Emerson Climate Technologies at a Glance

Emerson Climate Technologies is the world's leading provider of heating, ventilation, air conditioning, and refrigeration solutions for residential, industrial, and commercial applications. We combine technically superior products and services from our industry-leading divisions and brands with our global engineering, design and distribution capabilities to create reliable, energy efficient climate systems that improve human comfort, safeguard food, and protect the environment.

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For more details, see www.emersonclimate.eu

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EMERSON Climate Technologies

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Copeland Scroll heating

Copeland Scroll Heating™

Heat Pump Optimized Scroll Technology

EMERSON Climate Technologies

The Renewable Energy Sources (RES) Directive acknowledges energy from air, water and ground as renewable and heat pumps are recognized as the technology of choice to make it usable. This is an important step to achieve the European targets of 20% CO_2 reduction, 20% energy efficiency improvement and 20% increase in renewables in the energy mix, by 2020.

The recast of the Energy Performance of Buildings Directive, with the 'nearly zero-energy building' definition (*) and the Ecolabel for Buildings, with a minimum % of renewable in the energy used by the buildings (25% for existing and 50% for new buildings) are also pointing in the same direction.

Emerson Climate Technologies, the world's leading scroll compressor manufacturer, always committed to energy efficiency optimization and new technologies, has been the first in the market to offer a complete range of highly efficient scroll compressors optimized for heat pump applications.

(*) buildings will have to supply a large proportion of their energy requirement from renewable energy harvested either on site or nearby. An exact definition of 'nearly-zero' is not given allowing space for National interpretations.

Copeland Scroll Heating™ ZH series from 5 to 45 kW Heating Capacity

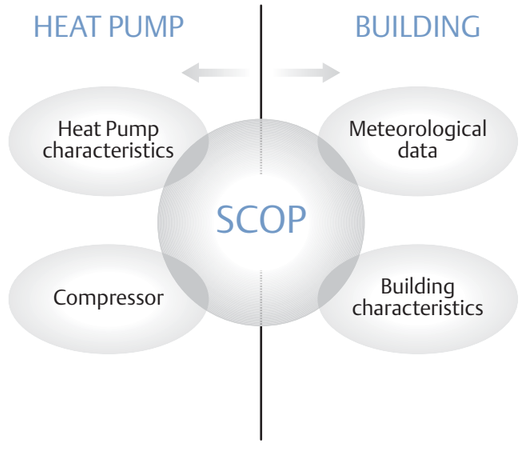
Heat pump system performance depends on several factors:

Building related factors

- Building location
- Heating demand (building insulation, new / existing construction)
- Heating distribution system
- Water temperature setpoint and curves

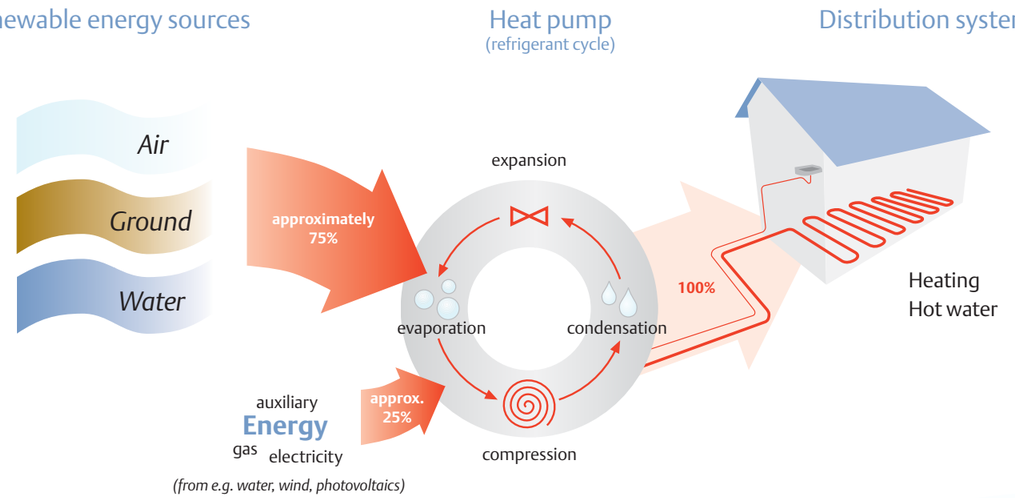
Heat pump related factors

- Type of heat source
- Type of refrigerant
- Delta temperature on the heat exchangers (condenser / evaporator)
- Defrost management
- ***Compressor technology***



Modern Heat Pump systems must be able to operate efficiently and deliver quality comfort at a wide range of climate conditions. There is a clear trend to move toward a seasonal efficiency concept **(SCOP)** versus the single point performance rating **(COP)** in order to better reflect the real operation of the installed equipment (EuP Directive, prEN14825,...).

