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Energy Efficiency

January 25th, 2024

Designing air source heat pumps with sizing and selection in mind

Contractor Heat Pump Training Initiative | Dan Wildenhaus

Housekeeping

- Recordings of this webinar will be available within the ComEd Training Workspace
- All attendees should be admitted with microphone **muted**
- Ask questions in the Q&A
  - Questions can be submitted anonymously
  - When a question is answered, all attendees will be able to see the question, who asked it (if provided), and the answer
  - Depending on time, some questions might not be answered. In that case we will do our best to follow up with everyone after the webinar ends

Required Modules for ComEd Home Heating and Cooling Program Incentives

As the HVAC industry evolves, so must ComEd's Energy Efficiency program. The purpose of ComEd's program is to offer incentives that impact decisions to purchase and install efficient equipment. Starting January 1, 2024, all contractors who participate in the Home Heating and Cooling program will be required to complete these heat pump trainings to access incentives for air source and mini-split heat pumps. These modules can be completed in 5 hours or less hours. The intent is supplement industry trainings and educational resources with context ComEd finds critical for the sale and installation of heat pumps. Our priority is to help you realize the rapidly growing market opportunity for air source heat pumps (ASHPs) in Northern Illinois.

ComEd® Webinar: Air Source Heat Pump Applications

Replacing Air Conditioners with Air Source Heat Pumps

Heat pump control strategies and best practices

Designing Air Source Heat Pumps with Sizing and Selection in Mind

https://comed.coassemble.com/c/required-modules-2023

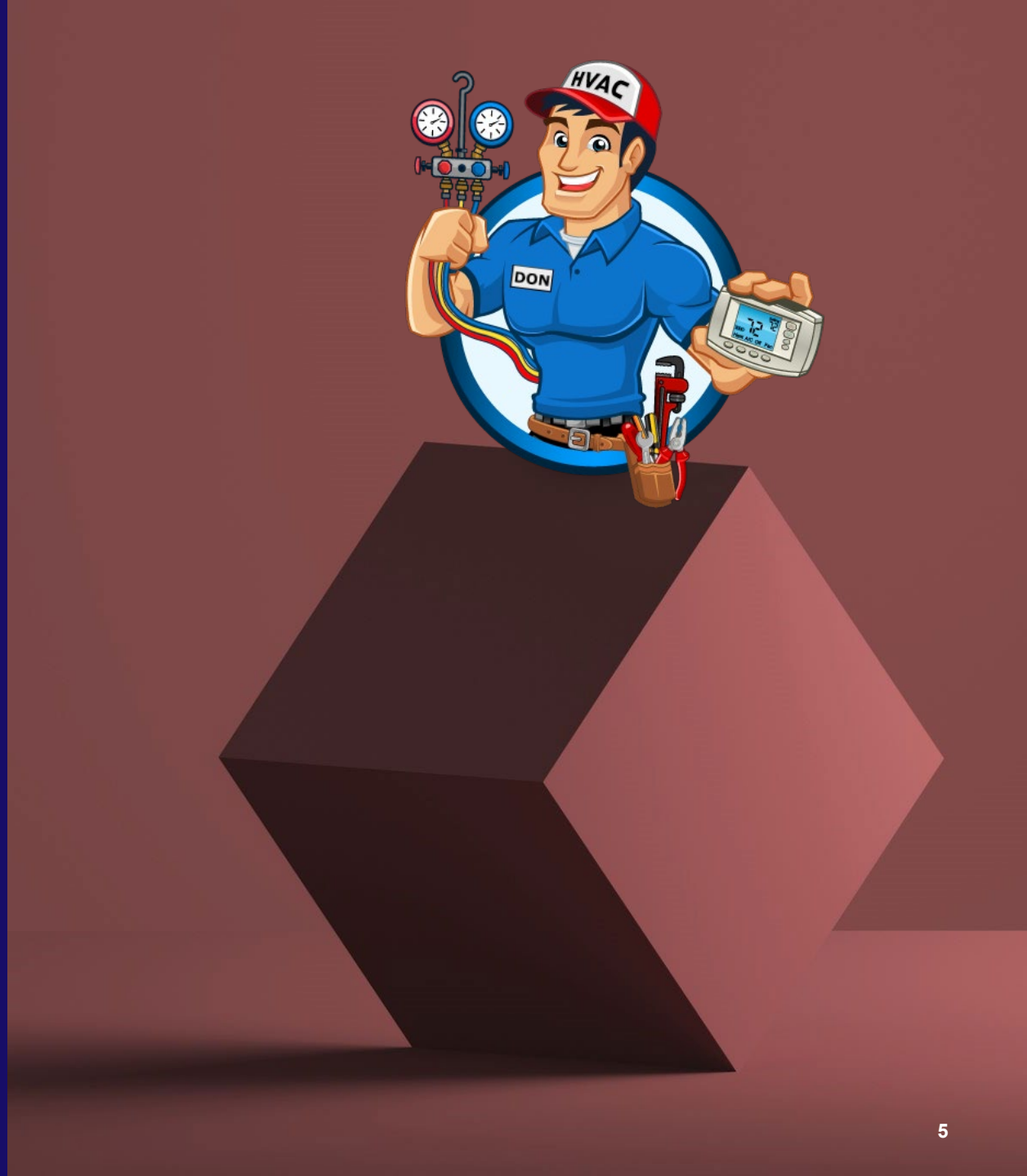
Dan Wildenhaus

- Technical Consultant and Industry Liaison
- Former contractor
- ComEd training team
- Working with contractor’s and distributors
- 29 years experience

Agenda

- **Why does right sizing matter?**
  - Identified gaps in practice
  - Right sizing benefits
  - Works for YOUR business case

- **How do we right size?**
  - Getting load calcs right
  - Sizing for heating vs sizing for cooling
  - Sizing primary system vs supplemental/back up heating system
  - Using new tools for equipment selection
  - Applying switchover temps
  - Connecting back to the business case



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Poll

How often do you perform full Manual J and S on projects?

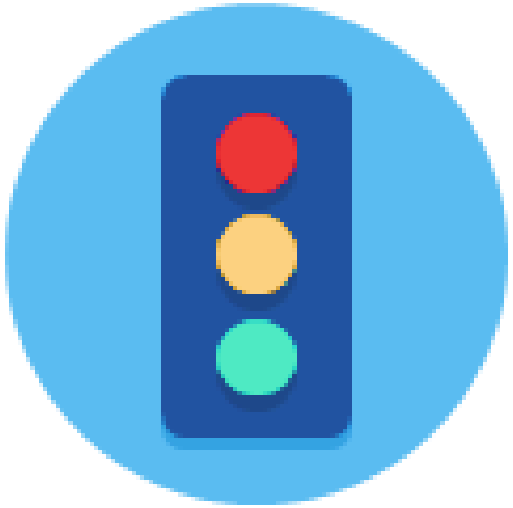
Problem statement:

Problem: Sizing, design, and selection is often done based solely on rules of thumb and based on previous sized systems. This most often leads to oversizing!

Truth: Variable Capacity Air Source Heat Pumps perform best and meet savings goals when sized appropriately for system type, application, and supplemental fuel type.

Current common approaches to load calcs
-What people are putting into it most often.

- “Shoot from the hip”
- Sized off existing equipment size
- Using rules of thumb
- Utility bill analysis
- Block load calculation

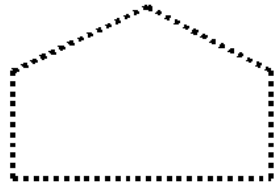


Sizing - rules of thumb

- One thousand BTU per 100 sq ft
- One cfm per sq. ft. of house
- 35 btu per sq ft
- Tonnage = half the number of cylinders in the customer's biggest car/truck
- What's in the shop today
- ½ ton bigger than their neighbor

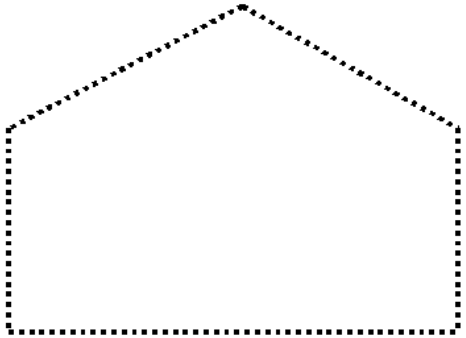
Air Conditioner or Heat Pump Sizing Chart

(Please understand that this is meant as humor,
however it is just as accurate as "x" number of square feet per ton!)



