



Expanding the Geothermal Market

Sam Neale, PE

Marketing Manager

AAON

Agenda



- Expansion of the Geothermal Market
- Advancements in Geothermal Heat Pump Design
 - Direct Expansion (DX) Cooling Technology
 - Air Delivery System
 - Thermal Loss Minimization

Expanding Markets?



- From where is geothermal market growth going to come?
 - ▣ Tax Benefits



Tax Benefits: Investment Credit

- **Commercial Geothermal Systems.** The credit is equal to 10% of expenditures, with no maximum credit limit stated. Eligible geothermal energy property includes geothermal heat pumps and equipment used to produce, distribute or use energy derived from a geothermal deposit. For geothermal heat pumps, this credit applies to eligible property placed in service after October 3, 2008.

Tax Benefits: (MACRS) + Bonus Depreciation (2008-2012)



- *The Small Business Jobs Act (signed 9/27/2010) may be just the economic jump-start for which you are looking!*
- The provision extends the additional 50-percent bonus depreciation on the cost of new equipment purchased and increases it to 100 percent for a limited time. This can mean substantial tax savings.

Tax Benefits: (MACRS) + Bonus Depreciation Example*



100% BONUS DEPRECIATION EXAMPLE (using 33% tax rate)	BEFORE THE ACT'S PERIOD	SEPT 9, 2010 – DEC 31, 2011
Cost of Annual Equipment Purchase	\$650,000	\$650,000
Depreciable Amount	\$650,000	\$650,000
Bonus Depreciation (100% of Dep. Amount)	-	(1.0*\$650,000) = \$650,000
Normal Depreciation (20% of Amount)** ** Renewable technologies classify as 5-year property	(0.2*\$650,000) = \$130,000	-
Total First-Year Depreciation	\$130,000	\$650,000
First-Year Tax Savings on Depreciation	(0.33*\$130,000) = \$42,900	(0.33*\$650,000) = \$214,500
Total First-Year Tax Savings	\$42,900	\$214,500

* Tax benefits described are only an example and should not be construed as tax advice. Consult your tax advisor regarding these tax savings opportunities.

Tax Benefits: (MACRS) + Bonus Depreciation Example*



- The purpose of the acts is to create movement in the economy today – right now!
- The money saved by the owner can be reinvested in capital improvements, expansion projects and more!
- Would your clients like to have an extra \$171,600 available this year?

** The tax information in this presentation is provided as a customer service by AAON. However, it should not be construed as tax advice. AAON strongly recommends that you consult with your tax advisor regarding how these tax-saving opportunities apply to your situation.*

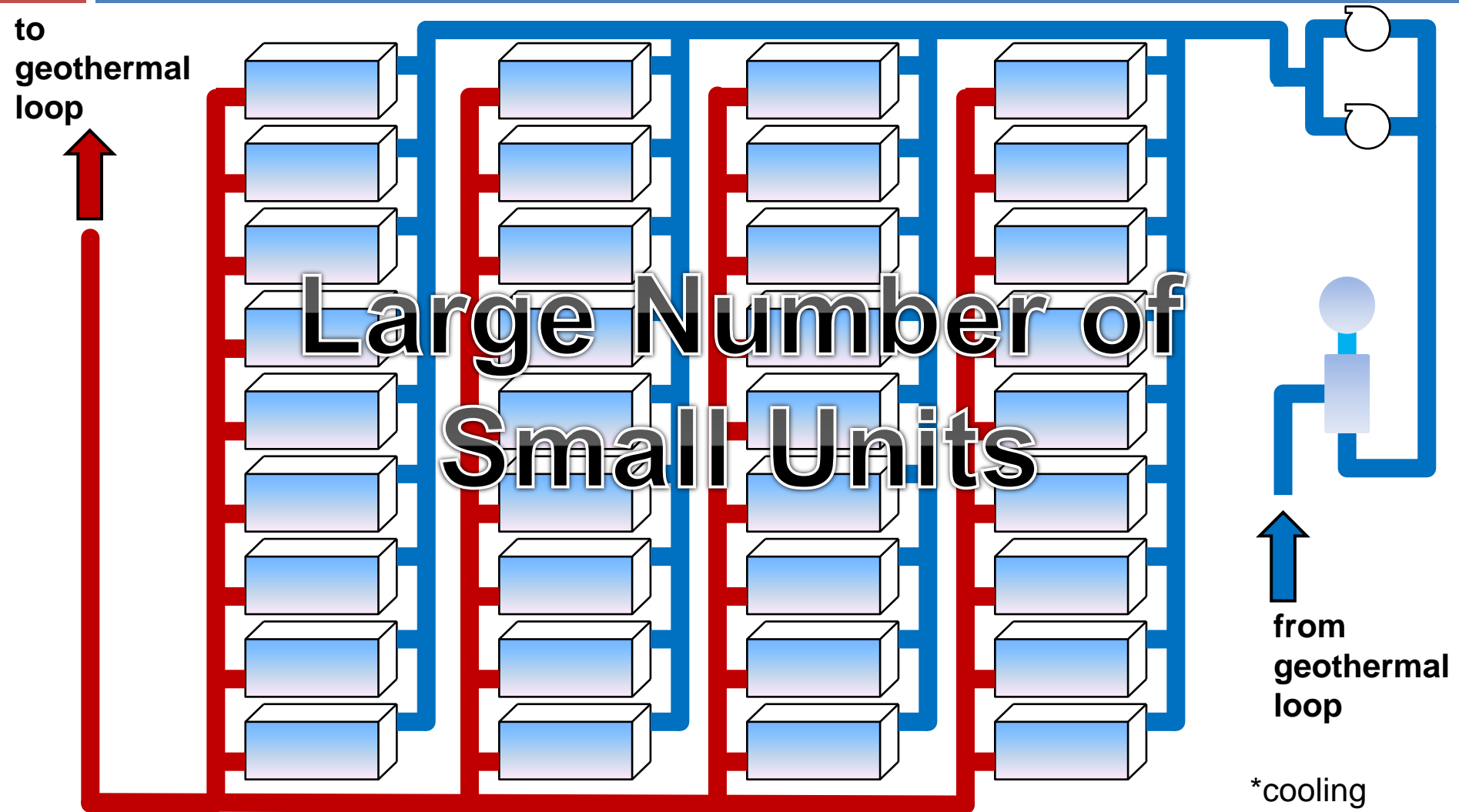
Expanding Markets?



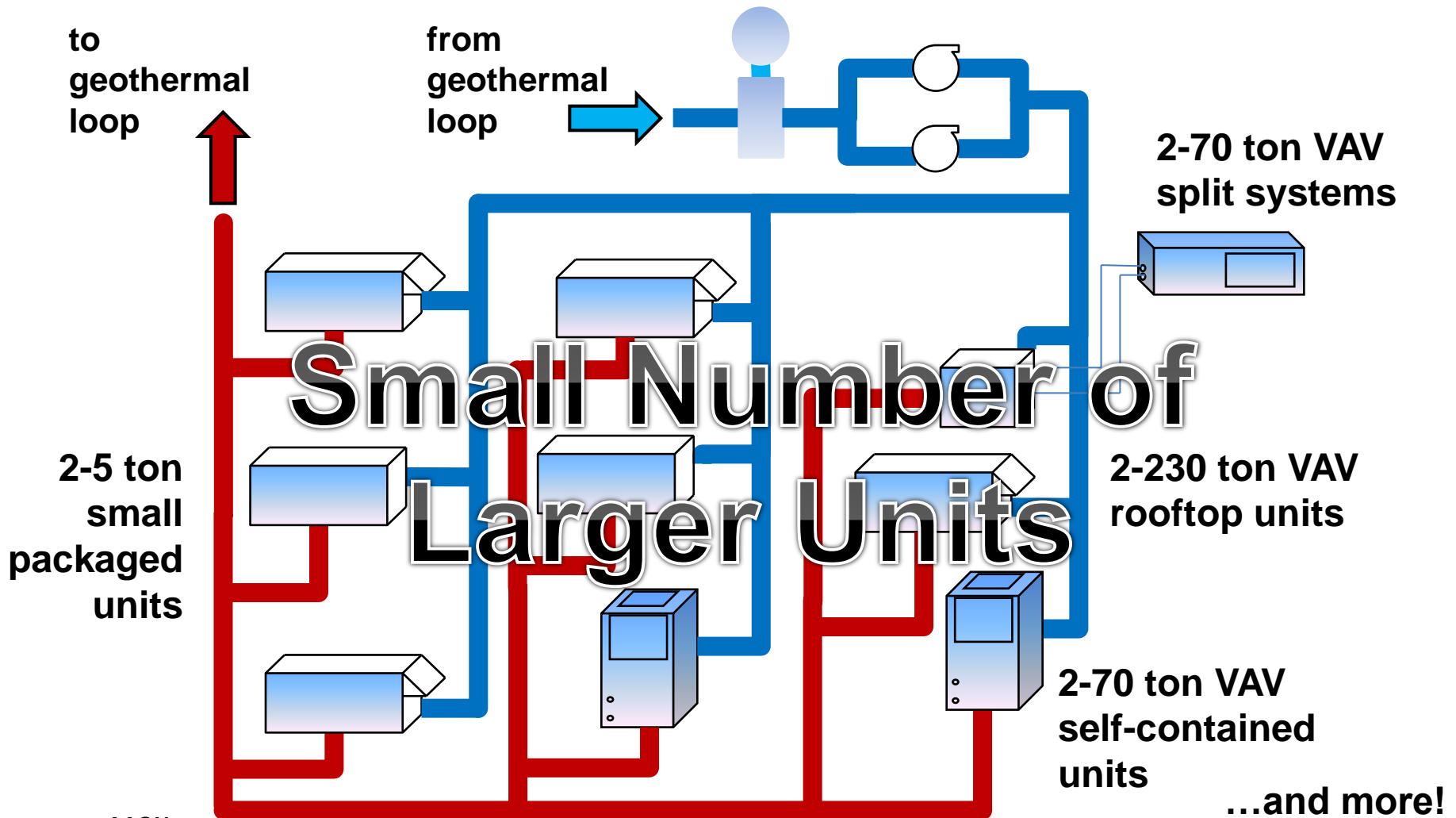
- From where is geothermal market growth going to come?
 - ▣ Tax Benefits
 - ▣ New Equipment Designs



