



# **CARBON DIOXIDE DOMESTIC HOT WATER HEAT PUMP**

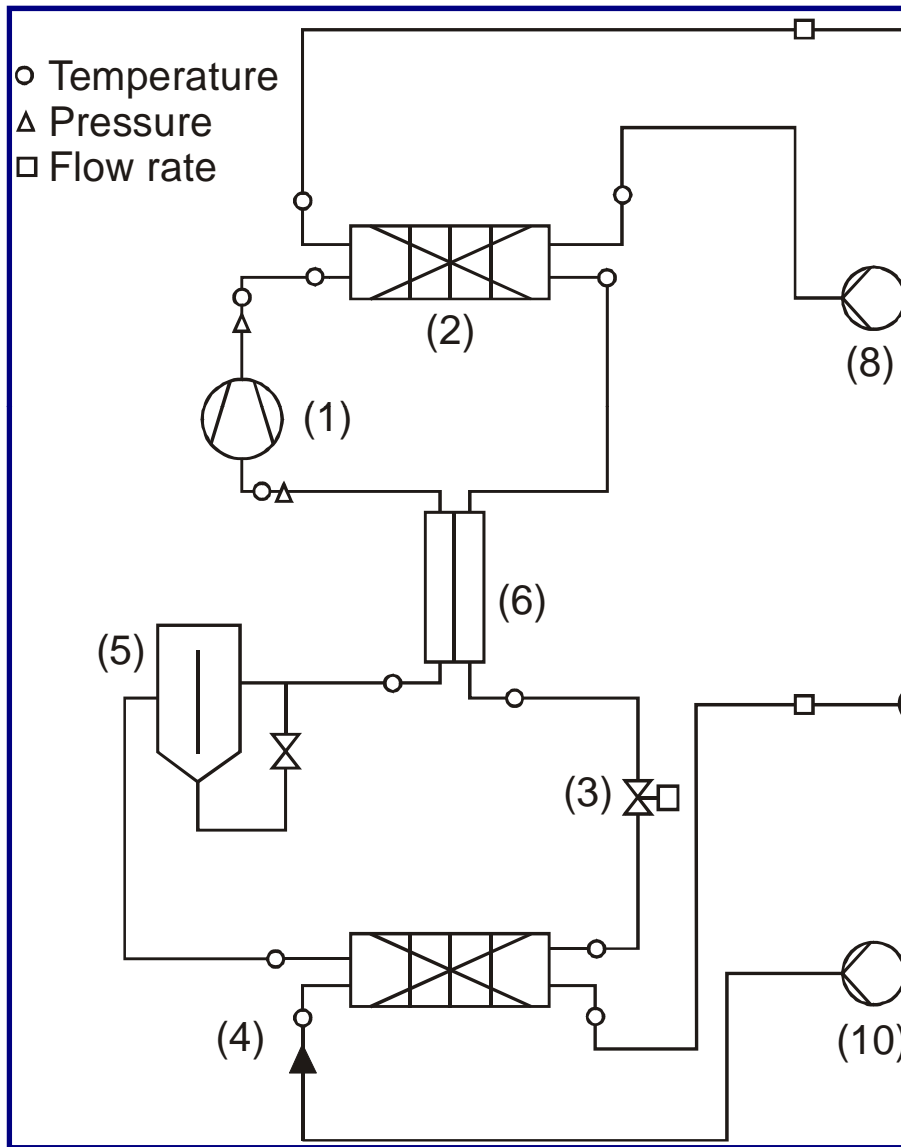
**Sergio Girotto**

Enex S.r.l., Italy  
[sergio.girotto@enex-ref.com](mailto:sergio.girotto@enex-ref.com)

