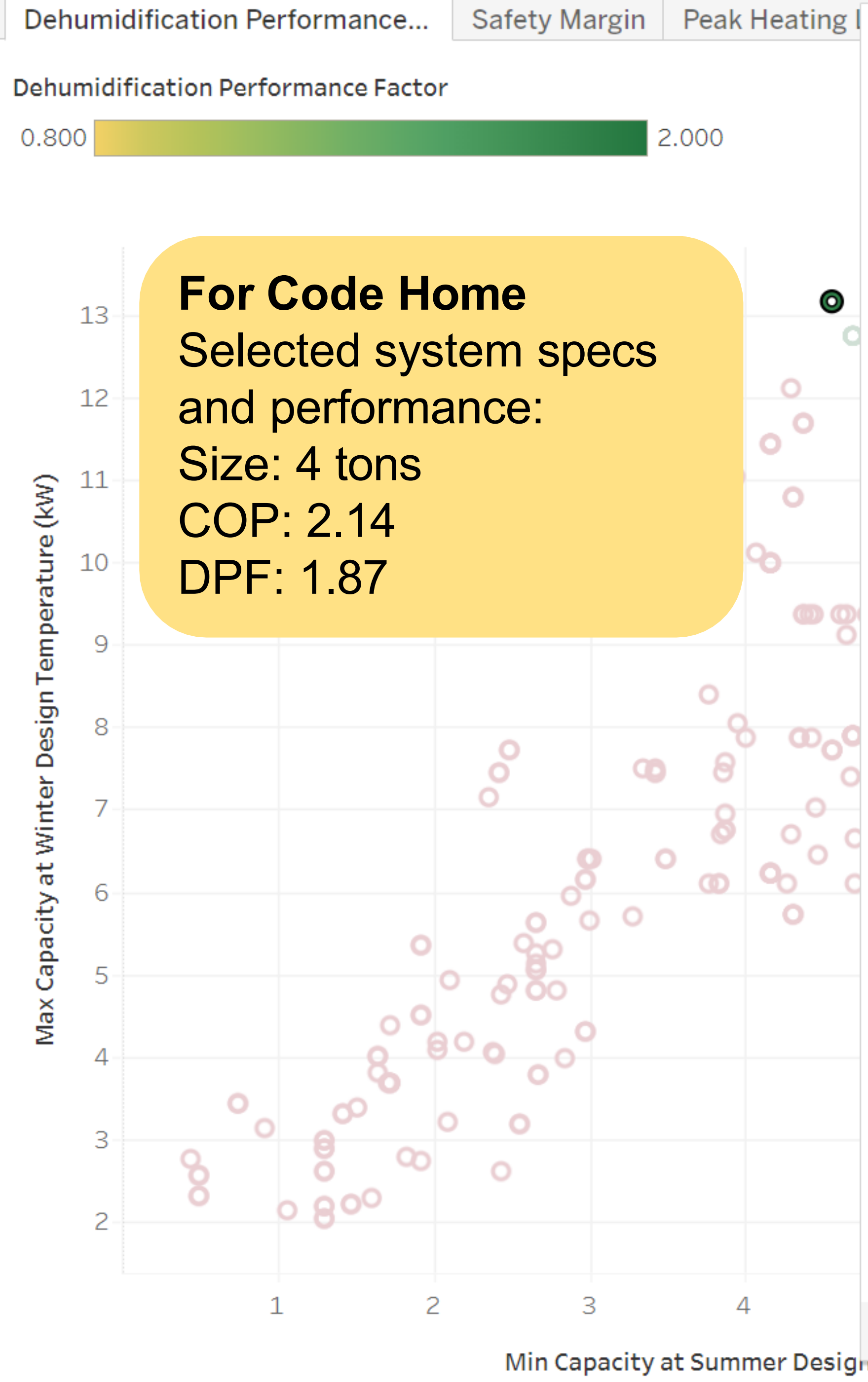
COP at Winter Design Temperature
1.4995 2.1433

Peak Heating Electrical Load (kW)
5.725 8.183

Safety Margin (ºC)
1.1052 1.4089

Brand Name
- (All)
- 1HVAC
- AC BEST LA
- AC PRO
- AC PRO.COM
- ACD
- ACIQ
- ADP
- AIC TECHNOLOGIES
- AIRDACH
- AIREASE
- AIRGREAN
- AIRLUX
- AIRQUEST
- AIRTEMP
- ALLIED
- ALSETRIA
- AMANA
- AMANA DISTINCTIONS
- AMERICAN STANDARD
- AMERICAN STANDARD / MITS...
- AMERISTAR
- APOODR
- ARCOAIRE
- ARCTIC KING
- ARM STRONG AIR
- ARMSTRONG AIR
- ATK
- AURORA
- AZUR
- BLADEX

For Code Home
Selected system specs and performance:
Size: 4 tons
COP: 2.14
DPF: 1.87



AHRI Certified Reference Number: 207517158
Search here: https://ashp.neep.org/#!/product_list/

Specified Design Loads and Temperatures:
Winter Design Temperature (ºC): -23.00
Winter Design Heat Loss (kW): 12.27
Summer Design Temperature (ºC): 34.00
Summer Design Heat Gain (kW): 8.530

Attributes (general):

HSPF (Region IV):	12.000
HSPF2 (Region IV):	11.500
HSPF2 (Region V):	
SEER:	23.00
SEER2:	23.00
System Size (tons):	**4.000**
Minimum Duct Capacity (CFM at 0.8 in WC)*:	**1,600**

***(System size multiplied by 400 CFM/ton)**

Attributes (function of design loads and temperatures):

Max Capacity at Winter Design Temperature (kW):	13.16
Min Capacity at Summer Design Temperature (kW):	4.55
Max Capacity at Summer Design Temperature (kW):	14.07
Dehumidification Performance Factor (Summer):	**1.87**
COP at Winter Design Temperature and Design Heat Loss:	**2.143**
Peak Heating Electrical Load at Winter Design Temperature and Design Heat Loss (kW):	**5.725**
Safety Margin (ºC)*:	**1.41**

***(Degrees below design temperature where supplemental heating is not needed)**
Safety Margin 2 (ºC)**: 2.00
**(Degrees below design temperature where heat pump will still operate)

Flags:

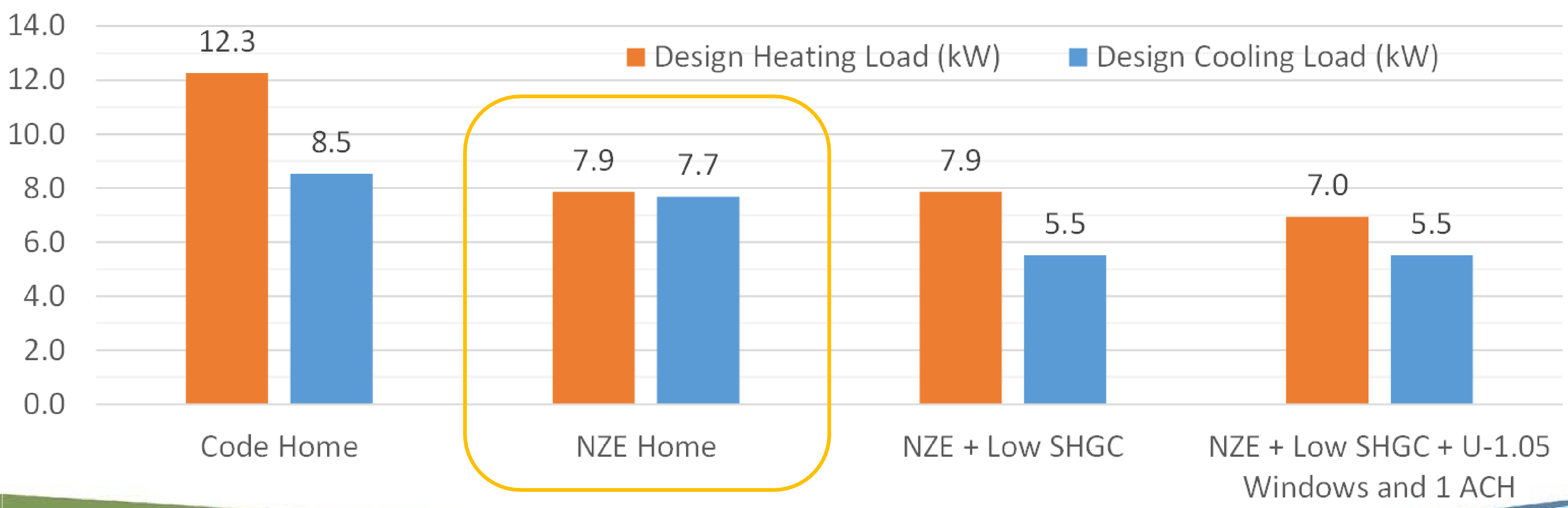
Outside of F280 or Minimum Temperature Constraints:	OK
Heating Capacity Flag:	OK
Cooling Min Capacity Flag:	OK
Cooling Max Capacity Flag:	OK
Minimum Temperature Flag:	OK

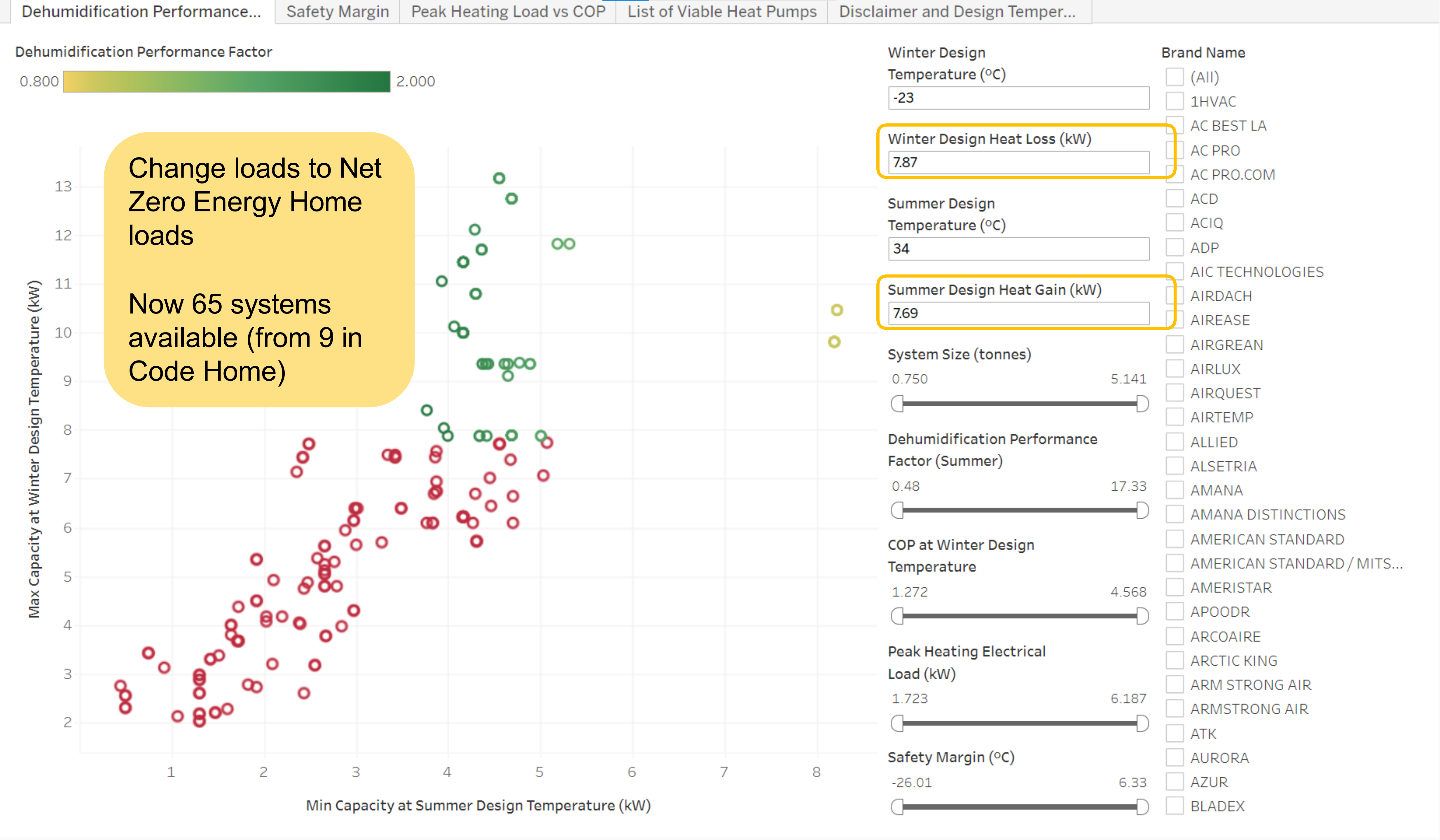
✓ Keep Only ⊘ Exclude

nd Name
(All)
1HVAC
AC BEST LA
AC PRO
AC PRO.COM
ACD
ACIQ
ADP
AIC TECHNOLOGIES
AIRDACH
AIREASE
AIRGREAN
AIRLUX
AIRQUEST
AIRTEMP
ALLIED
ALSETRIA
AMANA
AMANA DISTINCTIONS
AMERICAN STANDARD
AMERICAN STANDARD / MITS...
AMERISTAR
APOODR
ARCOAIRE
ARCTIC KING
ARM STRONG AIR
ARMSTRONG AIR
ATK
AURORA
AZUR
BLADEX

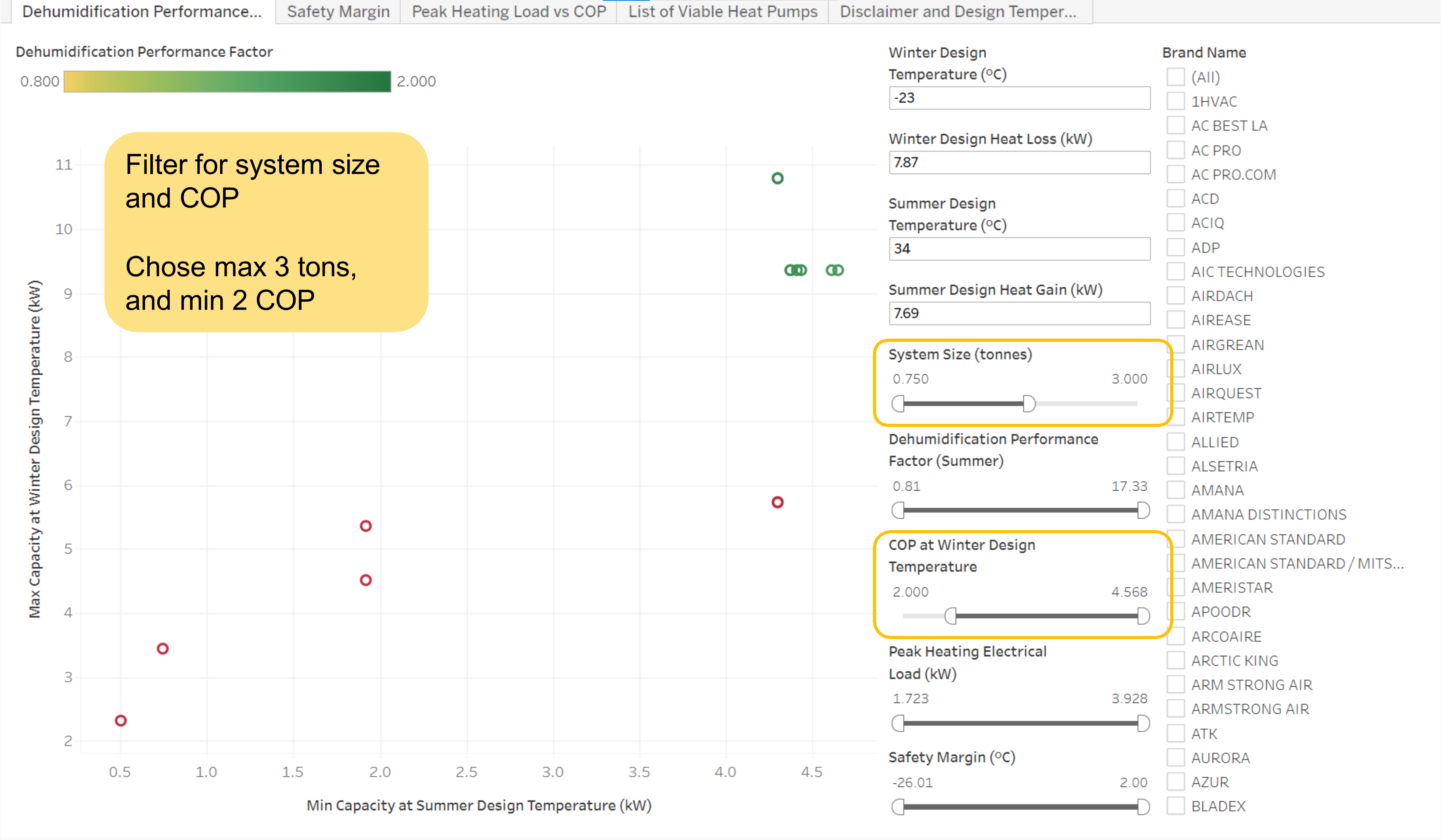
Case 2: Net Zero Energy Home

- Heating Loads: 7.87 kW (26,900 BTU/h, 2.24 Tons)
- Cooling Loads: 7.69 kW (26,200 BTU/h, 2.19 Tons)





Dehumidification Performance...
Safety Margin
Peak Heating Load vs COP
List of Viable Heat Pumps
Disclaimer and Design Temper...
Dehumidification Performance Factor
0.800
2.000
Change loads to Net Zero Energy Home loads
Now 65 systems available (from 9 in Code Home)
Max Capacity at Winter Design Temperature (kW)
Min Capacity at Summer Design Temperature (kW)
Winter Design Temperature (ºC)
-23
Winter Design Heat Loss (kW)
7.87
Summer Design Temperature (ºC)
34
Summer Design Heat Gain (kW)
7.69
System Size (tonnes)
0.750
5.141
Dehumidification Performance Factor (Summer)
0.48
17.33
COP at Winter Design Temperature
1.272
4.568
Peak Heating Electrical Load (kW)
1.723
6.187
Safety Margin (ºC)
-26.01
6.33
Brand Name
(All)
1HVAC
AC BEST LA
AC PRO
AC PRO.COM
ACD
ACIQ
ADP
AIC TECHNOLOGIES
AIRDACH
AIREASE
AIRGREAN
AIRLUX
AIRQUEST
AIRTEMP
ALLIED
ALSETRIA
AMANA
AMANA DISTINCTIONS
AMERICAN STANDARD
AMERICAN STANDARD / MITS...
AMERISTAR
APOODR
ARCOAIRE
ARCTIC KING
ARM STRONG AIR
ARMSTRONG AIR
ATK
AURORA
AZUR
BLADEX



Dehumidification Performance...
Safety Margin
Peak Heating Load vs COP
List of Viable Heat Pumps
Disclaimer and Design Temper...
Dehumidification Performance Factor
0.800
2.000
Filter for system size and COP
Chose max 3 tons, and min 2 COP
Max Capacity at Winter Design Temperature (kW)
Min Capacity at Summer Design Temperature (kW)
Winter Design Temperature (ºC)
-23
Winter Design Heat Loss (kW)
7.87
Summer Design Temperature (ºC)
34
Summer Design Heat Gain (kW)
7.69
System Size (tonnes)
0.750
3.000
Dehumidification Performance Factor (Summer)
0.81
17.33
COP at Winter Design Temperature
2.000
4.568
Peak Heating Electrical Load (kW)
1.723
3.928
Safety Margin (ºC)
-26.01
2.00
Brand Name
(All)
1HVAC
AC BEST LA
AC PRO
AC PRO.COM
ACD
ACIQ
ADP
AIC TECHNOLOGIES
AIRDACH
AIREASE
AIRGREAN
AIRLUX
AIRQUEST
AIRTEMP
ALLIED
ALSETRIA
AMANA
AMANA DISTINCTIONS
AMERICAN STANDARD
AMERICAN STANDARD / MITS...
AMERISTAR
APOODR
ARCOAIRE
ARCTIC KING
ARM STRONG AIR
ARMSTRONG AIR
ATK
AURORA
AZUR
BLADEX

Dehumidification Performance... | Safety Margin | Peak Heating Load vs COP | List of Viable Heat Pumps | Disclaimer and Design Temper...

