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Deliverable D3.1

Mapping of GSHP for cooling and for low and high temperature terminals for heating

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Publishable summary

Deliverable D3.1 “Mapping of GSHP for cooling and for low and high temperature terminals for heating” is a public document delivered in the context of WP3, Task 3.1 “Update of the mapping of the different types of geothermal based Heat Pumps for low and high temperature terminals”. The deliverable presents a market analysis of the most suitable Heat Pump configurations for the retrofit of buildings. Common applications (heating, cooling, Domestic Hot Water, etc.) are considered with their corresponding refrigerant cycles and operating conditions. Possible control strategies are defined. Selection rules to facilitate technology recommendation are drafted, and costs of the different Heat Pump configurations are estimated.

Ground source heat pumps account only for a small fraction of the European heat pumps market, which is dominated by air source heat pumps.

A market survey on GSHP manufacturers, brands and available models was performed. It found 23 manufacturers offering 33 GSHP brands of low capacity (2 to 50 kW_{th}) and 11 GSHP brands of high capacity (above 50 kW_{th}); moreover each brand offers a variety of models. In the low capacity range only scroll compressors are used; the most of models are controlled with an On-Off logic, whilst few models use the soft start-up function. Two brands have two stage compressors, two brands have inverter compressor and one brand has twin compressors. R410A is the most utilized refrigerant, whilst three brands use R407C and one R134a. The low capacity market is almost equally divided among those brands delivering hot water temperature up to 55°C and those with maximum water supply temperature up to 65°C, while there are a few brands delivering hot water up to 70-80°C. Multi scroll compressor heat pumps also dominate the high capacity market, most of which use R410A as refrigerant, but there are few brands using R407C or R134a. There is one brand with inverter scroll, three brands with screw compressors and R134a as refrigerant and one with reciprocating compressor and NH₃ as refrigerant. Most high capacity brands deliver up to 55°C hot water, followed by those delivering hot water up to 65°C, while a few brands deliver hot water up to 70-80°C.

Available control strategies include reversibility, building zone control, remote control, smart grid integration, smart price adaptation, photovoltaic integration, integration of several thermal sources, intelligent energy management, as well as on-off, multi compressors and inverter capacity control.

A 12 kW_{th} air to water heat pump costs around 11 thousand euro, while a geothermal heat pump system of the same capacity costs between 18 and 21,5 thousand euro depending on solution adopted, with a corresponding return on investment after 8 years.

Abbreviations

GEO4CIVHIC	Most Easy, Efficient and Low Cost Geothermal Systems for Retrofitting Civil and Historical Buildings
IEA	International Energy Agency
RAC	Residential Air Conditioning units
PAC	Packaged Air Conditioning units
VRF	Variable Refrigerant Flow air conditioning units
ASHP	Air Source Heat Pump
ATW	Air to Water Heat Pump
NZEB	Nearly Zero Energy Building
DHW	Domestic Hot Water
GSHP	Ground Source (geothermal) Heat Pump
HVAC	Heating, Ventilation, Air Conditioning
HVAC&R	Heating, Ventilation, Air Conditioning and Refrigeration
HFC	HydroFluoroCarbon
CFC	ChloroFluoroCarbon
ASERCOM	Association of European Refrigeration Component Manufacturers
HCFC	HydroChloroFluoroCarbon
HFO	HydroFluoroOlefin
VVR	Variable Volume Ratio
IPLV	Integrated Part Load Value
PV	Photovoltaic
EMS	Intelligent Energy Management System
NBP	Normal Boiling Point
EoS	Equations of State
VRE	Volumetric Refrigerating Efficiency
VHE	Volumetric Heating Efficiency
BLDC	Brushless Direct Current (electric motor)
th	Thermal

Introduction

This deliverable has been prepared in order to identify the most suitable available heat pump configurations in the market and their operating conditions.

For this purpose, mapping of the market available heat pumps for the different applications in the retrofit of buildings was carried out by CRES, CNR-ITC, UNIPD-DII, RGS and GALLETTI, based on their experience in the heat pump sector. TECNALIA and GALLETTI looked at the possible control strategies definition.

Selection rules identified in this document will be implemented in the DSS (Task 4.3) to facilitate technology recommendation, according to the main schemes of plants defined in Task 1.3. Costs of the HP solution (defined by GALLETTI) have also been included to be used in Task 1.4, in the DSS (WP4) and in business models (WP7). The deliverable will be also used for the training activity (WP8).

1. European heat pump market

In this chapter, the EU heat pump market and recent market trends are critically reviewed, based on published information [1], [2], [3], [4]. Ground source heat pumps account only for a small fraction of the European heat pumps market, which is dominated by air to air heat pumps.

1.1 Air-to-air heat pumps

According to the International Energy Agency (IEA), currently there are around 1.6 billion air conditioning units in use globally, which consume more than 1625 TWh electricity each year, while covering only 8% of world population (225 million people) that lives in hot climatic zones. As global population and gross domestic product (GDP) per capita are increasing more and more, the air conditioning market is going to grow very quickly, as well as electricity demand and, therefore, global warming. IEA estimates that the air conditioning market will increase by 200% until 2050. For this reason, the need for high efficiency heat pumps and use of low GWP refrigerants becomes imperative.

On the other hand, the EU economy has been constant for last few years, with recovering buildings retrofit and construction activity in the Southern part of Europe. In addition, favourable regulations have been introduced making obligatory the presence of air conditioning systems inside hospitals and other public buildings, since high death toll has occurred due to heat waves.

1.1.1 Residential Air Conditioners

Cold climate prevails in Europe, whilst cooling demand is much higher in Southern Europe during summer. Market volume of air conditioners in the residential sector is approximately 6 million units annually or 24 GW_{th} of installed capacity, and depend on summer temperature levels, i.e. during hot summers people purchase a higher amount of air conditioning systems. Market penetration amounts at less than 20% overall, but only 1% in central and north Europe.

RAC sales are expected to grow due to the more and more frequent heat waves that are occurring locally during the summer even in Northern Europe. Such heat waves are life threatening in particular to elderly people who live in houses not equipped with air conditioning units. These heat waves cause sudden peaks in demand for RACs, which pose additional challenges to manufacturers to maintain the necessary production rates and inventory volumes, which are needed in order to meet the sales demand and keep their market share.

Two main market segments can be distinguished. The first and larger one, corresponds to low cost and low efficiency units, and geographically covers the east part of Europe. The second one corresponds to highly priced high efficiency units, which dominate the west part of Europe. Small capacity RACs, with capacities less than 5000 BTU/h, or 1.5 kW_{th}, are gaining market share, due to the relatively cool summers compared to Asia and the new regulations and incentives for insulation of the building envelope.

The aesthetics of the RACs are important in Europe, where elegantly designed units have high market share. On the other hand, the market share of smart RACs is limited, despite different trends are prevailing in Asian markets.

The most utilized refrigerant is R410A: it is going to be replaced by lower GWP refrigerants, such as R32, in new models, in order to meet the latest regulations.

1.1.2 Packaged Air Conditioners

Packaged Air Conditioners sales amount to approximately half a million units in Europe each year. Due to their larger capacities, PAC units are mainly installed into commercial buildings. Sales tend to decrease in Italy and Germany but grow elsewhere. Their main advantage is installation flexibility, so they do not need any openings in the walls, as they are equipped with either floor standing units or roof terminals. This is particularly important for historical buildings, which are widespread in many EU member states, especially in Italy.

Main refrigerant used is R410A, but some newly introduced heat pump models use propane. In the latter case refrigerant charge is kept as low as possible, in order to comply with the EU regulations about flammable refrigerants.

1.1.3 Variable Refrigerant Flow air conditioners

Main markets of VRF air conditioners are Turkey, France and UK. They are suitable for large building installations. VRF market is driven by recovering investments of industrial enterprises. It faces declining sales volume due to the HFC limits imposed by EU regulations, as VRFs need large refrigerant charge; however even R32 is not applicable because of its mild flammability. End users may have either to keep existing inefficient systems, or to shift to water/water heat pumps.

The smaller capacity market (12-16 kW_{th}) is covered by mini VRF units, which foster innovations such as variable temperature control in each indoor space (room) according to the building user needs. Mini VRFs, having a market share of 30% of total VRF market, are widespread in large residential and small commercial buildings.

1.2 Air-to-water heat pumps

ATW heat pumps are characterized by air cooled external unit and indoor water distribution system to terminals such as fan-coils or radiant heating system. Their main advantage is that no onsite works are needed to the refrigerant circuit, but only hydraulic connections with the water piping or the air ducts feeding the indoor heating/cooling terminals. This allows high quality installation according to manufacturer's total quality system, very low refrigerant charge and no refrigerant leakages during installation and operation.

1.2.1 Heating and cooling

Due to the severe winters prevailing in Europe, even in the Southern regions, there is a large market for heating, which is mainly covered by fossil fuels (mostly natural gas) and, secondly, by electric heaters. ATW heat pumps capture a small market share estimated as 2% of total heating devices used in Europe, or 1/20 of boilers sold annually. ATW heat pump sales are higher in countries where heating is dominated by electric resistors such as France and Sweden, rather than in countries where natural gas is the main fuel used for heating.

ATW heat pumps are mainly installed in new buildings thanks to recently introduced European regulations on energy efficient buildings. They are installed in more than 80% of new buildings in Sweden and Switzerland each year and in approximately 40% of new buildings in France and Germany. Their market share is expected to increase further after 2020, when all new buildings will have to be NZEB. One type of ATW heat pumps is the exhaust air heat pump (also available and as an air-to-air heat pump but will less market share), which dominates the market of Sweden and is gaining market share in Scandinavia and UK.

1.2.2 Domestic hot water

With a fast growing market that has reached 130.000 units annually, most of which (65%) are sold mainly in France, both domestic and commercial hot water heat pumps are promising market segments, as they have captured only 3% of total sales of hot water boilers. Japanese products using CO₂ as refrigerant keep trying to enter the DHW market segment, but they are bound by the high costs attributed to the very high pressure needed at the CO₂ refrigerant circuit.

1.2.3 Commercial hot water

Large hot water quantities are needed in the commercial sector. ATW heat pumps gain market share replacing electric and diesel oil boilers in large apartment buildings, hotels, restaurants, sport facilities, hairdressers and hospitals providing both hot water and space heating. Use of CO₂ as refrigerant leads to high COP in sanitary hot water heat pump applications due to the high temperature difference encountered at the hot water circuit (from 10-15 °C to 80-90 °C or higher). Therefore such products are expected to gain market share in the near future, before new synthetic refrigerants take over.

1.3 Ground source heat pumps

With around 90000 units sold annually in Europe, GSHPs market has been stagnant during the last few years. The main market barriers encountered by GSHP diffusion are, firstly, the high initial cost for the installation of the ground heat exchangers and, secondly, the procedures needed to obtain the necessary permits in some countries. They cover the whole capacity range from small dwelling applications to large commercial, industrial and district heating systems.

Top GSHP markets are Sweden, where approximately 23000 units are sold annually and the market is self-sustained without any subsidies, Germany, where the market of 23000 units sold

annually is stimulated by subsidies, and Finland, where GSHPs account of 70% of overall heat pump market and 53% of new buildings.

1.4 Recent trends

Most of present HVAC and heat pump products must be redesigned, in order to comply with the new regulations for HFC refrigerants. Therefore significant technological and product changes must be met by the industry. This process needs a lot of resources in terms of training the service, repair and maintenance personnel in order to work with the new refrigerants. Furthermore the mild flammability of the new refrigerants makes more difficult the change from HFCs if compared with the past transition from CFCs to HFCs.

The continuous evolution of the market and the uncertainties for the future regulations towards a reduction of the overall GWP of the refrigerants – e.g. which market segments will be affected and how - forces the industry to keep stock inventories to minimum levels.

1.4.1 Energy efficiency improvements

The legal and regulatory framework recently introduced in Europe in the framework of Ecodesign Directive, Energy Labelling Directive and the transition to low GWP refrigerants leads to the need of efficient and environmentally friendly heating and cooling units, stimulating the use of renewable energy systems such as heat pumps.

Among regulations introduced in Europe concerning energy efficiency of heating and cooling system, it is worth mentioning the Renewable Heating Initiative in UK. Furthermore, energy consumption requirements for new buildings and tax refunds has been introduced in France and very high direct subsidies are offered in Germany.

All sectors of the economy have been affected, and heat pump manufacturers have improved their market offer according to, or even exceeding, the minimum energy efficiency and environmental requirements.

1.4.2 New refrigerants

Air conditioning industry

According to Paris agreement, European Union enforced quota on HFC refrigerants, with the objective to reduce their use in the next 15 years down to the 1/5 of their 2014 market volume. The enforcement of this quota, which affects all HVAC and refrigeration industries, including ATW heat pumps and GSHPs, resulted in rising prices of mainstream HFCs, such as R410A and R134a, forcing the manufacturers to seek alternative low GWP options.

The short term selection for the RAC industry has been the HFC R32, which is characterised by GWP equal to 1/3 of R410A and 1/4 of the corresponding refrigerant charge for the same heating or cooling effect. R32 units have been introduced in EU market in 2016 and now dominate the RAC market segment. All major manufacturers include R32 RACs in their product portfolio.

As R32 is a mildly flammable refrigerant, its use in closed and populated places is bound by refrigerant charge limits and is limited to PACs and small capacity ATW heat pumps. For this reason, the adoption of R32 in PACs, which are characterised by larger capacity, is not widespread.

The use of natural refrigerants such as ammonia and water, which are characterized by GWP equal to zero and very efficient cycle, are limited to large commercial or industrial applications. The same applies to the use of CO₂ heat pumps for hot water production.

Refrigeration industry

The objective of the refrigeration industry is the replacement of existing high GWP refrigerants, such as R404A and R134a, with new alternative lower GWP ones. Replacement of R134a is also relevant to the heat pumps industry, as it is widespread in large capacity heat pumps, also in high temperature heat pumps and has also been adopted by few small capacity products.

For this purpose ASERCOM association established a working group which evaluated different refrigerant options for replacing the currently used high GWP refrigerants. Some alternative options are described below.

- Natural refrigerants are always an option. Most common ones are propane, butane, isobutane, ammonia, CO₂, water and propylene.
- Replacement options for R404A and R507A:
 - Non-flammable replacements, which have a GWP approaching 4000, are R448A, R449A, R452A, R452C, R460A and R460C, which GWP lies in the range 1400-2200.
 - Mildly-flammable (A2L) replacements are R454A, R454C, R455A, R457A, R459B, which have GWP between 140-300.
 - Abovementioned refrigerants are characterised by high compressor discharge temperature and high temperature glide, therefore the corresponding refrigeration cycle must be re-engineered.
- Replacement options for R134a are
 - Non-flammable replacements, which GWP is equal to 1430, are R450A, R456A, R513A and R515B, which GWP is in the range 300-700.
 - Mildly-flammable (A2L) replacements are R1234yf, R1234ze(E), R444A and R516A, which GWP is in the range 4-150.
 - New refrigerants are characterised by somewhat reduced refrigerating capacity
 - R513A has been widely adopted for centrifugal and screw compressors of large capacity in markets with strict flammability regulations
 - R1234ze(E) has been widely adopted for centrifugal and screw compressors in EU, where the focus is on GWP
- New developments also include HFO refrigerants R1234ZE and R1233ZD(E), which are characterized by low pressure, high energy performance, relatively high boiling point

and critical temperature and flammability rating between A1 and A2L. They have been developed as a replacement of the HCFC R123 in those global markets where it is still in use.

New standards

The European standard EN378 “Refrigerating systems and heat pumps - Safety and environmental requirements” was revised in order to align with ISO5149 international safety standard. New items included the introduction of an additional flammability class 2L to refrigerant classification, the addition of two new alternative methods of refrigerant charge calculation, as well as informative annexes covering stress corrosion cracking, leak simulation, commissioning and ignition sources.

Standards IEC60335-2-40:2018 “Household and similar electrical appliances - Safety - Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers” and IEC60335-2-89:2019 “Household and similar electrical appliances - Safety - Part 2-89: Particular requirements for commercial refrigerating appliances and ice-makers with an incorporated or remote refrigerant unit or motor-compressor” were issued adding new requirements for mildly-flammable and flammable refrigerants and CO₂ refrigerant pressure tests.

Commission Regulation (EU) 2016/2281 of 30 November 2016 has been enforced implementing Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the setting of Ecodesign requirements for energy-related products, including air heating products, cooling products, high temperature process chillers and fan coil units. In addition, Ecodesign regulations on motors and drives, fans and circulators have been under review forcing the industry to re-engineer their products and introducing market uncertainty for the future.

Final remarks

Due to the continuous changes imposed to the external market environment it seems prudent when changing refrigerants to select the lowest GWP option, considering also flammability and safety matters, heat pump reengineering to account for temperature glide, discharge temperature control, heating-cooling capacity and overall energy efficiency.

1.4.3 Compressors

ATW heat pumps operate under severe boundary conditions compared to air conditioning units, in terms of external temperature and hot water supply temperature. Indeed fan coil units supply temperature is usually set at 45°C, whereas high temperature terminals are supplied with water at 55°C or above. These adverse boundary conditions impose additional load to the compressor in terms of defrosting cycles, operating pressure levels and reliability. For this reason, ATW heat pumps need specially designed compressors in order to ensure high energy efficiency and long service life.

All compressor types can be used in heat pump units. The different compressor types and their market volumes are presented in the Table 1. Manufacturers offer diversified compressors product range of wide capacity and applications range. Although each compressor type traditionally addressed specific market segments, today there is a lot of overlapping. In addition,

each manufacturer tends to provide more than one type of compressor, even if the scroll technology is becoming more and more widespread.

Table 1: Available compressor types and their global sales

Compressor type	Market Volume (million units sold each year)
Reciprocating	500
Rotary	195
Scroll	15
Screw	100
Centrifugal	20

Reciprocating

Reciprocating compressors dominate the small capacity refrigeration market (below 30 hp), with subcritical CO₂ compressors, and semi hermetic ones being the main technology used.

Rotary

Rotary compressors dominate the market of heat pump dryers and the most of the production is located in Poland, but are also used in RACs, refrigerators and ATW heat pumps. Their annual sales in Europe amount to around 3 million units. Leading suppliers are Rechi, GMCC, Shangai Highly, LG and Bosch.

As the demand for high efficiency is increasing more and more, inverter rotary compressors are gaining market share. In the segments of PACs, VRF, small chillers and ATW heat pumps competitive inverter twin rotary units of larger capacity have been introduced. New inverters are now able to operate under very low load conditions, improving energy saving. New heat pump controllers are also available.

Due to the ongoing adoption of low GWP refrigerants, compressor manufacturers are developing rotary compressors suitable for propane, CO₂ and HFOs.

Apart from improved energy efficiency, recent trends for rotary compressor technology are reducing size, increasing capacity especially for heating in cold climates and use of DC inverters. Increased capacity of rotary compressors is directed by recent trends of domestic air conditioning manufacturers to enter the market of commercial applications, where profits are higher. This has resulted in an increase of rotary compressors capacity range up to 20 hp. Technology evolution is taking place fast leading to new and more efficient products introduced every year.

Scroll

Overall market of scroll compressors in Europe amounts to 1.28 million units sold annually and is decreasing slowly. On the other hand, the demand of small capacity scroll compressors for heat pumps, RACs and PACs is growing each year. Scroll compressors are also present in the

refrigeration market and dominate the market of medium capacity commercial air conditioners. Recently, they have also captured a market share in large capacity heat pumps and chillers.

Emerson is the market leader offering a wide product range of Copeland Scroll Compressors. Other important scroll compressor manufacturers are Danfoss, Panasonic and Mitsubishi Electric. All compressor manufacturers redesign their product portfolio for use with the new alternative low GWP refrigerants, taking into account of the mild flammability (A2L and A3 classes).

Screw

In order to improve the efficiency of variable speed screw compressors for partial loads, a variable volume ratio (VVR) system has been introduced by some manufacturers. The VVR system continuously optimizes discharge pressures according to operating conditions by moving a set of sliding valves. This leads to reduce friction drag and eliminate bypass flow losses between the rotors, improving energy efficiency at off-peak conditions. Latest VVR variable speed screw compressor technology achieves COP values as high as 6.68 at nominal conditions and IPLV (SCOP at standard variable load conditions) of 10.77, which are comparable to latest centrifugal compressor technology.

Centrifugal

Centrifugal compressors are the main technology used in very large capacity chillers (more than 300 hp), and recently new products of smaller capacity (100-300 hp) have become available competing screw compressors.

Recent technology trends include oil free operation with magnetic, ceramic or gas bearings, leading to maximum motor efficiency, minimal maintenance needs and low operation cost.

Inverter controller

Inverters are more and more used in order to increase heat pump efficiency at partial load conditions. They are offered either separately from or integrated with the compressor. Initially they were coupled to rotary compressors, then they were added to scroll ones and now they are offered for all compressor types.

1.4.4 Smaller capacity

As more and more strict regulations on building envelope insulation are enforced in EU, the heating and cooling needs of buildings has been reduced significantly. A typical building usually needed a 16 kW_{th} heat pump for heating, whilst a new building insulated according to new regulations would need only a 5-8 kW_{th} heat pump to cover its heating needs. The result has been a rising demand for heat pumps of smaller capacities and new ATW heat pumps of small capacity have been released into the market.

1.4.5 ATW Heat Pumps for very cold climates

One of recent development of ATW heat pumps includes models targeting the market segment of very cold climates, such as the Scandinavian countries, where only ground source heat pumps could be used. These ATW heat pumps can function in extreme ambient temperatures,

e.g. as low as -25°C , while they are able to maintain satisfactory energy efficiency levels in temperatures as low as -15°C . They use two stage rotary compressors and can deliver hot water up to 70°C . In order to achieve smooth operation at extreme temperatures advanced defrosting technologies are adopted, such as using subcooling energy stored in PCM for reverse cycle defrosting, hot gas bypass defrosting or electrical resistor heating defrosting. Other advanced technology used is the Flash Injection Circuit, which ensures sufficient refrigerant flow to the compressor in extreme evaporation temperatures.

For external temperatures lower than -25°C ATW heat pumps may be coupled with a gas condensing boiler. Such system is equipped with a smart controlling unit, which gives priority to heat pump heating when external temperature exceeds 5°C and turns on the gas boiler at lower temperatures. Alternative controls are also available taking into account electricity costs, gas prices, ambient temperature and building or hot water needs.

1.4.6 Photovoltaic coupling

In order to be aligned with the concept of nearly zero energy buildings, heat pump manufacturers have released into the market ATW heat pumps with integrated photovoltaic panels. Their integrated controls allow the maximization of renewable energy use, by modulating the heat pump output according to the electricity generation from the PVs and the heating/cooling requirements of the building.

1.4.7 Compact units

In order to reduce installation time, space requirements, installation costs and maintenance needs, compact ATW heat pump models supplying heating, cooling and hot water, all in the same indoor unit, have been developed.

1.4.8 Noise

With more and more strict noise regulations being enforced, especially in Germany and other countries of central Europe, heat pump manufacturers have focused in developing low noise emitting units, especially for the outdoor part of the system. Noise levels are more important in cold climates, as the heat pump compressor operates at maximum power to overcome the low external temperatures. For this purpose new silent compressors and fans have been developed.

2. Market offer of GSHPs

A market survey on GSHP manufacturers, brands and available models was performed, which is summarised in this chapter. Following an internet survey, 34 heat pump manufacturers were contacted, of which 23 offer GSHP models.

For data processing purposes, the models were divided into two categories. The first category includes GSHPs with capacity range from 2 to 50 kW_{th} and the second category includes GSHPs with capacity range over 50 kW_{th}.

2.1 GSHPs with capacity range 2 – 50 kW_{th}

As mentioned in the previous paragraph, data have been collected from 23 manufacturers. Among them, 20 manufacturers sell models with capacity range from 2 to 50 kW_{th}, which are presented in Table 2.

Table 2: GSHP manufactures and models with capacity range 2-50 kW_{th}.