# PROJECT MAIN OBJECTIVES

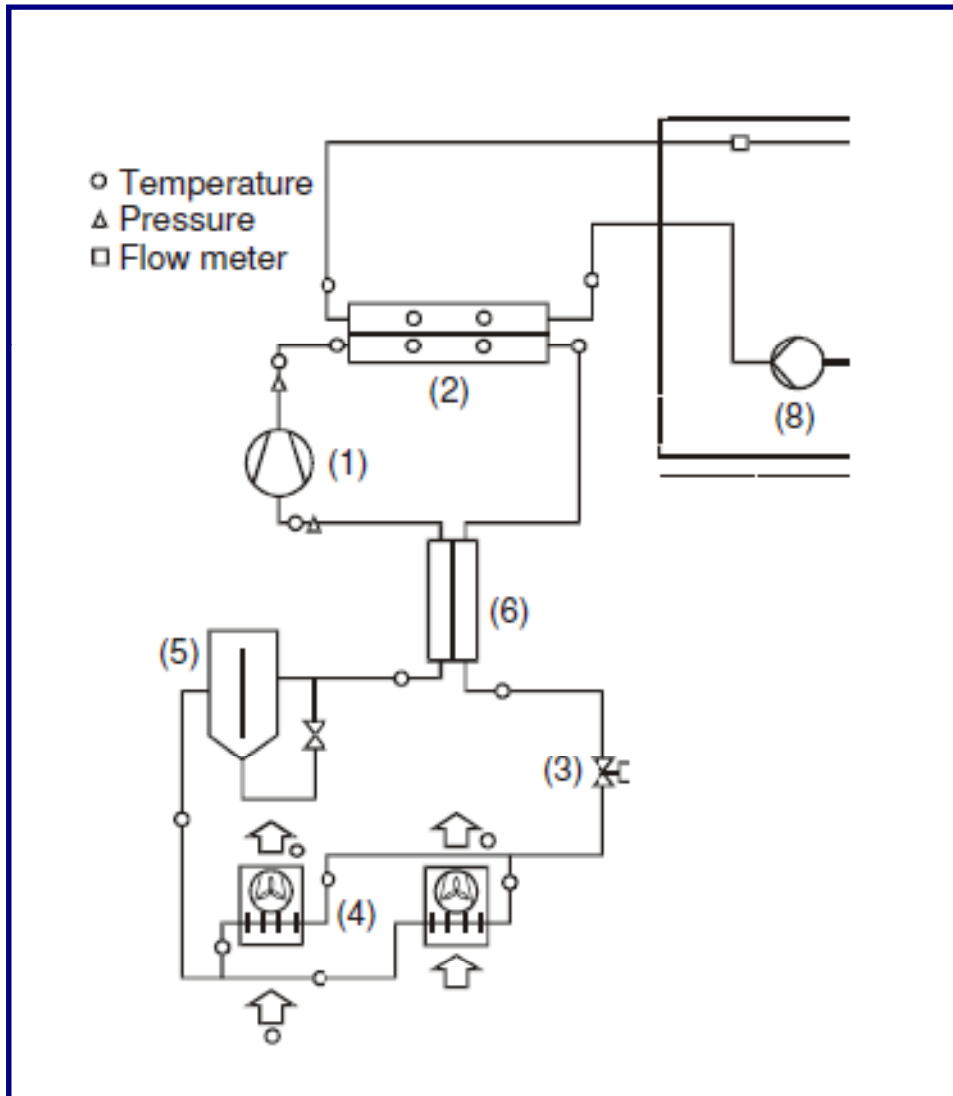
- Design and build an air/water and water/water hot water heat pump;
- Water delivery temperature: 50-80°C;
- Controlled water delivery temperature;
- Optimised performance (best COP at each working condition).

# HEAT PUMP DESIGN (water/water)



- 1 Compressors
- 2 Gas cooler
- 3 Electronic expansion valve
- 4 Evaporator
- 5 LPR
- 6 Internal heat exchanger
- 7 Water tank
- 8 Variable speed pump
- 8 Water tank
- 10 Pump