Viable Heat Pumps

AHRI Certified Reference Number	Info Box
207517152	■
207517153	■
207525855	■
207702691	■
211259275	■
211259276	■
211259278	■
211259279	■
211497055	■

- Now we can further:
  - Reduce system size
  - Improve dehumidification performance factor
  - Or Improve COP
- Since the COP modifications have a larger impact, chose to improve COP

Winter Design Temperature (ºC)
-23

Winter Design Heat Loss (kW)
7.87

Summer Design Temperature (ºC)
34

Summer Design Heat Gain (kW)
7.69

System Size (tonnes)
2.8330 3.0000

Dehumidification Performance Factor (Summer)
1.6540 1.7885

COP at Winter Design Temperature
2.0000 2.4070

Peak Heating Electrical Load (kW)
3.2696 3.9283

Safety Margin (ºC)
2.000 2.000

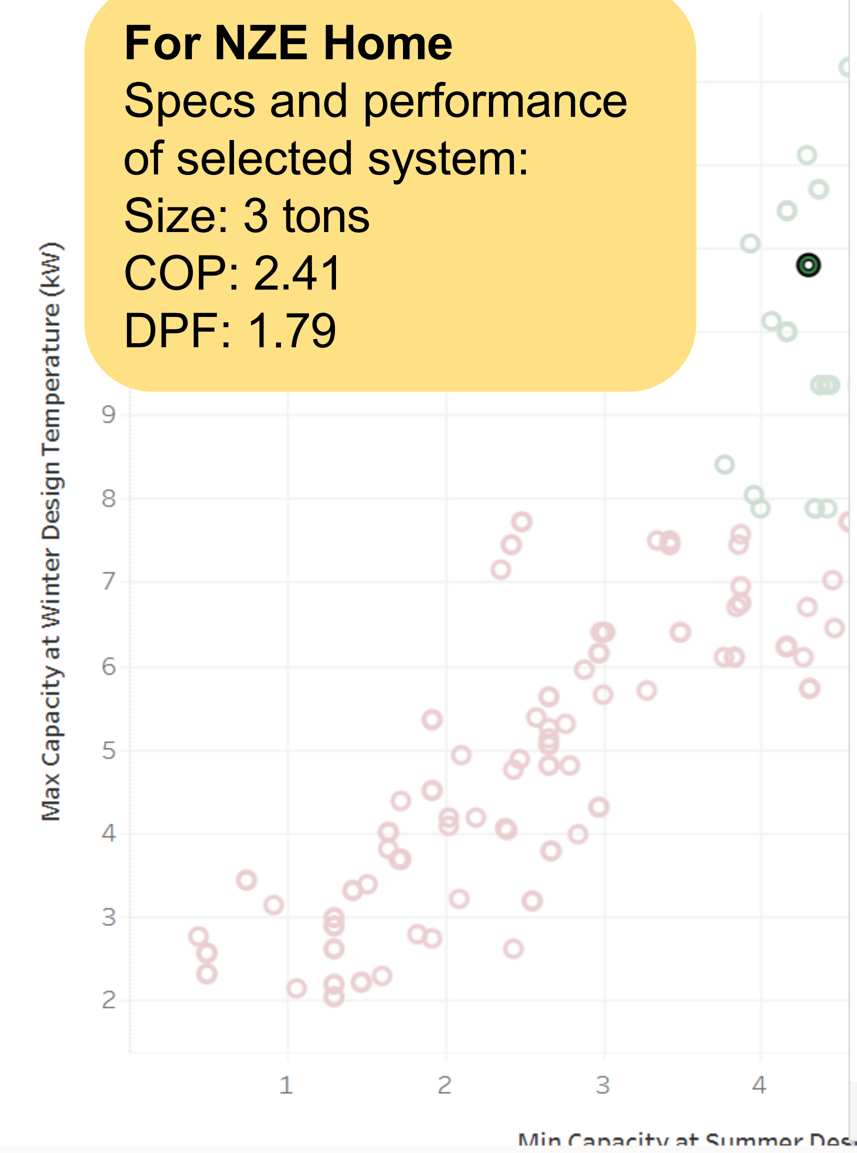
Brand Name
- (All)
- 1HVAC
- AC BEST LA
- AC PRO
- AC PRO.COM
- ACD
- ACIQ
- ADP
- AIC TECHNOLOGIES
- AIRDACH
- AIREASE
- AIRGREAN
- AIRLUX
- AIRQUEST
- AIRTEMP
- ALLIED
- ALSETRIA
- AMANA
- AMANA DISTINCTIONS
- AMERICAN STANDARD
- AMERICAN STANDARD / MITS...
- AMERISTAR
- APOODR
- ARCOAIRE
- ARCTIC KING
- ARM STRONG AIR
- ARMSTRONG AIR
- ATK
- AURORA
- AZUR
- BLADEX

Dehumidification Performance... | Safety Margin | Peak Heatin

Dehumidification Performance Factor

0.800 – 2.000

For NZE Home
Specs and performance of selected system:
Size: 3 tons
COP: 2.41
DPF: 1.79



AHRI Certified Reference Number: 207517152
Search here: https://ashp.neep.org/#!/product_list/

Specified Design Loads and Temperatures:

Winter Design Temperature (ºC):	-23.00
Winter Design Heat Loss (kW):	7.870
Summer Design Temperature (ºC):	34.00
Summer Design Heat Gain (kW):	7.690

Attributes (general):

HSPF (Region IV):	12.500
HSPF2 (Region IV):	12.000
HSPF2 (Region V):	
SEER:	23.00
SEER2:	23.00
System Size (tons):	**3.000**
Minimum Duct Capacity (CFM at 0.8 in WC)*:	**1,200**

*(System size multiplied by 400 CFM/ton)

Attributes (function of design loads and temperatures):

Max Capacity at Winter Design Temperature (kW):	10.79
Min Capacity at Summer Design Temperature (kW):	4.30
Max Capacity at Summer Design Temperature (kW):	10.55
Dehumidification Performance Factor (Summer):	**1.79**
COP at Winter Design Temperature and Design Heat Loss:	**2.407**
Peak Heating Electrical Load at Winter Design Temperature and Design Heat Loss (kW):	**3.270**
Safety Margin (ºC)*:	**2.00**

*(Degrees below design temperature where supplemental heating is not needed)

Safety Margin 2 (ºC)**: 2.00

**(Degrees below design temperature where heat pump will still operate)

Flags:

Outside of F280 or Minimum Temperature Constraints:	OK
Heating Capacity Flag:	OK
Cooling Min Capacity Flag:	OK
Cooling Max Capacity Flag:	OK
Minimum Temperature Flag:	OK

✓ Keep Only ⊘ Exclude

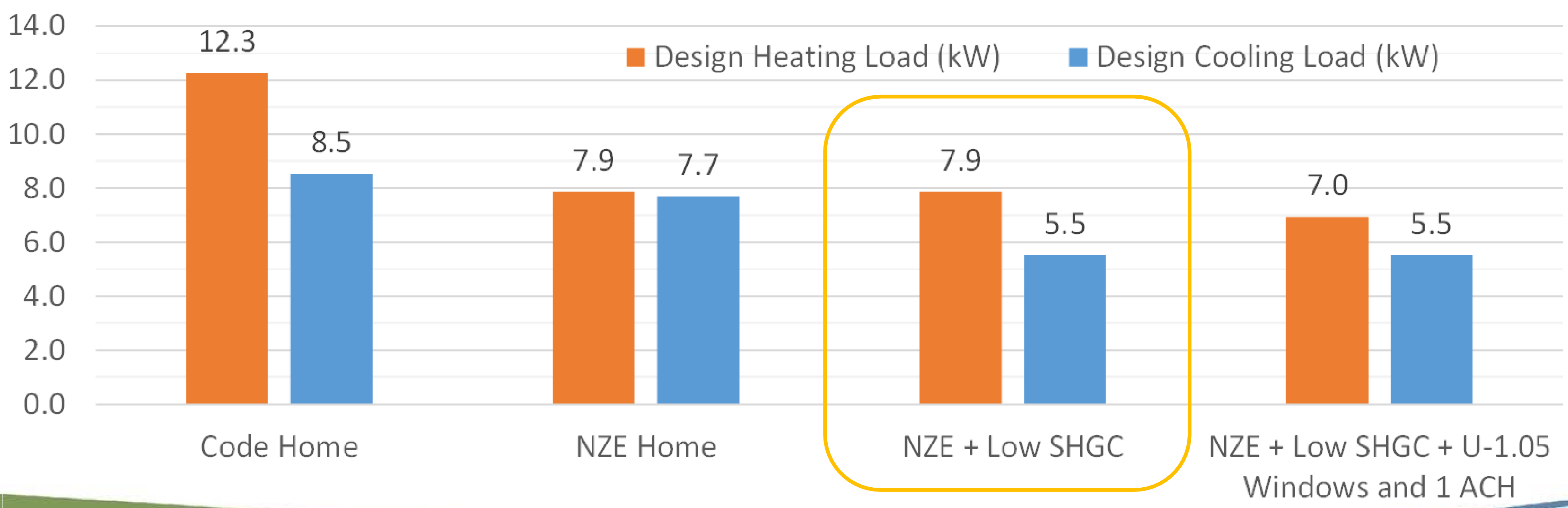
Brand Name

- AIRLUX
- AIRQUEST
- AIRTEMP
- ALLIED
- ALSETRIA
- AMANA
- AMANA DISTINCTIONS
- AMERICAN STANDARD
- AMERICAN STANDARD / MITS...
- AMERISTAR
- APOODR
- ARCOAIRE
- ARCTIC KING
- ARM STRONG AIR
- ARMSTRONG AIR
- ATK
- AURORA
- AZUR
- BLADEX
- BLUERIDGE
- BOREAL
- BOSCH
- BREEZE33
- BRYANT
- BRYANT HEATING AND COOLI...
- C&H
- CANAIR
- CARRIER
- CENTURY
- CHAMPION HEATING AND CO...

View on Tableau Public

Case 3: NZE Home + Low SHGC

- Reducing SHGC from 0.6 to 0.3 for resilience and comfort purposes
- Cooling Loads reduced to: 5.52 kW (18,800 BTU/h, 1.57 Tons)



For NZE Home with Low SHGC

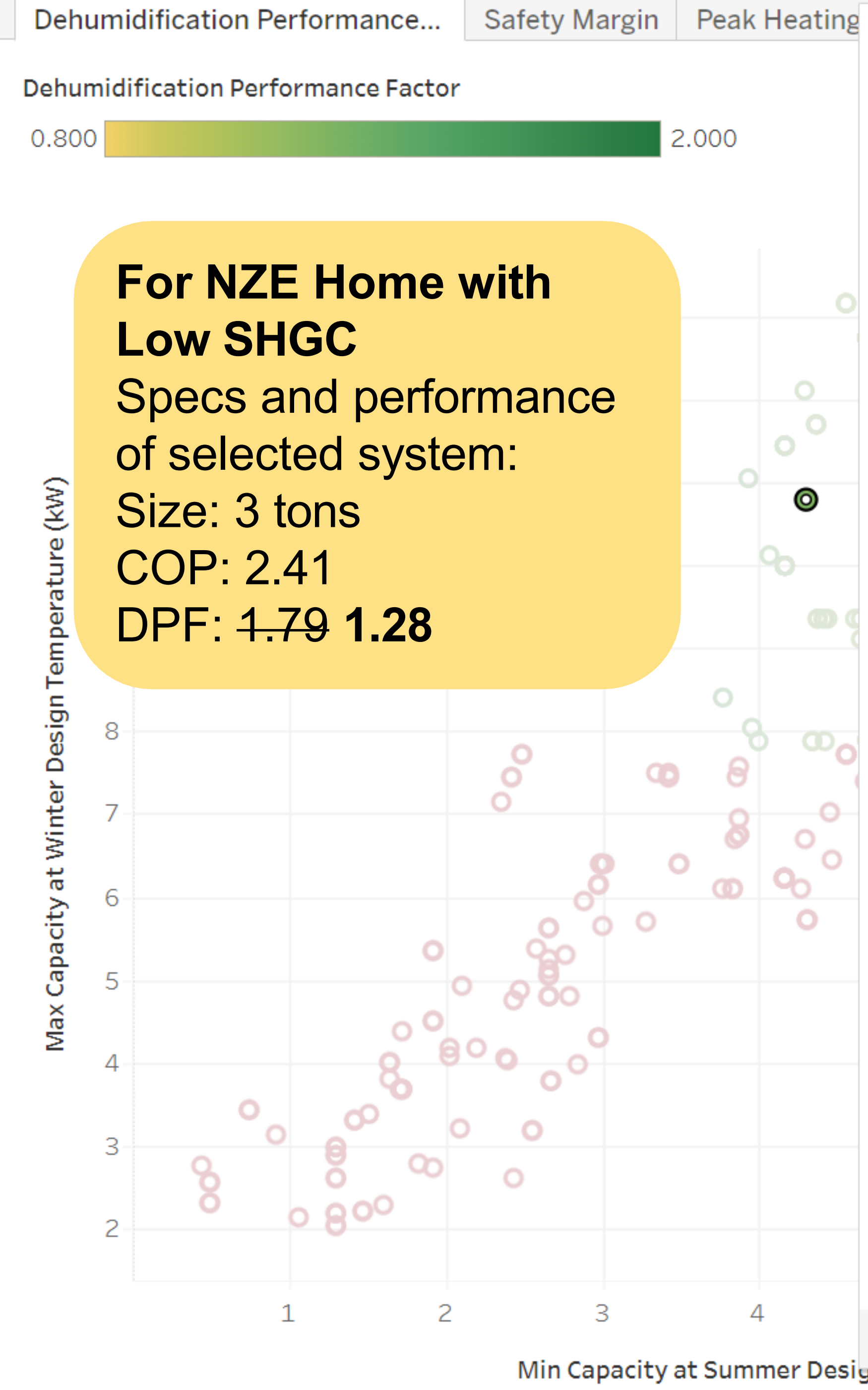
Specs and performance of selected system:

Size: 3 tons

COP: 2.41

DPF: ~~1.79~~ **1.28**

Same system as previous!