Manufacturer	Models
Stiebel Eltron	WPC (04, 05, 07, 10, 13) cool
	WPC (04, 05, 07, 10, 13) S
	WPC (04, 05, 07, 10, 13)
	WPF (05, 07, 10, 13, 16) basic
	WPF (04, 05, 07, 10, 13, 16) cool
	WPF (05, 07, 10,) S basic
	WPF (05, 07, 10, 13)
	WPF (04, 05, 07, 10, 13,16)
	WPW (07, 10, 13, 18, 22)
	WPW (06, 07, 10, 13, 18, 22)
Viessmann	Vitocal 200-G - BWC 201.(A06, A08, A10, A13, A17)
	Vitocal 222-G- BWT 221.(A06, A08, A010)
	Vitocal 242-G- BWT 241. .(A06, A08, A010)
	Vitocal 200-G-301.(B06, B08, B10,B13, B17)
	Vitocal 350-G- BW 351.(B20, B27, B33, B42)
Bosch (Buderus)	9 Rm, 12 Rm, 16R, 20 R, 23R, 33R

Bosch (IVT)	C6, C7/E7, C9/E9, C11/E11
	C7, C9/E9, C11/E11, E14, E17
Bosch (MTA)	HOCEAN Tech-018, 022, 0,30,040, 050, 070, 100, 130, 150
VAILLANT	geoTHERM plus - VWS 62/3, VWS 82/3, VWS 102/3, VWS 62/2, VWS 82/2, VWS 102/2
	geoTHERM - VWS 61/3, VWS 81/3, VWS 101/3, VWS 141/3, VWS 171/3, VWS 61/2, VWS 81/2, VWS 101/2, VWS 141/2, VWS 171/2, VWS 220/2, VWS 300/2, VWS 380/2, VWS 460/2
NIBE	F1145-5, F1145-6, F1145-8, F1145-10, F1145-12, F1145-15, F1145-17, F1145-5 PC, F1145-6 PC, F1145-8 PC, F1145-10PC, F1155-6, F1155-12, F1155-16, F1155-6PC
	F1245-5, F1245-6, F1245-8, F1245-10, F1245-12, F1245-5 PC, F1245-6 PC, F1245-8 PC, F1245-10PC, F1255-6, F1255-12, F1255-16, F1255-6PC, F1345-24, F1345-30, F1345-40, F1345-60
BAXI	GEOFLO 4, 6, 8, 10
Aermec	VENICE 20, 25, 30
	WRL 026, 031, 041, 051, 071, 081, 101, 141, 161)
	WRL ABP 026, 031, 041, 051, 071, 081, 101, 141, 161
CLIMAVENETA	BWR MTD2 0011, 0025, 0031, 0041, 0061, 0071, 0091, 0101, 0121
	NX-WN 0122, 0152
CLIVET	WSHN-EE 17, 21, 31, 41, 51, 61, 71, 81, 91, 101, 121
	WSHN-XEE2 10.2, 12.2, 14.2
Galletti	MCW 005M, 005, 007M, 007, 010M, 010, 012, 015, 018, 020, 022, 027, 031,039
RHoss	TCEEY 250, 260
	TCEEY 115,118, 122, 125, 230, 240
	THHEY 105, 107, 109, 112, 115, 118,122, 125, 230, 240, 245, 250
BLUE BOX	Core & Core Max 7M, 9M, 10M, 11M, 14M, 18M, 7, 9, 10, 11, 14, 18, 19, 22, 25, 27, 32, 37, 43, 50

	Mu Echos A 6, 8, 11, 16, 19, 22, 24, 28, 32, 35, 42, 48
	Mu Echos A LC 6, 8, 11, 16, 19, 22, 24, 28, 32, 35, 42, 48
	Mu Echos A LE 6, 8, 11, 16, 19, 22, 24, 28, 32, 35, 42, 48
CIAT	DYNACIAT ILG 120V, 150V
	DYNACIAT LG 80A, 90A, 100A, 120A, 130A
	GEOCIAT 18H, 20H, 33H, 45H, 45HT, 50H, 50HT, 65HT, 90HT, 120HT Modular, Power, Access
De Dietrich	GSHP
	GSHP B200 GHL
	GSHP B200 GSHL
	GSHP V200 GHL
	GSHP V200 GSHL
DAIKIN	WRA-036, 048, 060, 072, 120, 150
Mitsubishi Electric	CRHV-P600YA-HPB 45
	PQRY-P ...YLM-A-200, 250, 300, 350, 400
DIMPLEX	SIH... ME/TE/TU-6, 9, 11, 20TE, 90ME
	SI... ME 5, 7, 9, 11, 14
	SIK 11, 16ME
	WI9ME, WI14ME
	SI MER 10
	SI...TU-6, 8, 11, 14, 18, 22, 26, 35, 50, 75, 90
	SIK...TE 6, 8, 11, 14
	SIW...TE
	WI...TU 10, 14, 18, 22, 35, 45, 65
CARRIER	GW Hydronic 024, 036, 048, 060, 120, 072
B Cool	GEO 008, 010, 015, 020, 030, 040, 050
ROTEX	RGSQH10S18AA9W

2.1.1 Technology

Most of manufacturers divide the GSHPs into two technological categories. One category is brine to water and the other is water to water. Some brine to water models can also be used for free cooling. The brine to water GSHPs are used for closed loop systems, both horizontal and vertical. The water to water GSHPs are used for open loop system. Table 3 presents the amounts of brine to water models and water to water models sold by each manufacturer.

Table 3: Amounts of brine to water and water to water GSHP models

Manufacturer	Number of Models with brine to water technology	Number of Models with water to water technology
Stiebel Eltron	8	2
Viessmann	5	1
Bosch (Buderus)	0	1
Bosch (IVT)	2	0
Bosch (MTA)	0	3
VAILLANT	2	0
NIBE	3	0
BAXI	1	0
Aermec	0	9
CLIMAVENETA	1	1
CLIVET	0	3
Galletti	0	2
RHoss	0	5
BLUE BOX	0	4
CIAT	0	6
De Dietrich	0	5
DAIKIN	0	1
Mitsubishi Electric	1	3
DIMPLEX	8	2
CARRIER	1	1
B Cool	0	1
ROTEX	1	0

Depending on the technology used, the operating temperatures are different, as well as the performance (COP / EER) of GSHPs. Table 4 presents COP average values per manufacturer.

Table 4: COP average values per GSHP product range at nominal conditions.

Manufacturer		Nominal COP	Earth Loop Inlet/Outlet temperature (°C)	Inside Loop Inlet/Outlet temperature (°C)
Stiebel Eltron		4,76 (EN14511)	0/-3	30/35
		5,95 (EN14511)	10/7	30/35
Viessmann		4,75 (EN14511)	0/-3	30/35
		5,95 (EN14511)	10/7	30/35
Bosch	Buderus	4,47	0/-3	35/40
	IVT	3,98 (EN14511)	0/-3	30/35
	MTA	3,54	12/7	40/45
Vaillant		4,70 (EN 14511)	0/-3	30/35
Nibe		5,13 (EN 14511)	0/-3	30/35
Baxi		4,00 (EN 14511)	0/-3	30/35
Aermec		3,39	10/7	40/45
		4,10	10/7	40/45
Climaveneta		3,31	0/-3	40/45
Clivet		4,00	10/7	40/45
Galletti		3,20	10/7	40/45
Rhoss		3,93	12/7	30/35
Blue Box		4,20	10/7	40/45

Table 4: (continued)

Manufacturer		Nominal COP	Earth Loop Inlet/Outlet temperature (°C)	Inside Loop Inlet/Outlet temperature (°C)
CIAT	GEOCIAT Modular	4,55	0/-3	30/35
		3,55	0/-3	40/55
		2,91	0/-3	47/55
		6,00	10/7	30/55
		6 to 9 kW _(th)		
CIAT	GEOCIAT Power	4,24	0/-3	30/35
		3,32	0/-3	40/45
		12,5 to 27 kW _(th)		
	GEOCIAT Access	4,16	0/-3	30/35
		4,6 kW _(th)		
CIAT	DYNACIAT	5,51	10/7	30/35
	DYNACIAT ILGT	4,00	10/7	40/45
		38 to 100 kW _(th)		
De Dietrich		5,15	10/7	30/35
Daikin		2,95	0/-3	35/40
Mitsubishi Electric	CRHV-P600YA-HPB	5,11	12/7	30/35
	PQRY-P YLM-A	6,10 (Indoor 20 °C D.B., water temperature 20 °C)		
Dimplex	SIH ME	3,45	0/-3	40/45
	SI/SIK/WI	3,10	0/-3	40/45
	SI TUR	2,83	0/-3	50/55
	WI...TU	4,56	10/7	40/45
	SI MER	3,72	0/-3	40/45
Toshiba Carrier		4,30	0/-3	30/35
BCool		5,85	15/12	40/45
ROTEX		4,35	0/-3	30/35

2.1.2 Field of application

Heat pump manufacturers divide GSHPs into four categories according to the field application. The four categories are heating/Domestic Hot Water (DHW), heating/cooling, heating/cooling/DHW and heating/DHW/free cooling.

Table 5: number of heat pump models per field of application.

Manufacturer	Heating/ DHW	Heating/ Cooling	Heating/ Cool- ing/ DHW	Heating/ DHW/ free cooling
Stiebel Eltron	0	0	0	10
Viessmann	6	0	0	0
Bosch (Buderus)	0	0	1	0
Bosch (IVT)	2	0	0	0
Bosch (MTA)	0	3	0	0
VAILLANT	0	0	0	2
NIBE	1	0	0	4
BAXI	1	0	0	0
Aermec	0	9	0	0
CLIMAVENETA	0	0	2	0
CLIVET	0	0	3	0
Galletti	0	0	2	0
RHoss	0	1 model for heating & cooling and 4 models only cooling	0	0
BLUE BOX	0	0	4	0
CIAT	1 only heating	1 model only cooling, 1 heating/cooling	3	0
De Dietrich	5	0	0	0
DAIKIN	0	0	1	0
Mitsubishi Electric	2 models only heating	2	0	0

Table 5: (continued)

Manufacturer	Heating/ DHW	Heating/ Cooling	Heating/ Cooling/ DHW	Heating/ DHW/ free cooling
DIMPLEX	8	0	2	0
CARRIER	0	0	1	0
B Cool	0	1	0	0
ROTEX	0	1	0	0

2.1.3 Refrigerants used

The refrigerants used in 2-50 kW_{th} GSHPs capacity range are R410A, R407C and R134a. Figure 1 presents the distribution of refrigerants in EU GSHPs market. 29 GSHPs brands use R401A, 3 brands R407C and 1 brand R1234a.

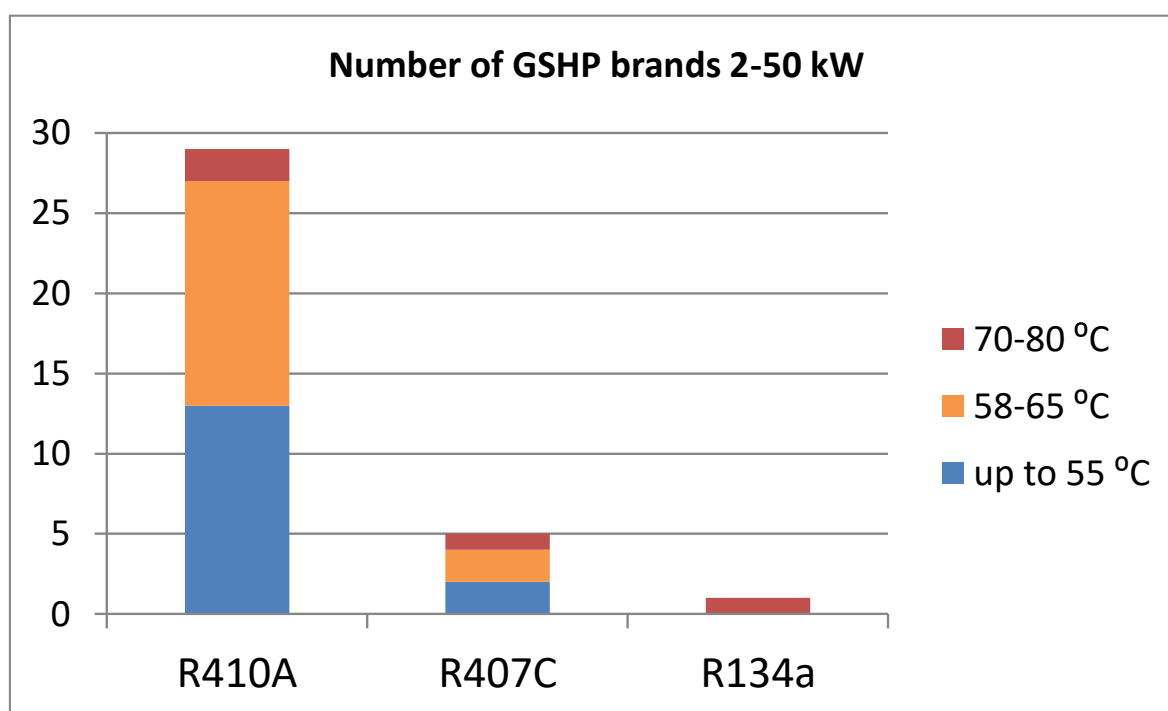


Figure 1: Distribution of refrigerants used in GSHPs with maximum temperature supply.

Figure 2 presents the relation between the coefficient of performance COP of each GSHP brand with refrigerant used. It is observed that GSHP units using R410A have a wide range of COP values, varying from 2,83 to 6,83. GSHP units using R407C as refrigerant exhibit smaller COP range, namely between 3,10 and 5,13. Finally, there is only one GSHP brand using R134a, which has nominal COP of 3,45.

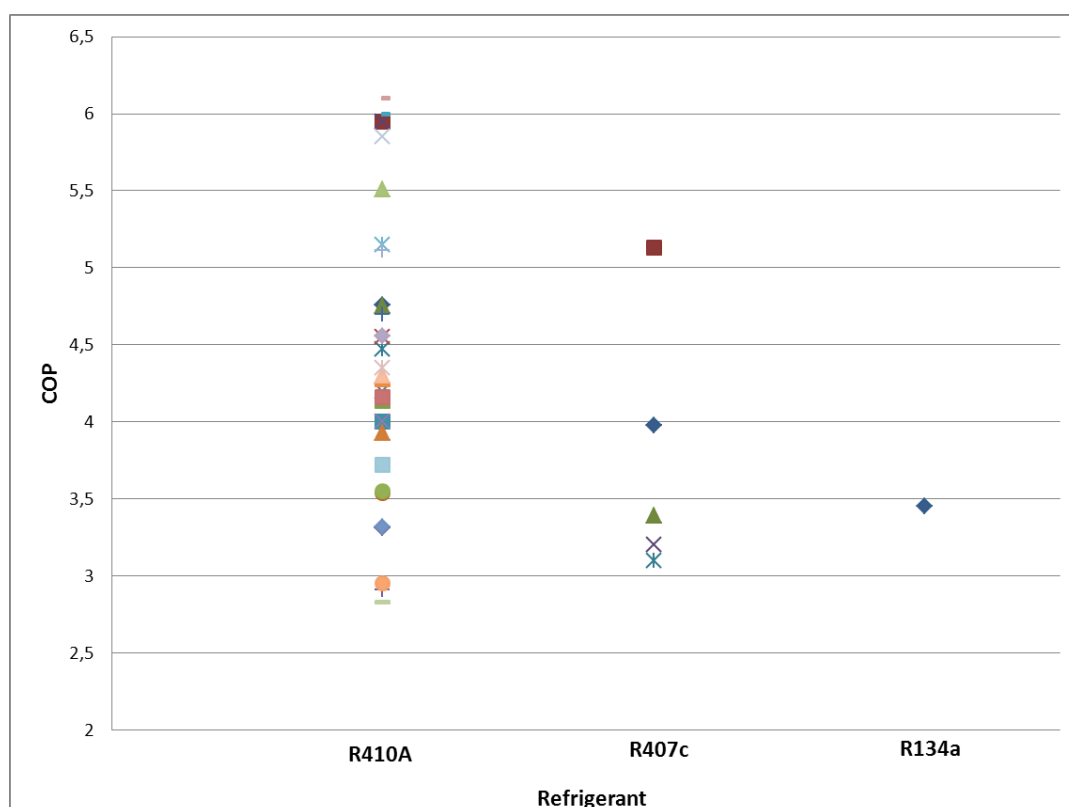


Figure 2: Relationship between refrigerant used and COP

2.1.4 Temperature

Maximum water temperature delivered by GSHP models vary according to end use. GSHP brands are categorised according to the maximum water temperature they supply in three classes. The first class corresponds to GSHP brands delivering hot water up to 55 °C, which is suitable for low temperature heating use only. In this class there are 15 GSHP brands, 13 of which use R410A and 2 uses R407C. The second class includes GSHP brands delivering hot water with maximum temperature in the range 58-65°C, which are suitable for low temperature heating and domestic hot water production. In this class there are 16 GSHP brands, 14 of which use R410A and 6 R407C. The third class comprises GSHPs able to deliver hot water at 70-80°C, which are suitable for both high temperature heating and domestic hot water production. In this class there are 4 GSHP brands, 2 of which use R410A, 1 uses R407C and 1 R134a.

Table 6: Classification of GSHP brands according to maximum water temperature supplied and refrigerant used.

2 – 50 kW _{th} capacity	R410A	R407C	R134a
up to 55 °C	13	2	
58-65 °C	14	2	
70-80 °C	2	1	1

Mapping of the maximum temperature delivered by GSHP units with nominal COP values declared by manufacturers is presented in Figure 3.

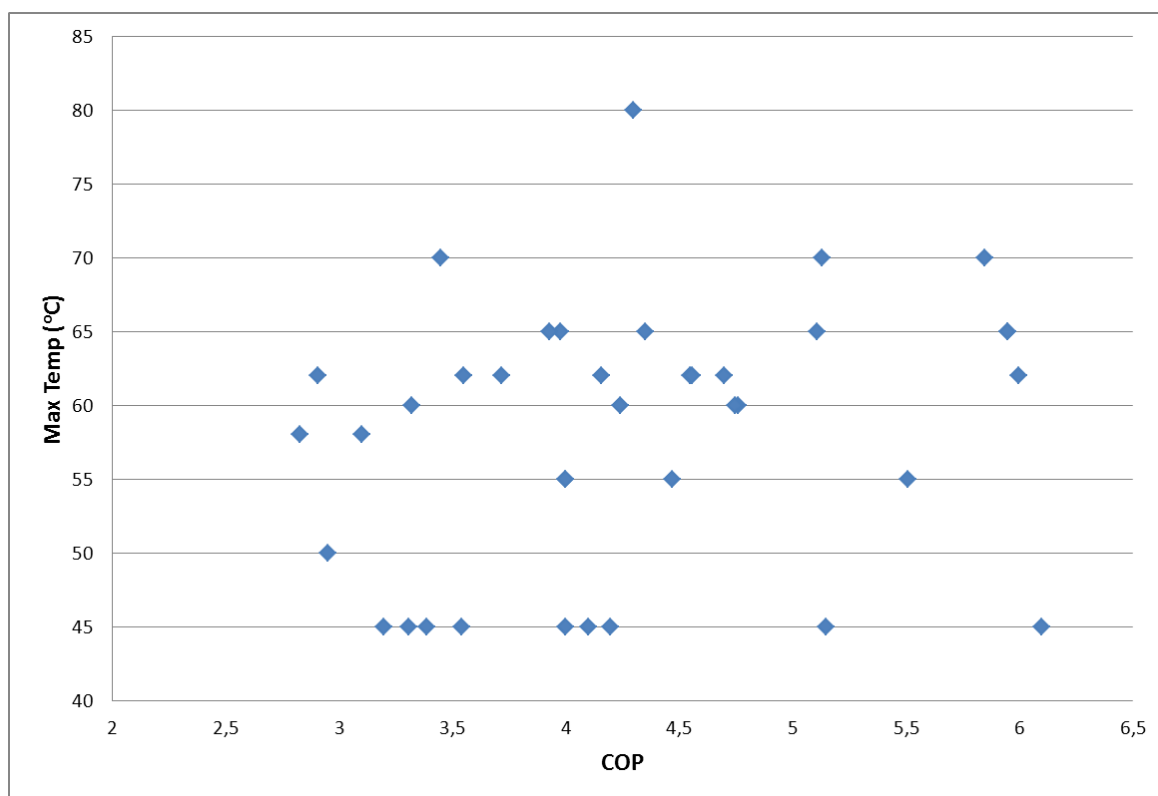


Figure 3: Mapping maximum water temperature supplied by heat pump brands with nominal COP values.

2.1.5 Compressor and control

All GSHP brand models with 2-50 kW_{th} capacities use scroll compressors. The compressor configuration and the control system differ from model to model. Available options are two stage compressors, twin compressors in parallel, inverter compressor, soft start compressor and on-off compressor, which are presented in Figure 4 and Table 7 coupled to the refrigerant used in each case.

Table 7: scroll compressor configuration and control with refrigerant used.

2 – 50 kW _{th} capacity	R410A	R407C	R134a
Scroll on-off	17	3	1
Scroll soft start	7	2	
Scroll inverter	2		
Scrolls twin	1		
Scroll two stage	2		

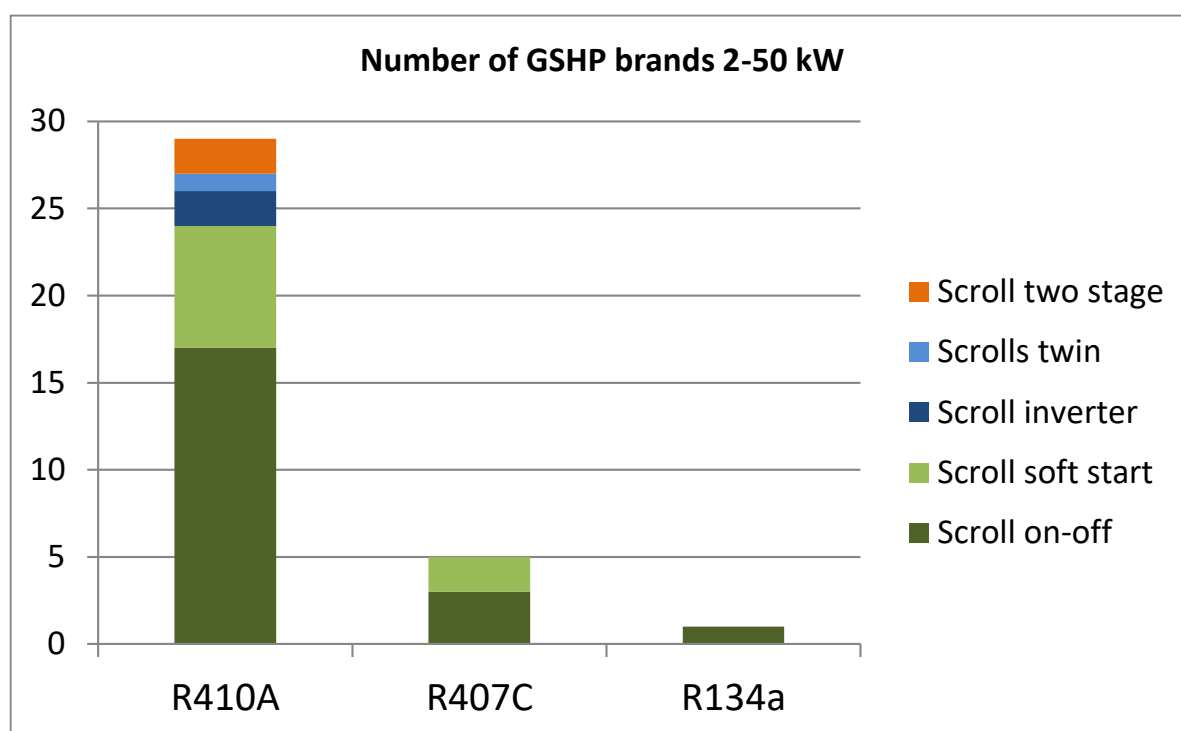


Figure 4: GSHPs brand models in relation to compressor configuration and control and to refrigerant used.

2.2 Capacity range >50 kW_{th}

As already mentioned, data have been collected from 23 manufacturers. Among them, 15 manufacturers sell models with a capacity range over 50 kW_{th}. Table 8 presents the manufacturers and models with capacity range over 50 kW_{th}.

Table 8: Manufactures and models with capacity range over 50 kW_{th}.