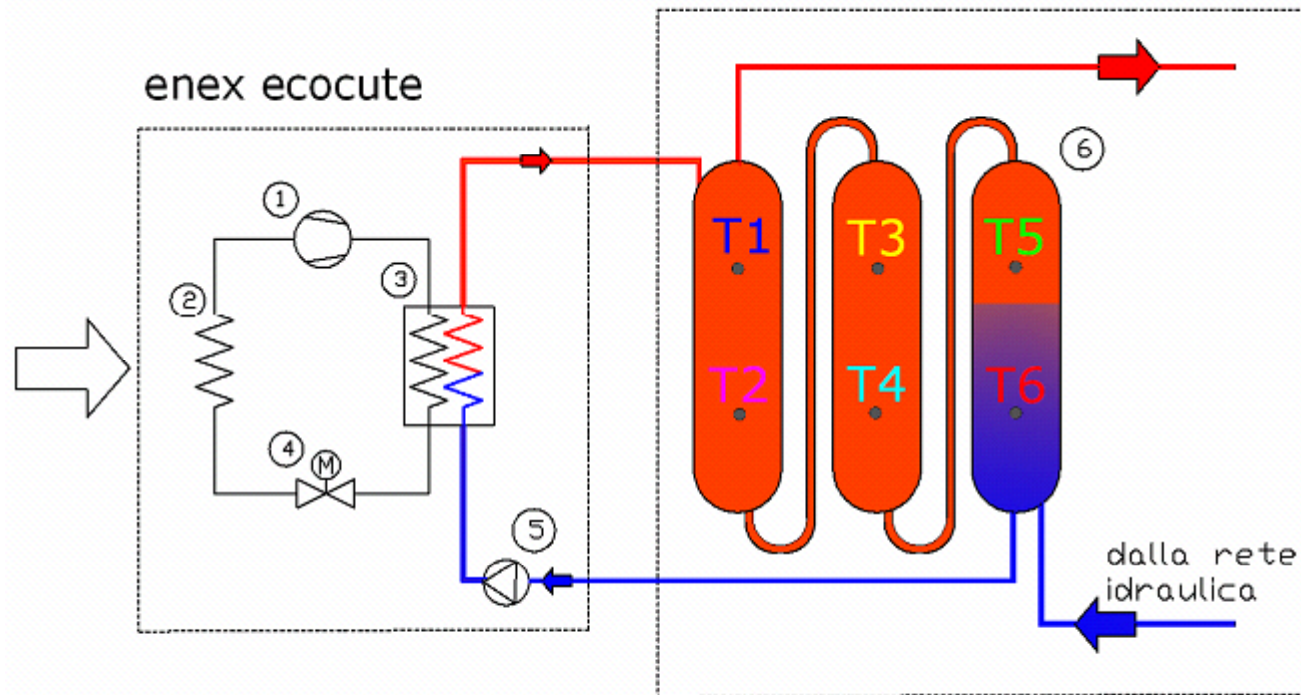
# HEAT PUMP DESIGN (air/water)



