Northwest Ductless Heat Pump Project

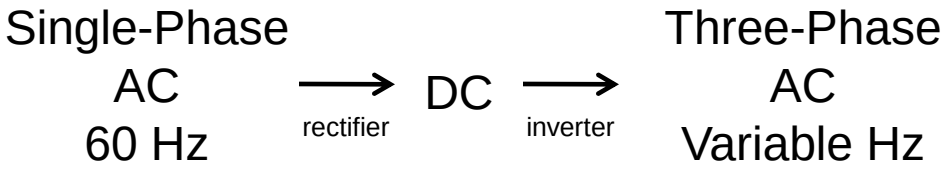
Technology and Application

Presented by Adam Hadley

Inverter Driven

Inverter driven means variable speed

Built-in electronics do the following:



3-phase induction motor drives the compressor at varying speeds

Why this is important:

-Comfort

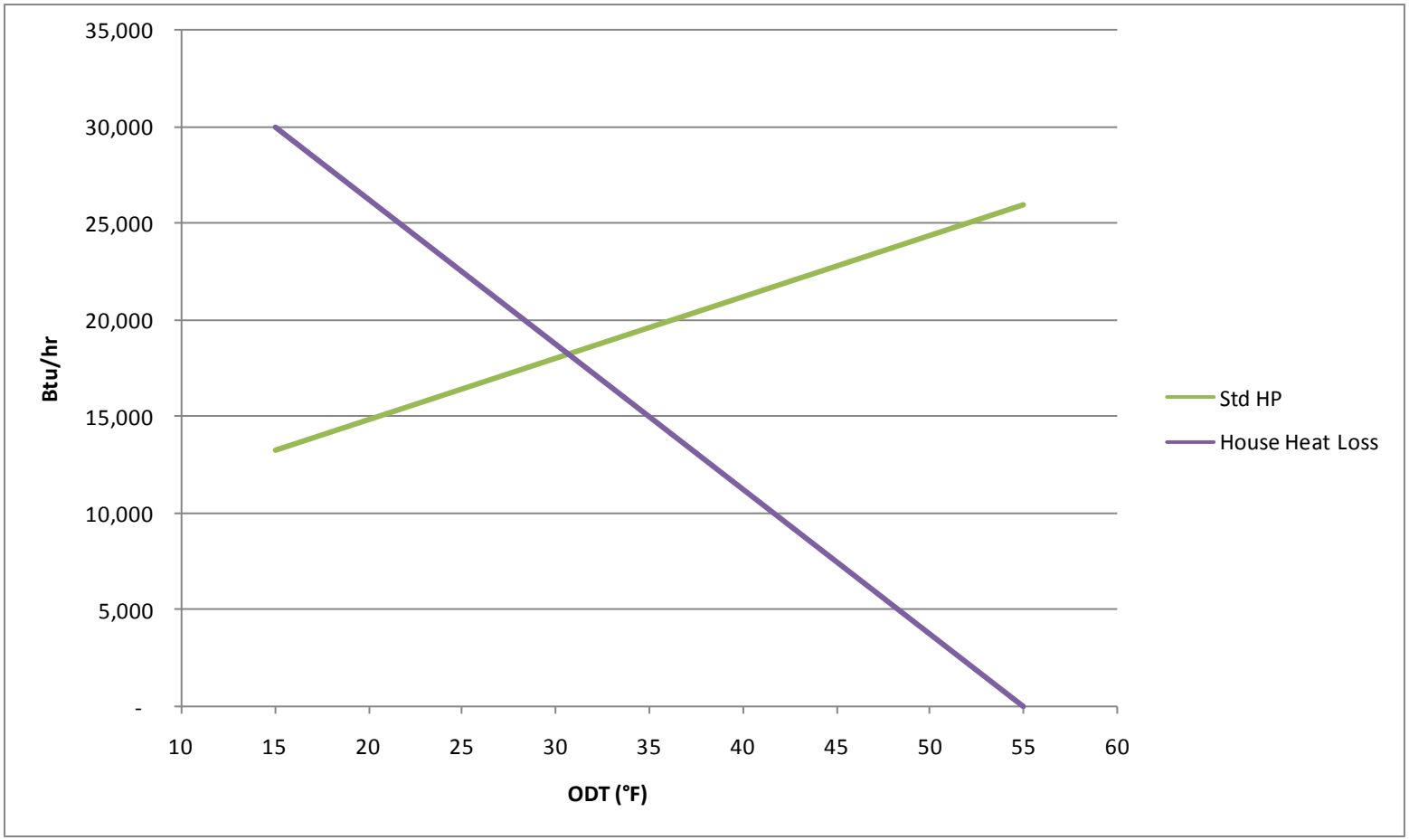
- Consistent temperatures
- Mixed air
- Comfortable supply air temperatures

