Advances in Heating & Cooling Technologies

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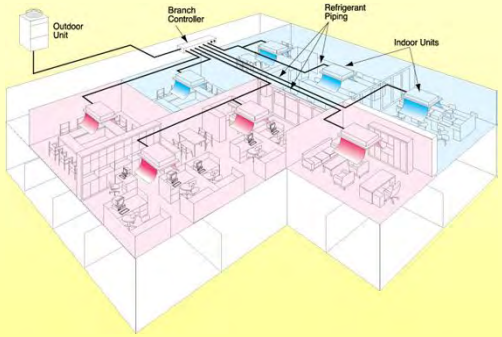
MITSUBISHI ELECTRIC

COOLING & HEATING

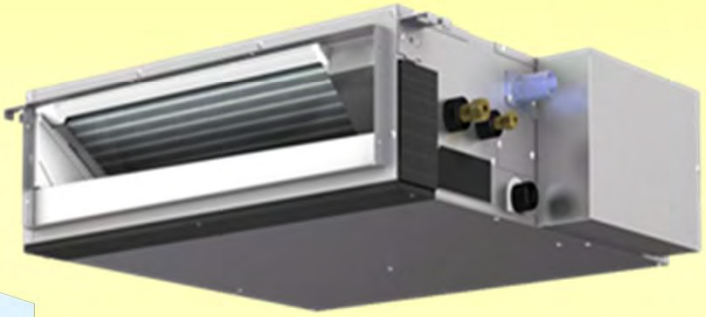
Ductless HVAC

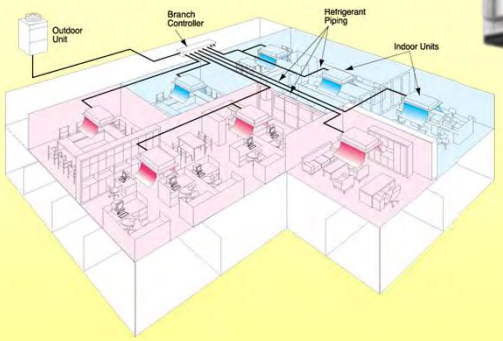
- Mini-Splits
- VRF Systems

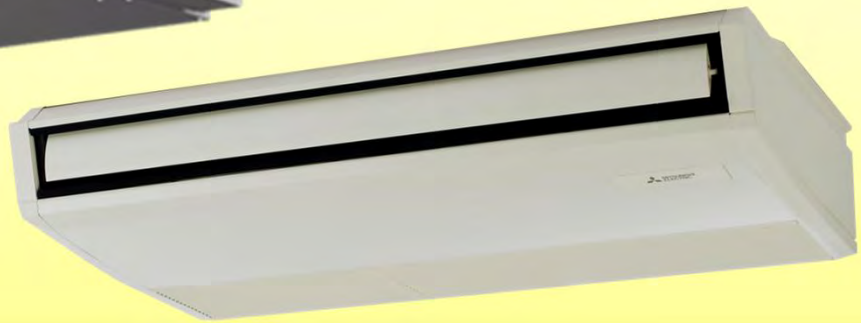


What is a Mini-Split?

- Indoor Fan Coil



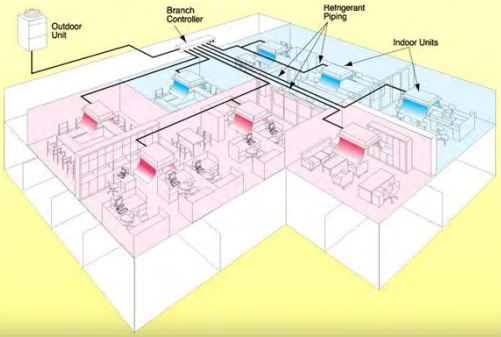




Wall-mounted Indoor Unit

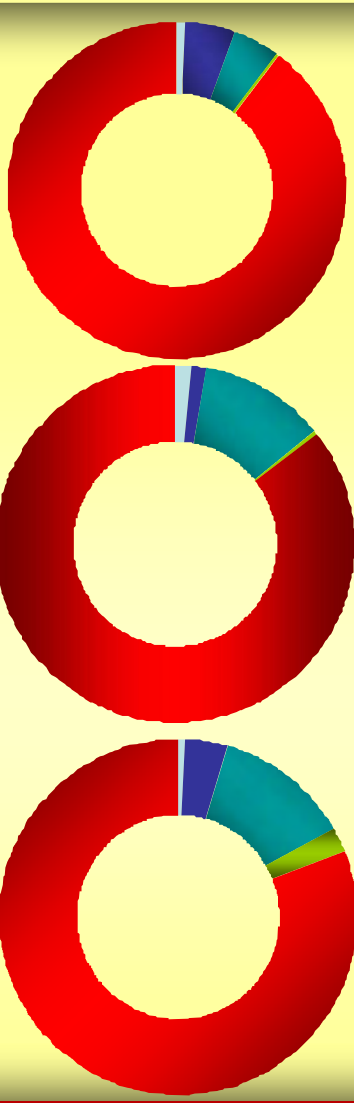
What is a Mini-Split?

- Outdoor "Condenser" Unit



Connected with Refrigerant Tubing

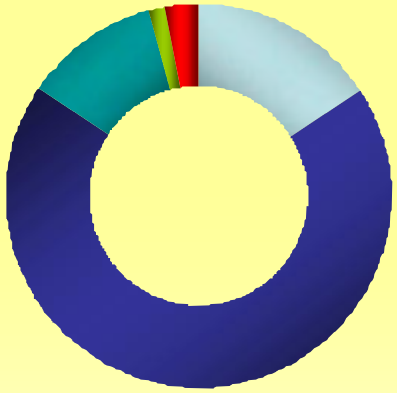
Worldwide Usage-Ductless Technology



Japan
90%
7.2M Systems

China
86%
16.7M Systems

Europe
81%
7.6M Systems



USA
3%
0.2M Systems

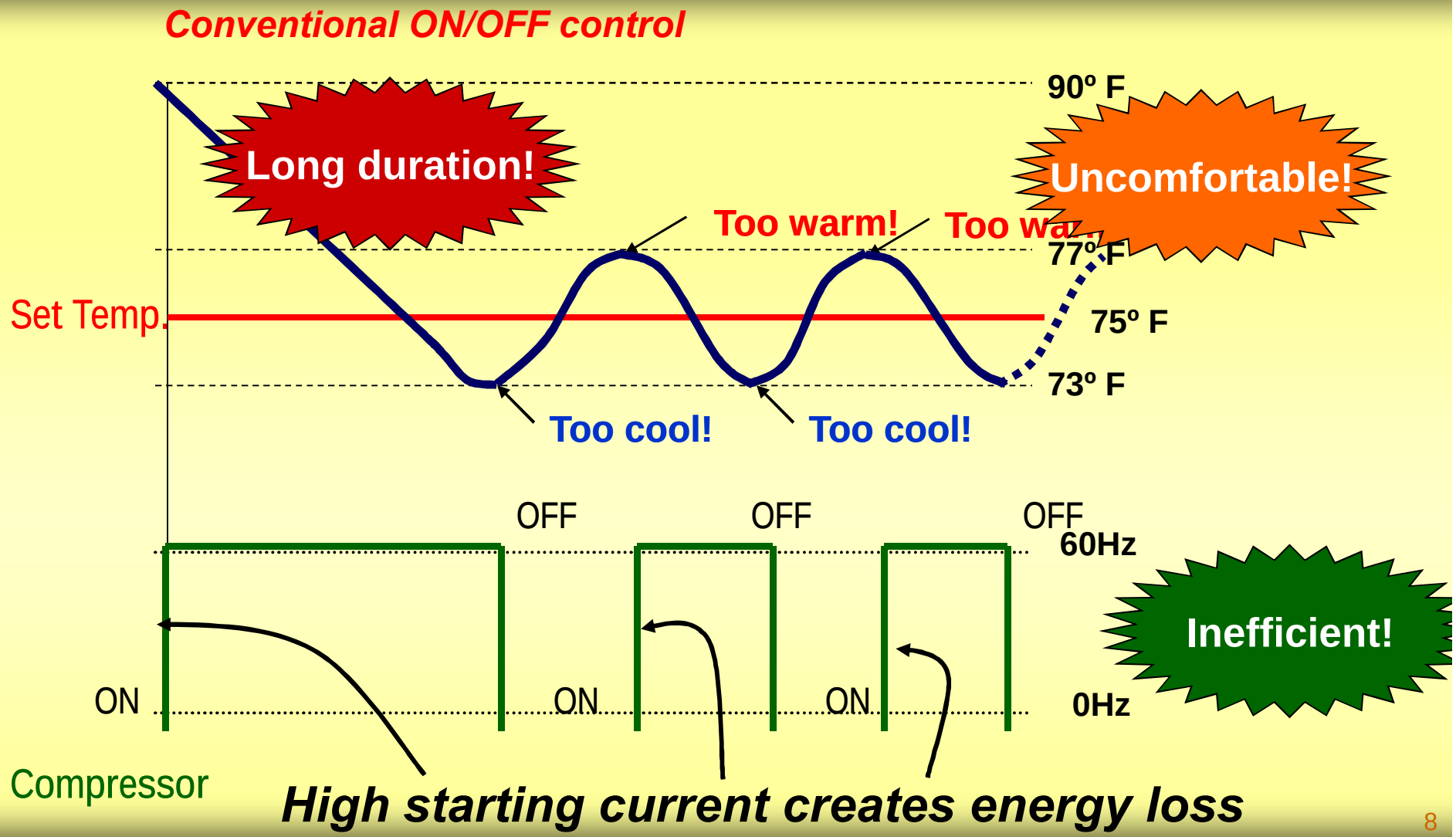
Ductless is a small percent of the U.S. HVAC market, but current building and energy usage trends indicate a large growth opportunity