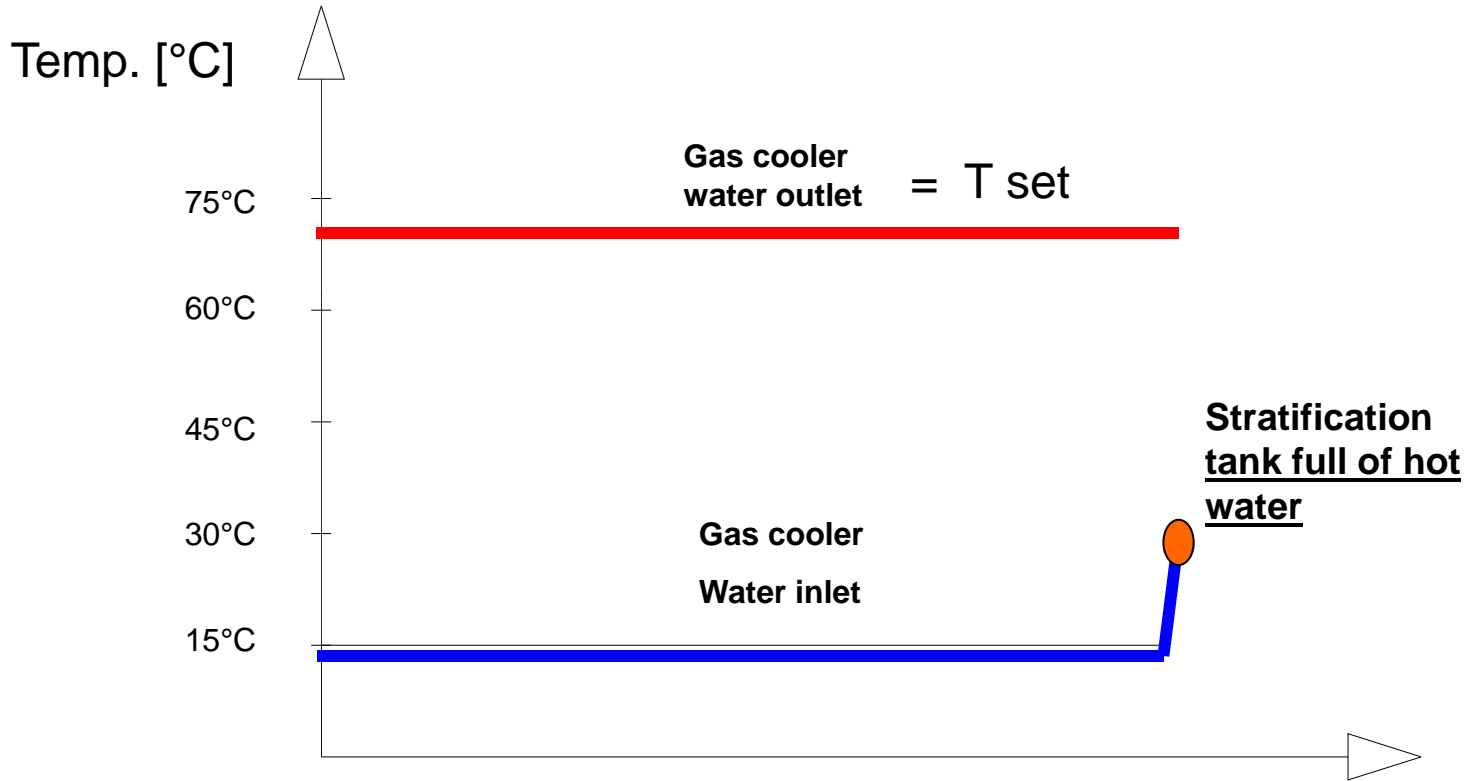
- 1 Compressors
- 2 Gas cooler
- 3 Electronic expansion valve
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- 6 Internal heat exchanger
- 8 Gas cooler variable speed pump

# WATER CIRCUIT DESIGN

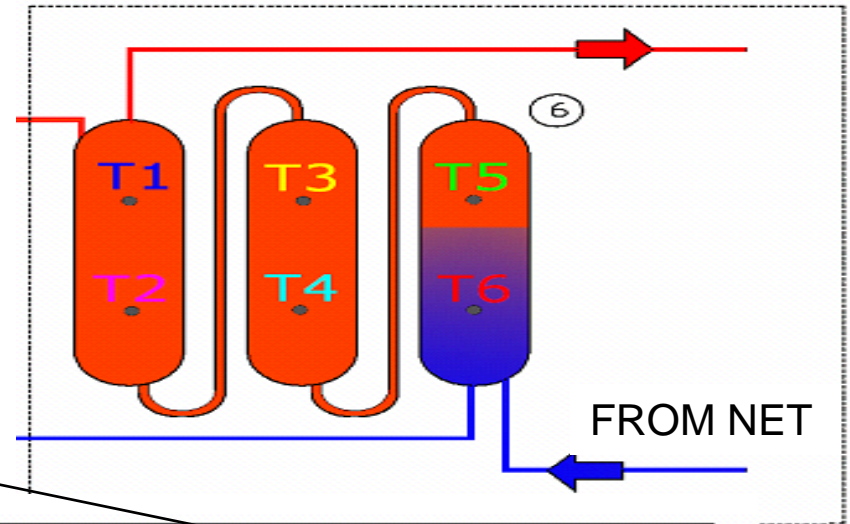
- In transcritical cycles energy efficiency is strongly linked to **the water inlet temperature**;
- the use of **once-through gas cooler** in association with stratification tanks is almost mandatory;
- in this way the best energy performance can be achieved