-Efficiency

- High capacity mode reduces need for supplemental heat
- Low capacity mode is efficient

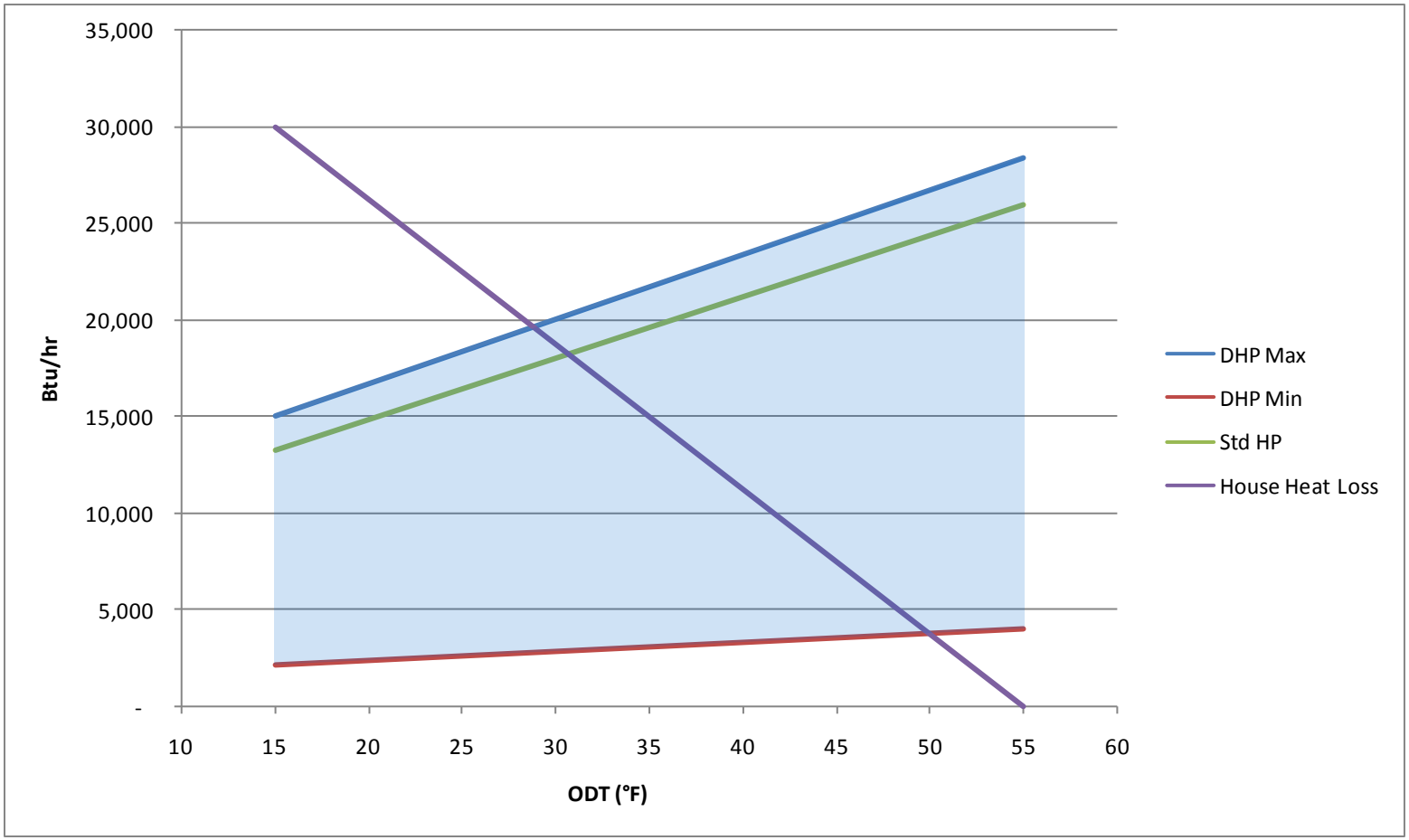
Sizing

Single-speed heat pump sizing (simplified)