AHRI Certified Reference Number: 207517152

Search here: https://ashp.neep.org/#!/product_list/

Specified Design Loads and Temperatures:

Winter Design Temperature (ºC):	-23.00
Winter Design Heat Loss (kW):	7.870
Summer Design Temperature (ºC):	34.00
Summer Design Heat Gain (kW):	5.520

Attributes (general):

HSPF (Region IV):	12.500
HSPF2 (Region IV):	12.000
HSPF2 (Region V):	
SEER:	23.00
SEER2:	23.00
System Size (tons):	**3.000**
Minimum Duct Capacity (CFM at 0.8 in WC)*:	**1,200**

*(System size multiplied by 400 CFM/ton)

Attributes (function of design loads and temperatures):

Max Capacity at Winter Design Temperature (kW):	10.79
Min Capacity at Summer Design Temperature (kW):	4.30
Max Capacity at Summer Design Temperature (kW):	10.55
Dehumidification Performance Factor (Summer):	**1.28**
COP at Winter Design Temperature and Design Heat Loss:	**2.407**
Peak Heating Electrical Load at Winter Design Temperature and Design Heat Loss (kW):	**3.270**
Safety Margin (ºC)*:	**2.00**

*(Degrees below design temperature where supplemental heating is not needed)

Safety Margin 2 (ºC)**: 2.00

**(Degrees below design temperature where heat pump will still operate)

Flags:

Outside of F280 or Minimum Temperature Constraints:	OK
Heating Capacity Flag:	OK
Cooling Min Capacity Flag:	OK
Cooling Max Capacity Flag:	OK
Minimum Temperature Flag:	OK

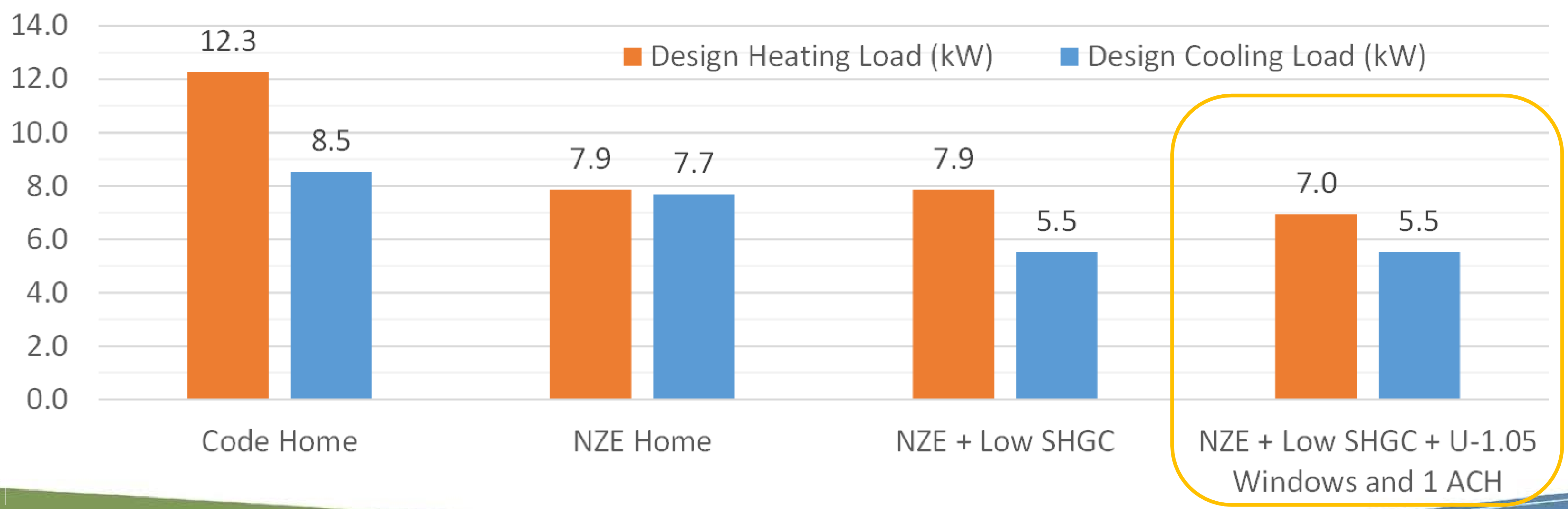
✓ Keep Only ⊘ Exclude

and Name

- (All)
- 1HVAC
- AC BEST LA
- AC PRO
- AC PRO.COM
- ACD
- ACIQ
- ADP
- AIC TECHNOLOGIES
- AIRDACH
- AIREASE
- AIRGREAN
- AIRLUX
- AIRQUEST
- AIRTEMP
- ALLIED
- ALSETRIA
- AMANA
- AMANA DISTINCTIONS
- AMERICAN STANDARD
- AMERICAN STANDARD / MITS...
- AMERISTAR
- APOODR
- ARCOAIRE
- ARCTIC KING
- ARM STRONG AIR
- ARMSTRONG AIR
- ATK
- AURORA
- AZUR
- BLADEX

Case 4: NZE + Low SHGC + Improved Envelope

- Upgrading windows (U-1.05 from U-1.4), and airtightness (1 ACH from 1.5 ACH)
- Heating Loads reduced to: 6.95 kW (23700 BTU/h, 1.98 Tons)



Dehumidification Performance... | Safety Margin | Peak Heat

Dehumidification Performance Factor

0.800 — 2.000

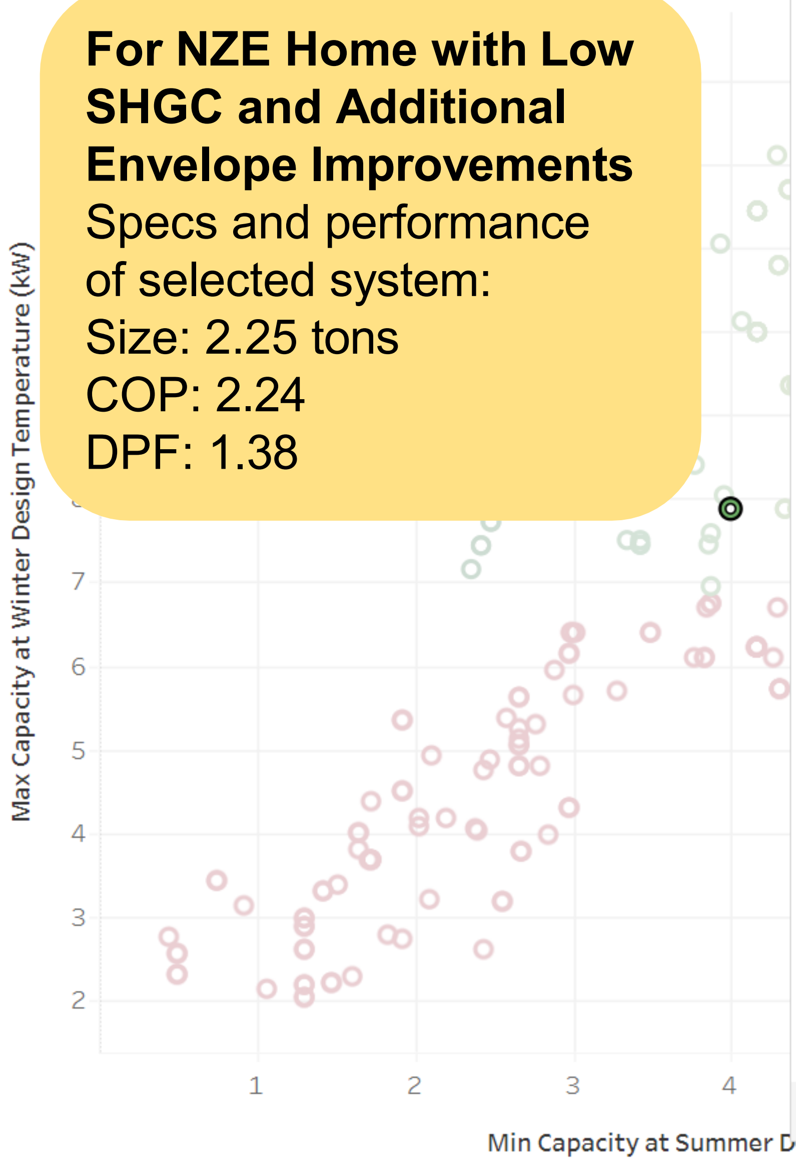
For NZE Home with Low SHGC and Additional Envelope Improvements

Specs and performance of selected system:

Size: 2.25 tons

COP: 2.24

DPF: 1.38



AHRI Certified Reference Number: 211273652
Search here: https://ashp.neep.org/#!/product_list/

Specified Design Loads and Temperatures:

Winter Design Temperature (°C):	-23.00
Winter Design Heat Loss (kW):	6.950
Summer Design Temperature (°C):	34.00
Summer Design Heat Gain (kW):	5.520

Attributes (general):

HSPF (Region IV):	9.000
HSPF2 (Region IV):	8.500
HSPF2 (Region V):	7.200
SEER:	15.00
SEER2:	15.20
System Size (tons):	**2.250**
Minimum Duct Capacity (CFM at 0.8 in WC)*:	**900**

*(System size multiplied by 400 CFM/ton)

Attributes (function of design loads and temperatures):

Max Capacity at Winter Design Temperature (kW):	7.88
Min Capacity at Summer Design Temperature (kW):	4.00
Max Capacity at Summer Design Temperature (kW):	8.03
Dehumidification Performance Factor (Summer):	**1.38**
COP at Winter Design Temperature and Design Heat Loss:	**2.237**
Peak Heating Electrical Load at Winter Design Temperature and Design Heat Loss (kW):	**3.107**
Safety Margin (°C)*:	**2.00**

***(Degrees below design temperature where supplemental heating is not needed)**

Safety Margin 2 (°C)**: 2.00

**(Degrees below design temperature where heat pump will still operate)

Flags:

Outside of F280 or Minimum Temperature Constraints:	OK
Heating Capacity Flag:	OK
Cooling Min Capacity Flag:	OK
Cooling Max Capacity Flag:	OK
Minimum Temperature Flag:	OK

✓ Keep Only ⊘ Exclude

Brand Name

- (All)
- 1HVAC
- AC BEST LA
- AC PRO
- AC PRO.COM
- ACD
- ACIQ
- ADP
- AIC TECHNOLOGIES
- AIRDACH
- AIREASE
- AIRGREAN
- AIRLUX
- AIRQUEST
- AIRTEMP
- ALLIED
- ALSETRIA
- AMANA
- AMANA DISTINCTIONS
- AMERICAN STANDARD
- AMERICAN STANDARD / MITS...
- AMERISTAR
- APOODR
- ARCOAIRE
- ARCTIC KING
- ARM STRONG AIR
- ARMSTRONG AIR
- ATK
- AURORA
- AZUR
- BLADEX

How did the envelope selection effect HP selections?

House Envelope Efficiency Level	Number of heat pumps meeting loads (#)	System Size (tons)	Duct Size (CFM)	COP at Winter Design Temperature	Dehumidification Performance Factor
Code	9	4.00	1600	2.14	1.87
NZE	65	3.00	1200	2.41	1.79
NZE + Low SHGC	56	3.00	1200	2.41	1.28
NZE + Low SHGC + U-1.05 Windows and 1 ACH	75	2.25	900	2.24	1.38

How did the envelope selection effect HP selections?

House Envelope Efficiency Level	Number of heat pumps meeting loads (#)	System Size (tons)	Duct Size (CFM)	COP at Winter Design Temperature	Dehumidification Performance Factor
Code	9	**4.00**	**1600**	2.14	1.87
NZE	65	**3.00**	**1200**	2.41	1.79
NZE + Low SHGC	56	**3.00**	**1200**	2.41	1.28
NZE + Low SHGC + U-1.05 Windows and 1 ACH	75	**2.25**	**900**	2.24	1.38

How did the envelope selection effect HP selections?

House Envelope Efficiency Level	Number of heat pumps meeting loads (#)	System Size (tons)	Duct Size (CFM)	COP at Winter Design Temperature	Dehumidification Performance Factor
Code	9	4.00	1600	2.14	**1.87**
NZE	65	3.00	1200	2.41	**1.79**
NZE + Low SHGC	56	3.00	1200	2.41	**1.28**
NZE + Low SHGC + U-1.05 Windows and 1 ACH	75	2.25	900	2.24	**1.38**

Key takeaways

01 Lowering heating loads of the house provides more heat pump options

Net zero envelop performance is well position for heat pump use
High-capacity heat pump are more expensive and require bigger ductwork

02 Matching heating and cooling loads helps to get good summer and winter performance for heat pumps

Its easier to design one system for two matching loads rather than two separate loads
Keep in mind that high solar heat gain can have negative contribution to comfort

03 Not all systems are equal in dehumidification performance

System if good turndown ratio will outperform system with system unable to operate in low-capacity cooling

Let's revisit…

Step	Current	Interested to explore
1	**Discovery:** barriers, challenges & pain points	
2	**Configuration**: centrally ducted system, hybrid install	
3	**Sizing approach**: Emphasis on cooling	
4	**Supply outlet approach:** perimeter supply	
5	**Duct Sizing**: low velocity	
6	**Choose Zoning**: single zone	
7	**Return Duct design:** traditional return design	
8	**Duct Sealing**: base level sealing	
9	**F280 HL/HG:** Work with HVAC contractor to complete F280 calculations	
10	**Heat pump selection**: HP does not meet full load, furnace backup	
11	**Utility rates/controls**: Backup only below TBP	
12	**Dehumidification controls**: not implemented/not designed	
13	GHG, cost, energy outcomes	

Canada

Natural Resources Canada
Ressources naturelles Canada

Control Strategies for Heat Pumps

Strategies for optimising cost, GHG and energy

June 10, 2024 – Vancouver

Rob Pope – Ecolighten Energy Solutions

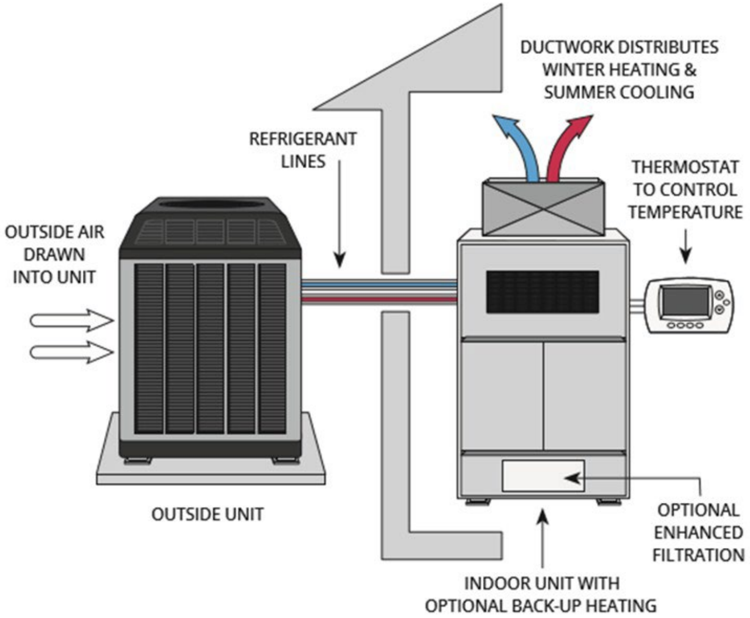
Canada

Heat Pump – Auxiliary Heat

ALL ELECTRIC - 2 POSSIBILITIES

1. Heat pump is **sized for full load** and has the capacity to run continuously over its full operating range throughout design conditions

2. Heat pump is **sized to a portion of the load** and requires auxiliary **electric heat**
   - Auxiliary heater added below the thermal balance point as needed to meet the load
   - Auxiliary heater can operate simultaneously in conjunction with the heat pump
   - Heat Pump switch-over runs according to one of the control options to be discussed.



Heat Pump – Auxiliary Heat

NATURAL GAS (Dual Fuel or Hybrid)

1. Heat pump is sized to a portion of the load and requires auxiliary **natural gas** heat
    - The heat pump is turned off when auxiliary gas starts
    - Heat pump and auxiliary do not run simultaneously, only one or the other at any given time
    - Heat Pump switch-over runs according to one of the control options to be discussed

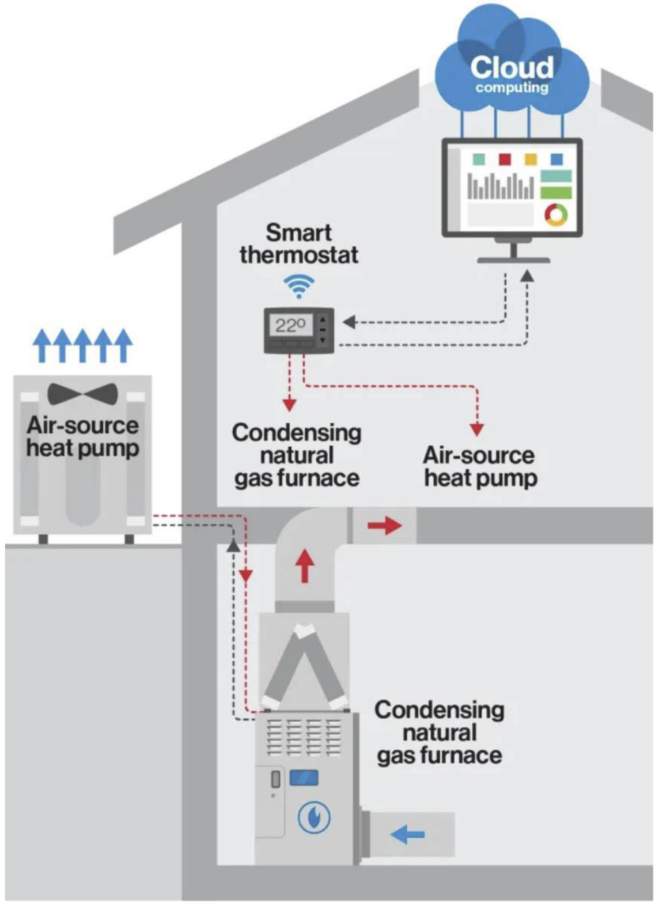


Figure: Hybrid Heating. Used with permission from Enbridge Gas Inc.

Control Approaches – What is out there?

There are many different ways to control a system with a Heat Pump and auxiliary heat

- ❑ Outside Temperature Balance Point Cutoff
- ❑ Single Temperature Point Economic Cutoff
- ❑ 2-Stage – Temperature Driven Cutoff
- ❑ 2-Stage – Time Based Cutoff

slido

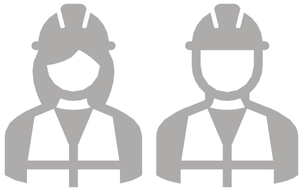
What thermostat or controls approach are you currently installing?

ⓘ Start presenting to display the poll results on this slide.

Why should we care about the selected control approach?