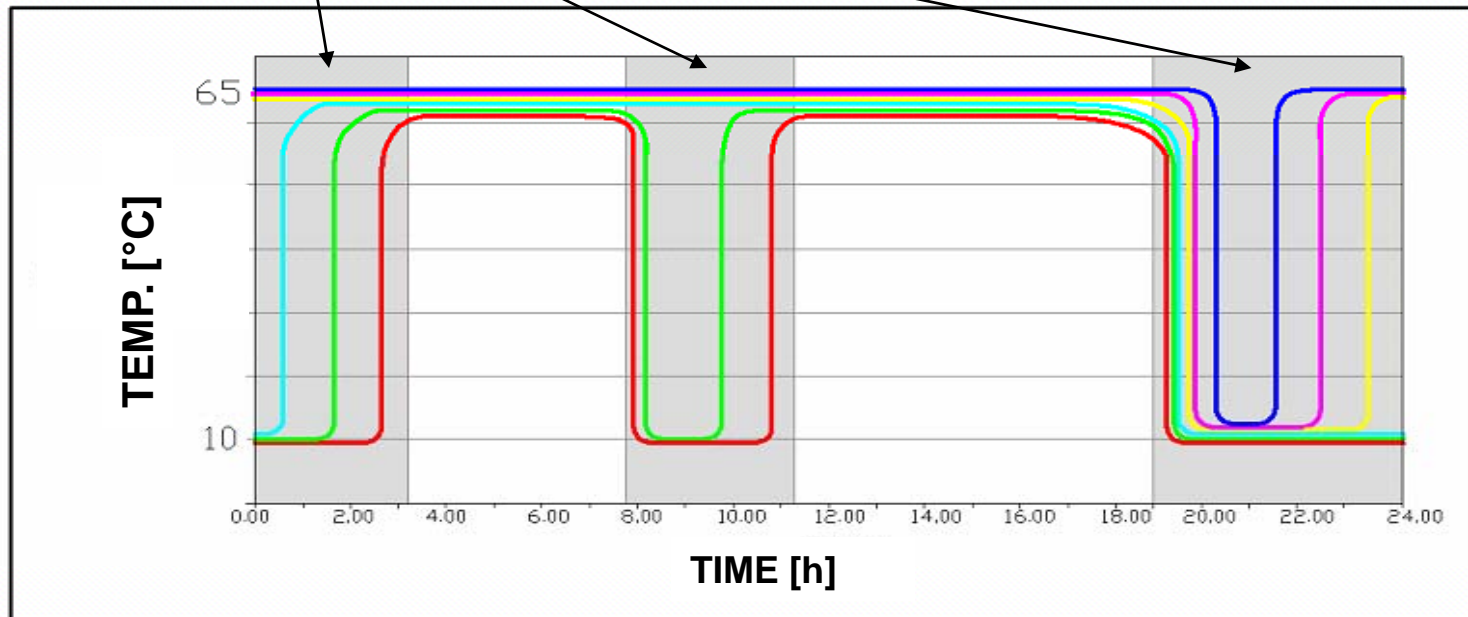
# WATER TEMPERATURE



# WATER TEMPERATURE PROFILES IN THE TANK



COMPRESSOR ON



# HIGH TEMPERATURE WATER STORAGE

- Energy performance is not much influenced by water delivery temperature
- High temperature water storage (70°C -80°C) minimises the storage volume
- High temperature water storage (70°C -80°C) avoids the legionella risks



