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Local Energy Efficiency Partnerships

January 28, 2025

Canada

Disclaimer

The aim of this publication is to provide HVAC contractors, homeowners, home builders and their design and construction teams with a framework for making decisions on better heat pump sizing & selection decisions in residential retrofit projects.

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Agenda for today

LEEP LOCAL ENERGY EFFICIENCY PARTNERSHIPS

TECHNICAL PRESENTATION

- **10 min** — INTRODUCTION TO LEEP
- **45 min** — MAKING THE CASE FOR CSA F280 IN NEW HOUSING
- **45 min** — MASTERING CONTROLS SYSTEMS FOR OPTIMAL HEAT PUMP PERFORMANCE
- **45 min** — HEAT PUMPS AND PANEL REQUIREMENTS: MITIGATING THE NEED FOR SERVICE UPGRADES
- **45 min** — LEEP ASHP Sizing & Selection Web Application

END

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.

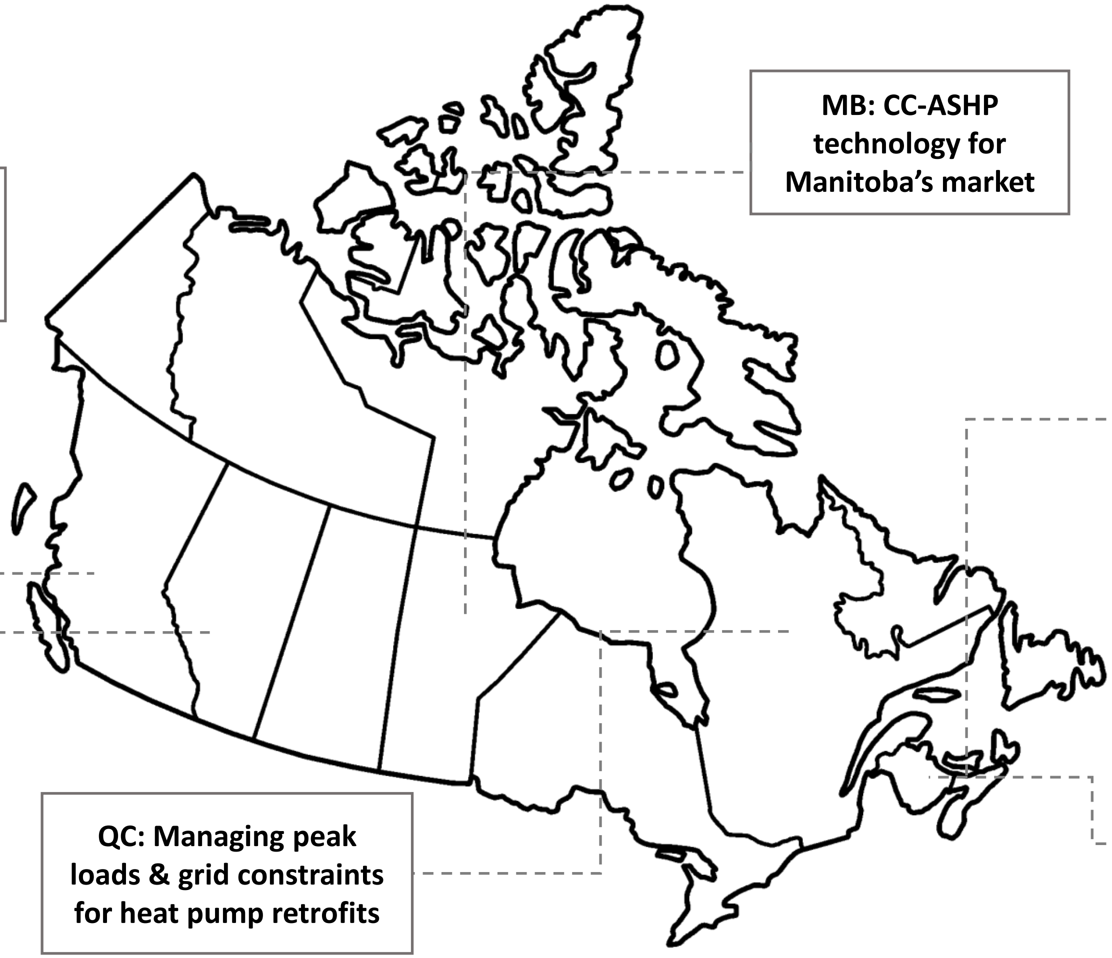
LEEP reduces industry **time & risk** in adopting new technology and building innovations.

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

Where is LEEP?



BC: Electrification & best practices in electrical service design for heat pump retrofits

MB: CC-ASHP technology for Manitoba's market

NS: Transitioning off-oil – to centrally ducted HP systems

AB: Electrification & heat pump best practices in new housing

QC: Managing peak loads & grid constraints for heat pump retrofits

NB: Controls for ductless mini-split systems

LEEP
LOCAL ENERGY EFFICIENCY PARTNERSHIPS

Workshops/Forums (New Homes) | Workshops/Forums (Renovations) | Workshops/Forums (Multi-Unit Residential Buildings) | Workshop for Contactors | Videos | Guides | Tools | College

Integrated Design Process	Operational & Embodied Carbon	Adaptation & Resilience	Electrical Load Management
Cost Benefit Analysis	Envelopes	Windows & Fenestrations	Modular & Panelization
Heat Pumps	High Performance Mechanicals	Solar PV	Case Studies & Field Trials

IDENTIFIED STRATEGIES

CALL TO ACTION FOR INDUSTRY – WE NEED YOU!

Influence

Canadians seek out information from HVAC-R contractors, heating/cooling companies, and utility providers as their trusted sources when selecting equipment for their homes.
Be prepared to explain heat pumps to homeowners, as there is only one intervention point every 20 years.

Trust

Your workers are the ones Canadians homeowners trust to install the equipment that they will rely on to heat their homes.

Use trusted resources to explain costs and benefits of electric heat pumps to homeowners.

Confidence

A homeowner's overall experience in installing a heat pump will inform their confidence in recommending a heat pump to someone else.

Take the time to upskill and learn how to properly size and select heat pumps.

KEY TAKE AWAY :

All areas of the HVAC-R industry play critical roles in promoting, installing, and maintaining the energy efficient heating equipment that will help us to achieve our net-zero goals.

Heat pumps are rapidly becoming the most popular heating equipment choice in Canada; outnumbering furnace sales by 20% in some regions

Learning objectives for today's workshop

1 Learn **better sizing practices** and techniques, considering:
- The heating loads of the house
- Understanding homeowner needs

2 Understand the **implications of different controls approaches** on energy, GHG and operating costs

3 Understand impacts of ASHPs and electrification on **Electrical Service and Panels**

4 How to **use NRCan's ASHP Sizing & Selection tool** for a data-driven approach to quoting retrofit jobs

Discussion

Describe your role in the housing industry.

81% of homes in Alberta are heated with gas furnaces

Incentive programs and fuel costs can make a **compelling business case** for homeowners to switch to hybrid heat pump systems… cold-climate centrally ducted systems make it easier to **manage utility costs**

- With better performing ASHP systems – operating costs **may be at competitive with furnaces**
- Increasing **consumer awareness of CO2 emissions** from space heating
- **Rebates & interest free loan programs** are bringing down the capital costs of ASHPs
- **Strong business case for heat pumps** in more remote communities with high prevalence of electric resistance, propane or oil heat

Heat pumps are one of the biggest investments Canadians make in their homes

Incentives and grants are bringing the prices down, but cost-competitive, data-driven quotes can set you apart from your competition

ASHP system to service the entire home (ductless or central)

$3,500 - $16,000
min max

CC-ASHP system to service the entire home (central)

$11,000 - $21,250
min max

! **Since 2021, almost 50,000 Canadians have received grants for heat pumps**

Discussion

What challenges or barriers do you face with HVAC systems in your projects?

Today’s case study home…

West End of Edmonton, AB

- Single family, 2 story home in Edmonton, 1890 heated sq. ft.
- 3 bedrooms;
- Year built: 2024
- Built with a centrally ducted gas furnace

What do we know about this home?

- Homeowners concerned about long term utility costs

TODAY’S GOAL

Identify a cost-effective heat pump solution that can best meet the needs of this home & family – using the data captured on this house.

Key takeaways

01 In many cases operating costs of gas furnaces may be competitive with hybrid heat pump systems

This will depend on

- Selecting right-sized heat pump systems that meet a significant portion of the home's load
- Selecting technology appropriate for the local climate
- Optimizing controls settings for back up heat

02 Installing air source heat pumps is different than furnaces

Pay close attention to sizing, control strategies and electrical panel requirements

03 NRCan has tools and resources to support industry with heat pumps

Provide cost, energy, and GHG efficient solutions for your customers
Minimize risks and reduce warranty calls
Build a strong and reliable reputation

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Making the case for CSA F280-12 heat loss calculations in new housing

January 28, 2025

Dave Turnbull

Canada

Agenda

01 What is an F280 calculation?

- Why should we care?
- What happens when a “rule of thumb” is used?
- Let’s explore a case study home…

02 Sizing Considerations for Heating & Cooling

- Considering temperature dependence of performance
- The opportunity is knowing the load

03 How do you do an F280 calculation?

04 Key Takeaways

What we heard from builders…

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
- **Space** for duct work and other mechanicals 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

What happens when a Heat Pump isn't sized properly?

- Higher risk of performance issues, callbacks, poor homeowner satisfaction, and unnecessary costs!

Undersized Heat Pump

- Risk of not meeting heating & cooling loads
- Greater reliance on backup heating
- Risk of higher utility costs (depending on back-up heat)
- Greater GHG emissions
- Risk of poorer occupant comfort

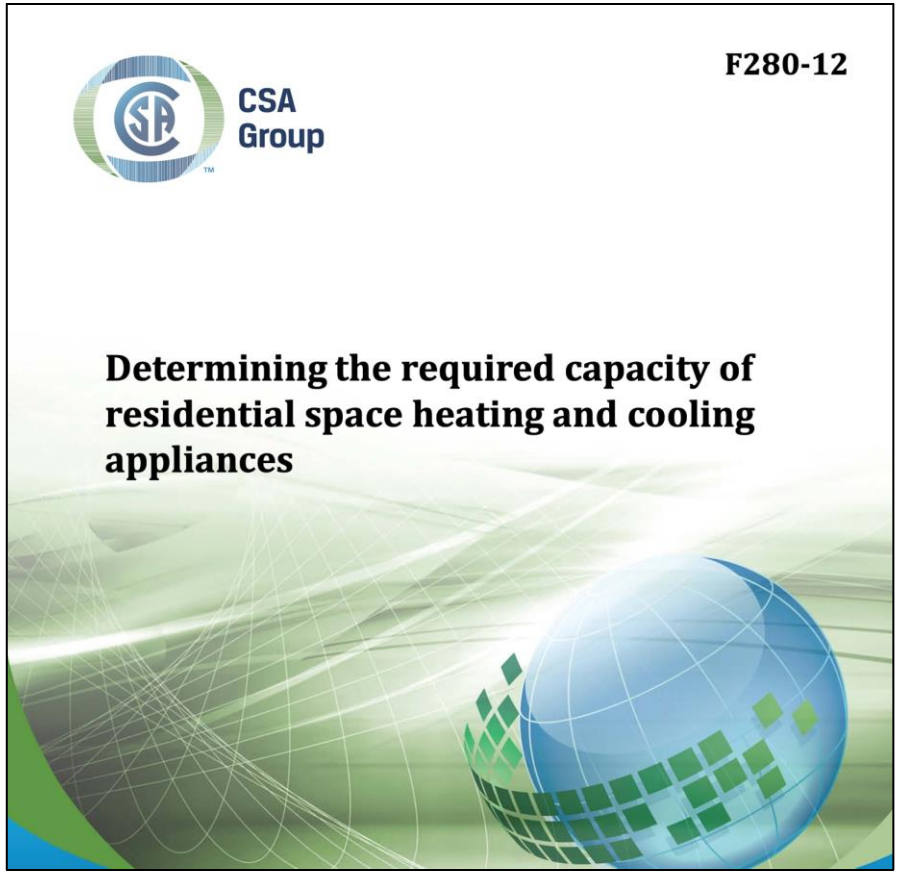
Oversized Heat Pump

- Higher capital costs
- Risk of poor performance - short cycling and reduced overall efficiency
- Risk of reduced equipment lifespan
- Risk of noisy ductwork and high static pressures
- Draw higher current on electrical panel
- Risk of poorer occupant comfort (dehumidification)

What is F280?

Calculation method for determining heat loss and gain to select the appropriate output capacity of both space heating and cooling appliances.

Best practice for sizing for <u>New Builds</u> and <u>Retrofits</u>



Key points for builders

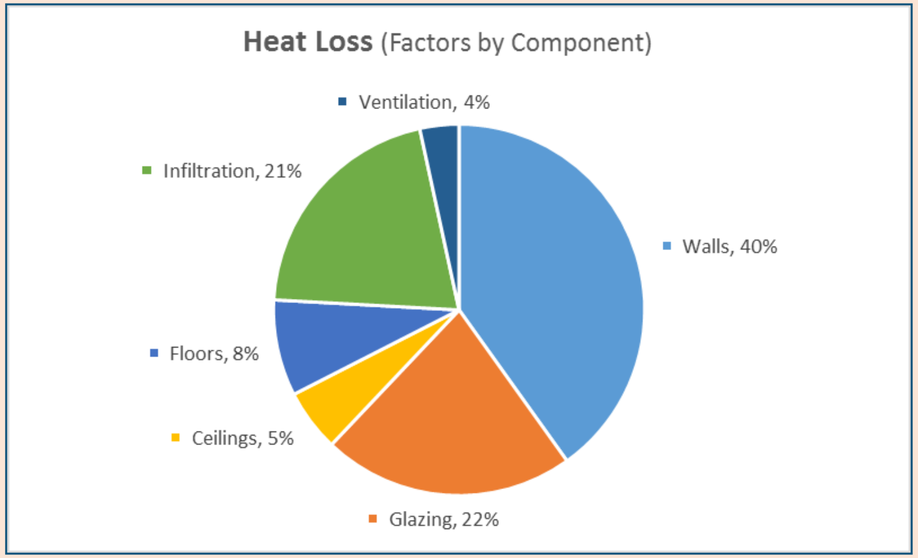
on heat loss/gain analysis

- ❑ Carrying out CSA F280-12 heat loss/gain analysis will right size heating and cooling systems, improve comfort, and reduce your build cost.
- ❑ Considering upgrade options that can further reduce the size of your mechanical systems is fast and cost effective
- ❑ Completing standardized and comprehensive performance details when submitting your plans for analysis will help make sure you get the best results.
- ❑ Reviewing the heat loss/gain results helps ensure the results are right and lets you see where you may want to focus on your next builds.
- ❑ Make sure your heat loss/gain professional is accredited, experienced, and using software that is certified for CSA F280-12.

Design Condition Context

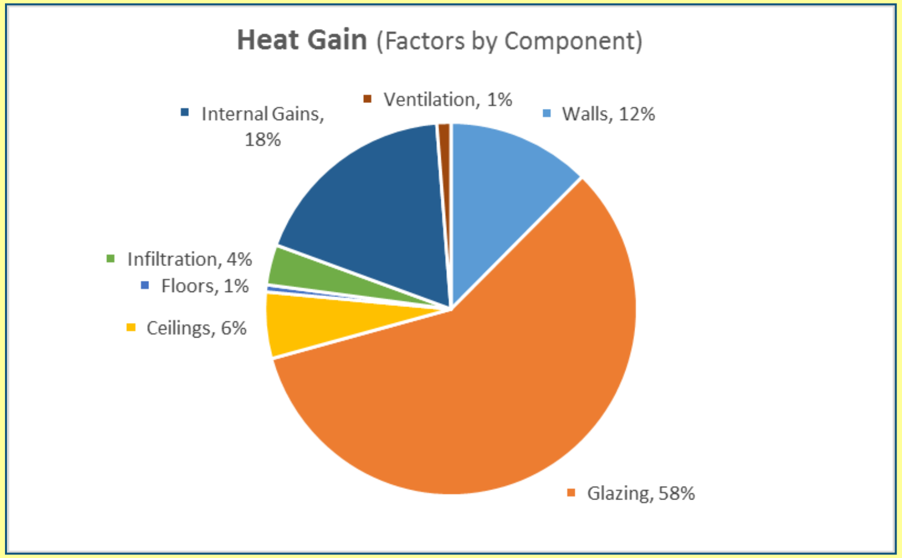
… and the factors that tend to most affect equipment sizing

Design Heat Loss (DHL)
Cold Winter Night



F280-12: must meet 100% of DHL, or more

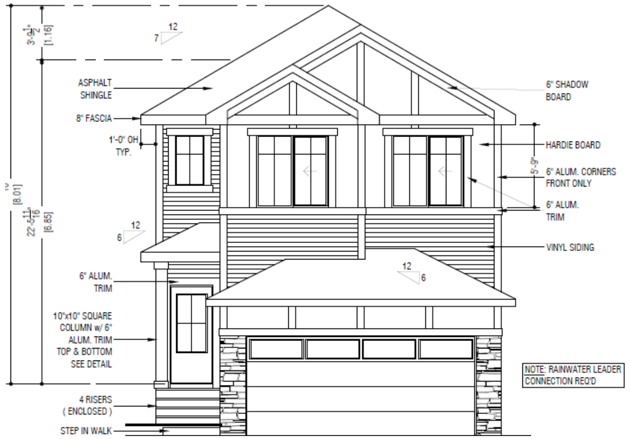
Design Heat Gain (DHG)
Hot Summer Day



F280-12: must meet 80% of DHG, or more

Design Loads

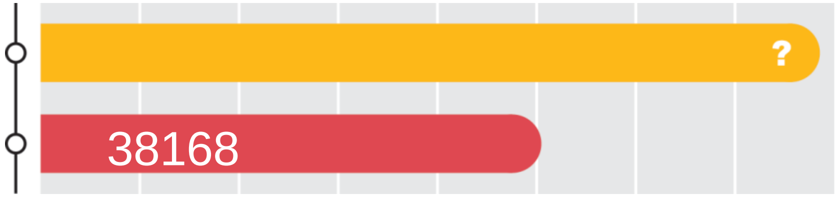
Rules of thumb generally overestimate heating and cooling loads



Space Heating Design Loads

Using CSA F280-12:

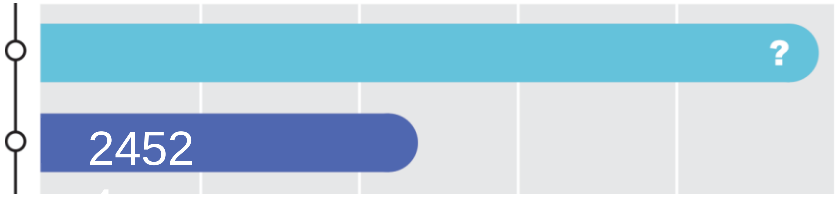
- Applying a 'rule of thumb'
- CSA F280-12



Space Cooling Design Loads

Using CSA F280-12:

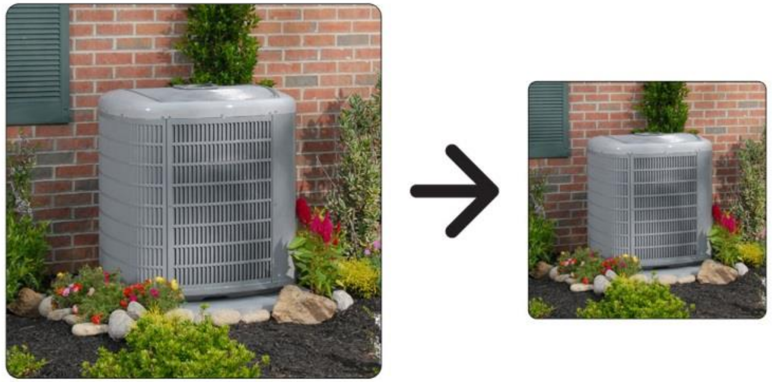
- Applying a 'rule of thumb'
- CSA F280-12



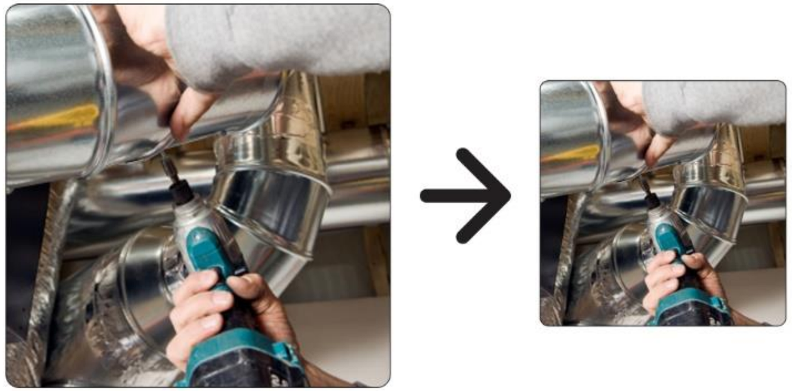
This allows for smaller equipment

Smaller heating equipment

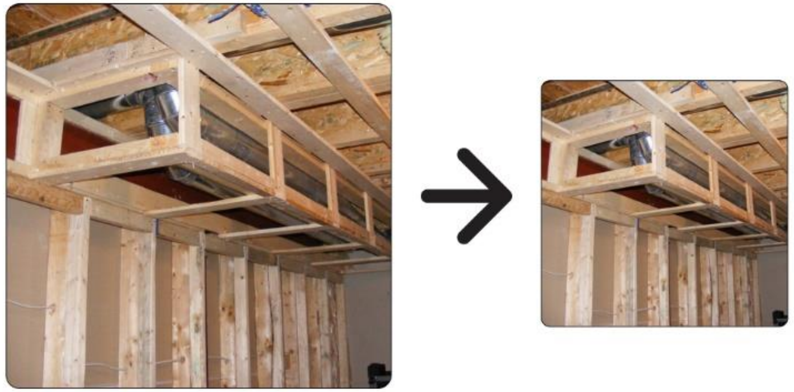
Smaller A/C equipment



Smaller duct work



Smaller and fewer bulkheads



Need properly sized equipment for cooling and dehumidification

How do we get there?