1 1/2 to 2 ton

2 1/2 to 3 1/2 ton



4 to 5 ton

Slide courtesy Bruce Manclark

Does sizing impact energy use and utility bills?
- What's wrong with inaccurate load calculations?

For single and **two speed systems**, maximum **efficiency happens during long run times,** not starts and stops. **This LIKELY has small energy penalties for over-sized systems oversized by more than 33%**.

For variable capacity equipment, **longer run times** may **mean more time spent at medium and low heat/fan speed**. This **LIKELY has energy penalties for systems oversized by more than 40% as they potentially will not have shorter run times and at higher heat/fan speed.**

Wrong sized for the **ductwork can lead to** much **higher fan watt draw**. An AHRI report showed that adding static pressure to Electrically Commutated Motors only reduced flow from 1 to 3% with increased fan power draw **up to 48%!**

NIST, NREL, Proctor Engineering, Illinois Institute of Technology

Fan watt draw and pressure

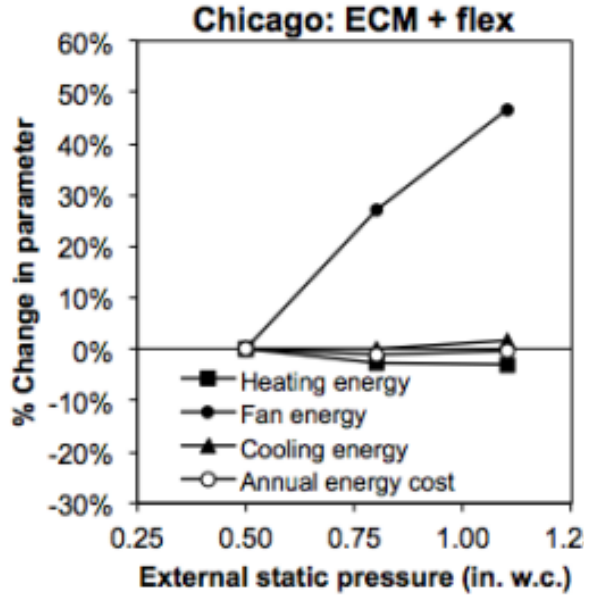
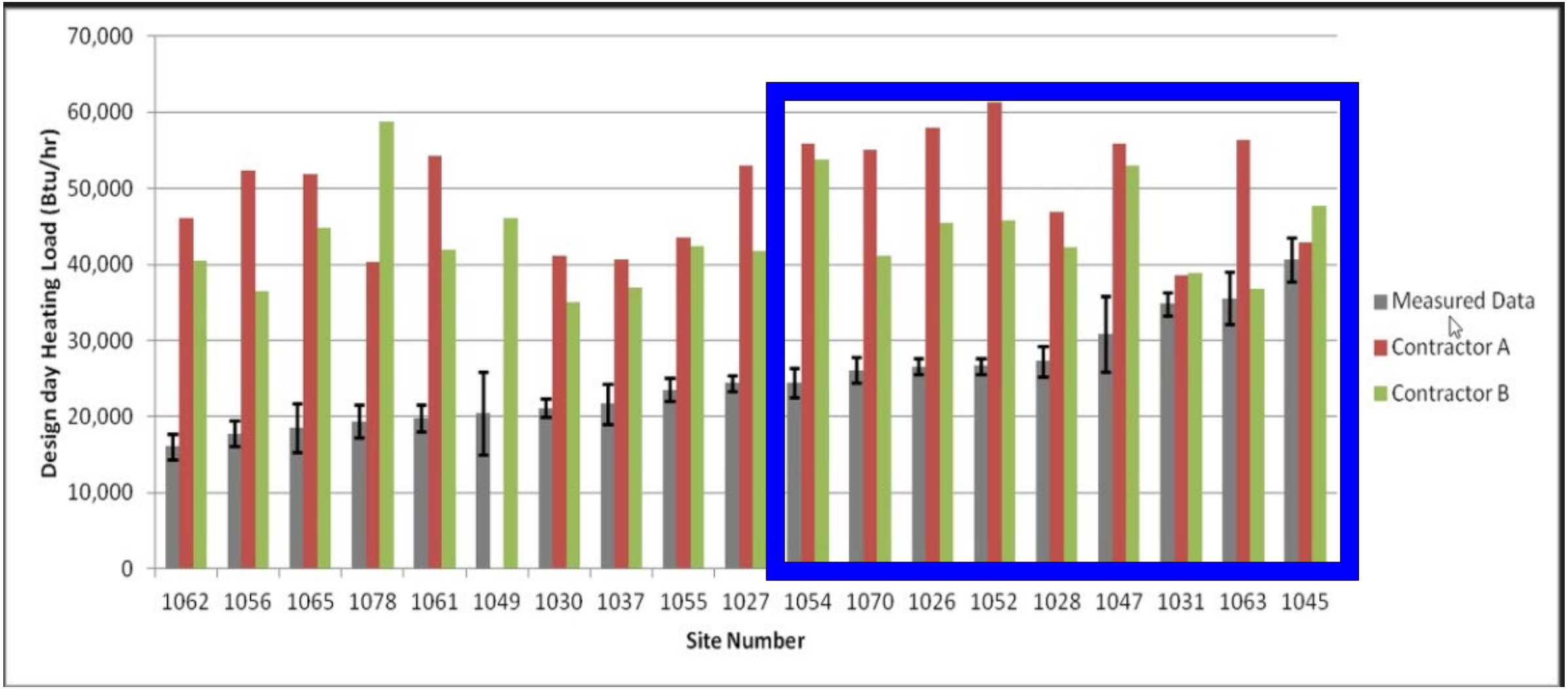


Table 10. Annual energy simulation results for both homes at baseline using the Austin contractor's designs

Home	Duct type	Blower type	Total Pressure (in. w.c.)	Airflow rate (CFM)	Cooling (kWh)	AHU Fans (kWh)	Total Electricity (kWh)	Heating ($\times 10^6$ Btu)	Total Gas Consumption ($\times 10^6$ Btu)
Chicago 3-ton AC Gas furnace 1200 CFM nominal	Flex	PSC	0.50"	1200	619	542	8108	60.95	88.88
			0.80"	964	661	531	8139	60.93	88.85
			1.10"	622	786	600	8331	63.71	91.70
		ECM	0.50"	1200	611	319	7878	61.55	89.51
			0.80"	1162	614	411	7972	60.47	88.39
			1.10"	1103	631	478	8056	60.86	88.78
	Metal	PSC	0.50"	1200	611	531	8086	59.52	87.41
			0.80"	964	656	525	8128	60.25	88.16
			1.10"	622	769	583	8300	62.17	90.12
			0.50"	1200	603	314	7861	60.10	88.02

Figure 14. Estimated relative change in annual fan, cooling, and heating energy usage and total annual HVAC energy costs for the Chicago home with both types of AHU fans and both rigid and flex duct work at each duct design (using only the Chicago contractor's duct designs).

Concerned that Manual J won't size large enough?



Recommended practices for sizing - Key takeaway's part 1

- Load calculations already have safety factors built in. There's no need to use estimations that increase the load calculation!
- Recommended load calculations include:
  - Energy bill or runtime analysis
  - Block load calculations
- Oversized systems may struggle with existing ductwork.
- Oversized systems will cost more to run.

Section goals

Review additional benefits for right sizing.

Introduce business case for right sizing.

How to do proper load calcs (with examples.)

Introduce duct system evaluation.