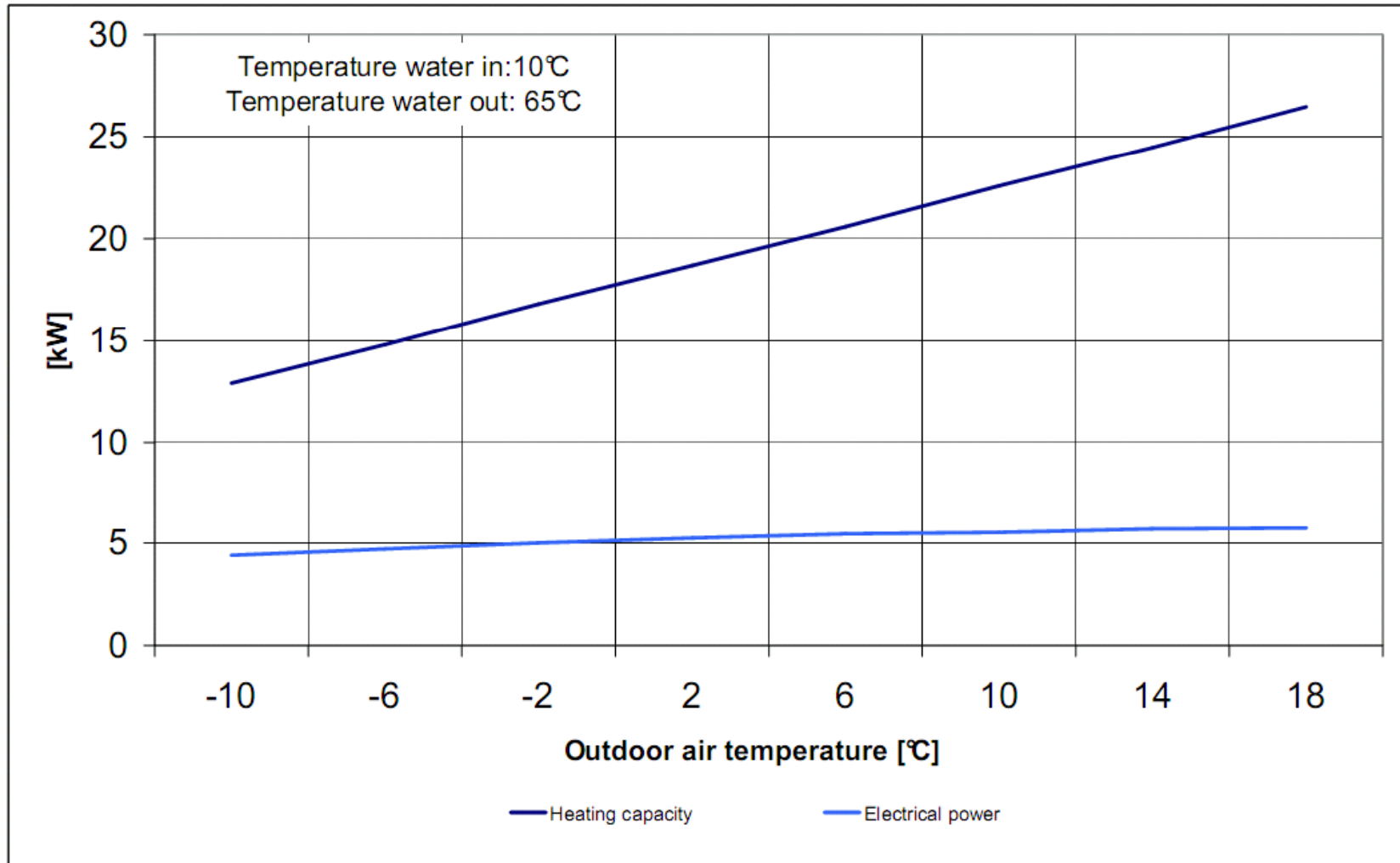
# THE OPTIMAL HIGH PRESSURE

- In a transcritical system the high pressure needs to be optimised;
- The gas cooler water flow rate is to be modulated in order to control the water delivery temperature;
- The water flow rate modulation affects the gas cooler performance;
- Gas cooler outlet temperature results strongly dependent, for given suction conditions, from the pressure and the water flow rate;
- **An adaptative algorithm is needed to find out the optimal high pressure and the water flow rate that result in the best COP for a given water delivery temperature.**