Variable Speed offers flexible sizing

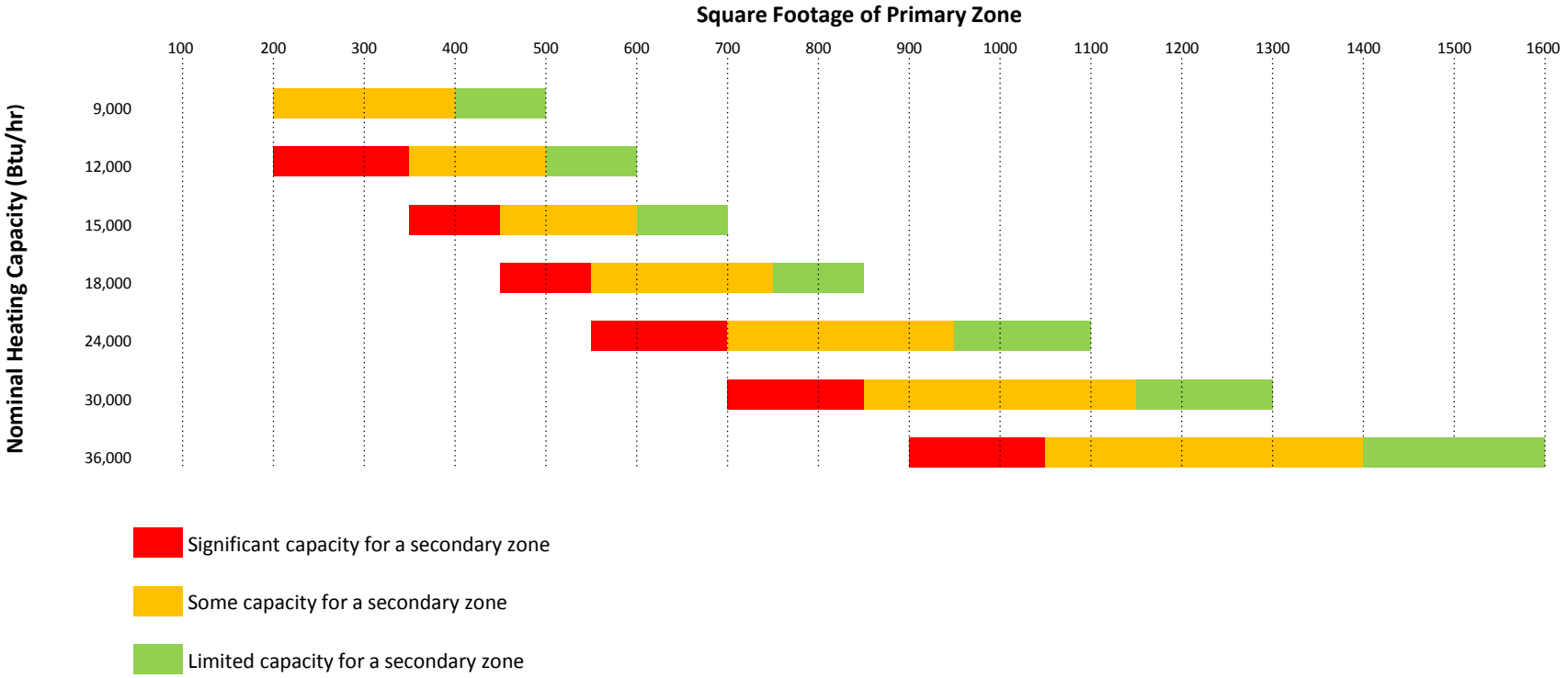
Variable speed heat pump



Sizing ???