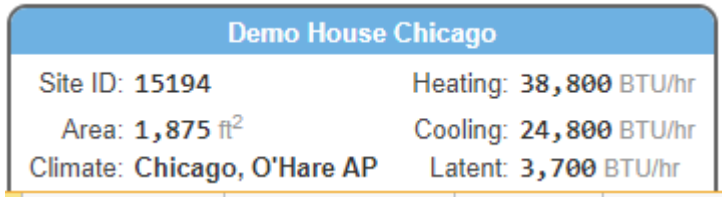
What other real-world challenges may exist when oversizing?

- For filtration, run times matter!
- For ventilation, run times matter!
- For home destratification, run times matter!
- On and off systems can lead to larger temperature swings.
- For dehumidification, run times matter!
- Larger compressors and fans may require larger electrical circuits.
- Larger compressors and fans may be noisier.
- Oversized systems may struggle with existing ductwork.

Dehumidification and “right sizing.”

Sensible Heat Ratio

- Ratio of sensible vs latent heat loads in the building

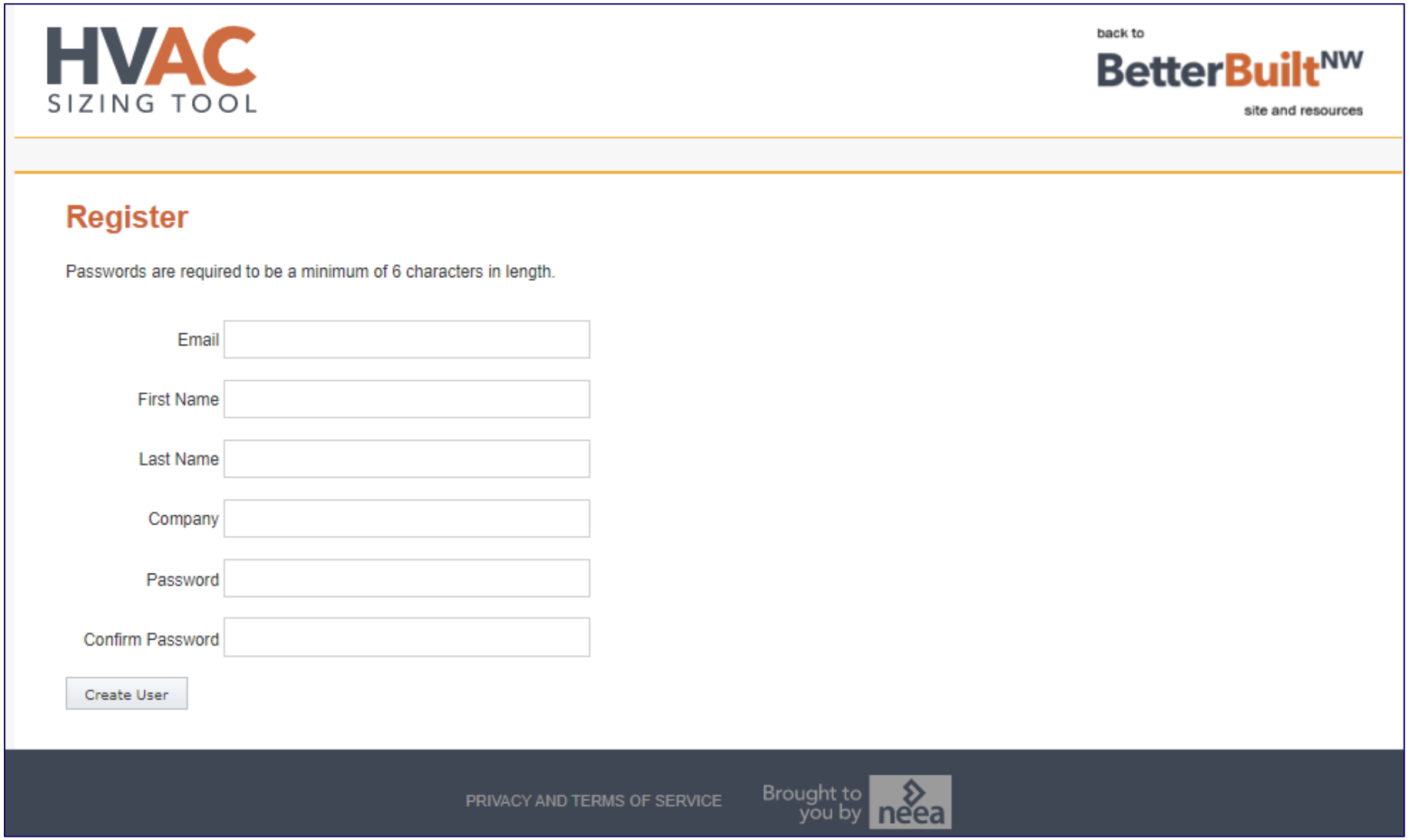


- For this building, the latent load for cooling is 3,700/24,800 or 15%. This means the sensible heat ratio is 85%

Sensible Heat Fraction

- This is the capability of the equipment you are selecting.
- Modern, high SEER2 heat pumps (and ACs) have much higher sensible heat fractions when compared to older systems.
- Your selected equipment should have a sensible heat fraction of **0.85 (85%) or lower** to dehumidify during typical run times. In addition, this fraction is only for once the system hits its full system capability, which depending on equipment could be 20 minutes.
- ***Therefore, you need to BOTH pick systems with the right SHF and have longer run times to ensure that the system is running at rated capabilities in order to properly dehumidify!***

Free sizing tool online we are using today



http://hvac.betterbuiltnw.com/Account/Register.aspx

Energy Vanguard
533 W Howard Ave, Suite E, Decatur, GA 30033
hvac@energyvanguard.com · (404) 428-3393

Manual J Data Collection Form

Date			
Data Collector		Contact #	
Homeowner / Builder		Contact #	
Property Street Address		Code Year	
City, State & Zip Code			

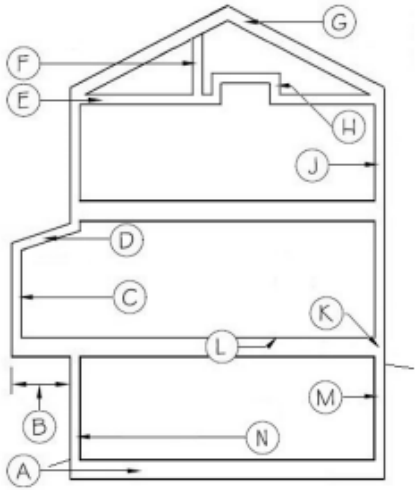
1. Front Door Faces ☐ N ☐ NE ☐ E ☐ SE ☐ S ☐ SW ☐ W ☐ NW

2. Home Description

3.Air Infiltration Rate

Blower Door @ cfm50	or	☐Tight	☐Semi-Tight	☐Average

4. Insulation



Location	R-Value Type	Cavity	Continuous
A: Slab Under			
Slab Edge			
B: Cantilevered & Frame Floors			
C: Exterior Walls, above grade			
D: Vaulted or Sloped Ceilings			
E: Flat Ceilings (typical blown attic)			
F: Attic Knee-walls			
G: Roofline (typical spray foam)			
H: Tray Ceiling Top/Side			
K: Rim/Band Joists			
L: Floor over Bsmt/Crawl/Garage			
M: Poured Bsmt or Crawl Walls Cavity			
Continuous ☐Exterior ☐Interior			
N: Framed Bsmt Walls			

XPS Extruded Polystyrene
EPS Expanded Polystyrene
ISO Polyisocyanurate
FGB Fiberglass Batts
BLN Blown Fiberglass/Cellulose
OC Open Cell Foam
CF Closed Cell Foam

5. Mark additional energy saving features present: ☐conditioned crawlspace, ☐encapsulated attic, ☐reflective shingles, ☐attic radiant barrier, ☐Energy Star home, ☐other above code certification program, ☐fireplace (sealed combustion), ☐fireplace (vented w/ outside air), ☐other: _____

6. Solid Doors (Only for information not on plans)

	Description	Location	Size (W x H x Thick)	☐R or ☐U-Value
Type 1				
Type 2				
Type 3				
Type 4				

7. Windows & Glazed Doors (=>50% glass) (Only for information not on plans)

	Description	Location	Size (W x H)	U-Value	SHGC
Type 1					
Type 2					
Type 3					
Type 4					
Type 5					
Type 6					
Glazed Doors					
Other					
Skylights					

8.HVAC System Preferences ☐no preference

	Location	Manufacturer	Area Served	Efficiency	Heat-Pump	Gas	Duct Type
1							
2							
3							

RM Round Metal **VF** Vinyl Flex
SQ Square Metal **DB** Duct Board

9. Mechanical Ventilation Preferences ☐no preference

On which system(s)? ☐1 ☐2 ☐3 ☐separately ducted

Fresh Air Intake Type	☐Vent. Dehumidifier	☐Supply Only	☐Exhaust Only	☐Balanced
Manufacturer		Model		
Rate (CFM)		Notes		

https://www.energyvanguard.com/hvac-design/

Example houses

Older house (1950s)

1856 sq ft, 2 story home over a semi-conditioned basement.