Manufacturer	Models
Bosch (MTA)	AQUARIUS PLUS 2 1401, 1601, 1801, 2001, 2301, 2601, 3001, 3301, 2802, 3202, 3402, 3602, 4002, 4302, 4602, 4902, 5202, 5602, 6002, 6602
	HOCEAN Tech 200, 230, 280, 350, 400, 500, 600
	NEPTUNE Tech 075, 090, 100, 110, 120, 135, 150, 165, 180
NIBE	F1345-60
Aermec	HWS 0601, 0701, 0801, 0901, 1101, 1202, 1402
	NXW 500, 550, 600, 650, 700, 750, 800, 900, 1000, 1250, 1400, 1500, 1650
	WF 2512, 2812, 3212, 3612, 4212, 4812, 5612, 7213, 8413,

	9613
	WRL 180, 200, 300, 400, 500, 550, 600, 650
	WS 0601, 0701, 0801, 0901, 1101, 1202, 1402, 1602, 1802, 2002, 2202, 2502, 2802
	WWM 0500
CLIMAVENETA	NX-WN 0152, 0182, 0202, 0252, 0262, 0302, 0352, 0402, 0452, 0502, 0552, 0602, 0702, 0802, 0604, 0704, 0804, 0904, 1004, 1104, 1204
CLIVET	WSHN-XEE2 16.2, 19.2, 22.2, 27.2, 30.2, 35.2, 40.2, 43.2, 45.2, 50.2, 55.2, 60.2, 70.2, 80.2, 90.2, 100.2, 120.2
	WSHN-XSC3 70.4, 75.4, 80.4, 90.4, 100.4, 110.4, 120.4, 140.4, 160.4, 180.4, 200.4, 220.4, 240.4
Galletti	LEW 041, 042, 051, 052, 061, 062, 071, 072, 081, 082, 091, 092, 111, 112, 131, 132, 141, 142, 144, 161, 162, 164, 181, 182, 184, 204, 214, 243, 244, 283, 284, 314, 344, 374, 424, 484, 485, 535, 576, 636
RHoss	TCEEBY 260, 270, 275, 290, 2100, 2115, 2130, 2145, 2165, 2185, 4180, 4205, 4235, 4260, 4290, 4330, 4360
	TCEVZ 1200, 1230, 1280, 1310, 1350, 1410, 1460, 1530
	TCHVZ 1201, 1231, 1281, 1311, 1351, 1421, 1481, 1531
	THHEY 260, 270, 275, 290, 2100
BLUE BOX	Core & Core Max 55, 63, 74, 84, 95, 111
	Mu Echos 48
CIAT	DYNACIAT ILG 200V, 240V, 300V
	DYNACIAT LG 150A, 180A, 200A, 240A, 260A, 300A, 360A, 390A, 450A, 480A, 520A, 600A
	DYNACIAT ^{POWER} LG 700V, 800V, 900V, 1000V, 1100V, 1200V, 1400V, 1600V, 1800V, 2100V, 2400V
	HYDROCIAT LW 708, 858, 1008, 1300, 1302, 1500, 1508, 1900, 2100, 2300, 2308, 2800, 3000, 3008, 3400, 4200, 4600, 4408, 4608, 1328HE, 1528HE, 1928HE, 2128HE, 2328HE, 2628HE, 3028HE, 3428HE, 3828HE, 4228HE, 4628HE
	HYDROCIAT LW 1800BX, 1800BX HPS, 2150BX, 2150BX HPS, 2500BX, 2500BX HPS, 2800BX, 2800BX HPS, 3050BX HPS, 3500BX HPS, 3600BX HPS, 3900BX HPS, 4200BX HPS, 4500BX

	HPS, 4800 BX HPS
Mitsubishi Electric	CRHV-P600YA-HPB 60
	PQRY-P ...YLM-A 450, 500, 550, 600
	PQRY-P ...YSLM-A 700, 750, 800
DIMPLEX	SI TUR 130
	SI 130TU
	WI 95TU, WI 120TU
JC-Hitachi	2 x RCME-...WH1 40, 50, 60, 70
	3 x RCME-...WH1 40, 50, 60, 70
	4 x RCME-...WH1 40, 50, 60, 70
	5 x RCME-...WH1 40, 50, 60, 70
	6 x RCME-...WH1 40, 50, 60, 70
	7 x RCME-...WH1 40, 50, 60, 70
	8 x RCME-...WH1 40, 50, 60, 70
	RCME-...WH1 40, 50, 60, 70
Mayekawa	PH-W125
	RCME-50WH1
	RCME-60WH1
	RCME-70WH1
PHNIX	PTWSHW 250S, 500S
B Cool	GEO 060, 080, 090, 100

2.2.1 Technology

The operating temperatures levels are different in function of the technology used, as well as GSHPs performance (COP / EER). Table 9 presents average COP values per manufacturer.

Table 9: COP nominal values per manufacturer.

Manufacturer		Nominal COP	Earth Loop Inlet/Outlet temperature (°C)	Inside Loop Inlet/Outlet temperature (°C)
Bosch (MTA)	NEPTUNE/HOCEAN	4,23	12/7	40/45
	AQUARIUS	4,95	12/7	40/45
Nibe		4,70 (EN 14511)	0/-3	30/35
Aermec	HWS/WF/WS	4,48	12/7	30/35
	NXW/WRL/WWM	4,51	12/7	30/35
Climaveneta		4,42	10/7	40/45
Clivet		4,18	10/7	40/45
Galletti		4,20	10/7	40/45
Rhoss		4,60	10/7	40/45
Blue Box		4,60	10/7	40/45
CIAT	DYNACIAT LG	5,38	10/7	30/45
	HYDROCIAT LW ST	4,85	10/7	40/45
Mitsubishi Electric		5,08	0/-3	30/35
Dimplex		3,66 3,1	0/-3 0/-3	40/45 50/55
JC-Hitachi (Freedom)		4,74	12/7	40/45
Mayekawa		4,5 (450 kW _{th})	n.a.	n.a.
PHNIX		3,21	20/15	65/70
BCool		5,23	15/10	40/45

2.2.2 Field of application

Heat pump manufacturers divide GSHPs into four categories according to the field application. The four categories are heating/Domestic Hot Water (DHW), heating/cooling, heating/cooling/DHW and heating/DHW/free cooling. Table 10 presents the number of models per field of application.

Table 10: Number of models per manufacturer and per application field.

Manufacturer	Heating/ DHW	Heating/ Cooling	Heating/Cooling / DHW	Heating/ DHW/ free cooling
Bosch (MTA)	0	3	0	0
Nibe	0	2	0	0
Aermec	0	6	0	0
Climaveneta	0	0	1	0
Clivet	0	0	2	0
Galetti	0	0	2	0
Rhoss	0	1 model only heating and 3 models only cooling	0	0
Blue Box	0	0	2	0
CIAT	0	1 model only cooling and 1 model only cooling or heating	3	0
Mitsubishi Electric	2 models only heating	2	0	0
Dimplex	2	2	0	0
JC-Hitachi (Freedom)	0	0	8	0
Mayekawa	0	1	0	0
PHNIX	0	0	1	0
BCool	0	1	0	0

2.2.3 Refrigerants used

In GSHPs market segment of large capacity ($> 50 \text{ kW}_{\text{th}}$), refrigerants used are R410A, R407C, R134a and R717 (NH_3). The brand models distribution according to refrigerant used are shown in Figure 5. 11 brands use R410A, 5 brands R134a, 1 brand R407C and 1 NH_3 (R717).

A correlation graph between refrigerant used and nominal COP is presented in Figure 6. GSHP brands using R410A have a wide range of nominal COP values between 3,66 and 5,88. Brands using R134a also exhibit a wide range of nominal COPs with lower values between 3,21 and 4,95. Finally, COP nominal value of the R407C brand is equal to 4,70 and the one of the NH_3 (R717) brand is equal to 4,50.

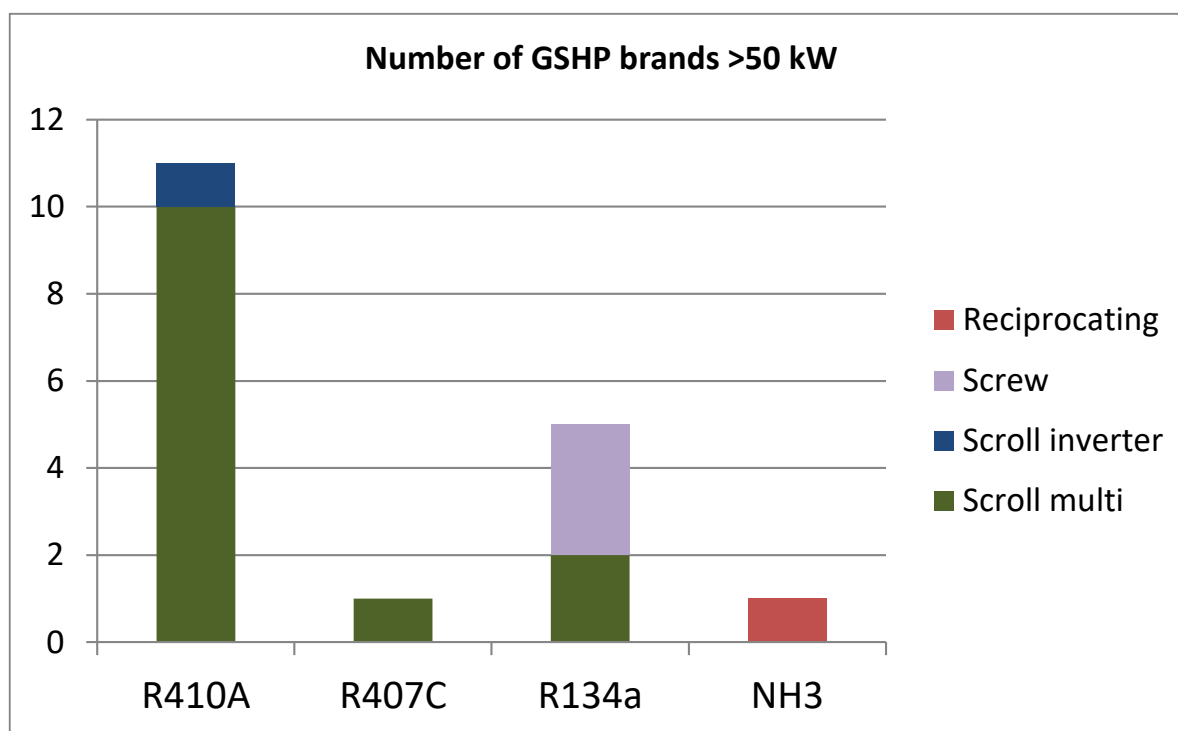


Figure 5: GSHP brands distribution according to refrigerant used and compressor type.

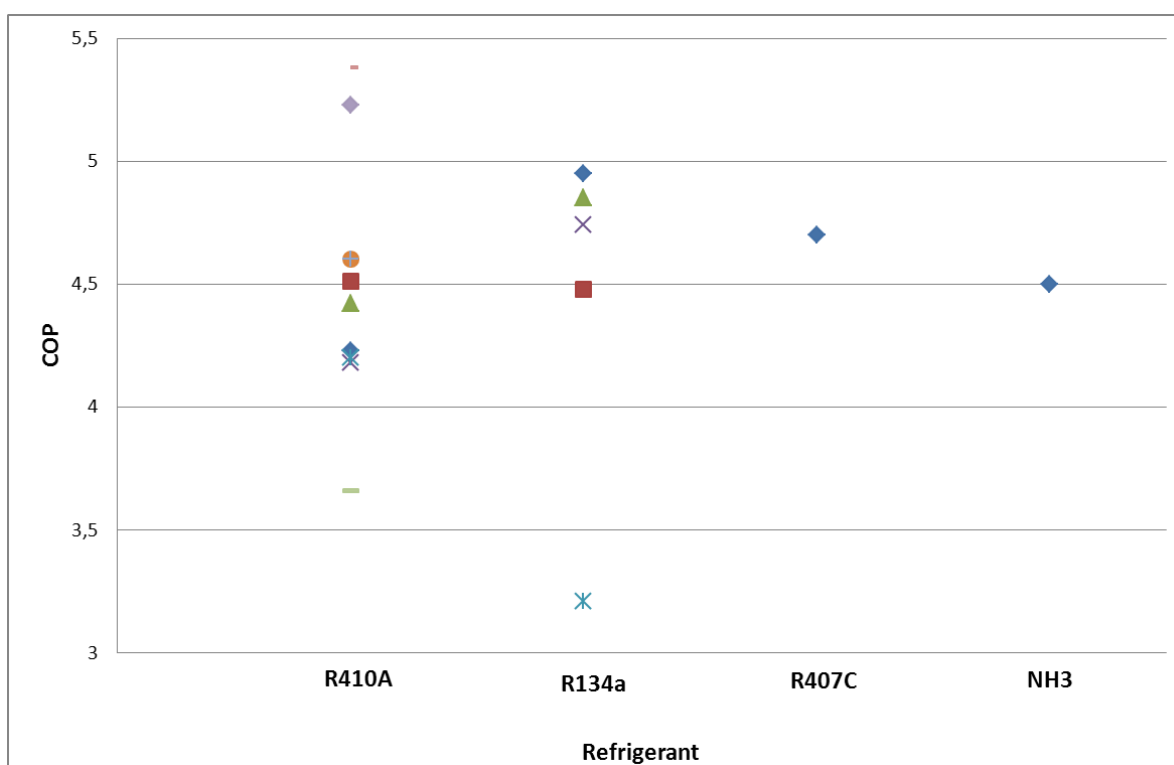


Figure 6: Correlation of refrigerant used with nominal COP value of GSHP brands

2.2.4 Temperature

As in the case of low capacity GSHPs, three categories of large capacity GSHPs ($> 50 \text{ kW}_{\text{th}}$) are defined, according to end use, which are presented in Figure 7 and Table 11. In the first class, which includes 10 GSHP brands supplying water temperature up to 55°C , 7 brands use R410A and 3 R134a. In the second class, which includes 6 GSHP brands which supply water temperature up to $58\text{--}65^\circ\text{C}$, 3 brands use R410A, 1 R407C, 1 R134a and 1 R717 (NH_3). In the third class, which includes 2 high temperature GSHP models delivering hot water up to $70\text{--}80^\circ\text{C}$, 1 uses R410A and 1 uses R134a.

Table 11: GSHP brands distribution according to refrigerant used and maximum temperature delivered.

$> 50 \text{ kW}_{\text{th}}$ capacity	R410A	R407C	R134a	NH3
up to 55°C	7		3	
$58\text{--}65^\circ\text{C}$	3	1	1	1
$70\text{--}80^\circ\text{C}$	1		1	

In addition, the mapping of maximum temperature delivered with nominal COP of the large capacity GSHPs is presented in Figure 8.

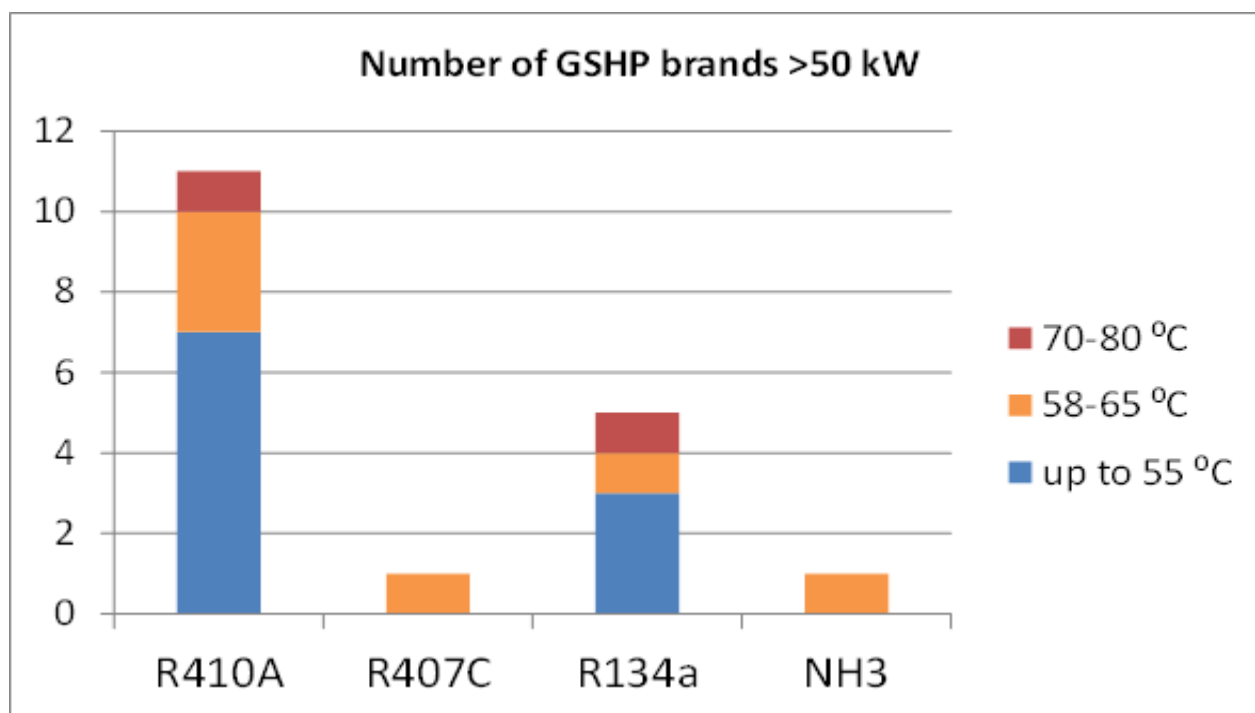


Figure 7: GSHP brands distribution according to refrigerant used and maximum temperature delivered.

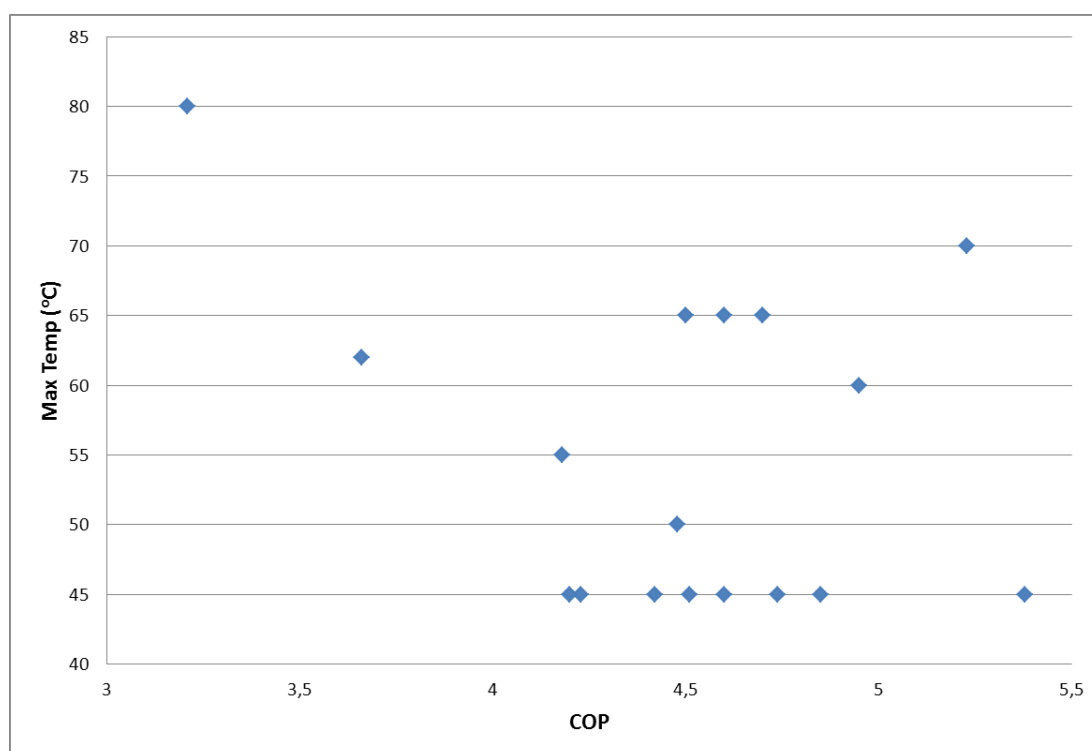


Figure 8: Mapping of maximum temperature supplied by large capacity GSHPs with nominal COP values declared by manufacturers.

2.2.5 Compressor and control

Large capacity GSHPs ($> 50 \text{ kW}_{\text{th}}$) are mainly equipped with scroll, screw and reciprocating compressors. A review of the large capacity GSHP market has been already presented in Figure 5 and is also summarized in Table 12 according to refrigerant and type of compressor used. Among 18 brands which sell large capacity GSHPs, 14 use scroll compressors, 3 screw compressors and 1 reciprocating compressor.

The scroll compressor brands use mainly more than one compressor (multi compressors) for capacity control, while there is only one brand using an inverter compressor for capacity control. Scroll compressor brands use all types of traditional refrigerants, such as R410A, R407C and R134a, the screw compressor brands R134a and the reciprocating compressor brand NH₃.

Table 12: Large capacity GSHP brands according to compressor and refrigerant used.

$> 50 \text{ kW}_{\text{th}}$ capacity	R410A	R407C	R134a	NH ₃
Scroll multi	10	1	2	
Scroll inverter	1			
Screw			3	
Reciprocating				1

2.2.6 Efficiency

Table 13 presents the nominal COP of GSHP brands according to the temperature levels. It is evident that the higher the temperature difference between earth and building loops, which is equivalent to the temperature delivered by the heat pump at nominal conditions, the lower the COP value.

In addition, the large capacity GSHP brands yield higher COP values than their lower counterparts.

Table 13: Correlation of nominal COP with temperature.

GSHP boundary conditions	2-50 kW_{th}	$>50 \text{ kW}_{\text{th}}$
	COP	
B0/W35	4.0 - 5.1	4.6 - 5.1
W10/W45	3.4 - 4.6	4.2 - 4.9
B0/W45	3.1 - 3.5	3.7
B0/W55	2.8 - 2.9	3.1
B0/W65	2.2 - 2.4	2.4

B*/W*: brine temperature to the heat pump/water temperature supply of the heat pump in °C

3. Control strategies

The modulating control of heat pumps strongly influences the seasonal performance of the HVAC system. Next, the main control strategies that exist in the market are presented.

3.1 Reversibility

Reversible heat pump are able to provide both heating and cooling and, therefore, optimal comfort in winter and summer. The configuration of this kind of heat pump is quite simple.

Multifunction heat pumps are able to produce cold water for cooling use and domestic hot water in the same time. Such function is called “total recovery”.

The switching from heating to cooling can be achieved either by reversing the heat pump cycle by means of a 4-way reversing valve, or by alternating the water loops by means of four 3-way valves or two 4-way valves.

3.2 Building zone control

With this control mode, the heat pumps are able to control two different flow temperatures, thereby managing two different heating load requirements. The system can adjust and maintain two flow temperatures when different temperatures are required for different rooms, or when two different kind of terminals are fed by the heat pump such as a radiator and radiant panels. Another feature of such models is two-zone cooling control.

This regulation is very important when in the system different types of terminals are present: in heating mode, fan coils need slightly low supply temperatures (40-45°C), whilst radiant systems are supplied with low water temperature (30-35°C).

In general, this type of regulation is achieved by means of a 3-way valve, that is able to mix the user water to guarantee a proper temperature for each terminal.

3.3 Remote control

Smart services for the heat pumps are provided by some manufacturers for a remote control of the heating and hot water functions, including monitoring of the energy consumption. By connecting to the Cloud portal, users can remotely operate all unit functions. Its advantages include energy savings, comfort, control from anywhere, increased efficiency, and resource management.

For example, the manufacturer provides an app for smartphones or a web site connection. That allows the user to access an overview of the present status of the installation, as well as to an historical database for the last month regarding the main parameters that influence the heat pump performance such as outdoor temperature. If the system is affected by a malfunction, the user receives an alert via e-mail.

With this service, the user can change the temperature, the comfort mode for DHW or modify advanced parameters such as the heating curve.

This instrument is very important for optimizing the system's parameters in order to save energy. In general, heat pump operating parameters depend on system type and user's life style.

3.4 Smart grid integration

The rapid growth of renewable energy generation has generated the problem of gaps between electricity supply and demand. To solve this problem, the heat pumps with a smart grid control function make the electricity demand response more flexible by creating a uniform interface for smart grid integration. The heat pumps equipped with this function can change the operating pattern when a signal is received from a controller.

3.4.1 Smart Price Adaptation

This refers to control strategy to exercise tariff based control in case an hourly tariff agreement with the electricity supplier exists.