The following sizing method is intended to maximize both the reduction of electric resistance heat use and occupant comfort in zonally heated houses:

1. Determine square footage of the primary zone (See below for more details on primary zone)
2. How much capacity should the heat pump should have available for a secondary zone? (Significant, Some, or Limited)
3. Use the chart below to determine the optimally sized ductless mini-split heat pump.



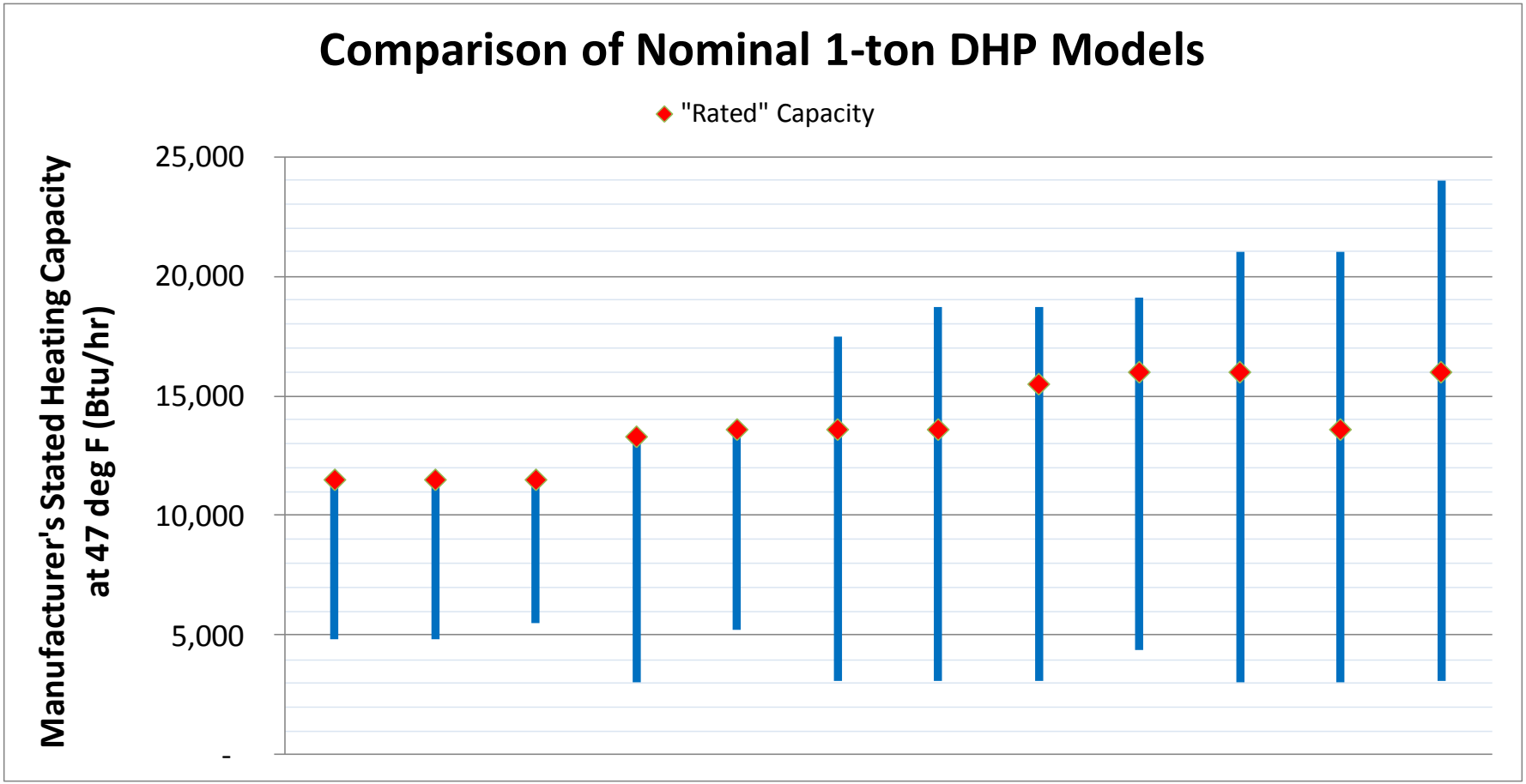
Notes:

"Primary Zone" is the area that the occupants keep warmest in the winter. This is usually a main living area consisting of some combination of living room, family room, dining room, and/or kitchen.