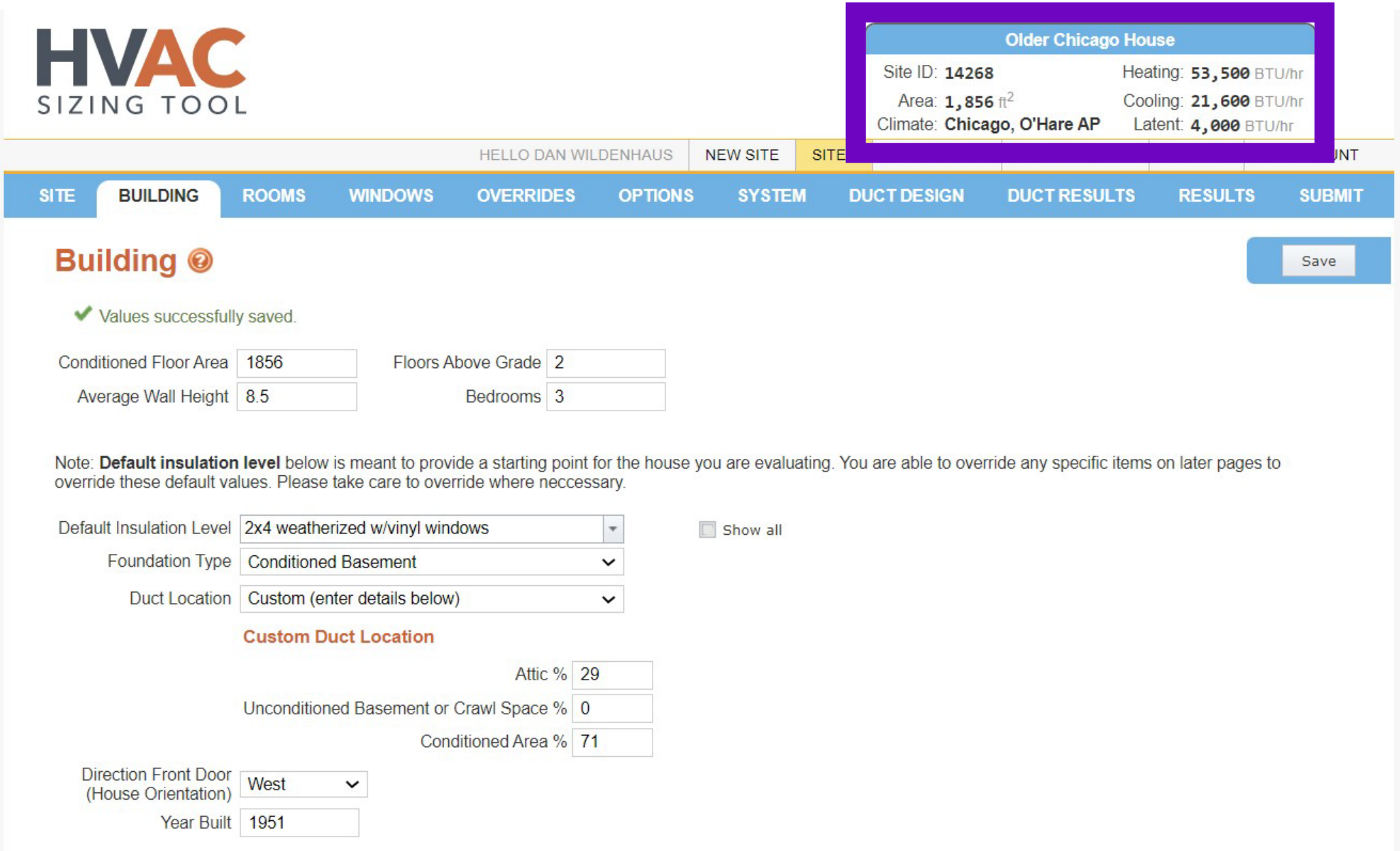
Heating load double the cooling load.

Newer house (2006)

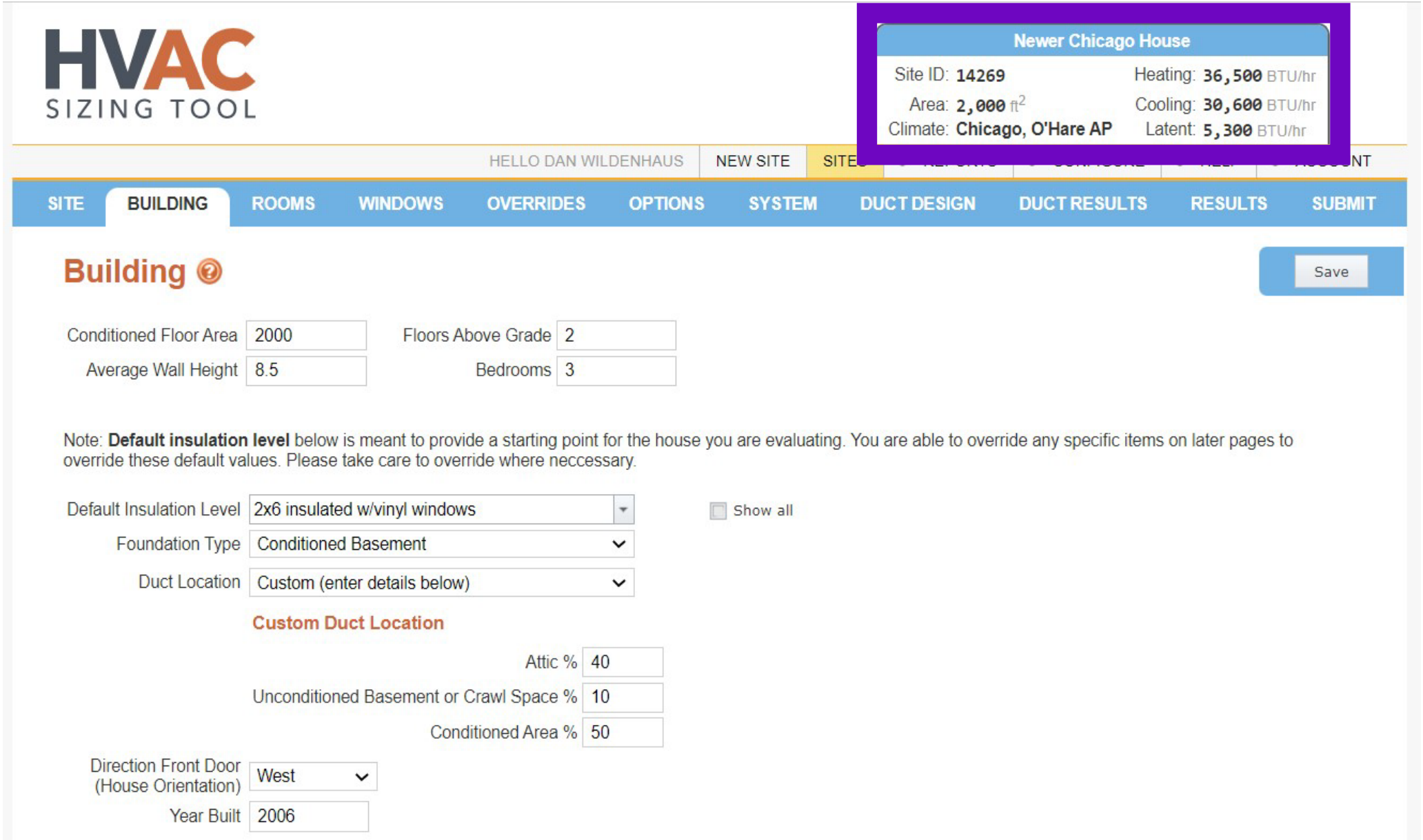
2000 sq ft, 2 story home over a partial basement

Heating and Cooling loads are similar.