- ✓ Reduce airflow (350-400 CFM/Ton)
- ✓ Size system to provide longer runtime (avoid meeting set-point too soon)

! Some systems offer better, intelligent fan controls, particularly for airflow < 350 CFM

If you are aiming for a comfortable 24°C at 50% RH

	No dehumidification	400CFM/Ton	350CFM/Ton
Supply temperature (°C)	13	11	10
Water removed (g/kg of air)	0	1	1.4

40% increase in dehumidification

Case study home

HOME CHARACTERISTICS
Year built: 2024; Heated sq ft: 1891 sq. ft
Current space heat: Gas furnace, 43,000 BTU/h, 96% AFUE Current space cooling: NA
Heating load: ? **Cooling Load: ?**
Utility panel size: 100 Amps

Having done a F280 analysis, now what can we do with it…

Need to consider temperature dependence of performance

Given that info, you need a system that…

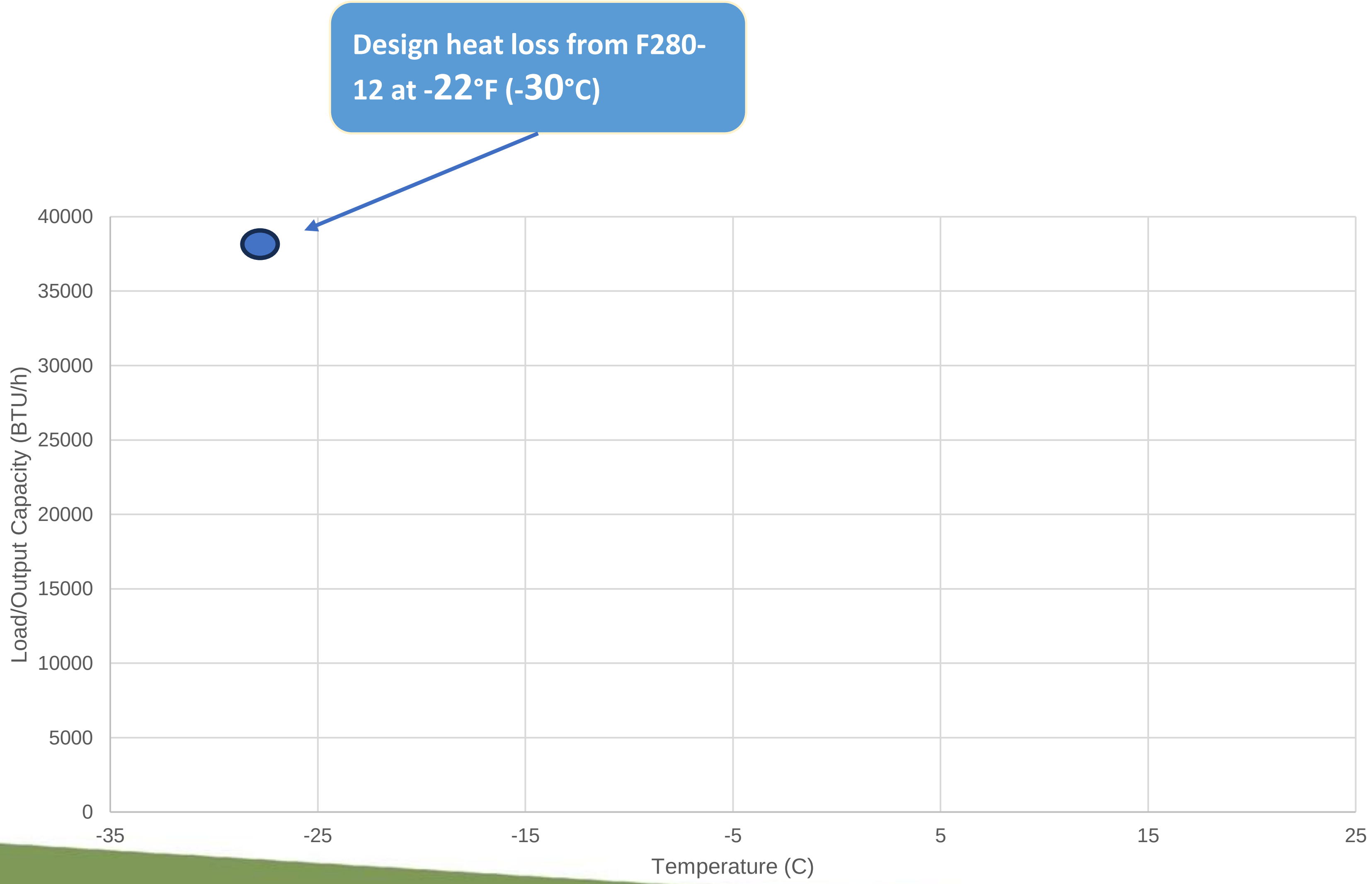
1. Calculates F280 design temperature heat loss
2. Creates the load line
3. Overlays the HP capacity curve
4. Identifies zones and TBPT

Want a system that:

✓ Meets most of HL/HG

✓ Provides good energy performance

Need to consider temperature dependence of performance

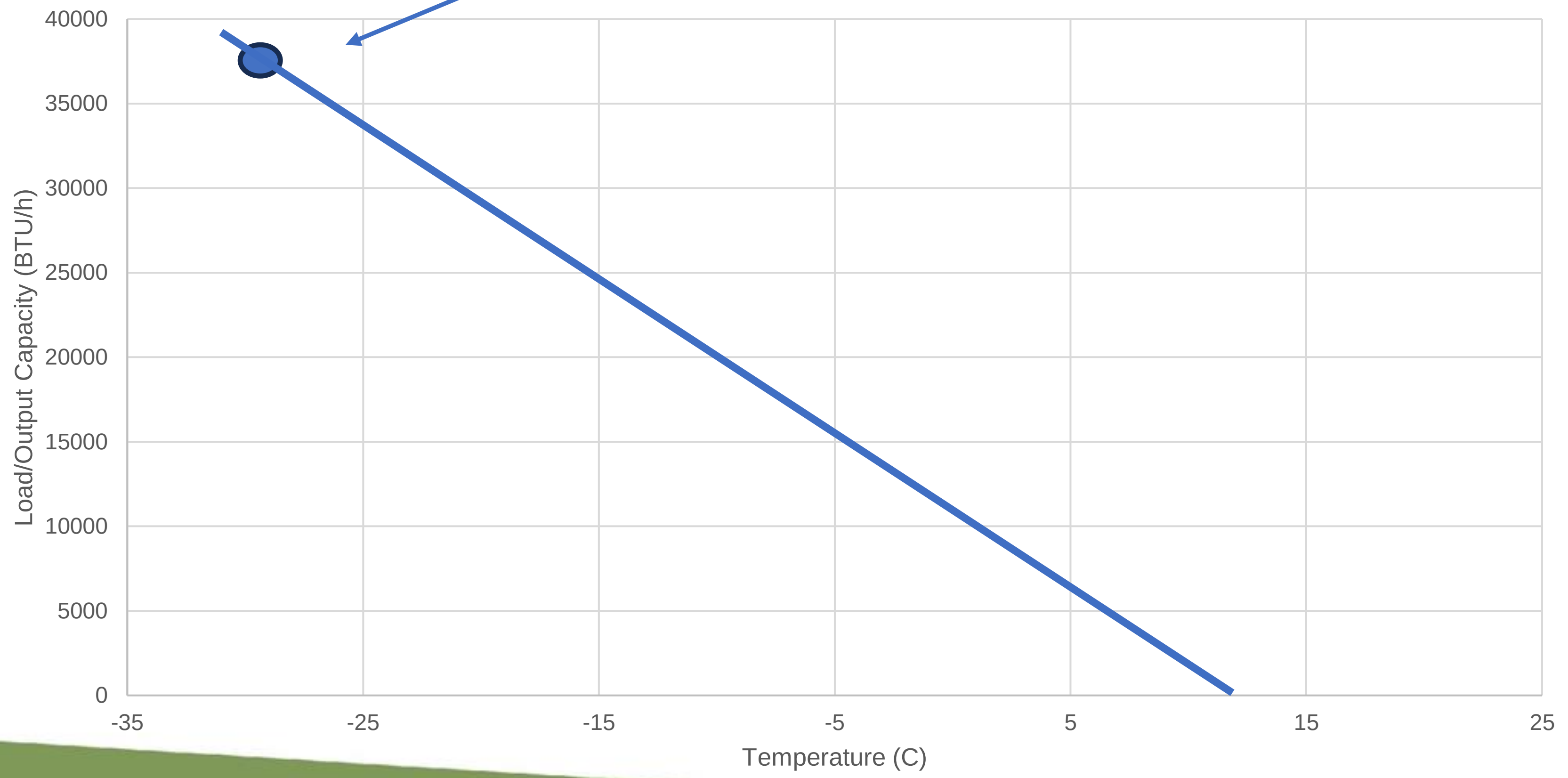


To do this manually:

1. Plot F280 design temperature heat loss

Need to consider temperature dependence of performance

Design heat loss from F280-12 at -22°F (-30°C)

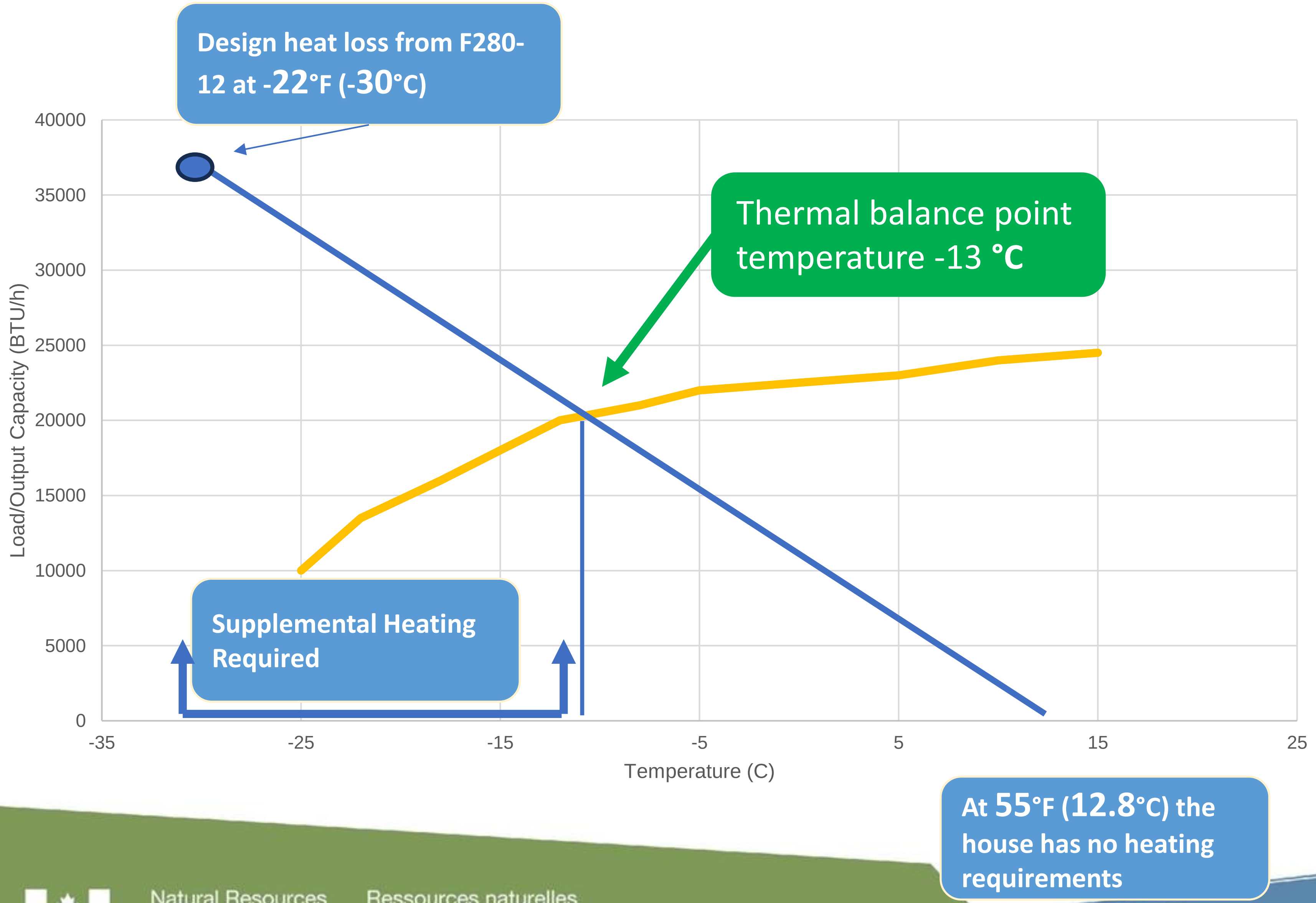


To do this manually:

1. Plot F280 design temperature heat loss
2. Plot heat loss load line

At 55°F (12.8°C) the house has no heating requirements

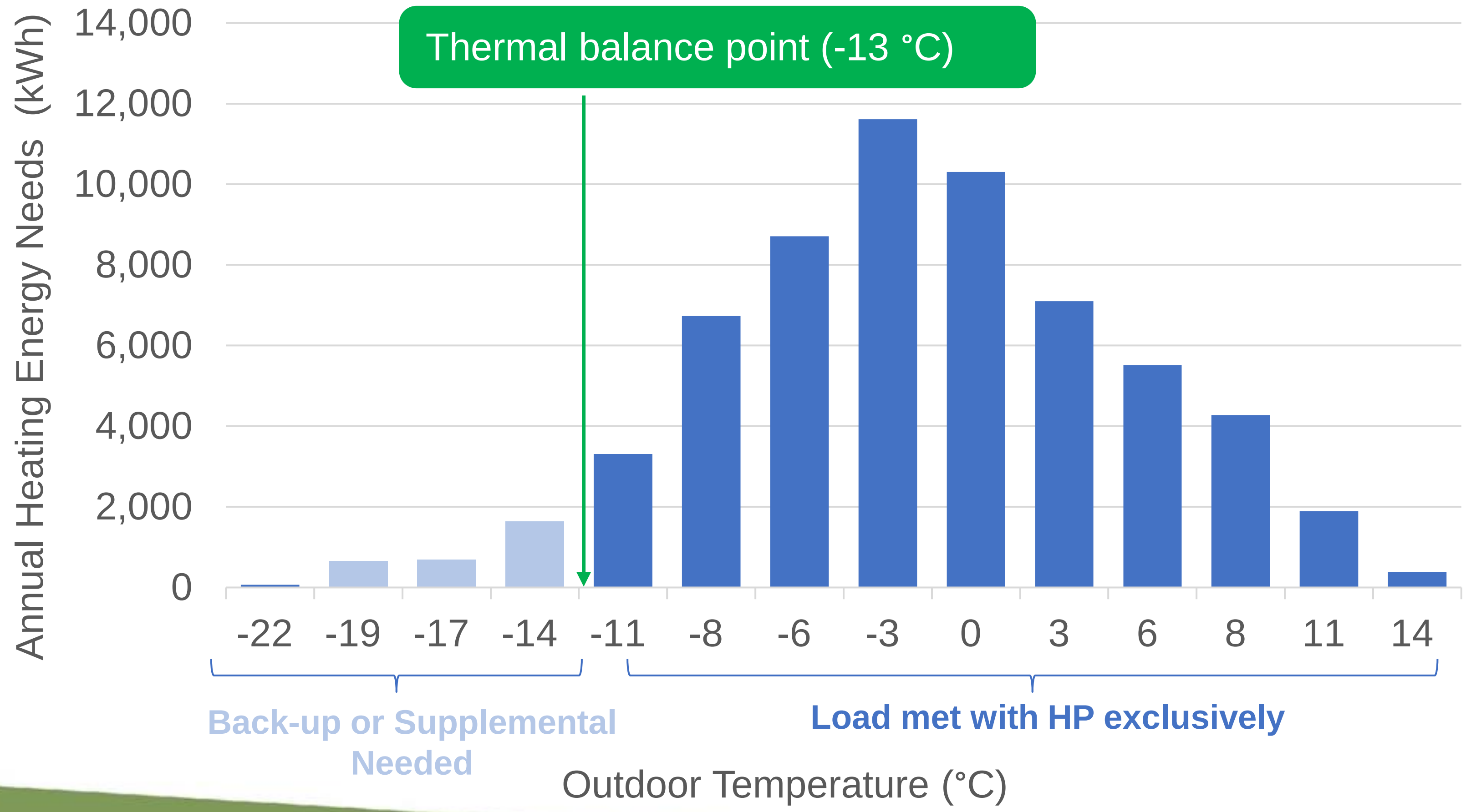
Need to consider temperature dependence of performance



To do this manually:

1. Plot F280 design temperature heat loss
2. Plot heat loss load line
3. Overlay heat pump capacity curve
4. Identify TBPT and zones where supplemental heating required

F280 Heat Loss Needed to Calculate Key Metrics



If you know the load, software can calculate other useful metrics for heat pump sizing:

- Operating costs
- Greenhouse Gas Emissions
- Fraction of annual heating needs that are above the TBPT
  - With a TBP of -12.8 C, ~70% of the load is above the TBPT
  - **Less than 2% of heating season load is below the outdoor design temp in Edmonton**

Using the sizing tool

- With the information above, you can use the NRCan sizing tool to easily determine costs, energy savings, GHG savings.
- Allows homeowner/contractor to explore different options including products, sizes and control strategies
- NRCan's new sizing and selection tool was developed to fit this need
- Will take a deep dive later today

Opportunity is knowing the load

When we know the load, we can install right sized systems that…

- ☑ Meets homeowner needs
  Operates as designed
- ☑ Achieve good occupant comfort
- ☑ Meets affordability and/or GHG emissions goals – lower upfront costs
- ☑ Reduce call backs
  Lower warranty calls

How do you do an F280 calculation?

What are your options for F280 calculations?