Installation of units in primary zones less than 200 square feet is not recommended.

"Secondary Zone" is any zone that is connected to the primary zone by an open hallway or open doorway. The occupant's behavior (open/closed doors) may factor into determing whether a zone should be classifed as secondary.

Sizing – Pay Attention to the Specs



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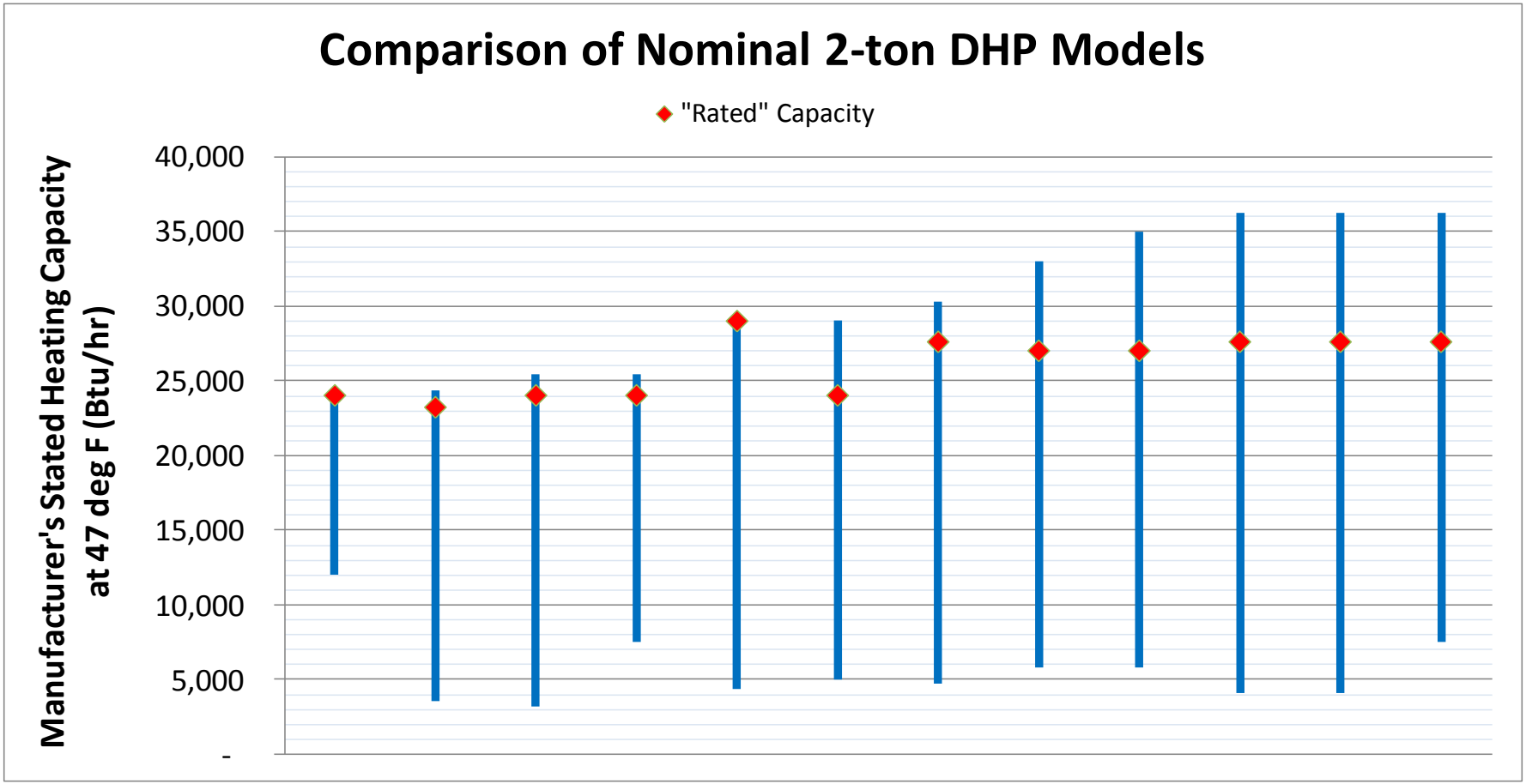