1. Installation cost
2. Operation cost
3. Comfort

1. Competitive pricing – business case
2. Customer satisfaction



1. Energy management
2. Environment

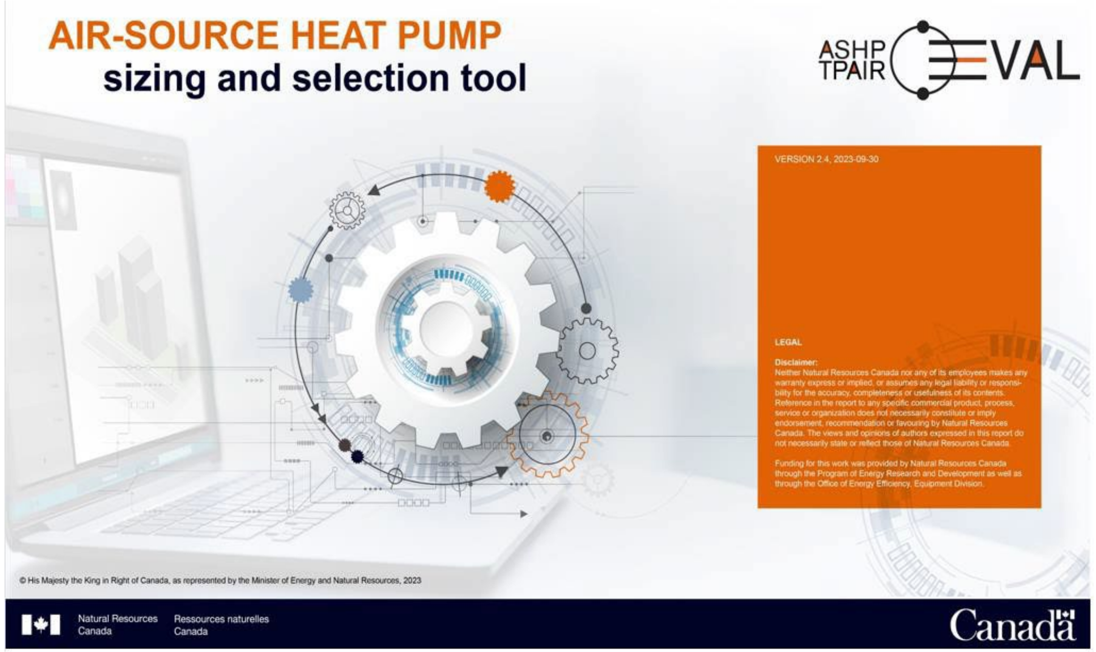
Natural Resources Canada

Detailed Review Of Control Approaches

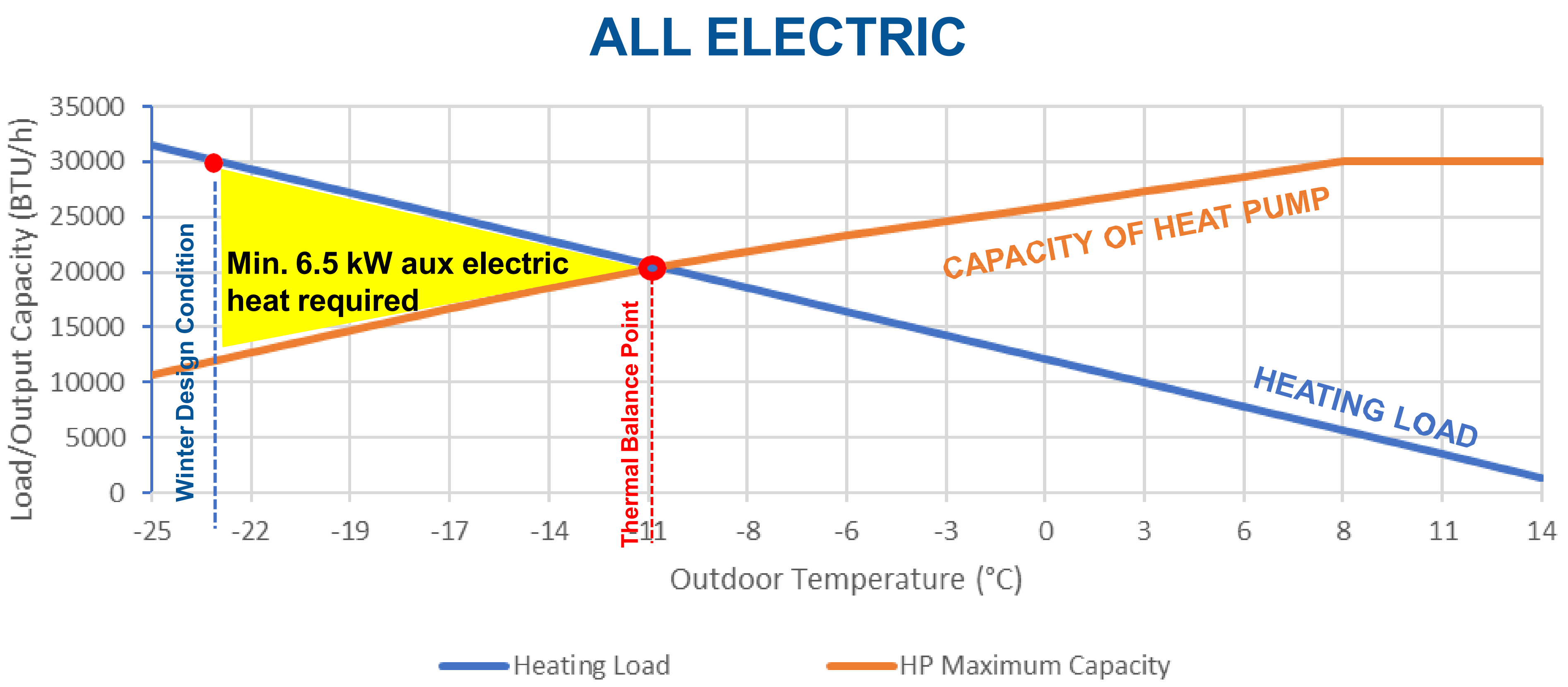
NRCan ASHP Sizing and Selection Tool

We used the sizing tool on the Case Study home in Kamloops.

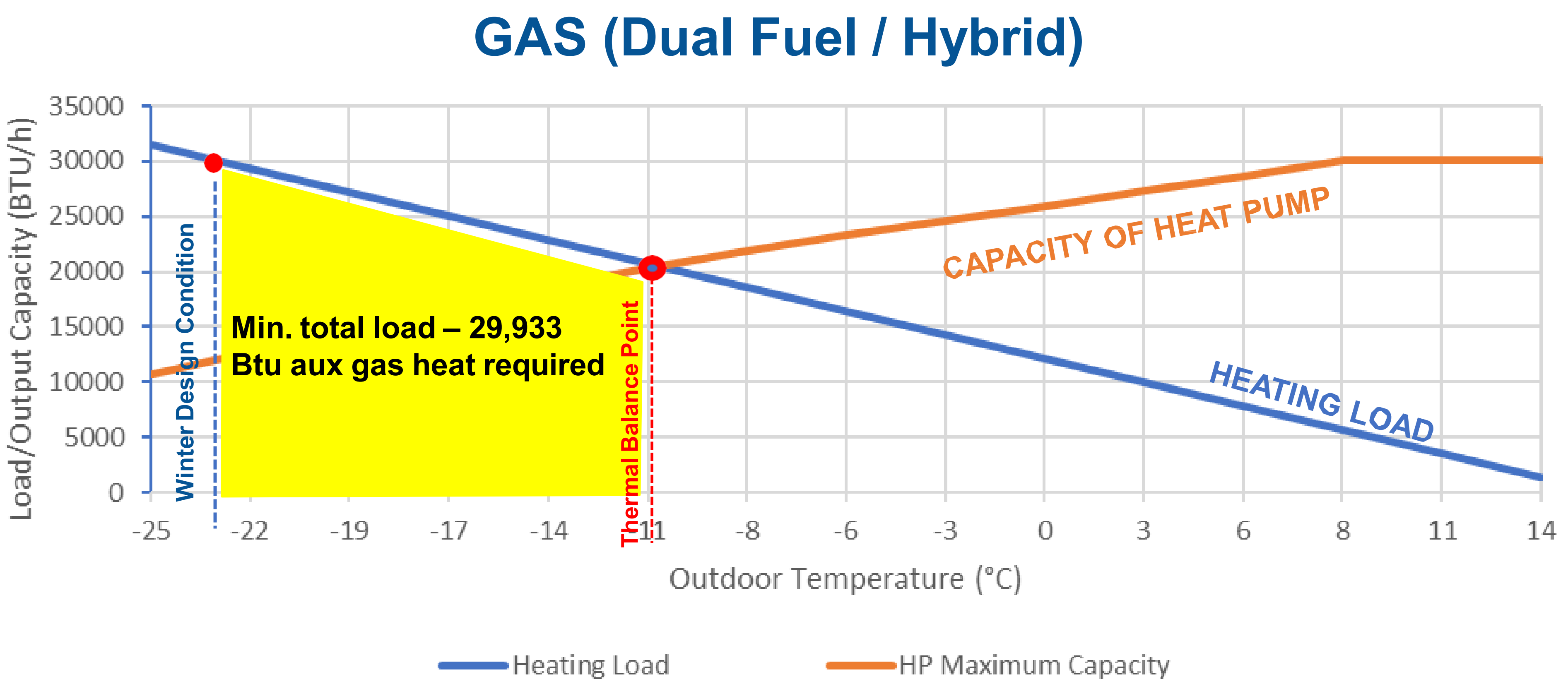
Keep in Mind
Heat Pump Capacity: 2.5 Tons (under consideration)



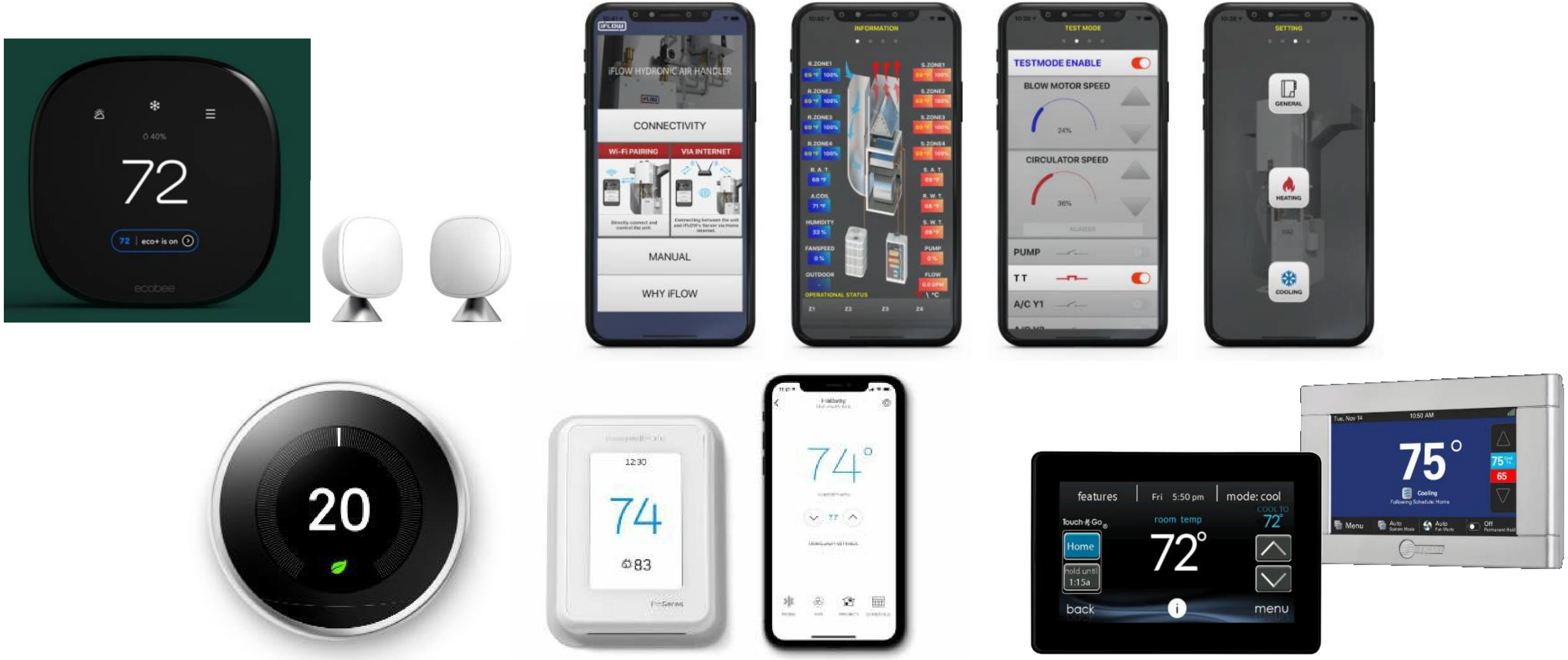
Heating Load and HP Capacity .vs. Outdoor Temp



Heating Load and HP Capacity .vs. Outdoor Temp



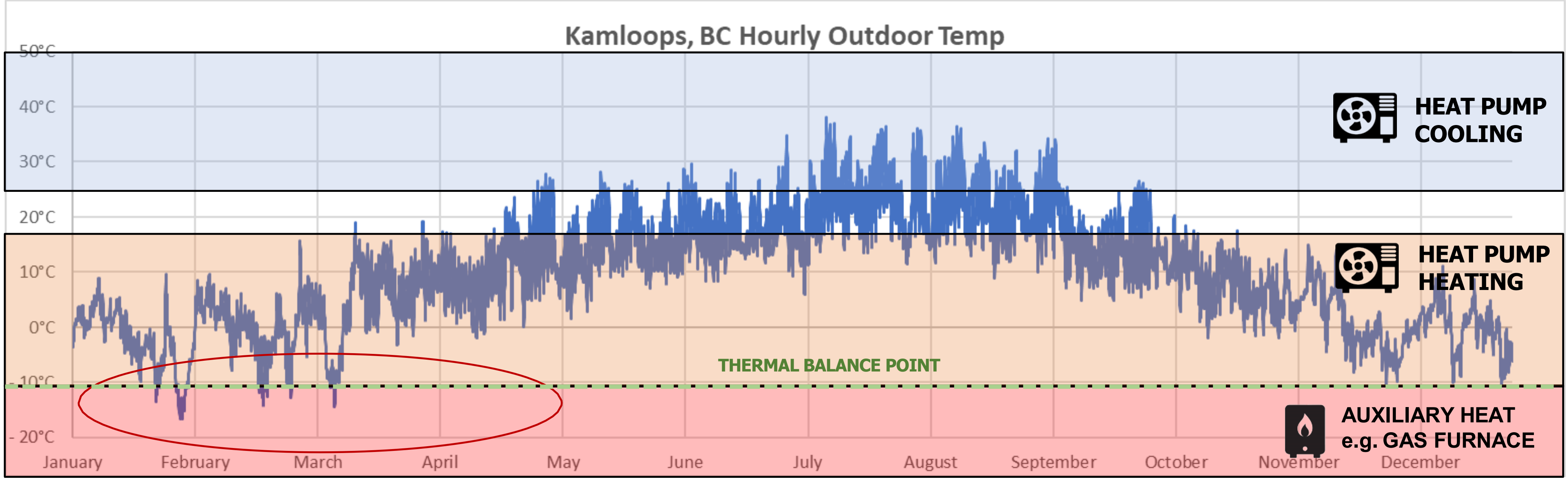
System performance may depend on thermostat selection



Control Approach 1

Cutoff At Balance Point Temperature (-11°C)

Depending on sizing of heat pump, it may not be able to supply all the heat required for the house. Backup may be required below the thermal balance point temperature.



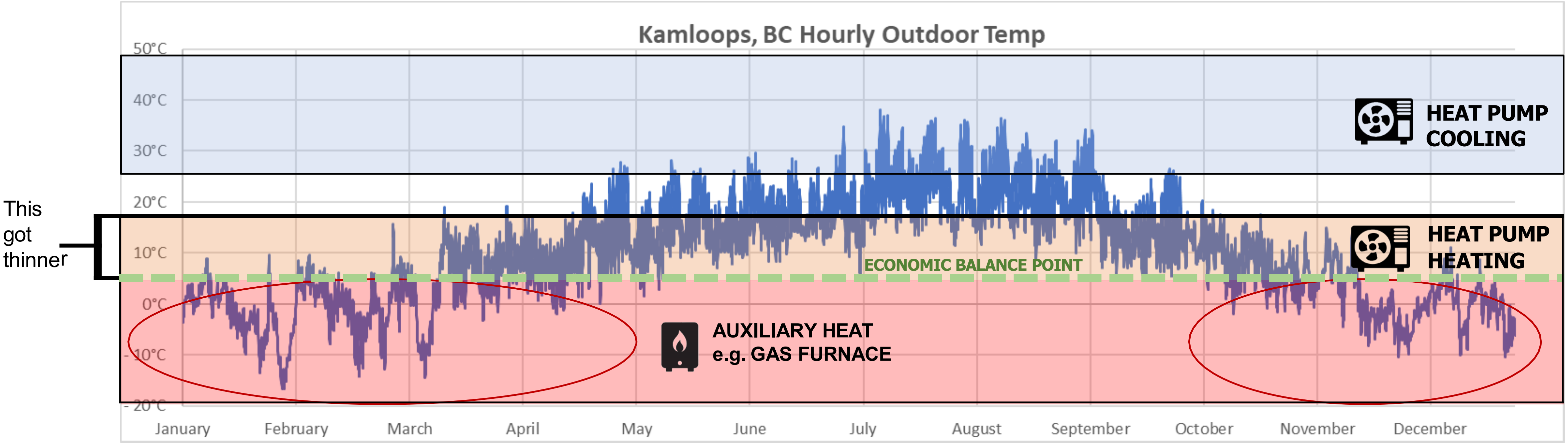
When the heat pump can no longer heat the house, the auxiliary heat takes over

Control Approach 2

Single Point Economic Temperature Cutoff (+3°C)

At a certain temperature, it becomes more cost effective to switch to auxiliary heating

- **COP** of the heat pump **is lower at colder temperatures**
- **The NRCan HP Sizing Tool** can help you determine economic balance point