Room by room F280 is critical for new construction

OPTION A:
FULL F280 CALCULATION

Room-by-room F280 analysis using custom software

- ✓ Required for new construction
- ✓ Comprehensive Heat Loss and Gain calculation
- ✓ Requires full take-off & data entry
- ✓ More Accurate
- ✓ Heat loss calculated for each room

OPTION B:
Whole home F280

Whole home F280 analysis using HOT2000 files & new Fast F280 Tool (Volta SNAP)

- ✓ Useful for retrofits
- ✓ Takeoffs already completed by EA
- ✓ Minimizes additional work for contractor
- ! Requires coordination with EA/homeowner
- ! Less time, but not as accurate

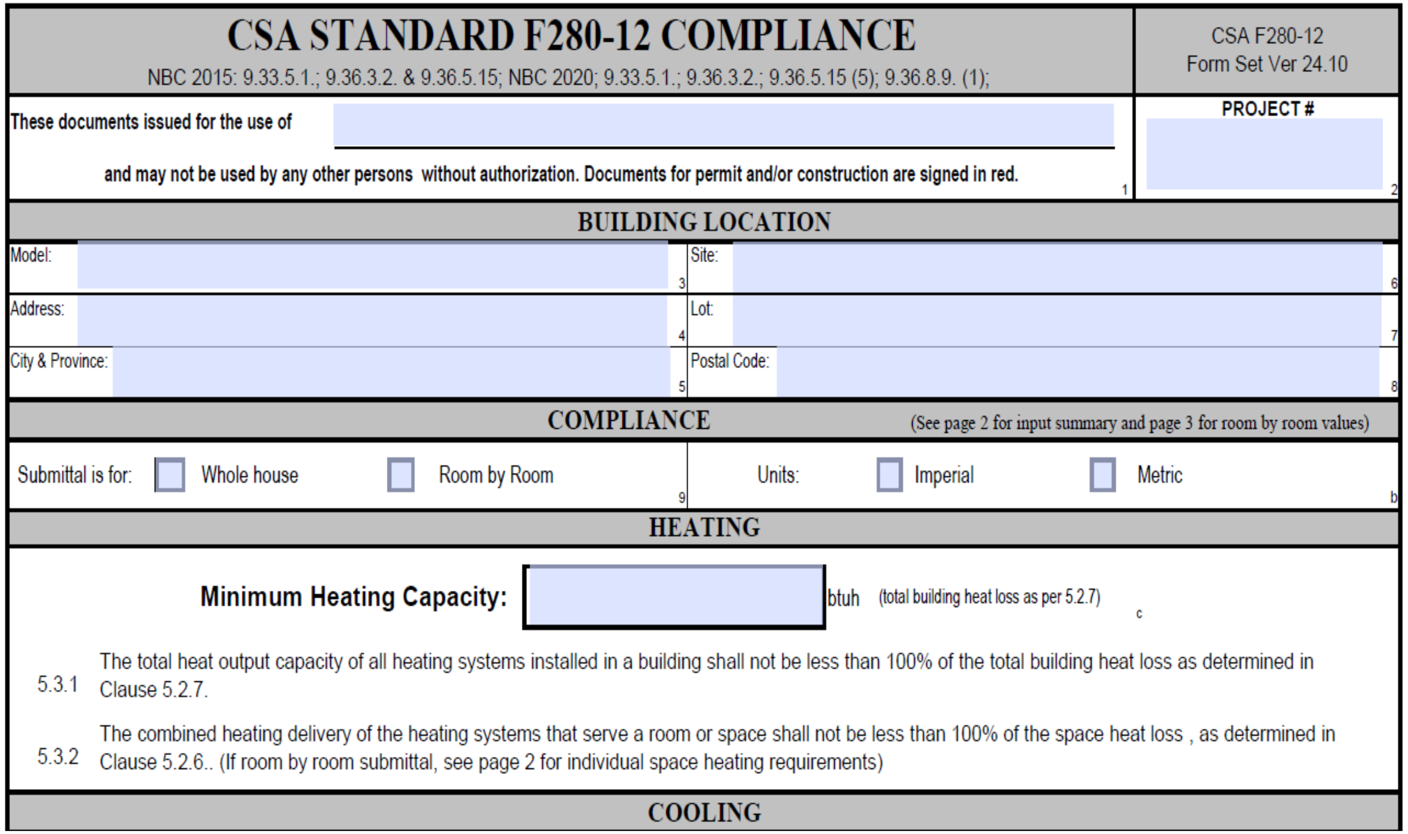
F280 Verified Software Listing

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

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

F280 Standard Forms

- Verified software vendors now have standardized F280 results forms
- Allows for faster and simpler process of approval from building officials
- Saves time and money on the design process



CSA STANDARD F280-12 COMPLIANCE

NBC 2015: 9.33.5.1.; 9.36.3.2. & 9.36.5.15; NBC 2020; 9.33.5.1.; 9.36.3.2.; 9.36.5.15 (5); 9.36.8.9. (1);

CSA F280-12
Form Set Ver 24.10

These documents issued for the use of

and may not be used by any other persons without authorization. Documents for permit and/or construction are signed in red. 1

PROJECT # 2

BUILDING LOCATION

Model: 3		Site: 6	
Address: 4		Lot: 7	
City & Province: 5		Postal Code: 8	

COMPLIANCE (See page 2 for input summary and page 3 for room by room values)

Submittal is for: ☐ Whole house ☐ Room by Room 9 Units: ☐ Imperial ☐ Metric b

HEATING

Minimum Heating Capacity: btuh (total building heat loss as per 5.2.7) c

5.3.1 The total heat output capacity of all heating systems installed in a building shall not be less than 100% of the total building heat loss as determined in Clause 5.2.7.

5.3.2 The combined heating delivery of the heating systems that serve a room or space shall not be less than 100% of the space heat loss , as determined in Clause 5.2.6.. (If room by room submittal, see page 2 for individual space heating requirements)

COOLING

Building officials can learn more at: https://hvacdc.ca/buildingofficials/

If you want to go in depth about F280 calculations

HRAI RESIDENTIAL HEAT LOSS & HEAT GAIN CALCULATIONS COURSE

HRAI
YOUR ENVIRONMENT OUR EXPERTISE

- 4-day course based on the new F280 standard
- Walk thru of step-by-step calculation process for heat loss and heat gain in the building envelope, including examining above and below grade HL/HG, air leakage and ventilation and the influence that people, appliances and window shading have on systems
- Target Audience: HVAC technicians and designers

Split into 2

Other Considerations

Other considerations	Details
Panel limitations	• If the panel may not have the capacity to handle a larger heat pump a proper load calculation should be conducted • Smart panels are becoming available at a lower cost than upgrading to 200 Amps
Ductwork capacity	• The physical size of the supply ductwork should be measured to determine the maximum airflow. • A CSA standard on airflow through ductwork is being developed. Some energy advisors have access to ductwork testing kits to provide you with static pressure measurements and airflow across the filter.
Ceiling height in basement	• Some older homes may have lower ceiling heights which can limit the size and/or model of heat pump selected
Location of outdoor unit	• Some homes may have limited options to locate the outdoor unit which may result in a smaller heat pump.

Let's compare the outcomes by calculation method

	Example Rule of Thumb (size to AC)	Example Rule of Thumb (size heating to area)	F280 Calculation
Heating Load (BTU/h)	60000	56000 = 30 BTU/hr per sq feet	38,168
Cooling Load (BTU/h)	24,000	1 Ton per 1,000 sq feet = 2 Ton	24,524
Heat Pump Size (Ton)	2 Ton	4 Ton	3 Ton variable capacity

Undersized for heating! More use of backup

Oversized for cooling! Dehumidification and ducting concerns

Sized appropriately for both heating and cooling

Key takeaways

01 Right-sizing systems leads to better results

- Happier homeowners and fewer warranty calls
- Comfortable & satisfied occupants – better reputation
- Lower upfront costs for builders
- More efficient installations

02 Using F280 is best practice for sizing

- Using verified F280 software is a cost-effective way to do an F280 calculation and get accurate heat loss and heat gain calculations.

03 Using a sizing and selection tool saves time

- Using the NRCan sizing and selection tool, you can quickly determine and compare potential systems

Questions?

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Mastering Control Systems for Optimal Heat Pump Performance

January 28, 2025

Dave Turnbull

Canada

Mastering Control Systems for Optimal Heat Pump Performance

01 **Current market offering in controls for centrally ducted systems and why we should care**

- Control Approaches
- What is Out There

02 **Detailed review of various control approaches available for centrally ducted systems**

03 **Case study – Impacts of different control strategies in an Edmonton Case Study home**

- Review Case Study Home
- Results From the Analyses
- Advantages and Disadvantages

04 **End goal and takeaways**

Heat Pump - Electric .vs. Gas Back-Up

Electric - Heat pump runs continuously over its full operating range

- Supplementary heater added below the thermal balance point as needed to meet the load
- Supplementary heater can operate simultaneously in conjunction with the heat pump

Natural Gas - Heat Pump runs according to one of the control options to be discussed

- The heat pump is turned off when back-up starts
- Heat pump and back-up do not run simultaneously, only one or the other at any given time

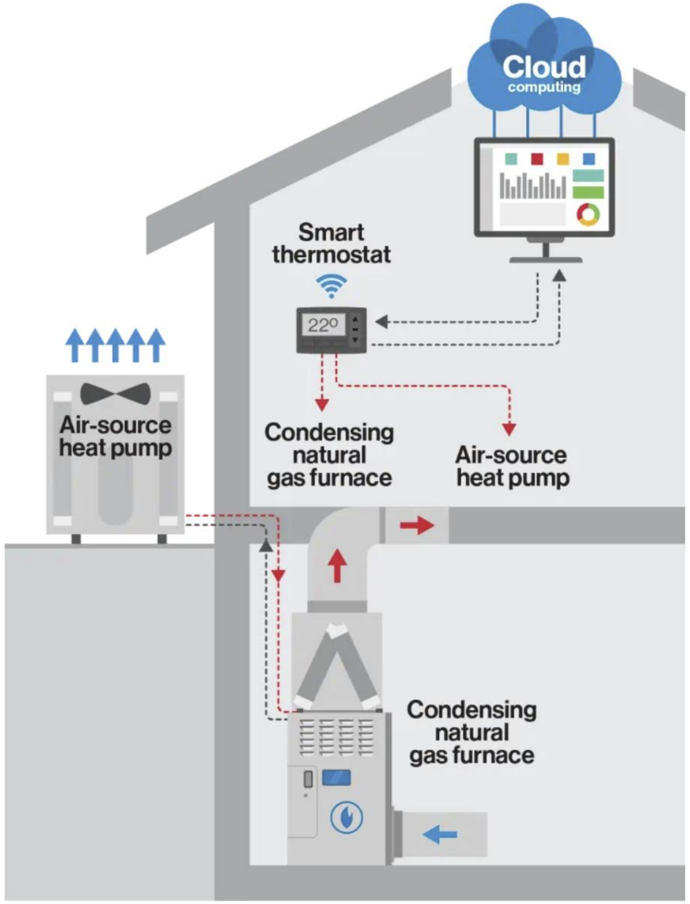

Figure: Hybrid Heating. Used with permission from Enbridge Gas Inc. All rights reserved. 2022.

Control Approaches // What is out there?

There are many different ways to control a hybrid system with a Heat Pump and auxiliary gas furnace back-up

- ❑ Outside Temperature Balance Point Cutoff
- ❑ Single Temperature Point Economic Cutoff
- ❑ 2 Stage Time-Temperature Hybrid

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

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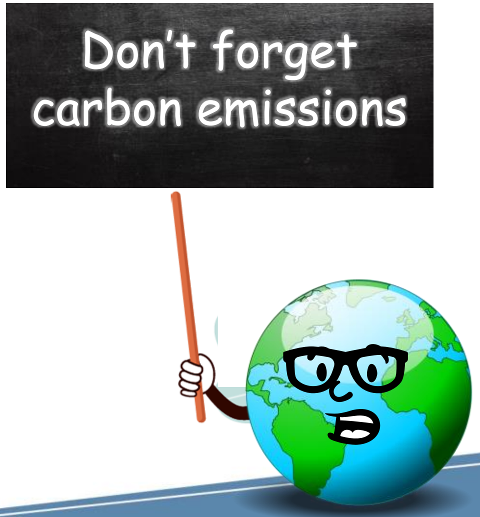
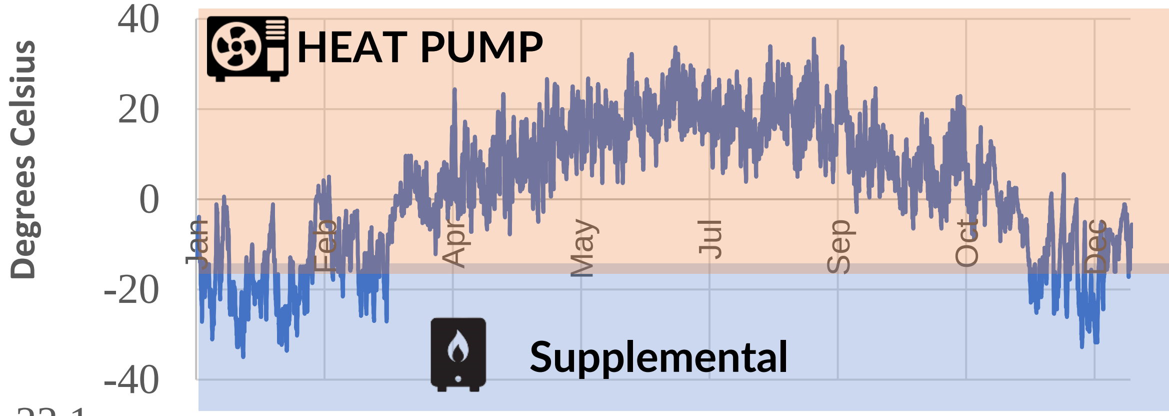
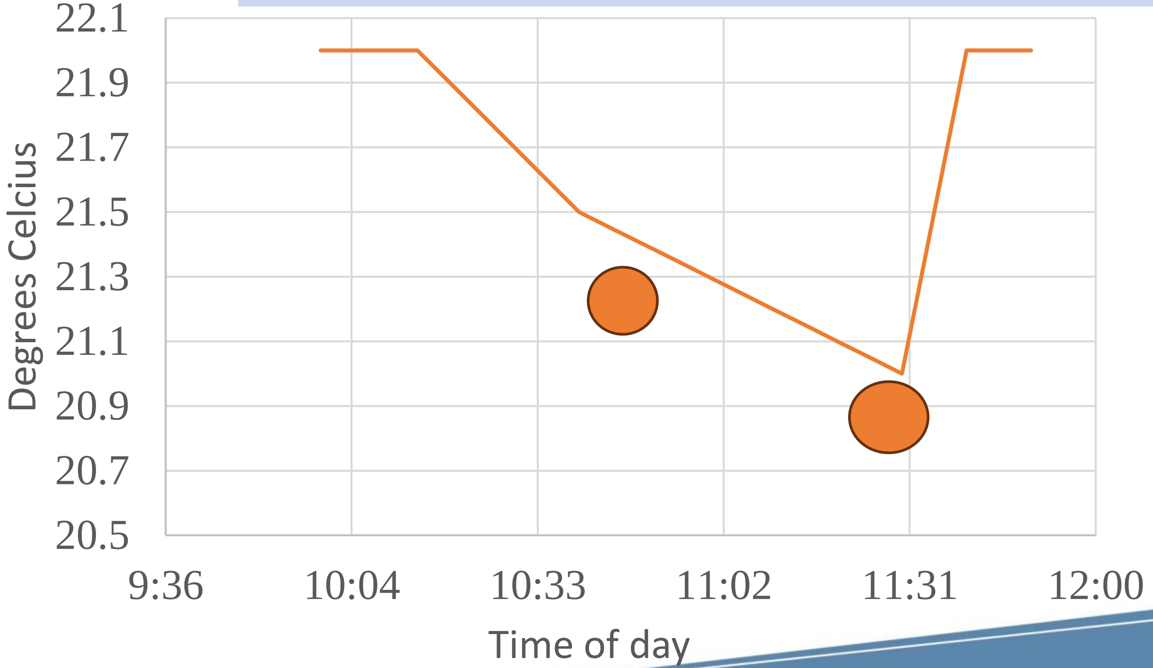


Let's investigate different control scenarios for this case study home

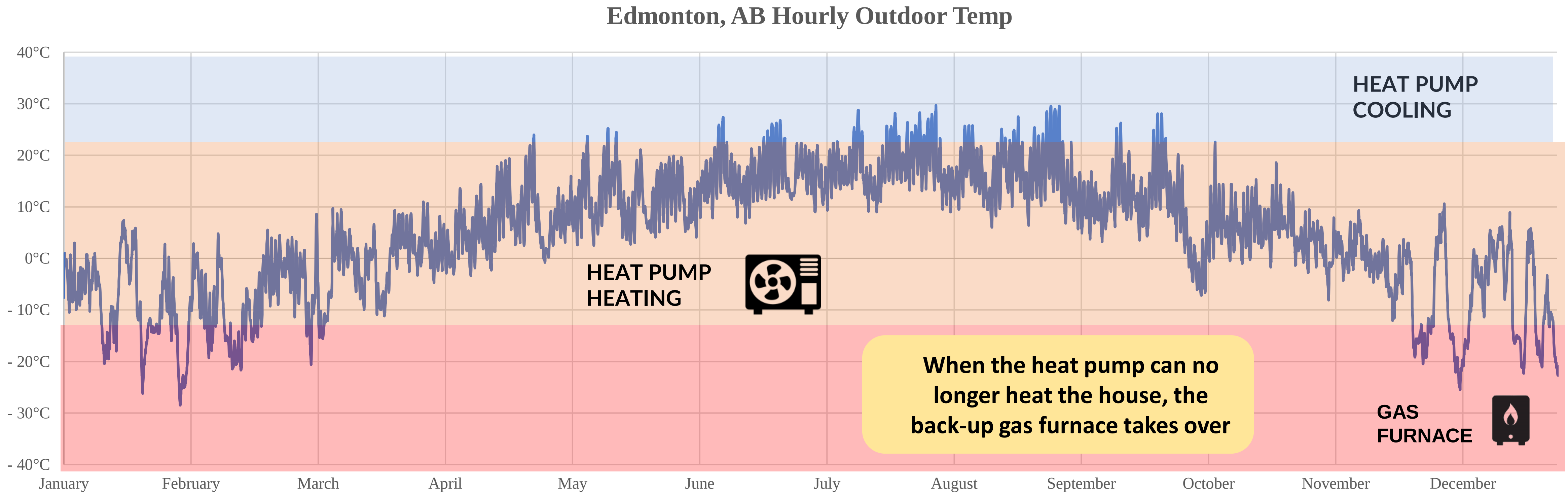
1. Cut off the heat pumps at their thermal balance point temperatures
2. Operate heat pump or supplemental heating when most economical
3. 2 Stage Time-Temperature based Hybrid Approach





Control Approach 1 //
Cutoff At Balance Point Temperature

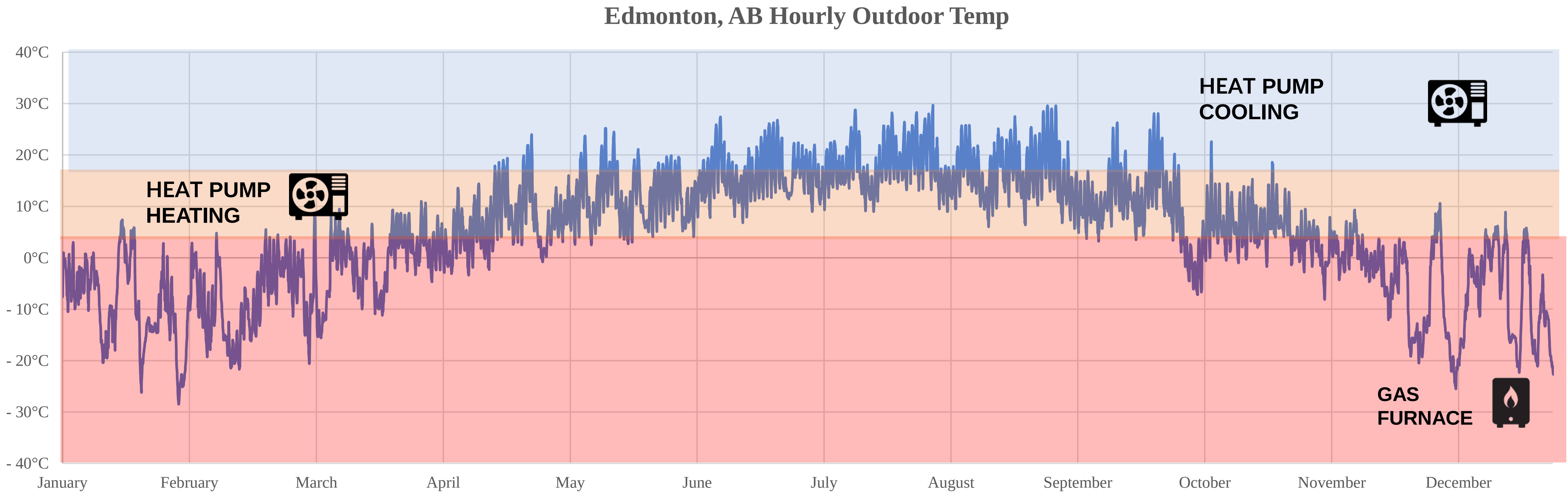
Depending on sizing of heat pump, it may not be able to supply all the heat required for the house. Backup may be required below the thermal balance point temperature.