Efficiency at low loads

Average Coefficient of Performance of Nominal 1-ton Units at 47 deg F:

- Lowest Compressor Frequency: 4.7
- Rated Compressor Frequency: 3.6
- Highest Compressor Frequency: 3.0

47°F … “Temperature Float” Allowed

Mild Day, Bedroom Doors Open, Resistance setting = 60

	1-ton HP	2-ton HP
DHP Capacity	18,000	30,000
House Heat Load	12,114	
Load on DHP	12,114	12,114
Load on Resistance	0	0

DHP Load	100%	100%
Resistance Load	0%	0%

DHP Load Factor	67%	40%

Units = btu/hr

35°F … “Temperature Float” Allowed

Cold Day, Bedroom Doors Open, Resistance setting = 60

	1-ton HP	2-ton HP
DHP Capacity	12,000	20,000
House Heat Load	17,918	
Load on DHP	12,000	17,918
Load on Resistance	5,918	0

DHP Load	67%	100%
Resistance Load	33%	0%

DHP Load Factor	100%	90%

Units = btu/hr

17°F … “Temperature Float” Allowed

Design Day, Bedroom Doors Open, Resistance setting = 60

	1-ton HP	2-ton HP
DHP Capacity	10,000	16,667
House Heat Load	28,622	
Load on DHP	10,000	16,667
Load on Resistance	18,622	11,955

DHP Load	35%	58%
Resistance Load	65%	42%

DHP Load Factor	100%	100%

Units = btu/hr

47°F … 70°F Throughout the House

Mild Day, Bedroom Doors Closed, Resistance setting = 70

	1-ton HP	2-ton HP
DHP Capacity	18,000	30,000
House Heat Load	13,107	
Load on DHP	7,238	7,238
Load on Resistance	5,869	5,869

DHP Load	55%	55%
Resistance Load	45%	45%

DHP Load Factor	40%	24%

Units = btu/hr

35°F … 70°F Throughout the House

Cold Day, Bedroom Doors Closed, Resistance setting = 70

	1-ton HP	2-ton HP
DHP Capacity	12,000	20,000
House Heat Load	20,263	
Load on DHP	11,187	11,187
Load on Resistance	9,076	9,076