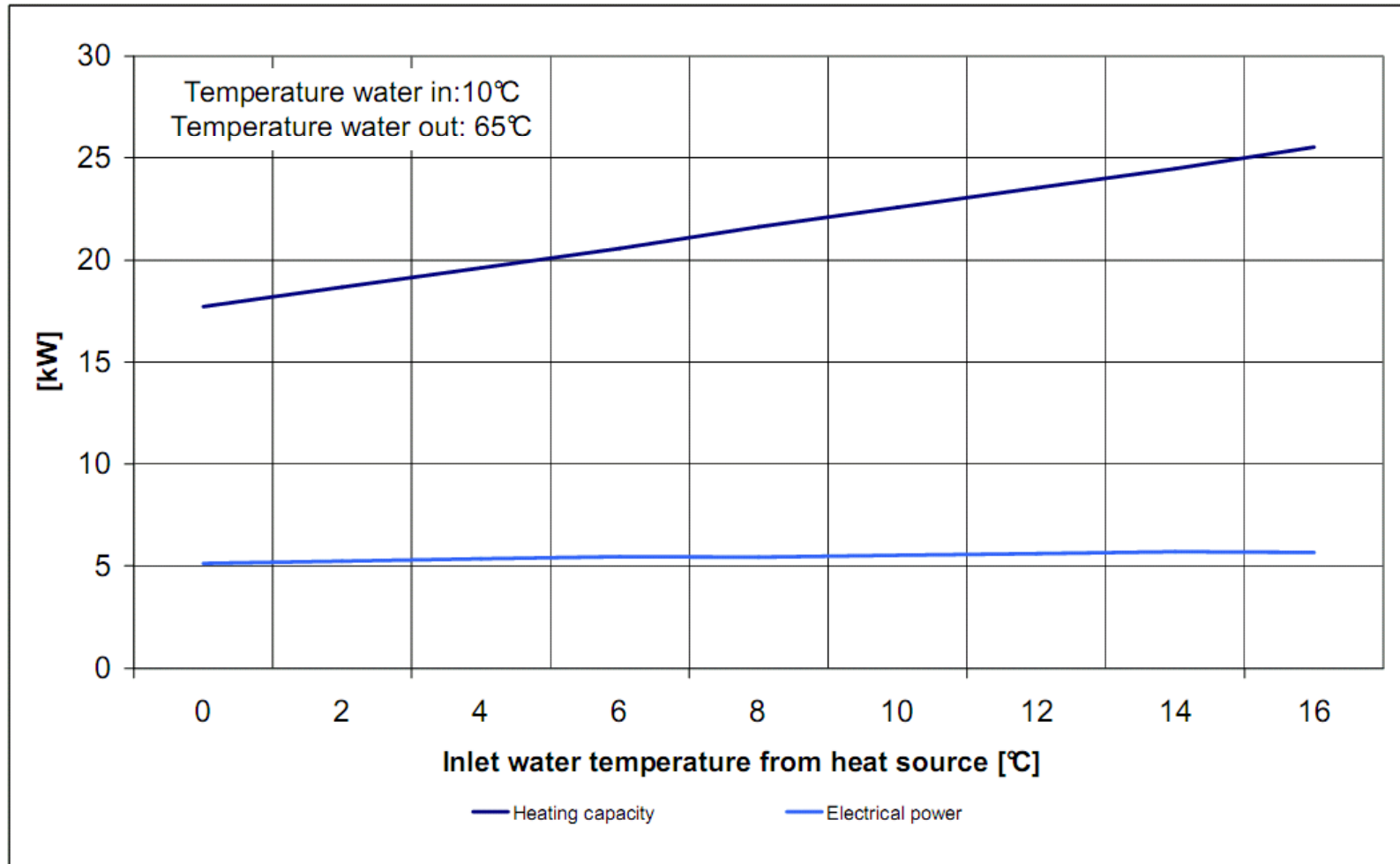
# THE CONTROL LOGIC

- Dedicated logic which controls the water delivery temperature and finds and maintain the optimal pressure:
  - water mass** flow modulated by a PID controller so as to reach and maintain the outlet water temperature at the set-point value;
  - at the same time COP is estimated as a function of the relevant working conditions of the system and the expansion valve setting modified so as to find out and keep the **high pressure** value that, in those conditions, gives the best COP;
- required inputs to real-time calculation of COP: compressor discharge and suction pressures, gas cooler outlet temperature and suction temperature.