When it is more cost effective to run auxiliary heat rather than the heat pump

Control Approach 3

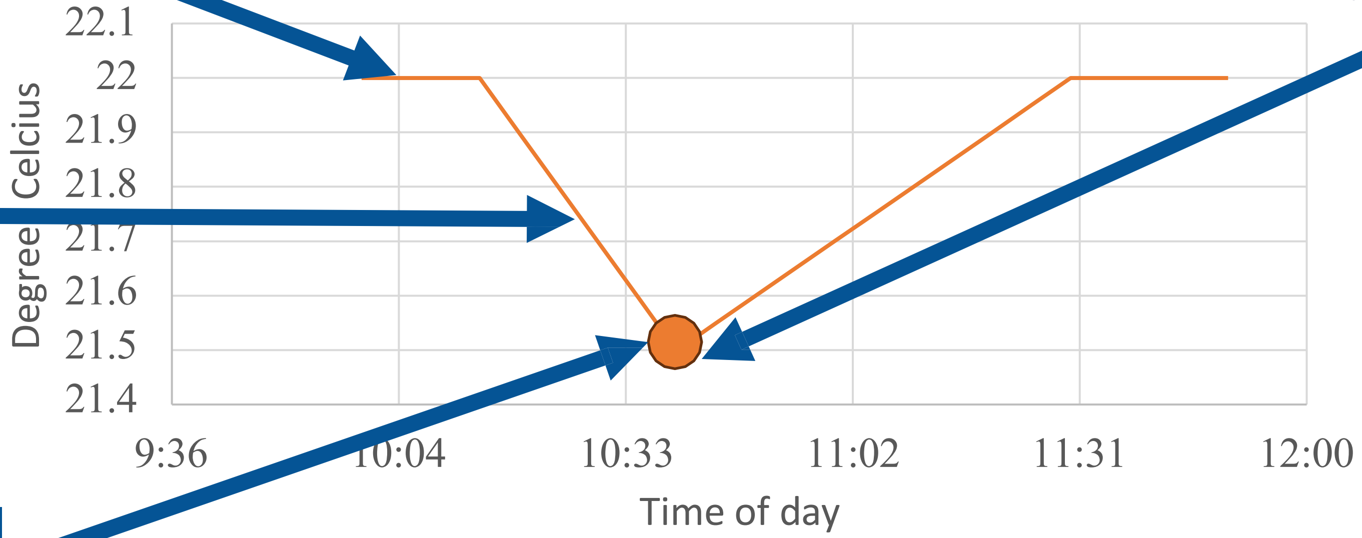
2 Stage –Indoor Temperature Driven

1 Setpoint temperature is maintained
- ❑ Heat pump « off »
- ❑ Aux heat « off »

At warmer outdoor temperature

2 Temperature drops below setpoint
- ❑ Heat pump « off »
- ❑ Aux heat « off »

3 Temperature reaches half a degree below setpoint
- ❑ Heatpump « on » until setpoint is reached
- ❑ Aux heat « off »



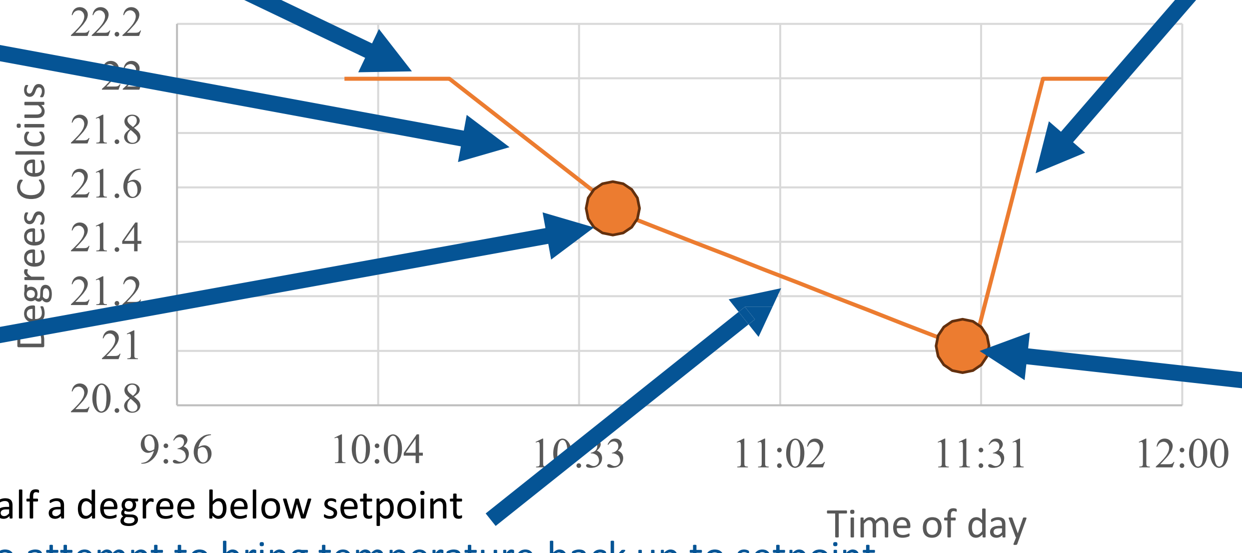
Stage 1: 21.5°C

Control Approach 3
2 Stage – Indoor Temperature Driven

1 Setpoint temperature is maintained
- ❑ Heat pump « off »
- ❑ Aux heat « off »

2 Temperature drops below setpoint
- ❑ Heat pump « off »
- ❑ Aux heat « off »

At warmer outdoor temperature



Stage 1: 21.5°C

Stage 2: 21°C

4 Setpoint temperature isn't reached
- ❑ Heat pump « off (for Gas systems »
- ❑ Aux heat « on » until setpoint is reached

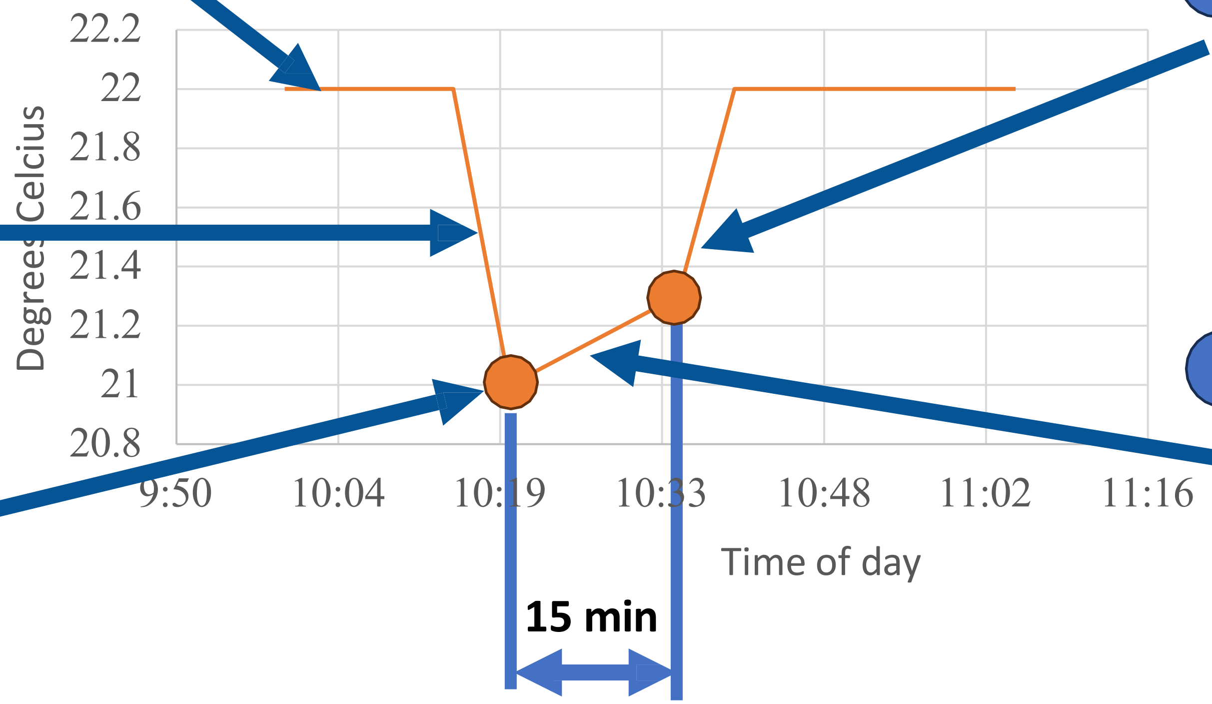
3 Temperature reaches half a degree below setpoint
- ❑ Heat pump « on » to attempt to bring temperature back up to setpoint
- ❑ Aux heat « off »

Control Approach 4
2 Stage – Time Based

1 Setpoint temperature is maintained
- ❑ Heat pump « off »
- ❑ Aux heat « off »

2 Temperature drops below setpoint
- ❑ Heat pump « off »
- ❑ Aux heat « off »

Call for heat: 21°C



4 Setpoint temperature isn't reached in 15 min
- ❑ Heat pump « off (for Gas systems) »
- ❑ Aux heat « on » until setpoint is reached

3 Attempt to bring temperature back up to setpoint
- ❑ Heat pump « on »
- ❑ Aux heat « off »

Let’s look at our case study home (Climate Zone 5)

HOME CHARACTERISTICS

	Heating load	Cooling Load
Zone 1 (Basement):	11,076 BTU/h	7,756 BTU/h
Zone 2 (Main floor):	9,535 BTU/h	9,983 BTU/h
Zone 3 (Second Floor):	9,383 BTU/h	10,002 BTU/h
	29,933 BTU/h (2.49 Ton)	27,441 BTU/h (2.29 Ton)

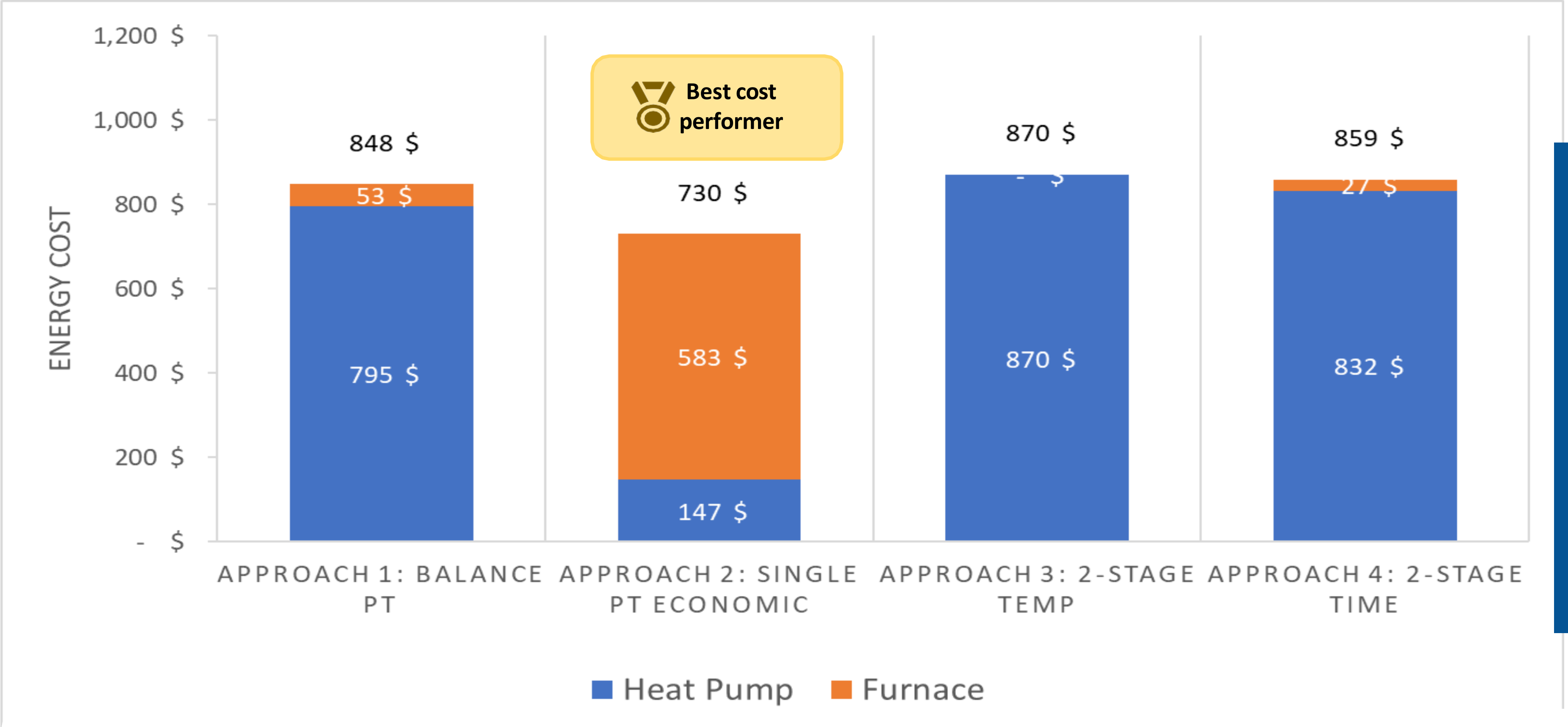
NET ZERO SPECIFICATIONS

Air Tightness	1.5 ACH50
Attic	R60
Walls	R22+10continuous
Basement	R22+10continuous
Exposed Floor	R40
Windows	Double R4, 0.6 SHGC, 10.6% of wall area
Ventilation	75% Efficiency-HRV
Heating & Air Conditioning	Cold Climate Air Source Heat Pump
Design Temperature	-23°C

BUILDER GOALS:

- Achieve NZ standard
- Improve home thermal comfort
- Manage costs

COST PERFORMANCE



Energy cost in Kamloops:

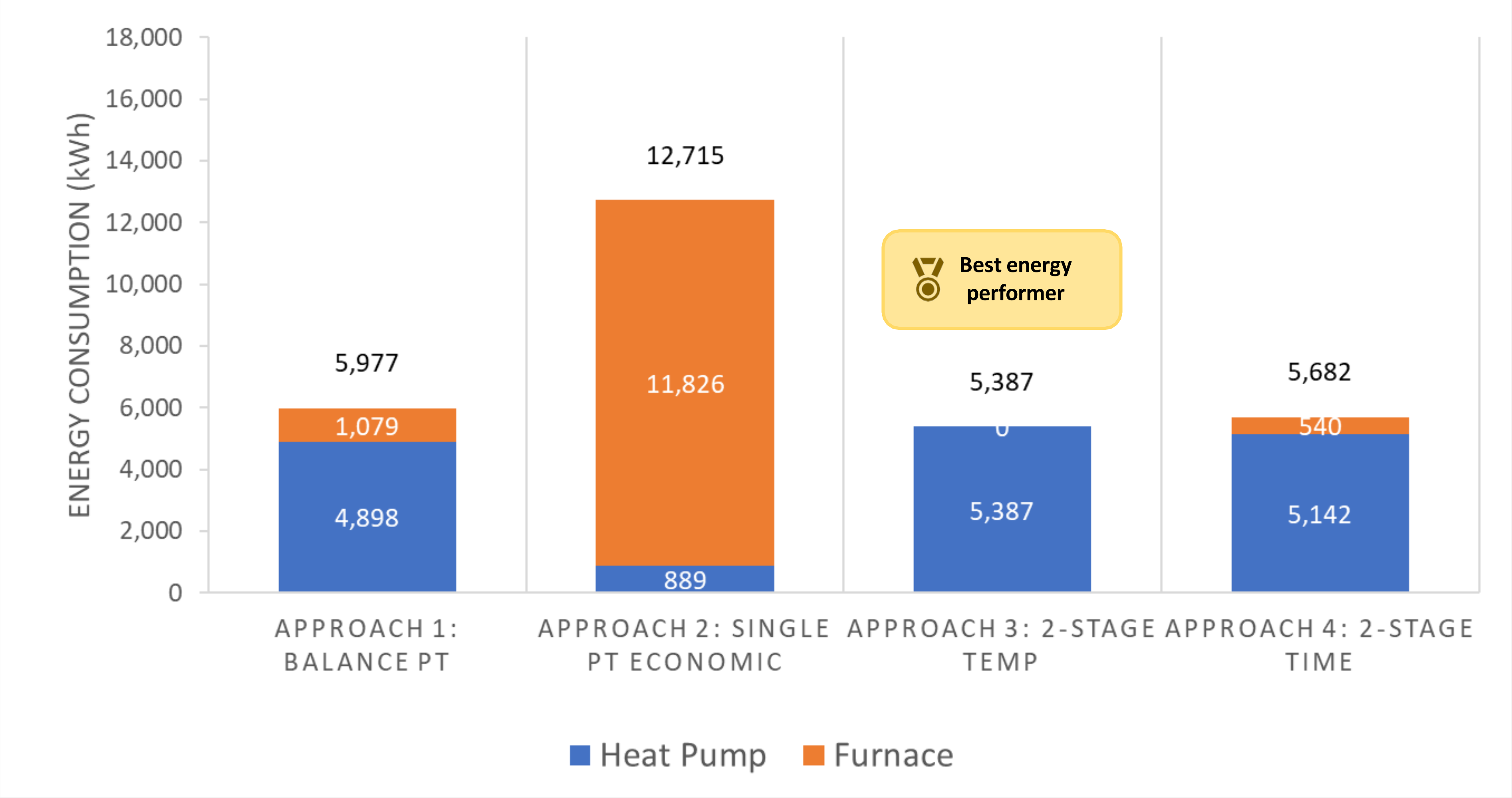
Gas: $13.82/GJ

Electricity: 14.78 ¢/kwh

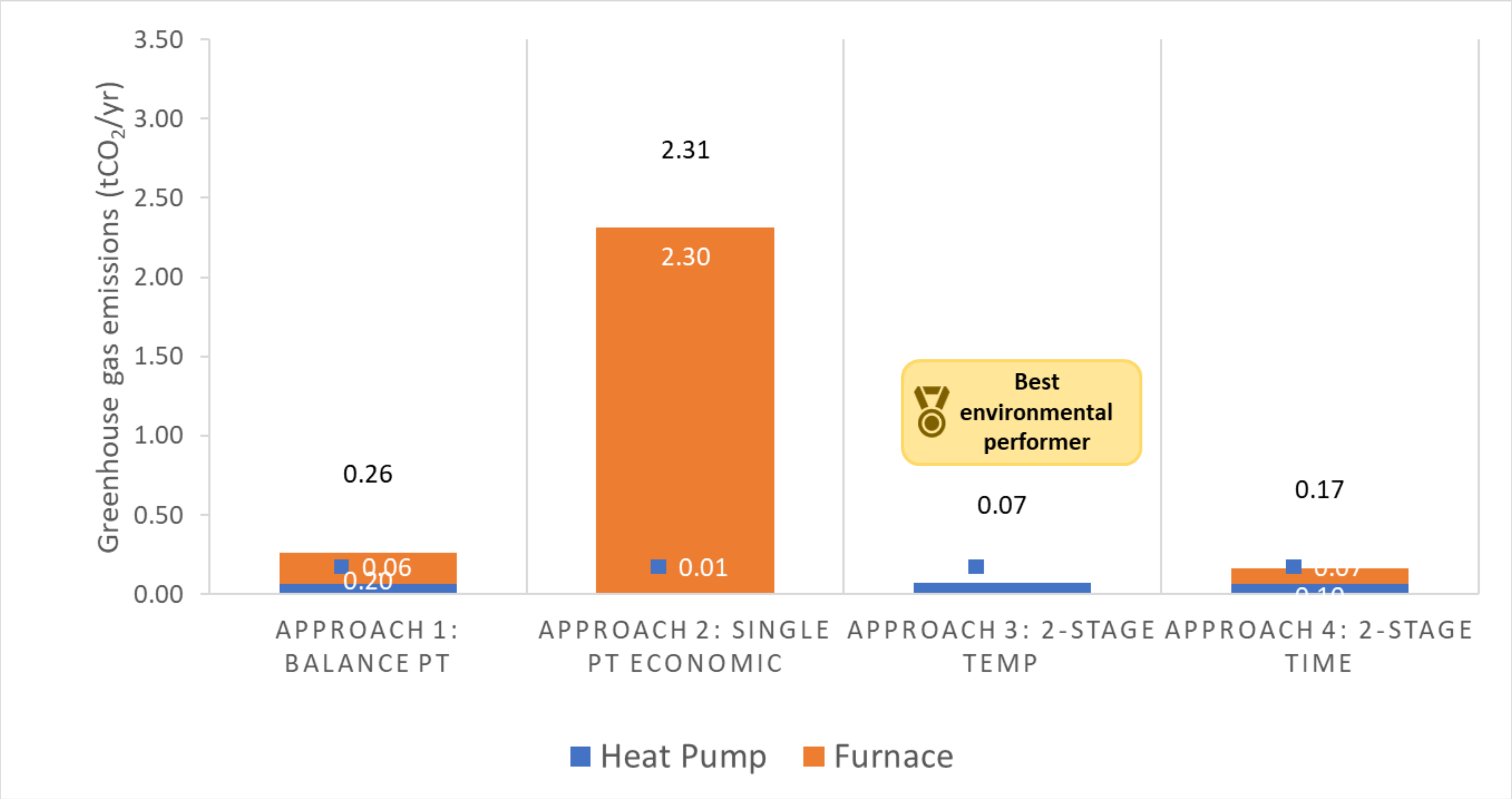
Includes all variable charges. Excludes monthly charges.

Caution: This depends on the efficiency (COP) of the heat pump. At current cost of gas in BC, a heat pump with a seasonal average COP of approximately 2.5 will be at par. Many products on the market exceed this efficiency

ENERGY PERFORMANCE



GHG PERFORMANCE



WHAT HAVE WE LEARNED?

01 Current market offering in switch-over strategies and why we should care

- There are different approaches out there and choosing the right one depends on different factors such as goals, location, equipment

02 Detailed review of various control approaches available

- Operating costs, energy efficiencies, and carbon emissions will vary depending on regional utility costs, equipment capacity & efficiency, and Homeowner priorities
- All switch-over approaches require competent HVAC designers to provide accurate and best options

03 Case study – Impacts of different control strategies in a Kamloops home

- Control approaches can have vastly different results costing homeowners hundreds of dollars per year
- Reduced GHG emissions are not necessarily correlated to lower operating costs

Let's revisit…

Step	Current	Interested to explore
1	**Discovery:** barriers, challenges & pain points	
2	**Configuration**: centrally ducted system, hybrid install	
3	**Sizing approach**: Emphasis on cooling	
4	**Supply outlet approach:** perimeter supply	
5	**Duct Sizing**: low velocity	
6	**Choose Zoning**: single zone	
7	**Return Duct design:** traditional return design	
8	**Duct Sealing**: base level sealing	
9	**F280 HL/HG:** Work with HVAC contractor to complete F280 calculations	
10	**Heat pump selection**: HP does not meet full load, furnace backup	
11	**Utility rates/controls**: Backup only below TBP	
12	**Dehumidification controls**: not implemented/not designed	
13	GHG, cost, energy outcomes	

Natural Resources Canada
Ressources naturelles Canada

Panel Session: Control Strategies

June 10, 2024 – Vancouver

Canada

LEEP Heat Pump Day: Net Zero Summit 2024

Ron Sim

Residential Business Manager BC & Yukon

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Mitsubishi Electric Heating and Cooling Canada

A leader in the manufacturing world, Mitsubishi Electric has been at the forefront of innovation for over 100 years.

Mitsubishi Electric Sales Canada Inc. was established in 1979 and provides an extensive line of commercial and residential products that includes heating and air conditioning, energy recovery and fresh air ventilators, water heating and cooling technology, and more.

Our BC wholly owned supply branch was opened in 2009 and has seen growth both in the residential and the commercial market every year.

Vision

To be the most trusted industry leader in providing innovative heating, cooling and ventilation technology engineered specifically for Canadian climates

Mission

To deliver quality comfort and value to all Canadians through leading-edge engineering, locally inspired design, and a dedication to superior service

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Multiple Indoor Options Available

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Case Study Home

BUILDER GOALS:

- Achieve NZ standard
- Improve home thermal comfort
- Manage costs

HOME CHARACTERISTICS

	Heating load (29,933 BTU/h) (2,49 Ton)	**Cooling Load** (27,441 BTU/h) (2,29 Ton)
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Net Zero Specification

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Attic:………………R60
Walls:………………R22+10continuous
Basement………R22+10continuous
Exposed Floor..R40
Windows……….Double R4, 0.6 SHGC, 10.6% of wall area
Ventilation…….75% Efficiency-HRV
Heat & Air………CCASHP
Kamloops……….-23ºC Design Temp

Mitsubishi Electric Sales Canada HVAC Solution

We propose an all-electric solution to this design comprised of the following:

– Forced Air Central System Servicing the Basement and Ground Floor

-Ducted Ceiling Concealed System Servicing the Second Floor

- Advantage – Standard design – Simpler Installation for Material Costs – Reduced Installation Labour – Reduced Ductwork Requirements for Return Air Natural zoning with separate systems for the variety of temperature zones No requirement for zoning systems, reduces requirement for multiple thermostats

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System Design Components

OUTDOOR UNIT
PUMY-HP36NKMU2

PAC-MKA33BC BRANCH BOX

BASEMENT AND GROUND FLOOR
SVZ-KP24NA

SECOND FLOOR
PEAD-A12AA

CONTROLLERS
PAR-41MAAU

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Mitsubishi Heat Pump Auxiliary Heat Options

Central Forced Air Systems have add-on electric heater systems that work in conjunction with the heat pump units and are an auxiliary system not a replacement system. Sizing ranges from 2 to 17 kW heaters. Only where design temperature exceeds -28 C. require a full load secondary heater.

Model: PAC-YU25HT - External Heater Adaptor. With the addition of the External Heater Adapter and a 12VDC Relay any secondary heating system can be operated as an auxiliary heater. Baseboard heater, Secondary duct heater or Electric Fireplace are some of the choices that can be utilized.

Multi-Zone Flexibility- all our Residential indoor units are compatible with our Multi-zone Outdoor units allowing a huge variety of possible applications

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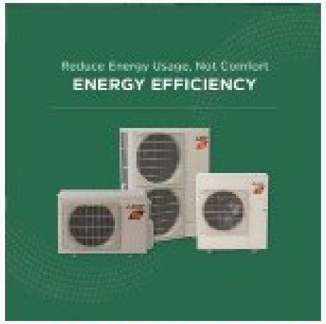
NEEP'S COLD CLIMATE AIR SOURCE
Heat Pump List



MITSUBISHI ELECTRIC S-Series H2i

Central Air Conditioning Heat Pump (HP)

Multizone All Ducted

AHRI Cert #⁺: **202423533**

Outdoor Unit Model #⁺: **PUMY-HP36NKMU**

Indoor Model #⁺:

Maximum Heating Capacity (Btu/h) @5°F: **42,000**

Rated Heating Capacity (Btu/h) @47°F⁺: **42,000**

Rated Cooling Capacity (Btu/h) @95°F⁺: **36,000**

Related Products

⁺AHRI certified and verified product information. Rated capacity information is certified and verified by AHRI, input power is manufacturer reported and COP is calculated. Source: ahridirectory.org

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OUTDOOR UNIT PERFORMANCE

Information Tables

Brand	MITSUBISHI ELECTRIC
Series	S-Series H2i
Ducting Configuration	Multizone All Ducted
AHRI Certificate #*	202423533
Outdoor Unit Model #*	PUMY-HP36NKMU
Indoor Model #*	
Indoor Unit Type*	Ducted Indoor Units
Furnace Model* #	
EER*	12.6
SEER*	18.3
HSPF (Region IV)*	11.7
EER2*	
SEER2*	
HSPF2 (Region IV)*	
HSPF2 (Region V)	

Performance Specs

Heating / Cooling	**Outdoor Dry Bulb**	**Indoor Dry Bulb**	**Unit**	**Min**	**Rated***	**Max**
Cooling	95°F	80°F	Btu/h*	8,852	36,000	36,000
			kW	0.55	2.86	2.86
			COP	4.72	3.69	3.69
Cooling	82°F	80°F	Btu/h*	9,508	-	36,180
			kW	0.48	-	2.26
			COP	5.81	-	4.69
Heating	47°F	70°F	Btu/h*	12,498	42,000	42,000
			kW	0.62	3.32	3.32
			COP	5.91	3.71	3.71
Heating	17°F	70°F	Btu/h*	9,690	32,000	45,898
			kW	0.73	4.58	4.58
			COP	3.89	2.05	2.94
Heating	5°F	70°F	Btu/h*	6,687	-	42,000
			kW	0.58	-	6.48
			COP	3.38	-	1.9

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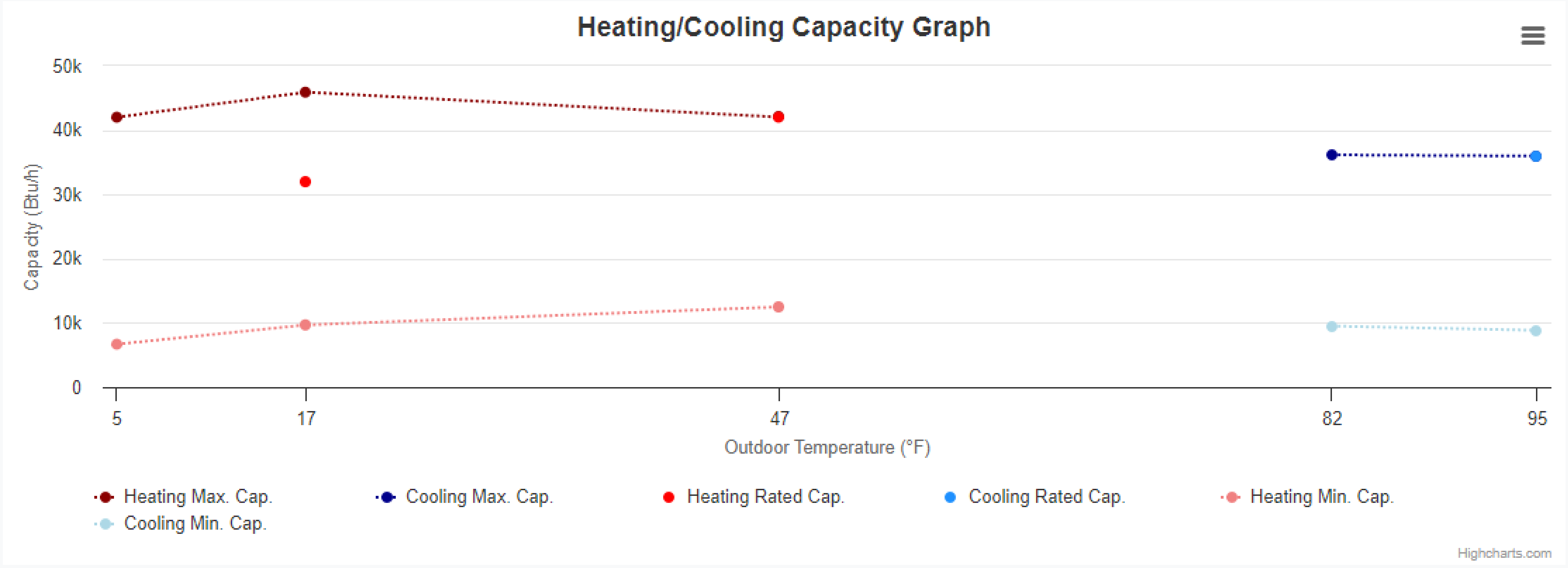

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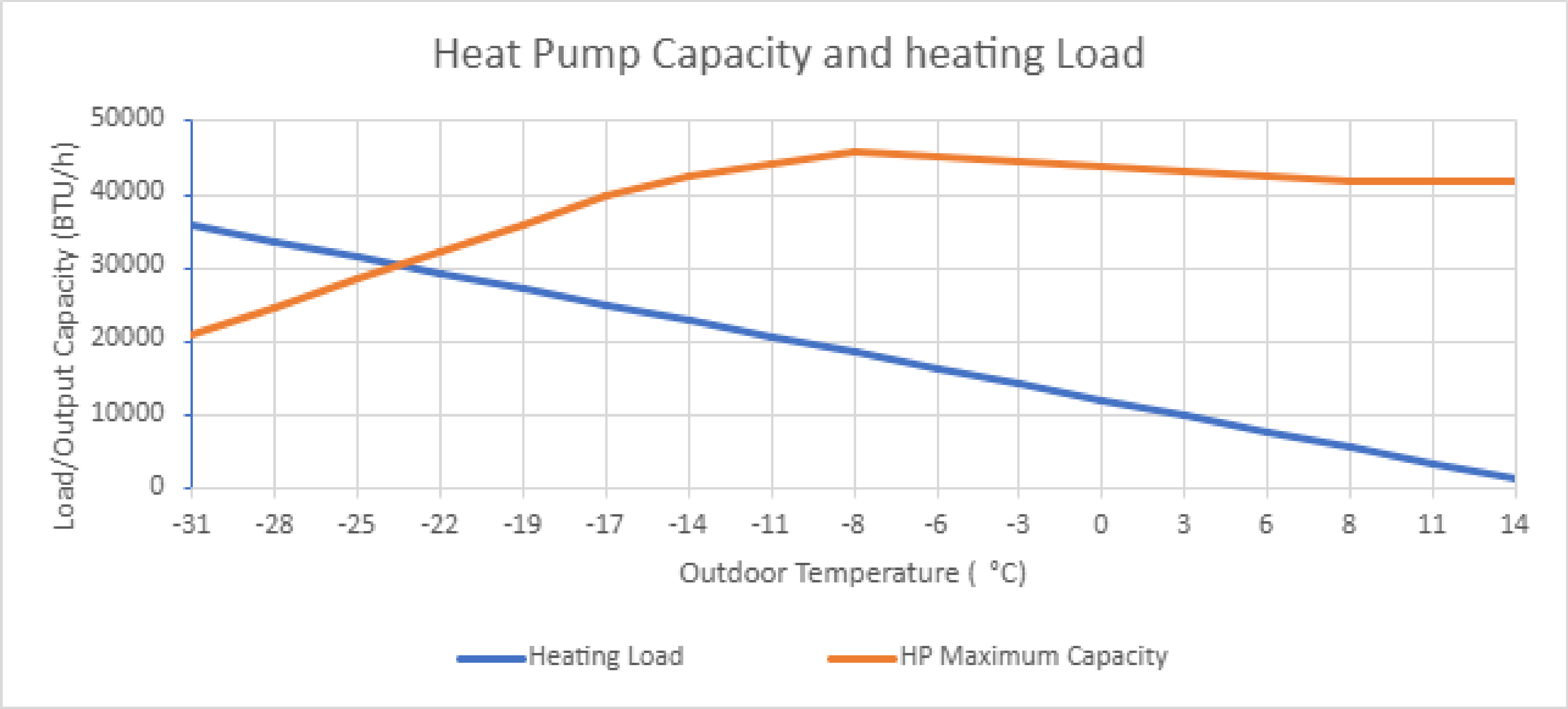
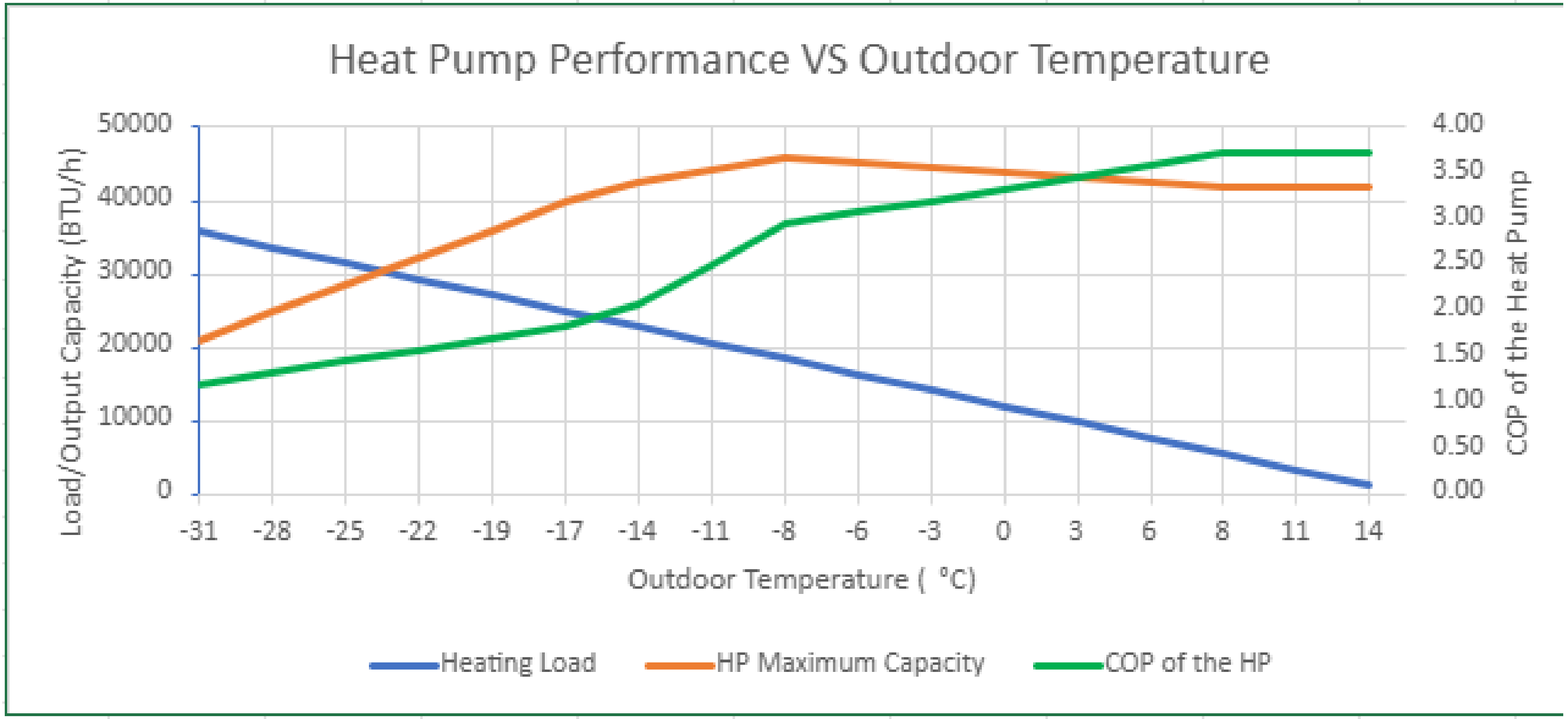
Capacity Vs. Heating Load Balance Point





Heat Pump Performance VS Outdoor Temperature
Load/Output Capacity (BTU/h)
50000
40000
30000
20000
10000
0
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
COP of the Heat Pump
-31 -28 -25 -22 -19 -17 -14 -11 -8 -6 -3 0 3 6 8 11 14
Outdoor Temperature (°C)
Heating Load
HP Maximum Capacity
COP of the HP

What an indoor air handling unit looks like when properly installed.

