Design Principles for Heat Pumps in Low Load Buildings

With Myth Busting!

Benjamin Knopp - April 2021

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Why Heat Pumps?

Many reasons:

- Low carbon emissions - which continue to decline
- Low cost (install + operating)
- Unparalleled comfort (with variable speed)
- Safer than combustion heaters

“Compared to radiators, forced air systems provide dry heat.”

FALSE

Low winter humidity comes from air leakage not the heating source.

Heat Pump Basics

Efficiency/Carbon Comparison

- Heat pumps: move heat from one location to another: out during the summer (AC) and in during the winter (heating)
- Why generate heat when you can move it around at a fraction of the cost?

Site Efficiency:

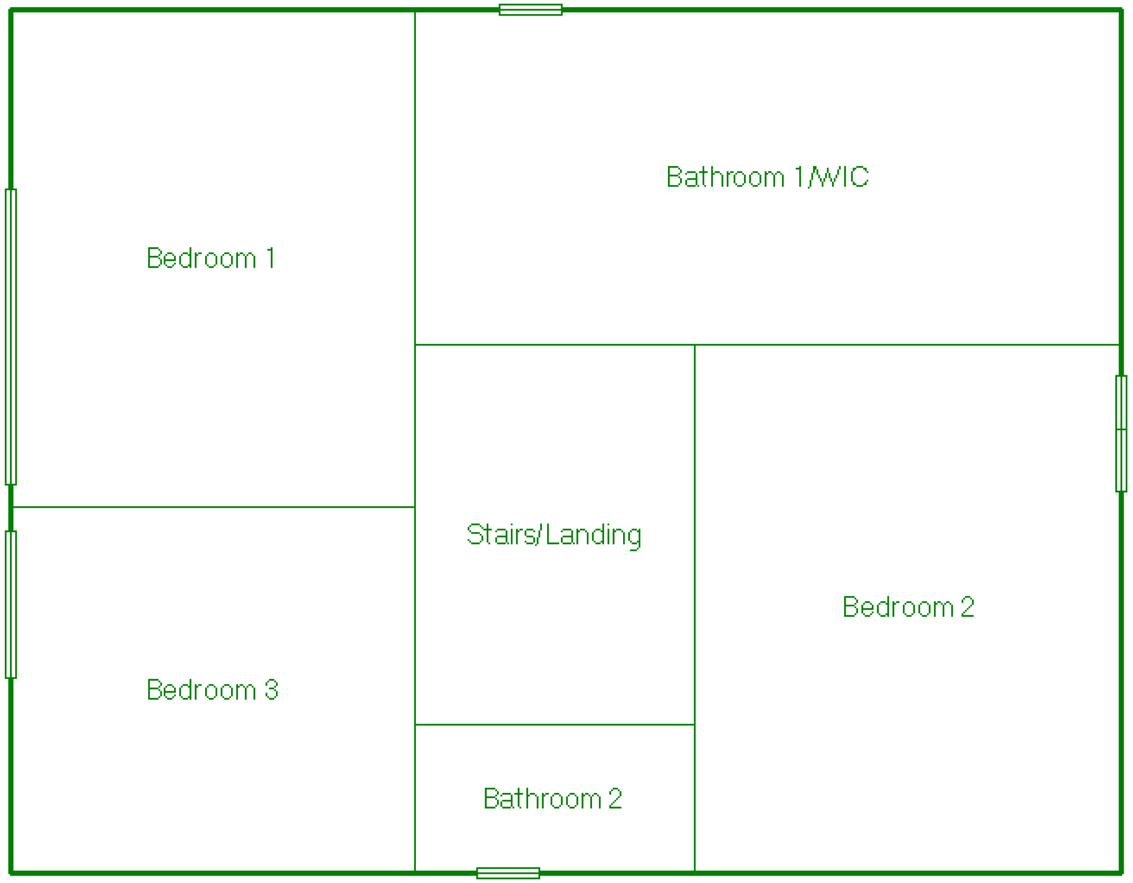
- Fossil fuel heaters: 50-97%
- Electric resistance: ~100%
- Electric heat pumps: 200-500%