Example house – Chicago older home



Example house – Chicago newer house



Rule of thumb vs Manual J for older home

Was system oversized for heating?

35 btu per sq ft

1856 sq ft = 5.41 tons

Man J = 4.46 tons

Image courtesy Adobe Commons

YES, by almost a ton!!

Rule of thumb vs Manual J for newer home

Was system oversized for heating?

35 btu per sq ft

2000 sq ft = 5.83 tons

Man J = 3.1 tons

YES, by more than 2 tons!!

Image courtesy Flickr – Mike Kline

Example enhanced rule of thumb for Northern Illinois

Heating Load Estimator (*in BTUs per square foot of floor area*)				
	Local Design Temperature			
House Description	**Below -10˚ F**	**-10˚ F to 5˚ F**	**5˚ F to 20˚ F**	**Above 20˚ F**
No-wall Insulation; single pane window	47	41	35	29
2x4 wall w/ insulation; 2P windows	25	22	19	16
2x6 wall w/ insulation; 2P windows	18	15	13	11
New Construction (Post 2012)	16	14	12	9

Chart courtesy of the Northwest Energy Efficiency Alliance

Evaluating existing ductwork

1. Engaged discussion with homeowners and qualitative test - does the existing system and ductwork deliver hot/cold air to all rooms?
2. Visual inspection of the ductwork:
   a) Is it located in attic and unconditioned basement?
   b) Are the ducts visually damaged or leaking?
   c) Are the ducts properly insulated?
   d) Ducts that are leaky and outside the envelope can lose 25% of the heating energy!
3. **Perform static pressure test(s)**
4. **Record static pressure and identify key components that will add to static pressure build up**

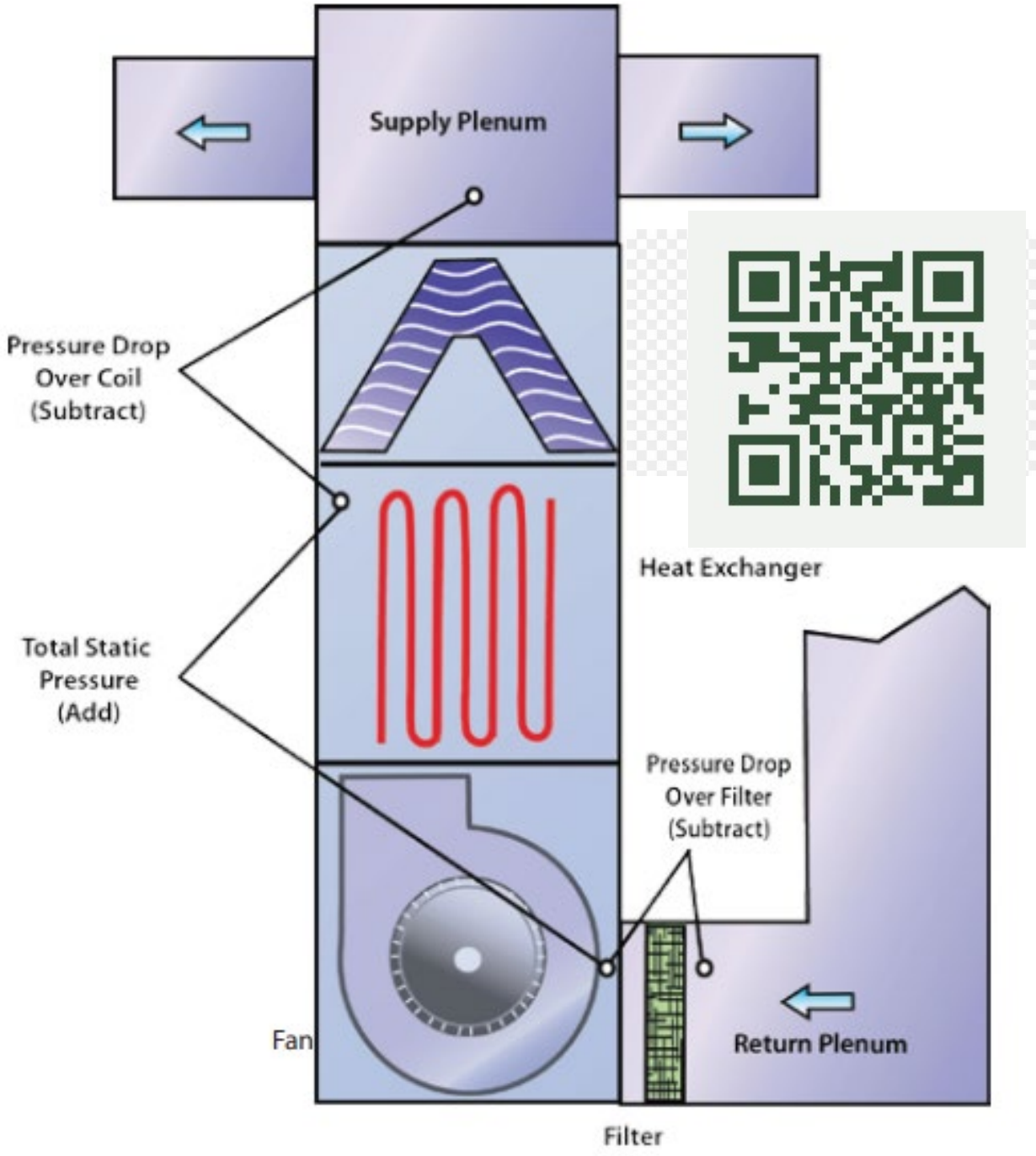
TESP and fan tables and what is meant by “external”

“External” designates how the unit was shipped:

With a central heat pump utilizing auxiliary heat, the air handler and coil are shipped in one piece. The fan curves reflect this the resistance of the of the coil

With gas furnaces with an AC or HP coil, the coil is not shipped with the air handler. The fan curves in this case, do not reflect the resistance of the coil. When testing these systems, the supply side measurement MUST be furnaces taken before the coil

https://www.energystar.gov/sites/default/files/specs/National%20Comfort%20Institute%20-%20Measure%20and%20Interpret%20Static%20Pressures.pdf



Best practices for load calculations - Key takeaways

- Determine what tool or software you are going to use, Use tools you are comfortable with
- Decide how data collection is best done
  - Onsite - This is very beneficial and demonstrates confidence
  - Remote – Data collection will come from the homeowner and may need to be verified before installation
- Compare against enhanced rules of thumb to ensure accuracy
- Evaluate the duct work
  - Existing performance / location
  - Test total static pressure

General design and selection

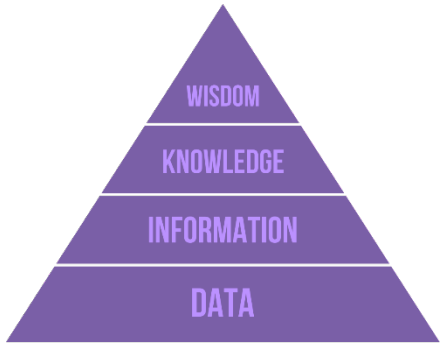
Size for heating or cooling?

Old School

Size for cooling and then go up a ton.

Based on older single or two speed systems.

Does not maximize heating potential of HPs and does not account for modulation capabilities of VSHPs!