Source: BSRA report 2005-2007

Split-zoning Advantages

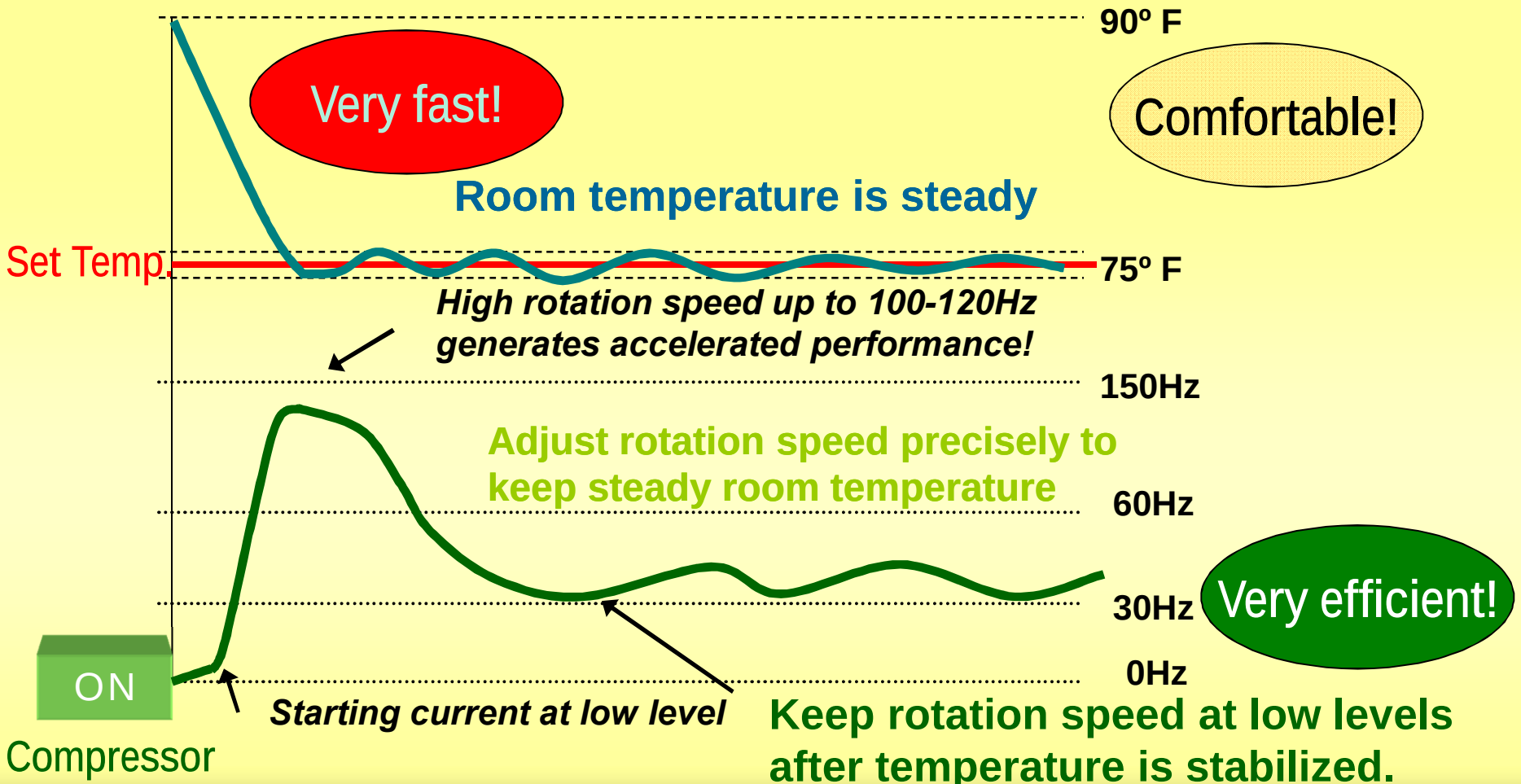
- Easy Retrofit
- No Duct Losses
- Inverter-Driven Variable Speed Compressor
- Enormous Potential Savings with Zoning

INVERTER Compressor Advantages



INVERTER Compressor Advantages

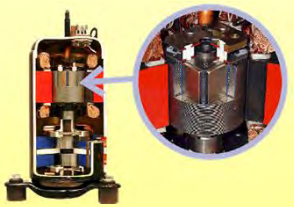
Smooth INVERTER control



INVERTER Compressor Advantages

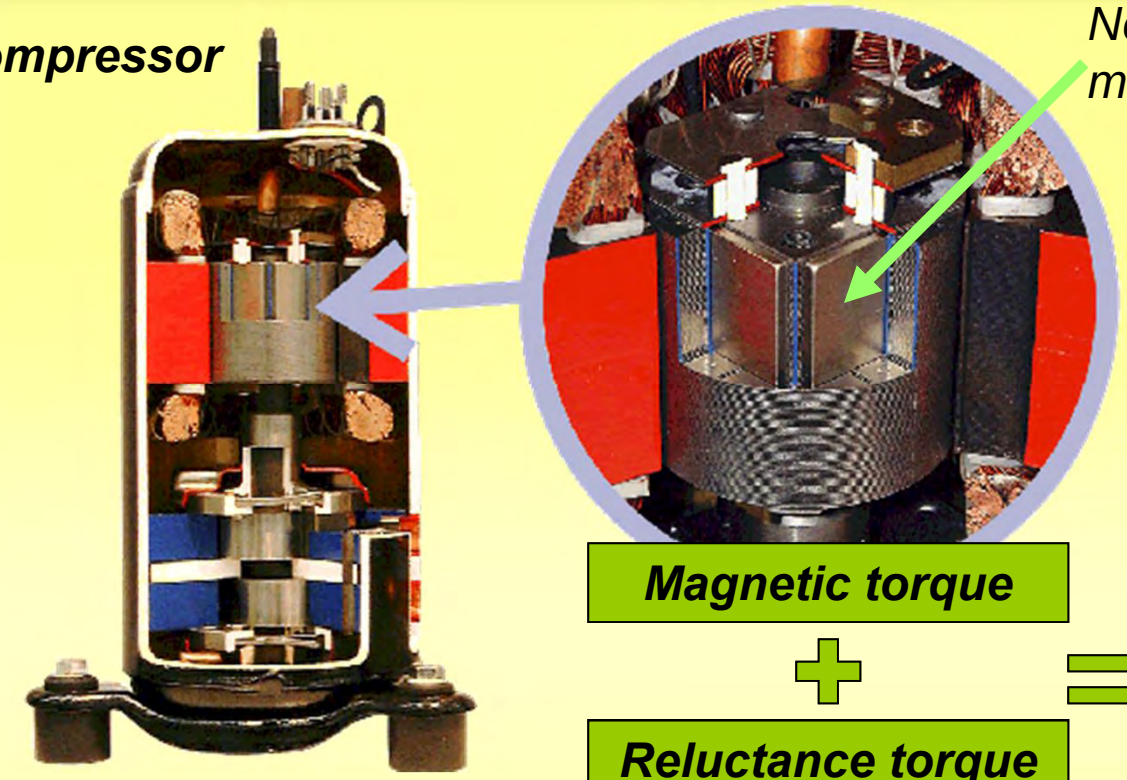
Compressor starts at minimum frequency

- Quiet start
- No light flicker
- No locked rotor amps for very low in-rush
- Very low starting amperage
- No stress on windings or compressor frame
- Bearing lubrication increased during ramp-up
- Reduces noise and stress on piping with gradual start
- Greatly improved heating capacity



DC Compressor

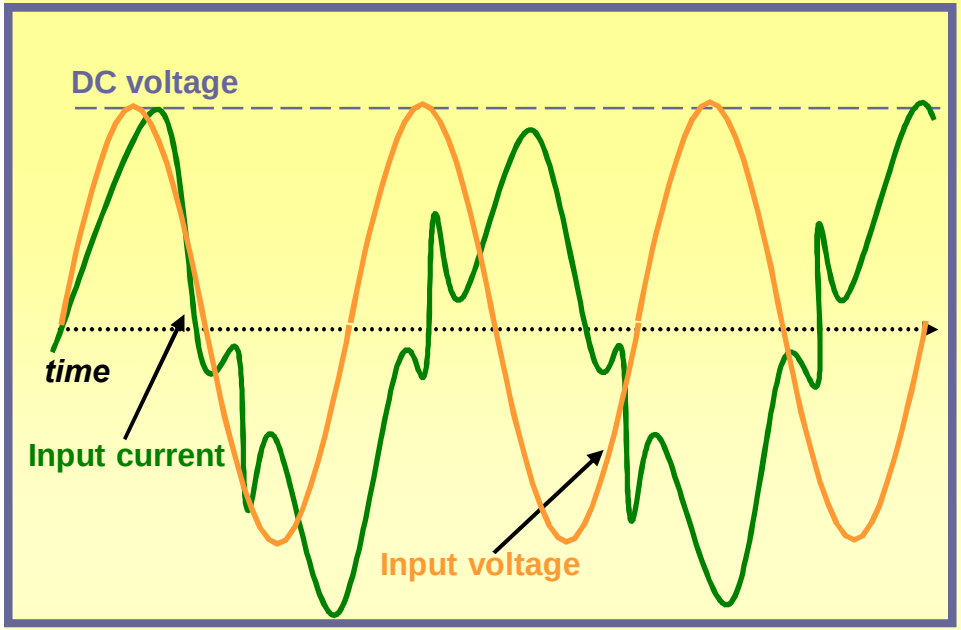
INVERTER Compressor Advantages



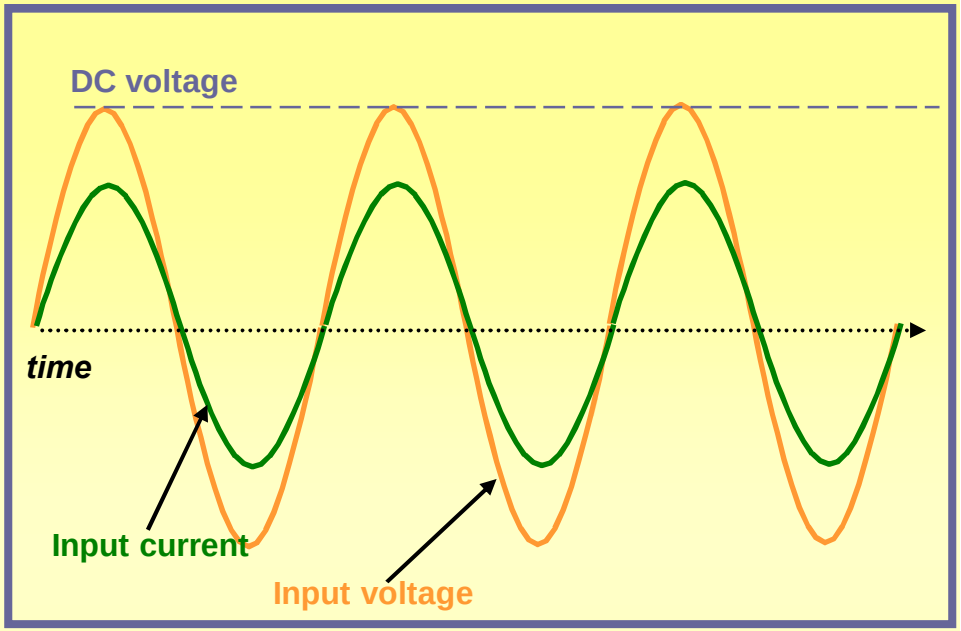
DC rotary compressor motor equipped with powerful magnets assists compressor rotation