Things to note

1 Tapered return air drop ducting

2 Radius turn inside elbow on the return air

3. Full flow return air plenum

4. Cased Filter c/w airtight door

5. Vented condensate drain properly trapped

6. Straight piping and tight 90 bends with correct radius turns

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PUMY Outdoor Units Evolution

NKMU / HP-NKMU Models

3, 4 and 5 Ton Outdoor Unit, Single Phase.

HP indicates H2i Hyper Heat Models.

(-BS) indicates unit is salt-protected.

Production: 2019 - Current

- PUMY-P60NKMU(-BS)
- PUMY-P-NKMU1(-BS)
- PUMY-P-NKMU2(-BS)_HP-NKMU
- PUMY-P-NKMU3(-BS)_HP-NKMU1 - Current
- PUMY-P-NKMU4(-BS)_HP-NKMU2 - Current

NHMU Models

3 and 4 Ton Outdoor Unit, Single Phase.

(-BS) indicates unit is salt-protected.

Production: 2006 - Obsolete

- PUMY-P-NHMU(-BS)

VM(A) - R22 Models

3 and 4 Ton Outdoor Unit, Single Phase.

Production: 2003 - Obsolete

- PUMY-VM(A) - R22

www.mitsubishitechinfo.ca

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What makes our equipment different?

Dependability and Reliability have always been the hallmark at Mitsubishi Electric Sales Canada.

Tradespeople, Engineers and Developers have learned over the years to count on our dependability.

Through mandatory requirements of having Certified Journeyperson Refrigeration technicians working for the contractor and requiring contractors to take technical training programs both on-line and in-person training.

Technical Support is available with technical advisers based in Burnaby BC and available to travel to various communities for training opportunities. Primarily our out-of-town training has focused on Vancouver Island but training is being scheduled for the Okanagan communities also.

We offer technical assistance during start-up and diagnostic reviews, our technicians are based in BC, 2 commercial technicians and 2 residential and light commercial technicians

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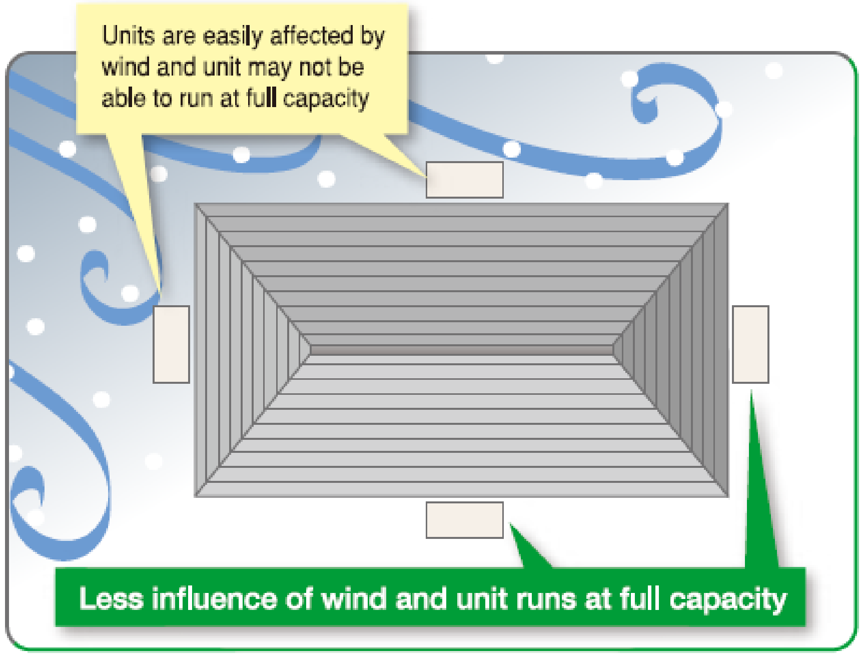
Training Facilities Burnaby

CONFIDENTIAL

Outdoor Unit Installation Considerations

1 Installation location

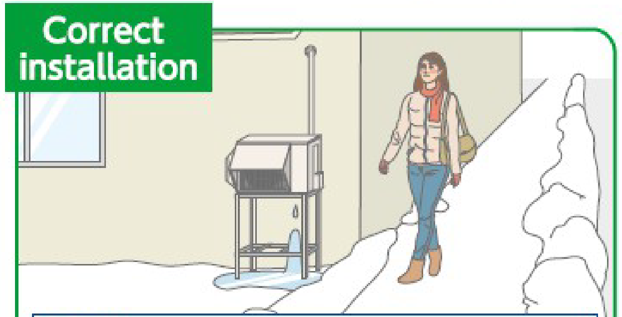
Be aware of the prevailing wind direction in winter and install the outdoor unit where it is sheltered from the wind when possible. When not possible, it is recommended to use an accessory wind baffle



2 Measures for drainage of water

Case 1: Unit installed near walkway

Do not install the unit near a walkway as the drainage water can freeze causing a slip hazard

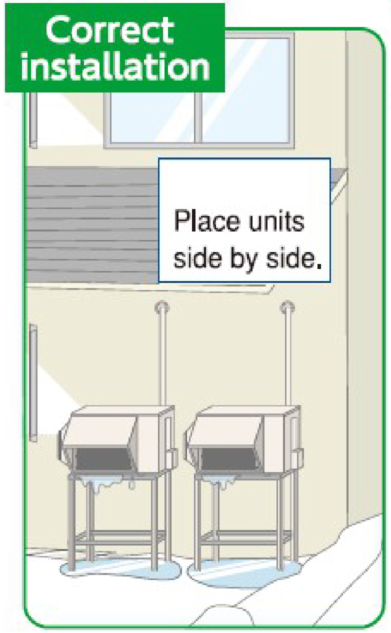


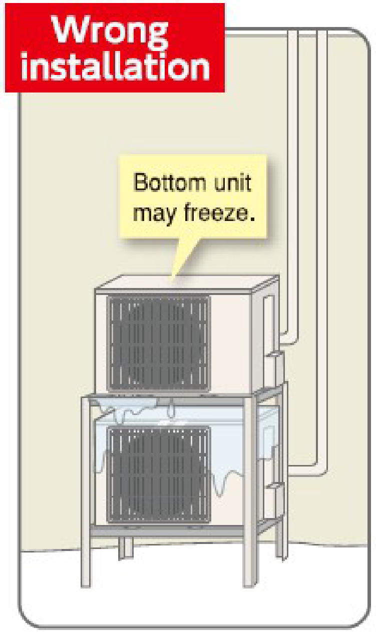
Point!

①Install at a sufficient height from the ground to prevent problems caused by frozen drainage water.
②Install in a location where frozen drainage water will not be a hazard.
③Install in an upright position to allow proper drainage from the drainage outlet.

Case 2 : Multiple units are installed

Do not install units on top of one another as it may cause frozen drainage water on the bottom unit.





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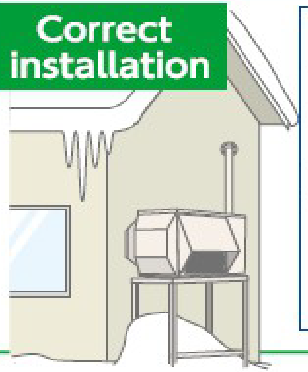
3 Measures for snow

M&P Series

Unit is installed on the ground

To avoid the adverse effects of snow, ice and defrosting issues, install the unit on a stand to ensure a sufficient height from the ground

Correct installation



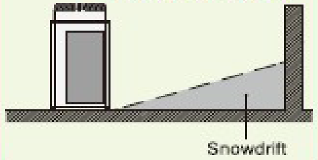
Point!

①Install at a position/height to prevent the unit being buried in snow *1 and the adverse effects of frozen drainage water.*2
②Install so as to avoid the effects of snow or snowdrift.
③Install so as to avoid the damage from falling snow or icicles.

*1 Install at a height above the highest snowfall depth.
*2 Even for correct installations, dripping drainage water may form an icicle which needs to be cleared away regularly to prevent a blocked drainage outlet.

Correct installation

CITY MULTI



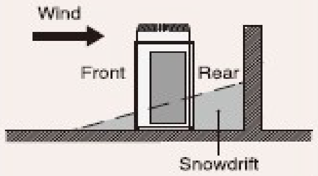
Wrong installation

Unit may become buried in snow due to heavy snowfall, snow sliding off the roof or snowdrift.

Wrong installation

Unit may be damaged due to snowfall or icicles.

Wrong installation



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Key Considerations

Your Heat Pump is a long-term investment you are making for the future.

For best performance and peace of mind, some key considerations include

❖ **Choosing the right contractor:**

- For quality work, make sure that your contractor is **licensed, bonded and insured** to ensure that they meet professional standards & legal requirements.
- Check **references and reviews** to gauge their reputation.
- Look for a contractor with **specific experience in heat pump installation** and knowledgeable for both design & installation. Ask about familiarity with different types of heat pumps
  – **air source, cold climate, etc.**
- Confirm that the contractor is **trained by the manufacturer** to ensure that your system is optimally installed as recommended by the manufacturer.
- A good contractor will guide you through the decision-making process and help you make informed choices. They should provide **high-quality installation** to ensure optimal system performance
- A thorough contractor will analyze the home to **determine the best heat pump solution**. They will consider factors such as insulation, ductwork and your specific heating needs.
- Inquire about manufacturer's **warranty and on-going maintenance services** to keep your system running efficiently.
- **ASK QUESTIONS**

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Thank You

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Natural Resources Canada | Ressources naturelles Canada

Let’s recap: ASHPs for High Performance Homes

June 10, 2024 – Vancouver

Sneha Bernard - Local Energy Efficiency Partnerships
Jérémie Léger - Local Energy Efficiency Partnerships

Canada

LEEP has tools, resources & training to support

01 NRCan's Air Source Heat Pump Sizing & Selection App

- Supports a collaborative discussion and decision-making process with builders, HVAC designer and trades – leading to better-fit equipment that is right sized for the home

02 LEEP Technology Guides & Tools

- Master Planning & Decision Tool & Guide for Forced Air Mechanical Systems
- Toolkit for air source heat pump sizing and selection
- Dashboards to navigate the NEEP database for product availability

03 LEEP video series for new and retrofit housing

- Best practices in heat pump retrofits in a range of communities and housing types across Canada
- Planning, design and best practices in mechanicals system design for new homes

04 Industry expertise!

- Leverage the expertise in the room today!
- HVAC Designers of Canada networks
- Manufacturer & industry training programs for your trades & installers

How did your design selections change through the day?