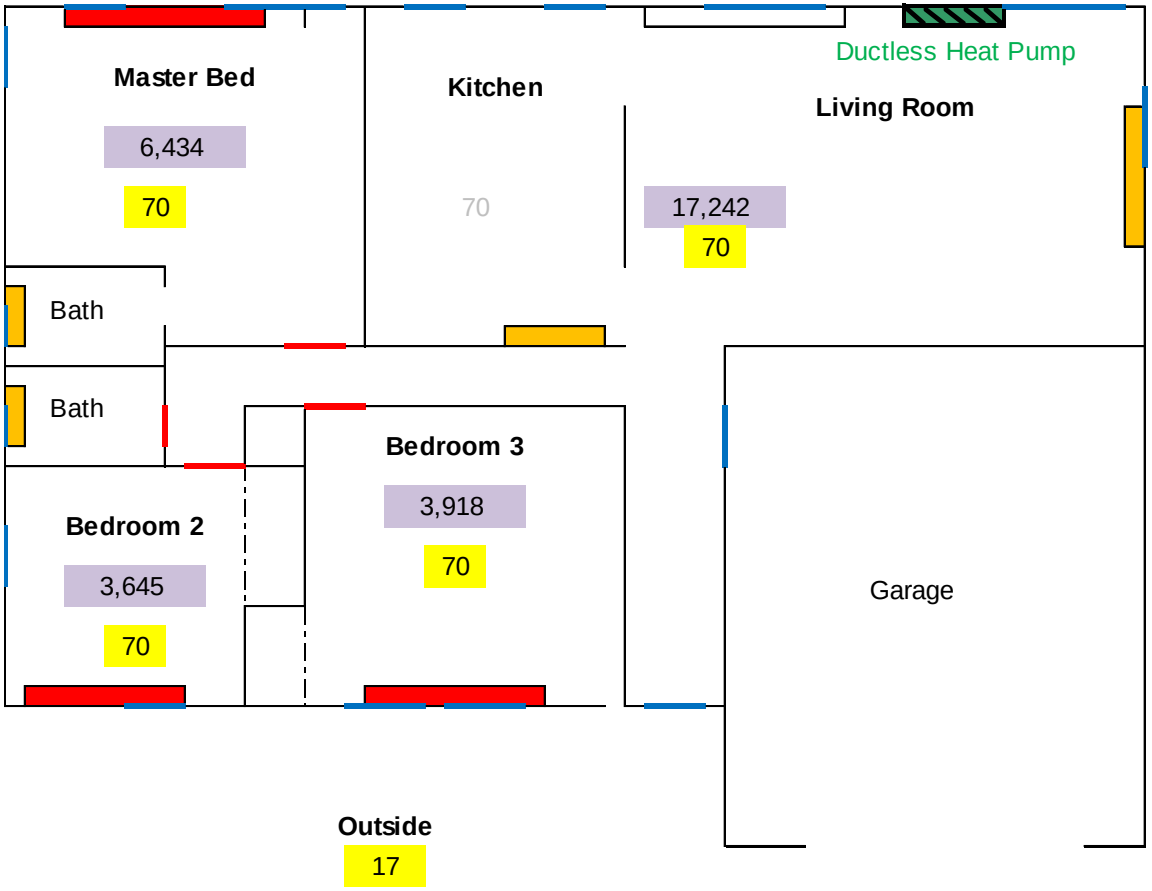
DHP Load	55%	55%
Resistance Load	45%	45%

DHP Load Factor	93%	56%

Units = btu/hr

17°F … 70°F Throughout the House

Design Day, Bedroom Doors Closed, Resistance setting = 70



	1-ton HP	2-ton HP
DHP Capacity	10,000	16,667
House Heat Load	31,240	
Load on DHP	10,000	16,667
Load on Resistance	21,240	14,573

DHP Load	32%	53%
Resistance Load	68%	47%

DHP Load Factor	100%	100%

Units = btu/hr

Summary

	ODT (deg F)	Temperature Float Allowed		70 deg Throughout the House	
		1-ton	2-ton	1-ton	2-ton
House Load met by DHP	47	100%	100%	55%	55%
	35	67%	100%	55%	55%
	17	35%	58%	32%	53%
DHP Load Factor	47	67%	40%	40%	24%
	35	100%	90%	93%	56%
	17	100%	100%	100%	100%

(Early) Conclusions on Sizing

Pay attention to heating capacities

Bigger is more efficient (?)

Occupant Interaction Matters

-Doors open?

-Cool bedrooms ok?

More to think about

-Two stories, basements

-Noise & Airflow Rates & Comfort of larger equipment

-Efficiency at the loading factor

-What if indefinite operation is not allowed for all compressor frequencies?

-Cost

The Main Point: Variable Speed provides a LOT of wiggle room when sizing.

What About HSPF and SEER?

Cooling Efficiency Rating:

SEER – Seasonal Energy Efficiency Ratio

Range: 13 to 26+ (COP translation: 3.8 to 7.6)

Main Issue: Cooling doesn't account for much energy use in the PNW (especially in houses that never had cooling).

Heating Efficiency Rating:

HSPF – Heating Seasonal Performance Factor

Range: 7.7 to 12 (COP translation: 2.3 to 3.5)

Main Issue: HSPF can be based on an assumed building heating load calculated from the heating capacity (at 47) of the system at the maximum cooling mode compressor frequency. This causes the test unit to operate at the low end of the compressor frequencies (high efficiency) for much of the "season".

The Main Points:

1. We have more to learn more about the effect of the efficiency ratings on variable speed equipment.
2. When displacing electric resistance heat, heating capacities seem more important than efficiency ratings (given inverter driven systems).

Questions