INVERTER Compressor Advantages

Without PAM control

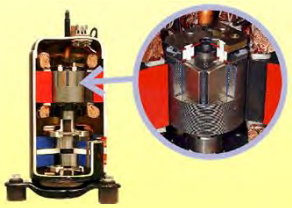


With PAM control



PAM (Pulse Amplitude Modulation) adjusts the form of the output current wave so that it becomes close to that of the supply voltage wave.

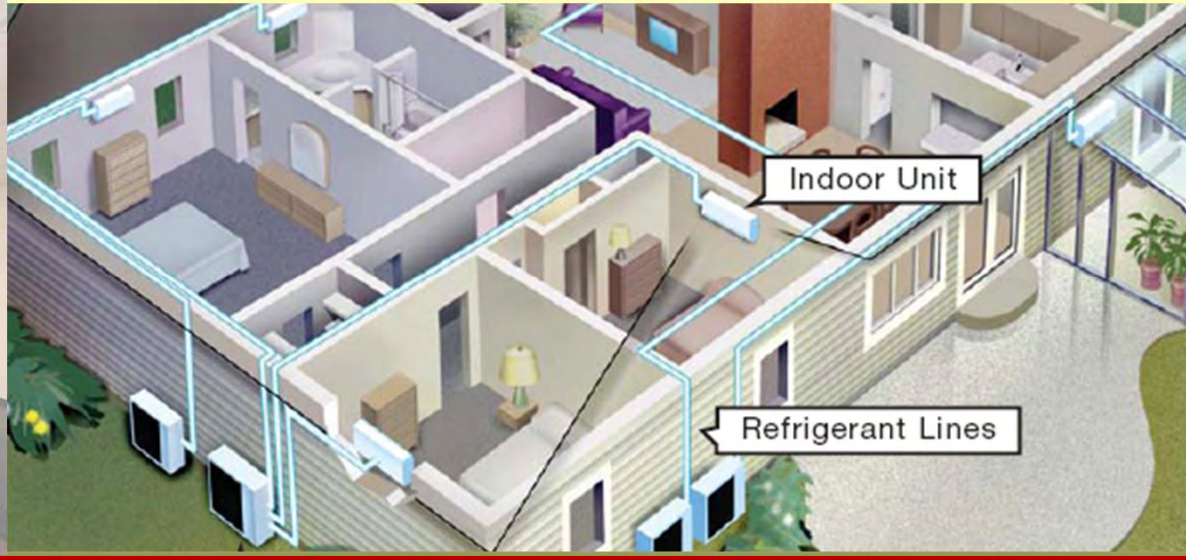
98% of input power supply is effectively utilized.



DC Compressor

Split-ductless Advantages

- Unmatched zone comfort
- Extremely quiet
- Flexible solutions
- Efficient zoning
- Easy to install



A Heat Pump Like no Other

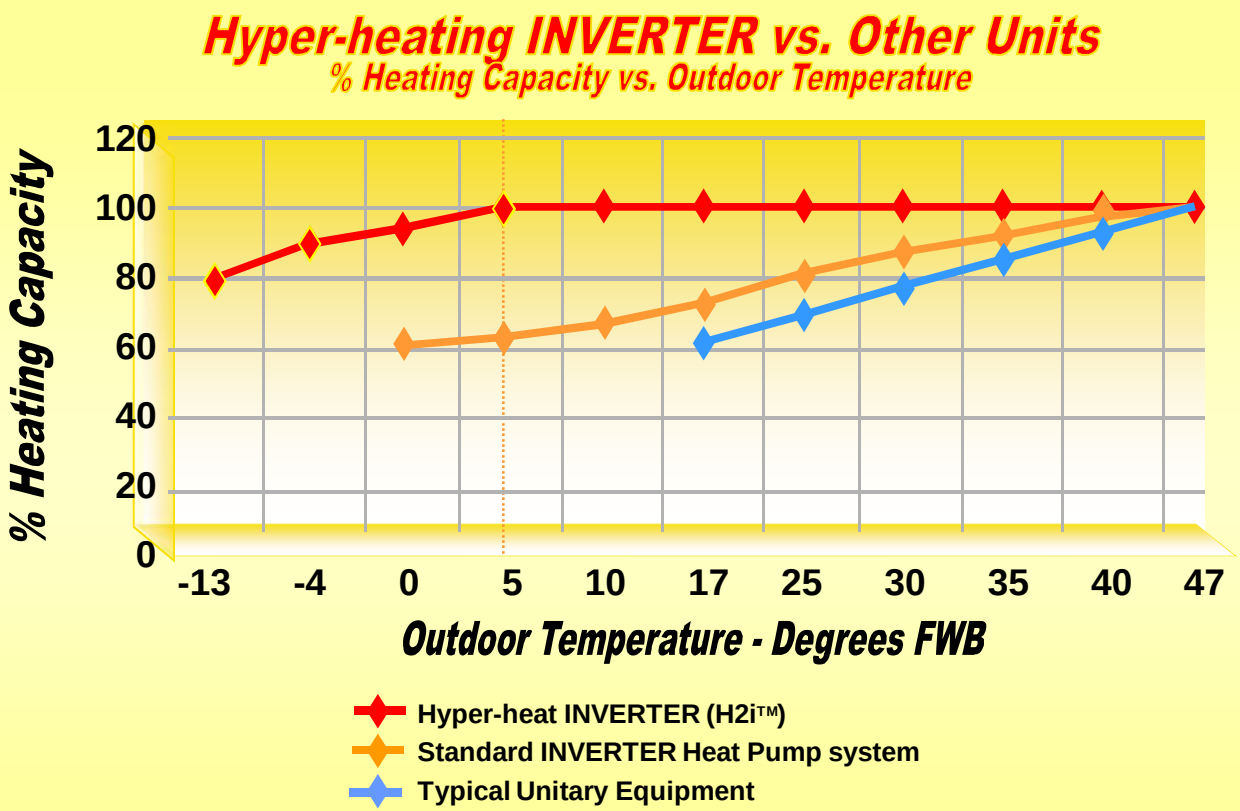
Hyper-Heating INVERTER

Tremendous year-round comfort!

100% @ 5º F

87% @ -4º F

80% @ -13º F



A Heat Pump Like No Other

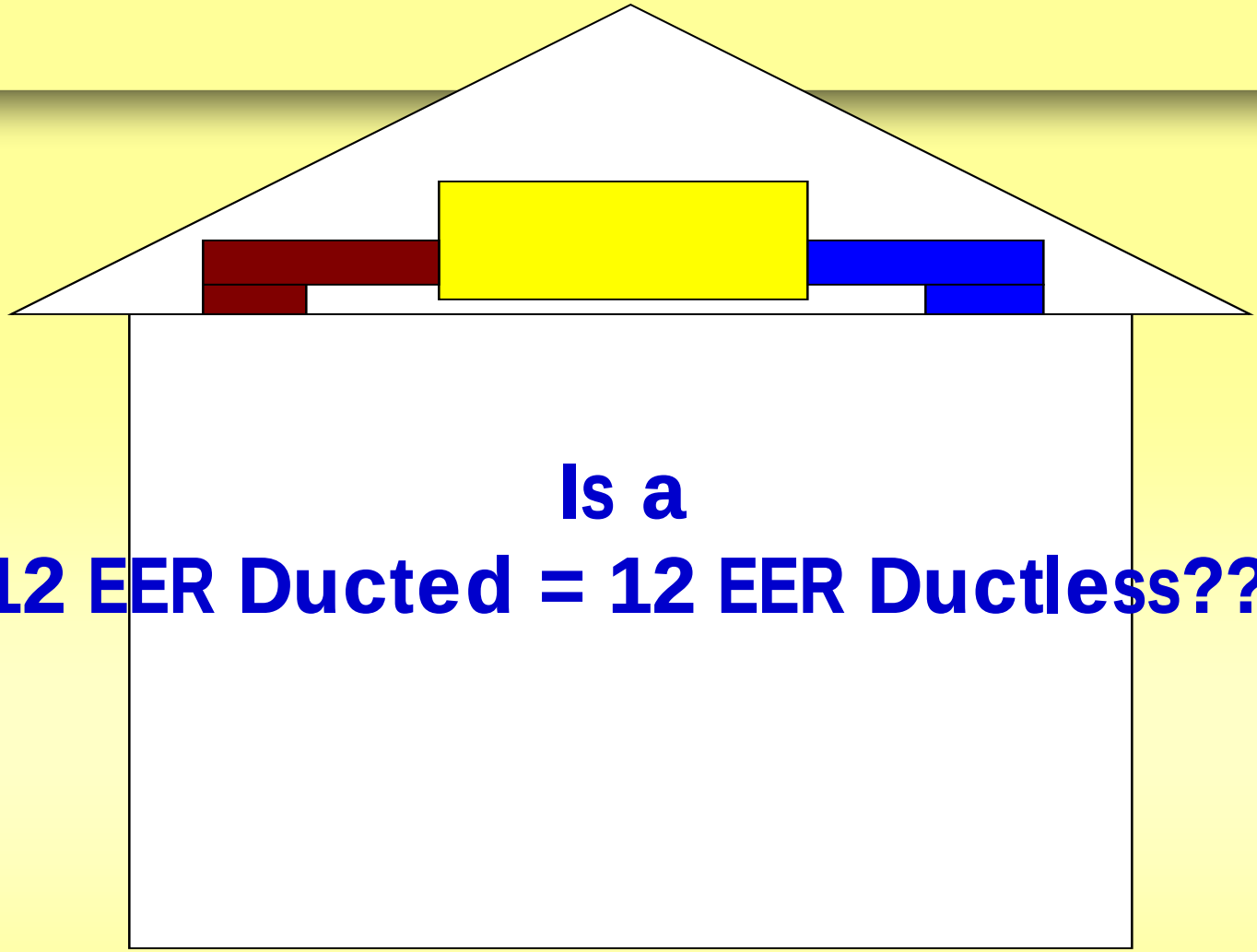
Lake Mills (Milwaukee), WI [Design 0° F] PK in Church