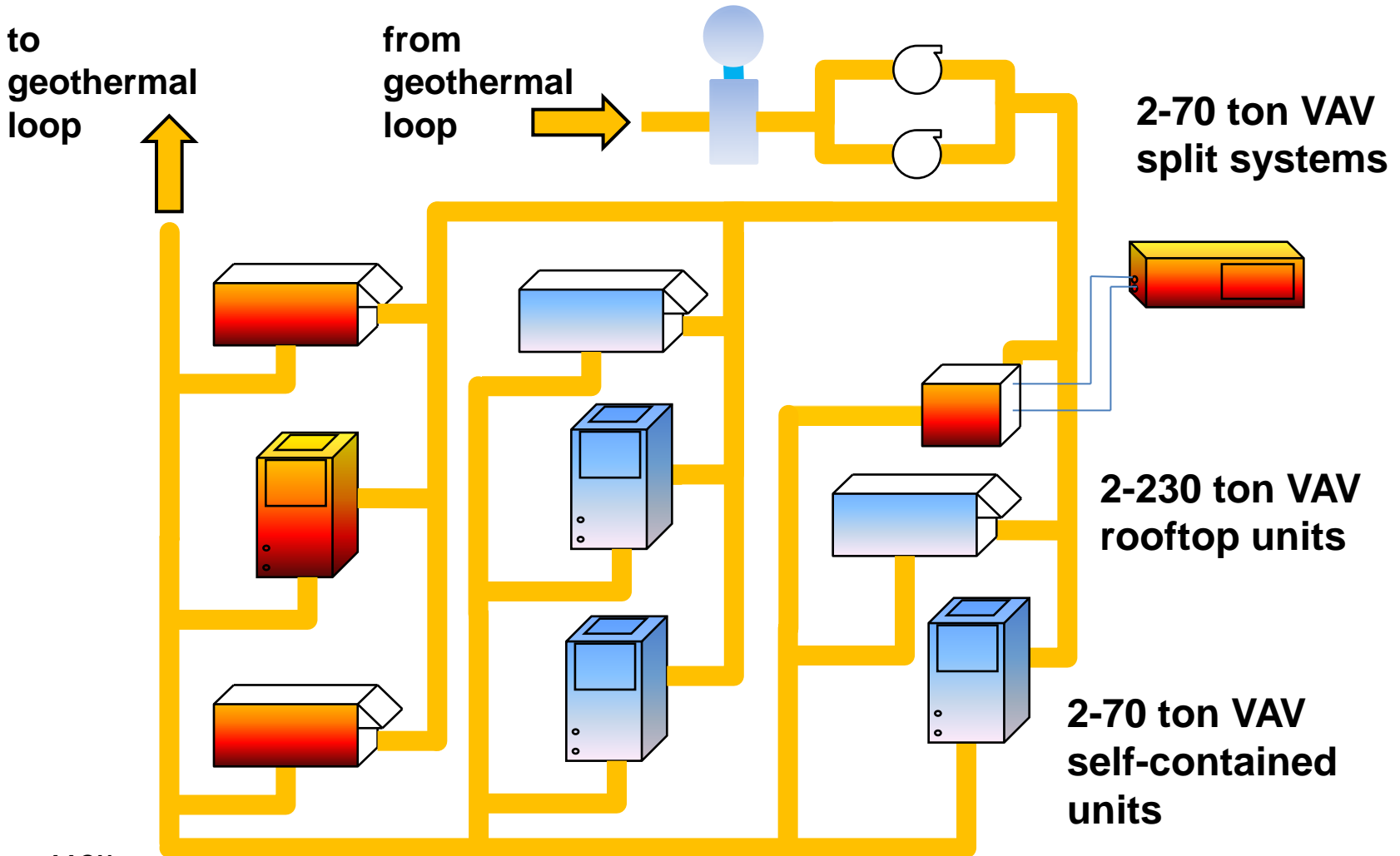
Old Geothermal Layout



New Geothermal Layout

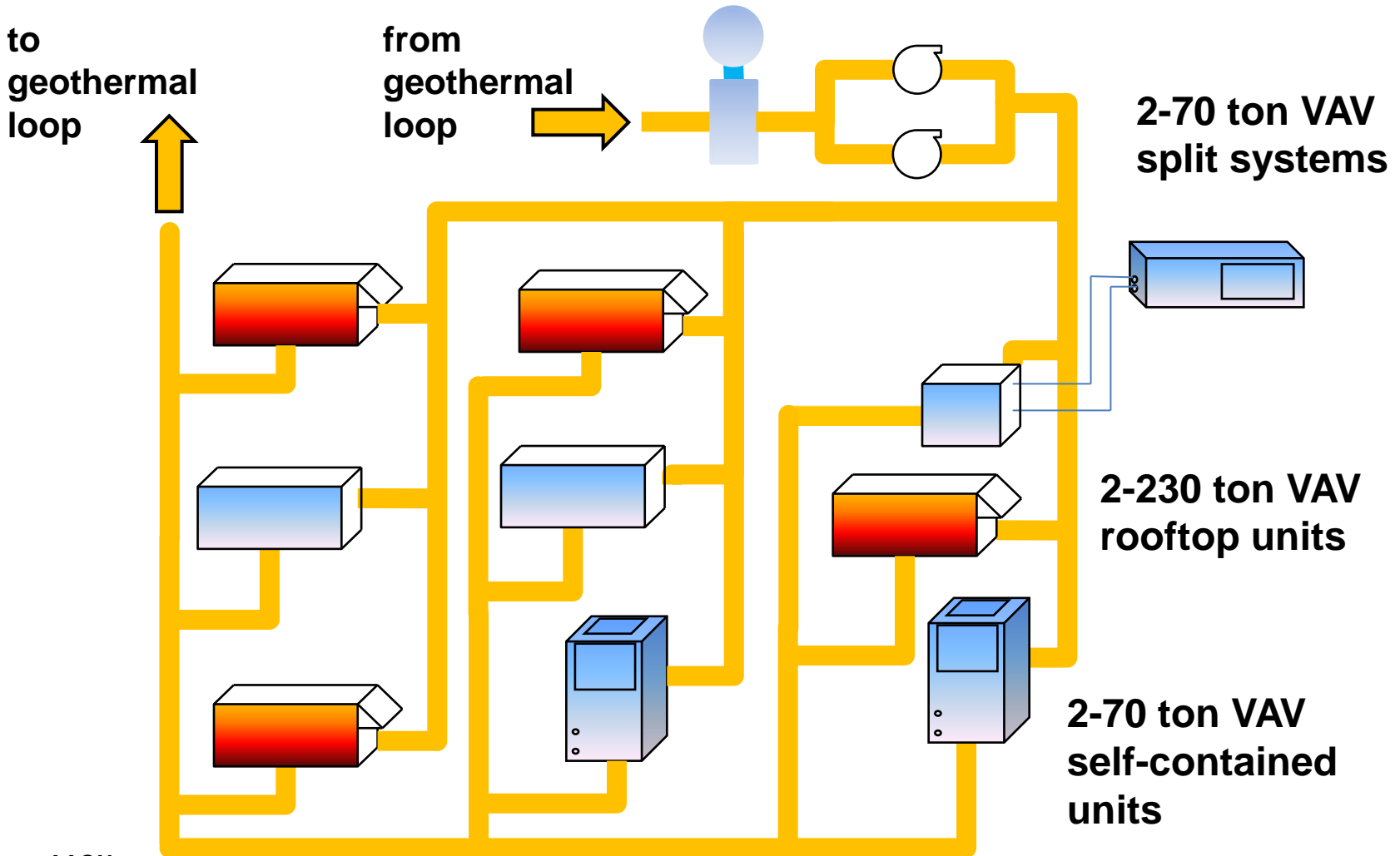


Load Sharing



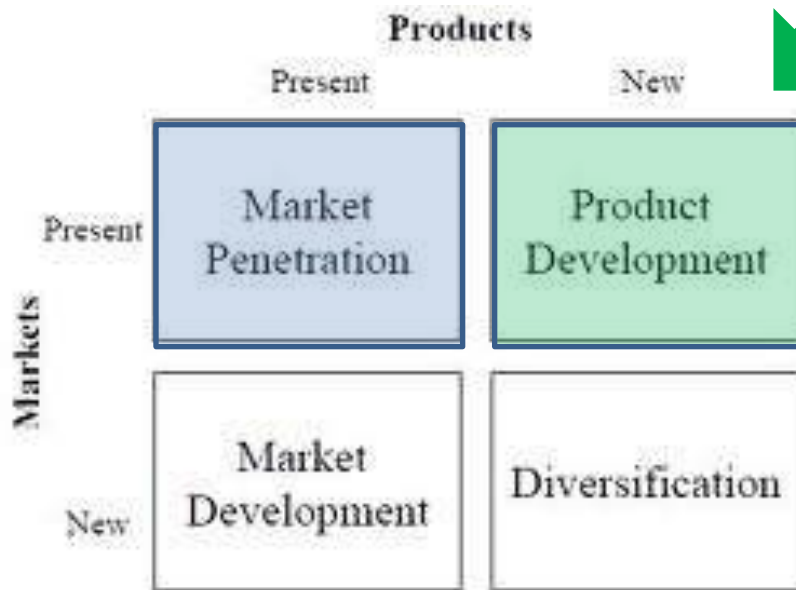
And more!

Load Sharing



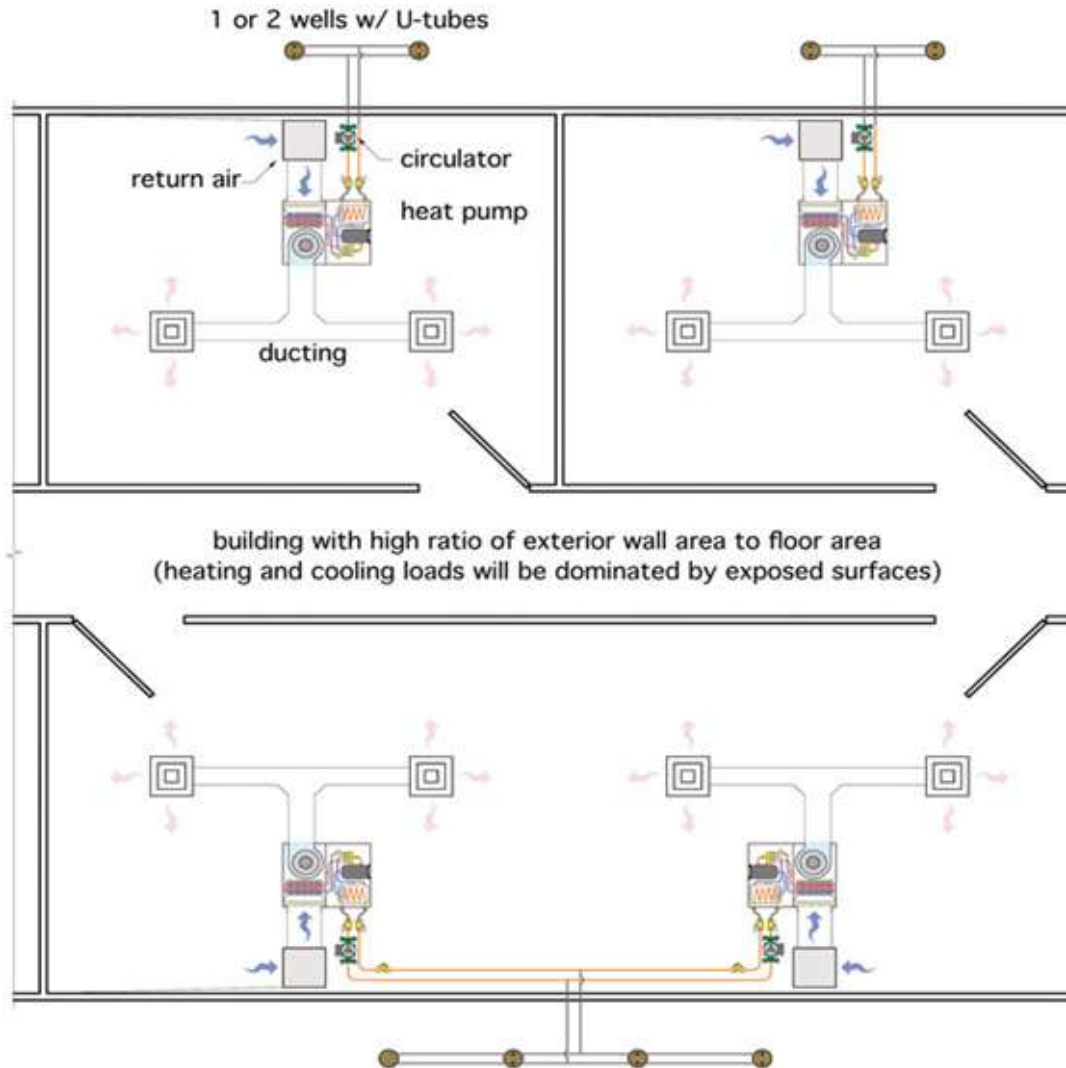
And more!

How to expand the geothermal market

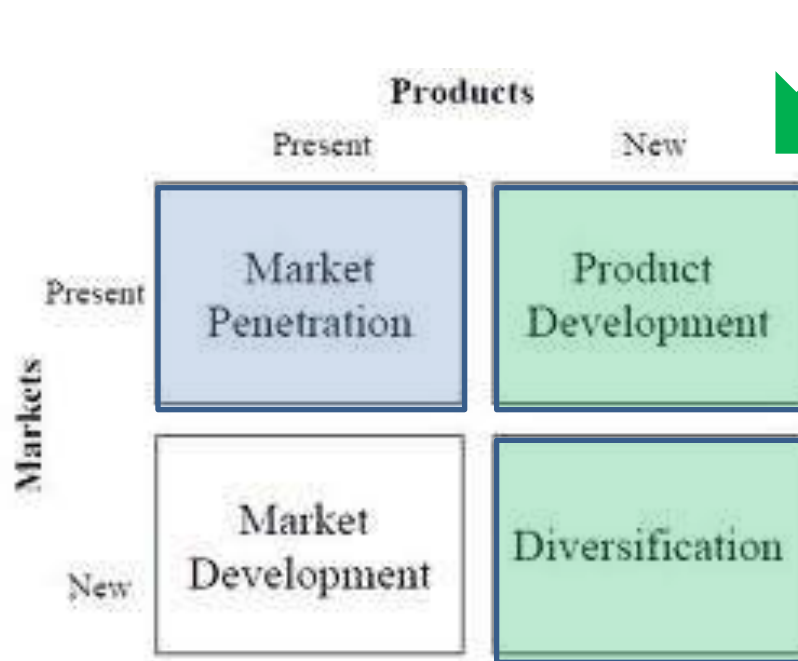


- Existing Products in Existing Market yields “Market Penetration”
 - Where we were
- New products in an existing market expand market applications!
 - Where we are
- These new products also expand the applications...

New applications...



How to expand the geothermal application market



- Not limited by application?
- **New geothermal products** also means we have **new markets** that geothermal can now be applied!

The AAON Geo product difference



- Historically, geothermal units have been confined to small (5 tons or less), packaged indoor units.
- Today, geothermal can be applied to:
 - ▣ Rooftop Units: 2-230 tons in a single unit
 - ▣ Water-to-Water Chillers/Heat Pumps: 2-365 tons
 - ▣ Heat Pump Split Systems: 2-70 tons
 - ▣ Commercial Self-Contained Units: 2-70 tons
- For any application today, there is geothermal equipment available!