Emerson Climate Technologies has developed a full range (from 5 to 45kW) of heating optimized scroll compressors, with and without vapour injection, to provide seasonal efficient heating capacity and effective domestic hot water production in residential and commercial building applications.



The prEN14825 defines three different climate zones for Europe:

- ***Warm***, defined around the climate profile of Athens
- ***Average***, based on Strasbourg
- ***Cold***, based on Helsinki

Each climate profile has a certain amount of hours at each outdoor temperature.

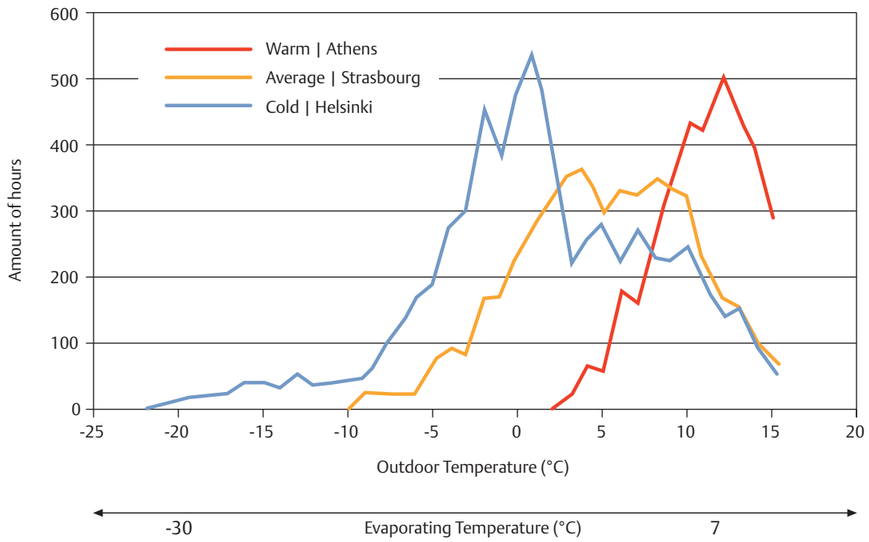
For air to water heat pumps, the outdoor temperatures directly determine the system evaporating temperatures which count as an important factor effecting the heat pump system performances.

The other fundamental factor effecting the heat pump system performances is the water temperature used to transfer the heat inside the building. The heat pump water temperature directly determines the condensing temperature.

The heat distribution systems for residential and commercial buildings can be summarized in three main groups:

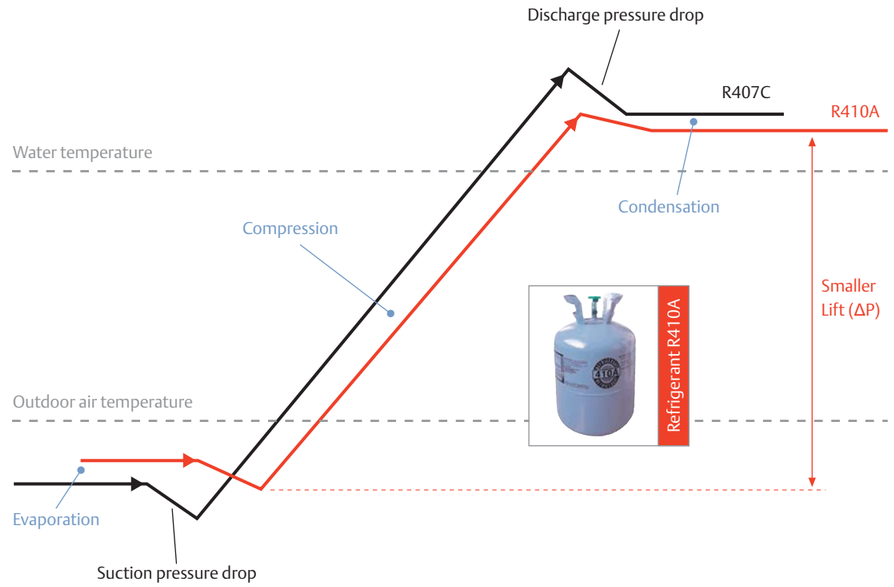
- Underfloor / radiant panels: max water temperature around 35ºC for **low temperature heat pumps**
- Low Temperature Radiators and Fan Coils: max water temperature around 45-50ºC for **medium temperature heat pumps**
- Normal radiators: originally sized for 80-90ºC but 60-65ºC is sufficient (design margin, insulation upgrade) for **high temperature heat pumps**