A Heat Pump Like No Other

Yes, it is +2° F Outside of the church

A Heat Pump Like No Other

Inside it is +70° F AND the Discharge temperature is +123° F

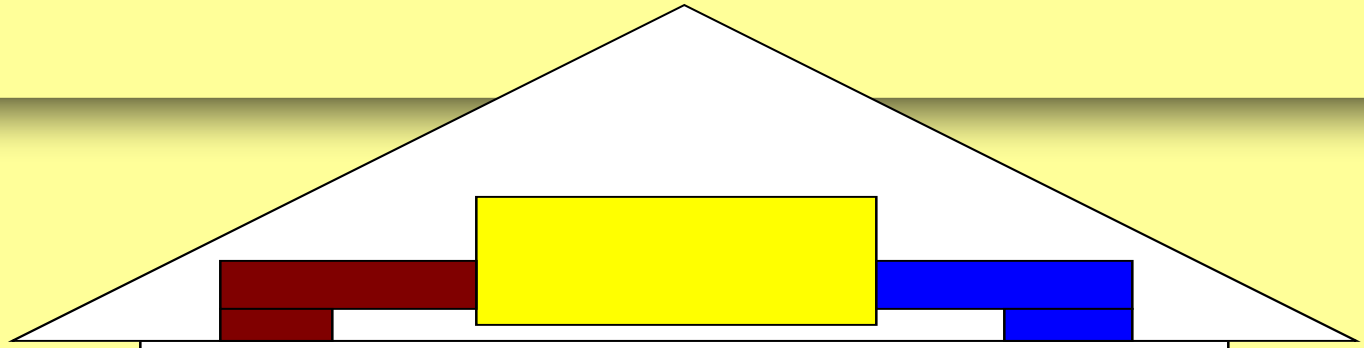


Is a

12 EER Ducted = 12 EER Ductless??

**Many thanks to Ductesters for the use of these graphics*

Benefits of Ductless Application



Retrofit with 15% supply leakage:

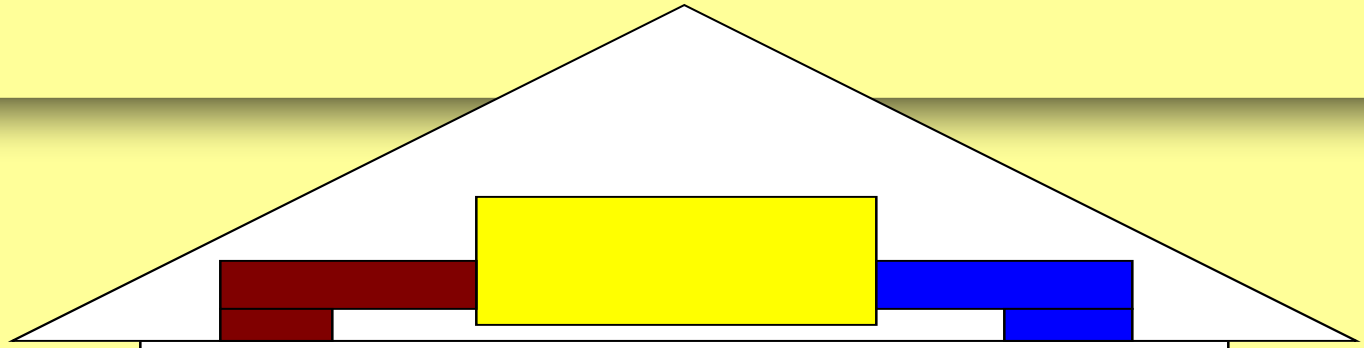
12 EER Ducted x 0.85 = 10.2 EER

Benefits of Ductless Application

True Zoning Benefits

Residential Solutions

Commercial Solutions



Application of Multi-zone

12 EER Standard Ducted 2.5 ton
2,500 Watts (Whole House)

2.5 Ton MXZ-3B30 (3,120W)
18 mbh F.C.=1,270 Watts
9mbh+12mbh F.C.=1,940 Watts

True Zoning Benefits

R2 series | Y series | H2i Y-Series | S series

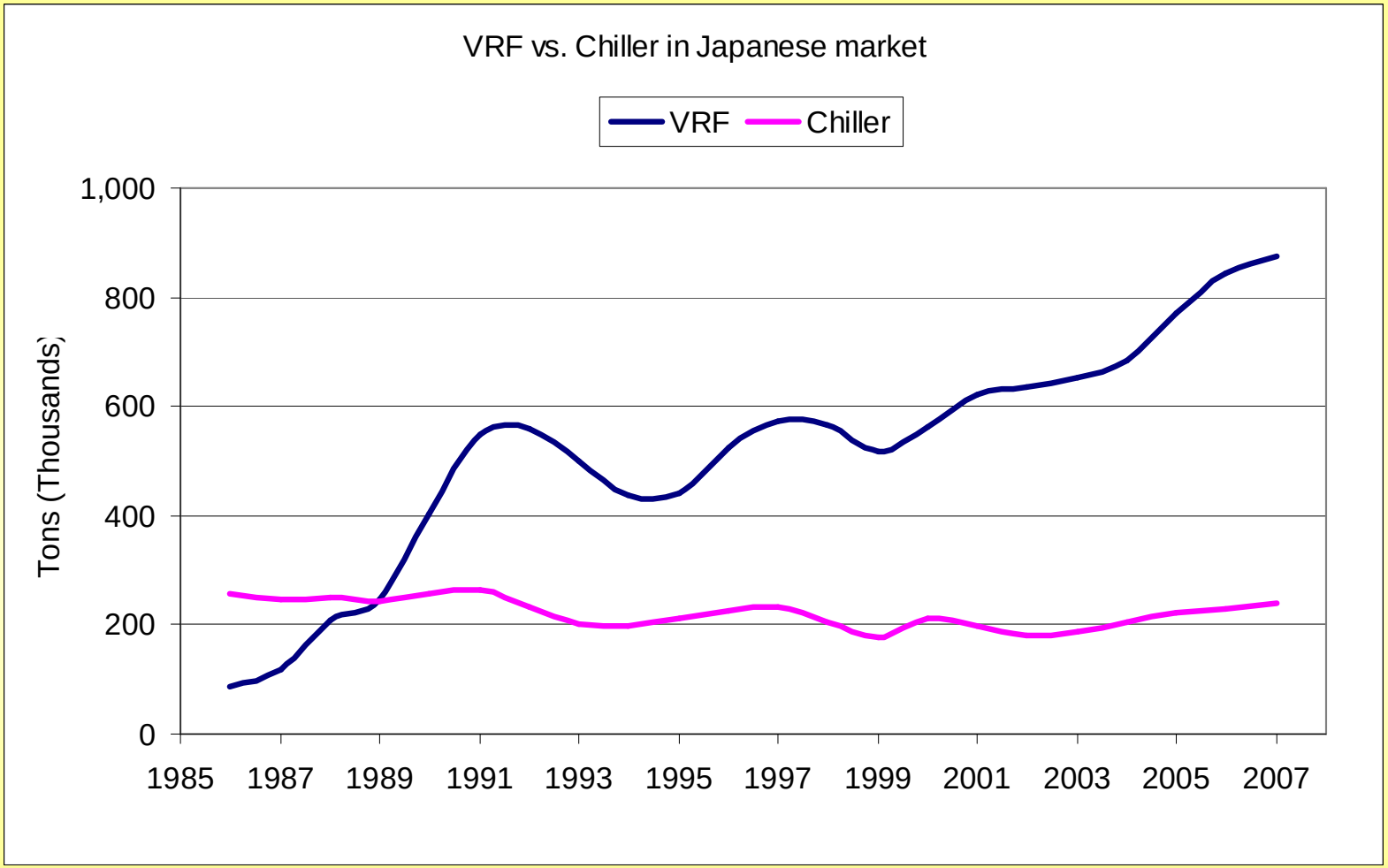
Variable Refrigerant Flow Zoning Systems

WR2 series | WY series

History of VRF

VRF was introduced to the Japanese market in the early 1980s to provide a more efficient solution for heating and cooling buildings.