This control strategy adjusts the heat pump consumption according to the period of day during which electricity is cheaper. This allows economic savings, provided that an hourly rate subscription has been signed with the electricity supplier. The control strategy could be based for example on hourly rates for the following day.

3.4.2 Photovoltaic integration

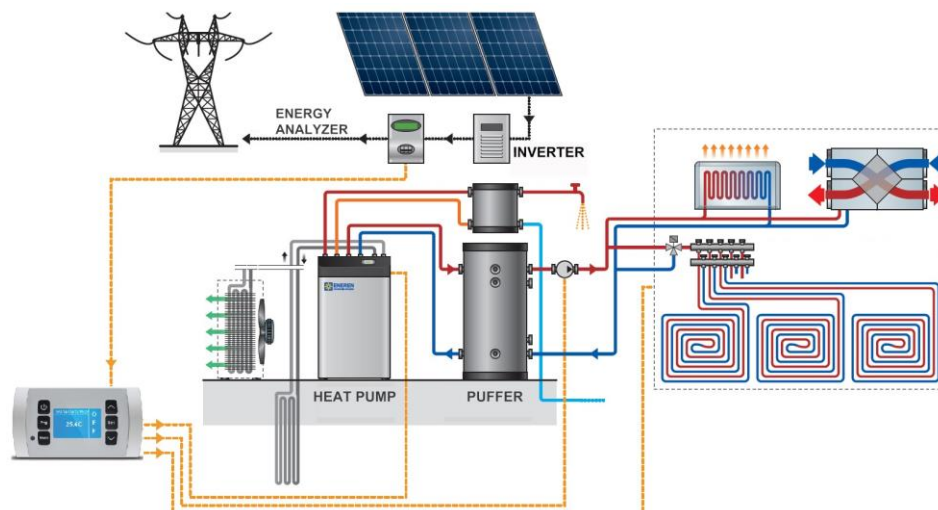


Figure 9: Photovoltaic integration

Solar photovoltaic panels can provide renewable electricity to the heat pump improving sustainability and reducing costs. In case of surplus PV electric power generation, the interface system between the heat pump and the PV can convert the surplus electric energy into heat

increasing self-consumption. The optimized use of surplus electric production, converted in thermal energy, can be stored inside water tanks or taking advantage from the inertia of the building envelope.

3.5 Integration of several thermal sources

In case that two or more thermal energy sources are available, there are several control strategies to integrate them efficiently with the heat pump. The alternative sources can be solar thermal panels and a gas boiler.

3.5.1 Integration of renewable solar thermal sources

If zero carbon technologies are available, the system control should prioritize them. Some control solutions available in the market, such as the “Solar regulator”, optimize the combination of a heat pump, a solar thermal field and a tank.

According to this control strategy the water temperature at the DHW tank is regulated by automatically turning ON and OFF a pump which supplies the DHW tank with hot water from the solar collector. This pump is termed as the solar charge pump. The temperature regulation is done as follows:

Solar charge pump turns ON: when $T_{\text{solar}} > T + DT_{\text{set1}}$

Solar charge pump turns OFF: when $T_{\text{solar}} < T + DT_{\text{set2}}$

Solar charge pump turns OFF: when $T \geq T_{\text{max}}$

where:

- T_{solar} is the measured water temperature in the solar collector
- T is the measure water temperature in the DHW tank
- T_{max} is the predefined value of maximum allowable temperature in the DHW tank
- DT_{set1} and DT_{set2} are predefined values of upper and lower temperature difference set points

Therefore, the function prioritises how and to what extent each docked energy source will be used. Here it can be chosen if the system has to use the energy source that is cheapest, or the most green one, at the time. In general, the solar panels are used to produce the domestic hot water in parallel to the heat pump, but the priority is to use solar energy first.

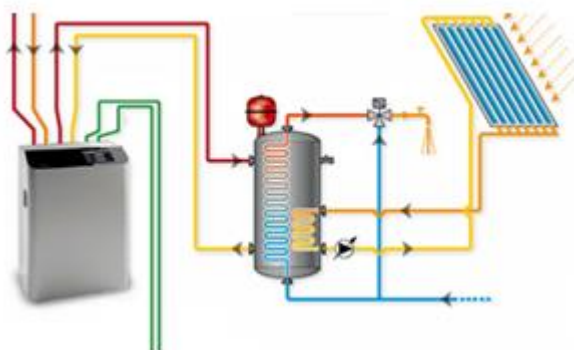


Figure 10: Solar Thermal Panel integration

3.5.2 Integration of extra heating sources

If a heat pump must operate with very low levels of external temperature, an extra heating source may be required. When temperature is considerably below freezing point, e.g. at -15°C , air/water heat pumps could not be able to satisfy the entire heating needs of the building/s. An existing boiler, circular electrical heater, or a fireplace can be used to provide the extra heat required.

In the market, existing electronic controls of heat pumps allow regulating the bivalent system with an extra heating source. At a certain environment temperature, e.g. -10°C , the control mechanism activates the extra source to work with the heat pump in heating the building to the desired room temperature. Another option is to let only the extra source operate, without the heat pump, once the bivalent point (i.e. the point or temperature when heating with the heat pump alone is no longer sufficient) is reached. The heat pump will be reactivated when the temperature rises above the bivalent point. A third alternative is to use an oversized heat pump to attain monovalent operation without an extra heating source.

Control systems support a broad range of different hydraulic schemes, enabling to combine air/water heat pump with other equipment and create a customized heating system. The control system can manage many heat pumps together in the same system and connect the heat pump with another heating source such as gas boiler, oil boiler, electric heaters or district heating.

3.6 Capacity control

An efficient regulation system is crucial in order to save energy. During partial load, the heat pump must be able to reduce the heating capacity.

3.6.1 ON-OFF

The on-off control is a straightforward strategy; the heat pump is switched off when the set point is reached (obviously taking into account the defined dead band to avoid unstable operation). In this case, the heat pump deliver the nominal output capacity (according to the settings of the user and the boundary conditions), it is set into a standby mode. Single stage systems are

typically found in the older models, or in the newer models in smaller homes and/or in milder climates.

The on-off control is also known as single-stage heat pump. These controls modulate the capacity by means of a sequence of on-off cycles which generally decreases the energy performance of the device.

The key component defining the regulation method is the compressor unit. In order to allow the compressor to be switched on and off less frequently, these systems require a hot water tank. Less frequent compressor switching extends the useful life of the heat pump.

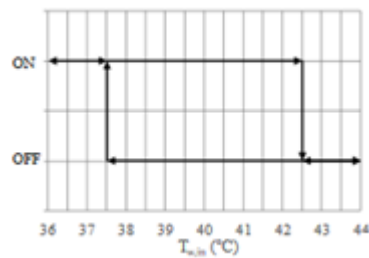


Figure 11: ON/OFF regulation

3.6.2 Multi compressors

As alternative to the on/off control, there are multi-stage heat pumps that could work continuously switching the number of active compressors. The control, applied to a two compressors heat pump, works following the behaviour shown in Figure 12. Since the heat pump is composed by two compressors, its controller uses two set-point values for the water return temperature and two dead bands. More in detail, the return water set-point temperature for the activation of the first compressor (TSP,1) is 41.25°C, while the set-point for the second compressor (TSP,2) is 38.75°C; both dead bands are wide 2.5 K. If the heat pump is switched off, when the water temperature entering the condenser $T_{w,in}$ is lower than 40°C (TSP,1 minus half dead band), the first compressor is activated.

This type of solution allows to have a step regulation; the number of the steps is in function of the compressors number. When the unit has more than of 4 compressors, the regulation is very similar to continuous regulation.

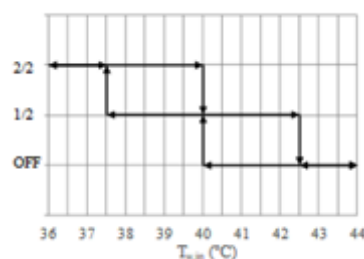


Figure 12: Multi steps regulation

In this operating mode, the heat pump heating capacity could be higher or lower than the building thermal load.

3.6.3 Inverter control

Opposite to single-stage, variable-speed heat pumps could work continuously for a longer time interval during the season, changing the inverter frequency at which the compressor works. In this way, these devices are able to reduce the frequency of their on-off cycles with respect to single-stage units, reducing the cycling losses phenomena.

Some heat pumps provide optimum savings since the heat pump automatically adapts to requirements all year round thanks to its intelligent inverter control. An Inverter is used to control the speed of the compressor motor, so as to continuously regulate the temperature. The DC Inverter units have a variable-frequency drive that comprises an adjustable electrical inverter to control the speed of the engine, which means the compressor and the cooling / heating output.

Variable-capacity (also variable-speed and modulating) compressors vary capacity from about 40% to 100% in increments of less than 1%. The inverter frequency is set in agreement with the thermal loads of the building. When the minimum inverter frequency is reached no further heating capacity modulation is possible; in this case on-off cycles are performed to match the building thermal load.

Studies show that inverter-driven heat pumps are characterized by better seasonal energy efficiency if compared to on-off ones.

3.6.4 EMS

The BaCnet/IP virtual network enables heat pumps to be integrated into a building management system. So the heat pump can update and download the information from the net of the system in order to optimize performance.



Figure 13: Hardware for Ethernet communication

4. Heat pump solutions and associated costs

4.1 Introduction

New buildings are becoming more and more environmentally friendly and use a lot of renewable energy, with electricity produced by photovoltaic panels. The heating, cooling and domestic hot water production is satisfied by the heat pump, which uses electricity from PV panels.

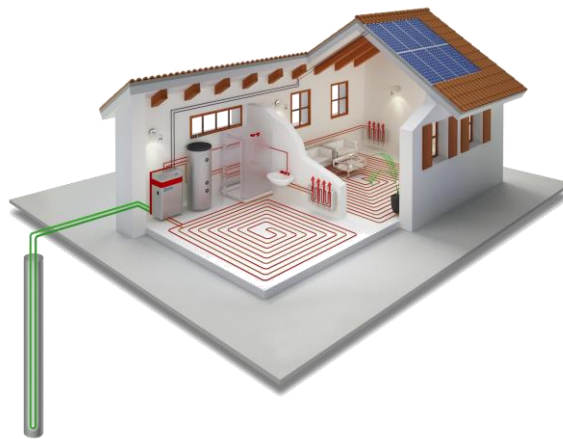


Figure 14: New building with GSHP and PV

The heat pump functions by absorbing energy from a low enthalpy source and rejecting it at high enthalpy. The heat sources of a heat pump are air or water. In general, the air has a lower enthalpy value respect of water, so it is a less valuable source. The water source can be available in nature, for example, from a lake, a river and/or wells. But in general, it is very difficult to use it because usually the water quality is not good in terms of corrosive and scaling properties, or it is not possible to have permission to use it. For this reason, the ground is widely exploited as heat source. Water exchanges heat with the ground reaching temperature levels suitable for an efficient operation of the heat pump. A GSHP system layout comprises:

- ground source heat exchanger
- heat pump
- buffer tank for use side (only on/off solution)
- buffer tank for domestic hot water
- instantaneous production for domestic hot water
- integration of solar thermal panels inside the domestic hot water
- user terminals (fan coils, radiant panels, dehumidifiers)
- water loop 4-way valve for efficiency increase (an option)

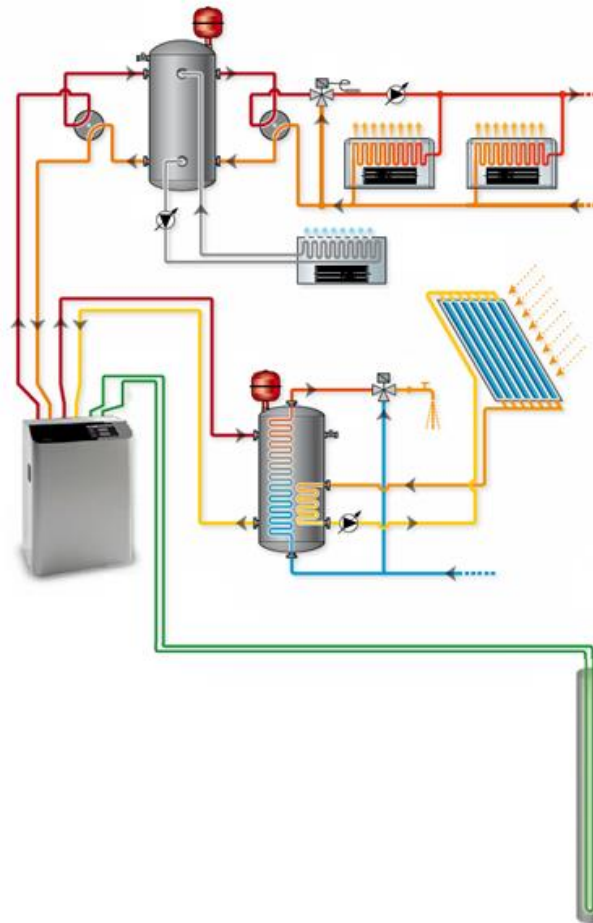


Figure 15: Geothermal system layout

Among many different configurations of heat pump systems, the following five configurations, combining heat pump type and system layout, will be analysed:

- ON-OFF heat pump solution
- Inverter heat pump solution
- Multi-function heat pump solution
- Plug and Play heat pump solution
- Air to water heat pump solution

4.2 ON-OFF heat pump solution

The first layout is composed by the following items:

- heat pump with fixed speed compressor
- buffer tank for user side
- buffer tank for domestic hot water
- instantaneous preparation of domestic hot water



Figure 16: Layout of ON-OFF heat pump solution

The heat pump has a fix speed compressor, so the heating production capacity is always constant, when in operation. For this reason, it is necessary to use a buffer tank to decouple the building heat demand and heating capacity produced by heat pump. The user buffer tank is important to reduce the on/off cycling of the compressor, because in general the heat demand of the building is lower than the heating capacity of the heat pump, so the working time of the compressor is low.

The heat pump is a reversible unit, therefore it is possible produce hot water for heating mode or domestic hot water and cold water for cooling mode. So, it has only two function modes:

- Heating mode: produce hot water
- Cooling mode: produce cold water

With this technology the domestic hot water is produced during the heating mode and a 3-way valve steers the water flow to domestic hot water buffer tank.

This point is very important, because if during the cooling mode domestic hot water is required, the compressor must be turned off, in order to change the heat pump mode from cooling to heating and also switch the 3 way valve for production of domestic hot water. During this period the cooling demand of the building is not satisfied.

In general, the 3-way valve for domestic hot water production is installed inside the unit. The advantage of this system is the simplicity and the low cost in comparison with the other system configuration options. The abovementioned operating modes are schematically shown in the following Figures.



Figure 17: Heating mode



Figure 18: Cooling mode



Figure 19: Domestic hot water mode



Figure 20: Domestic hot water mode

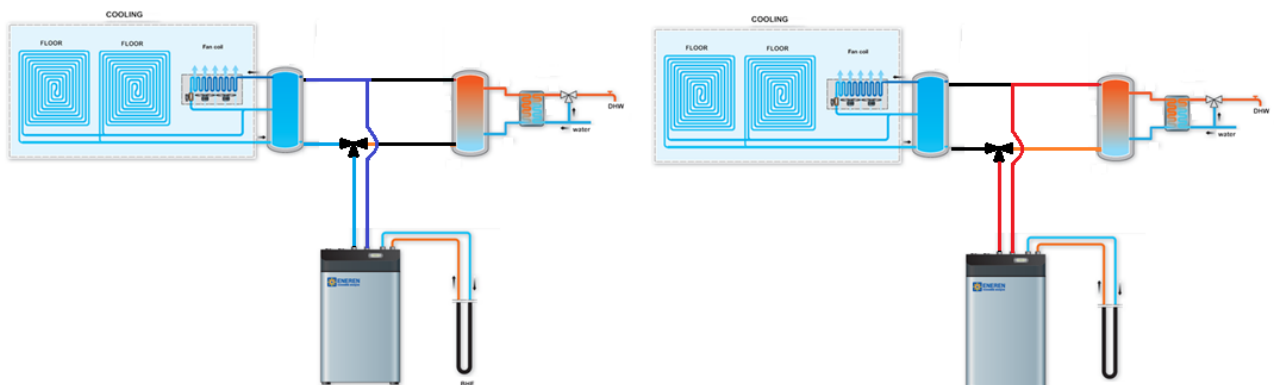


Figure 21: Changeover mode from cooling mode to domestic hot water mode

4.3 Inverter heat pump solution

The second layout is composed by:

- heat pump with variable speed compressor
- buffer tank for domestic hot water
- instantaneous preparation of domestic Hot water

In this case the compressor can change its rotation speed, therefore the heating capacity can be varied in order to satisfy the demand of the building. For that reason, the user side buffer tank is not necessary, so it is possible to reduce the feedback from plant and response of the heat pump.



Figure 22: System layout with Inverter heat pump

The functions of this heat pump are like the ones of the on/off heat pump, but the regulation is different.

With this solution it is possible to reduce the total volume of water inside the plant and optimize system efficiency. In this case, the heat pump is more expensive in respect to the on/off solution, but the system has less components and higher seasonal efficiency.

4.4 Multi-function heat pump solution

The third system has a similar component layout as the second configuration:

- Multifunction heat pump with variable speed compressor
- buffer tank for domestic hot water
- instantaneous preparation of domestic Hot water



Figure 23: System layout with multi-function heat pump

The most important difference is the refrigerant circuit of the heat pump, so the multifunction heat pump has an additional heat exchanger as follows:

- a heat exchanger for source side (connected to geothermal probes water/brine loop) [S3]
- a heat exchanger only for user side (satisfying the energy demand of the building) [S1]
- a heat exchanger only for domestic hot water [S2]

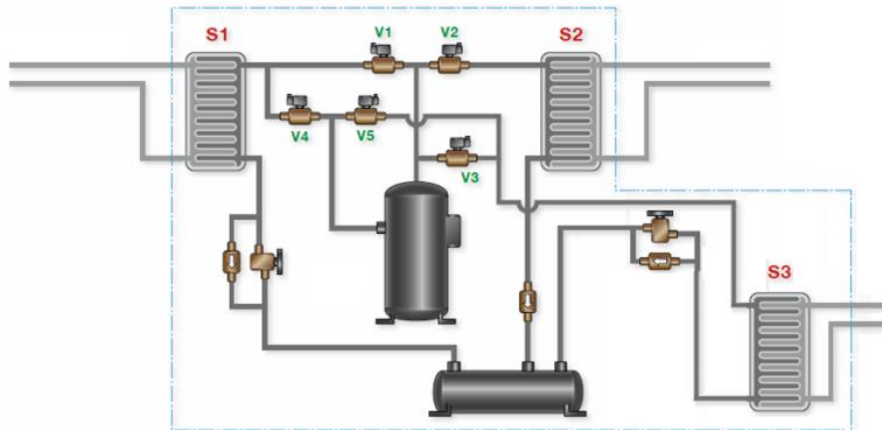


Figure 24: Refrigerant circuit of multi-function heat pump

This type of heat pump does not use a 3-way valve for production of domestic hot water, but it has a dedicated heat exchanger for this purpose. The heat pump functions are listed below and are presented schematically in Figures 25 to 28:

- Heating mode
- Cooling mode
- Domestic hot water mode
- Cooling mode + domestic hot water; (total recovery mode)

During total recovery mode, the heat pump satisfies the cooling demand and the domestic hot water request at the same time. The main advantage of this technology is reducing the cycle reversing need during summer mode. Secondly the heat extracted from user side during cooling operation is rejected as domestic hot water heat, so the heat pump produces a double useful effect of cooling and heating. The global COP during this mode is very high and the system achieves the maximum efficiency.

The Advantage of this system is the higher efficiency, but the heat pump is very expensive.

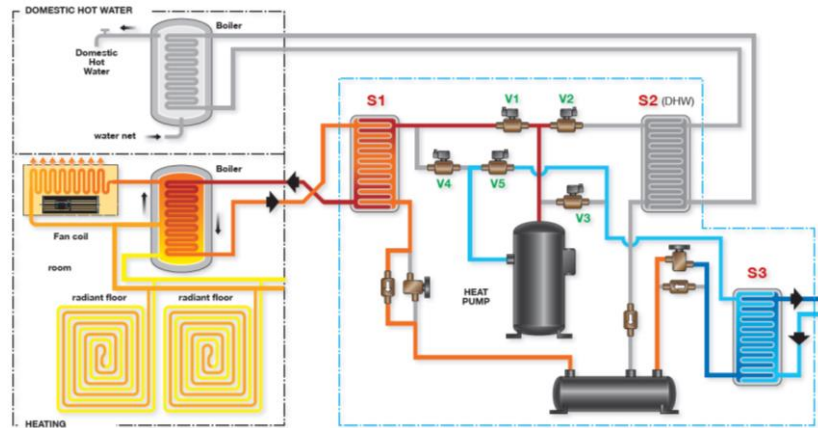


Figure 25: Heating mode

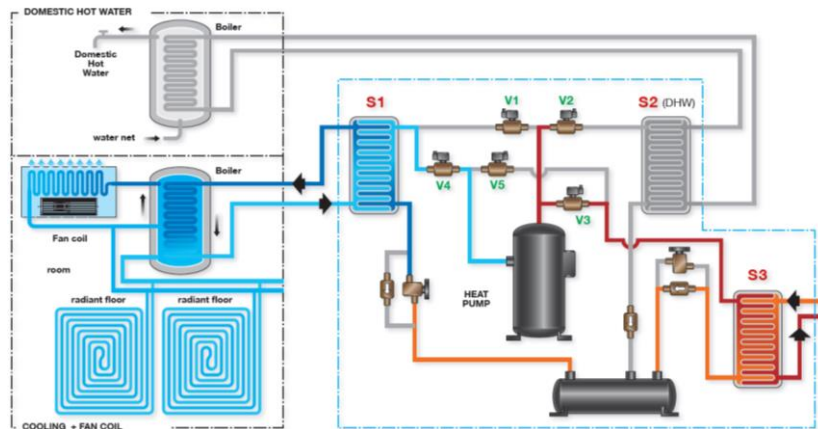


Figure 26: Cooling Mode

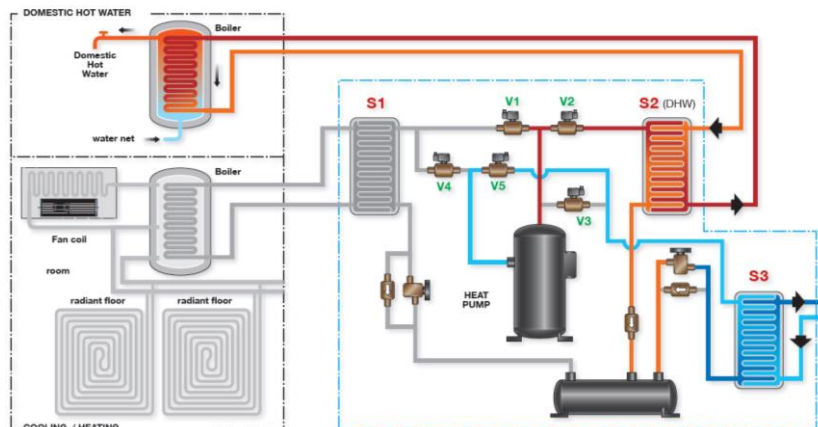


Figure 27: Domestic hot water mode

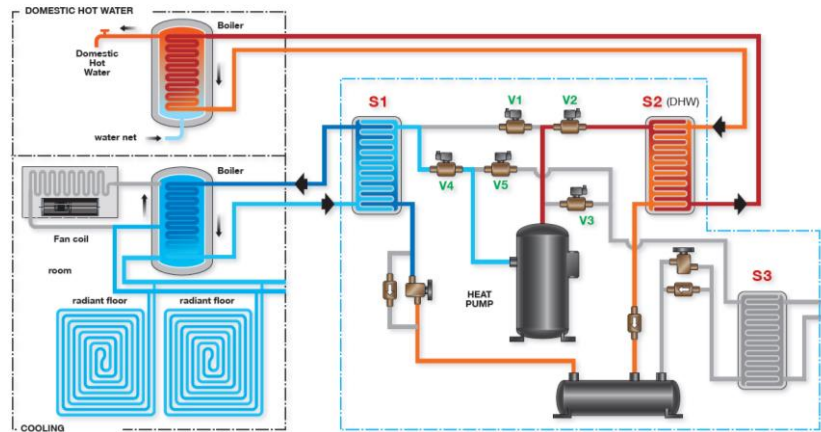


Figure 28: Total recovery mode

4.5 Plug and Play heat pump solution

The new generation of heat pump is equipped with:

- Refrigerant circuit with inverter compressor
- User pump
- Source pump
- 3-way valves for domestic hot water
- Buffer tank for domestic hot water
- instantaneous preparation of domestic hot water
- integration for solar thermal panels

The objective of this product is to reduce the installation cost and time, while using minimum space inside the technical room, because in general in a standard house the technical room is very small.