Each Degree Increase in Evaporating or Decrease in Condensing Temperature Implies a 2.5 to 3% Increase of the Compressor SCOP



Refrigerant Considerations

The choice of the refrigerant also impacts the performance and behavior of the heat pump system.



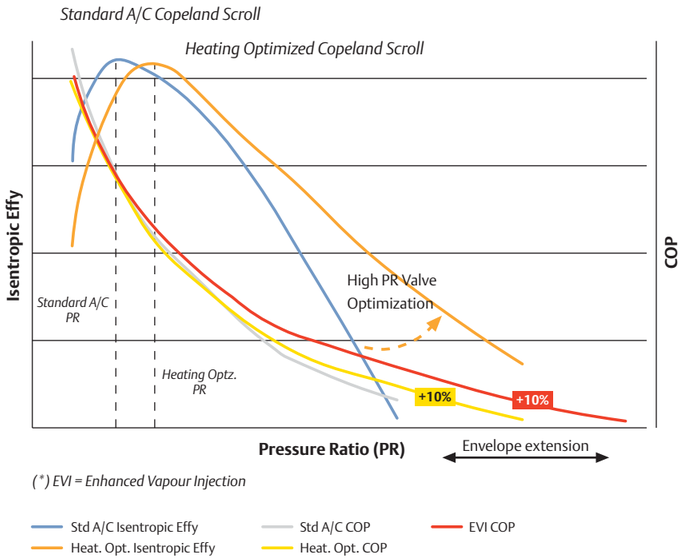
R134a

- Best theoretical COP but worse system performance due to low heat transfer capability and high pressure drops
- Requires more heat exchange surface for given ΔT & bigger compressor => negative applied cost impact
- Can be considered for application requesting very high water temperatures (>70°C) but COP decreases proportionally to the temperature lift

R410A & R407C

Most interesting refrigerants for heat pump applications

- R410A not as good in theoretical COP as R134a but best heat transfer capability and lower pressure drops lead to impact to the best system COP
- R410A advantages in terms of system compactness (applied cost), defrost and system reversibility (no glide)
- R410A has a high discharge temp. -> more challenging for high water temperature in air to water heat pumps
- R407C close to R410A

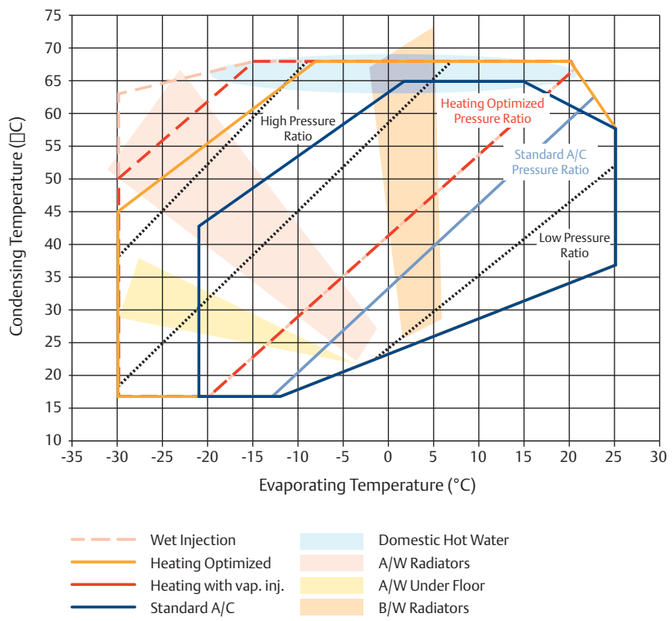


The high pressure ratio valve specifically designed for Copeland Scroll Heating™ compressors helps reducing under-compression losses and thus improves compressor COP at high condensing and low evaporating conditions (up to +10% without Enhanced Vapor Injection and up to +20% with EVI compared to a standard A/C Copeland scroll).