History of VRF



Office Application-Standard Process

Fresno IRS Building

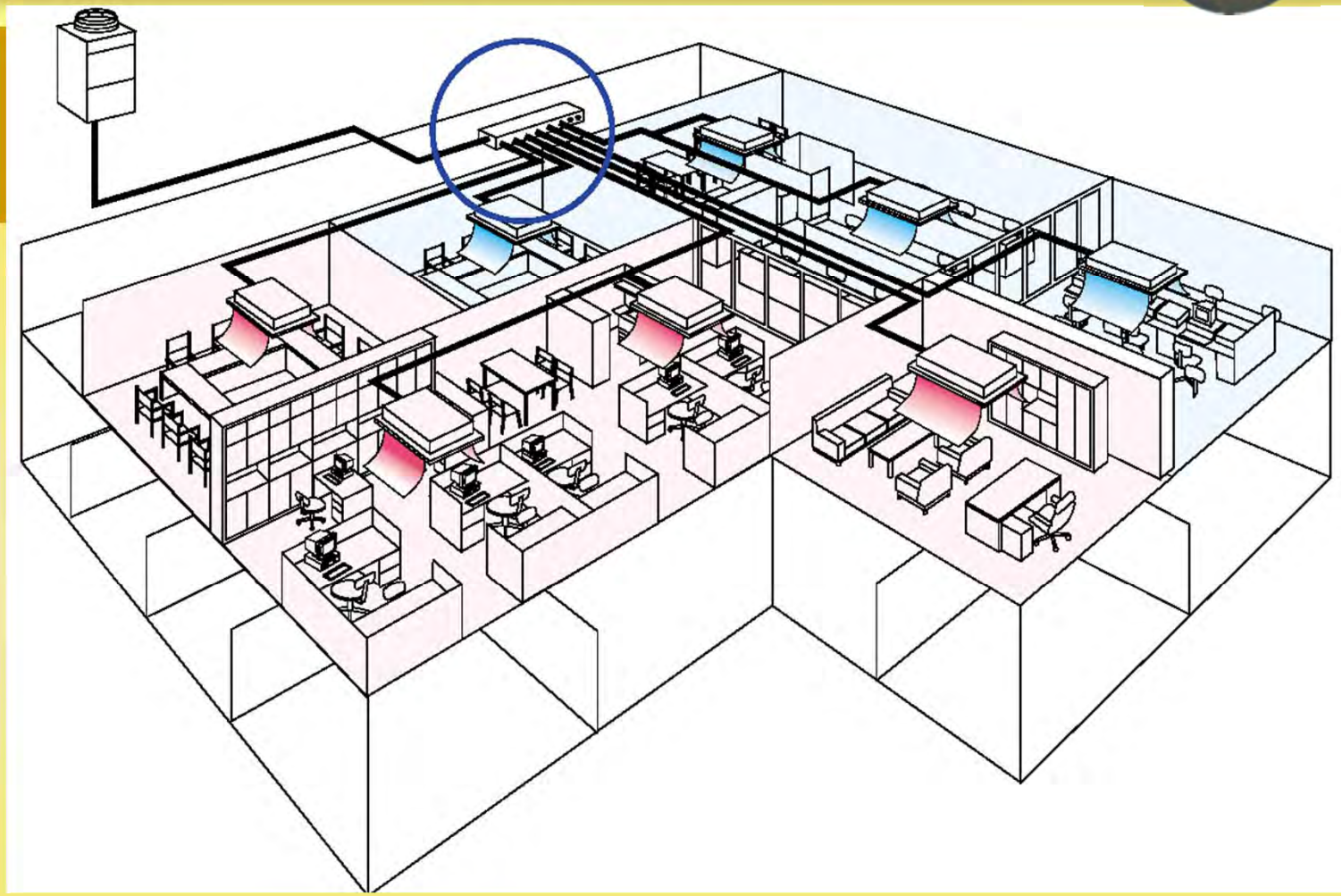
What is VRF Technology?

INVERTER

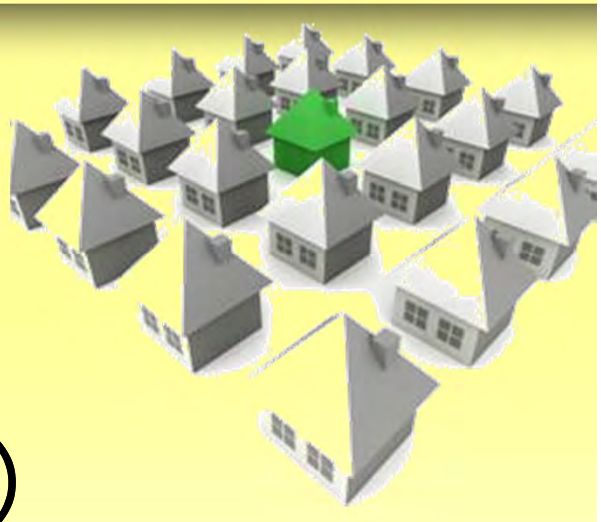
Variable

Refrigerant

Flow



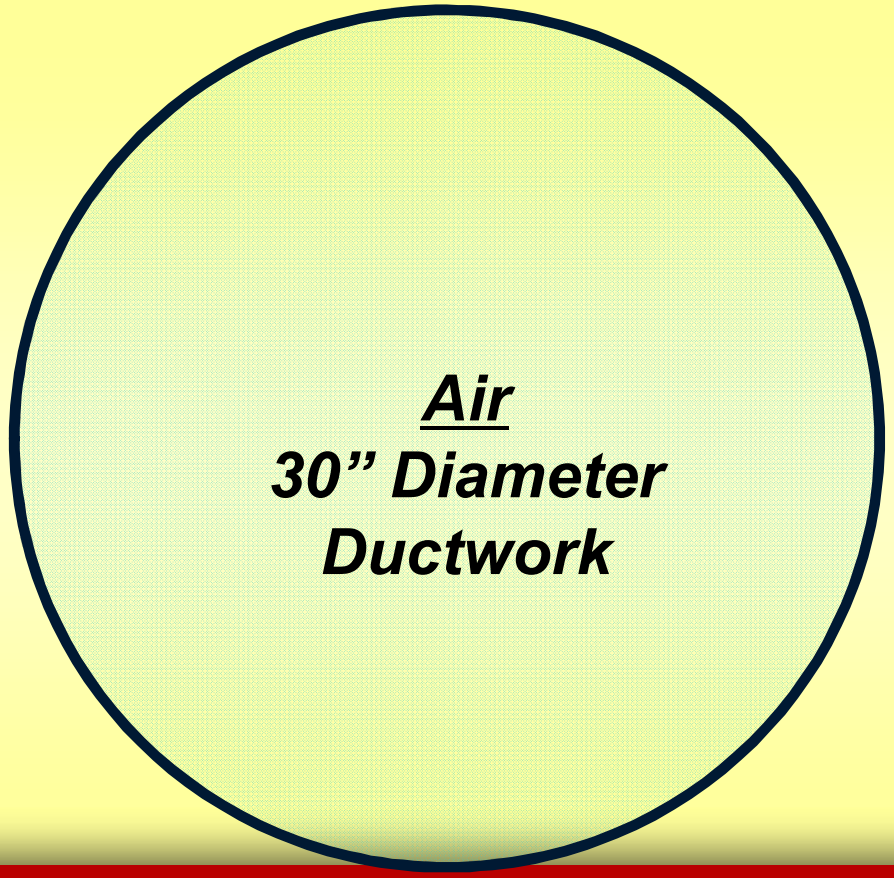
There are 3 ways to Move Thermal Energy



- Air (low density, compressible)
- Water (high density, non-compressible)
- Refrigerant (*phase change*, compressible)

Moving Thermal energy comparison

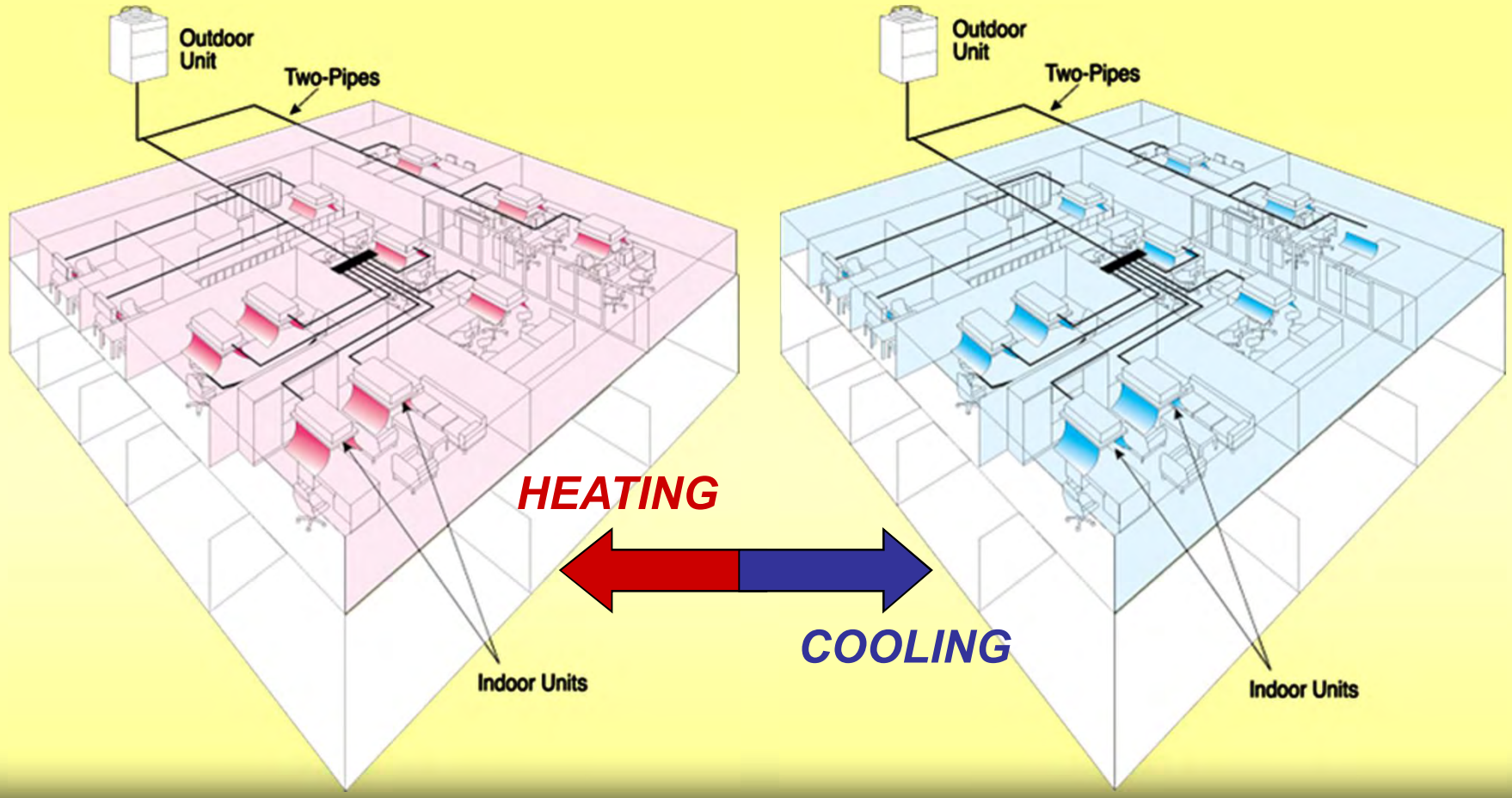
Space required to deliver 20 tons of cooling