New School

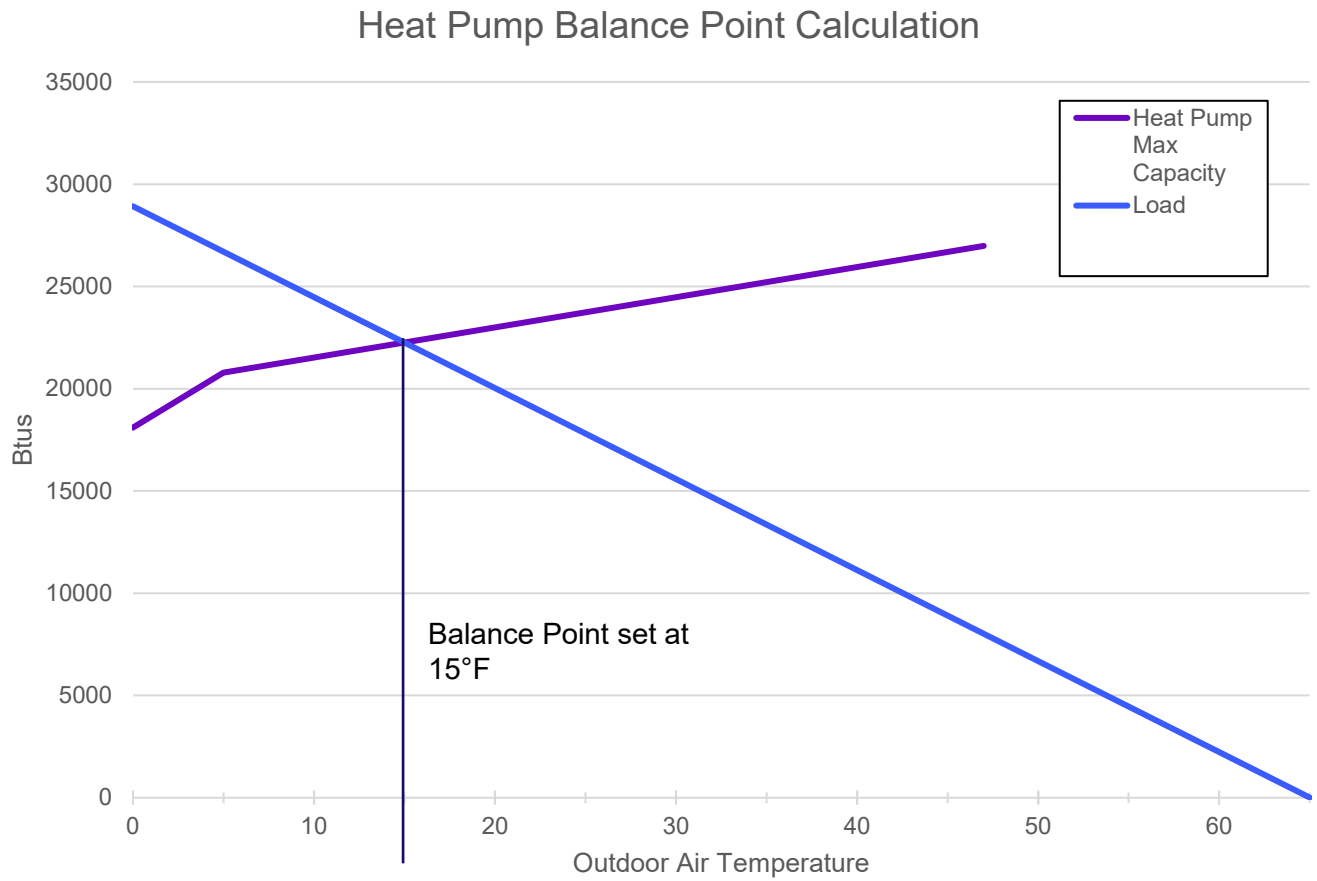
Start by **sizing to largest load for ER, old heat pumps, propane**/home heating oil backup.

For natural gas, size to cooling load unless the homeowner driver is carbon savings.

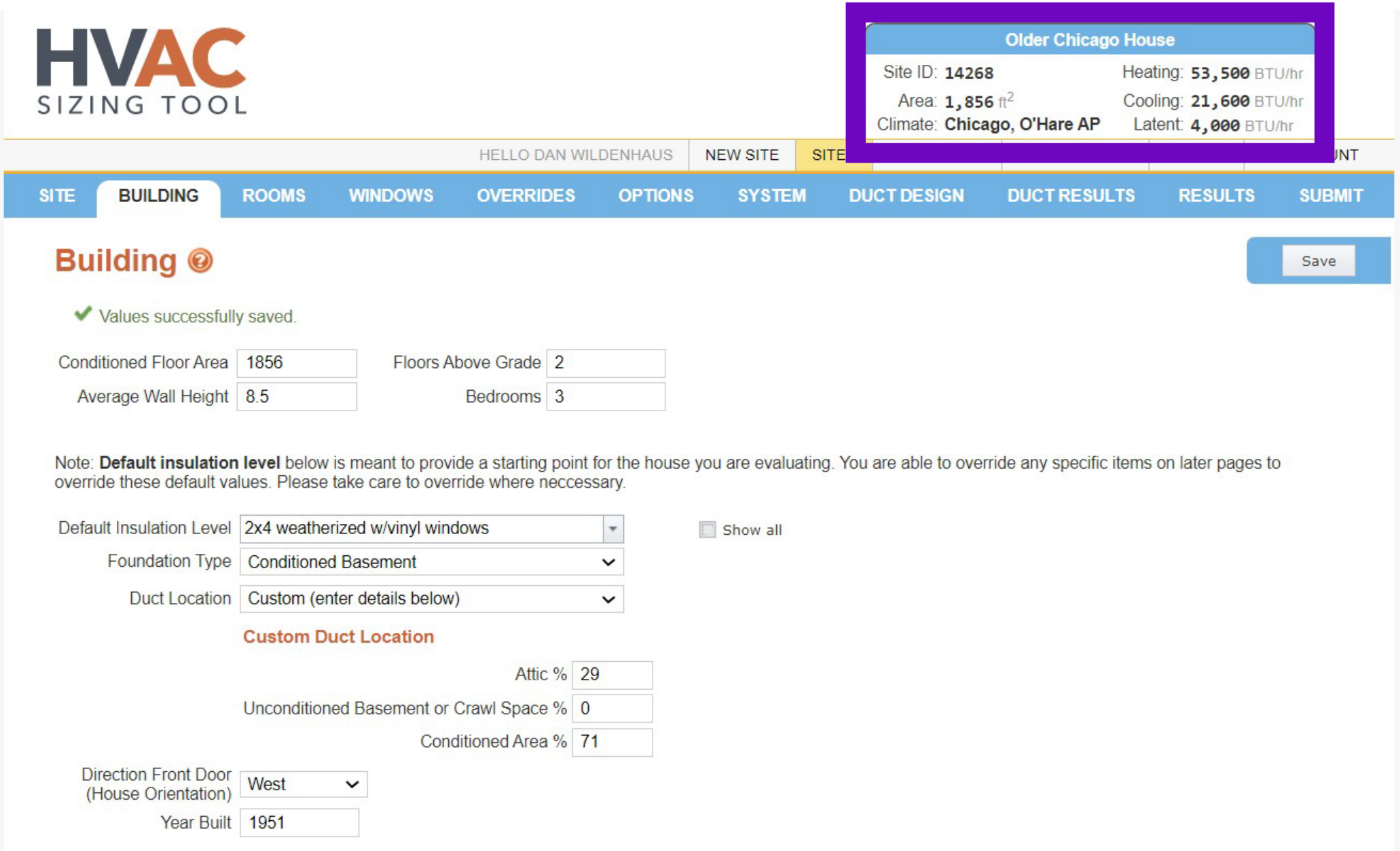
Using Manufacturer data for Max and Min capacities, check to see if the smaller load is between the Max and Min at the design temp.

Likely OK to be within a half ton with variable capacity HPs!