Retrofits: Existing equipment influences GHP designs



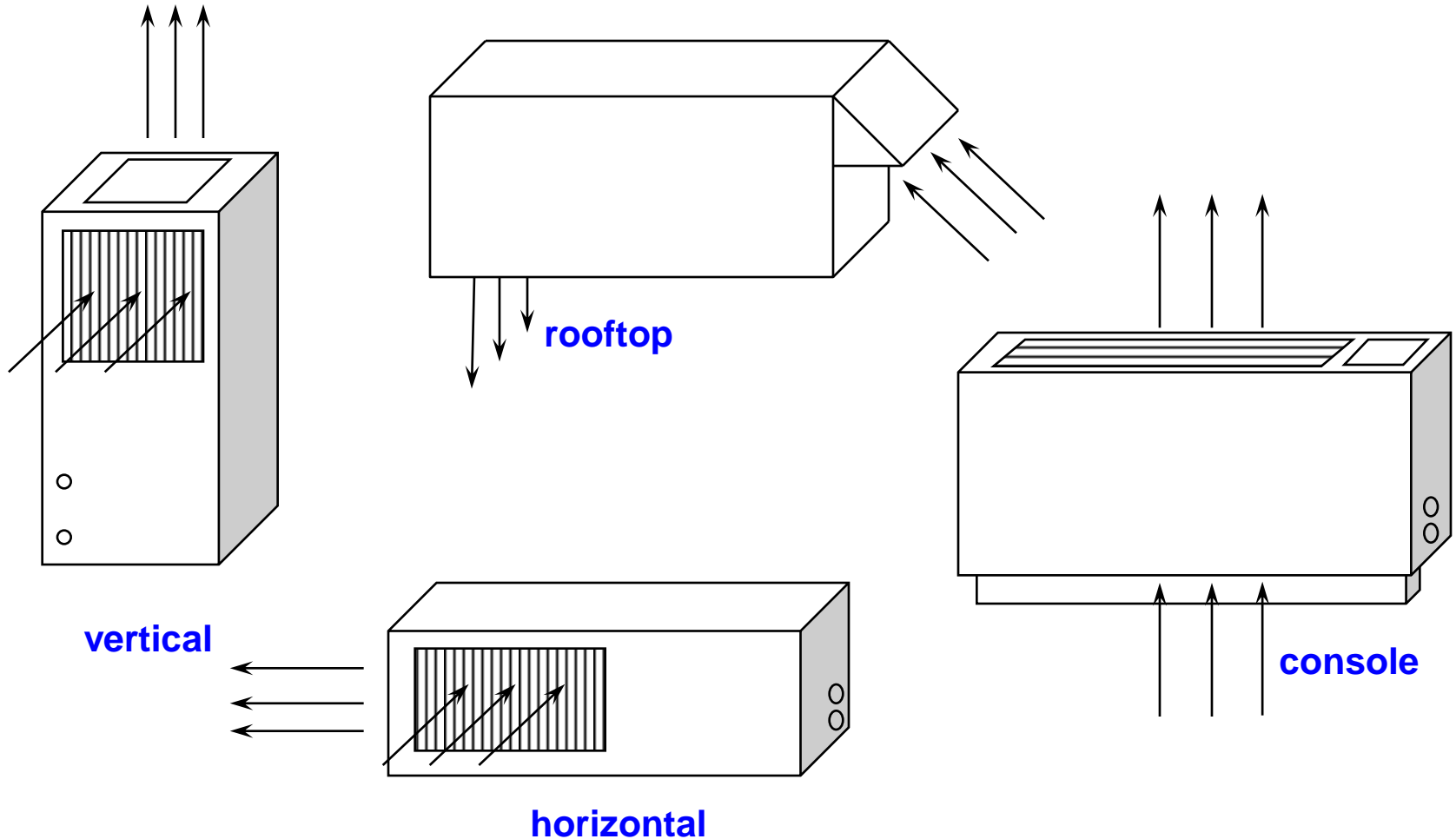
25

- What space is available in zones for individual heat pumps?
 - ▣ Above dropped ceiling → rooftop units with duct system or horizontal units
 - ▣ Mechanical closets → vertical units
 - ▣ Through-wall Packaged Terminal Air Conditioner (PTAC) units & perimeter → vertical units or console units
 - ▣ Rooftop mounted → rooftop units

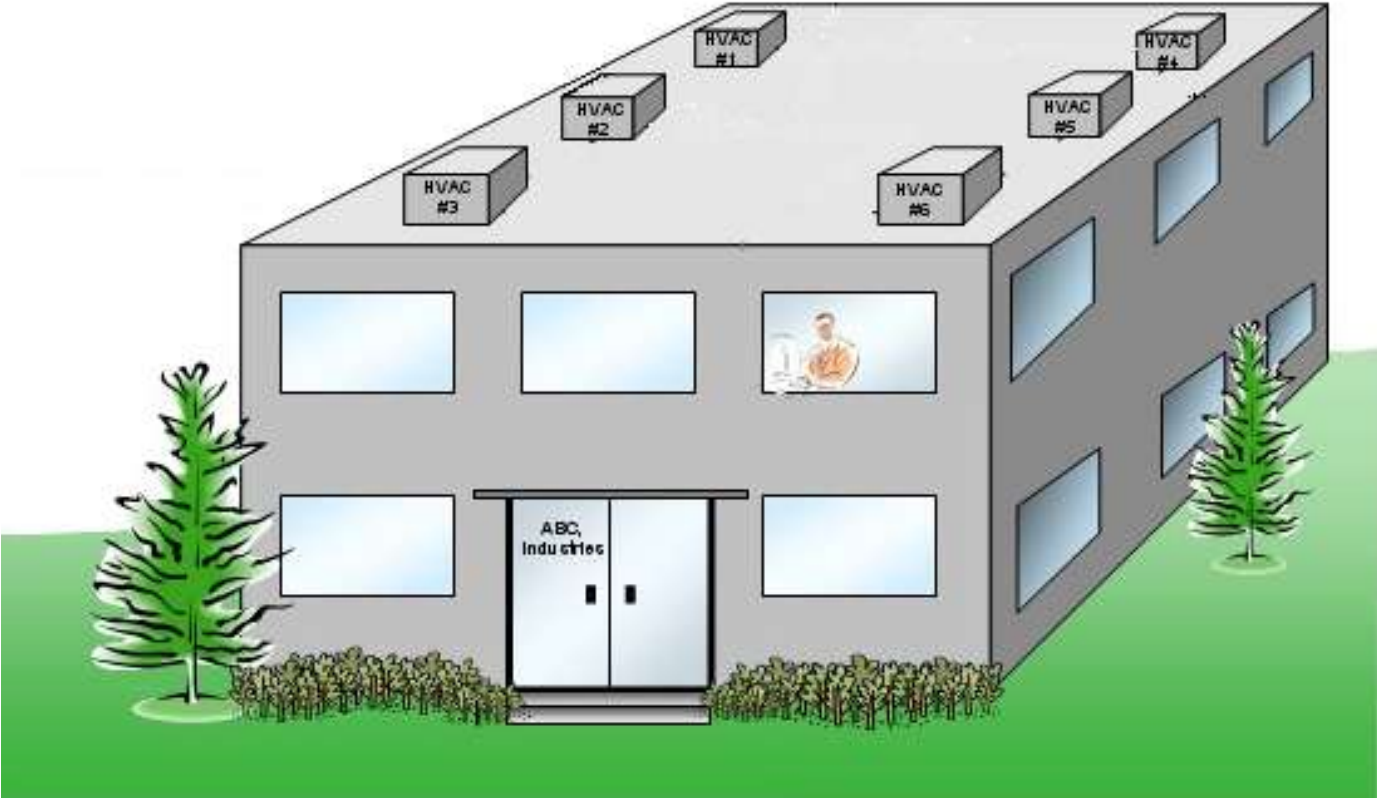
Four basic configurations of geothermal heat pumps