Control Approach 2 //
Single Point Economic Temperature Cutoff

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

- **COP** of the heat pump **is lower at colder temperatures**
- **The NRCan HP Web application** calculates this in the backend



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

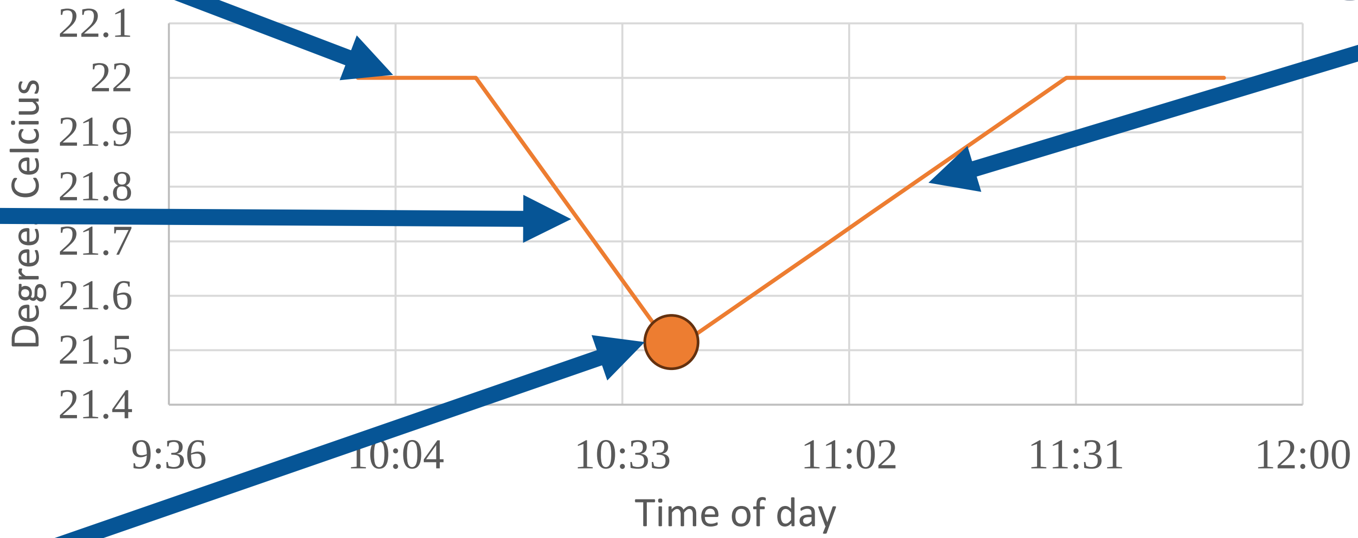
Control Approach 3 // 2 Stage Time-Temperature Hybrid

Temperature …

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

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

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



Stage 1: 21.5°C

Control Approach 3 // 2 Stage Time-Temperature Hybrid

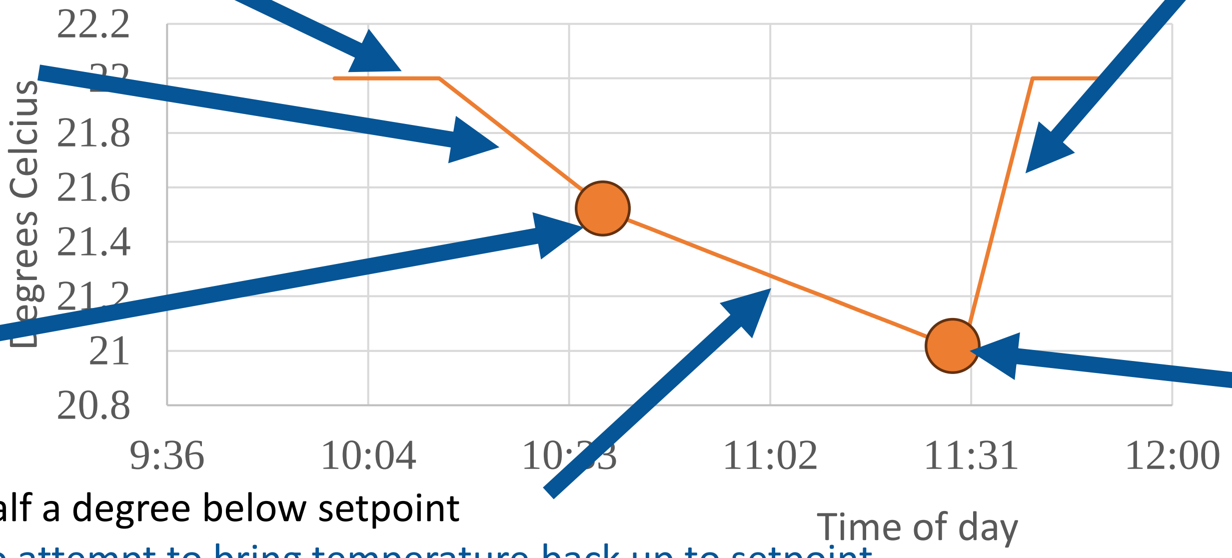
Temperature …

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

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

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

4. Setpoint temperature isn’t reached
   - ❑ Heat pump « off »
   - ❑ Gas heat « on » until setpoint is reached



Stage 1: 21.5°C

Stage 2: 21°C

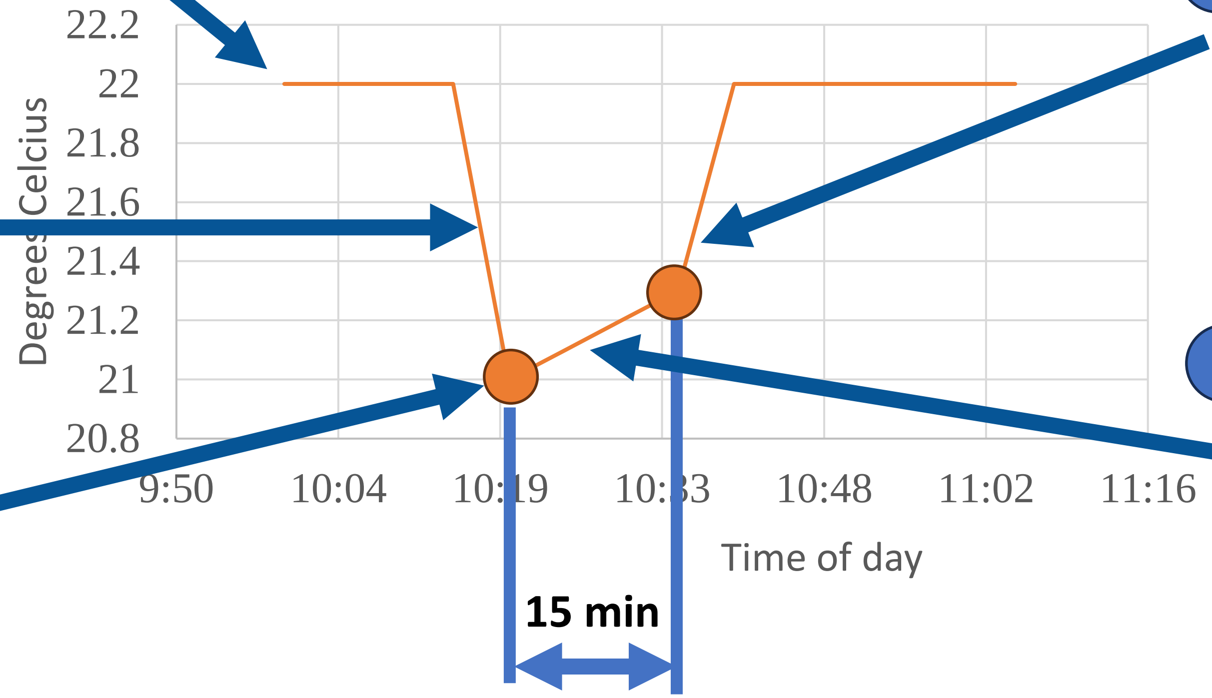
Control Approach 3 // 2 Stage Time-Temperature Hybrid

Time …

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

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

Call for heat: 21°C



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

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

Control Approach 3 // 2 Stage Time-Temperature Hybrid

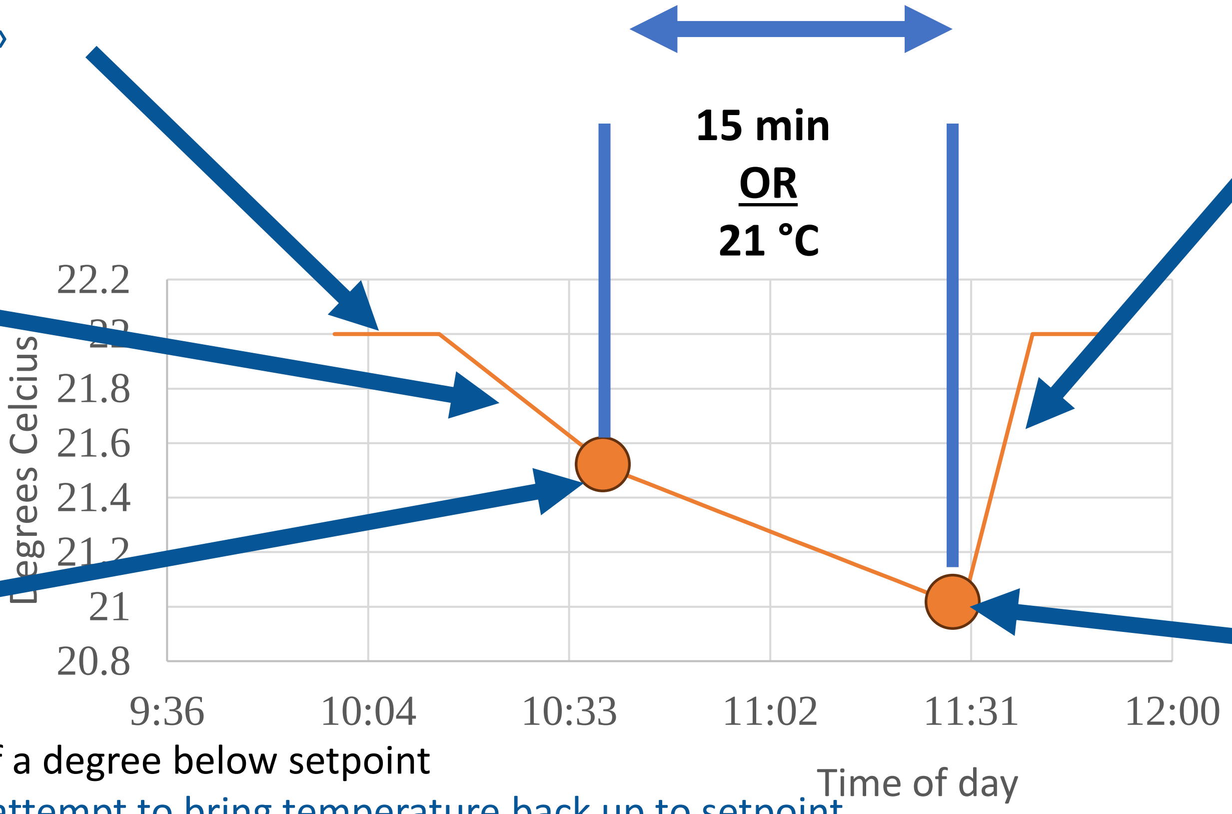
Bringing them together …

1 Setpoint temperature is maintained

- ❑ Heat pump « off »
- ❑ Gas heat « off »

2 Temperature drops below setpoint

- ❑ Heat pump « off »
- ❑ Gas heat « off »



4 Setpoint temperature isn't reached after 15 minutes, or temperature reaches 1°C below setpoint

- ❑ Heat pump « off »
- ❑ Gas heat « on » until setpoint is reached

Stage 1: 21.5°C

Stage 2: 21°C

3 Temperature reaches half a degree below setpoint

- ❑ Heat pump « on » to attempt to bring temperature back up to setpoint
- ❑ Gas heat « off »

For New Housing: Requirements in National Building Code

9.36.3.6. Temperature Controls

6) Heat pumps equipped with supplementary heaters shall incorporate controls to prevent supplementary heater operation when the heating load can be met by the heat pump alone, except during defrost cycles.

7) Heat pumps with a programmable thermostat shall be equipped with setback controls that will temporarily suppress electrical back-up or adaptive anticipation of the recovery point, in order to prevent the activation of supplementary heat during the heat pump's recovery. (See Note A-9.36.3.6.(7).)

Case Study investigating impact of various control approaches

Case Study Home

HOME CHARACTERISTICS

2024 New Build; **1,890 sq. ft**.

Original Heating: 43,000 BTU / hr Natural Gas Furnace

	Heating load (38,168 BTU/h)	**Cooling Load** (24,524 BTU/h)
Zone 1 (Basement):	10,702 BTU/h	6,876 BTU/h
Zone 2 (Living Area):	12,457 BTU/h	8,004 BTU/h
Zone 3 (Bedrooms):	15,008 BTU/h	9,643 BTU/h

Utility panel size: 100A

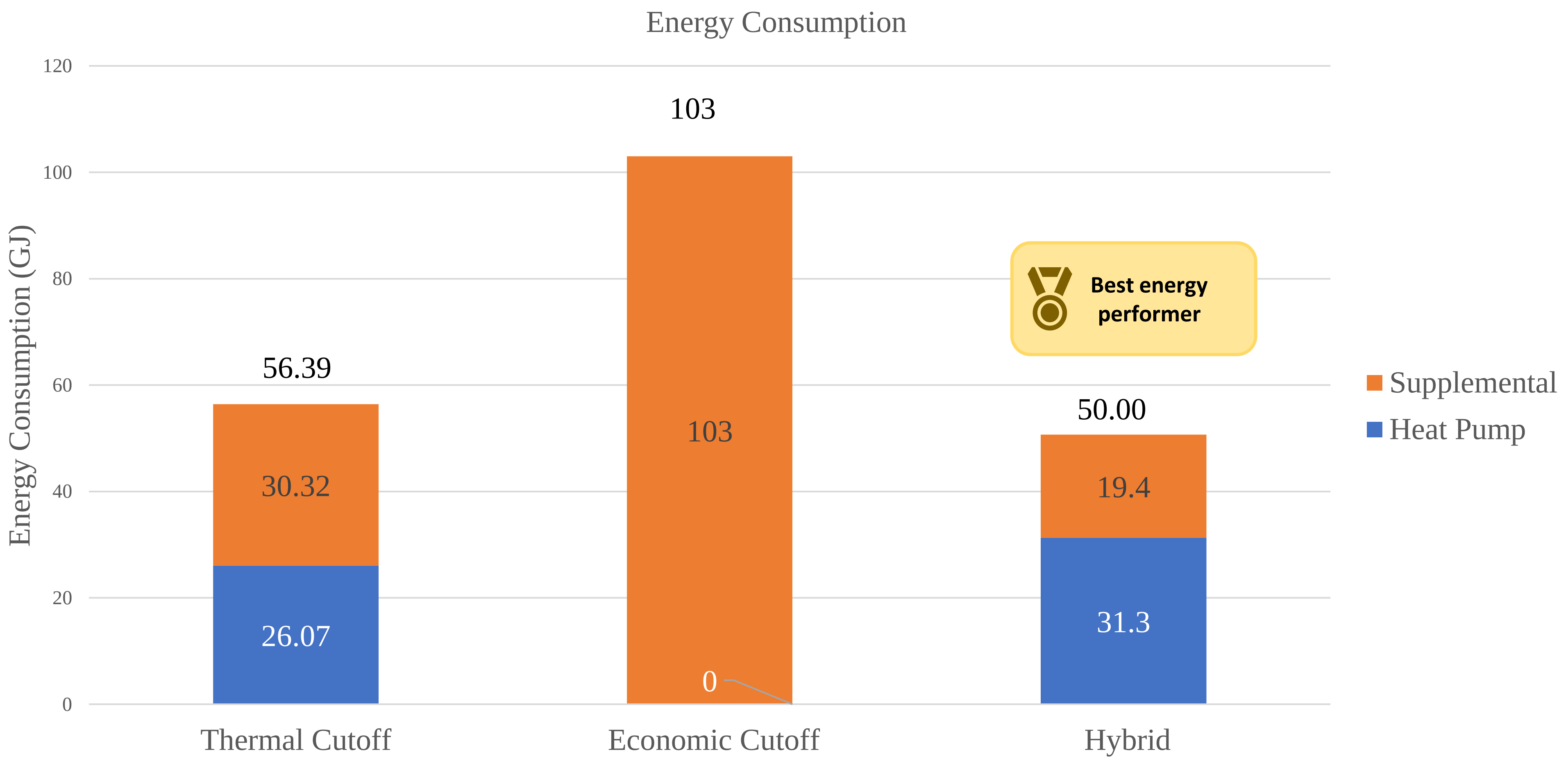
HOMEOWNER GOALS:

- **Reduce electricity consumption**
- **Have air conditioning for the summer months**
- **Manage costs**
- **Reduce Carbon Footprint**

Utility Pricing and Emissions Factors

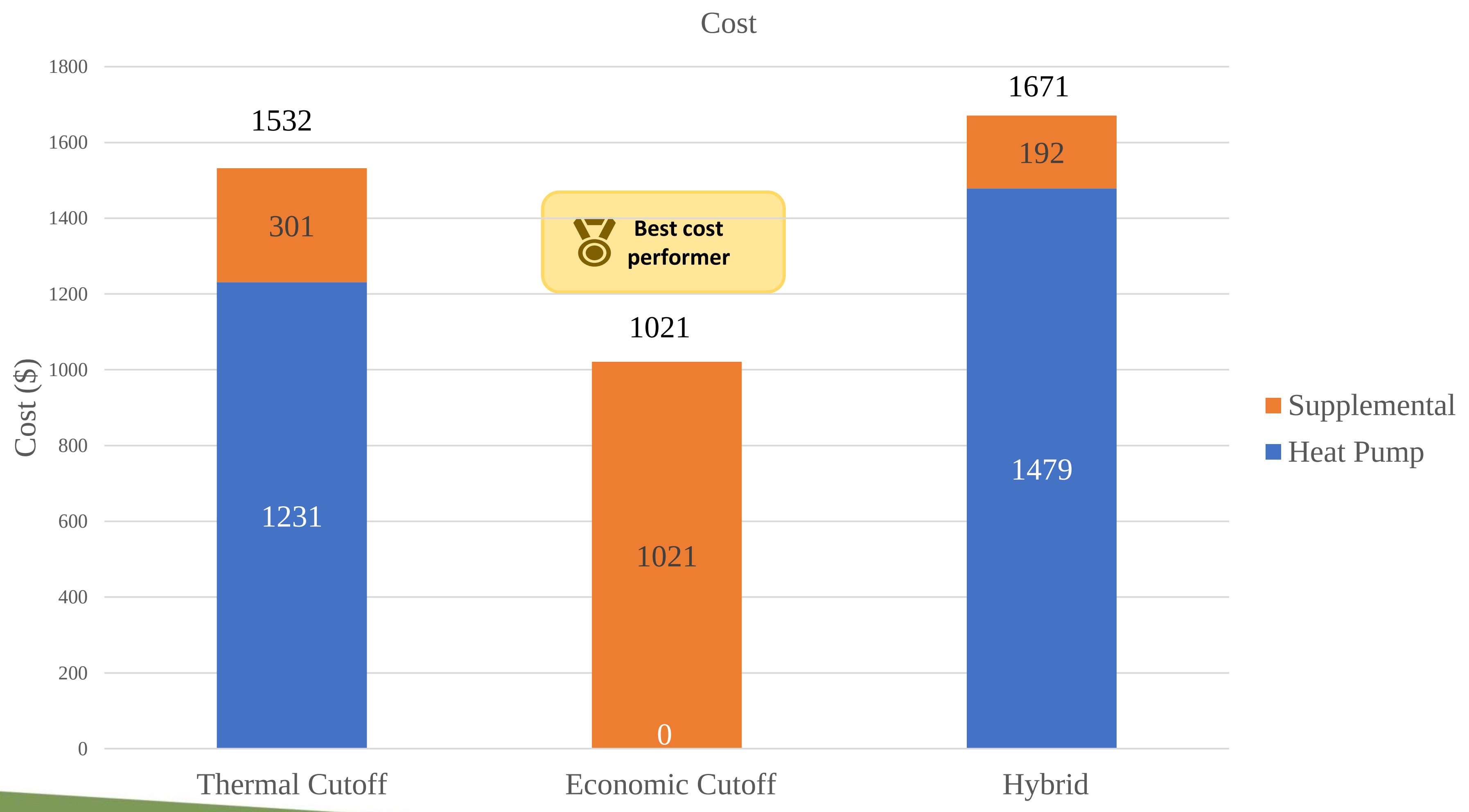
- Electricity and Natural Gas Prices vary across locations and providers
- NRCan Sizing and Selection App considers consumption costs of electricity and natural gas
- In Edmonton, assumes variable rates of 17 c/kwh for electricity, and 37 c/m^3 for natural gas.
- Web application currently assumes an electrical grid emissions intensity of 790 gCO2e / kWh, based on older estimates

ENERGY PERFORMANCE

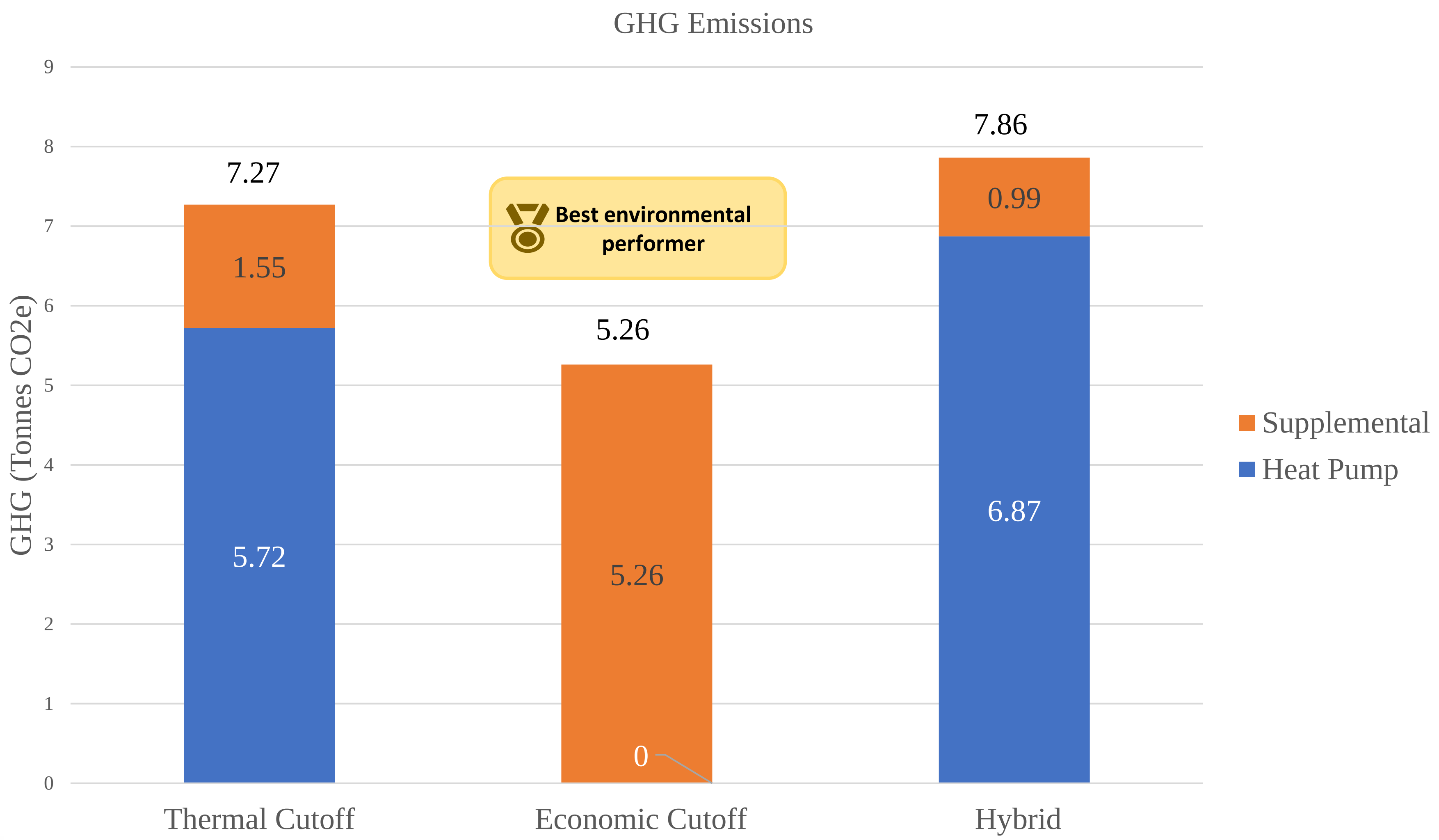


COST PERFORMANCE

Energy cost in Edmonton:
Gas: 37¢/m3 (3.8¢/kwh)
Electricity: 17 c/kwh
Includes all variable charges. Excludes fixed charges.