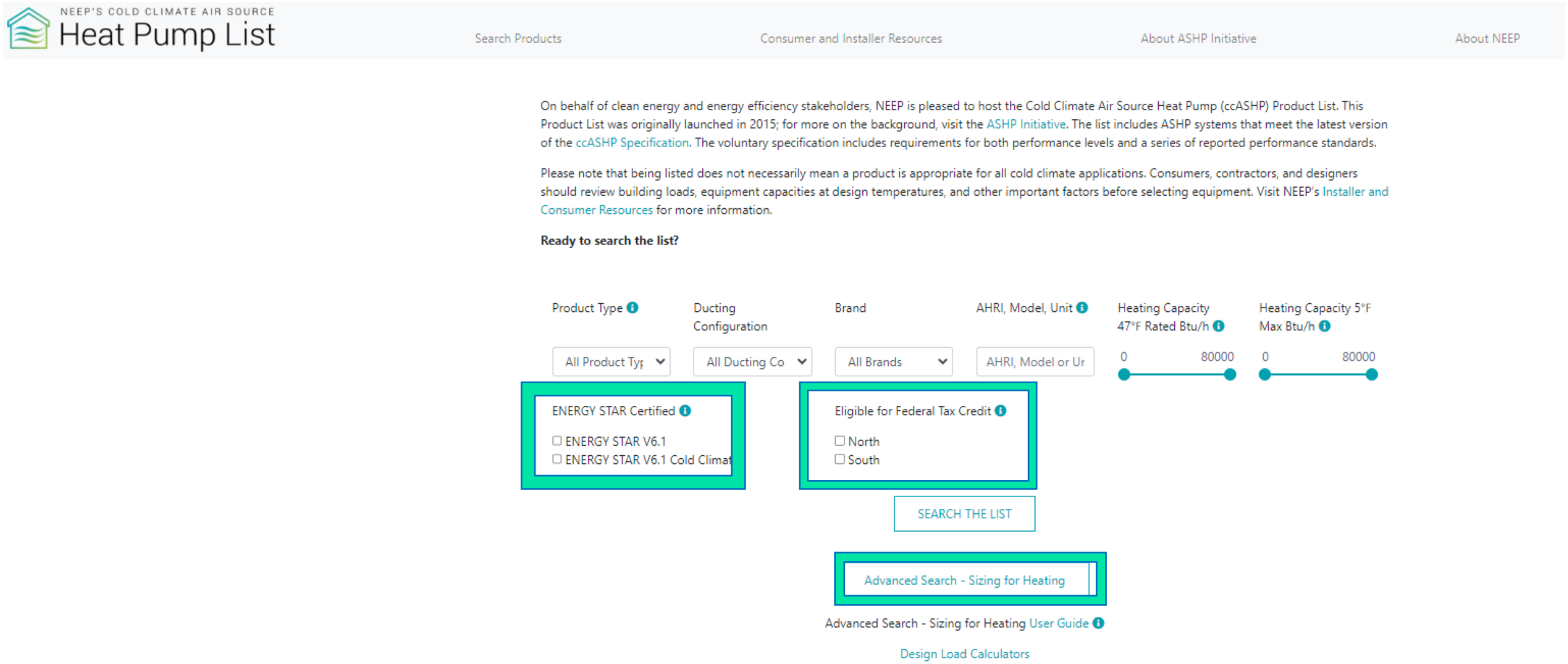
Determining the thermal/capacity balance point



Example house – Chicago older home



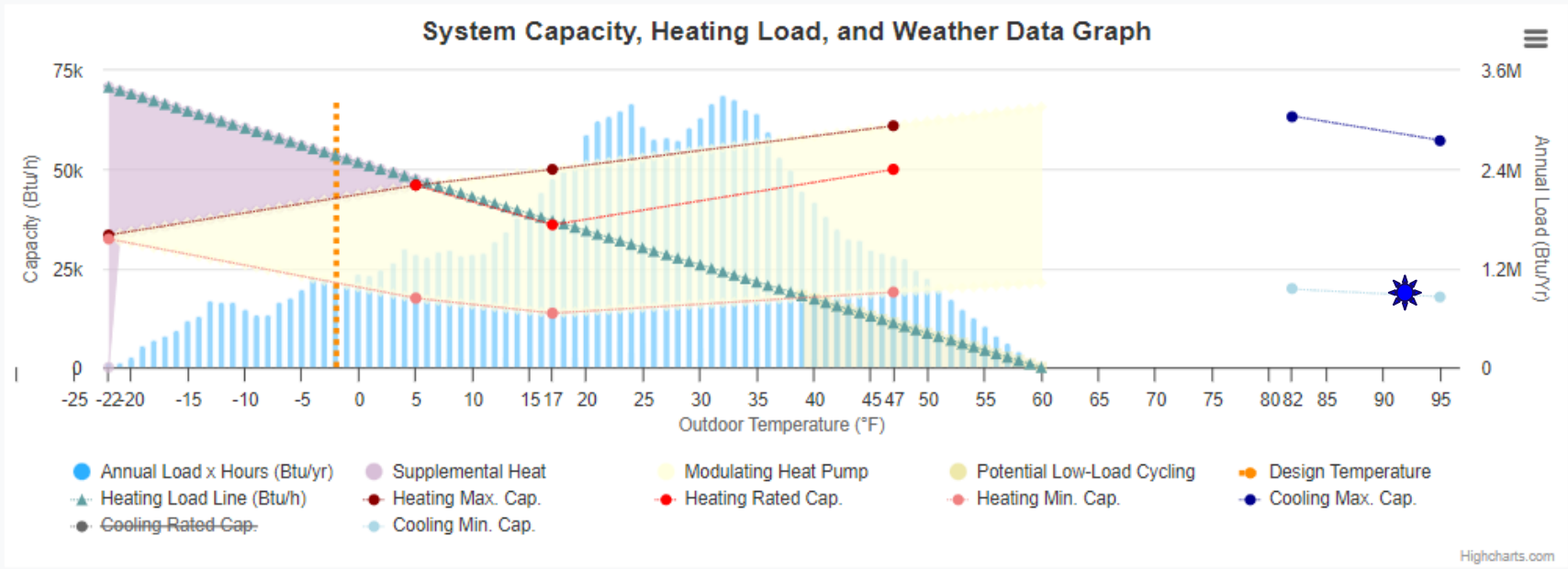
https://ashp.neep.org/#!/product_list/



Example system

Remember our heating and cooling load for the older home?

Graph Information



Older Chicago House

Site ID:	14268	Heating:	53,500 BTU/hr
Area:	1,856 ft²	Cooling:	21,600 BTU/hr
Climate:	Chicago, O'Hare AP	Latent:	4,000 BTU/hr

Product Sizing For Heating

Field Information

Capacity Balance Point (°F)	6
Minimum Capacity Threshold (°F)	39
Maximum Capacity at Design Temp (Btu/h)	42,741
Percent Design Load Served	79.9%
Annual Heating Load (MMBtu)	125.9
Percent Annual Heating Load Served	86.9%

Field Information

Annual Btu's Covered by Supplemental Heat (MMBtu)	16.5
Hours Requiring Supplemental Heat	395
Percent Hours Requiring Supplemental Heat	6.9%
Percent Annual Load Modulating	68.4%
Percent Annual Load with Low-Load Cycling	16.8%

https://ashp.neep.org/

Sizing guidance resources

- NEEP Installer Resources - Guide to Sizing and Selecting Heat Pumps
- Air-Source Heat Pump Sizing and Selection Guide NRCAN
- NEEP Size for Heating Users Guide

Best practices for equipment selection - Key takeaways

- Use the NEEP tool or expanded performance data to view system performance
- Compare different size products against the load
- Ensure the heat pump can run at low enough capacity to properly maintain the cooling load
- Communicate the systems performance to the customer
  - Ensure proper control strategy
  - Ensure proper balance point settings