Carbon Emissions: $lbCO_2/MMBtu$

- Fossil fuel heaters: 284-159
- Electric resistance: 261
- Electric heat pumps: 131-52

Design Best Practices

1. **Heat load calculation**
2. Equipment selection
3. Filtration design
4. Duct design
5. Termination design

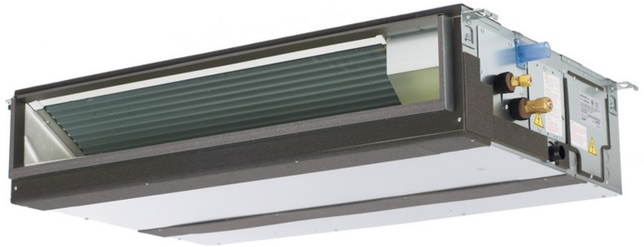


“It is important to start with an accurate heat load calculation.”

TRUE

ACCA Manual J or in-depth monitoring

Design Best Practices



1. Heat load calculation
2. **Equipment selection**
3. Filtration design
4. Duct design
5. Termination design

2. Equipment Selection

Climate-Dependent

- **Dry climate**: size to the highest load (cooling vs heating)

- **Cold climate**: use cold-climate heat pumps, balance between capacity and partial-load performance

- **Humid/Mixed Humid climate**: focus on moisture removal and avoid electric resistance backup if possible

What Kind of HP?

Single, Multi, Variable-speed

Examples:

- Single speed: 0% or 100%
- Multi-speed: 0%, 70%, 100%
- **Variable-speed**: 0%, 20%, 30%, … 90%, 100%

“You can’t really oversize variable speed equipment because it can ramp down.”

FALSE

Oversized variable speed = single speed

“Ductless mini-splits are more efficient than ducted mini-splits.”

FALSE

Two reasons: ratings vs reality & soiling

Design Best Practices

1. Heat load calculation
2. Equipment selection
3. **Filtration design**
4. Duct design
5. Termination design

“You can’t use high MERV filters with ducted mini-splits because they don’t have enough fan power.”

FALSE

You could use HEPA…

Design Best Practices

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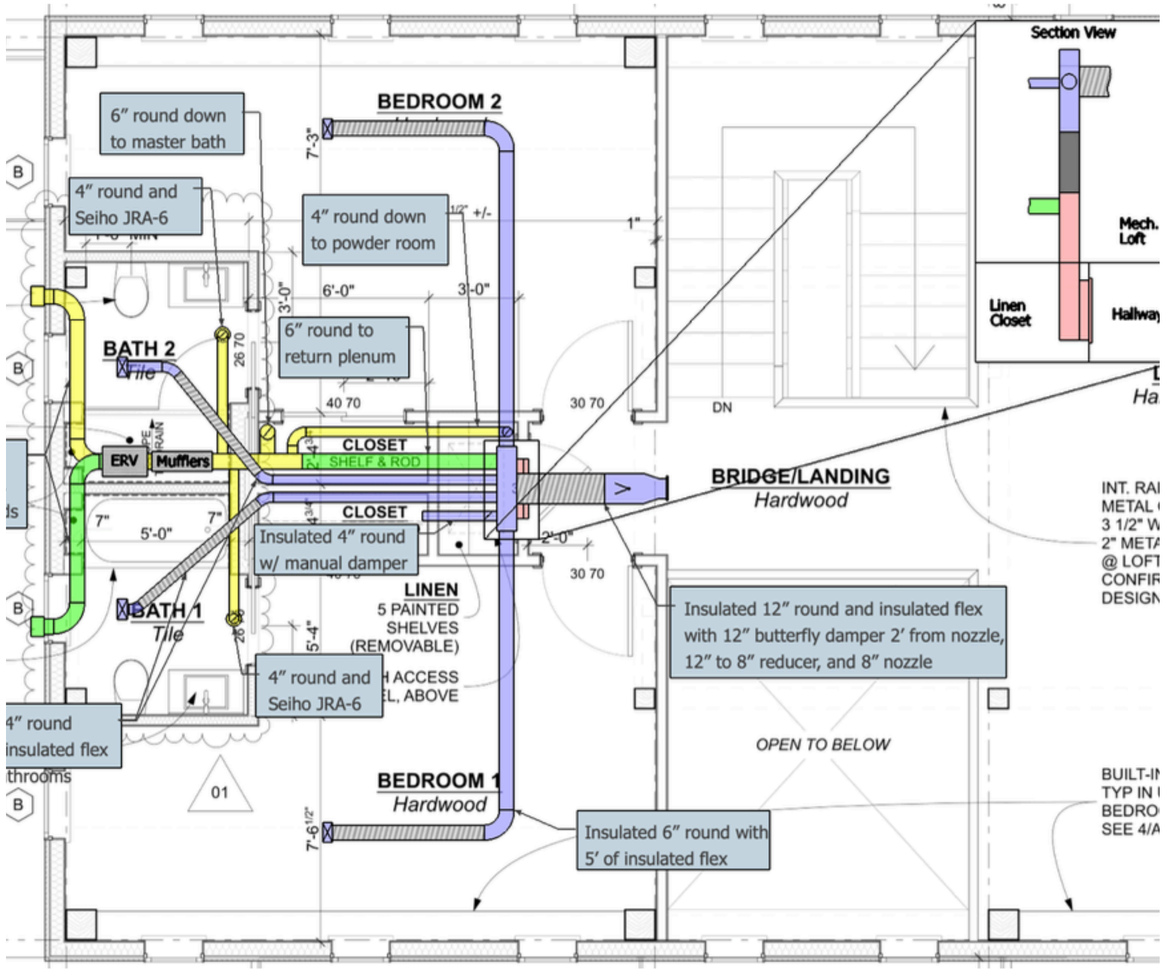
3. Filtration design
4. **Duct design**
5. Termination design