GHG PERFORMANCE

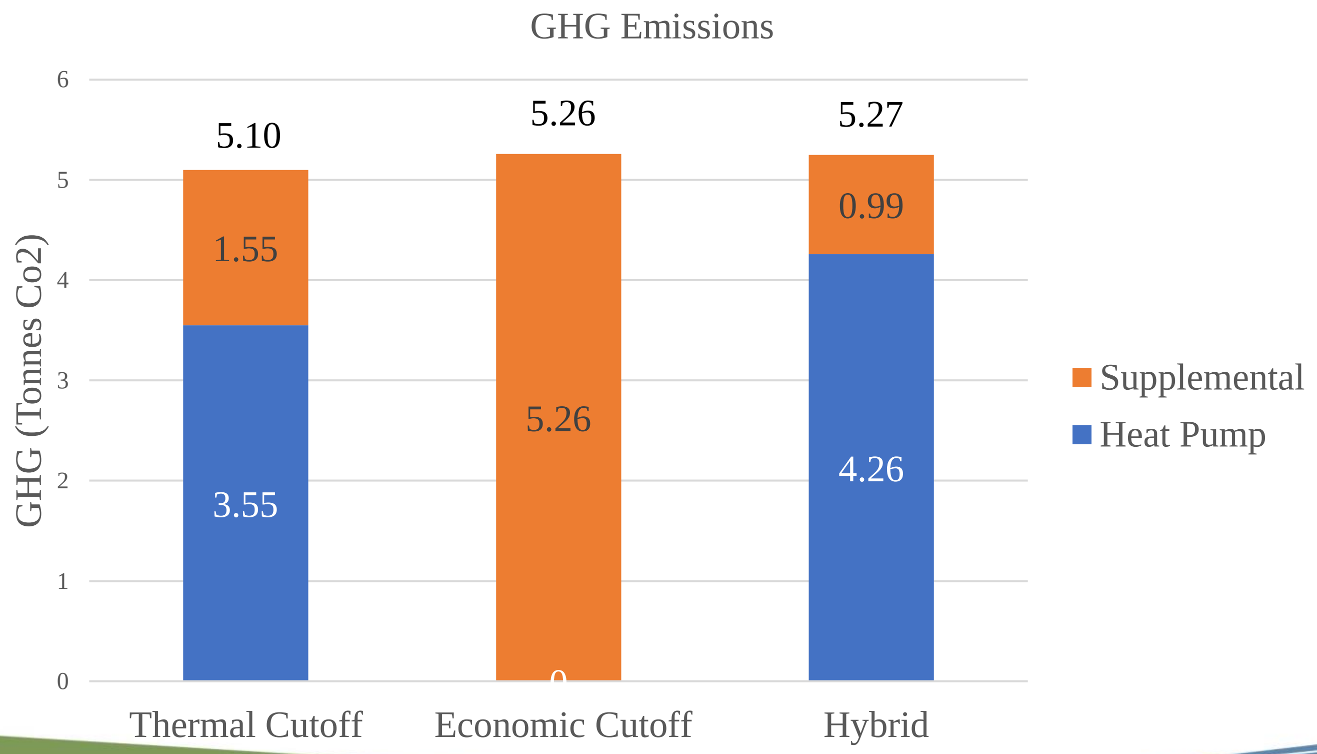


ADVANTAGES OF EACH APPROACH

Homeowner Goals	Approach 1 Balance Pt	Approach 2 Economic Pt	Approach 3 Hybrid
Resiliency to changing energy costs			
Reduced reliance on fossil fuels			
Reduced energy use			

A Note on GHG PERFORMANCE…

- Alberta's Electrical Grid is decarbonizing quickly
- Grid emissions intensity has dropped 38% from 790 gCO2e in 2018 to 490 gCO2e in 2025.
- Projected to drop to 390 gCO2e by 2029, aided by the phase out of coal power plants



WHAT CONTRIBUTES TO COMFORT?

- ❑ Continuous air circulation
- ❑ Variable Capacity
- ❑ Thermostat set up!
- ❑ Homeowner education

WHAT HAVE WE LEARNED?

01 Current market offering in controls and why we should care

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

02 Detailed review of various control approaches available

- Outside Temp at Balance Point Cutoff
- Single Temperature Point Economic Cutoff
- 2-Stage Hybrid Approach

03 Case study – Impacts of different control strategies in an Edmonton 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
- Heat pumps have a large potential to improve energy and GHG performance going forward

Questions?

Natural Resources Canada | Ressources naturelles Canada

Electrical Service Impacts of Heat Pumps

January 28, 2025
Dave Turnbull

Canada

Electrical Service Impacts of Heat Pump Installations

01 **Why Should Electrical Impacts Matter to Home Builders?**

02 **ASHP Electrification Challenges**

03 **Changing a Home's Electrical Personality**

- Careful ASHP Equipment Selection
- Load Limiting or Selection (Smart Switches and Splitters)
- Prioritized Load Enabling/Shedding (Smart Panels)

04 **Let's look at a case study home**

- Existing loads and classic service sizing methods
- Contemplated ASHP load with classic service sizing

05 **Call to Action – Achieving Best Results**

Why Should Electrical Impacts Matter to Builders?

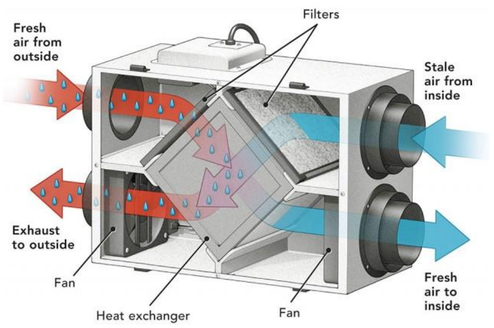
- HVAC selections **dramatically affect electrical service requirements** and overall project costs.
  - Service upgrades costs $6k - $12k for service panel and supply conductors.
  - Much more if utility transformer or secondary conductor upgrades required.

- Projects that reduce electrical service upgrading needs are **more likely to proceed.**

Discussion

How many of your projects are being constrained by electrical service capacity?

ASHPs and Electrification Challenges



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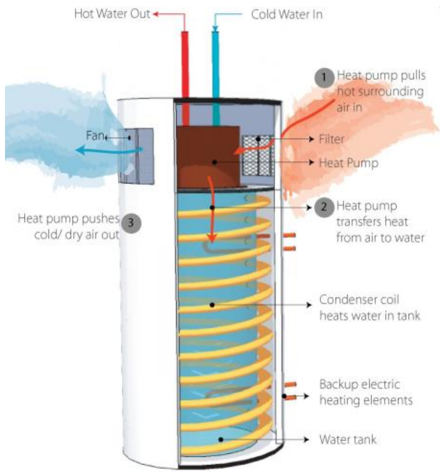

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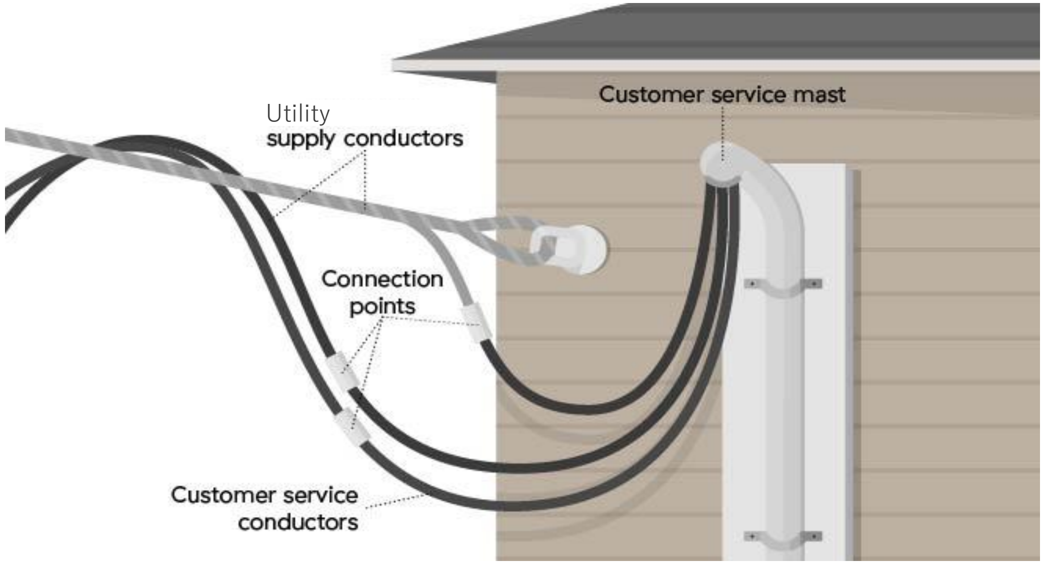
- ❑ Higher continuous load demand.
- ❑ Existing 100A or 125A services need upgrading (CEC Section 8)

Customer Service Constraints

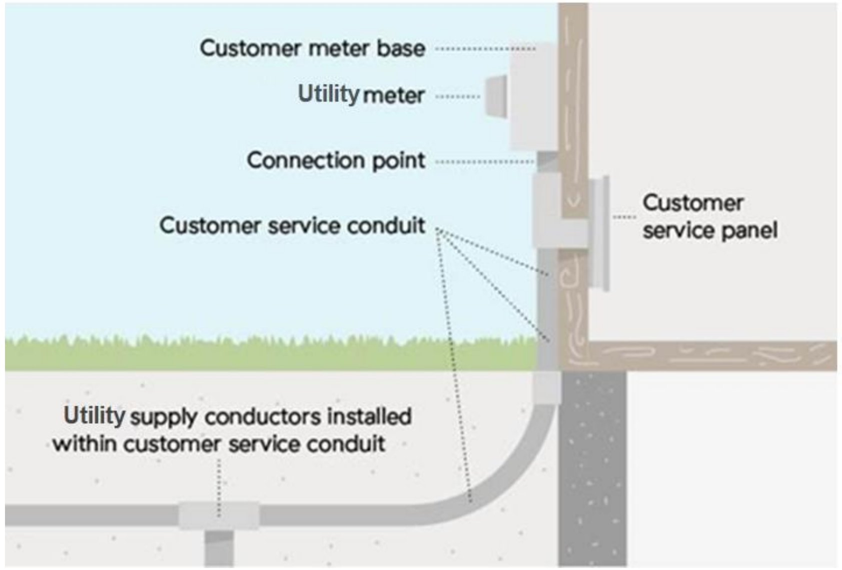
Upgrading costs vary dependent on customer service type.

Overhead Service



Supply conductors most easily upsized.

Underground Service



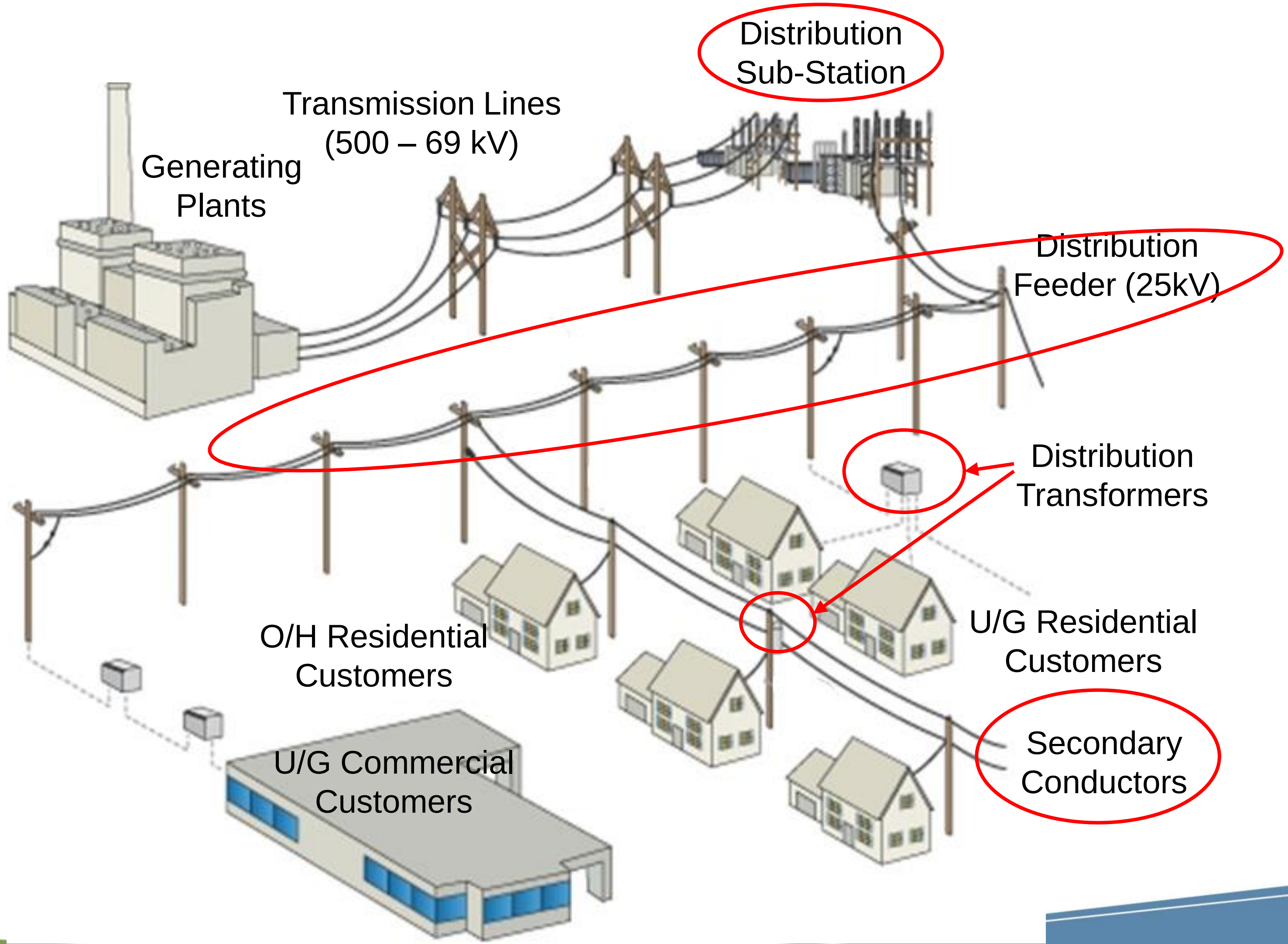
Supply conductor upsizing requires excavation, driveway cutting/repairs, landscaping disruptions, etc.

Utility Infrastructure Limitations

Multiple neighborhood or service area service upgrades can require utility infrastructure upgrades including:

- Substation equipment
- Distribution feeders
- Distribution transformers
- Secondary conductors.

Expensive, difficult, or even impossible in some regions.

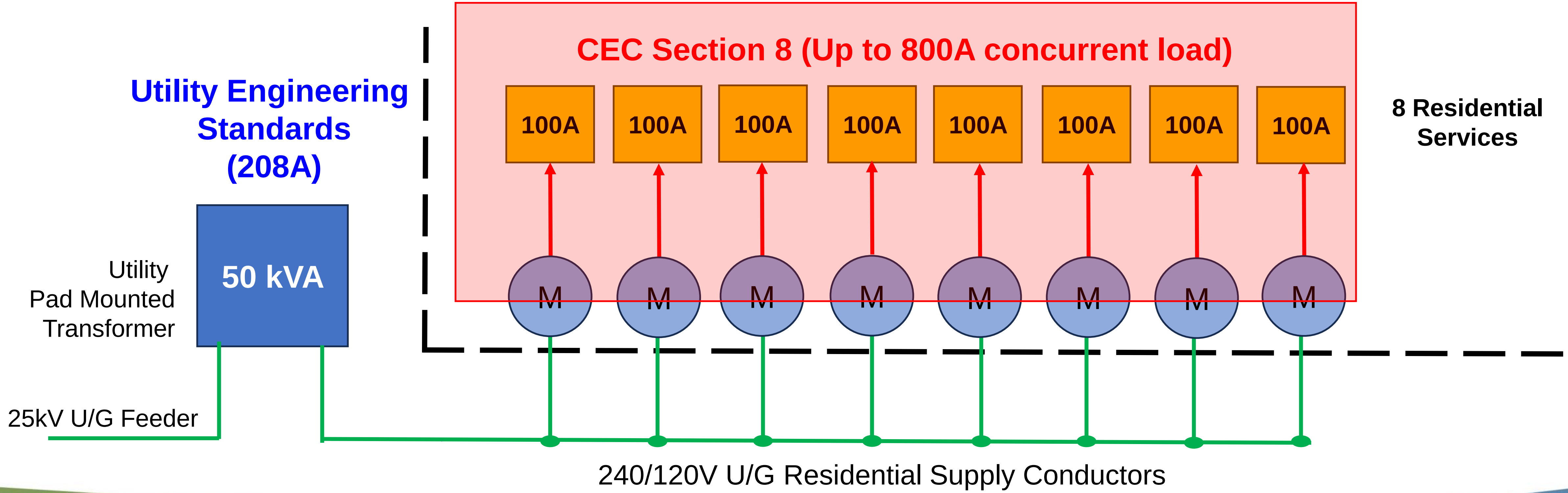


CEC Section 8 – Service Sizing Requirements

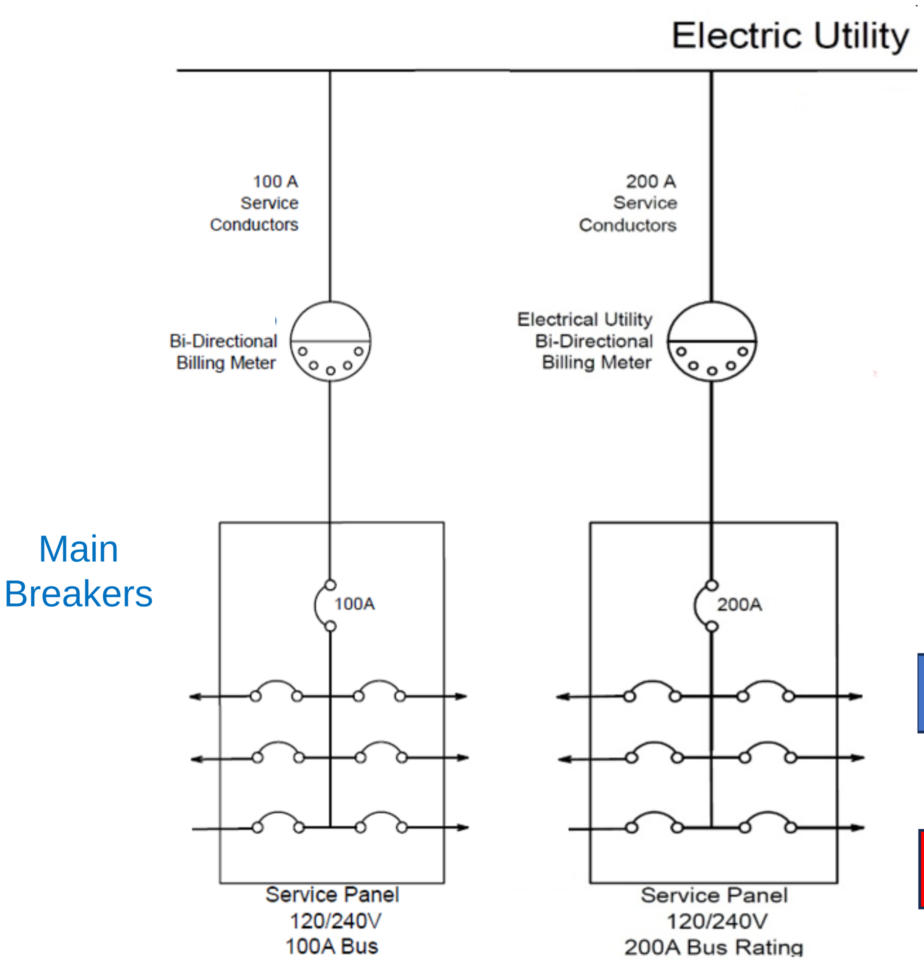
- Safety centered to avoid service overload under worst case scenarios
- Key principles include:
  1. Service overcurrent protection devices (OCPD), like breakers and fuses, do not limit or justify service sizing.
  2. Living area (m^2) dictates continuous base loading (load is never less)
  3. Heavy loads (> 1500W) assumed to all run concurrently, with some allowable derating factors for specific loads.
- Includes permissible load control methods that may lessen service upgrading requirements if carefully applied.