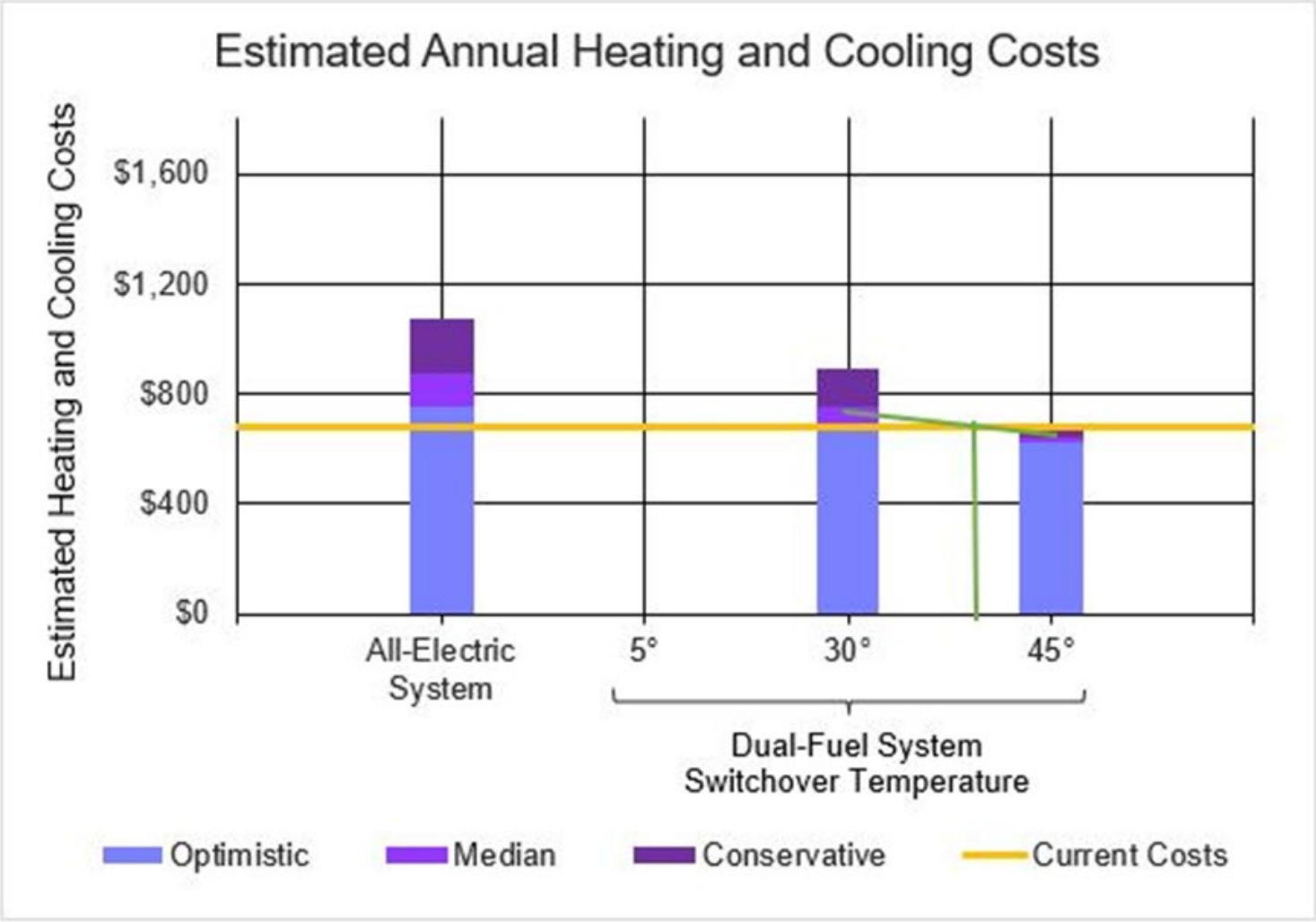
Final section goals

Bringing switchover temperatures and cost of heat into the discussion.

How does this look for operational costs?

Based on your inputs, you could save up to:

$57 per year



Dual Fuel home – heat pump with a natural gas furnace backup

https://goelectric.comed.com

Switchover (changeover/cutoff) temperatures and service contracts

Typically, around 70% of contractors offer service/maintenance contracts

Of these, the average close rate on contracts is around 50%

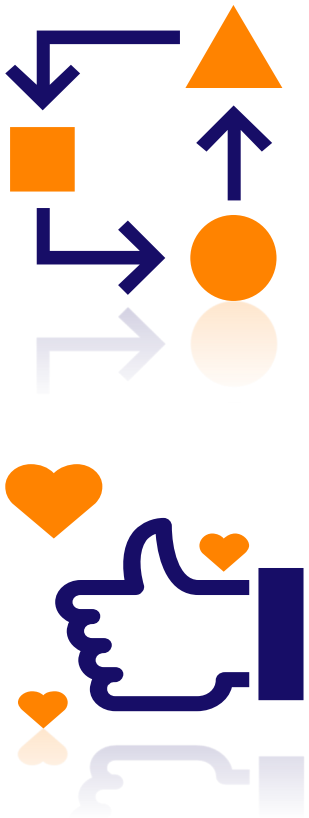
What if your service contract included adjusting switchover temperatures to minimize homeowner utility bills (or comfort)?

Do you think your competitors are doing this?

Typical switchover temperatures by application

Application	Typical switchover temp
ccDHP displacing baseboard heat or gas boiler	0-5º F (compressor lockout no higher than this)
ccASHP displacing propane furnace	Depends on cost of propane and sizing, including duct evaluation 5-25º F
ASHP displacing natural gas furnace	Depends on gas and electric rates & customer motivation: 25-45º F (ccASHP) 35-45º F (two stage HP)

Summary of key milestones



Understand	Understand the resident's goals, pain points, wants, and budget as a guide
Perform	Perform an accurate load calculation
Design around	Design around application and fuel types
Evaluate	Evaluate ductwork
Size and Select	Size and Select to the right application and fuel type
Use Tools	Use tools that help you sell and instill confidence!

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Poll

Which task will you be adopting more often after this course?

Take the Knowledge Check

- Knowledge Check
  - You can find it in the chat
  - We'll send it out via a follow up email from registration@slipstreaminc.org
- Complete it by **EOD Wednesday January 31** to check this course off your required trainings

Coming Up!

Be sure to join us at our upcoming webinars!

- **February 8 at 7:45 AM** – Heat Pump Control Strategies and Best Practices
- **February 15 at 7:45 AM** – Replacing Air Conditioners with ASHPs

Register online if you haven't yet: slipstreaminc.org/ComEd-ASHP

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Air Source Heat Pumps Training Requirement for 2024

Contractor Heat Pump Training Initiative | Zak Paine, Dan Wildenhaus

30% of Installers and Technicians must complete BOTH of the following components. The following survey is required to determine # of installers/techs https://www.surveymonkey.com/r/XLR7QJX

ComEd Module Requirements

- **Air Source Heat Pump Applications (approx. 1 hour):** explore various product use cases and how to identify the right product for your customers.
- **Replacing Air Conditioners with ASHPs (approx. 1 hour):** explore air source heat pumps as an AC replacement and a growing business opportunity.
- **Heat Pump Control Strategies and Best Practices (approx. 1 hour):** introduction to heat pump control strategies and best practices to keep them performing at their best.
- **Designing Air Source Heat Pumps with Sizing and Selection in Mind (approx. 1 hour):** the why and what matters when properly designing, sizing and selecting air source heat pumps for Northern Illinois homeowners.

Manufacturer-Based Training

- Installers and service technicians will be required to attend one manufacturer training session per year.
- Reach out to comed.homeheatingcooling@dnv.com or contact your distributor for more information on manufacturer-based trainings.
- Manufacturer trainings attended in 2023 will be accepted for participation in 2024

Companies that have completed all training requirements will be listed on the ComEd website under the “Heat Pump Contractors” list.

https://comed2.my.salesforce-sites.com/HHC

Installers and service technicians may take the training after January 1st but will not be eligible to receive incentives until training is complete. Manufacturer training on heat pumps received in 2023 will be accepted to meet 2024 requirements.

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Thank you

For technical and training questions, please contact:

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