Water
2 1/2” Iron Pipe
2” Iron Pipe

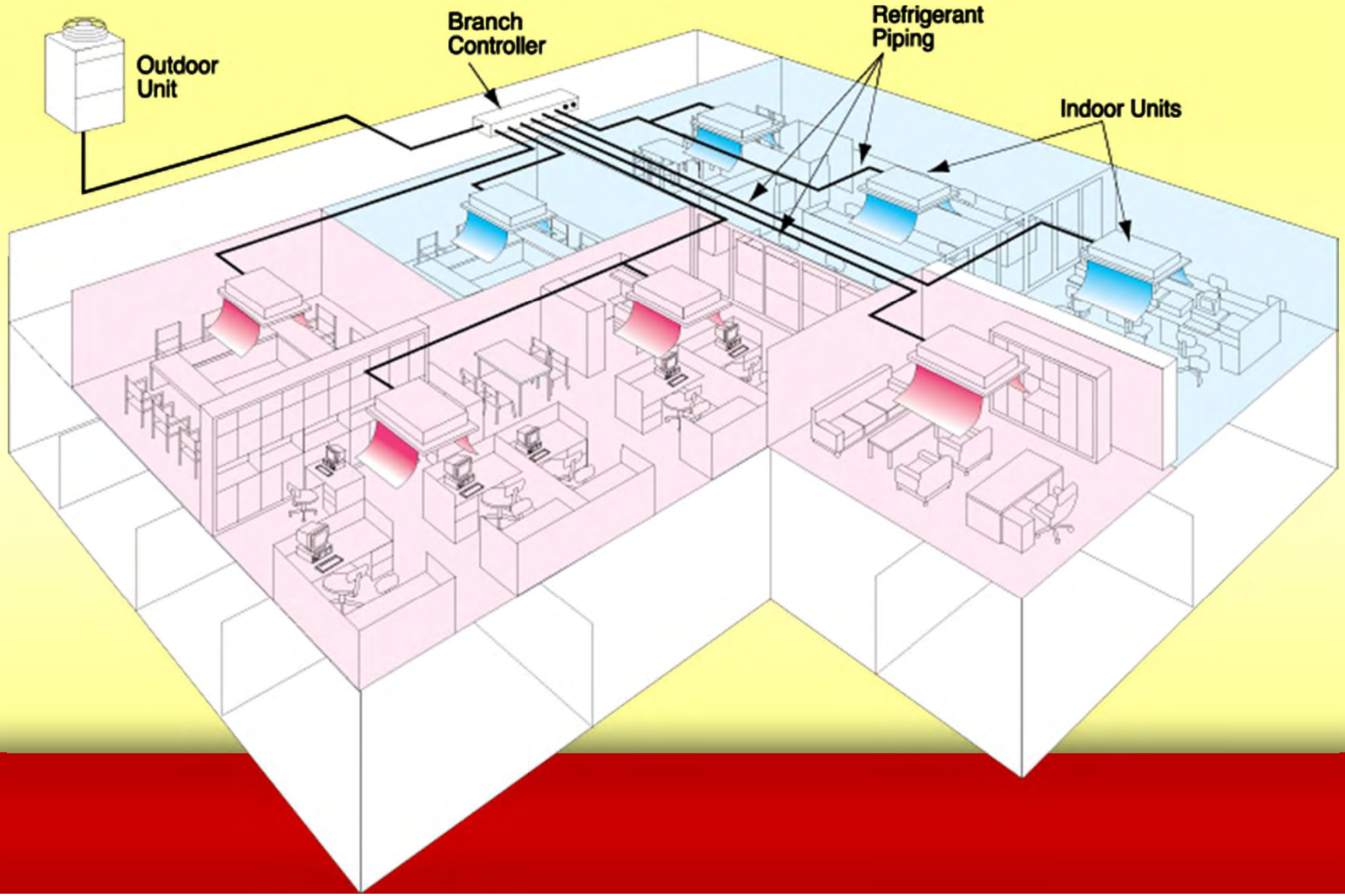
Refrigerant R410A
1 1/8” Copper Pipe

VRF Heat Pump Technology

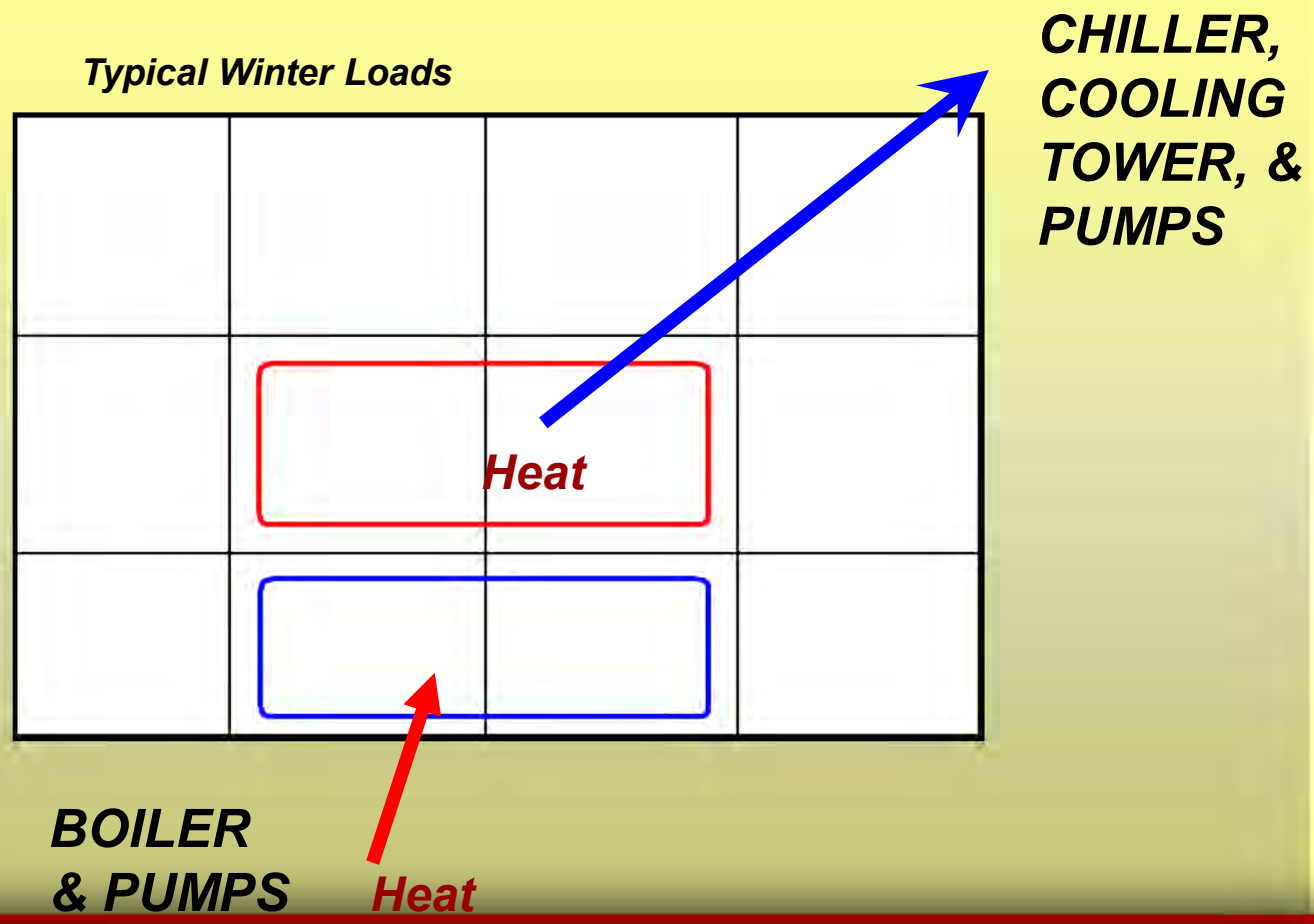


VRF Heat Recovery Technology

Simultaneous cooling and heating