CEC Service Sizing vs Utility Distribution Capacity

- ❑ Utility Engineering Standards – Empirical, sustainable. Load Diversity.
- ❑ CEC Section 8 – Caution for consumer safety. Load Concurrence.



Service OCPDs Do Not Limit or Justify Service Size



- Service sizing must be based on the nature and size of Connected Load, and Living Area.
- Eg. CEC does not permit the tripping of a 200A main service breaker on sustained overload, to justify connecting more than 200A of calculated service load. Rather, a 400A service is required.

198A → OK

202A → Not OK

Service Load Calculated
Per CEC Section 8

Living Area (m^2) Dictates Continuous Basic Load

Ground Floor Area (m^2)	86
Living Area Above Ground Floor (m^2)	103
Living Area Below Ground Floor (m2) x 70%	73
Effective Living Area (m2) 8-110 a,b,c	**262**
Basic Load (first 90 m2) 5000 W	5000
Additional (per 90 m2 Increment) 1000 W	2000
Effective Base Load (Watts) 8-200, 1a	**7000**

- **Basic Load** (Receptacles and Lighting) calculated by living area
  - 5000 W first 90 m^2.
  - 1000 W per additional 90 m^2 or portion.
- **Basic Load** considered continuous (i.e. Load never less than this)
- **7000 W (29.2 Amps)** for two story 2685 ft^2 case study home
- 29.2% of 100A service capacity used by prescriptive basic load calculation
  - Only 70.7A left to work with.

Continuous Loads (>1500W) Assumed to All Run Concurrently

- ❑ Space Heating
- ❑ Air Conditioning
- ❑ Electric DHW
- ❑ Electric Range
- ❑ Electric Dryer
- ❑ EV Charging
- ❑ Others
  - Hot Tub
  - Sauna

Even though permissible deratings apply (space heating, electric range), these can quickly use up remaining service margin!

Discussion

How many of your customers are also planning other electrification upgrades – e.g. EV chargers, pools/hot tubs, other?

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

Case study home

HOME CHARACTERISTICS
Year built: 2024; 2685 sq. ft
Current space heat: Gas furnace, 43,000 BTU/h, 96% AFUE Current space cooling: NA
Heating load 38,168 BTU/h Cooling Load: 24,524 BTU/h
Utility panel size: 100 Amps

Changing a Home's Electrical Personality

Several options available:

1. Careful ASHP Equipment Selection
2. Load Limiting or Selection (Smart Switches and Splitters)
3. Prioritized Load Enabling/Shedding (Smart Panels)
4. Sneak peak: Demonstrated Load

Case Study Home with a 100A Service Before Heat Pump

CEC Section 8 - 200					
Single Dwelling Residential Service Sizing					
Continuous Loads	**Num**	**Rated Watts**	**Rule**	**Eff. Watts**	**Amps**
Electric Range Load	1	7500	8-200 1a, iv)	6000	25.0
Electric Dryer (30A @ 0.8)	1	5760	8-200 1a, vii)	1440	6.0
Air Conditioning 2.5 Ton	1	3250	8-200 1a, iv)	3250	13.5
Total Calculated Load				**10690**	**44.5**
Effective Basic Load				**7000**	**29.2**
Continous Calculated Current	**Service Size is OK**				**73.7**

Main OCB Device Rating (Amps)	100
Permissible for Calculated Load	100%
Maximum Demand Current (Amps)	**100**

26.3A Margin Remaining

- 2685 ft^2 home
  - NG Furnace
  - NG DHWT
  - Electric Range
  - Electric Dryer
  - 2.5 Ton AC unit
- 100 Amp service suffices before heat pump.
- Calculated 38,168 BTU heating load, 24,524 cooling load (F280)

Changing a Home's Electrical Personality

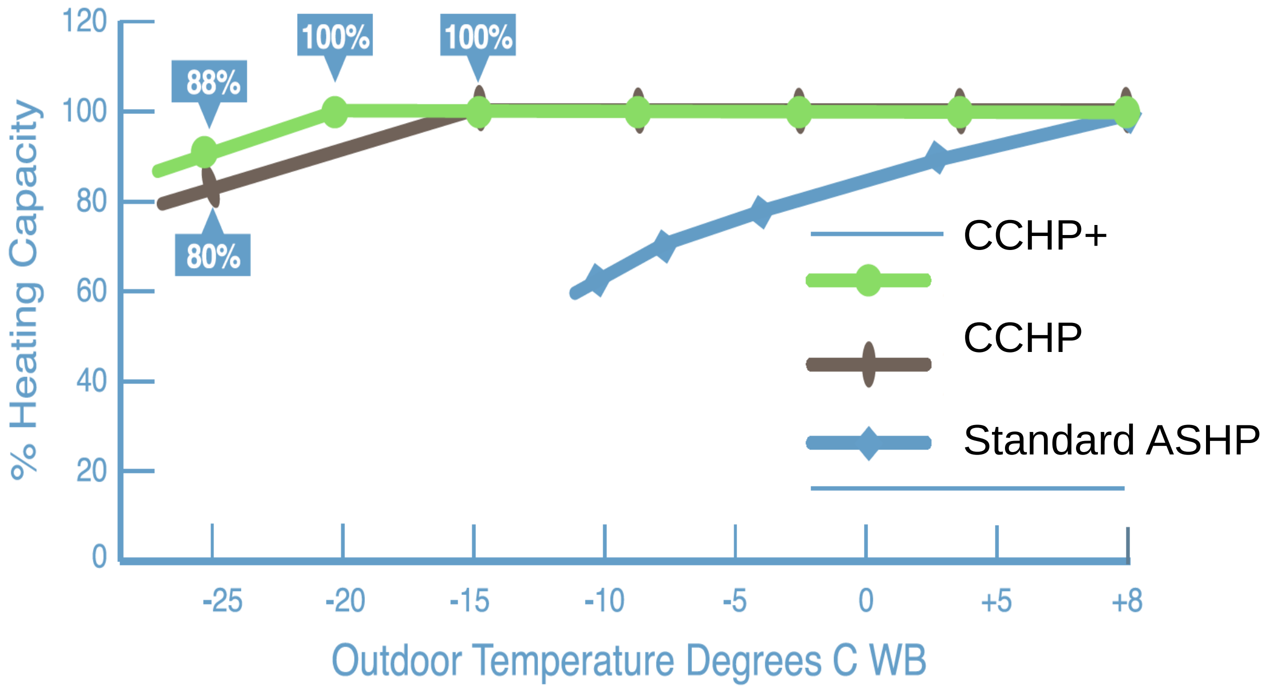
CEC Section 8 – Allowable Load Control Practices

! Requires collaboration between electrical/HVAC contractors

- ❑ EV charger load can be neglected in service load calculation when charger supply is automatically controlled by real-time service current monitoring (eg. Smart Switch)
  - **Rule 8-106, 11)**
- ❑ If multiple loads are connected such that only one may operate at once, only largest load need be considered in service sizing.
  - **Rule 8-106, 2) and 3)**
- ❑ Service sizing calculations for electrical retrofits can be justified based on historical load measurements (Demonstrated Load – Sneak Peak!).
  - **Rule 8-106, 9)**

Changing a Home's Electrical Personality

1. Careful ASHP Equipment Selection



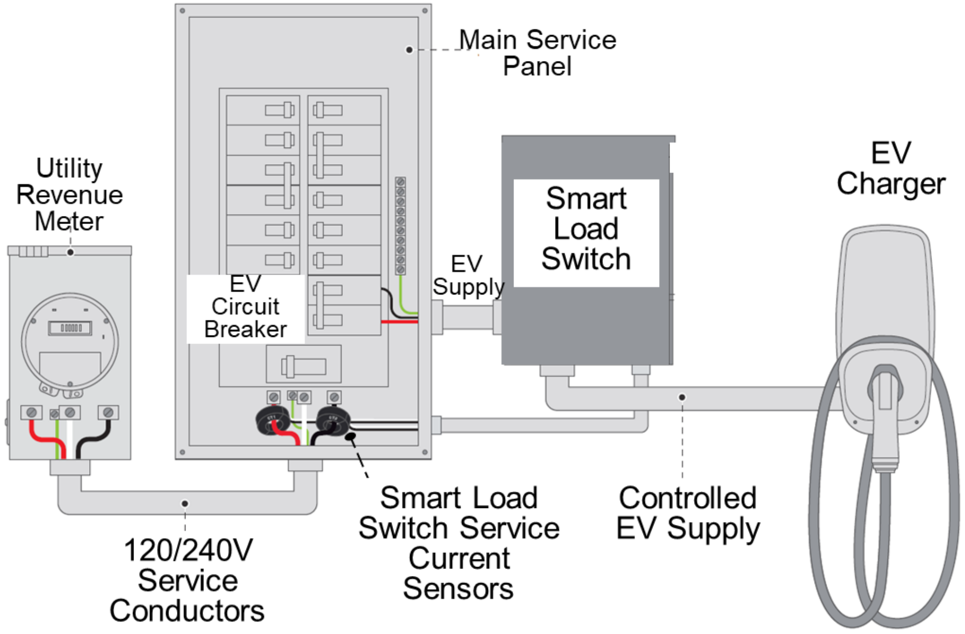
Direct responsibility of HVAC installers

- ❑ Extending cold temp operating range with CCHP may lower supplementary heat dependence.
- ❑ Alternate supplemental heat to electric can accomplish the same. E.g. NG

Changing a Home's Electrical Personality

2. Load Limiting (Smart Load Switches and Splitters)

! Requires collaboration between electrical/HVAC contractors



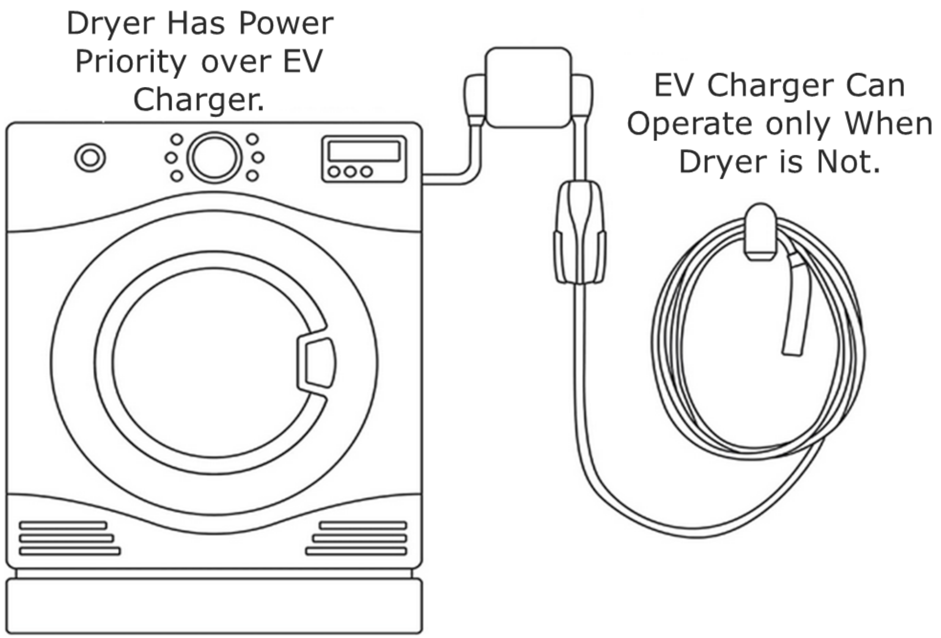
- Smart Load Switch measures service currents, and allows load to be powered only if service will not be overloaded
- EV charger can operate only when charging will not exceed the service rating.
- By **Rule 8-106, 11),** EV charger load does not have to be included in service sizing.

Changing a Home's Electrical Personality

2. Load Limiting (Smart Load Switches and Splitters)

Requires collaboration between electrical/HVAC contractors

Plug-in Smart Splitter on 240VAC Outlet

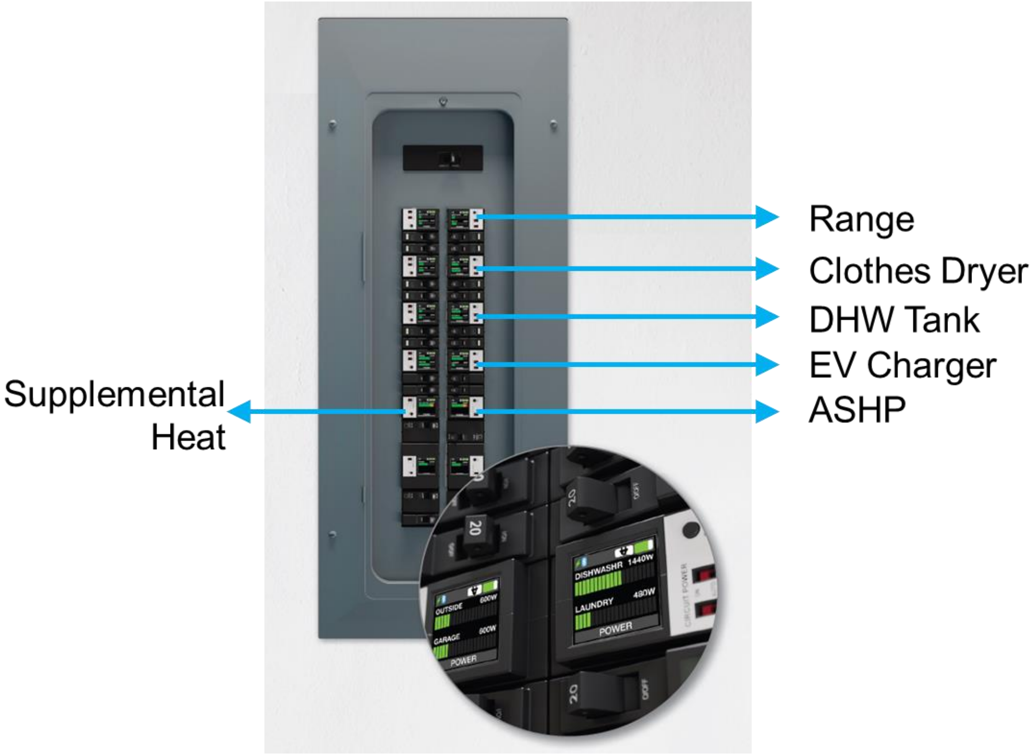


- ❑ Smart Splitter selects one load over another on a single shared supply circuit. An example of "Interlocking".
- ❑ EV charger can operate only if the electric dryer is not operating.
- ❑ **Rule 8-106, 2) 3)** requires only the larger of the two loads to be included in load calculations.

Changing a Home's Electrical Personality

3. Prioritized Load Enabling/Shedding (Smart Panels)

Requires collaboration between electrical/HVAC contractors



- ❑ Smart Panel enables/disables continuous electrical loads based on real-time service current measurement.
- ❑ Loads prioritized based on available service current margin and programmed load shedding.
- ❑ **Rules 8-106 2) 3)** and **8-106 11)**.
- ❑ Not widely endorsed by safety authorities but holds future promise.

Case Study Home with oversized ASHP

CEC Section 8 -200

Single Dwelling Residential Service Sizing

Continuous Loads	Num	Rated Watts	Rule	Eff. Watts	Amps
Electric Range Load	1	7500	8-200 1a, iv)	6000	25.0
Electric Dryer (30A @ 0.8)	1	5760	8-200 1a, vii)	1440	6.0
Air Source Heat Pump 4 Ton	1	5300		5300	22.1
Supplementary Electric Heat (Nat. Gas)	1	0		0	0.0
Total Calculated Load				**12740**	**53.1**
Effective Basic Load				**7000**	**29.2**
Continous Calculated Current	**Service Size is OK**				**82.3**

Main OCB Device Rating (Amps)	100
Permissible for Calculated Load	100%
Maximum Demand Current (Amps)	**100**

- 2685 ft² home
  - NG DHWT
  - Electric Range
  - Electric Dryer
  - 4 Ton ASHP with natural gas supplemental.
- Uses more service margin than needed.
- Workable only because Supp. Heat is not electric.

Case Study Home with oversized ASHP

CEC Section 8 -200					
Single Dwelling Residential Service Sizing					
Continuous Loads	**Num**	**Rated Watts**	**Rule**	**Eff. Watts**	**Amps**
Electric Range Load	1	7500	8-200 1a, iv)	6000	25.0
Electric Dryer (30A @ 0.8)	1	5760	8-200 1a, vii)	1440	6.0
Air Source Heat Pump 4 Ton	1	5300		5300	22.1
Supplementary Electric Heat	1	10000		10000	41.7
Total Calculated Load				**22740**	**94.8**
Effective Basic Load				**7000**	**29.2**
Continous Calculated Current	**Larger Service Needed**				**123.9**
Main OCB Device Rating (Amps)	100				
Permissible for Calculated Load	100%				
Maximum Demand Current (Amps)	**100**				

- 2685 ft^2 home
  - NG DHWT
  - Electric Range
  - Electric Dryer
  - 4 Ton ASHP with electric supp heat
- Min 125A service certainly required.

Case Study Home with ASHP sized by F280

CEC Section 8 -200					
Single Dwelling Residential Service Sizing					
Continuous Loads	**Num**	**Rated Watts**	**Rule**	**Eff. Watts**	**Amps**
Electric Range Load	1	7500	8-200 1a, iv)	6000	25.0
Electric Dryer (30A @ 0.8)	1	5760	8-200 1a, vii)	1440	6.0
Air Source Heat Pump 3 Ton	1	3900		3900	16.3
Supplementary Electric Heat (Nat. Gas)	1	0		0	0.0
Total Calculated Load				**11340**	**47.3**
Effective Basic Load				**7000**	**29.2**
Continous Calculated Current	**Service Size is OK**				**76.4**

Main OCB Device Rating (Amps)	100
Permissible for Calculated Load	100%
Maximum Demand Current (Amps)	**100**

- 2685 ft^2 home
  - NG DHWT
  - Electric Range
  - Electric Dryer
  - 3 Ton ASHP with natural gas supplemental.
- No service upgrade required.
- More margin for additional loads.

Case Study Home with added loads

CEC Section 8 -200						
Single Dwelling Residential Service Sizing Using Demonstrated Load						
Continuous Loads	**Num**	**Rated Watts**	**Rule**	**Eff. Watts**		**Amps**
Electric Range Load	1	7500	8-200 1a, iv)	6000		25.0
Electric Dryer (30A @ 0.8)	1	5760	8-200 1a, vii)	1440		6.0
Electric DHW Tank	1	4000	8-200 1a, v)	4000		16.7
EV Charger (30A @ 0.8)	1	5760	8-200 1a, vi)	5760		24.0
ASHP 3 Ton	1	2600	8-200 1a, iv)	3900		16.3
Supplementary Heat	1	0	8-200 1a, iii)	0		0.0
New Added Effective Loads				**9660**		**88.0**
Effective Base Loads	1					**29.2**
Continous Current	**Larger Service Needed**					**117.2**
Main OCB Device Rating (Amps)	100					
Derating Factor	100%	TSBC Bulletin				
Maximum Demand Current (Amps)	**100**					

- 2685 ft^2 home
  - Electric DHWT
  - Electric Range
  - Electric Dryer
  - 3 Ton ASHP with natural gas supplemental.
- Without mitigation strategies, extra loads quickly eat up our service

Case Study Home with All Electric Solution

CEC Section 8 -200

Single Dwelling Residential Service Sizing Using Demonstrated Load

Continuous Loads	Num	Rated Watts	Rule	Eff. Watts	Amps
Electric Range Load	1	7500	8-200 1a, iv)	6000	25.0
Electric Dryer (30A @ 0.8)	1	5760	8-200 1a, vii)	1440	6.0
Electric DHW Tank	1	4000	8-200 1a, v)	4000	0.0
EV Charger (30A @ 0.8)	1	5760	8-200 1a, vi)	5760	0.0
ASHP 3 Ton	1	2600	8-200 1a, iv)	3900	16.3
Supplementary Heat	1	5000	8-200 1a, iii)	5000	20.8
New Added Effective Loads				**14660**	**68.1**
Effective Base Loads	1				**29.2**
Continous Current	**Service Size is OK**				**97.3**

- 2685 ft^2 home
  - Electric DHWT
  - Electric Range
  - Electric Dryer
  - 3 Ton ASHP with Elec. Supp. Heat
  - Smart splitter on Range and Dryer
  - Load switch on EV charger

- Lots of room saved on EV charger, and splitting range with dryer
- No service upgrade required if Elec. Supp. Can be kept to 5 kW or less.

Changing a Home's Electrical Personality

4. Using the Demonstrated Load Clause Rule 8-106, 9)

Requires collaboration between electrical/HVAC contractors, and access to electrical utility Interval/billing data

- Historical load measurements may be used to justify remaining electrical service capacity for retrofit projects versus classic approach of adding up all continuous loads.

- Historical load measurements may be completed by a qualified professional (Electrical FSR, Electrical Engineer) using one of:

    - 12 month (or more) hourly kWh utility data to estimate maximum load.
    - 12 month (or more) third party power/energy data logger; 1hr or smaller sampling intervals.