“Ducted mini-splits only work with short ductwork.”

FALSE

Resistance is the problem, not duct length.

“ERVs and HRVs help distribute conditioned air around the home.”

FALSE

Non-conditioning ERVs/HRVs just provide less-uncomfortable outdoor air

“Every room should have a dedicated return air duct.”

FALSE

Every room should have a return air *pathway*

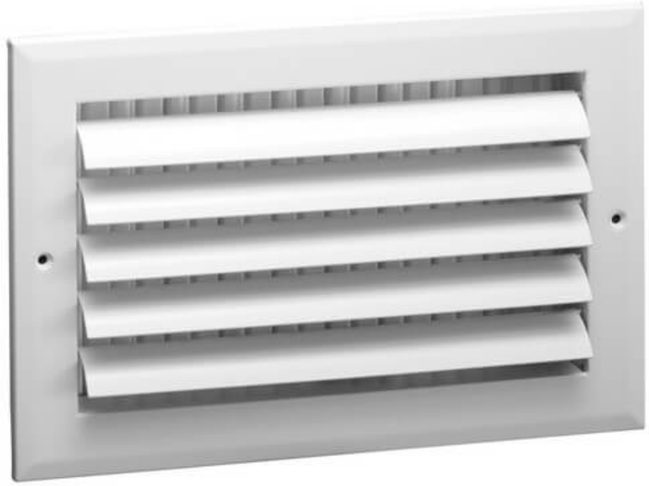
“Door undercuts are not a sufficient return air pathway.”

TRUE & FALSE

The undercut is not the only path

Design Best Practices

1. Heat load calculation
2. Equipment selection
3. Filtration design
4. Duct design
5. **Termination design**



“The location and height of return air intakes is important for comfort.”

FALSE

Comfort comes from properly delivering *supply air*

“Supply registers should be located at exterior walls, near windows.”

TRUE & FALSE

True for most existing construction
False for low-load buildings

Design Best Practices

Don’t forget to finish the job!

1. Heat load calculation
2. Equipment selection
3. Filtration design
4. Duct design
5. Termination design
6. **Quality installation!**
7. **Commissioining, airflow balancing, and monitoring!**

Thanks for Watching!

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