Step	Current	Interested to explore
1	**Discovery:** barriers, challenges & pain points	
2	**Configuration**: centrally ducted system, hybrid install	
3	**Sizing approach**: Emphasis on cooling	
4	**Supply outlet approach:** perimeter supply	
5	**Duct Sizing**: low velocity	
6	**Choose Zoning**: single zone	
7	**Return Duct design:** traditional return design	
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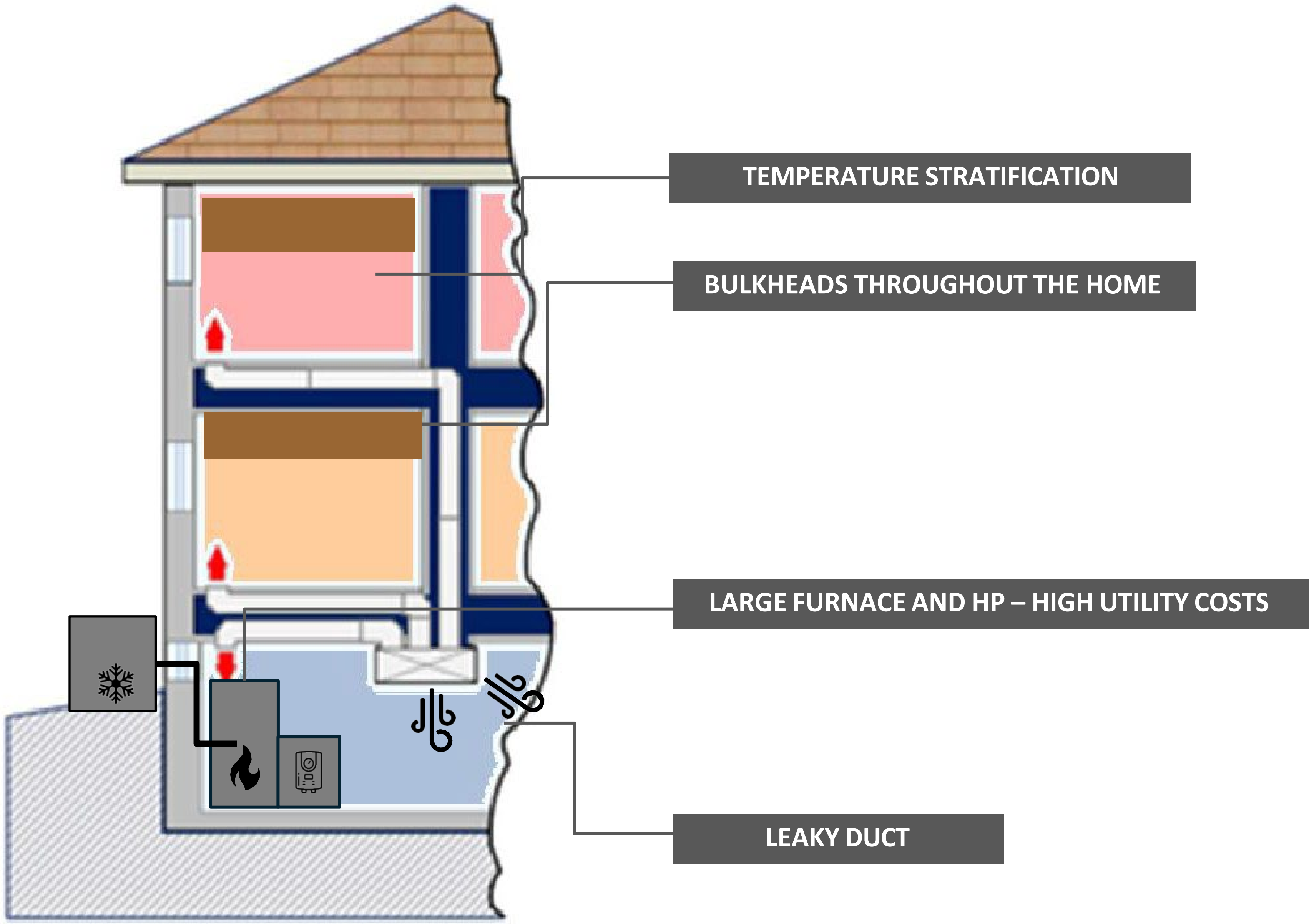
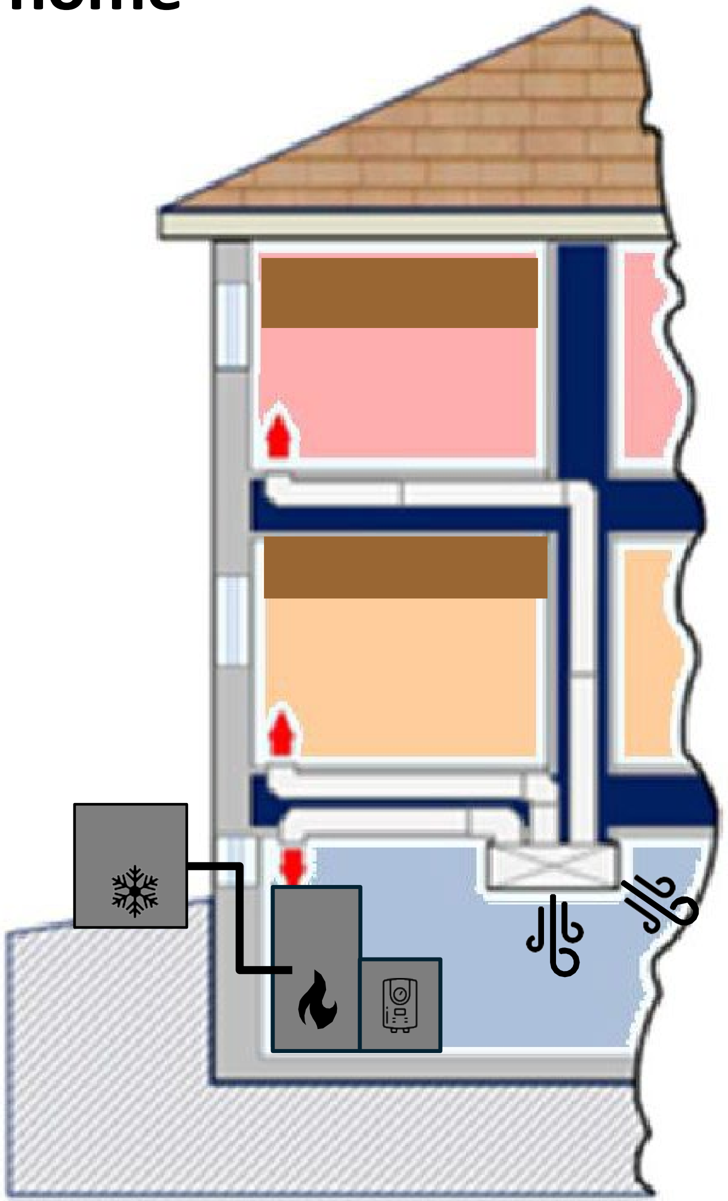
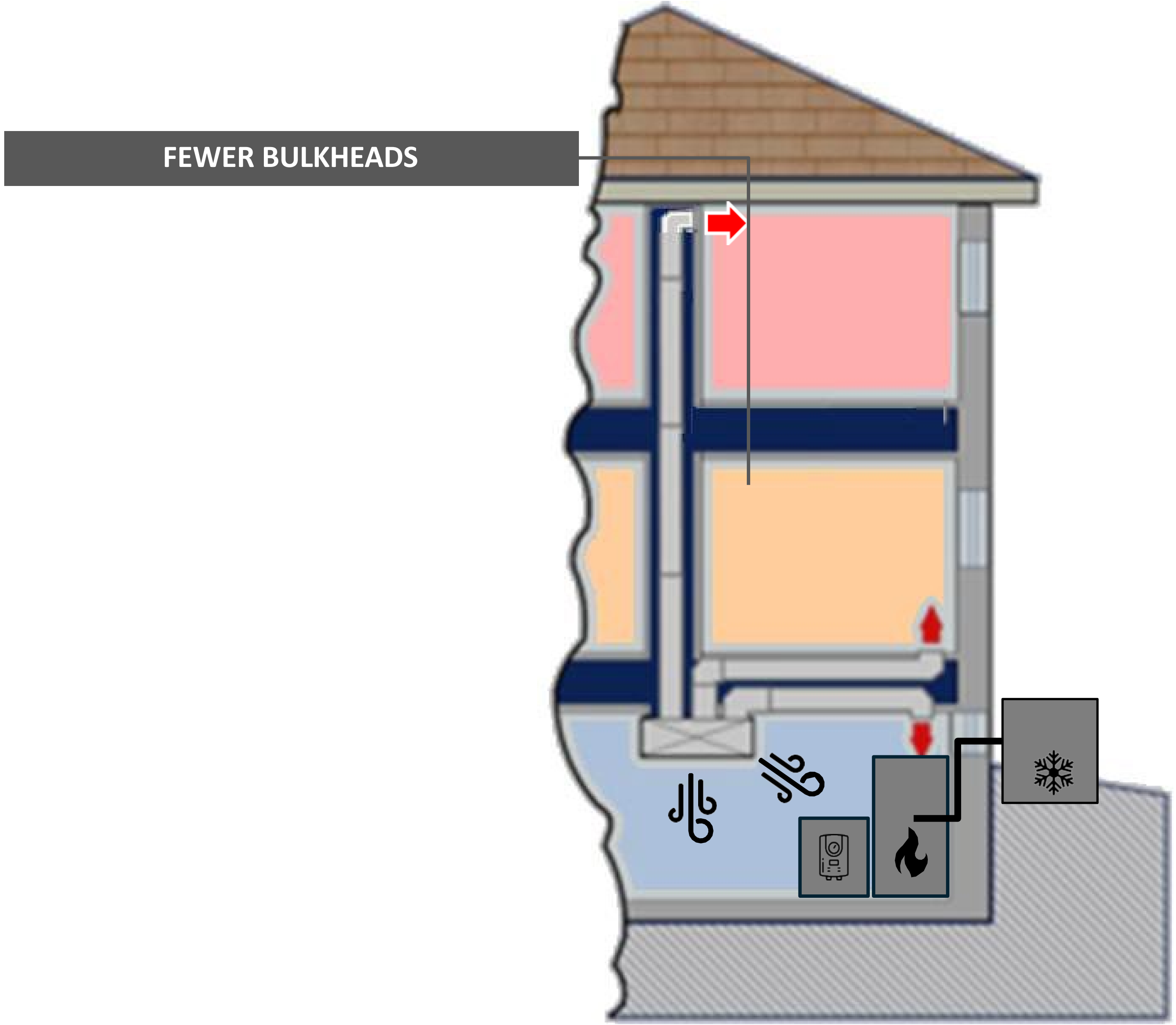
12	**Dehumidification controls**: not implemented/not designed	
13	GHG, cost, energy outcomes	

How does this impact our case study home? Let's look at the business as usual scenario…

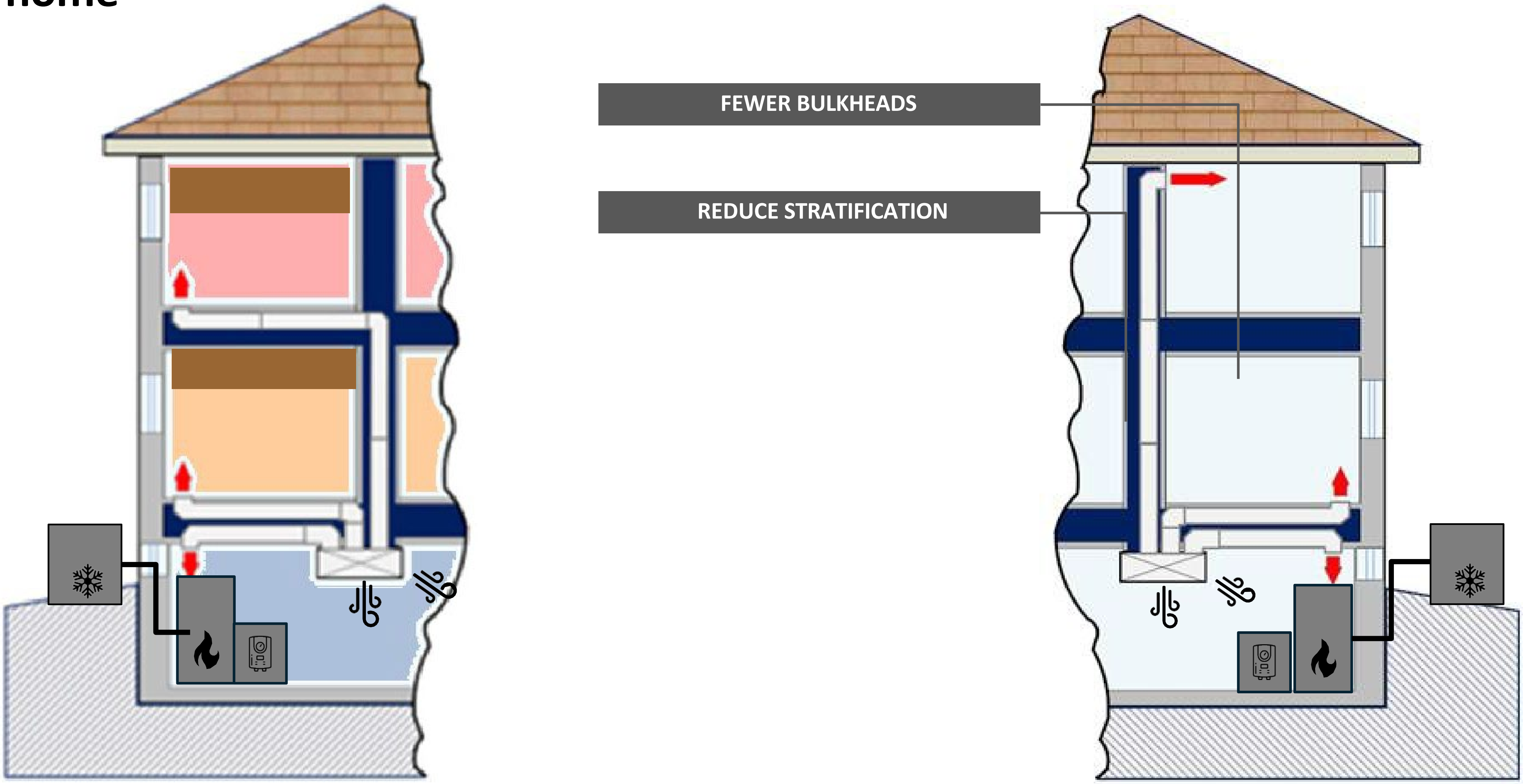


Steps 4-7: Better distribution design and temperature control through the home

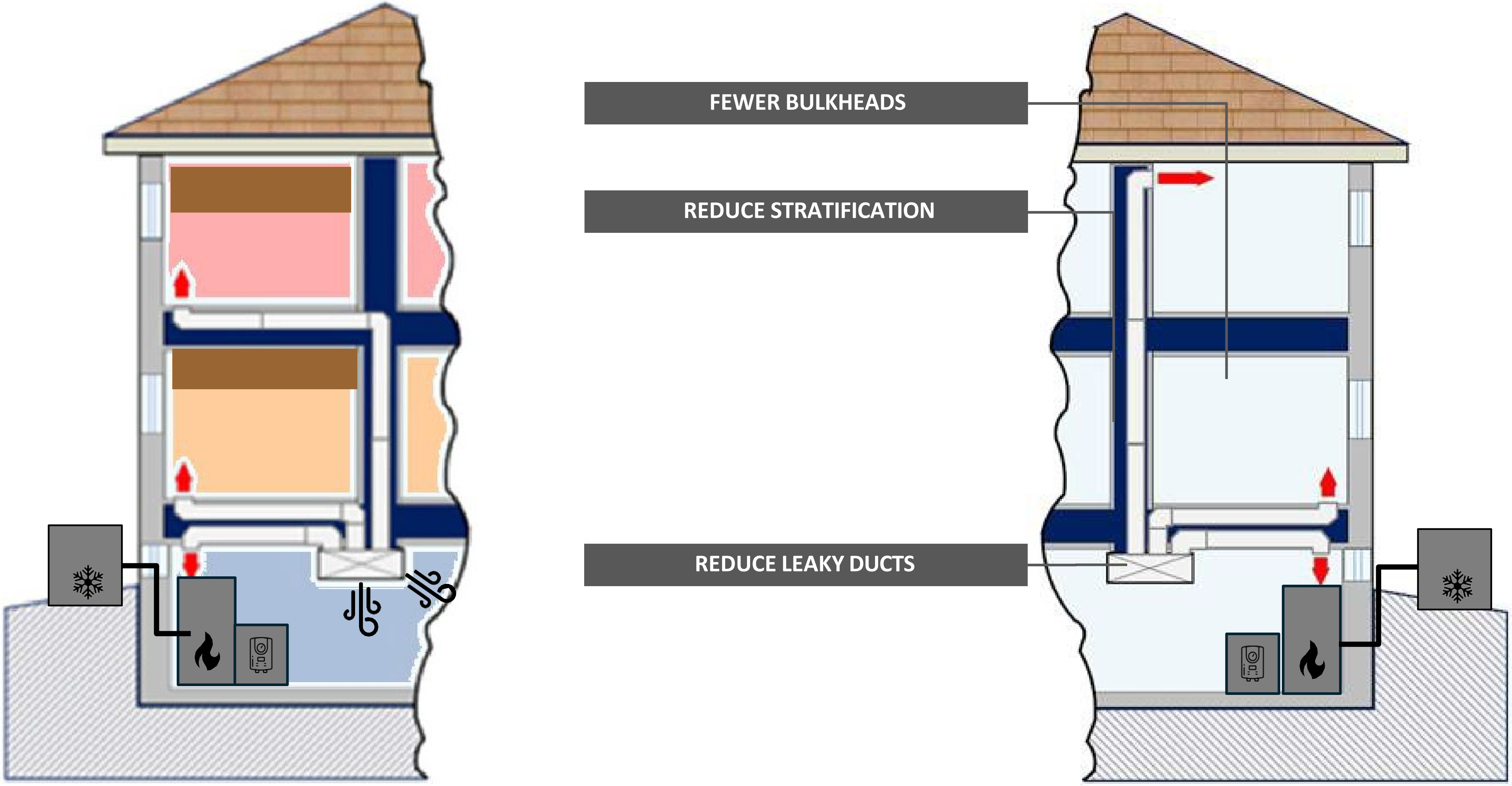




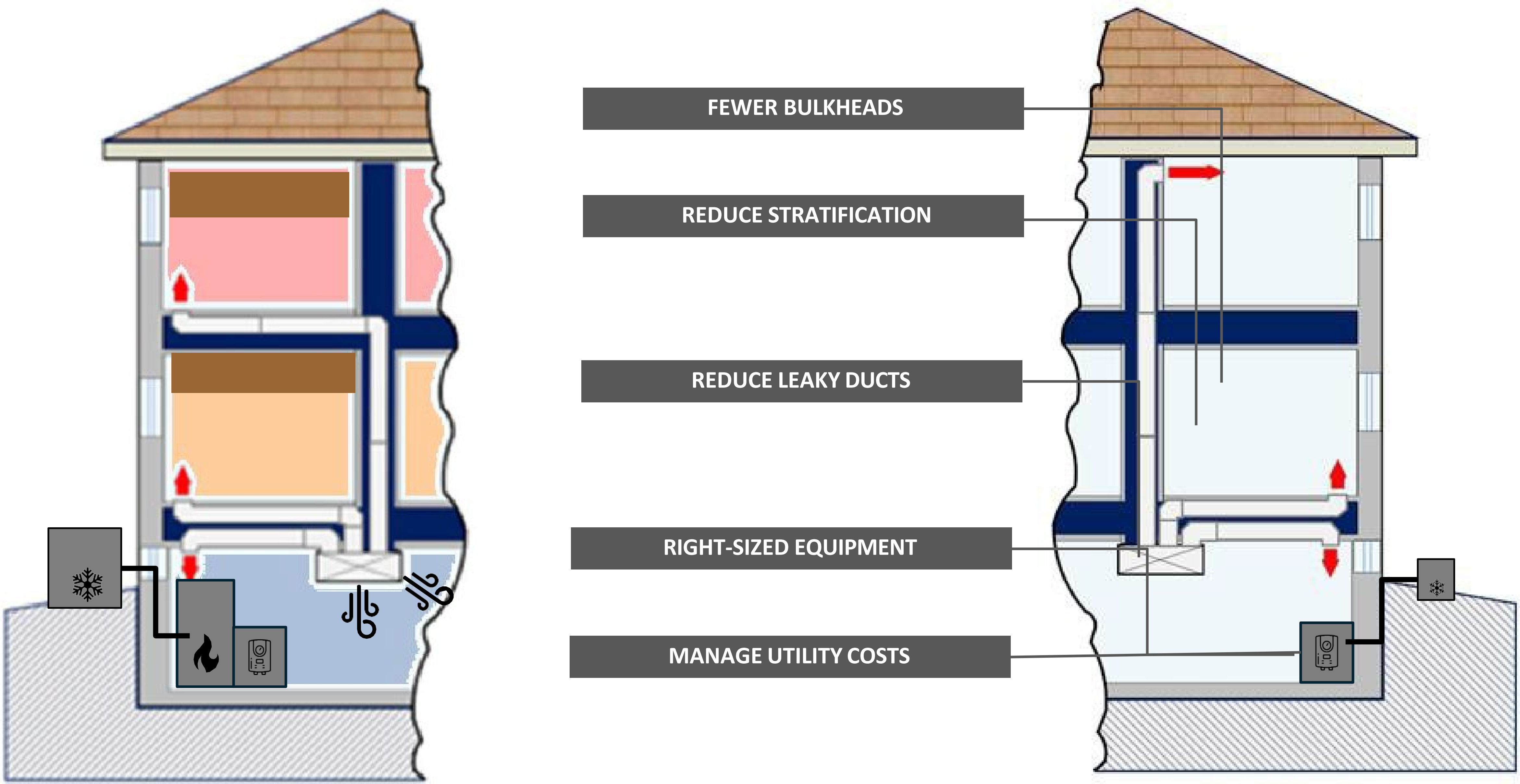
Steps 4-7: Better distribution design and temperature control through the home



Step 8: Reduce duct leakage



Step 9-11: Right-sized equipment, minimize reliance on backup furnace



Key takeaways

01 **Improved collaboration and verification between builders and mechanical designers will optimize the HVAC system within the project requirements.**

02 **F280 Load Calculations:**

- Code compliant F280-12 load calculations is the foundation on which all other HVAC decisions are dependent. Builders need to take ownership of their load calculations.

03 **Control approaches can have vastly different results costing homeowners hundreds of dollars per year**

04 **NRCan's ASHP Sizing & Selection App provides data to support you selecting your mechanical systems.**

- Better data - leads to effective communication of performance
- Careful selection through discussion leads to better performance – and fewer callbacks

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Thank you for joining us today!

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