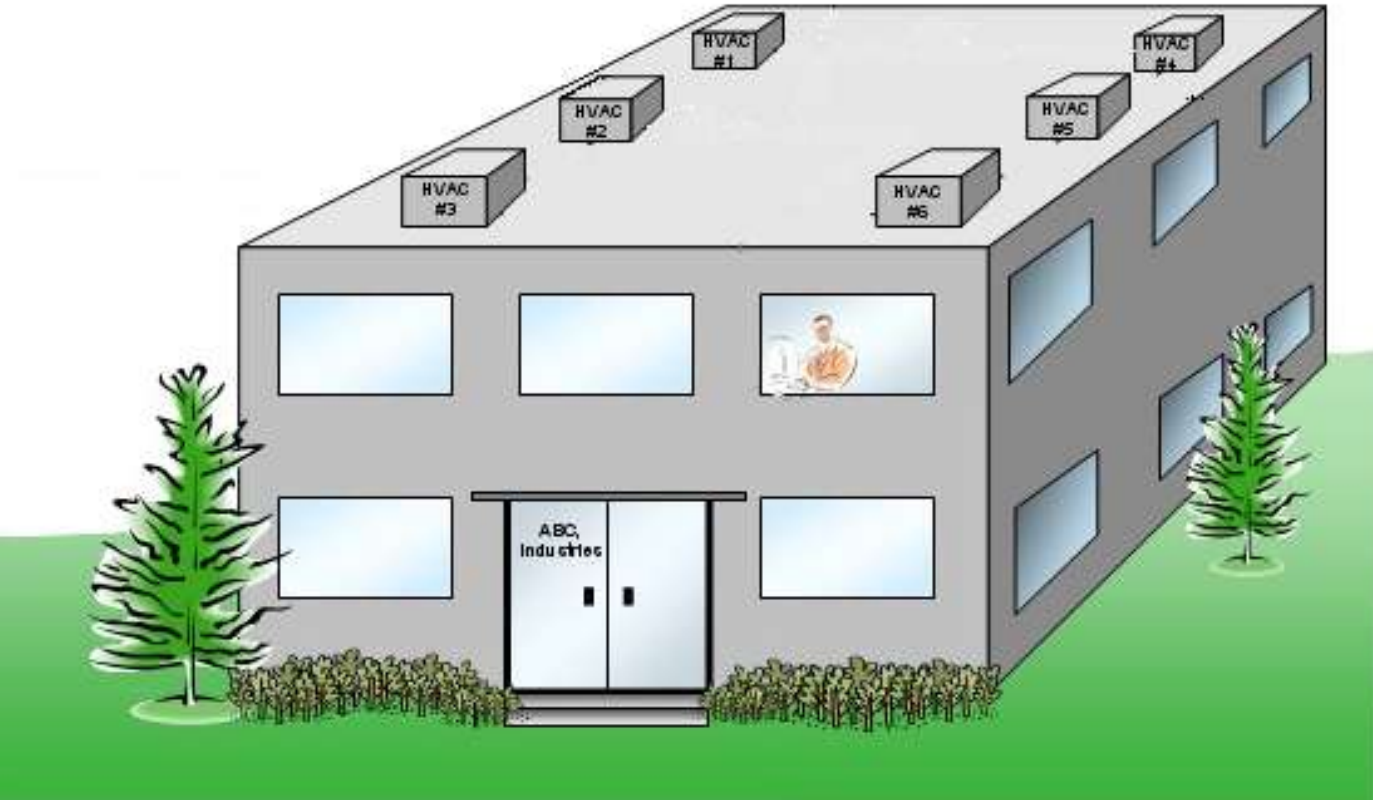
26



Standard Rooftop Application



Geothermal Rooftop Application



AAON

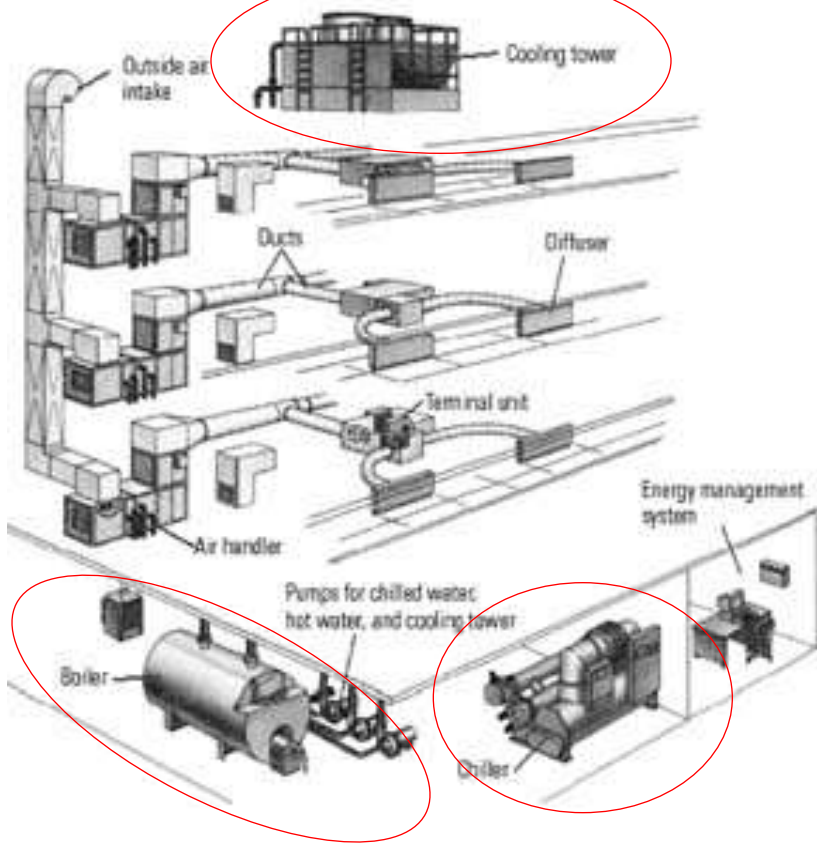
Defining Quality. Building Comfort



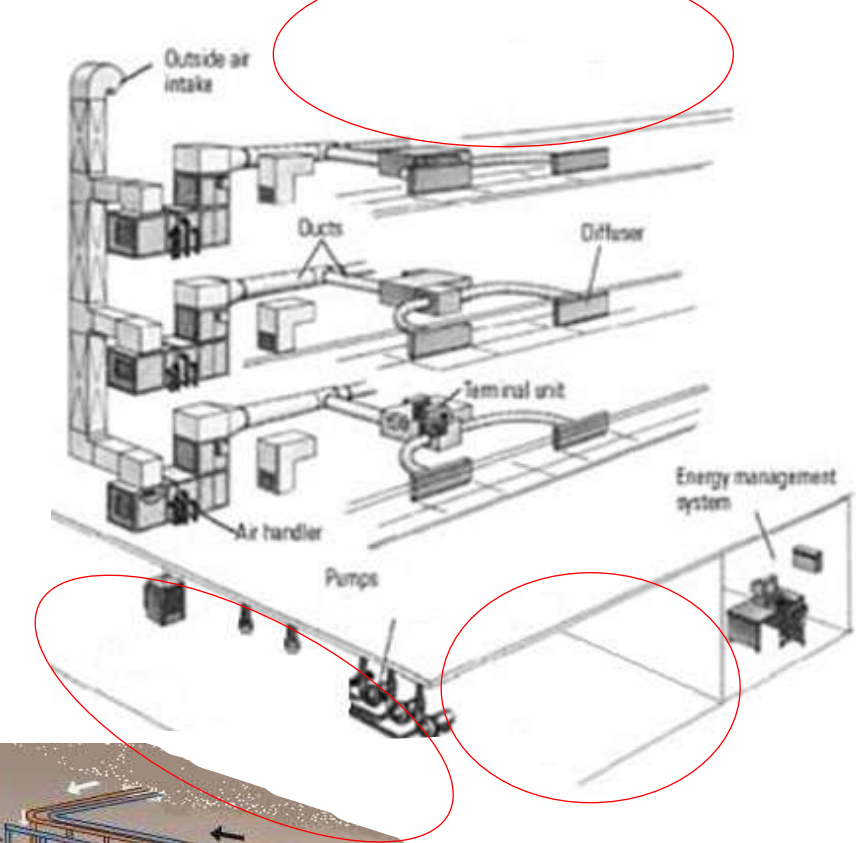
Geo Floor-by-Floor Retrofit



Chiller/Boiler/Cooling Tower



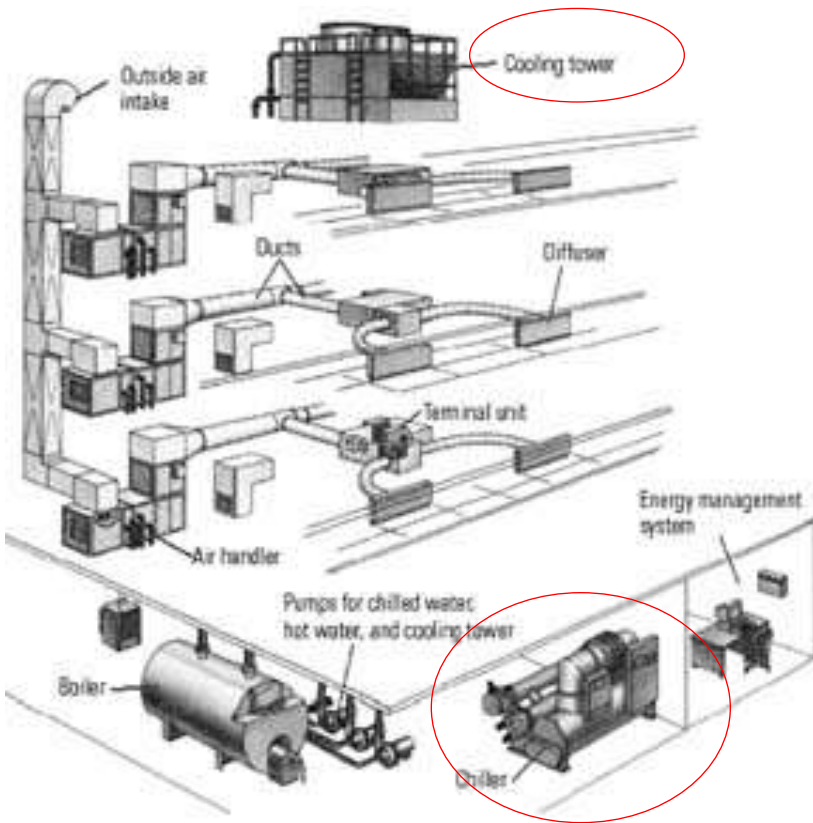
Geothermal Direct Expansion



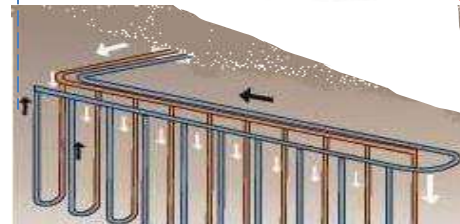
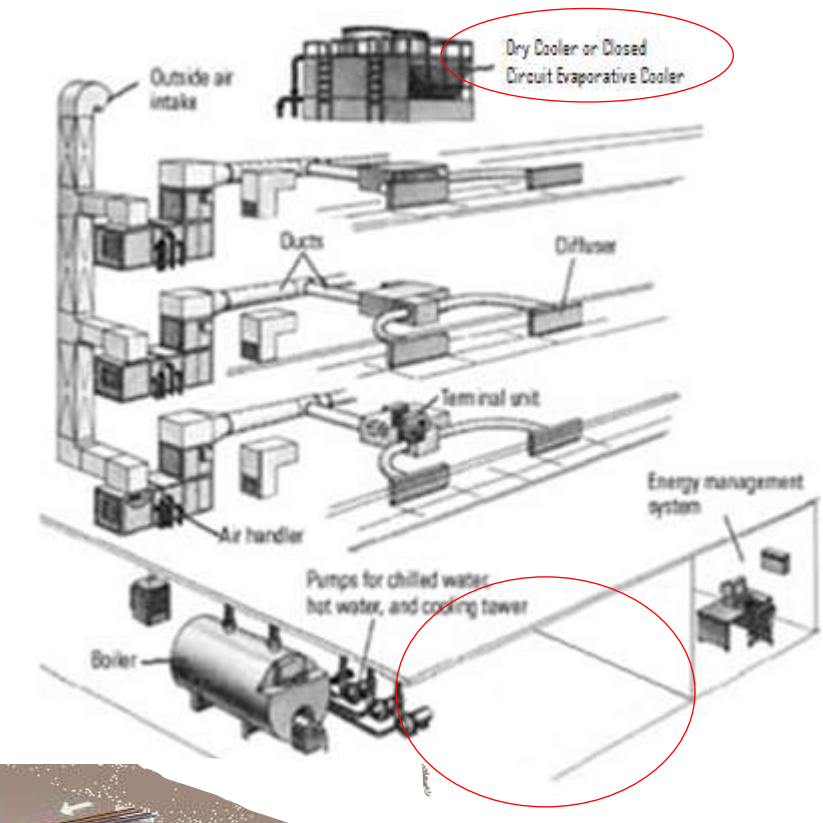
Hybrid Geo Floor-by-Floor Retrofit



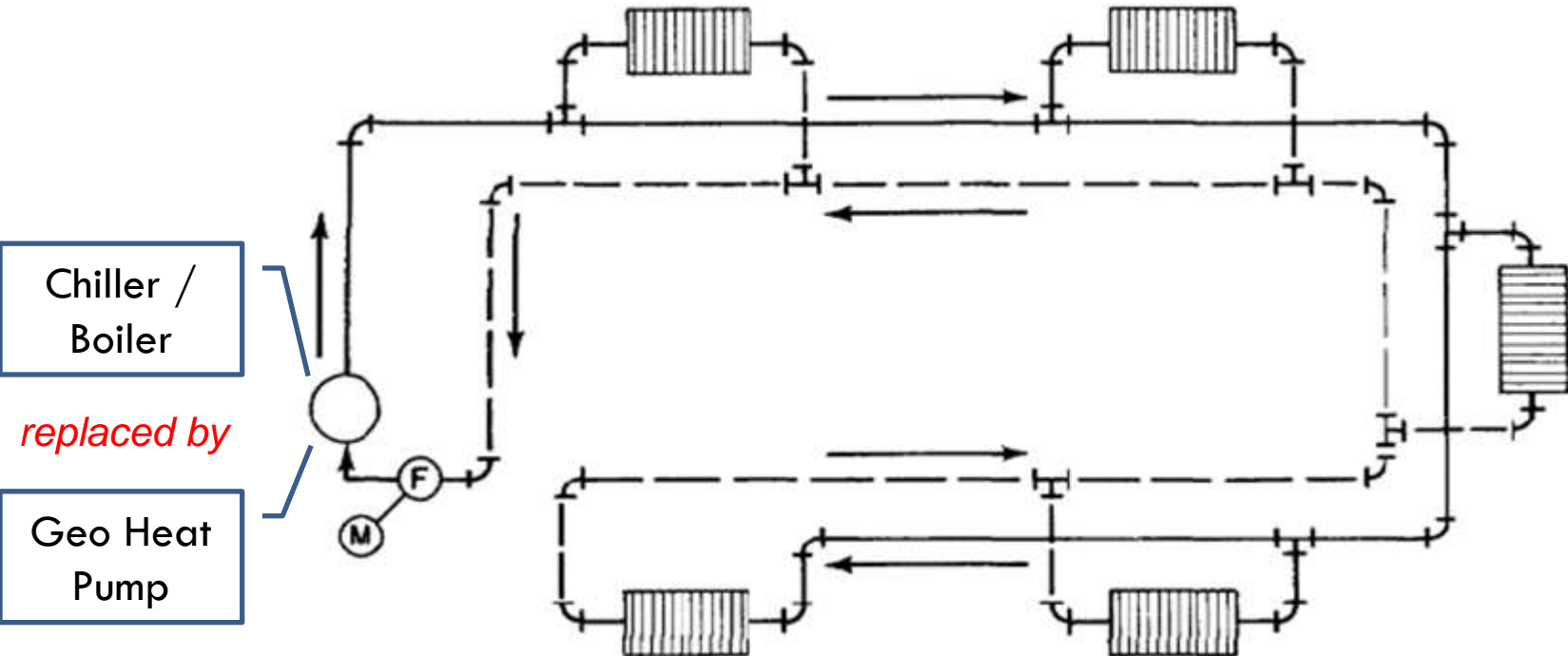
Chiller/Boiler/Cooling Tower



Hybrid Geothermal



Two-Pipe Retrofit



In a two-pipe system, the same coil is used for both cooling and heating. Using this large coil in heating mode allows for lower hot water temperatures. This makes a geothermal retrofit economical and possible.

Market Expansion Summary



- If a geothermal loop can be installed, geothermal equipment is available!
- This includes:
 - ▣ Rooftop Units: 2-230 tons in a single unit
 - ▣ Water-to-Water Chillers/Heat Pumps: 2-365 tons
 - ▣ Heat Pump Split Systems: 2-70 tons
 - ▣ Commercial Self-Contained Units: 2-70 tons
 - ▣ And more!

Advancements in Geo. Equip.

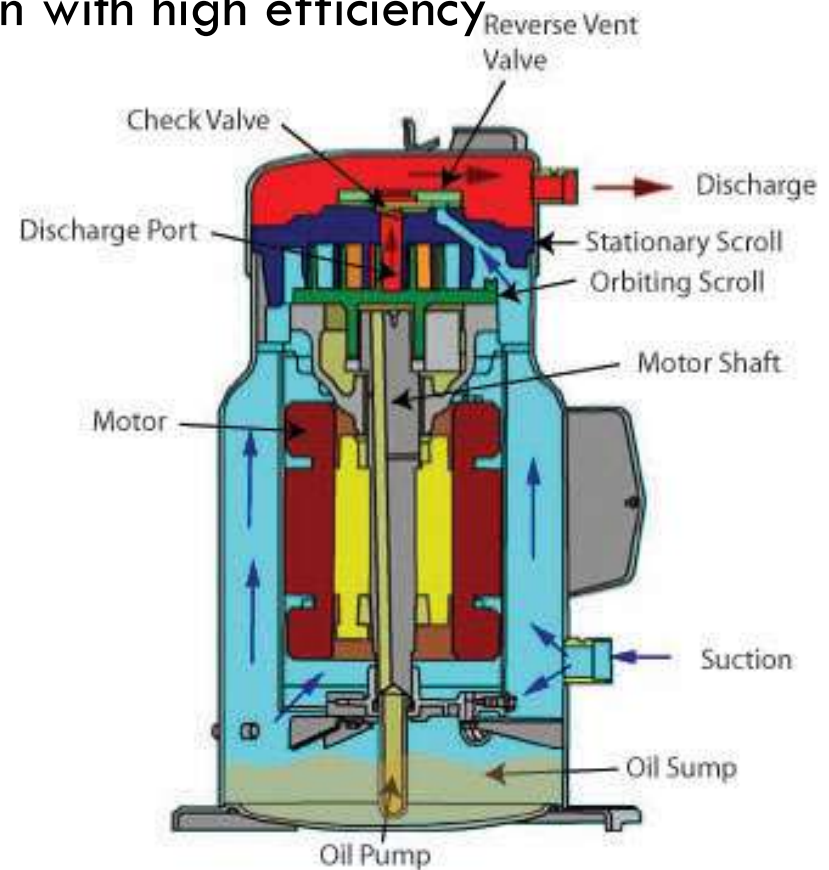
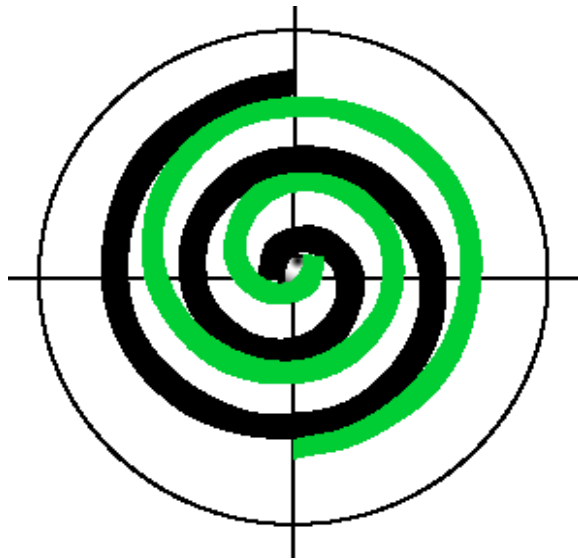


- Applications of a Geothermal Heat Pumps
- AAON Advancements in Geothermal Heat Pump Design
 - Direct Expansion (DX) Cooling Technology
 - Air Delivery System
 - Thermal Loss Minimization

Direct Expansion (DX) Cooling Technology



- High Efficiency Scroll Compressor
 - ▣ Performs the work of compression with high efficiency

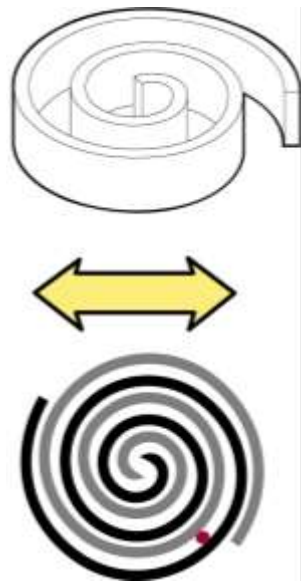


DX Cooling Technology

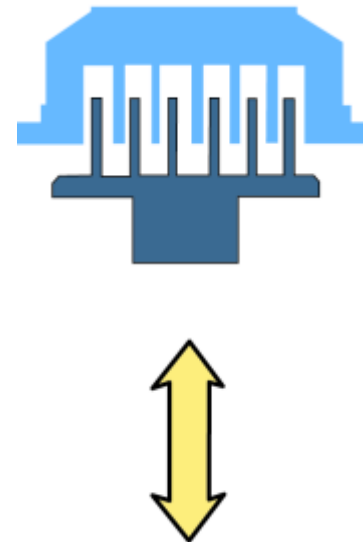


- High Efficiency Scroll Compressor

Radial Compliance



Axial Compliance



- Tight Radial & Axial Tolerance or “Compliance” is required for the Scroll compressor
- If the scroll mating tolerance is not maintained, there is no work of compression.