Availability in Alberta

4. Using the Demonstrated Load Clause Rule 8-106, 9)

! Requires collaboration between electrical/HVAC contractors, and access to electric utility interval/billing data

- Beginning in 2021, ATCO has installed over 75000 smart meters in Alberta, including Edmonton.
- Historical load measurement method not currently permitted in Alberta, used in BC and Ontario.
  - 12 months hourly data available to homeowners through utility website (BC, ON)
  - New installation of smart meters raises potential for use in the near future.

Hydro One

Technical Safety BC –CEC 8-106 "Demonstrated Load" for Single Family Dwellings - IB-EL 2022-01

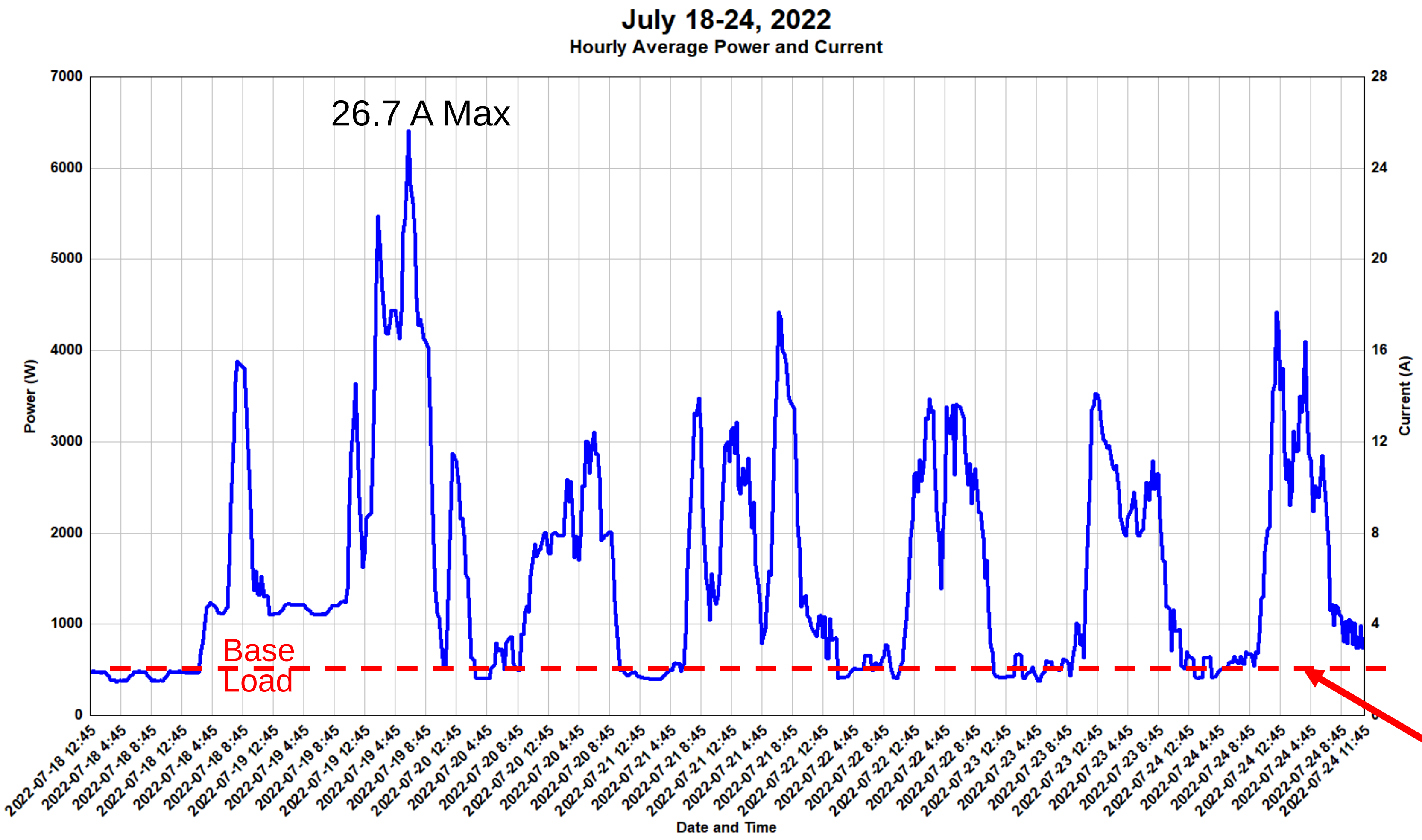
Where loads are to be added, augmented load may be calculated by

- *adding the sum of the additional loads, to the "Maximum Demand Load" of the existing installation as measured over the most recent 12-month period.*
- *"Maximum Demand Load" may be obtained using maximum utility 1 hr interval data for existing demand over the last 12 (or more) months X 125%*
- *The new load (hot tub, electric vehicle charger, etc.) can then be added to the utility supplied load to calculate the new demand.*

Case study home maximum demand load was 26.7 A for the previous 24 months. Maximum Historical Utility Data x 125% = 1.25 x 26.7A = 33.4 A

Demonstrated Load - Case Study Home Before Retrofit

100A Service – Electrical Utility Hourly Data



- Maximum demand 26.7 A over 2 year period.
- **Demonstrated Load** less than 50% of classic CEC simultaneous continuous load assumptions.
- Hourly consumption (kWh) available from utilities for **Demonstrated Load** calculations

2–3A Base Load Versus 29.2 A CEC Living Area Method

BC Case Study ASHP Retrofit – "Demonstrated Load" Approach

CEC Section 8 -200

Single Dwelling Residential Service Sizing

Continuous Loads	**Num**	**Rated Watts**	**Rule**	**Eff. Watts**	**Amps**
Maximum Historical Utility Data x 1.25				**8016**	**33.4**
Air Source Heat Pump 2.5 Ton	1	2800		2800	11.7
Supplementary Electric Heat	1	10000		10000	41.7
Total Calculated Load				**20816**	**86.7**
Effective Basic Load					N/A
Continous Calculated Current	**Service Size is OK**				**86.7**

Main OCB Device Rating (Amps)	100
Permissible for Calculated Load	100%
Maximum Demand Current (Amps)	**100**

- 2000 ft² home
  - NG DHWT
  - Electric Range
  - Electric Dryer
  - 2.5 Ton ASHP Retrofit with 10 kW electric supp. heat.
- Maximum Historical Load measurements replace concurrent continuous load assumptions.
- No service upgrade required.

Key takeaways

01 Be mindful of how HVAC electrification impacts electrical service sizing

Realize electrical service upgrades are expensive and may even be unavailable in some utility jurisdictions occupants. Proper heat pump sizing can make the difference between saving a service upgrade.

02 Classic service sizing assuming concurrent continuous loads can trigger unnecessary service upsizing

Collaboration with electrical trades early on in a project can mitigate some of these impacts

03 CEC section 8 provides methods that can soften service impacts including

- Reducing peak service demand using Smart Load Switches/Splitters, etc
- Sharing loads can save considerable space on the panel

04 Hybrid heating solutions are easily manageable in a 100 Amp service

Questions?

Natural Resources Canada | Ressources naturelles Canada

Air Source Heat Pump Sizing & Selection Web Application

LEEP Air Source Heat Pump Workshops

January 28, 2025

Canada

Overview of Webinar

01 Challenges with ASHP Installations

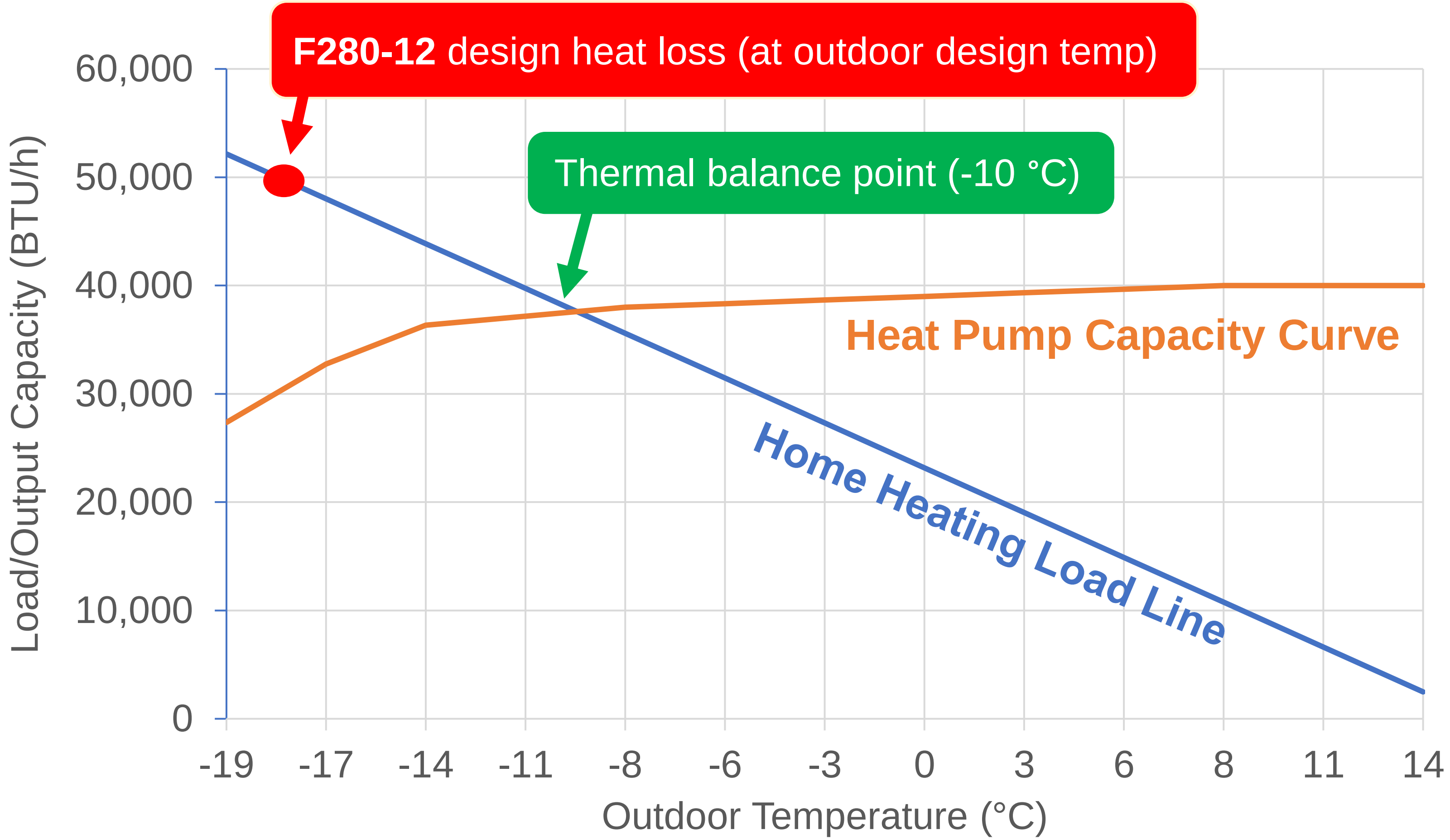
02 CSA F280 Heat Loss Calculations

03 Introduction to the Web App

04 Using the app…

05 Key Takeaways & Discussion

F280 Heat Loss is Needed in Sizing Calculations



If you know F280 heat loss you can use software to:

1. Create home heating load line
2. Overlay a HP capacity curve
3. Determine TBPT and other useful metrics
4. Right-size a system to meet homeowner needs

Using the sizing tool

- With the information above, you can use the sizing tool to easily determine costs, energy savings, GHG savings.
- Allows builder/contractor to explore different options including products, sizes and control strategies
- NRCan's new sizing and selection tool was developed to fit this need

NRCan's Sizing & Selection Web App

- The App integrates different facets of ASHP sizing in a mobile-friendly, easy-to-walk-through package
  - ❑ **System sizing & product selection:** Access an extensive library of products including all leading brands to select equipment most appropriate for your new builds
  - ❑ **Cost, 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

The ASHP Sizing & Selection Tool allows builders, HVAC contractors and mechanical designers to select systems based on more than just lowest cost

The App is a Combination of…

- **ASHP Sizing and Selection Guide**

  Best practice steps for the sizing and selection of heat pumps

- **ASHP Sizing and Selection Tool**

  Energy, Cost, and GHG calculation engine

- **Master Planning & Decision Guide**

  Best practice on ductwork for new housing

- **Industry engagement**

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

Before beginning, you will need:

- ✓ The whole home design heating and cooling
- ✓ Understand past issues and goals for the project
- ✓ Understand market challenges and what is motivating sales

Case study home

HOME CHARACTERISTICS
Year built: 2024; Heated sq ft: 2685 sq. ft
Current space heat: Gas furnace, 43,000 BTU/h, 96% AFUE Current space cooling: NA
Heating load 38,168 BTU/h Cooling Load: 24,524 BTU/h
Utility panel size: 100 Amps

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Air-Source Heat Pump Sizing and Selection App

The Air-Source Heat Pump Sizing and Selection App is a tool for HVAC designers and contractors to use with builders and homeowners in both new-builds and retrofits of existing homes. The tool helps designers and contractors quickly define an air-source heat pump system that will meet the needs of the project. Users first start by identifying important factors to be considered for their situation, and are then pointed to potential solutions to consider in selecting their air-source heat pump system. This tool is a simplified version of Natural Resources Canada's Excel-based Air-source Heat Pump Sizing and Select Tool and accompanying guide. Designers, contractors, builders, and other parties can exchange comments on each of these solutions and work towards a better, more comfortable, less expensive, and more sustainable HVAC system.

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Air-Source Heat Pump Sizing and Selection App

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Name	Builder	Date Created	Last Modified ▾	Status		
Project 3		2024/09/25	2024/11/08	Created	Copy	Delete
Project 2		2024/10/22	2024/11/08	In Progress (1/8)	Copy	Delete
Project 1		2024/10/24	2024/11/08	In Progress (1/13)	Copy	Delete

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Date modified: 2021-06-15

Creating a New Project

Create New Project

1. Project Settings | 2. Identification | 3. Details and Options

1. Project Settings

Project Name

Please give your project a name. It will be visible to anyone who has access to it. Refrain from using terms that may hint at private or exclusive information.

Project 3

Client

Enter the name of the builder associated with this project, if applicable.

Your Role

Please select the role you most closely occupy for this project:

HVAC Designer

Collaborators

Please identify your collaborators for this project by indicating their name, email address and role in the project. Make sure to obtain their consent beforehand. You will be able to share this project with an unlimited number of people.

Collaborator name	Email address	Role
No collaborators		

Add Collaborator

Save and Continue | Cancel

Can also share projects with others to work collaboratively!

Step 1: Project Details

Project 3 - Step 1

Overview | STEP-BY-STEP | Checklist | Project Settings | Share project

Identification, details and options

☑ Mark as complete

Copy Link

Project Status

Completed

Add new comment

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Identification

Installation Type

◉ New Home

○ Existing Home

Please select the installation type required for the project:

◉ New System Installation

Location

Please select the country, province or state, and the city where the house is located.

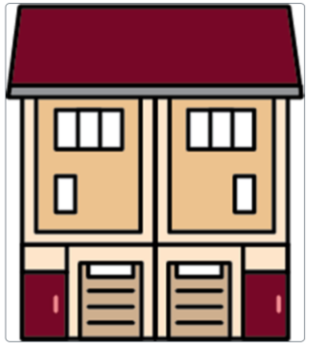
Country	Province / State	City
Canada	Alberta	Edmonton

House Type

Please select the house type that most closely matches the house being evaluated:

◉ Multi level detached home

○ Bungalow



○ Townhome

Step 1: Project Details

Details and Options

Common Situations and Challenges

- [x] Energy efficiency is important
- [x] Lower upfront costs and operational costs are important
- [x] Environmentally friendliness /reducing green house gas emissions / low carbon emissions are important
- [ ] Quiet outdoor operation is important (due to noise bylaws and /or proximity to neighbours or outdoor living space)
- [ ] Homebuyer humidity complaints (from previous projects)
- [ ] Homebuyer hot spotting (summer) or cold spotting (winter) complaints
- [ ] Homebuyer complaints: second floor too warm, basement too cold in summer months
- [ ] Homebuyer outdoor noise complaints (due to the HVAC system)
- [ ] Homebuyer indoor noise complaints (due to the HVAC system)
- [ ] Aiming for a particular energy standard (Net zero, Step Code, Passive House, LEED for homes)
- [ ] Challenges related to the familiarity of trades with new HVAC technologies/designs
- [ ] Would like to consider zoning the home
- [ ] Utility service option and restrictions
- [ ] Challenges with aesthetics of HVAC systems (indoor placement)
- [ ] Challenges with aesthetics of HVAC systems (outdoor placement)
- [ ] Challenges with amenity space conflicting with HVAC systems (outdoor placement)
- [ ] Bylaws on placement of outdoor units (outdoor placement)
- [ ] Supply chain issues related to specific equipment/availability of trades/ other components
- [ ] Basement will be finished.

Watch Video

Step 2: Unit Configuration

Project 3 - Step 2

Overview | STEP-BY-STEP | Checklist | Project Settings | Share project

ASHP units configuration

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◉ **Option 2A**

Centrally Ducted

More Information

○ **Option 2B**

Ductless Mini-split, Single Zone

More Information

○ **Option 2C**

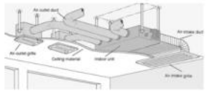
Ductless Mini-split, Multi-Zone

More Information

○ **Option 2D**

Ducted Mini-split

More Information



Project Status

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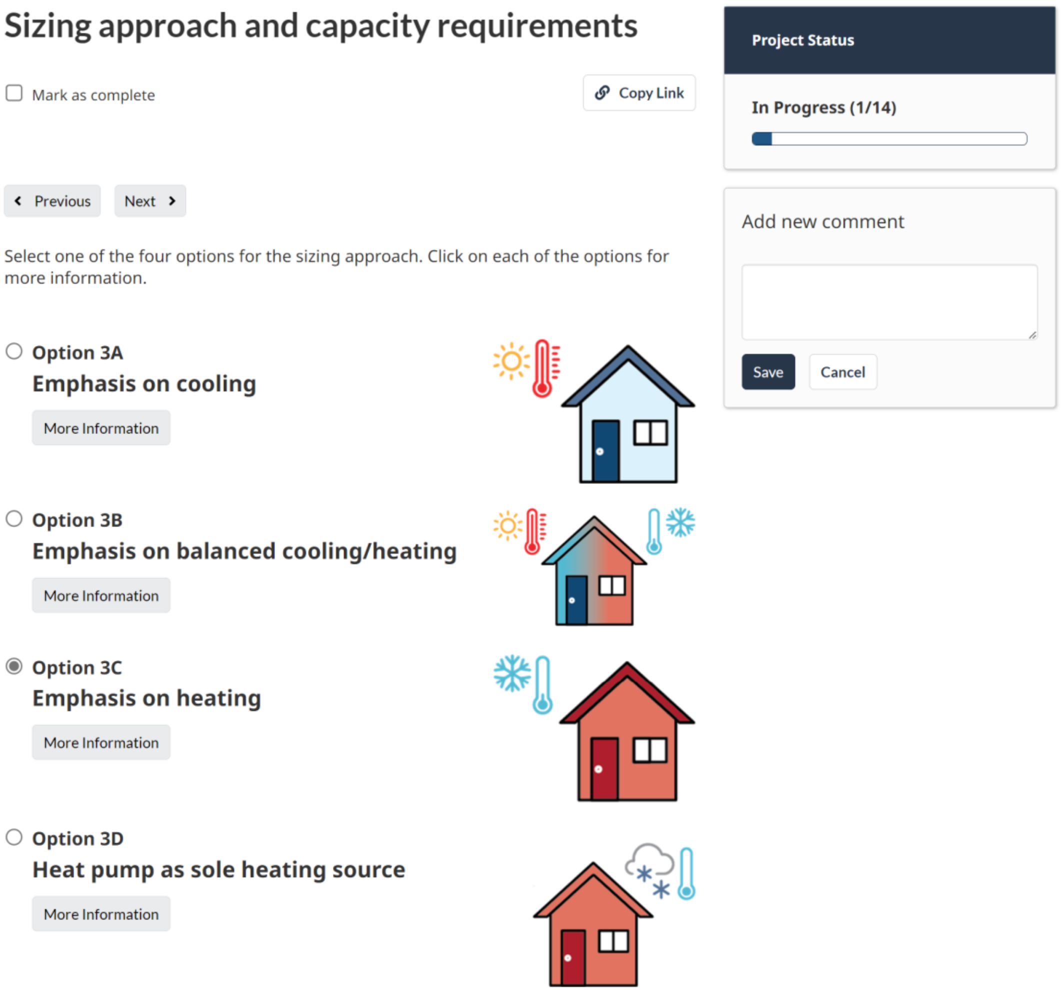
Step 3: Sizing Approach



Step 4: Air supply

Project 3 - Step 4

Overview STEP-BY-STEP Checklist Project Settings Share project

Supply outlet approach

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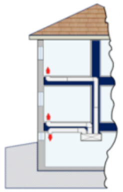
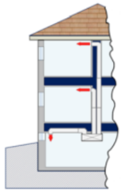
Select one of 3 options for the supply outlet approach. Users can click on each of the options to see more information and details:

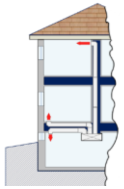
Option 4A
Perimeter supply
More Information



Option 4B
Central supply
More Information



Option 4C
Hybrid supply
More Information Watch Video



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Step 5: Duct Sizing

Project 3 - Step 5

Overview | STEP-BY-STEP | Checklist | Project Settings | Share project

Duct Sizing

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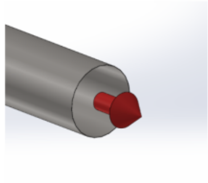
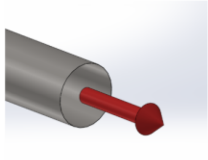
Select one of 3 options for duct sizing. Users can click on each of the options to see more information and details:

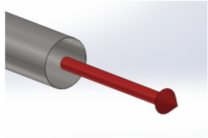
○ **Option 5A**
Low-velocity ducting
More Information



◉ **Option 5B**
Medium-velocity ducting
More Information | Watch Video



○ **Option 5C**
High-velocity ducting
More Information



Project Status

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Step 6: Zoning

Project 3 - Step 6

Overview | STEP-BY-STEP | Checklist | Project Settings | Share project

Zoning of supply ducts

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Project Status

In Progress (1/13)

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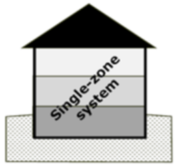
Select one of 3 options for your supply duct configuration. Users can click on each of the options to see more information and details:

◉ **Option 6A**

Single-zoning ducting

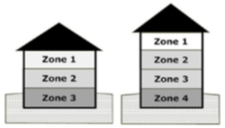
More Information



○ **Option 6B**

Assign one zone per floor

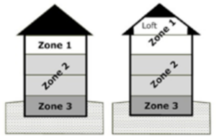
More Information



○ **Option 6C**

Other zoning approaches

More Information



Step 7: Return duct design

Project 3 - Step 7

Overview | STEP-BY-STEP | Checklist | Project Settings | Share project

Select return air duct design

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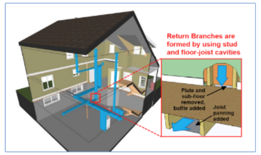
Select one of 2 options for return air duct design. Users can click on each of the options to see more information and details:

◉ **Option 7A**

Traditional return system

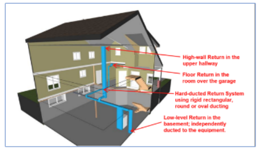
More Information



○ **Option 7B**

Simplified return system

More Information | Watch Video



Project Status

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Step 8: Duct Sealing

Select duct sealing

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Project Status

In Progress (1/13)

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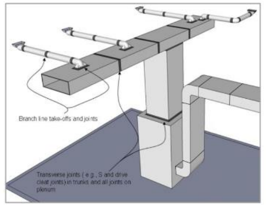
◉ **Option A**

Base-level sealing

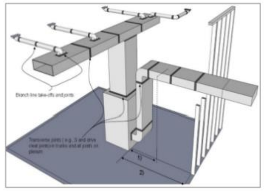
More Information | Watch Video



○ **Option 8B**

Sealing to ESNH requirements

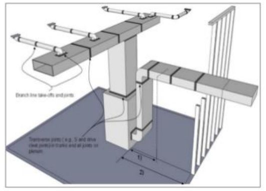
More Information



○ **Option 8C**

Sealing to ESNH requirements with verification testing

More Information



Step 9: Heating and Cooling Load Input

Project 4 - Step 9

Overview | STEP-BY-STEP | Checklist | Project Settings | Share project

House heating and cooling loads according to CSA F280-12

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Some items for builders to consider are:

- Carrying out CSA F280-12 heat loss/gain analysis enables right sizing heating and cooling systems to improve comfort, reduce cost, and lower your risk of call backs. It is also required by most building codes across the country.
- When completing CSA F280-12 analyses, it is fast and cost-effective to considering upgrade options that can further reduce the size of your mechanical systems.
- Providing standardized and comprehensive performance details when submitting your plans for analysis will help to ensure you get the best results.
- Reviewing the heat loss/gain detailed results helps ensure the results are right and lets you see where you may want to focus during your next builds.

Make sure your heat loss/gain professional is accredited, experienced, and uses software that has been developed to conform to the CSA F280-12 standard. Enter the design heat loss and gain for the full home including the existing portion as well as the addition.

Design space heating loads are now much lower than in previous years as a result of trends towards using more and continuous insulation, better air sealing, and better windows. Builders should expect their heat equipment sizing to change as they improve envelope efficiency.

Design Heat Loss (DHL)

38,168 BTU

Design Heat Gain (DHG)

24,524 BTU

Project Status

Completed

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Step 10: Unit Selection

#	Brand	AHRI #	Heating Rated BTU/h	
1	CARRIER (25VNA436A*031*)	214569648	36400 Rated Btu/h @47°F 31000 Rated Btu/h @17°F 14560 Rated Btu/h @5°F	Remove
2	CARRIER (25VNA424A*031*)	214569392	26600 Rated Btu/h @47°F 24800 Rated Btu/h @17°F 10640 Rated Btu/h @5°F	Remove
3	CARRIER (25VNA448A*031*)	214243985	46000 Rated Btu/h @47°F 43500 Rated Btu/h @17°F 18400 Rated Btu/h @5°F	Remove

Filter

Brand

All Brands

AHRI, Model, Unit

AHRI, Model, Unit

Heating Capacity @47°F

0 BTU

Heating Capacity @5°F

0 BTU

Apply Filter

Reset All Filters

Search Result

FRASER-JOHNSTON

AHRI #: **214398453**
Outdoor Unit Model #: **HH860E2S11**
Indoor Model #: **CTM60C5CHS1**

- **53500** Rated Btu/h @**47°F**
- **36800** Rated Btu/h @**17°F**
- **38000** Rated Btu/h @**5°F**

COP @5°F: **2**

+ Compare

LUXAIRE

AHRI #: **214398452**
Outdoor Unit Model #: **HH860E2S11**
Indoor Model #: **CTM60C5CHS1**

- **53500** Rated Btu/h @**47°F**
- **36800** Rated Btu/h @**17°F**
- **38000** Rated Btu/h @**5°F**

COP @5°F: **2**

+ Compare

COLEMAN

AHRI #: **214398451**
Outdoor Unit Model #: **HH860E2S11**

YORK

AHRI #: **214395892**
Outdoor Unit Model #: **HH860E2S11**

Choose 3 units to analyse.
1. 2 Ton Unit
2. 3 Ton Unit
3. 4 Ton Unit

Browse large database of options.

Step 10.1: Backup Source

Project 4 - Step 10.1

Overview | STEP-BY-STEP | Checklist | Project Settings | Share project

Select back-up heat source

Copy Link

Previous | Next

#1 CARRIER (25VNA436A*031*)

○ Option 1 **Electric Backup**

◉ Option 2 **Furnace Backup**

Type	Condition	AFUE	Backup Capacity (BTU/h)
Gas	New	96	43,000

#2 CARRIER (25VNA424A*031*)

#3 CARRIER (25VNA448A*031*)

Project Status

Completed

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Step 11: Utility Rates

Project 3 - Step 11

Overview STEP-BY-STEP Checklist Project Settings Share project

Utility Rates

☐ Mark as complete

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Previous Next

Electricity

Select the billing type

Fixed

Cost of electricity

cents/kWh

This app requires the consumption-based cost of electricity, including energy, delivery and taxes, but excluding any fixed monthly customer and regulatory charges and other levies that do not vary with the amount of electricity used. Use a recent electricity bill to calculate the consumption-based cost of electricity in one of the following ways:

- For utilities with a single electricity rate ($/kWh) covering both energy and delivery, use this rate plus any applicable taxes and additional charges (e.g., rate riders) that are based on usage to calculate a consumption-based cost of electricity.
- For utilities with multiple steps / tiers of electricity rates ($/kWh) covering both energy and delivery, use the highest rate-step / tier that is the most likely to frequently apply when the ASHP is operating, plus any applicable taxes and additional charges (e.g., rate riders) that are based on usage to calculate a consumption-based cost of electricity.
- For utilities where electricity delivery and regulatory costs are shown separately (such as in the province of Ontario), and include "distribution system loss-factor adjustments" and fixed costs that vary from utility to utility, it may be easier to calculate the consumption-based delivery and regulatory costs based on "kWh usage" and add this rate to the energy commodity rates, that are shown on the bill, together with any applicable taxes. This will require going to the utility website to determine the value of fixed charges (Customer Charge ($ per billing period); Standard Supply Service Rate ($ per month)) that apply to the particular utility (see example for details).

Project Status

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Step 11.1: Control Strategy

Control Strategy

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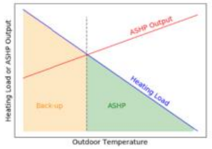
Previous | Next

#1 CARRIER (25VNA436A*031*)

Option 11.1A

Backup only below thermal balance point

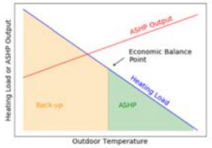
More Information



Option 11.1B

Single point economic cut-off temperature

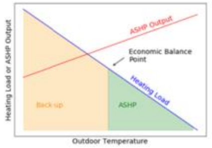
More Information



Option 11.1C

Hourly scheduled economic cut-off temperature

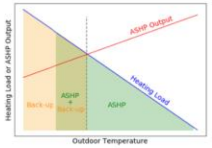
More Information



Option 11.1D

Both heat pump and backup operating below balance point temperature (staging approach)

More Information



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Step 12: Dehumidification

Project 3 - Step 12

Overview | STEP-BY-STEP | Checklist | Project Settings | Share project

Dehumidification Strategy

☑ Mark as complete

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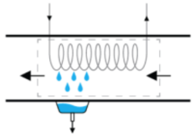
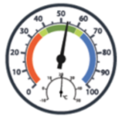
Select one of 2 options for the dehumidification strategy of any equipment that was selected. Users can click on each of the options to see more information and details:

#1 DETTSON (MHD-24)

○ **Option 12A**
Do not use dehumidification strategy
More Information



◉ **Option 12B**
Use a dehumidification strategy
More Information



#2 DAIKIN (4MXL36WVJU*)

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Step 13: Results and Review

Project 4 - Step 13

Overview | STEP-BY-STEP | Checklist | Project Settings | Share project

GHG, cost, and energy use comparison

☑ Mark as complete

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Project Status

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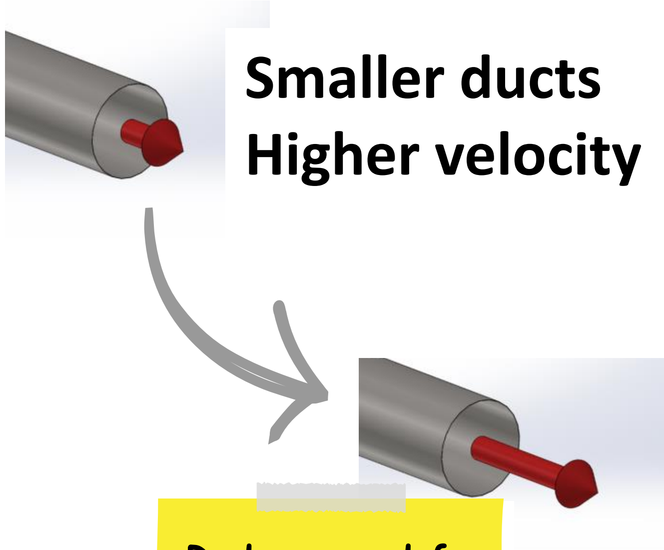
Note that ASHPs with an HSPF greater than 10 have the highest heating season performance. This means they consume less electricity, cost less to operate, and produce fewer greenhouse gases than units that have a lower HSPF. The heating capacity of the heat pump is also a key factor for efficiency, utility bills, and environmental benefits. For colder climates, it is important to ensure the heat pump will keep providing heat during the coldest days because this means that the heat pump will overall be able to handle most (or all) of the heating load. Be sure to check the BTU/hr heating capacity in cold temperatures.

#	Heat pump Model	GHG Emissions (tonneCO2e)	Heating Cost ($)	Heating Energy Consumption (GJ)
1	CARRIER (25VNA436A*031*)	7.27	1532.18	56.4
2	CARRIER (25VNA424A*031*)	6.89	1442.43	60.85
3	CARRIER (25VNA448A*031*)	7.03	1480.91	55.31

Whirlwind Tour of New Builds Pathway

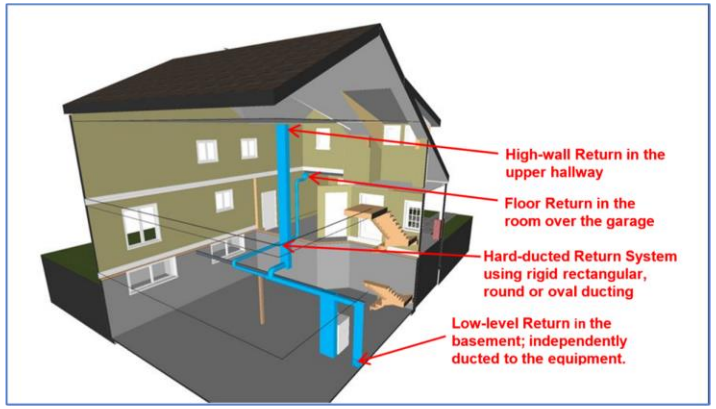
➢ Calculations are the same but additional steps encourage user to consider other best practices in ductwork system design (adapted from NRCan's Master Planning & Decision App/Guide)



Smaller ducts
Higher velocity

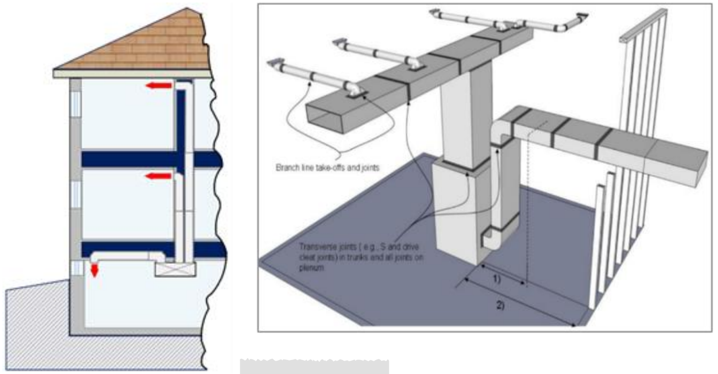
Reduce need for bulkheads

Simplified return



Simplify install and reduce cost

High wall and air sealing



Improve comfort

Impacts of Back-up System- 3 Ton

	Base Case	Gas Back-up; TBPT Control; 3T HP
System size	43, 000 BTU/h 96% AFUE	3 Ton HP Gas Furnace (96%)
Total Energy Consumed [GJ]	103	56 GJ
Operating Costs [$]	$1021	$1532
GHG emissions	5.26 T CO_2e	7.27 T CO_2e
% of Heating from ASHP	0	67%
% of Heating Above TBPT	0	77%
Thermal Balance Point Temp [^oC]	NA	-12^oC
Economic Balance Point Temp [^oC]	NA	NA

In **BLACK** are app outputs you can see in the app.

Most parameters in **RED** are parameters that are calculated in back-end. They are outputs of the excel tool and are currently under development in the app.

Using assumptions of app…
The HP in the 3T system can do 70% of the heating load– but it will cost more than the base case.

Impacts of Control

	Base Case	Gas Back-up; TBPT Control; 3T HP	Gas Back-Up; Hybrid; 3T HP
System size	60, 000 BTU/h 96% AFUE	3 Ton HP Gas Furnace (96%)	3 Ton HP Gas Furnace (96%)
Total Energy Consumed [GJ]	**103**	**56 GJ**	**50 GJ**
Operating Costs [$]	**$1021**	**$1532**	**$1671**
GHG emissions	**5.26 T CO2e**	**7.27 T CO2e**	**7.86 T CO2e**
% of Heating from ASHP	**0**	**63%**	**82%**
% of Heating Above TBPT	**0**	**77%**	**77%**
Thermal Balance Point Temp [°C]	**NA**	**-12°C**	**-12°C**
Economic Balance Point Temp [°C]	**NA**	**NA**	**NA**

Using a fixed consumption based utility rate, using a hybrid approach reduces energy consumed, while raising GHG and cost.

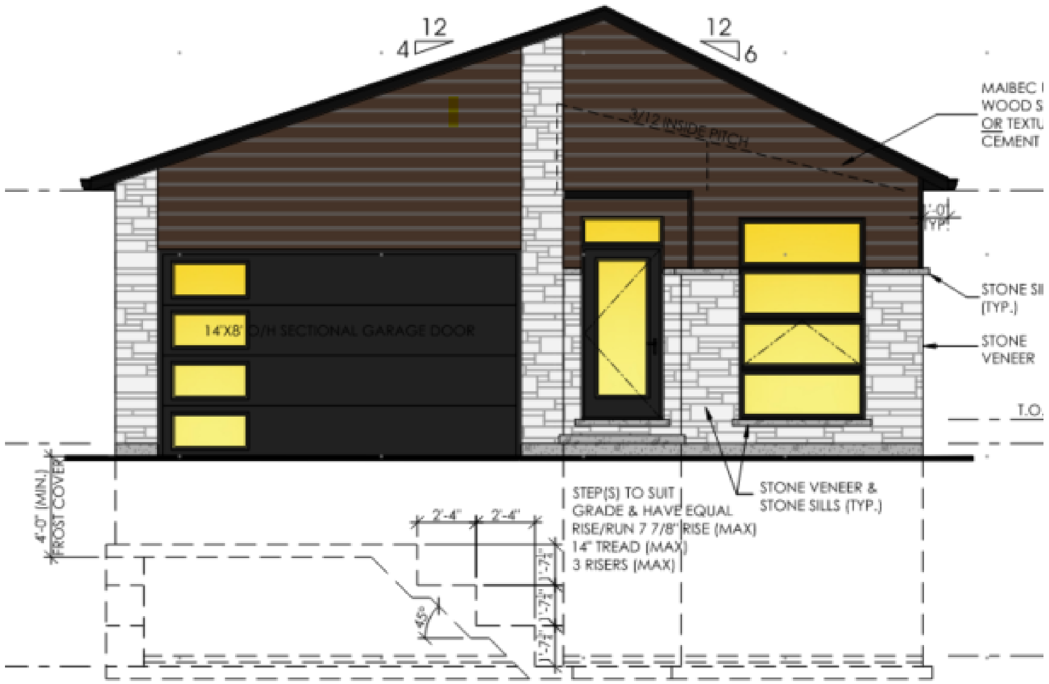
Results calculated using updated grid intensity values coming soon!

Impacts of Size

Upping the size by 1 T allows the ASHP to cover more of the heating load, however factors such as duct size, electrical service size, and dehumidification can be constraints.

	Base Case	Gas Back-up; TBPT Control; 2T HP	Gas Back-Up; TBPT Control; 3T HP	Gas Back-Up; Hybrid; 3T HP	Gas Back-up; TBPT Control; 4T HP
System size	40, 000 BTU/h 96% AFUE	2 Ton HP Gas Furnace (96%)	3 Ton HP Gas Furnace (96%)	3 Ton HP Gas Furnace (96%)	4 Ton HP Gas Furnace (96%)
Total Energy Consumed [GJ]	**82**	**60 GJ**	**56 GJ**	**50 GJ**	**55 GJ**
Operating Costs [$]	**$1029**	**$1442**	**$1532**	**$1671**	**$1480**
GHG emissions	**4.2 T CO2e**	**6.89 T CO2e**	**7.27 T CO2e**	**7.86 T CO2e**	**7.03 T CO2e**
% of Heating from ASHP	**0**	**63%**	**70%**	**82%**	**70%**
% of Heating Above TBPT	**0**	**73%**	**77%**	**77%**	**81%**
Thermal Balance Point Temp [°C]	**NA**	**-10.5°C**	**-12°C**	**-12°C**	**-14°C**
Economic Balance Point Temp [°C]	**NA**	**NA**	**NA**	**NA**	**NA**

Recap on System Selection and Outcomes



- ➢Used the App to test impacts of **backup**, **control**, and **size** on key metrics
- ➢Put some numbers to what is often just “rule-of-thumb”
- ➢System selection that works with **existing ductwork capacity**
- ➢Can use app to **collaborate** with others on system selection and planning

With **better data and analysis**, builders, contractors, and mechanical designers can make work together to make better decisions to **best meet client needs**!

Key Takeaways for the day…

01 **Heat pumps require special considerations that are <u>critical</u> for proper sizing and best outcomes**

Better data - leads to effective communication of performance

Careful selection through discussion leads to better performance – and fewer callbacks

02 **Right-sizing <u>reduces warranty callbacks</u>, helps <u>avoid added costs</u>, <u>increases client satisfaction</u>, and <u>builds a positive reputation</u>**

03 **CSA F280 heat loss calculations are the <u>foundation</u> of heat pump sizing calculations**

04 **NRCan's ASHP Sizing & Selection App provides the software engine that outputs useful metrics for right-sizing systems, selecting products, and project planning**

Link:

heatpump-tool-outil-thermopompe.nrcan-rncan.gc.ca/

If you have feedback or want to request features, please contact us through the LEEP Mailbox

leep@nrcan-rncan.gc.ca

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