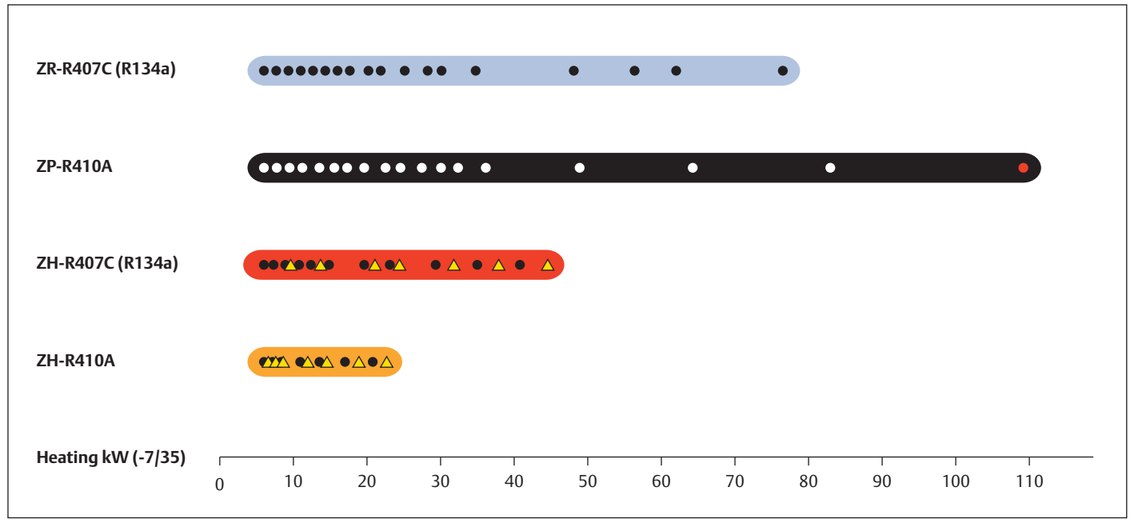
Moreover, the heating optimization and the Enhanced Vapor Injection feature enlarge the compressor operating map allowing efficient operation even in very cold climates.

Plotting the Pressure Ratio lines over the compressor operating envelope and shading the typical working conditions for the various applications (based on the considerations done so far), shows quite clearly that certain applications, from a heat pump stand point, are more challenging than others.

Whenever the heat source is the outdoor air (low evaporating) and the heat pump has to deliver very high water temperature either for radiators or domestic hot water production, the Copeland Scroll Heating™ ZH compressor is the best choice.



Copeland Scroll Residential & Commercial Line-up



△ Enhanced Vapor Injection models - not available for R134a

● New 40HP Scroll

Summary Based on Seasonal Efficiency Considerations

Air to Water Heat Pumps (A/W)

- Heating optimized Copeland Scrolls (ZH) provide important efficiency improvements for cold and average climates for all water temperature applications (low, medium, high)
- Enhanced Vapour Injection further increases the efficiency heating capacity & operating envelope and therefore is particularly indicated for cold climates and high water temperature heat pumps.
- Standard A/C compressors might be interesting for the warm climate and low water temperature, but the operating envelope limitation might lead to an excessive use of the electrical heater.

Brine to Water (B/W) and Water to Water (W/W)

- Both technologies (heating optimized and standard A/C) are possible envelope-wise, but the heating optimized range features higher efficiency especially for high temperature water applications.

Domestic Hot Water (DHW)

- For cost effective DHW production heating optimized compressors offer the best solution (efficiency and envelope-wise) for all heat pump types (A/W, B/W, W/W).