DX Cooling Technology

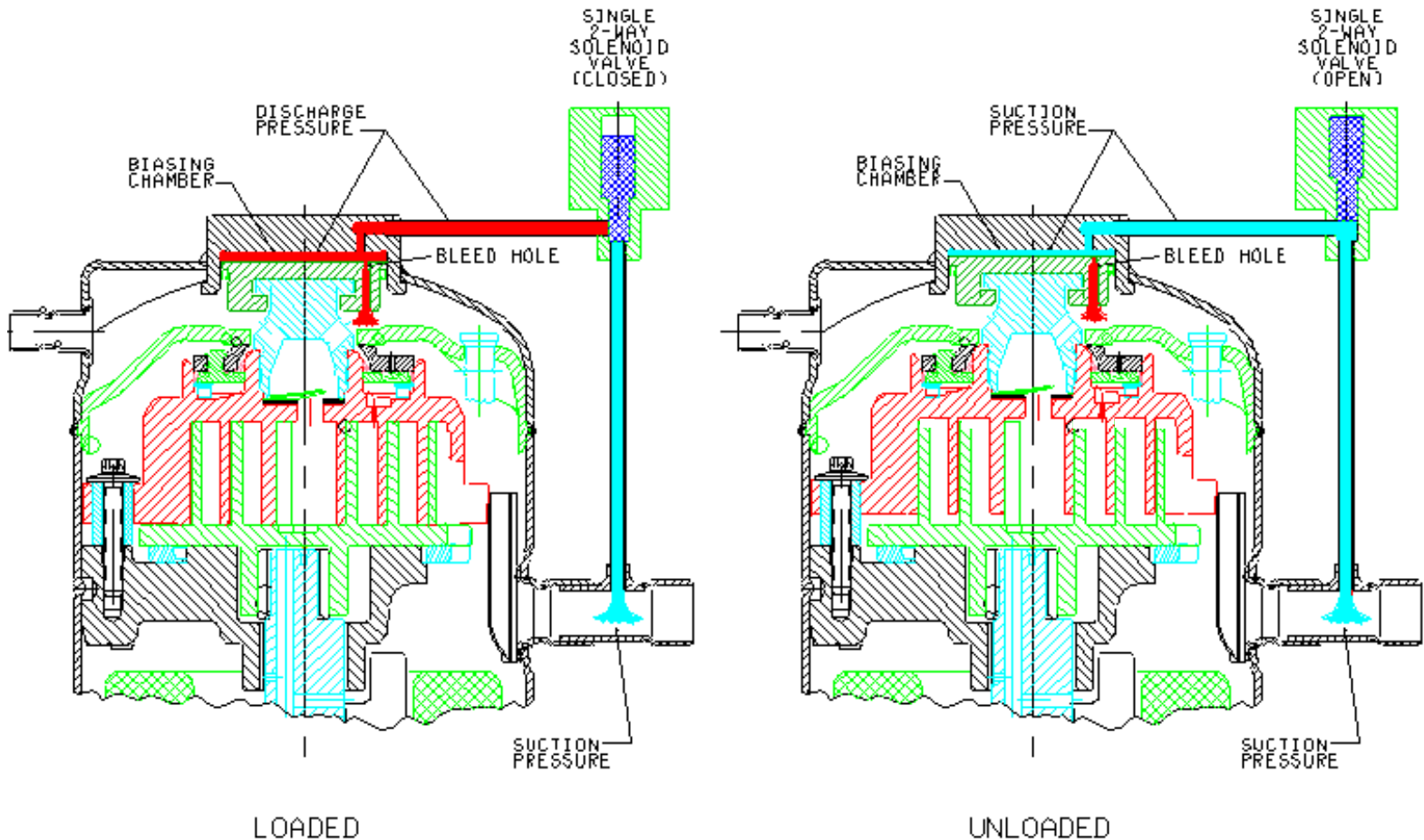


- High Efficiency Scroll Compressor
 - If the mating scroll members are separated axially, there is no refrigerant gas compressed. This lead to two questions...
 - Can this manufacturing tolerance challenge be utilized for efficient capacity control?
 - If we controlled the amount of time the scrolls are separated or are mated, what would the result be?

DX Cooling Technology



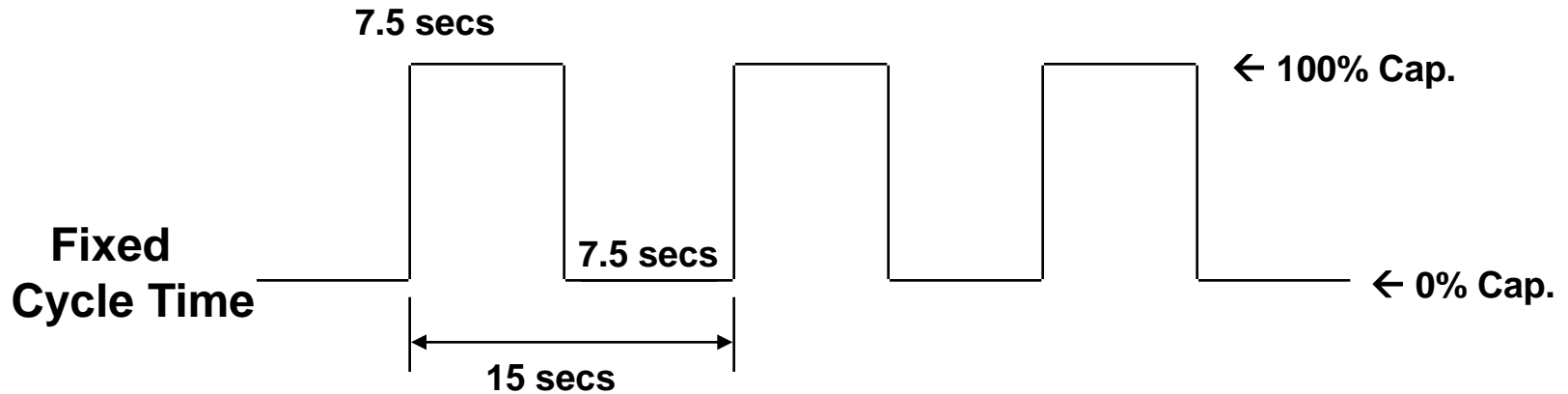
□ High Efficiency Variable Capacity Scroll Compressor



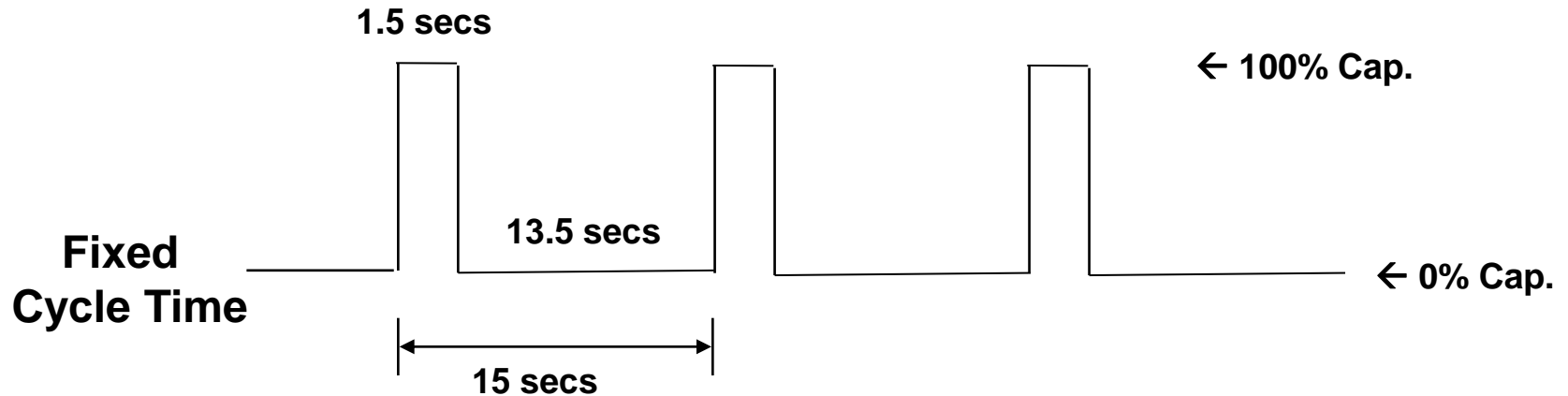
DX Cooling Technology



50% Capacity



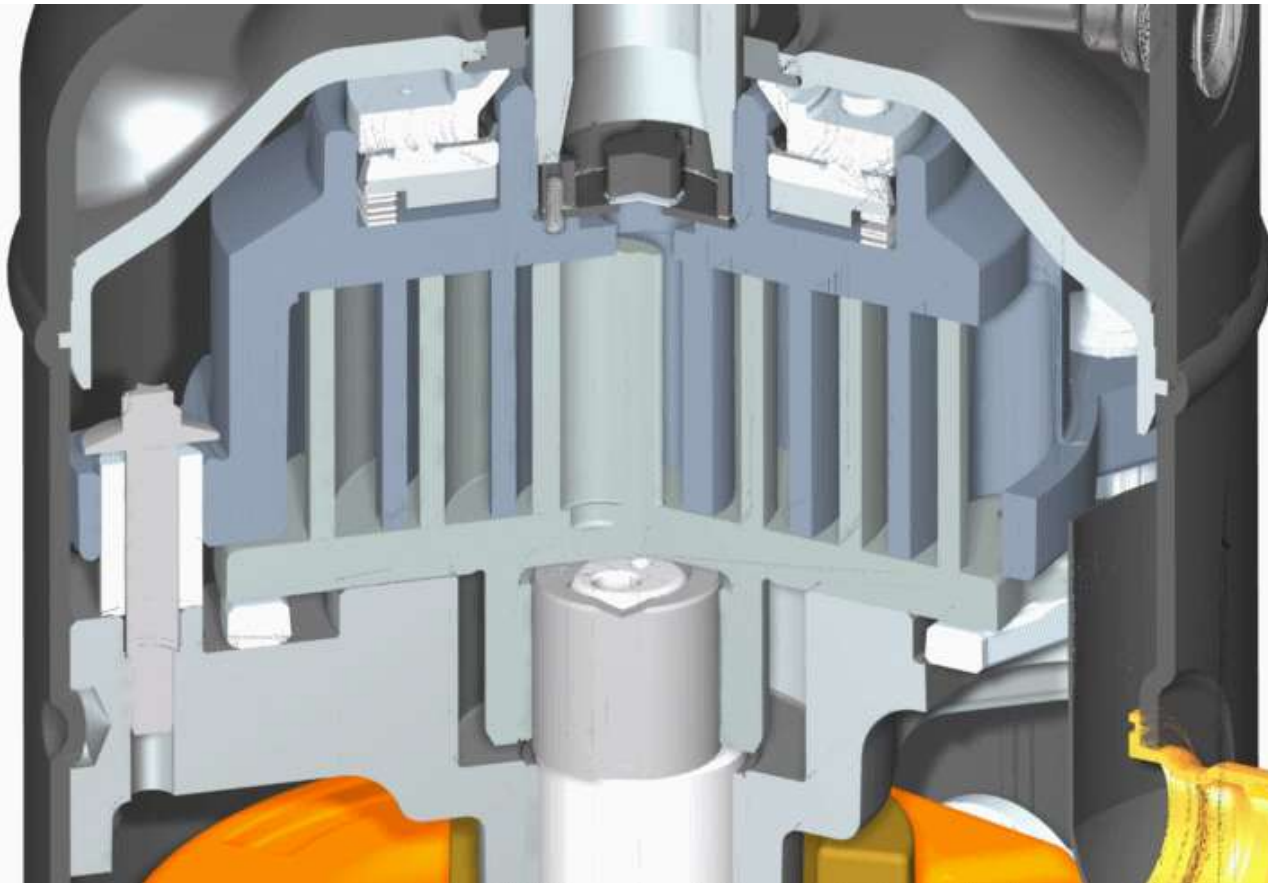
10% Capacity



DX Cooling Technology



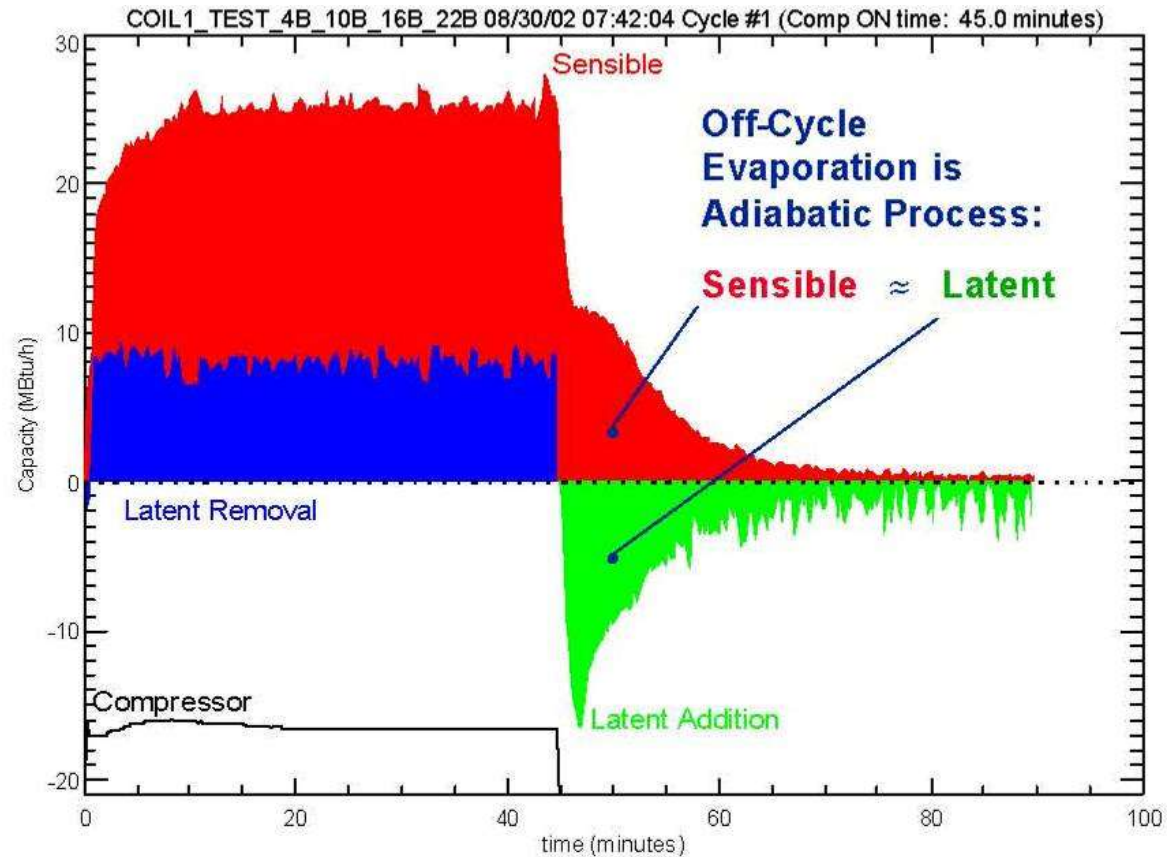
- High Efficiency Variable Capacity Scroll Compressor