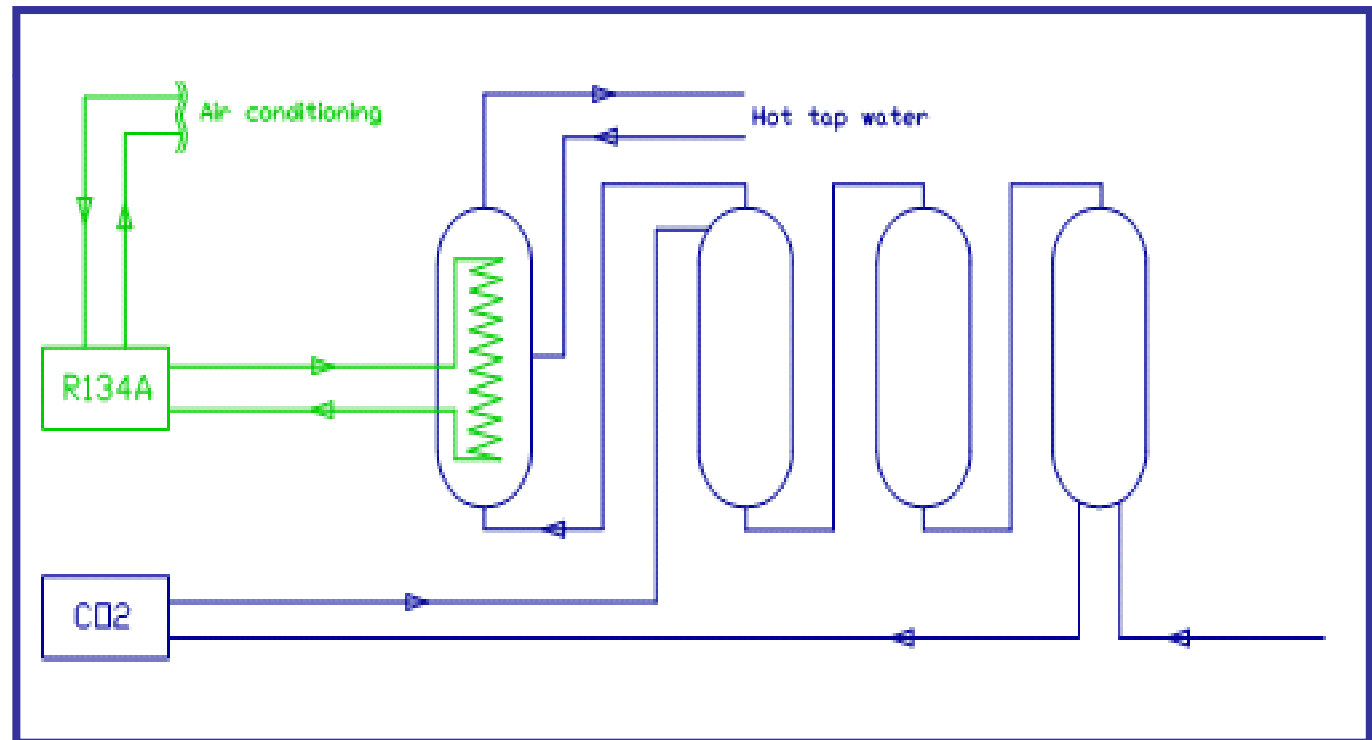
# AIR HEAT PUMP PERFORMANCE



# GEO HEAT PUMP PERFORMANCE



# APPLICATION: RESIDENTIAL BUILDING



# APPLICATION

## **Where to use enEX Heat Pumps ?**

Whenever big quantities of hot water are needed and/or big peaks of absorption are present.

- Restaurants
- Laundries
- Hospitals
- Hotel
- Residential Complex
- Agrifood industry
- Canteens
- Sport Centers
- Gyms

# ENEX Ecocute Air



# ENEX Ecocute Geo





# CONCLUSIONS

- Water/water and air/air hot water heat pump for domestic use is available on the market;
- The heat pump is associated with stratification water tanks;
- Water storage temperature is high (up to 80°C);
- Energy efficiency is high;
- Energy efficiency is high;
- Enex Ecocute is suitable for applications where high quantities of hot water are required (swimming pools, gyms, etc.).

THANK YOU!