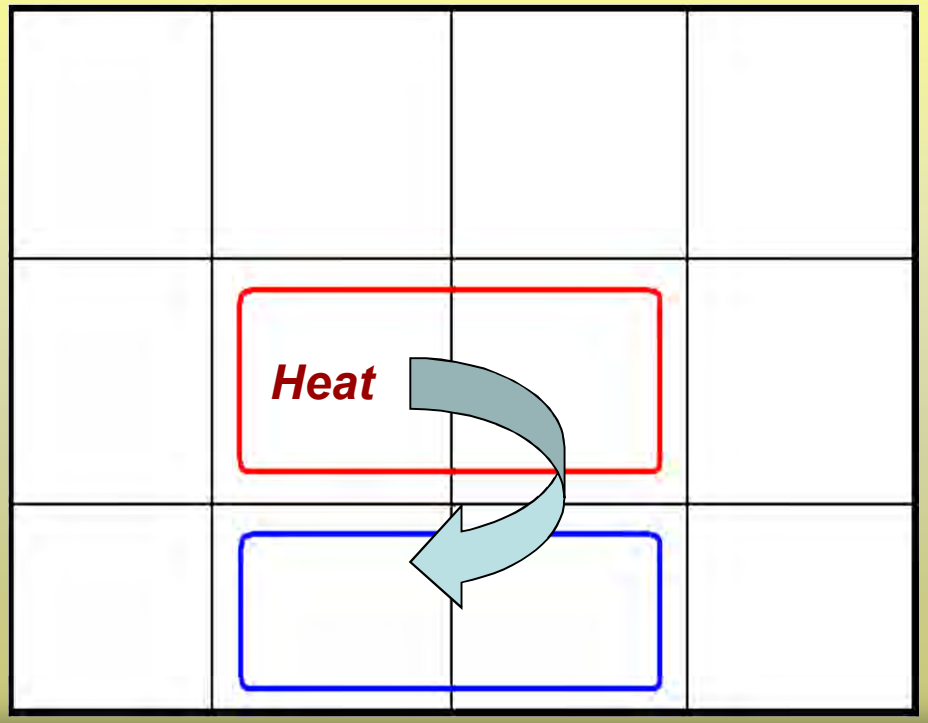


Heating & Cooling with Traditional Systems



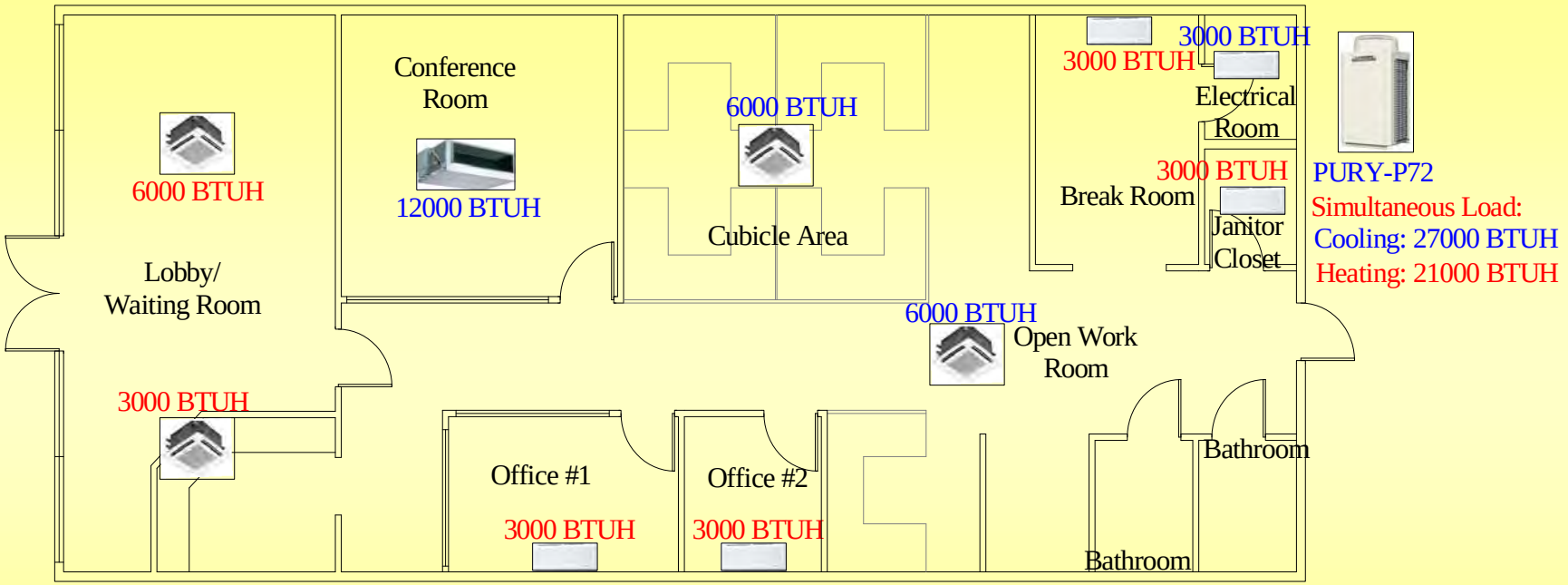
Heating & Cooling With VRF Heat Recovery

Typical Winter Loads



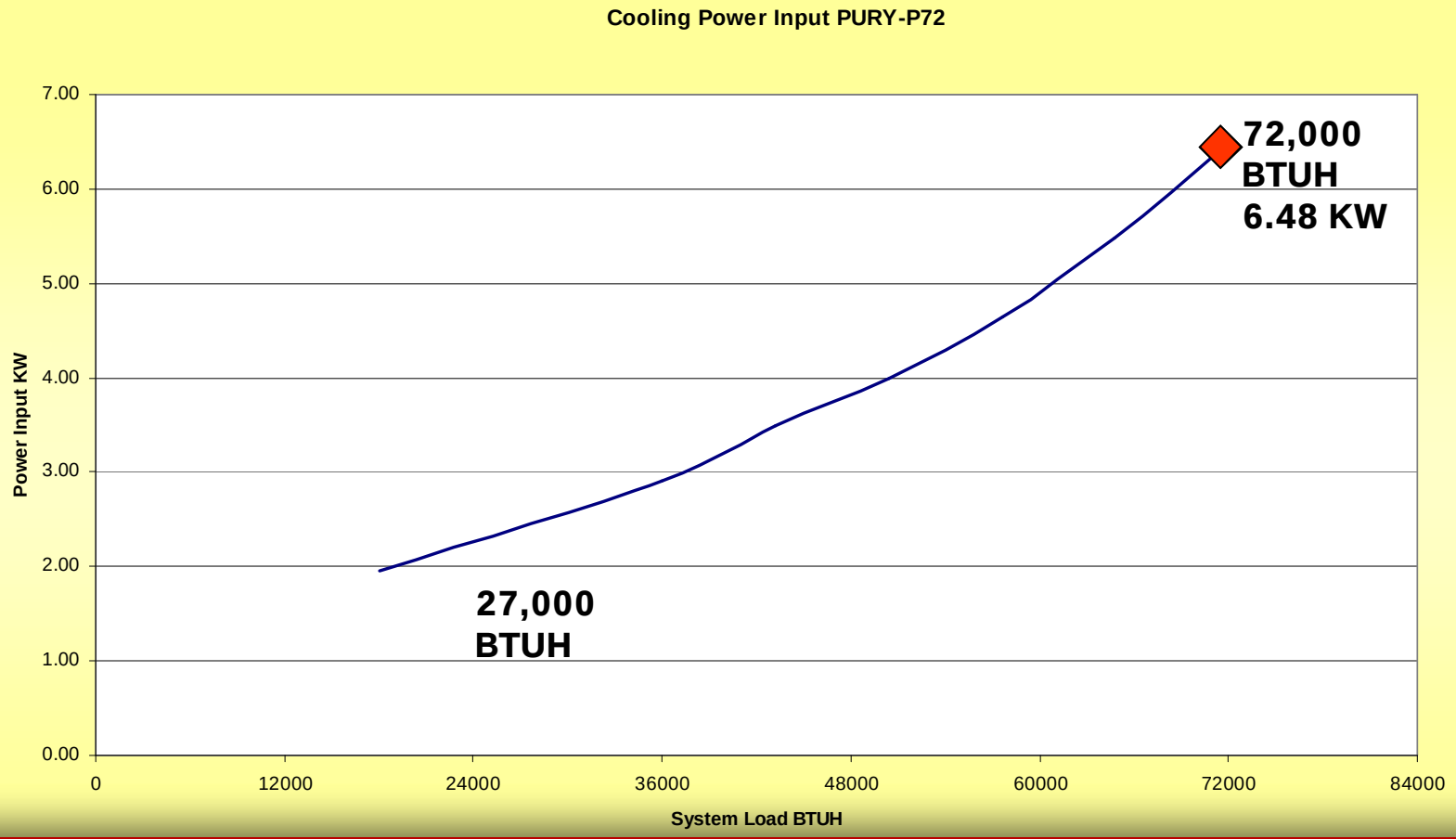
Why is VRF More Efficient?