On/Off Compressors



Evaporation effect of On/Off compressors due to cycling

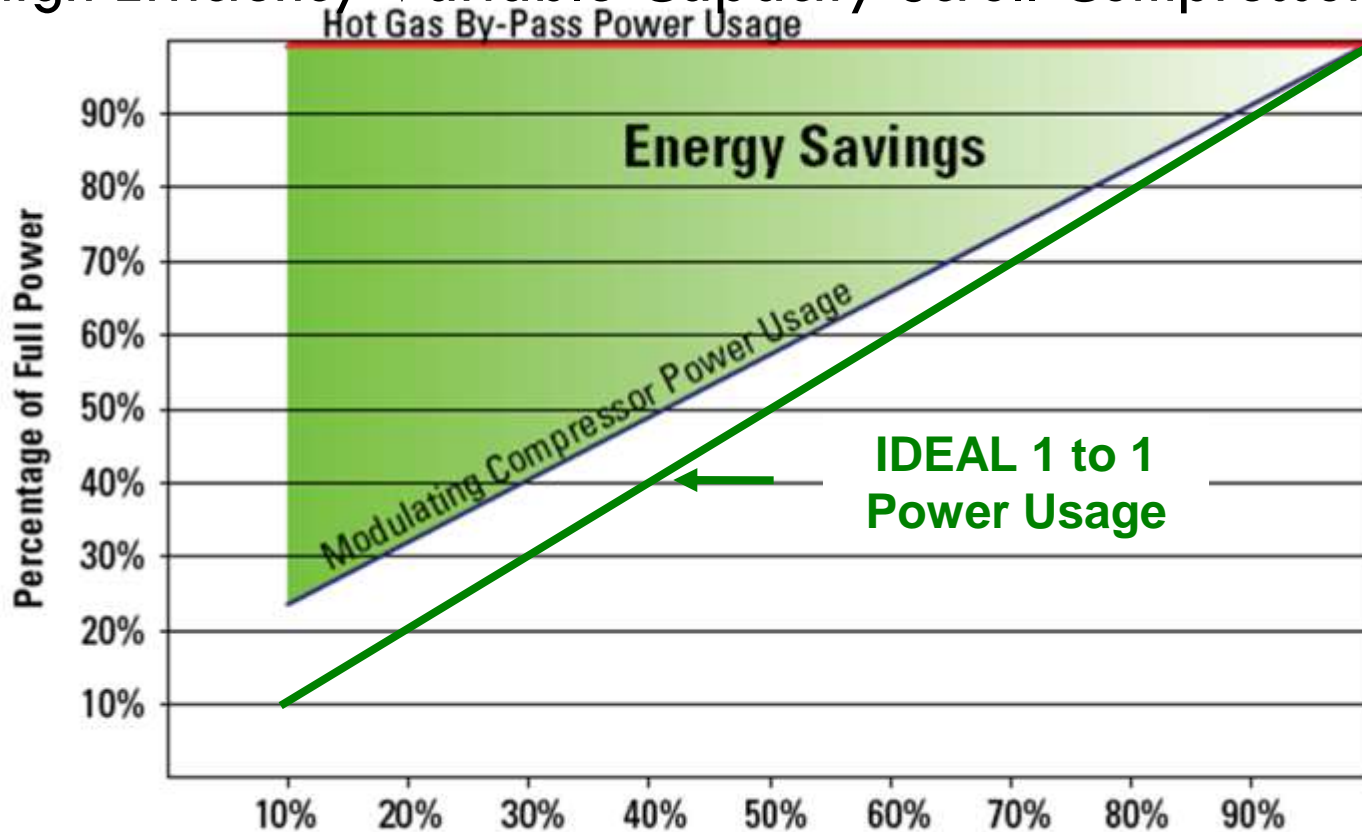


Courtesy of DOE/NETL Project #DE-FC26-01NT41253

DX Cooling Technology



- High Efficiency Variable Capacity Scroll Compressor

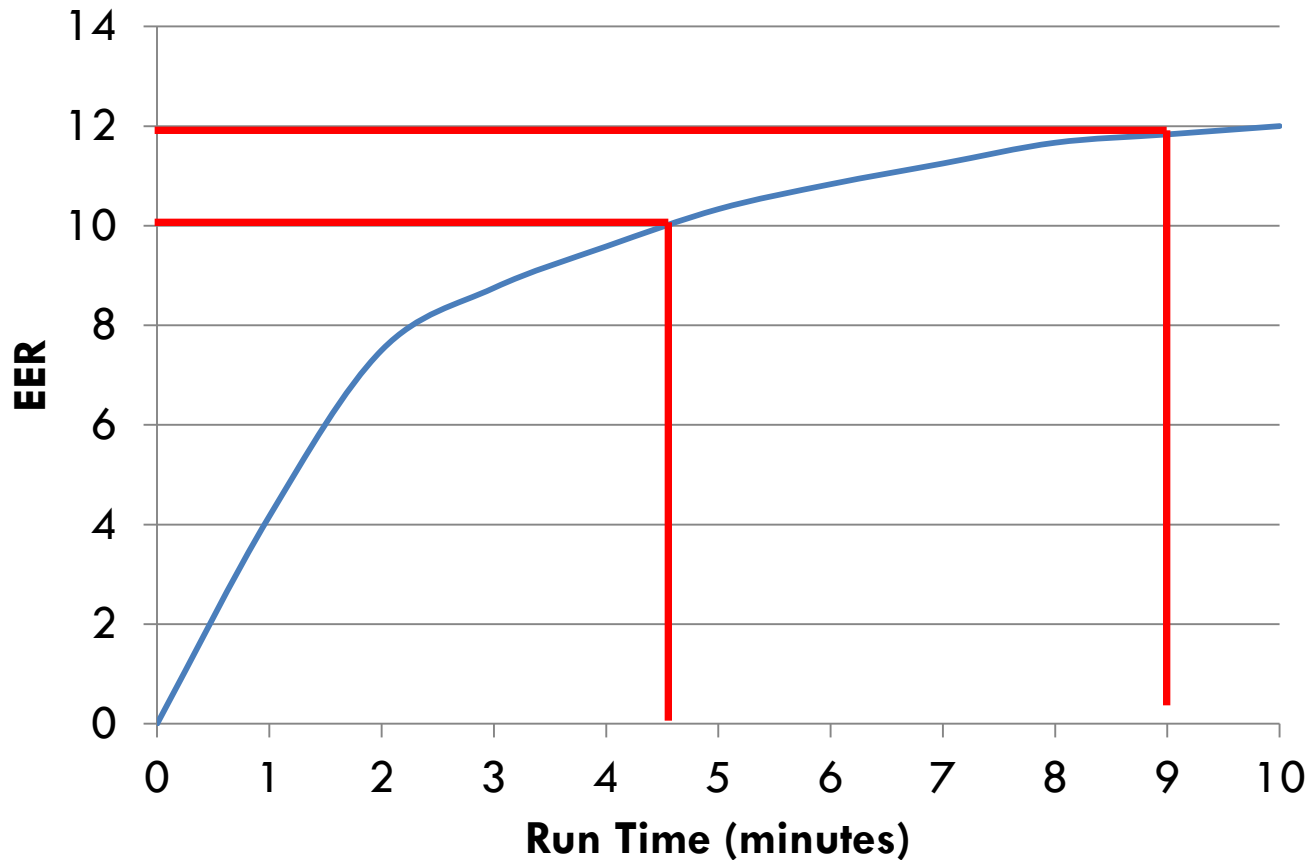


Great Part Load Energy Efficiency!

DX Cooling Technology



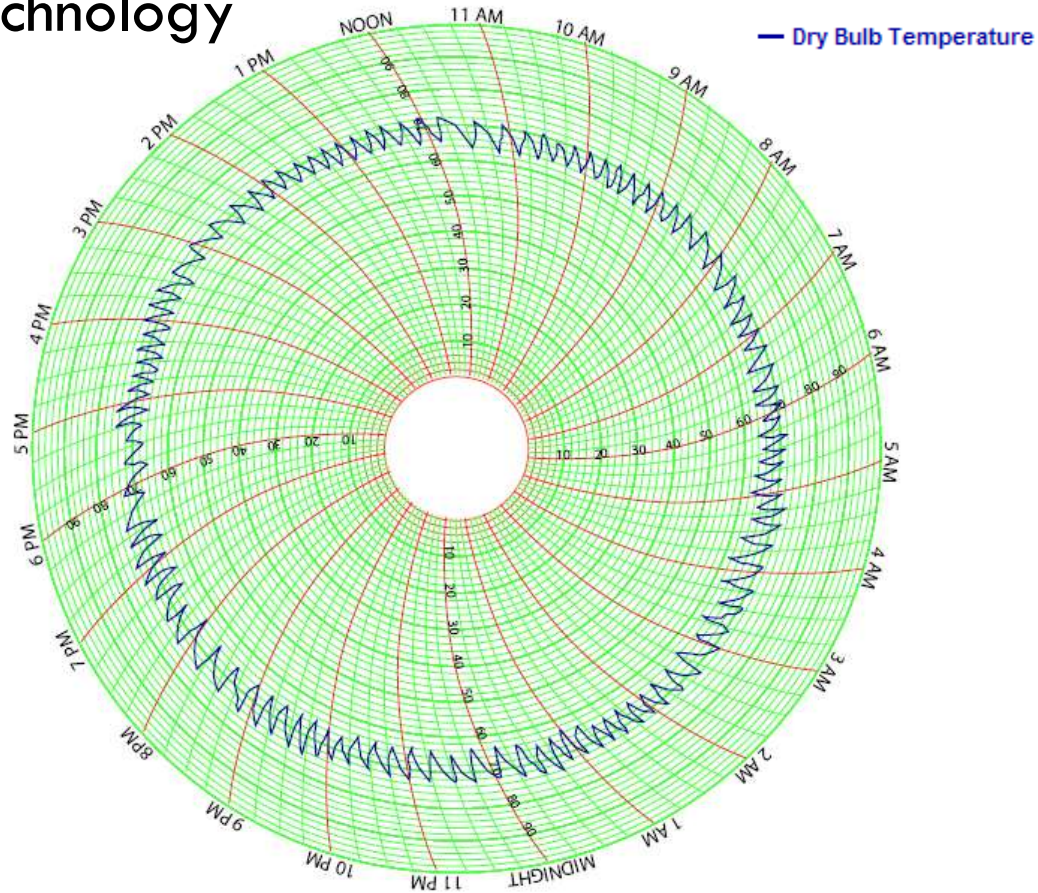
EER vs. Unit Run Time



DX Cooling Technology



□ On/Off Technology

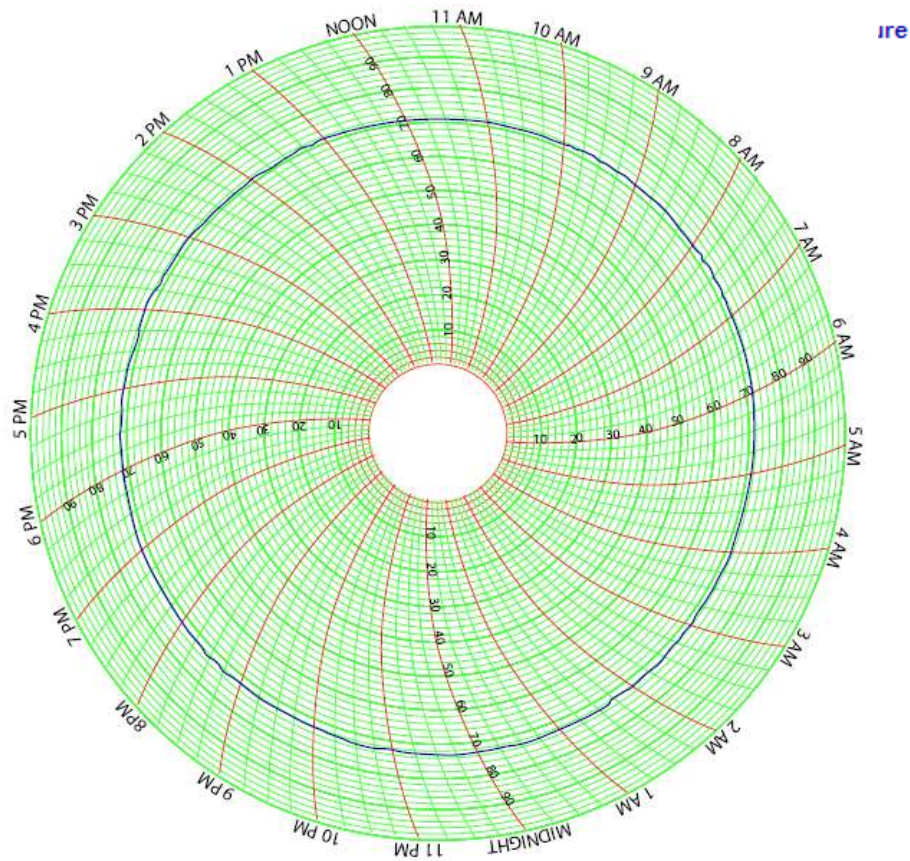


Poor Dry Bulb Temperature Control!