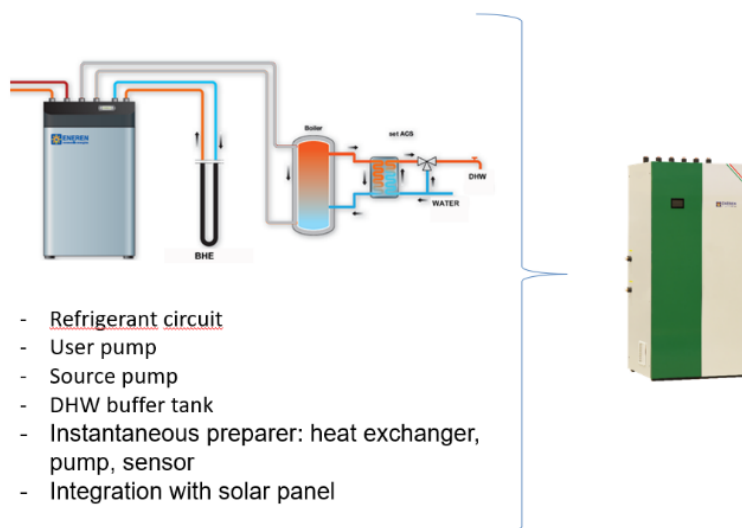


Figure 29: Characteristic of plug and play heat pump

The new layout of system is very simple and is shown in Figure 30.

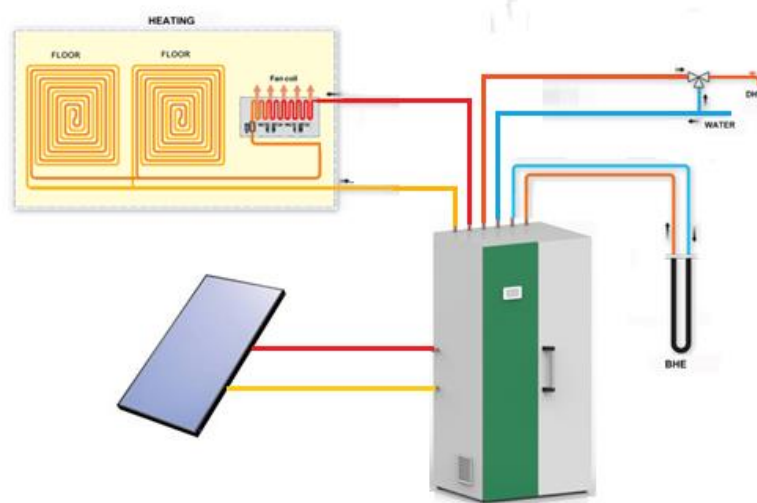


Figure 30: Layout plug and play heat pump

This heat pump is a smart and easy solution for domestic heating, cooling and hot water supply applications.

4.6 Air to water heat pump solution

The last system uses air as a heat source. This solution is very easy because drilling for geothermal heat exchanges is not needed. In this case the heat pump system is less expensive, but also less efficient.

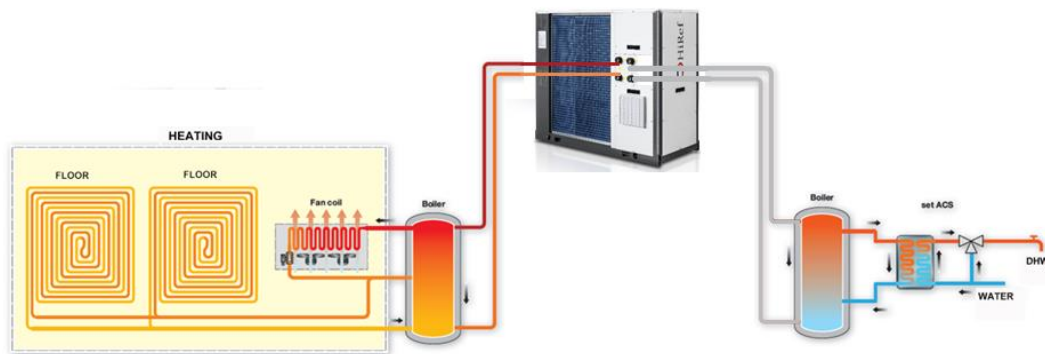


Figure 31: Air to water heat pump solution

This layout comprises:

- air to water heat pump with variable speed compressor
- buffer tank for user side
- buffer tank for domestic hot water
- instantaneous preparation of domestic hot water

The functions are similar to a geothermal heat pump with variable speed compressor. But the important difference is the user buffer tank; in this layout the user buffer tank is necessary for

heat storage during the defrosting mode. When the user side request the heating capacity, but the heat pump is in defrost mode, both the plant and the heat pump absorb thermal energy from the buffer tank. Due to its multi-function and in order to provide the necessary heating to the building while also defrosting, correct design of the buffer tank is very important.

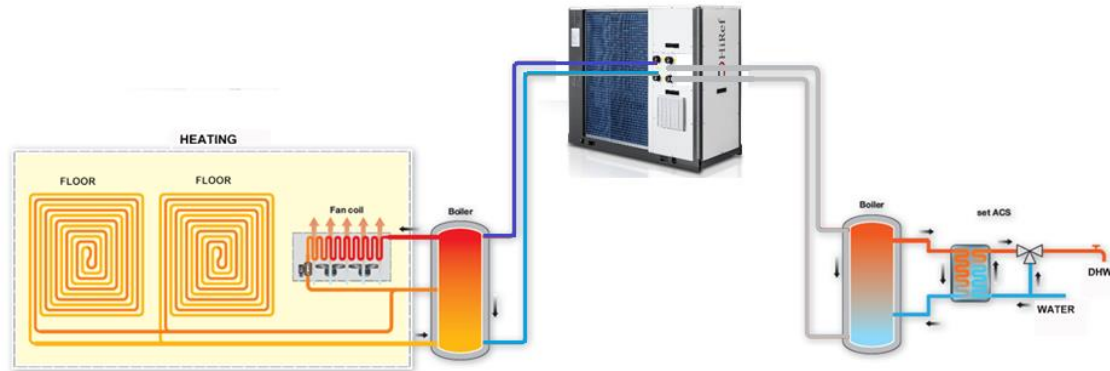


Figure 32: Defrosting mode

4.7 Cost analysis

A plant with the following components is considered:

- Heat pump with heating capacity of 12 kW_{th}
- 200 lt of User Side Buffer Tank
- 200 lt of DHW Buffer Tank
- Instantaneous preparation of 25 l/min hot water
- N°2 ground heat exchanger with 100 m of length

The cost estimation of each of the heat pump system components considered, using average market prices, is presented in the Table 14.

Table 14: Price comparison of each heat pump configuration studied

Layout	Heat Pump	User side buffer tank	DHW buffer tank	DHW heat exchanger	Ground Heat Ex-changers	Total cost	Difference %
ON-OFF heat pump	6.855,00 €	505,00 €	505,00 €	1.568,00 €	8.500,00 €	17.933,00 €	0%
Inverter heat pump	7.235,00 €	- €	505,00 €	1.568,00 €	8.500,00 €	17.808,00 €	-1%
Multi-function heat pump	10.910,00 €	- €	505,00 €	1.568,00 €	8.500,00 €	21.483,00 €	+20%
Plug & play heat pump	10.750,00 €	- €	- €	- €	8.500,00 €	19.250,00 €	+7%
Air to water heat pump	8.333,00 €	505,00 €	608,00 €	1.568,00 €	- €	11.014,00 €	-39%

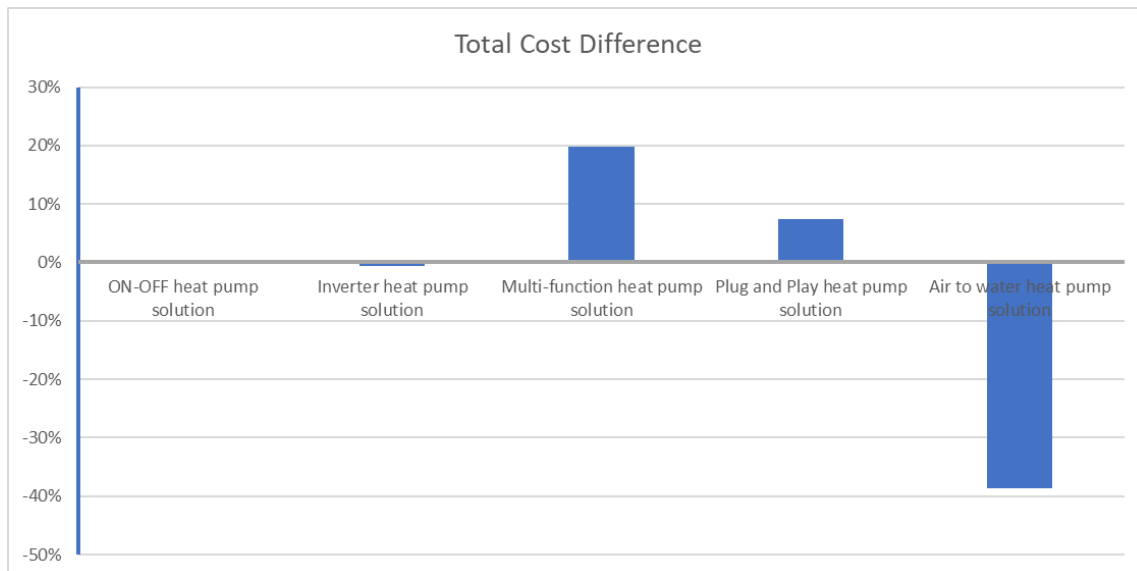


Figure 33: Comparison of different solutions

The cheapest solution is the air to water solution because the investment for a ground source heat exchanger is very high, but it lasts for a very long time and the investment must be divided over many years. The other advantage of the geothermal system is the lower operating cost, as the geothermal heat pump has a seasonal performance factor higher than an air source heat pump.

Figure 34 presents a comparison of total costs (capital costs + accumulated operation costs over time) of the air to water heat pump with the plug and play heat pump.

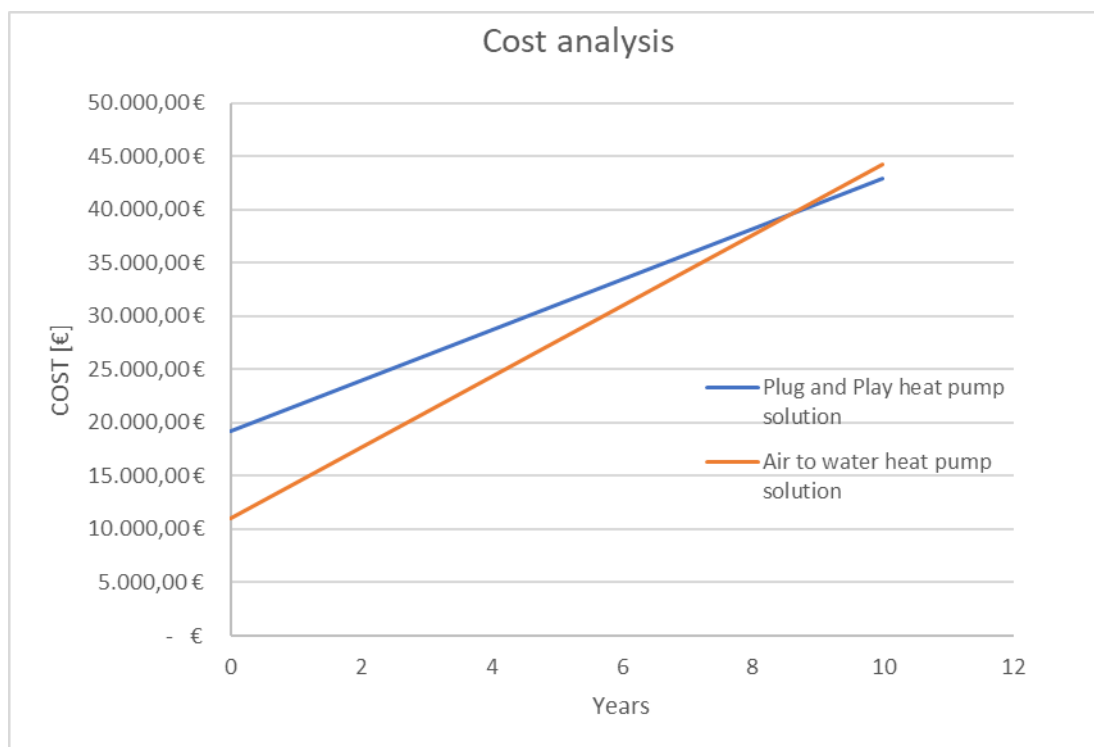


Figure 34: Cost analysis of air to water and plug and play heat pumps

Although 8 years are necessary for the recovery of the initial investment of the ground source heat exchangers, the plug and play geothermal heat pump is considered as the best solution, as ground heat exchangers have a much longer service life span, which is similar to the building life.

5. Technology selection rules

5.1 Introduction

For each identified heat pump solution the following selection rules have been drafted, which will be input in the decision support system.

The main components of the geothermal heat pumps are typically:

- refrigerant
- compressor
- heat exchangers
- refrigerant circuit

As each component influences the application range of the heat pump, we are going to analyse all these components for extracting the technology selection rules.

5.2 Refrigerants

The GSHPs require the selection of suitable refrigerants, with as low as possible GWP and, at the same time, good energetic efficiency and volumetric refrigerating/heating efficiency. At present, GSHPs mainly employ refrigerant R410A (GWP=2087) as well as R134a (GWP=1300). However, according to EU Regulation No. 517/2014 on fluorinated greenhouse gases, these high GWP refrigerants will have to be substituted for residential applications in the next years to increase the sustainability of GSHPs.

Considering different working conditions, source typology and time horizon for the refrigerant substitution, two different groups of refrigerants can be considered: a) short time alternative fluids, with lower GWP than current refrigerants (transition solution); b) medium-long term solutions, characterised by very low GWP (final solution).

a) **SHORT TERM ALTERNATIVE FLUIDS:** these fluids are characterised by a lower GWP than current refrigerants, but still higher than the long-term requirements fixed by the regulations. Thus, they can be considered as a temporary solution valid for the few years necessary to identify long-term solutions. To give a reference limit, their GWP must be lower than 1000 and in any case significantly lower than present refrigerants GWP. These fluids can be selected amongst the fluids already classified by ASHRAE (from R444A to R463A) and typically constituted by multicomponent mixtures of HFCs and HFOs. HFCs are traditional refrigerants like R32, R125, R134a, characterized by high GWP, while HFOs are the new generation of refrigerants characterised by very low GWP (1-6). GWP of mixtures is a weighted average of components GWP and their amount in the mixture. Typical GWP for ASHRAE mixtures range from 150 to 700, but can be up to 2000. In any case, the presence of HFOs allows reducing the average GWP of the fluids.

b) LONG TERM ALTERNATIVE FLUIDS: international and in particular European regulations have imposed the use of low GWP (<150) refrigerants, with the aim to reduce the impact on global warming and improve the sustainability of HVAC&R systems. Only few chemical compounds can satisfy such condition; they belong to two main groups, that is hydrocarbons (HCs) and hydro-fluoroolefins (HFOs). Thus, long-term alternative fluids for a given application must be identified within pure compounds or mixtures formed by fluids belonging to these groups. The most attractive pure fluids for GSHPs applications could be R1234ze(Z) (for its NBP) or binary and ternary mixtures of HCs+HFOs or HFOs+HFOs. However, thermodynamic properties of these mixtures have not been satisfactorily studied at the moment, thus it is not easy to evaluate which ones are the most suitable.

SELECTION METHODOLOGY: The refrigerants to be used in the new heat pumps are selected among fluids with well-established EoS, by calculating their thermodynamic properties and comparing their performance with the one of the reference fluid, which in case of GSHPs is R410A. Internationally, the most consolidated method is based on inverse cycle simulation taking into account the heat exchange with secondary fluids at fixed conditions. Heat transfer in the heat exchangers is determined by fixing the pinch point temperature (ΔT_{pp}). The thermodynamic analysis is based on both energy and exergy evaluation to compare COP (Coefficient of Performance), VRE or VHE (Volumetric Refrigerating/Heating Efficiency) and distribution of exergy losses along the circuit for both fluids. A parametric analysis at various heat source and sink conditions is required, with the aim to identify the fluid giving the best energetic performance and to evaluate the distribution of the irreversibility sources along the cycle. Special attention must be given to the compression stage and the heat transfer in the evaporator and the condenser.

The other classification of refrigerant is in function of working pressure. Two refrigerant classes may be defined: high-pressure and low-pressure refrigerants. The high-pressure refrigerants are recommended for reversible or multifunction applications, as they can guarantee a very good efficiency. But in general, these refrigerants do not work at high temperature, so it is not possible to produce high temperature water.

The low-pressure refrigerants can work at very high temperatures, therefore high temperature water can be produced efficiently. However, when a pressure drop occurs inside the refrigerant circuit of the heat pump, as it happens within the 4-way valve of a reversible cycle, the efficiency of the heat pump decreases. For this reason, the low-pressure refrigerant is not recommended for a reversible heat pump.

5.3 Compressor types

Of the compressor types mentioned in chapter §1.4.3 where recent market trends are analysed, the following types are more suitable for the geothermal and hybrid source heat pumps under development within the Geo4CivHic project:

- Rotary
- Scroll
- Screw
- Reciprocating

Rotary compressors are suitable for small heat pumps. In general, this type of compressor has not a good efficiency and it is very noisy. Anyway it is very cheap and widespread. It is present in on/off configuration or BLDC version for inverter modulated heat pump. This compressor type can work with all standard refrigerants. Although the envelope of a rotary compressor is small (range of refrigerant supply pressure and temperature), it is sufficient enough for the GSHP units supplying heating and cooling to residential buildings.

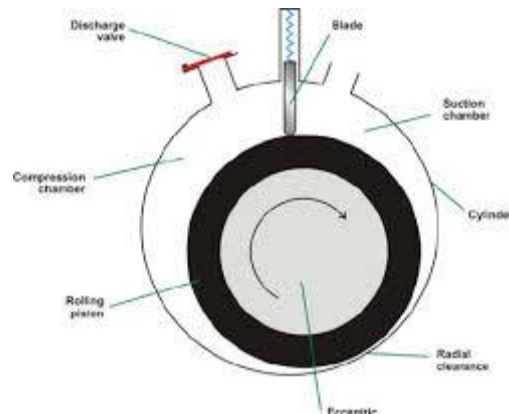


Figure 35: Rotary compressor

Scroll compressors are suitable for medium capacity heat pumps. Compared to rotary compressors, they have better efficiency and similar cost. This technology is available only for high pressure refrigerants, such as R410A or R32. It is possible to put one or more compressors in parallel in order to increase the heating capacity range of the heat pump. Scroll compressor is available in on/off configuration or in BLDC versions for inverter application but only for small size heat pumps.



Figure 36: Scroll compressor

Screw compressors are mainly used in large capacity heat pumps. This compressor technology achieves a big volumetric flow as well as a higher heating capacity. In general, this compressor is used with low pressure refrigerants, such as R134a or R1234ze. Screw compressors can be controlled by means of step capacity control devices or external inverter. Compressor with step

capacity control have 4 steps of partial load (0-25%-50%-75%-100%). This regulation is achieved by using an inside mechanical component, but it causes efficiency losses when the compressor works at partial load. The compressor with external inverter is can achieve a high efficiency in all load conditions.



Figure 37: Screw compressor

The last type is the reciprocating compressor; it is first type of compressor used in the refrigeration history. It is the most durable and reliable, but it is very expensive. It can work with many typologies of refrigerant, but in general uses a low pressure refrigerant in extreme operating conditions. With this technology it is possible to manufacture the heat pump for producing very high temperature water.



Figure 38: Reciprocating Compressor

5.4 Heat exchanger type

Ground source heat pumps use a water-antifreeze mixture (brine) as heat source. Available heat exchangers (evaporator and condenser) types are:

- plate heat exchanger

- shell and tube heat exchanger.

Plate heat exchanger is made by stainless steel or copper plates. The plates allow for an efficient heat transfer without direct contact between refrigerant and secondary fluid such as brine or water. This type of heat exchanger is very cheap and has very good performance; however it cannot elaborate huge mass flow, so it is used only in low and medium capacity GSHPs.



Figure 39: Plate heat exchanger

The shell and tube heat exchanger is composed by a big shell in steel with a lot of parallel tubes inside of it. The refrigerant flows inside the tubes, whilst the water or brine flows between the small tubes and the shell. This type of heat exchanger is suitable for use with large capacity heat pumps.

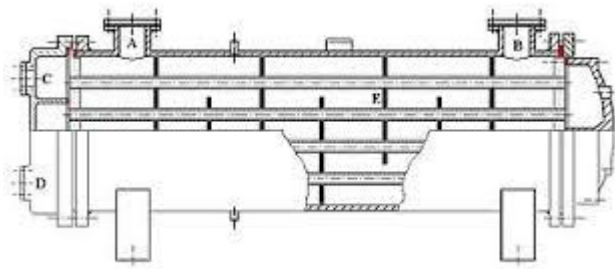


Figure 40: Shell and tubes heat exchanger

5.5 Refrigerant circuit

The simplest refrigerant circuit is a non-reversible refrigerant circuit. This type of heat pump can produce only hot water, so it can work only in heating mode. However, the heat pump operation can be reversed externally by the hydraulic circuit using a set of two 4-way, or four 3-way valves to provide heating and cooling; however 3-way or 4-way valves add complexity and reduce system reliability.

A reversible heat pump allows to produce either hot or cool water. It is possible to add 3-way valves to produce of domestic hot water.

The most complex refrigerant circuit is the multifunction heat pump. This type of heat pump can produce both cold water and domestic hot water at the same time, in total recovery mode.

5.6 Applications Technologies

Summing up, the possible GSHP configurations are:

- low and medium temperature heat pump for small applications with high pressure refrigerant (R410A or R32), rotary or scroll compressor and plate heat exchanger;
- high temperature heat pump for small applications with reciprocation compressor, low pressure refrigerant (R134a and R1234ze) and plate heat exchanger;
- large capacity heat pump with screw compressor, low pressure refrigerant and shell and tubes heat exchanger.

Conclusion

Air source heat pumps dominate the market and tend to gain market share entering traditional segments of ground source heat pumps. Recent trends include efficiency improvements and shift to refrigerants with lower global warming potential. On the other hand, GSHP market segment has remained stagnant with considerable sales volumes only in Sweden, Germany and Finland. Main market barrier has been the additional cost of the ground heat exchanger.

A market survey on GSHP manufacturers, brands and available models was performed, which revealed 23 manufacturers offering 35 GSHP brands of low capacity (2 to 50 kW_{th}) and 11 GSHP brands of high capacity (above 50 kW_{th}), each brand having a variety of models. In the low capacity range only scroll compressors are used, with the majority of brands to be On-Off controlled, a few of which use the soft start up function. Two brands have two stage compressors, two brands have inverter compressor and one brand has twin compressors. The main refrigerant used is R410A, with five brands using R407C and one R134a. The low capacity market is almost equally divided among those brands delivering up to 55°C and those with maximum water supply temperature up to 65°C, while there are a few brands delivering hot water up to 70-80°C. Multi scroll compressor heat pumps also dominate the high capacity market, most of which use R410A as refrigerant, but there are a few brands using R407C or R134a. There is one brand with inverter scroll, three brands with screw compressors and R134a as refrigerant and one with reciprocating compressor and NH₃ as refrigerant. Most high capacity brands deliver up to 55°C hot water, followed by those delivering hot water up to 65°C, while a few brands deliver hot water up to 70-80°C.

Available control strategies include reversibility, building zone control, remote control, smart grid integration, smart price adaptation, photovoltaic integration, integration of several thermal sources, intelligent energy management, as well as on-off, multi compressors and inverter capacity control.