Sample Building in Part Load: OA Temp 50ºF

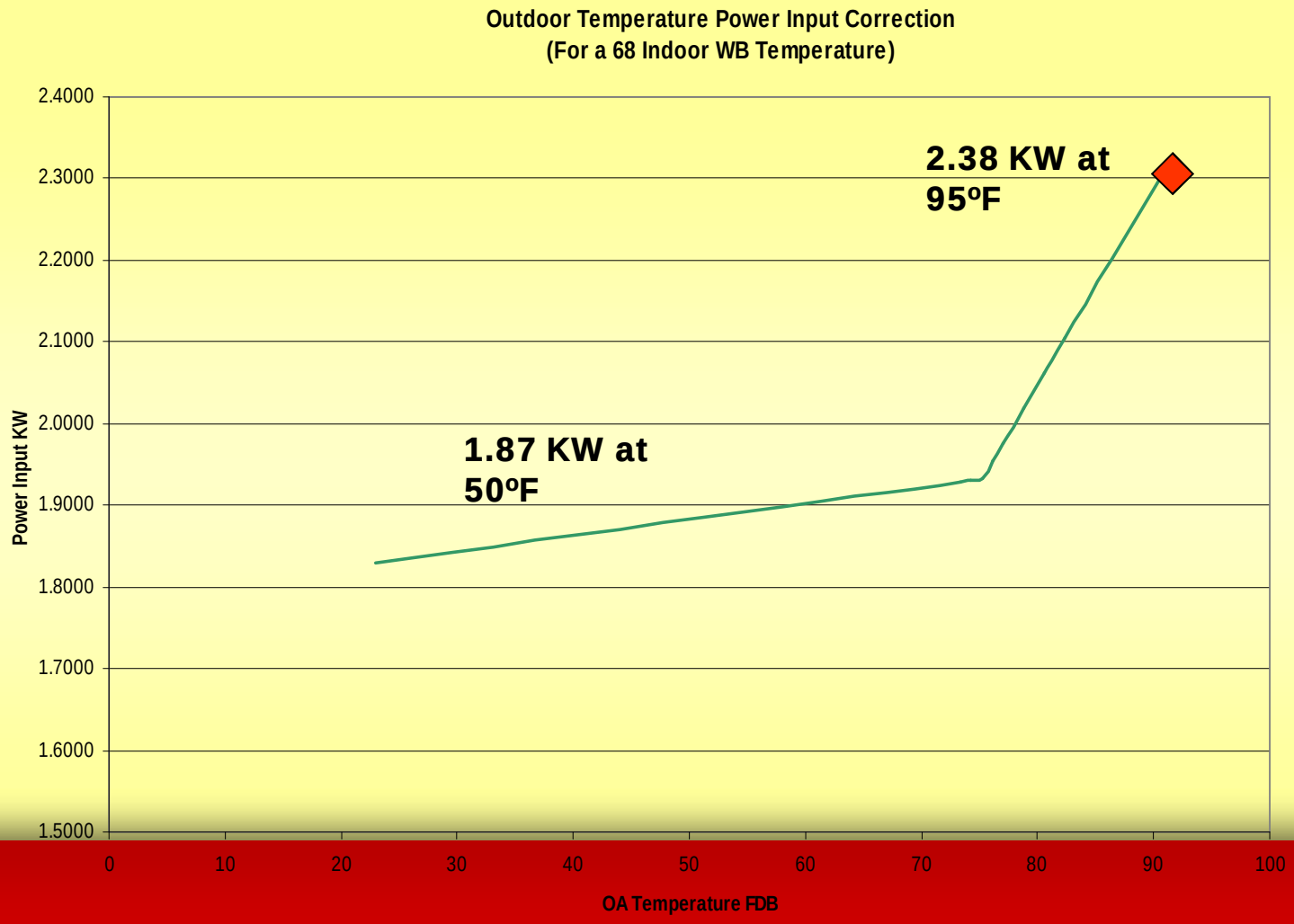


Increased Efficiency Opportunity

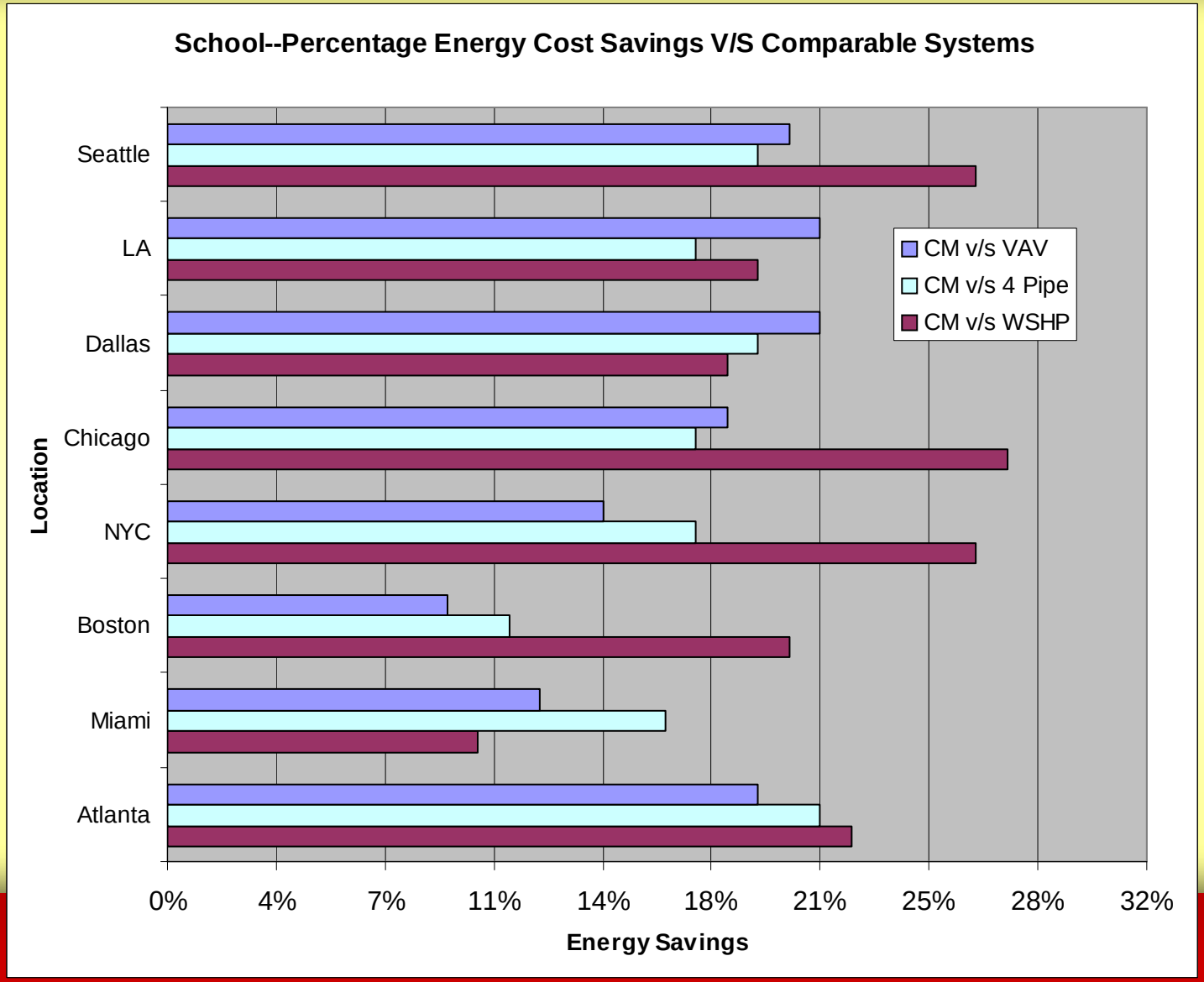
Why is VRF More Efficient?



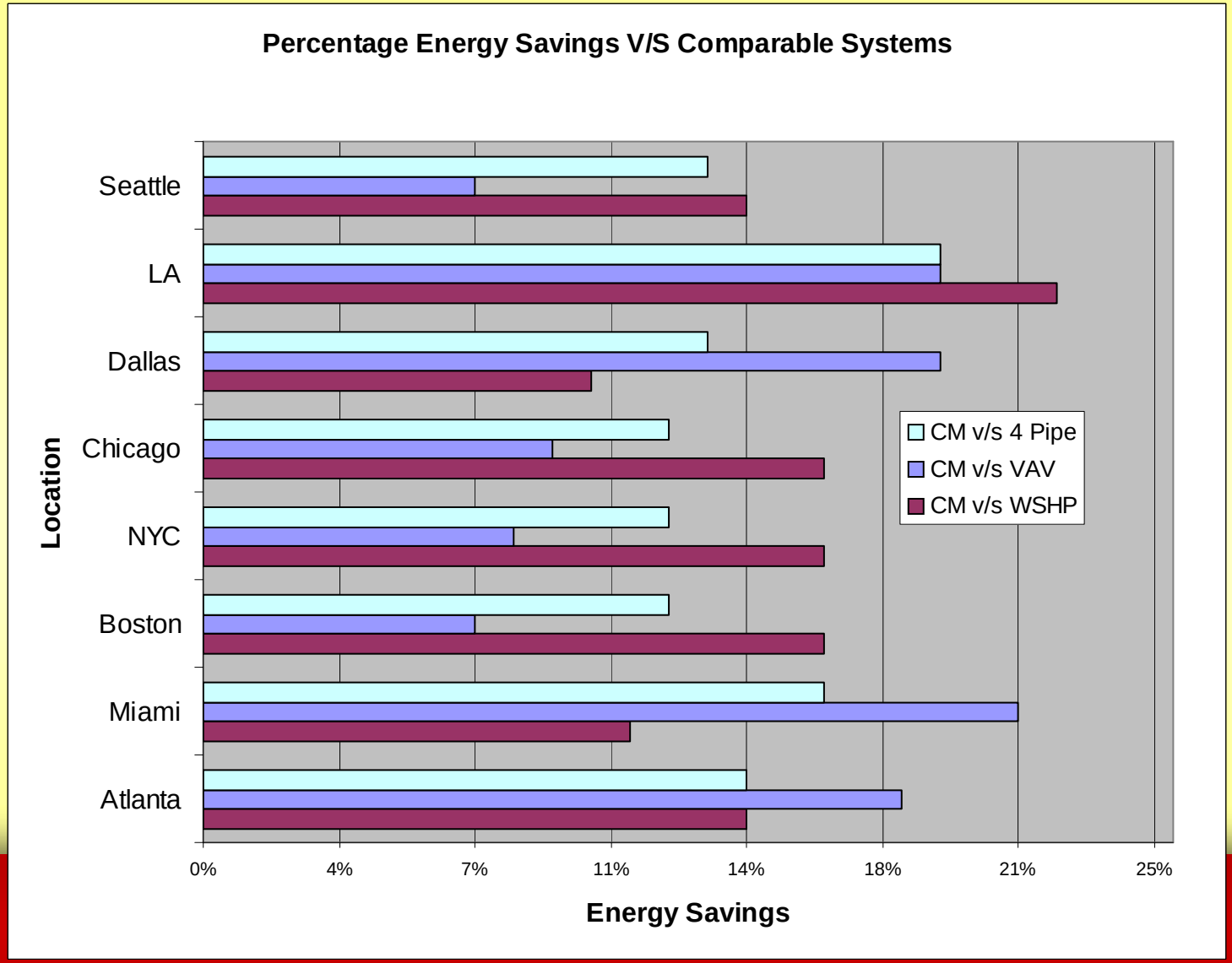
Why is VRF More Efficient?



School Energy Modeling Results



Office Building Energy Modeling Results



Italian Bank Study

- Side-by-Side comparison of 14 branch retrofit
  - **7 Buildings with VRF**
  - **7 with 4-pipe system (boiler, chiller)**
- Equipment cost was higher for VRF
- Installed cost was less for VRF
  - **2 Copper pipes cost more, labor was**
  - **4 ABS pipes cost less, labor higher**

Italian Bank Study

Maintenance cost 40% lower for VRF

Operating cost lower for VRF

- **Energy cost was 28% to 48% less**
- **Average was 35% less**

Traditional HVAC Solutions

40-60%

of a building's energy usage is from its HVAC system.

Source:
http://www1.eere.energy.gov/buildings/commercial/hvac.html

Sacramento Drill Tower

- Retrofit of Sac City offices inside 1st floor of water tower
- Old system was 30 Ton air-cooled chiller & natural draft boiler
- Replaced with 2x16 ton Heat Recovery VRF systems & all ducted fan coils
- ERV for ventilation air

Total Building Energy cost savings in 2009 vs. 2007 = 27%

Thank You

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COOLING & HEATING

Questions