DX Cooling Technology



□ Variable Capacity Technology



Excellent Temperature Control!

DX Cooling Technology

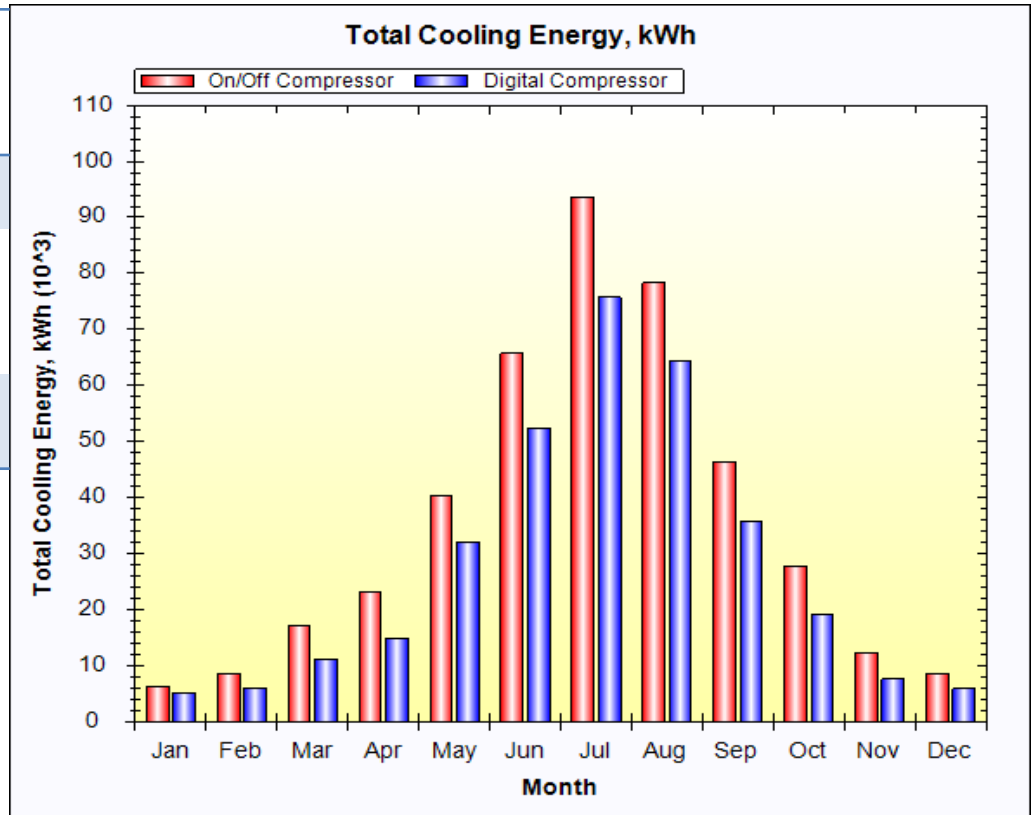


□ High Efficiency Variable Capacity Scroll Compressor

COMPARISON OF ALTERNATIVES Energy and Economics Analysis Program Version 9003

Weather Data : TULSA, OK TMY2

	On/Off Compressor	Digital Compressor
DX electric (kWh)	342,214	244,291



Great Part Load Energy Efficiency!

AAON Advancements



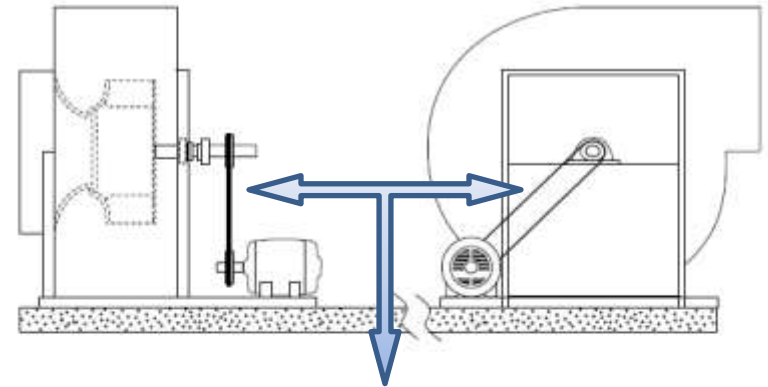
- Operation of a Geothermal Heat Pump
- AAON Advancements in Geothermal Heat Pump Design
 - Direct Expansion (DX) Cooling Technology
 - Air Delivery System
 - Thermal Loss Minimization

Air Delivery System

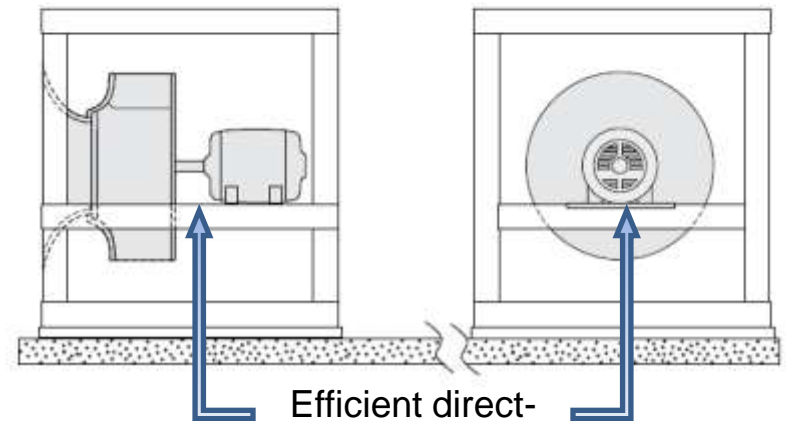


49

- Reduce energy consumption and improve quality through the application of direct-drive fans



Inefficient belt driven system



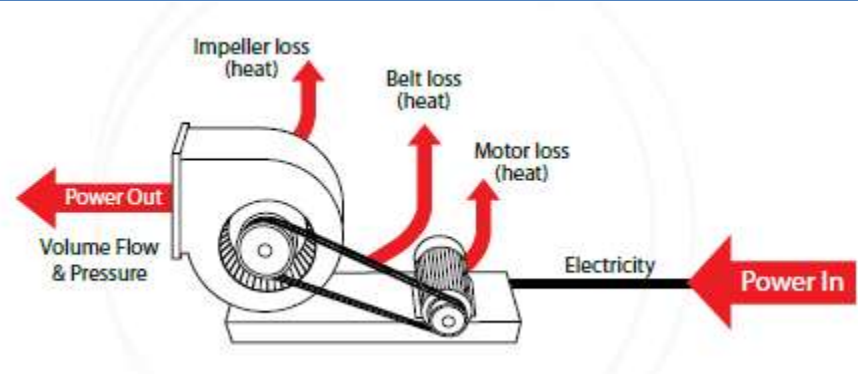
Efficient direct-drive system
(no belts)

Air Delivery System

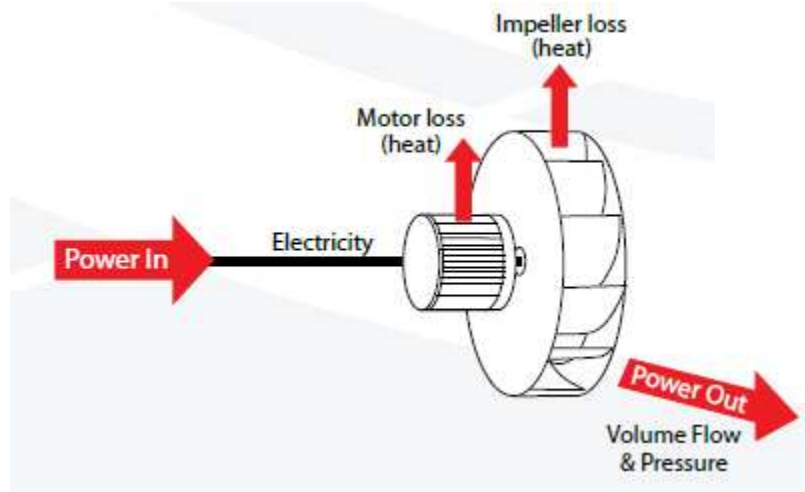


50

- Belt losses include sound, friction and vibration.



Inefficient belt driven system



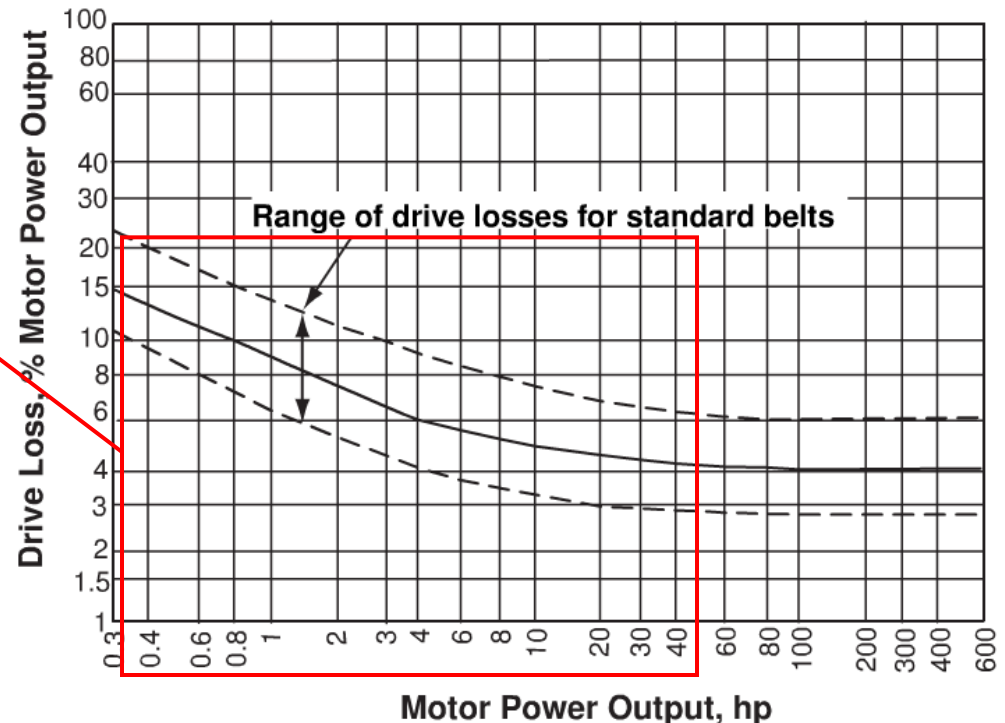
Efficient direct-drive system
(no belts)

Air Delivery System



- Fan/Motor Drive Type to be Used
- Belt Drive or Direct Drive?
 - ▣ Belt Drive Fans result in Energy Efficiency Losses

Using Belt Drive Fans in HVAC applications typically results in a 3% to 20% Loss of Air Delivery Energy Efficiency



Air Delivery System



- Fan/Motor Drive Type to be Used
- Belt Drive or Direct Drive?
 - Belts require maintenance for change out and replacement
 - Belts create additional noise as the belt “seam” rolls over the drive and driven sheaves
 - Belts wear releases belt dust into the airstream