A 12 kW_{th} air to water heat pump costs around 11 thousand euro, while a geothermal heat pump system of the same capacity costs between 18 and 21,5 thousand euro depending on solution adopted (on-off, inverter controlled, multi-function, plug and play), with a corresponding return on investment after 8 years.

Possible GSHP configurations are:

- low and medium temperature heat pump for small applications with high pressure refrigerant (R410A or R32), rotary or scroll compressor and plate heat exchanger;
- high temperature heat pump for small applications with reciprocation compressor, low pressure refrigerant (R134a and R1234ze) and plate heat exchanger;
- large capacity heat pump with screw compressor, low pressure refrigerant and shell and tubes heat exchanger.

References of chapter 1

- [1] JARN, <https://www.ejarn.com/>, 2019.
- [2] ASERCOM – Association of European Refrigeration Component Manufacturers, www.asercom.org, 2019.
- [3] EHPA – European Heat Pump Association, <https://www.ehpa.org/>, 2019.
- [4] IEA-HPT – Heat Pumping Technologies Magazine, <https://heatpumpingtechnologies.org/> , 2019.
- [5] Standard EN14511
- [6] Standard EN14825

Appendix A: Market map

1. Stiebel Eltron

Manufacturer: Stiebel Eltron	Brand name: WPC...cool	Model: WPC (04, 05, 07, 10, 13) cool	
Short description of main technology: Short description of main technology: Heat Pump Brine to Water The WPC cool model can be used for free cooling.			
Heating output at B0/W35 (EN14511):			
Model	Capacity (kWth)	COP	SCOP
WPC04 cool	4,77	4,50	4,93
WPC05 cool	5,82	4,80	5,33
WPC07 cool	7,50	4,84	5,33
WPC10 cool	10,31	5,02	5,40
WPC13 cool	13,21	4,82	5,28
Cooling capacity at B15/W23:			
Model	Capacity (kWth)		
WPC04 cool	3,00		
WPC05 cool	3,80		
WPC07 cool	5,20		
WPC10 cool	6,00		
WPC13 cool	8,50		
Field of application: Heating, DHW and free cooling	Refrigerant: R410A	Supply temperature: 15 °C to 65 °C	

Control: Can be controlled via a home network Compressor (ON/OFF)	Cost:
Strengths & weaknesses: WPC heat pumps by Stiebel Eltron are easy to install even where space is tight, thanks to its compact dimensions and split design. As the 200/DHW cylinder with internal indirect coil is already integrated, high heating power can be delivered with low encumbrance. Space required is further reduced by the integration of the highly efficient circulation pumps and the WPM 3 heat pump control device.	

Manufacturer: Stiebel Eltron	Brand name: WPC....S	Model: WPC (04, 05, 07, 10, 13) S	
Short description of main technology: Heat Pump Brine to Water			
Heating output at B0/W35 (EN14511):			
Model	Capacity (kWth)	COP	SCOP
WPC05 S	5,88	4,78	5,23
WPC07 S	7,61	4,75	5,30
WPC10 S	10,31	4,76	5,20
WPC13 S	13,01	4,75	5,18
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 15 °C to 60 °C	
Control: Can be controlled via a home network Compressor (ON/OFF) Scroll compressor with a soft starter		Cost:	
Strengths & weaknesses: Compact brine / water heat pump is suitable for indoor installation thanks to DHW cylinder integrated. It provides heating and DHW in new buildings as well as in retrofits due to the high flow temperatures. The compact design of the appliance occupies only a very small installation area. The heat pump unit is equipped with a scroll compressor with a soft starter and optimized heat exchangers for improved efficiency.			

Manufacturer: Stiebel Eltron	Brand name: WPC	Model: WPC (04, 05, 07, 10, 13)	
Short description of main technology: Heat Pump Brine to Water			
Heating output at B0/W35 (EN14511):			
Model	Capacity (kWth)	COP	SCOP
WPC04	4,77	4,50	4,93
WPC05	5,82	4,80	5,33
WPC07	7,50	4,84	5,33
WPC10	10,31	5,02	5,40
WPC13	13,21	4,82	5,28
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 15 °C to 65 °C	
Control: Can be controlled via a home network Compressor (ON/OFF)		Cost:	
Strengths & weaknesses: WPC heat pumps by Stiebel Eltron are easy to install even where space is tight, thanks to its compact dimensions and split design. As the 200/DHW cylinder with internal indirect coil is already integrated, high heating power can be delivered with low encumbrance. Space required is further reduced by the integration of the highly efficient circulation pumps and the WPM 3 heat pump control device.			

Manufacturer:	Brand name:	Model:																		
Stiebel Eltron	WPF...basic	WPF (05, 07, 10, 13, 16) basic																		
Short description of main technology: Heat Pump Brine to Water																				
Heating output at B0/W35 (EN14511): <table> <tr> <th>Model</th><th>Capacity (kWth)</th><th>COP</th></tr> <tr> <td>WPF05 Basic</td><td>5,88</td><td>4,33</td></tr> <tr> <td>WPF07 Basic</td><td>7,64</td><td>4,50</td></tr> <tr> <td>WPF10 Basic</td><td>9,70</td><td>4,37</td></tr> <tr> <td>WPF13 Basic</td><td>12,56</td><td>4,42</td></tr> <tr> <td>WPF16 Basic</td><td>16,64</td><td>4,16</td></tr> </table>			Model	Capacity (kWth)	COP	WPF05 Basic	5,88	4,33	WPF07 Basic	7,64	4,50	WPF10 Basic	9,70	4,37	WPF13 Basic	12,56	4,42	WPF16 Basic	16,64	4,16
Model	Capacity (kWth)	COP																		
WPF05 Basic	5,88	4,33																		
WPF07 Basic	7,64	4,50																		
WPF10 Basic	9,70	4,37																		
WPF13 Basic	12,56	4,42																		
WPF16 Basic	16,64	4,16																		
Field of application:	Refrigerant:	Supply temperature:																		
Heating and DHW	R410A	15 °C to 60 °C																		
Control: Can be controlled via a home network Compressor (ON/OFF)		Cost:																		
Strengths & weaknesses: WPF heat pumps provide DHW and central heating. With its integral heating control unit, circulation pump, safety valve and integral heating cartridge, this unit is virtually ready for a basement installation. The heat pump is suitable to be installed at cramped places.																				

Manufacturer:	Brand name:	Model:
Stiebel Eltron	WPF...cool	WPF (04, 05, 07, 10, 13, 16) cool
Short description of main technology:		
Heat Pump Brine to WaterThe WPC cool model can be used for free cooling.		
Heating output at B0/W35 (EN14511):		
Model	Capacity (kWth)	COP
WPC04 cool	4,77	4,50
WPC05 cool	5,82	4,80
WPC07 cool	7,50	4,84
WPC10 cool	10,31	5,02
WPC13 cool	13,21	4,82
WPC16 cool	17,02	4,54
Cooling capacity at B15/W23:		
Model	Capacity (kWth)	
WPC04 cool	3,00	
WPC05 cool	3,80	
WPC07 cool	5,20	
WPC10 cool	6,00	
WPC13 cool	8,50	
WPC16 cool	11,00	
Field of application:	Refrigerant:	Supply temperature:
Heating, DHW and free cooling	R410A	15 °C to 65 °C
Control:		Cost:
Can be controlled via a home network		

Compressor (ON/OFF)	
---------------------	--

Strengths & weaknesses:

Such heat pump model by Stiebel Eltron provides cooling in addition to DHW heating and central heating. This high efficiency unit can be controlled by means of the novel WPM 3 heat pump control device. The expansion vessels for both the heating and brine sides are pre-fitted, as well as the highly efficient circulation pumps for the heating circuit and brine circuit. A further benefit is the combination with any heat pump cylinder from the STIEBEL ELTRON portfolio.

Manufacturer: Stiebel Eltron	Brand name: WPF...S basic	Model: WPF (05, 07, 10,) S basic												
Short description of main technology: Heating output at B0/W35 (EN14511): <table> <tr> <th>Model</th><th>Capacity (kWth)</th><th>COP</th></tr> <tr> <td>WPF05 Basic</td><td>5,80</td><td>4,30</td></tr> <tr> <td>WPF07 Basic</td><td>7,80</td><td>4,40</td></tr> <tr> <td>WPF10 Basic</td><td>9,90</td><td>4,50</td></tr> </table>			Model	Capacity (kWth)	COP	WPF05 Basic	5,80	4,30	WPF07 Basic	7,80	4,40	WPF10 Basic	9,90	4,50
Model	Capacity (kWth)	COP												
WPF05 Basic	5,80	4,30												
WPF07 Basic	7,80	4,40												
WPF10 Basic	9,90	4,50												
Field of application: Heating, DHW	Refrigerant: R410A	Supply temperature: 15 °C to 60 °C												
Control: Can be controlled via a home network Compressor (ON/OFF)		Cost:												
Strengths & weaknesses: WPF heat pumps provide DHW and central heating. With its integral heating control unit, circulation pump, safety valve and integral heating cartridge, this unit is virtually ready for a basement installation. The heat pump is suitable to be installed at cramped places.														

Manufacturer: Stiebel Eltron	Brand name: WPF...S	Model: WPF (05, 07, 10, 13)															
Short description of main technology: Heat Pump Brine to Water																	
Heating output at B0/W35 (EN14511): <table border="1"> <thead> <tr> <th>Model</th><th>Capacity (kWth)</th><th>COP</th></tr> </thead> <tbody> <tr> <td>WPF05S</td><td>5,88</td><td>4,78</td></tr> <tr> <td>WPF07S</td><td>7,61</td><td>4,75</td></tr> <tr> <td>WPF10S</td><td>10,31</td><td>4,46</td></tr> <tr> <td>WPF13S</td><td>13,01</td><td>4,75</td></tr> </tbody> </table>			Model	Capacity (kWth)	COP	WPF05S	5,88	4,78	WPF07S	7,61	4,75	WPF10S	10,31	4,46	WPF13S	13,01	4,75
Model	Capacity (kWth)	COP															
WPF05S	5,88	4,78															
WPF07S	7,61	4,75															
WPF10S	10,31	4,46															
WPF13S	13,01	4,75															
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 15 °C to 60 °C															
Control: Can be controlled via a home networkCompressor (ON/OFF)		Cost:															
Strengths & weaknesses: Such heat pump model by Stiebel Eltron provides cooling in addition to DHW heating and central heating. This high efficiency unit can be controlled by means of the novel WPM 3 heat pump control device. The expansion vessels for both the heating and brine sides are pre-fitted, as well as the highly efficient circulation pumps for the heating circuit and brine circuit. A further benefit is the combination with any heat pump cylinder from the STIEBEL ELTRON portfolio.																	

Manufacturer: Stiebel Eltron	Brand name: WPF	Model: WPF (04, 05, 07, 10, 13,16)																					
Short description of main technology: Heat Pump Brine to Water																							
Heating output at B0/W35 (EN14511): <table> <tr> <th>Model</th><th>Capacity (kWth)</th><th>COP</th></tr> <tr> <td>WPF04</td><td>4,77</td><td>4,50</td></tr> <tr> <td>WPF05</td><td>5,82</td><td>4,80</td></tr> <tr> <td>WPF07</td><td>7,50</td><td>4,484</td></tr> <tr> <td>WPF10</td><td>10,31</td><td>5,02</td></tr> <tr> <td>WPF13</td><td>13,21</td><td>4,82</td></tr> <tr> <td>WPF16</td><td>17,02</td><td>4,54</td></tr> </table>			Model	Capacity (kWth)	COP	WPF04	4,77	4,50	WPF05	5,82	4,80	WPF07	7,50	4,484	WPF10	10,31	5,02	WPF13	13,21	4,82	WPF16	17,02	4,54
Model	Capacity (kWth)	COP																					
WPF04	4,77	4,50																					
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Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 15 °C to 65 °C																					
Control: Can be controlled via a home network Compressor (ON/OFF)		Cost:																					
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Manufacturer: Stiebel Eltron	Brand name: WPW	Model: WPW (06, 07, 10, 13, 18, 22)																					
Short description of main technology: Heat Pump Water to Water Heating output at W10/W35 (EN14511): <table> <tr> <th>Model</th><th>Capacity (kWth)</th><th>COP</th></tr> <tr> <td>WPW06</td><td>5,99</td><td>5,76</td></tr> <tr> <td>WPW07</td><td>7,26</td><td>5,90</td></tr> <tr> <td>WPW10</td><td>9,60</td><td>6,11</td></tr> <tr> <td>WPW13</td><td>13,25</td><td>6,67</td></tr> <tr> <td>WPW18</td><td>16,82</td><td>6,16</td></tr> <tr> <td>WPW22</td><td>20,88</td><td>5,14</td></tr> </table>			Model	Capacity (kWth)	COP	WPW06	5,99	5,76	WPW07	7,26	5,90	WPW10	9,60	6,11	WPW13	13,25	6,67	WPW18	16,82	6,16	WPW22	20,88	5,14
Model	Capacity (kWth)	COP																					
WPW06	5,99	5,76																					
WPW07	7,26	5,90																					
WPW10	9,60	6,11																					
WPW13	13,25	6,67																					
WPW18	16,82	6,16																					
WPW22	20,88	5,14																					
Field of application: Heating, DHW	Refrigerant: R410A	Supply temperature: 15 °C to 65 °C																					
Control: Can be controlled via a home network Compressor (ON/OFF)		Cost:																					
Strengths & weaknesses: <p>The WPF heat pump with the GWS module extracts energy from groundwater. With an appropriately sized on-site well, the WPF heat pump exploits a practically never-ending source of energy. Indeed, in our region, there is no shortage of groundwater. Two boreholes are sufficient to utilise the energy in groundwater. In many cases such a configuration is more favourable than drilling for geothermal probes required for brine/water heat pumps. Groundwater has a relatively constant temperature all year round, therefore the heat pump can operate with a consistently high COP. Moreover, stainless steel plate heat exchanger ensures a long service life and enhances the operational reliability of the heat pump. In the end the heat pump cannot be contaminated by any suspended matter or other contamination sources. The GWS module can be combined with almost all brine/water heat pumps.</p>																							

2. Viessmann

Manufacturer: Viessmann	Brand name: Vitocal 200-G	Model: BWC 201.A06, BWC 201.A08, BWC 201.A10, BWC 201.A13, BWC 201.A17																		
Short description of main technology: Brine to water Heating output at B0/W35 (EN14511): <table> <tr> <th>Model</th><th>Capacity (kWth)</th><th>COP</th></tr> <tr> <td>BWC 201.A06</td><td>5,60</td><td>4,40</td></tr> <tr> <td>BWC 201.A08</td><td>7,60</td><td>4,40</td></tr> <tr> <td>BWC 201.A10</td><td>9,70</td><td>4,40</td></tr> <tr> <td>BWC 201.A13</td><td>13,00</td><td>4,50</td></tr> <tr> <td>BWC 201.A17</td><td>17,20</td><td>4,50</td></tr> </table>			Model	Capacity (kWth)	COP	BWC 201.A06	5,60	4,40	BWC 201.A08	7,60	4,40	BWC 201.A10	9,70	4,40	BWC 201.A13	13,00	4,50	BWC 201.A17	17,20	4,50
Model	Capacity (kWth)	COP																		
BWC 201.A06	5,60	4,40																		
BWC 201.A08	7,60	4,40																		
BWC 201.A10	9,70	4,40																		
BWC 201.A13	13,00	4,50																		
BWC 201.A17	17,20	4,50																		
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 15 °C to 60 °C																		
Control: Scroll compressor on/off		Cost:																		
Strengths & weaknesses: Provides DHW and central heating in mono mode operation all year round. Menu-guided control unit with plain text and graphic display for weather-compensated operation. Natural cooling function and control of the ventilation unit. Heat meter can be retrofitted (option). Prepared for optimized utilization of photovoltaic power generated on site.																				

Manufacturer: Viessmann	Brand name: Vitocal 222-G	Model: BWT 221.A06, BWT 221.A08, BWT 221.A10												
Short description of main technology: Brine to water Heating output at B0/W35 (EN14511): <table> <tr> <th>Model</th><th>Capacity (kWth)</th><th>COP</th></tr> <tr> <td>BWT 221.A06</td><td>6,10</td><td>4,50</td></tr> <tr> <td>BWT 221.A08</td><td>7,40</td><td>4,50</td></tr> <tr> <td>BWT 221.A10</td><td>10,00</td><td>4,50</td></tr> </table>			Model	Capacity (kWth)	COP	BWT 221.A06	6,10	4,50	BWT 221.A08	7,40	4,50	BWT 221.A10	10,00	4,50
Model	Capacity (kWth)	COP												
BWT 221.A06	6,10	4,50												
BWT 221.A08	7,40	4,50												
BWT 221.A10	10,00	4,50												
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 15 °C to 60 °C												
Control: Scroll compressor on/off		Cost:												
Strengths & weaknesses: Compact ground source heat pump with DHW cylinder integrated. It can also be used with conventional radiators. High efficiency circulation pumps have been newly integrated into the heating and brine circuits.														

Manufacturer: Viessmann	Brand name: Vitocal 242-G	Model: BWT 241.A06, BWT 241.A08, BWT 241.A10
Short description of main technology: Brine to water		
Heating output at B0/W35 (EN14511):		
Model	Capacity (kWth)	COP
BWT 241.A06	6,10	4,50
BWT 241.A08	7,40	4,50
BWT 241.A10	10,00	4,50
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 15 °C to 60 °C
Control: Scroll compressor on/off		Cost:
Strengths & weaknesses: Vitocal 242-G compact brine/water heat pump unit with the option of connecting a solar system. High efficiency circulation pumps have been newly integrated into the heating and brine circuits.		

Manufacturer: Viessmann	Brand name: Vitocal 200-G	Model: 301.B06, 301.B08, 301.B10, 301.B13, 301.B17																		
Short description of main technology: Brine to water Heating output at B0/W35 (EN14511): <table> <tr> <th>Model</th><th>Capacity (kWth)</th><th>COP</th></tr> <tr> <td>301.B06</td><td>5,70</td><td>4,60</td></tr> <tr> <td>301.B08</td><td>7,60</td><td>4,70</td></tr> <tr> <td>301.B10</td><td>10,40</td><td>5,00</td></tr> <tr> <td>301.B13</td><td>13,00</td><td>5,00</td></tr> <tr> <td>301.B17</td><td>17,20</td><td>4,70</td></tr> </table>			Model	Capacity (kWth)	COP	301.B06	5,70	4,60	301.B08	7,60	4,70	301.B10	10,40	5,00	301.B13	13,00	5,00	301.B17	17,20	4,70
Model	Capacity (kWth)	COP																		
301.B06	5,70	4,60																		
301.B08	7,60	4,70																		
301.B10	10,40	5,00																		
301.B13	13,00	5,00																		
301.B17	17,20	4,70																		
Water to water Heating output at B0/W35 (EN14511): <table> <tr> <th>Model</th><th>Capacity (kWth)</th><th>COP</th></tr> <tr> <td>301.B06</td><td>7,50</td><td>6,10</td></tr> <tr> <td>301.B08</td><td>10,20</td><td>6,60</td></tr> <tr> <td>301.B10</td><td>13,50</td><td>6,60</td></tr> <tr> <td>301.B13</td><td>16,90</td><td>6,50</td></tr> <tr> <td>301.B17</td><td>22,60</td><td>6,10</td></tr> </table>			Model	Capacity (kWth)	COP	301.B06	7,50	6,10	301.B08	10,20	6,60	301.B10	13,50	6,60	301.B13	16,90	6,50	301.B17	22,60	6,10
Model	Capacity (kWth)	COP																		
301.B06	7,50	6,10																		
301.B08	10,20	6,60																		
301.B10	13,50	6,60																		
301.B13	16,90	6,50																		
301.B17	22,60	6,10																		
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 15 °C to 65 °C																		
Control: Scroll compressor single stage or two stage		Cost:																		

Strengths & weaknesses:

Ground source heat pump (brine to water): heating outputs, single stage: 5.7 to 17.2 kW, two stage: 11.4 to 34.4 kW.

Water/water heat pump: heating outputs, single stage: 7.5 to 22.6 kW, two-stage: 15 to 45.2 kW.

Heat pump with integral high efficiency pump for brine and heating circuits, plus circulation pump for cylinder heating, safety assembly with safety valve, pressure gauge and air vent valve. Designed for Smart Grid integration and utilization of PV power generated on site. Control of a Vitovent 300-F ventilation unit. The Refrigerant Cycle Diagnostic (RCD) system constantly monitors the refrigerant circuit in the Vitocal 300-G and, in conjunction with the electronic expansion valve, ensures the highest efficiency at any operating point, which results in high seasonal performance.

Manufacturer: Viessmann	Brand name: Vitocal 350-G (single stage, master) Vitocal 350-G (2-stage, slave without own control unit)	Model: BW 351.B20, BW 351.B27, BW 351.B33, BW 351.B42, BWS 351.B20, BWS 351.B27, BWS 351.B33, BWS 351.B42															
Short description of main technology: Brine to water Heating output at B0/W35 (EN14511): <table border="1"> <thead> <tr> <th>Model</th><th>Capacity (kWth)</th><th>COP</th></tr> </thead> <tbody> <tr> <td>BW/BWS 351.B20</td><td>20,50</td><td>4,80</td></tr> <tr> <td>BW/BWS 351.B27</td><td>28,70</td><td>4,90</td></tr> <tr> <td>BW/BWS 351.B33</td><td>32,70</td><td>5,00</td></tr> <tr> <td>BW/BWS 351.B42</td><td>42,30</td><td>4,80</td></tr> </tbody> </table>			Model	Capacity (kWth)	COP	BW/BWS 351.B20	20,50	4,80	BW/BWS 351.B27	28,70	4,90	BW/BWS 351.B33	32,70	5,00	BW/BWS 351.B42	42,30	4,80
Model	Capacity (kWth)	COP															
BW/BWS 351.B20	20,50	4,80															
BW/BWS 351.B27	28,70	4,90															
BW/BWS 351.B33	32,70	5,00															
BW/BWS 351.B42	42,30	4,80															
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 15 °C to 65 °C/70 °C															
Control: Scroll compressor single stage or two stage		Cost:															
Strengths & weaknesses: Low running costs with the highest level of efficiency at any operating point through the innovative Refrigerant Cycle Diagnostic (RCD) system with electronic expansion valve (EEV). Mono mode operation for central and DHW heating. Single stage: 20.5 to 42.3 kW, two-stage: 41.0 to 84.6 kW. Flow temperatures of up to 70 °C thanks to EVI compressor for efficient DHW production. The Vitocal 350-G high temperature heat pump extends the product segment by four output sizes up to 84.6 kW. It achieves a high flow temperature of up to 70 °C. This results from the use of an EVI (Enhanced Vapor Injection) refrigerant circuit.																	

3. Bosch (Buderus)

Manufacturer: Bosch (Buderus)	Brand name: Logatherm WPS	Model: 9 Rm, 12 Rm, 16R, 20 R, 23R, 33R		
Short description of main technology: Water to water Nominal heating capacity (IN/OUT 40/35 °C and evaporator IN/OUT 0/-3 °C) and Nominal cooling capacity (IN/OUT 12/7 °C and condenser IN/OUT 30/35 °C)				
Model	Heating Capacity (kWth)	Cooling Ca- pacity (kWc)	COP	EER
9Rm	9,20	8,80	3,92	3,38
12Rm	11,70	11,30	4,57	3,53
16R	16,00	15,70	4,57	3,93
20R	19,80	19,80	4,50	3,88
23R	23,00	22,90	4,57	3,93
33R	33,30	33,40	4,56	3,88
Field of application: Heating, cooling and DHW	Refrigerant: R410A		Supply temperature: 7 °C to 55 °C	
Control: Scroll compressor on/off		Cost:		
Strengths & weaknesses The dynamic pump control (DPC) optimizes the output to meet the demands of your home, providing greater savings. The Energy Measurement System (ESM) clearly shows on the heat pump display how much energy the heat pump is delivering.				

Manufacturer: Bosch (IVT)	Brand name: IVT Greenline HE	Model: C6, C7/E7, C9/E9, C11/E11
Short description of main technology: Brine to water single phase		
Heating output at B0/W35 (EN14511) SCOP (EN14825):		
Model	Capacity (kWth)	SCOP
C6	5,00	4,08
C7/E7	6,60	3,70
C9/E9	8,70	3,87
C11/E11	10,20	4,34
Field of application: Heating and DHW	Refrigerant: R407c	Supply temperature: 15 °C to 65 °C
Control: Scroll compressor on/off, REGO 1000	Cost:	
Strengths & weaknesses The dynamic pump control (DPC) optimizes the output to meet the building demand; huge energy saving is achieved. The Energy Measurement System (ESM) clearly shows on the heat pump display how much energy the heat pump is delivering.		

Manufacturer: Bosch (IVT)	Brand name: IVT Greenline HE	Model: C7, C9/E9, C11/E11, E14, E17																		
Short description of main technology: Brine to water three phase Heating output at B0/W35 (EN14511) SCOP (EN14825): <table border="1"> <thead> <tr> <th>Model</th><th>Capacity (kWth)</th><th>SCOP</th></tr> </thead> <tbody> <tr> <td>C7</td><td>7,20</td><td>3,72</td></tr> <tr> <td>C9/E9</td><td>8,80</td><td>3,87</td></tr> <tr> <td>C11/E11</td><td>10,30</td><td>4,34</td></tr> <tr> <td>E14</td><td>14,80</td><td>3,77</td></tr> <tr> <td>E17</td><td>16,40</td><td>4,12</td></tr> </tbody> </table>			Model	Capacity (kWth)	SCOP	C7	7,20	3,72	C9/E9	8,80	3,87	C11/E11	10,30	4,34	E14	14,80	3,77	E17	16,40	4,12
Model	Capacity (kWth)	SCOP																		
C7	7,20	3,72																		
C9/E9	8,80	3,87																		
C11/E11	10,30	4,34																		
E14	14,80	3,77																		
E17	16,40	4,12																		
Field of application: Heating and DHW	Refrigerant: R407c	Supply temperature: 15 °C to 65 °C																		
Control: Scroll compressor on/off, REGO 1000		Cost:																		
Strengths & weaknesses: The dynamic pump control (DPC) optimizes the output to meet the building demand; huge energy saving is achieved. The Energy Measurement System (ESM) clearly shows on the heat pump display how much energy the heat pump is delivering.																				

Manufacturer: Bosch (MTA)	Brand name: AQUARIUS PLUS 2	Model: 1401, 1601, 1801, 2001, 2301, 2601, 3001, 3301, 2802, 3202, 3402, 3602, 4002, 4302, 4602, 4902, 5202, 5602, 6002, 6602		
Short description of main technology: Water to water. The models 1401 to 3301 have one circuit and one scroll compressors. The models 2802 to 6602 have two circuits and two scroll compressors. All models have single pass shell and tube heat exchangers				
Nominal heating capacity and COP (IN/OUT 40/45 °C and evaporator IN/OUT 12/7 °C) and Nominal cooling capacity and EER (IN/OUT 12/7 °C and condenser IN/OUT 30/35 °C)				
Model	Heating Capacity (kWth)	Cooling Ca- pacity (kWc)	COP	EER
1401	422	377	4,86	5,22
1601	471	422	4,93	5,30
1801	539	482	4,89	5,27
2001	592	531	4,94	5,33
2301	663	595	4,94	5,31
3001	730	655	4,95	5,34
3301	803	722	5,00	5,40
2802	863	776	5,01	5,42
3202	950	849	4,98	5,35
3402	1017	909	4,95	5,32
3602	1078	959	4,90	5,24
4002	1185	1062	4,96	5,36
4302	1252	1122	4,96	5,36
4602	1343	1208	5,01	5,42
4902	1403	1257	4,99	5,38
5202	1463	1307	4,97	5,35
5602	1547	1387	5,02	5,41
6002	1613	1442	5,01	5,39
6602	1688	1499	4,88	5,20
Field of application: Heating and Cooling		Refrigerant: R134a		Supply temperature: 5 °C to 60 °C

Control: Scroll compressor	Cost:
Strengths & weaknesses: High energy efficiency are achieved both for full and partial loads. Stepless cooling capacity regulation with self-adaptive control. High precision and adaptability in cooling capacity regulation. Compressors minimum capacity step 25%. Heat exchangers with low water side pressure drops in order to save pumping costs. Low noise levels, thanks also to the availability of two different acoustic versions. Fully bundled heat recovery solutions. Condenser outlet water temperature up to 60 °C.	

Manufacturer: Bosch (MTA)	Brand name: HOCEAN Tech	Model: 018, 022, 030,040, 050, 070, 100, 130, 150, 200, 230, 280, 350, 400, 500, 600		
Short description of main technology: Water to water. The models 018 to 150 have one compressor. The models 200 to 600 have two compressors. The models 018 to 030 have hermetic rotary compressor, the models 040 to 600 have scroll compressor. Nominal heating capacity and COP (IN/OUT 40/45 °C and evaporator IN/OUT 12/7 °C) and Nominal cooling capacity and EER (IN/OUT 12/7 °C and condenser IN/OUT 30/35 °C)				
Model	Heating Capacity (kWth)	Cooling Capacity (kWc)	COP	EER
018	5	4	3,31	3,19
022	6	5	3,43	3,43
030	8	7	3,41	3,34
040	12	10	3,46	3,83
050	17	15	3,52	3,71
070	26	22	3,50	3,74
100	34	30	3,69	3,93
130	45	40	3,80	4,18
150	50	45	3,78	4,00
200	68	60	3,73	3,97
230	77	68	3,67	3,90
280	94	84	3,72	3,99
350	118	104	3,73	4,04
400	134	121	3,59	4,14
500	172	153	3,63	3,99
600	200	179	3,62	4,01
Field of application: Heating and Cooling		Refrigerant: R410A	Supply temperature: 5 °C to 45 °C	

Control: Scroll compressor	Cost:
Strengths & weaknesses <p>Lowest noise levels, down to 30 dB(A), for installation in residential, surroundings, high EER/COP levels, especially at partial loads, extremely compact, allows installation just about anywhere, operates with water outlet temperatures from 0 °C to 20 °C, unloading function (model 200-600) allowing unit operation even in extreme conditions, self-Adapting Control (SAC) with dynamic set point, for increased precision with low thermal inertias, robust design with high quality components from renowned international suppliers, fruit of MTA's industrial background, flexibility of use, sized for operation with water either from a tower or from a geothermal source, easy installation and complete access to all components, easy to use intuitive controller with dual icon display.</p>	

Manufacturer:	Brand name:	Model:		
Bosch (MTA)	NEPTUNE Tech	075, 090, 100, 110, 120, 135, 150, 165, 180		
Short description of main technology:				
Water to water. The models 075 to 090 have one circuit and three hermetic scroll compressors. The models 100 to 110 have two circuits and four hermetic scroll compressors. The model 135 has two circuits and five hermetic scroll compressors. The models 150, 165 and 180 have two circuits and six hermetic scroll compressors.				
Nominal heating capacity and COP (IN/OUT 40/45 °C and evaporator IN/OUT 12/7 °C) and Nominal cooling capacity and EER (IN/OUT 12/7 °C and condenser IN/OUT 30/35 °C)				
Model	Heating Capacity (kWth)	Cooling Capacity (kWc)	COP	EER
075	270	232	4,27	4,48
090	340	289	4,15	4,27
100	359	307	4,22	4,42
110	403	342	4,07	4,21
120	454	385	4,17	4,24
135	501	428	4,24	4,39
150	549	474	4,39	4,63
165	619	532	4,30	4,49
180	693	593	4,30	4,44
Field of application:				
Heating and Cooling		Refrigerant:	Supply temperature:	
		R410A	5 °C to 45 °C	
Control: Hermetic scroll compressor		Cost:		
Strengths & weaknesses:				
Desuperheater (20% heat recovery). Total heat recovery (100% heat recovery). Antifreeze heater for exchangers.				

4. VAILLANT

Manufacturer: VAILLANT	Brand name: geoTHERM plus	Model: VWS 62/3, VWS 82/3, VWS 102/3, VWS 62/2, VWS 82/2, VWS 102/2
Short description of main technology: Brine to water. The models VWS 62/2, VWS 82/2, VWS 102/2V have supplementary heating (6kW).		
Heating output at B0/W35 (EN 14511):		
Model	Capacity (kWth)	COP
VWS 62/3	6,10	4,70
VWS 82/3	7,80	4,70
VWS 102/3	10,90	4,90
VWS 62/2	5,90	4,30
VWS 82/2	8,00	4,30
VWS 102/2	10,40	4,40
Field of application: Heating, DHW and passive cooling	Refrigerant: R410A	Supply temperature: 25 °C to 62 °C
Control: EVI Scroll compressor	Cost:	
Strengths & weaknesses: Weather-compensating energy balance controller with graphical display of the environmental output. Can be combined with controlled mechanical ventilation. All geoTHERM plus models are equipped with a hot water cylinder.		

Manufacturer: VAILLANT	Brand name: geoTHERM	Model: VWS 61/3, VWS 81/3, VWS 101/3, VWS 141/3, VWS 171/3, VWS 61/2, VWS 81/2, VWS 101/2, VWS 141/2, VWS 171/2, VWS 220/2, VWS 300/2, VWS 380/2, VWS 460/2
Short description of main technology: Brine to water.		
Heating output at B0/W35 (EN 14511):		
Model	Capacity (kWth)	COP
VWS 61/3	6,10	4,70
VWS 81/3	7,80	4,70
VWS 101/3	10,90	4,90
VWS 141/3	14,00	4,70
VWS 171/3	17,60	4,90
VWS 61/2	5,90	4,30
VWS 81/2	8,00	4,30
VWS 101/2	10,40	4,40
VWS 141/2	13,80	4,30
VWS 171/2	17,30	4,30
VWS 220/2	22,00	4,40
VWS 300/2	29,80	4,60
VWS 380/2	38,30	4,50
VWS 460/2	45,90	4,60
Field of application: Heating, DHW and passive cooling	Refrigerant: R410A	Supply temperature: 25 °C to 62 °C
Control: EVI Scroll compressor	Cost:	
Strengths & weaknesses: Weather-compensating energy balance controller with graphical display of the environmental output. Can be combined with controlled mechanical ventilation.		

5. NIBE

Manufacturer: NIBE	Brand name: F1145/F1145PC	Model: F1145-5, F1145-6, F1145-8, F1145-10, F1145-12, F1145-15, F1145-17, F1145-5 PC, F1145-6 PC, F1145-8 PC, F1145-10PC
Short description of main technology: Brine to water.		
Nominal Heating output at B0/W35 and SCOP (EN14825):		
Model	Nominal Heating output (kWth)	SCOP
F1145-5	6	4,60
F1145-6	7	5,00
F1145-8	9	5,10
F1145-10	12	5,20
F1145-12	14	4,90
F1145-15	18	4,70
F1145-17	20	4,50
Field of application: Heating, DHW and passive cooling (only PC models)	Refrigerant: R407C	Supply temperature: 25 °C to 70 °C
Control: Soft starter	Cost:	
Strengths & weaknesses: NIBE F1145 – Ground source heat pump without an integrated water heater. Extraordinarily high efficiency. NIBE F1145PC – Ground source heat pump with integrated passive cooling but without an integrated water heater.		

Manufacturer: NIBE	Brand name: F1155/F1155PC	Model: F1155-6, F1155-12, F1155-16, F1155-6PC
Short description of main technology: Brine to water.		
Nominal Heating output at B0/W35 and SCOP (EN14825):		
Model	Nominal Heating output (kWth)	SCOP
F1155-6	6 (1,50-6,00)	5,50
F1155-12	12 (3,00-12,00)	5,40
F1155-16	16 (4,00-16,00)	5,50
Field of application: Heating, DHW and passive cooling (only PC model)	Refrigerant: R407C	Supply temperature: 25 °C to 70 °C
Control: Speed-controlled compressor	Cost:	
Strengths & weaknesses: NIBE F1155 – Ground source heat pump without an integrated water heater. The heat pump adjusts itself automatically according to the building energy demand. NIBE F1155 PC – Ground source heat pump with passive cooling without integrated water heater. The heat pump adjusts itself automatically to the power demand of the house.		

Manufacturer: NIBE	Brand name: F1245/F1245PC	Model: F1245-5, F1245-6, F1245-8, F1245-10, F1245-12, F1245-5 PC, F1245-6 PC, F1245-8 PC, F1245-10PC
Short description of main technology: Brine to water.		
Nominal Heating output at B0/W35 and SCOP (EN14825):		
Model	Nominal Heating output (kWth)	SCOP
F1245-5	6	4,60
F1245-6	7	5,00
F1245-8	9	5,10
F1245-10	12	5,20
F1245-12	14	4,90
Field of application: Heating, DHW and passive cooling (only PC models)	Refrigerant: R407C	Supply temperature: 25 °C to 70 °C
Control: Soft starter	Cost:	
Strengths & weaknesses: NIBE F1245 – Ground source heat pump with an integrated water heater and extraordinarily high efficiency. NIBE F1245 PC – Ground source heat pump with passive cooling, integrated water heater and extraordinarily high efficiency.		

Manufacturer: NIBE	Brand name: F1255/F1255PC	Model: F1255-6, F1255-12, F1255-16, F1255-6PC
Short description of main technology: Brine to water.		
Nominal Heating output at B0/W35 and SCOP (EN14825):		
Model	Nominal Heating output (kWth)	SCOP
F1255-6	6 (1,50-6,00)	5,50
F1255-12	12 (3,00-12,00)	5,40
F1255-16	16 (4,00-16,00)	5,50
Field of application: Heating, DHW and passive cooling (only PC model)	Refrigerant: R407C	Supply temperature: 25 °C to 70 °C
Control: Speed-controlled compressor	Cost:	
Strengths & weaknesses: NIBE F1255 – Inverter controlled ground source heat pump with an integrated water heater and extraordinarily high efficiency. F1255 PC – Inverter controlled ground source heat pump with passive cooling, integrated water heater and extraordinarily high efficiency. Integrated water heater.		

Manufacturer: NIBE	Brand name: F1345	Model: F1345-24, F1345-30, F1345-40, F1345-60,															
Short description of main technology: Brine to water.																	
Nominal Heating output at B0/W35 and SCOP (EN14825): <table border="1"> <thead> <tr> <th>Model</th> <th>Nominal Heating output (kWth)</th> <th>SCOP</th> </tr> </thead> <tbody> <tr> <td>F1345-24</td> <td>28</td> <td>5,00</td> </tr> <tr> <td>F1345-30</td> <td>35</td> <td>4,90</td> </tr> <tr> <td>F1345-40</td> <td>46</td> <td>5,00</td> </tr> <tr> <td>F1345-60</td> <td>67</td> <td>4,70</td> </tr> </tbody> </table>			Model	Nominal Heating output (kWth)	SCOP	F1345-24	28	5,00	F1345-30	35	4,90	F1345-40	46	5,00	F1345-60	67	4,70
Model	Nominal Heating output (kWth)	SCOP															
F1345-24	28	5,00															
F1345-30	35	4,90															
F1345-40	46	5,00															
F1345-60	67	4,70															
Field of application: Heating and DHW	Refrigerant: R407C/R410a	Supply temperature: 25 °C to 65 °C															
Control: Soft starter, twin scroll for the large capacity model.		Cost:															
Strengths & weaknesses																	

6. BAXI

Manufacturer: BAXI	Brand name: GEOFLO	Model: GEOFLO 4, 6, 8, 10
Short description of main technology: Brine to water.		
Nominal Heating output at B0/W35 and COP:		
Model	Nominal Heating output (kWth)	SCOP
Geoflo 4	4	4,00
Geoflo 6	6	4,00
Geoflo 8	8	4,00
Geoflo 10	10	4,00
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 30 °C and 45 °C
Control: Single phase compressor (on/off)	Cost:	
Strengths & weaknesses: Weather compensation sensor		

7. Aermec

Manufacturer:	Brand name:	Model:		
Aermec	HWS	HWS 0601, 0701, 0801, 0901, 1101, 1202, 1402		
Short description of main technology:				
Water to water.				
(1) Water system side (in/out) 12°C/7°C Water condenser (in/out) 30°C/35°C				
(2) Water system side (in/out) 40°C/45°C Water evaporator (in/out) 10°C/7°C				
Model	Cooling output (kWc) (1)	EER	Heating output (kWth) (2)	COP
HWS 0601	146,40	4,61	164,30	4,33
HWS 0701	179,00	4,69	199,70	4,40
HWS 0801	212,00	4,91	235,30	4,57
HWS 0901	233,00	4,74	260,60	4,44
HWS 1101	233,00	4,91	324,80	4,56
HWS 1202	293,00	4,61	328,60	4,31
HWS 1402	356,00	4,63	398,90	4,33
Field of application:		Refrigerant:		Supply temperature:
Heating and Cooling		R134a		45 °C
Control: Twin screw compressor. The models WS 0601 to WS 1101 have one compressor and one circuit. All others models have two compressors and two circuits.			Cost:	
Strengths & weaknesses: High efficiency, low noise screw compressors with modulating capacity control from 40 to 100% with standard thermostatic expansion valve (25 to 100% with electronic expansion valve option). Units for internal installation offering chilled/hot water (reversible on the water side). Compact and flexible, perfect alignment to the requested load thanks to an accurate control algorithm. The screw compressors are optimized for low condensing temperatures, plate heat exchangers are applied on both the system and source side. The base and frame are in steel treated with anticorrosion polyester paint. With the addition of a desuperheater or total recovery system, domestic hot water can also be produced.				

Manufacturer: Aermec	Brand name: NXW	Model: NXW 500, 550, 600, 650, 700, 750, 800, 900, 1000, 1250, 1400, 1500, 1650		
Short description of main technology: Water to water. (1) Water system side (in/out) 12°C/7°C Water condenser (in/out) 30°C/35°C (2) Water system side (in/out) 40°C/45°C Water evaporator (in/out) 10°C/7°C				
Model	Cooling out-put (kWc) (1)	EER	Heating out-put (kWth) (2)	COP
NXW 500	111,60	4,83	127,90	4,63
NXW 550	120,50	4,83	138,10	4,62
NXW 600	148,40	4,84	170,40	4,40
NXW 650	166,30	4,84	190,90	4,67
NXW 700	188,20	4,83	216,10	4,66
NXW 750	222,00	4,87	256,00	4,71
NXW 800	256,90	4,84	294,40	4,68
NXW 900	290,70	4,82	333,90	4,62
NXW 1000	325,00	4,89	372,50	4,72
NXW 1250	353,90	4,87	405,80	4,71
NXW 1400	383,80	4,88	440,00	4,72
NXW 1500	453,00	4,89	518,90	4,73
NXW 1650	510,20	4,91	584,00	4,74
Field of application: Heating and Cooling		Refrigerant: R410A		Supply temperature: 45 °C
Control: Hermetic Scroll compressor. The models NWX 500 and NWX 550 have three compressors and two circuits. All others models have four compressors and two circuits.				Cost:

Strengths & weaknesses:

The NXW controller provides several functions:

- Two chiller units in parallel (run/standby)
- Programmed pump rotation
- Inverter condenser pump control to manage the condensing pressure
- Programmable time-clock
- Automatic water set point compensation
- Data logging

Manufacturer:	Brand name:	Model:		
Aermec	VENICE	VENICE 20, 25, 30		
Short description of main technology:				
Water to water.				
(1) Water system side (in/out) 12°C/7°C Water condenser (in/out) 30°C/35°C				
(2) Water system side (in/out) 40°C/45°C Water evaporator (in/out) 10°C/7°C				
Model	Cooling output (kWc)	EER	Heating output (kWth)	COP
Venice 20	6,94	3,99	8,20	3,35
Venice 25	8,24	4,16	9,70	3,41
Venice 30	9,75	4,10	11,50	3,41
Field of application:		Refrigerant:	Supply temperature:	
Heating and Cooling		R407C	45 °C	
Control: Scroll compressor		Cost:		
Strengths & weaknesses:				
VENICE is designed and built to meet the heating and cooling needs of small/medium-sized services in residential buildings. It can be installed in the narrowest spaces thanks to its compact size. It works with R407C gas and is designed for indoor installation. The units have high-efficiency plate heat exchangers and are characterized by extremely quiet operation thanks to the scroll compressors that ensure optimum performance and low noise levels. They are factory tested, so only require the hydraulic and electric connections at the installation site. The units have an IP24 protection level. Fitted with an accumulation tank, water filter, safety valve, differential pressure switch and flow switch.				

Manufacturer:	Brand name:	Model:		
Aermec	WF	WF 2512, 2812, 3212, 3612, 4212, 4812, 5612, 7213, 8413, 9613		
Short description of main technology:				
Water to water.				
(1) Water system side (in/out) 12°C/7°C Water condenser (in/out) 30°C/35°C				
(2) Water system side (in/out) 40°C/45°C Water evaporator (in/out) 10°C/7°C				
Model	Cooling out-put (kWc) (1)	EER	Heating output (kWth) (2)	COP
WF 2512	630,00	5,04	702,80	4,52
WF2812	720,00	5,03	807,30	4,55
WF3212	872,00	5,01	973,30	4,50
WF3612	984,00	5,05	1.097,00	4,53
WF4212	1.111,00	5,06	1.237,70	4,54
WF4812	1.276,00	5,02	1.403,50	4,55
WF5612	1.406,00	5,02	1.577,10	4,54
WF7213	1.877,00	5,00	2.086,40	4,42
WF8413	2.085,00	4,93	2.337,40	4,44
WF9613	2.310,00	4,94	2.599,00	4,44
Field of application:	Refrigerant:	Supply temperature:		
Heating and Cooling	R134a	50 °C		
Control: Screw compressor. The models WF 2512 to WF 6412 have two compressors and two circuits. All others models have three compressors and two circuits. All models have two shell & tubes heat exchangers.			Cost:	
Strengths & weaknesses:				
Leaving water temperature control with modulating capacity control (12.5-100% for each compressor) and dynamic display of the refrigeration capacity.				

Manufacturer: Aermec	Brand name: WRL	Model: WRL 026, 031, 041, 051, 071, 081, 101, 141, 161																																																																			
Short description of main technology: Water to water. (1) Water system side (in/out) 12°C/7°C Water condenser (in/out) 30°C/35°C (2) Water system side (in/out) 40°C/45°C Water evaporator (in/out) 10°C/7°C																																																																					
<table><tr><th>Model</th><th>Cooling out-put (kWc)</th><th>EER</th><th>Heating out-put (kWth)</th><th>COP</th></tr><tr><td>WRL 026 (230 Volt)</td><td>6,58</td><td>4,19</td><td>7,70</td><td>3,78</td></tr><tr><td>WRL 031(230 Volt)</td><td>8,27</td><td>4,38</td><td>9,40</td><td>3,81</td></tr><tr><td>WRL 041(230 Volt)</td><td>11,30</td><td>4,41</td><td>12,60</td><td>3,96</td></tr><tr><td>WRL 026 (400 Volt)</td><td>6,70</td><td>4,37</td><td>7,70</td><td>3,85</td></tr><tr><td>WRL 031(400 Volt)</td><td>8,40</td><td>4,60</td><td>9,30</td><td>3,95</td></tr><tr><td>WRL 041(400 Volt)</td><td>11,30</td><td>4,25</td><td>12,70</td><td>3,85</td></tr><tr><td>WRL 051(400 Volt)</td><td>14,70</td><td>4,57</td><td>16,30</td><td>3,97</td></tr><tr><td>WRL 071(400 Volt)</td><td>19,20</td><td>4,63</td><td>21,20</td><td>4,09</td></tr><tr><td>WRL 081(400 Volt)</td><td>21,80</td><td>4,49</td><td>24,10</td><td>3,97</td></tr><tr><td>WRL 101(400 Volt)</td><td>29,40</td><td>4,61</td><td>32,60</td><td>4,01</td></tr><tr><td>WRL 141(400 Volt)</td><td>38,40</td><td>4,65</td><td>42,30</td><td>4,11</td></tr><tr><td>WRL 161(400 Volt)</td><td>43,70</td><td>4,54</td><td>48,30</td><td>4,01</td></tr></table>					Model	Cooling out-put (kWc)	EER	Heating out-put (kWth)	COP	WRL 026 (230 Volt)	6,58	4,19	7,70	3,78	WRL 031(230 Volt)	8,27	4,38	9,40	3,81	WRL 041(230 Volt)	11,30	4,41	12,60	3,96	WRL 026 (400 Volt)	6,70	4,37	7,70	3,85	WRL 031(400 Volt)	8,40	4,60	9,30	3,95	WRL 041(400 Volt)	11,30	4,25	12,70	3,85	WRL 051(400 Volt)	14,70	4,57	16,30	3,97	WRL 071(400 Volt)	19,20	4,63	21,20	4,09	WRL 081(400 Volt)	21,80	4,49	24,10	3,97	WRL 101(400 Volt)	29,40	4,61	32,60	4,01	WRL 141(400 Volt)	38,40	4,65	42,30	4,11	WRL 161(400 Volt)	43,70	4,54	48,30	4,01
Model	Cooling out-put (kWc)	EER	Heating out-put (kWth)	COP																																																																	
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Field of application: Heating and Cooling		Refrigerant: R410A		Supply temperature: 45 °C																																																																	
Control: Scroll compressor. The models WRL 101, WRL 141 and WRL 161 have two compressors and one circuit.			Cost:																																																																		

Strengths & weaknesses

WRL is the range of water cooled chillers operating with refrigerant R410A. They are internal units with hermetic scroll compressors that respond perfectly to the market requirements, small dimensions, easy installation, low noise. Connections: The electric and hydraulic connections are all located on the upper part of the unit facilitating installation and maintenance. This allows reduced plant room space and installation in the smallest space possible. Silent: The WRL units are distinguished for their silence in operation. Careful soundproofing of the unit with suitable sound-absorbent material results in low sound levels for all units. Dynamic set point: Using the latest generation of electronic controller and with an external air temperature sensor "KSAE" (accessory). The heat pump unit can vary the leaving water temperature based on climatic conditions, thus increasing the energy efficiency of the system.