Air Delivery System



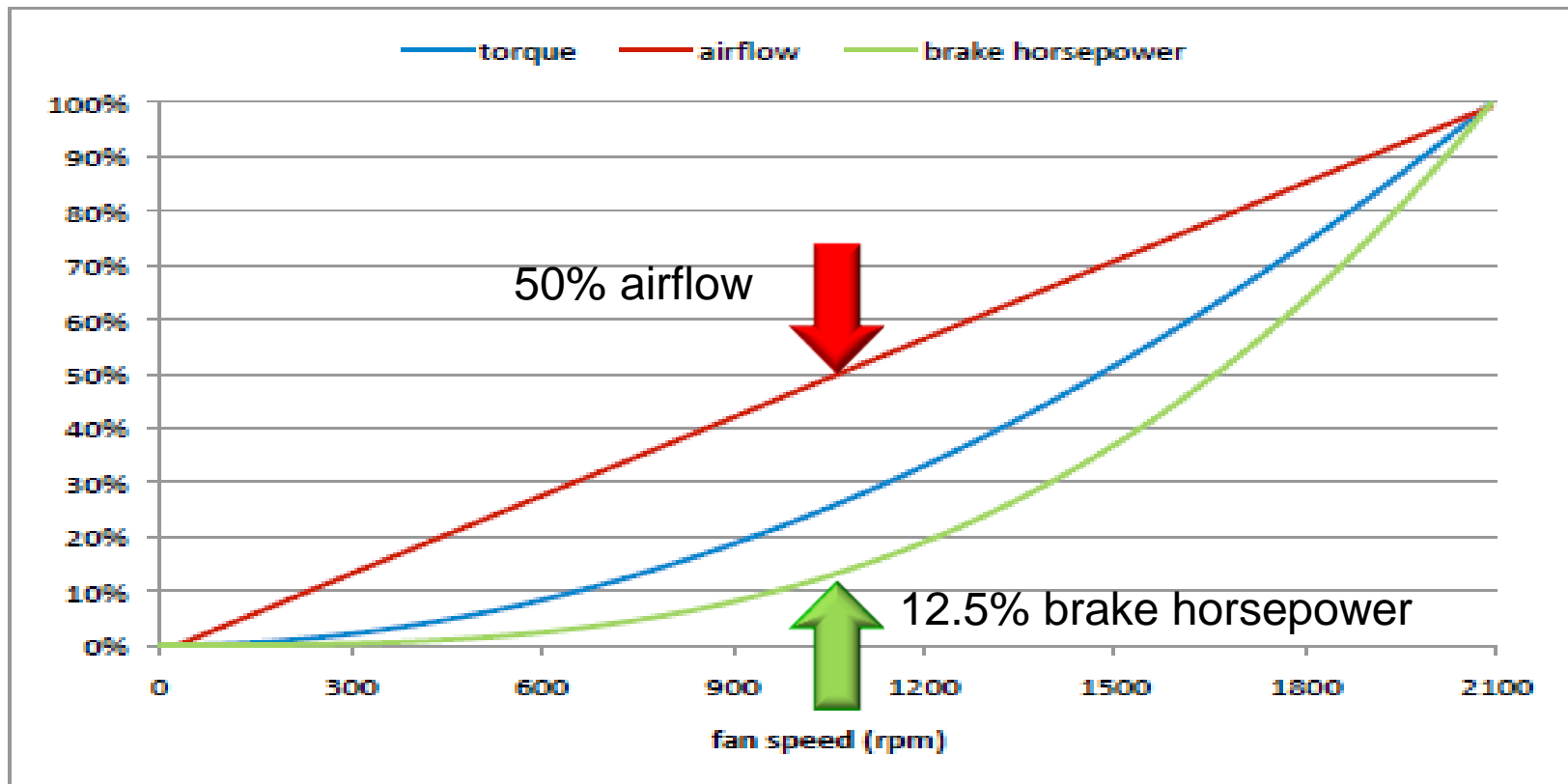
- Constant or Variable Air Volume
 - ▣ Which system uses less energy, CAV or VAV?
 - Variable Air Volume (VAV)
 - ▣ Is it substantially less?
 - Yes
 - Air Delivery Energy Usage occurs Year Round, not just during the cooling season
 - Air Delivery Energy is commonly greater than Compressor Energy, so it represents a great opportunity to reduce a building's energy usage

Air Delivery System



54

Reducing the fan rotational speed in half cuts the required input horsepower by eight!

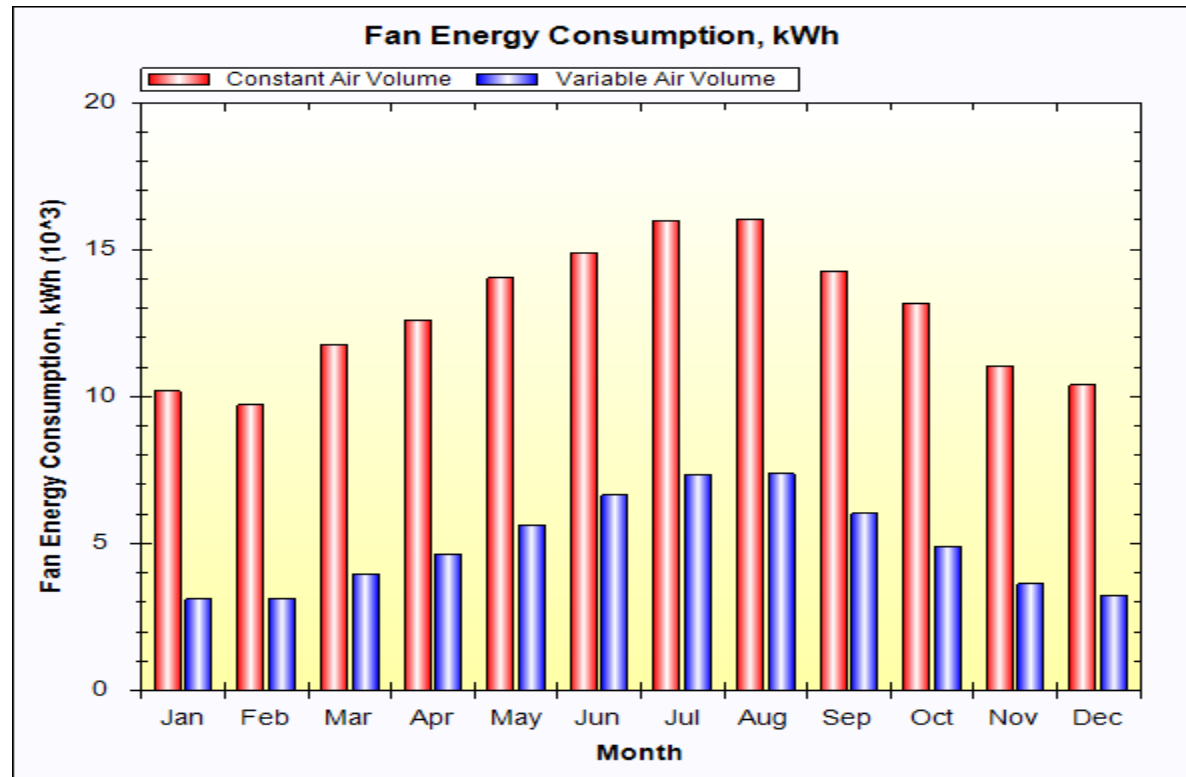


Air Delivery System



- Constant or Variable Air Volume
 - ▣ What are the typical savings of VAV Air Delivery versus CAV?

✓ **VAV**
Variable
Air
Volume



AAON Advancements



- Operation of a Geothermal Heat Pump
- AAON Advancements in Geothermal Heat Pump Design
 - Direct Expansion (DX) Cooling Technology
 - Air Delivery System
 - Thermal Loss Minimization

Thermal Loss Minimization

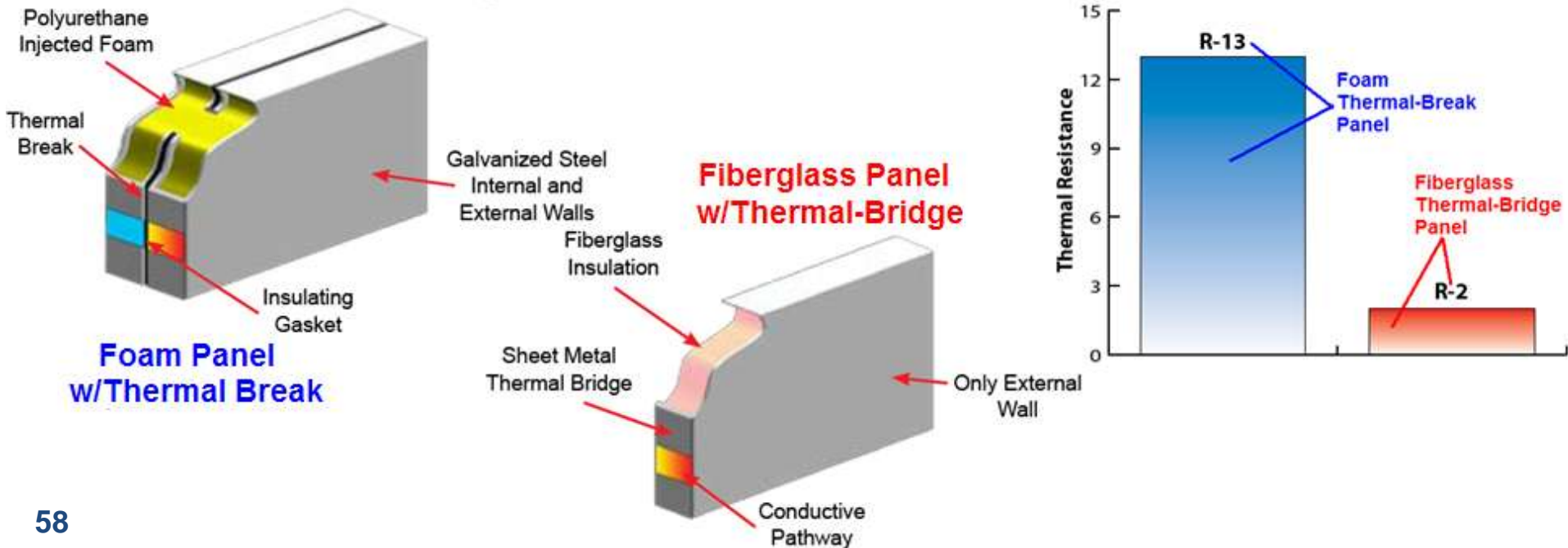


- Are Thermal Losses for an HVAC unit important?
 - Yes, millions of dollars are spent on providing an owner a tight, thermally resistant building envelope (90.1 mandates U-values)
 - Since HVAC units draw in all of the building's indoor air during conditioning, it can be easily argued that HVAC unit thermal losses are as important as the building's thermal losses

Thermal Loss Minimization



- What are the sources of HVAC unit Thermal Losses?
 - ▣ Conduction through the Unit Cabinet
 - ▣ Solution: High R-Value Cabinets w/ Thermal Break



Thermal Loss Minimization



- What are some sources of HVAC unit Thermal Losses?
 - ▣ Infiltration and Exfiltration from Cabinet Air Leakage
 - ▣ Solution: Tight Air Leak and Stringent Panel Deflection Specification Requirements

Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360.

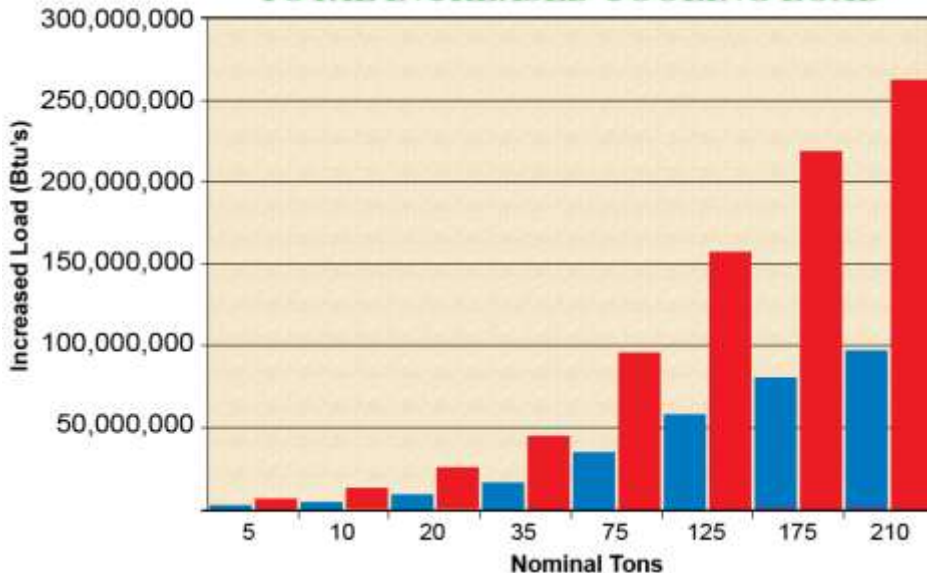
Thermal Loss Minimization



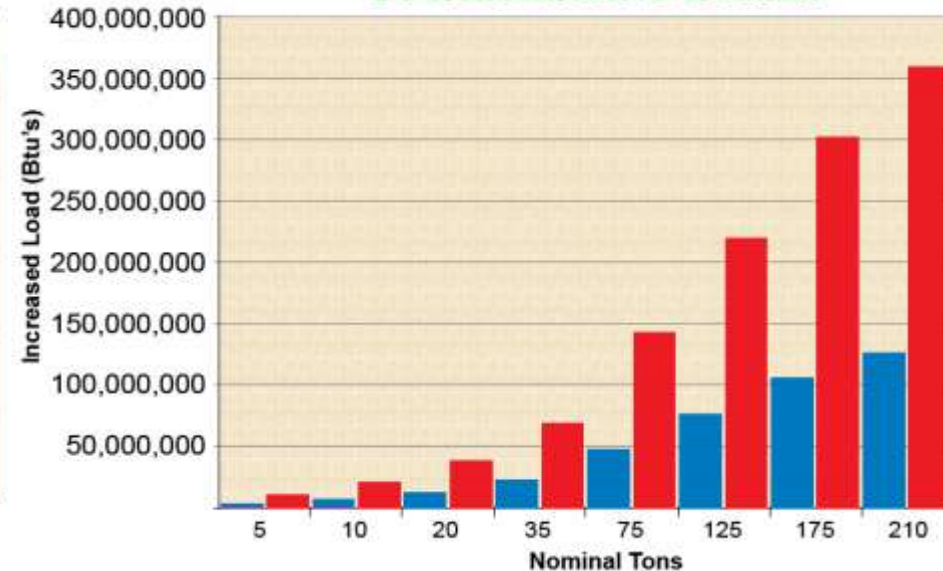
- What is the magnitude of Energy Savings of High R-Value & Low Leak HVAC Units in Cooling and Heating seasons?

■ Conventional Fiberglass Insulation Design ■ Rigid Polyurethane Foam Design

TOTAL INCREASED COOLING LOAD



TOTAL HEATING LOSSES



AAON Advancements



- Applications of a Geothermal Heat Pumps
- AAON Advancements in Geothermal Heat Pump Design
 - Direct Expansion (DX) Cooling Technology
 - Air Delivery System
 - Thermal Loss Minimization



Expanding the Geothermal Market

Sam Neale, PE

Marketing Manager

AAON