Manufacturer:	Brand name:	Model:		
Aermec	WRL	WRL 180, 200, 300, 400, 500, 550, 600, 650		
Short description of main technology:				
Water to water.				
(1) Water system side (in/out) 12°C/7°C Water condenser (in/out) 30°C/35°C				
(2) Water system side (in/out) 40°C/45°C Water evaporator (in/out) 10°C/7°C				
Model	Cooling out-put (kWc)	EER	Heating output (kWth)	COP
WRL 180	50,00	4,52	56,00	4,22
WRL 200	64,00	4,42	72,90	4,13
WRL 300	74,00	4,39	84,40	4,12
WRL 400	86,00	4,67	96,10	4,29
WRL 500	100,00	4,86	111,10	4,47
WRL 550	129,00	4,79	144,20	4,39
WRL 600	150,00	4,83	166,80	4,41
WRL 650	168,00	4,71	188,50	4,30
Field of application:	Refrigerant:		Supply temperature:	
Heating and Cooling	R410A		45 °C	
Control: Scroll compressor. All models have two compressors and one circuit. Capacity control 50%-100%			Cost:	
Strengths & weaknesses				
WRL is the range of water cooled chillers operating with refrigerant R410A. They are internal units with hermetic scroll compressors that respond perfectly to the market requirements, small dimensions, easy of installation, low noise. Connections: The electric and hydraulic connections are all located on the upper part of the unit facilitating installation and maintenance. This allows reduced plant room space and installation in the smallest space possible. Silent: The WRL units are distinguished for their silence in operation. Careful soundproofing of the unit with suitable sound-absorbent material results in low sound levels for all units. Dynamic set point: Using the latest generation of electronic controller and with an external air temperature sensor "KSAE" (accessory). the heat pump unit can vary the leaving water temperature based on climatic conditions, thus increasing the energy efficiency of the system.				

Manufacturer: Aermec	Brand name: WRL-ABP	Model: WRL ABP 026, 031, 041, 051, 071, 081, 101, 141, 161		
Short description of main technology: Water to water. (1) Water system side (in/out) 12°C/7°C Water condenser (in/out) 30°C/35°C (2) Water system side (in/out) 40°C/45°C Water evaporator (in/out) 10°C/7°C				
Model	Cooling out-put (kWc)	EER	Heating out-put (kWth)	COP
WRL ABP 026 (230 Volt)	6,70	4,89	7,50	4,16
WRL ABP 031(230 Volt)	8,42	5,07	9,30	4,18
WRL ABP 041(230 Volt)	11,48	5,06	12,40	4,28
WRL ABP 026 (400 Volt)	6,80	5,11	7,60	4,25
WRL ABP 031(400 Volt)	8,50	5,39	9,20	4,35
WRL ABP 041(400 Volt)	11,50	4,84	12,50	4,15
WRL ABP 051(400 Volt)	14,90	5,03	16,10	4,25
WRL ABP 071(400 Volt)	19,44	5,06	20,90	4,34
WRL ABP 081(400 Volt)	22,06	4,88	23,90	4,15
WRL ABP 101(400 Volt)	30,08	4,80	31,90	3,98
WRL ABP 141(400 Volt)	39,31	4,84	41,30	4,10
WRL ABP 161(400 Volt)	44,70	4,74	47,20	4,01
Field of application: Heating and Cooling	Refrigerant: R410A	Supply temperature: 45 °C		
Control: Scroll compressor. The models WRL 101, WRL 141 and WRL 161 have two compressors and one circuit. ABP models have buffer tanks and circulator inverter.		Cost:		

Strengths & weaknesses

WRL ABP is the range of water cooled chillers operating with refrigerant R410A. They are internal units with hermetic scroll compressors that respond perfectly to the market requirements, small dimensions, easy installation, low noise. Connections: The electric and hydraulic connections are all located on the upper part of the unit facilitating installation and maintenance. This allows reduced plant room space and installation in the smallest space possible. Silent: The WRL ABP units are distinguished for their silence in operation. Careful soundproofing of the unit with suitable sound-absorbent material results in low sound levels for all units. Dynamic set point: Using the latest generation of electronic controller and with an external air temperature sensor "KSAE" (accessory). the heat pump unit can vary the leaving water temperature based on climatic conditions, thus increasing the energy efficiency of the system.

Manufacturer: Aermec	Brand name: WS	Model: WS 0601, 0701, 0801, 0901, 1101, 1202, 1402, 1602, 1802, 2002, 2202, 2502, 2802		
Short description of main technology: Water to water. (1) Water system side (in/out) 12°C/7°C Water condenser (in/out) 30°C/35°C (2) Water system side (in/out) 40°C/45°C Water evaporator (in/out) 10°C/7°C				
Model	Cooling out-put (kWc) (1)	EER	Heating out-put (kWth) (2)	COP
WS 0601	148,00	5,06	165,30	4,50
WS 0701	187,00	5,09	209,10	4,52
WS 0801	212,00	5,06	237,80	4,50
WS 0901	234,00	5,07	261,90	4,51
WS 1101	299,00	5,09	334,70	4,52
WS 1202	308,00	5,09	344,90	4,49
WS 1402	369,00	5,06	413,20	4,49
WS 1602	421,00	5,06	472,00	4,48
WS 1802	469,00	5,06	525,90	4,47
WS 2002	545,00	5,10	609,30	4,50
WS 2202	599,00	5,11	669,60	4,50
WS 2502	653,00	5,10	730,50	4,49
WS 2802	699,00	5,11	781,30	4,49
Field of application: Heating and Cooling	Refrigerant: R134a	Supply temperature: 45 °C		
Control: Twin screw compressor. The models WS 0601 to WS 1101 have one compressor and one circuit. All others models have two compressors and two circuits.		Cost:		
Strengths & weaknesses: High efficiency, low noise screw compressors with modulating capacity control from 40 to 100% with standard thermostatic expansion valve. (25 to 100% with electronic expansion valve option).				

Manufacturer: Aermec	Brand name: WWM	Model: WWM 0500 (Single refrigerant circuit) WWM 0500 (Double refrigerant circuit)		
Short description of main technology: Water to water. (1) Water system side (in/out) 12°C/7°C Water condenser (in/out) 30°C/35°C (2) Water system side (in/out) 40°C/45°C Water evaporator (in/out) 10°C/7°C				
Model	Cooling output (kWc)	EER	Heating output (kWth)	COP
WWM 0500 (Single re- frigerant circuit)	96,00	4,70	109,00	4,35
WWM 0500 (Double re- frigerant circuit)	95,00	4,72	107,00	4,31
Field of application: Heating and Cooling	Refrigerant: R410A	Supply temperature: 45 °C		
Control: Scroll compressor. The models has two compressors and one circuit (single) and two circuit (double).		Cost:		
Strengths & weaknesses: Single refrigerant circuit. Double refrigerant circuit.				

8. CLIMAVENETA

Manufacturer: CLIMAVENETA	Brand name: BWR MTD2	Model: BWR MTD2 0011, 0025, 0031, 0041, 0061, 0071, 0091, 0101, 0121																																																																	
Short description of main technology: Heating capacity at 0/-3°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER																																																																			
<table><tr><th>Model</th><th>Heating capacity (kWth)</th><th>COP</th><th>Cooling capacity (kWc)</th><th>EER</th></tr><tr><td>BWR MTD2 0011 (230V)</td><td>5,23</td><td>3,06</td><td>5,17</td><td>3,47</td></tr><tr><td>BWR MTD2 0025 (230V)</td><td>7,21</td><td>3,13</td><td>7,16</td><td>3,60</td></tr><tr><td>BWR MTD2 0031 (230V)</td><td>9,11</td><td>3,03</td><td>8,84</td><td>3,38</td></tr><tr><td>BWR MTD2 0041 (230V)</td><td>11,50</td><td>3,19</td><td>11,30</td><td>3,53</td></tr><tr><td>BWR MTD2 0025 (400V)</td><td>7,13</td><td>3,23</td><td>7,34</td><td>3,84</td></tr><tr><td>BWR MTD2 0031 (400V)</td><td>8,84</td><td>3,26</td><td>8,88</td><td>3,71</td></tr><tr><td>BWR MTD2 0041 (400V)</td><td>12,00</td><td>3,24</td><td>11,80</td><td>3,69</td></tr><tr><td>BWR MTD2 0061 (400V)</td><td>15,50</td><td>3,52</td><td>15,70</td><td>3,93</td></tr><tr><td>BWR MTD2 0071 (400V)</td><td>19,10</td><td>3,41</td><td>19,80</td><td>3,88</td></tr><tr><td>BWR MTD2 0091 (400V)</td><td>22,20</td><td>3,58</td><td>22,90</td><td>3,95</td></tr><tr><td>BWR MTD2 0101 (400V)</td><td>25,50</td><td>3,45</td><td>26,00</td><td>3,82</td></tr><tr><td>BWR MTD2 0121 (400V)</td><td>32,50</td><td>3,61</td><td>33,40</td><td>3,98</td></tr></table>			Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER	BWR MTD2 0011 (230V)	5,23	3,06	5,17	3,47	BWR MTD2 0025 (230V)	7,21	3,13	7,16	3,60	BWR MTD2 0031 (230V)	9,11	3,03	8,84	3,38	BWR MTD2 0041 (230V)	11,50	3,19	11,30	3,53	BWR MTD2 0025 (400V)	7,13	3,23	7,34	3,84	BWR MTD2 0031 (400V)	8,84	3,26	8,88	3,71	BWR MTD2 0041 (400V)	12,00	3,24	11,80	3,69	BWR MTD2 0061 (400V)	15,50	3,52	15,70	3,93	BWR MTD2 0071 (400V)	19,10	3,41	19,80	3,88	BWR MTD2 0091 (400V)	22,20	3,58	22,90	3,95	BWR MTD2 0101 (400V)	25,50	3,45	26,00	3,82	BWR MTD2 0121 (400V)	32,50	3,61	33,40	3,98
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER																																																															
BWR MTD2 0011 (230V)	5,23	3,06	5,17	3,47																																																															
BWR MTD2 0025 (230V)	7,21	3,13	7,16	3,60																																																															
BWR MTD2 0031 (230V)	9,11	3,03	8,84	3,38																																																															
BWR MTD2 0041 (230V)	11,50	3,19	11,30	3,53																																																															
BWR MTD2 0025 (400V)	7,13	3,23	7,34	3,84																																																															
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BWR MTD2 0061 (400V)	15,50	3,52	15,70	3,93																																																															
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BWR MTD2 0121 (400V)	32,50	3,61	33,40	3,98																																																															
Field of application: Heating, cooling and DHW	Refrigerant: R410A	Supply temperature: 45 °C																																																																	
Control: Scroll compressor (on/off). All models have one circuit.		Cost:																																																																	
Strengths & weaknesses Flexibility, domestic hot water production, optimized for central heating, Nadisystem for intelligent control of available energy sources.																																																																			

Manufacturer: CLIMAVENETA	Brand name: NX-WN	Model: NX-WN 0122, 0152, 0182, 0202, 0252, 0262, 0302, 0352, 0402, 0452, 0502, 0552, 0602, 0702, 0802, 0604, 0704, 0804, 0904, 1004, 1104, 1204
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Short description of main technology:**Heating capacity at 10/7°C and 40/45°C and COP****Cooling capacity at 12/7°C and 30/35°C and EER**

Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
NX-WN 0122	41,80	4,31	37,50	4,85
NX-WN 0152	52,10	4,38	46,70	4,91
NX-WN 0182	61,20	4,47	55,00	4,95
NX-WN 0202	71,50	4,47	63,90	4,95
NX-WN 0252	78,60	4,44	70,80	5,02
NX-WN 0262	89,50	4,41	80,50	4,94
NX-WN 0302	105,00	4,44	94,60	4,93
NX-WN 0352	121,00	4,44	109,00	4,92
NX-WN 0402	137,00	4,45	123,00	4,95
NX-WN 0452	154,00	4,44	138,00	4,91
NX-WN 0502	172,00	4,42	154,00	4,89
NX-WN 0552	197,00	4,46	177,00	4,93
NX-WN 0602	222,00	4,47	200,00	4,94
NX-WN 0702	251,00	4,45	225,00	4,87
NX-WN 0802	281,00	4,45	252,00	4,83
NX-WN 0604	208,00	4,35	187,00	4,78
NX-WN 0704	239,00	4,35	215,00	4,79

NX-WN 0804	270,00	4,36	244,00	4,81
NX-WN 0904	305,00	4,35	275,00	4,80
NX-WN 1004	340,00	4,36	306,00	4,79
NX-WN 1104	390,00	4,39	351,00	4,83
NX-WN 1204	439,00	4,40	396,00	4,84

Field of application: Heating, cooling and DHW	Refrigerant: R410A	Supply temperature: 45 °C
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Control: All models have two scroll compressors, one circuit and two capacity steps (0-50%-100%).	Cost:
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Strengths & weaknesses High efficiency, erp ready, variable primary flow (option), extremely silent operation, integrated condensation’s control total versatility, electronic expansion valve supplied standard.

9. CLIVET

Manufacturer: CLIVET	Brand name: WSHN-EE	Model: WSHN-EE 17, 21, 31, 41, 51, 61, 71, 81, 91, 101, 121		
Short description of main technology: Heating capacity at 10/7°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
WSHN-EE 17	6,68	4,19	6,23	4,04
WSHN-EE 21	7,27	4,19	6,57	3,93
WSHN-EE 31	8,83	3,63	8,05	3,95
WSHN-EE 41	11,50	3,81	10,8	4,39
WSHN-EE 51	15,60	3,94	13,20	3,93
WSHN-EE 61	18,90	3,92	16,30	3,87
WSHN-EE 71	23,60	3,97	20,70	4,07
WSHN-EE 81	25,10	3,79	22,30	4,27
WSHN-EE 91	29,30	3,93	25,80	4,13
WSHN-EE 101	34,20	3,87	29,50	4,00
WSHN-EE 121	38,70	3,97	33,10	4,06
Field of application: Heating, cooling and DHW	Refrigerant: R410A	Supply temperature: 55 °C		
Control: All models have hermetic scroll compressors, one circuit.		Cost:		
Strengths & weaknesses They preserve all the benefits of air-cooled units, such as efficiency, automatic adaptation, and silent operation. Suitable for systems with terminal units, radiant panels or radiators Heating and cooling, using the heat from the ground (geothermal) or water Flexible operation: water to water or glycol water to water.				

Manufacturer: CLIVET	Brand name: WSHN-XEE2	Model: WSHN-XEE2 10.2, 12.2, 14.2, 16.2, 19.2, 22.2, 27.2, 30.2, 35.2, 40.2, 43.2, 45.2, 50.2, 55.2, 60.2, 70.2, 80.2, 90.2, 100.2, 120.2		
Short description of main technology: Heating capacity at 10/7°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
WSHN-XEE2 10.2	34,40	4,20	29,20	4,57
WSHN-XEE2 12.2	40,40	4,19	34,40	4,58
WSHN-XEE2 14.2	48,00	4,15	40,70	4,47
WSHN-XEE2 16.2	56,80	4,25	48,40	4,56
WSHN-XEE2 19.2	67,00	4,27	57,70	4,62
WSHN-XEE2 22.2	79,50	4,15	67,60	4,38
WSHN-XEE2 27.2	93,80	4,38	82,00	4,68
WSHN-XEE2 30.2	107,00	4,32	91,80	4,49
WSHN-XEE2 35.2	119,00	4,21	102,00	4,32
WSHN-XEE2 40.2	139,00	4,30	120,00	4,47
WSHN-XEE2 43.2	151,00	4,18	131,00	4,38
WSHN-XEE2 45.2	163,00	4,24	138,00	4,37
WSHN-XEE2 50.2	178,00	4,32	155,00	4,52
WSHN-XEE2 55.2	195,00	4,27	168,00	4,46
WSHN-XEE2 60.2	218,00	4,20	187,00	4,38
WSHN-XEE2 70.2	252,00	4,34	217,00	4,50
WSHN-XEE2 80.2	280,00	4,27	240,00	4,40
WSHN-XEE2 90.2	314,00	4,17	265,00	4,31
WSHN-XEE2 100.2	343,00	4,16	292,00	4,31
WSHN-XEE2 120.2	408,00	4,07	347,00	4,25
Field of application: Heating, cooling and DHW	Refrigerant: R410A	Supply temperature: 55 °C		
Control: All models have two hermetic scroll compressors and one circuit.		Cost:		

Strengths & weaknesses

HIGH SEASONAL EFFICIENCY - The combination of different size compressors allows to gain more control steps, to provide the energy actually required by the system, to reduce the consumption and to achieve the high seasonal efficiency. The unit reaches the Eurovent Class A heating and cooling for use with underfloor heating. VERSION GROUND WATER OR GEOTHERMAL - The use of heat exchangers for specific applications with ground water or geothermal closed loop maximize the energy efficiency. PREASSEMBLED UNIT - All major components are provided on the unit, ensuring maximum reliability and ease of installation.

The compact construction allows combining multiple units in confined spaces, realizing a high power system. The control allows coordinating up to 7 units managing automatically the operation with maximum efficiency.

Manufacturer: CLIVET	Brand name: WSHN-XSC3	Model: WSHN-XSC3 70.4, 75.4, 80.4, 90.4, 100.4, 110.4, 120.4, 140.4, 160.4, 180.4, 200.4, 220.4, 240.4																																																																													
Short description of main technology: Heating capacity at 10/7°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER																																																																															
<table><tr><th>Model</th><th>Heating capacity (kWth)</th><th>COP</th><th>Cooling capacity (kWc)</th><th>EER</th></tr><tr><td>WSHN-XSC3 70.4</td><td>244,00</td><td>4,13</td><td>211,00</td><td>4,36</td></tr><tr><td>WSHN-XSC3 75.4</td><td>260,00</td><td>4,06</td><td>225,00</td><td>4,28</td></tr><tr><td>WSHN-XSC3 80.4</td><td>279,00</td><td>4,13</td><td>242,00</td><td>4,36</td></tr><tr><td>WSHN-XSC3 85.4</td><td>302,00</td><td>4,06</td><td>261,00</td><td>4,29</td></tr><tr><td>WSHN-XSC3 90.4</td><td>327,00</td><td>4,08</td><td>283,00</td><td>4,32</td></tr><tr><td>WSHN-XSC3 100.4</td><td>358,00</td><td>4,14</td><td>313,00</td><td>4,42</td></tr><tr><td>WSHN-XSC3 110.4</td><td>393,00</td><td>4,15</td><td>341,00</td><td>4,37</td></tr><tr><td>WSHN-XSC3 120.4</td><td>446,00</td><td>4,18</td><td>389,00</td><td>4,46</td></tr><tr><td>WSHN-XSC3 140.4</td><td>508,00</td><td>4,19</td><td>443,00</td><td>4,44</td></tr><tr><td>WSHN-XSC3 160.4</td><td>570,00</td><td>4,20</td><td>496,00</td><td>4,42</td></tr><tr><td>WSHN-XSC3 180.4</td><td>641,00</td><td>4,11</td><td>555,00</td><td>4,36</td></tr><tr><td>WSHN-XSC3 200.4</td><td>704,00</td><td>4,15</td><td>610,00</td><td>4,38</td></tr><tr><td>WSHN-XSC3 220.4</td><td>771,00</td><td>4,13</td><td>666,00</td><td>4,36</td></tr><tr><td>WSHN-XSC3 240.4</td><td>833,00</td><td>4,04</td><td>717,00</td><td>4,27</td></tr></table>					Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER	WSHN-XSC3 70.4	244,00	4,13	211,00	4,36	WSHN-XSC3 75.4	260,00	4,06	225,00	4,28	WSHN-XSC3 80.4	279,00	4,13	242,00	4,36	WSHN-XSC3 85.4	302,00	4,06	261,00	4,29	WSHN-XSC3 90.4	327,00	4,08	283,00	4,32	WSHN-XSC3 100.4	358,00	4,14	313,00	4,42	WSHN-XSC3 110.4	393,00	4,15	341,00	4,37	WSHN-XSC3 120.4	446,00	4,18	389,00	4,46	WSHN-XSC3 140.4	508,00	4,19	443,00	4,44	WSHN-XSC3 160.4	570,00	4,20	496,00	4,42	WSHN-XSC3 180.4	641,00	4,11	555,00	4,36	WSHN-XSC3 200.4	704,00	4,15	610,00	4,38	WSHN-XSC3 220.4	771,00	4,13	666,00	4,36	WSHN-XSC3 240.4	833,00	4,04	717,00	4,27
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Field of application: Heating, cooling and DHW		Refrigerant: R410A	Supply temperature: 55 °C																																																																												
Control: All models have four hermetic scroll compressors, two circuits and electronic expansion valve.			Cost:																																																																												

Strengths & weaknesses

The WSH-XSC3 liquid chiller units and WSHN-XSC3 water source heat pump units for indoor installation belong to the SPINchiller3 family, and are thus distinguished for their excellent energy efficiency, modularity and reliability, thanks to the high degree of industrialisation distinguishing all products of the family. The EFFICIENCY of these products increases as the load decreases, thanks to the modular technology characterising the compressors and cutting-edge heat exchange solutions, yet they guarantee top-ranking performances in their category even with maximum load conditions. The high seasonal efficiency of SPINchiller3 products and their precision in satisfying the requested load guarantee maximum comfort at all times with excellent performance, resulting in considerably lower energy consumption. The high seasonal efficiency of MODULARITY offers an effective solution for large-size central heating plants. The possibility of controlling in cascade mode SPINchiller3 units having different functions (chiller or heat pump) allows for satisfying demands of up to 5 MW, with guaranteed superior efficiency, reliability and construction quality compared to most solutions available on the market. The extensive range of options available with SPINchiller3, including the pumping units mounted on the product – even inverter-driven – make the product suitable for installation in any system. The entire series is Eurovent-certified.

10. Galletti

Manufacturer:	Brand name:	Model:
Galletti	LEW	LEW 041, 042, 051, 052, 061, 062, 071, 072, 081, 082, 091, 092, 111, 112, 131, 132, 141, 142, 144, 161, 162, 164, 181, 182, 184, 204, 214, 243, 244, 283, 284, 314, 344, 374, 424, 484, 485, 535, 576, 636

Short description of main technology:				
Heating capacity at 10/7°C and 40/45°C and COP				
Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
LEW041	55,50	4,07	48,40	4,32
LEW042	54,30	4,18	47,60	4,52
LEW051	65,30	3,99	56,40	4,17
LEW052	65,40	4,00	56,30	4,16
LEW061	74,00	4,12	65,00	4,42
LEW062	74,10	4,13	64,90	4,42
LEW071	84,50	4,07	73,50	4,32
LEW072	84,60	4,08	73,40	4,32
LEW081	96,10	4,25	84,70	4,60
LEW082	96,10	4,25	84,60	4,60
LEW091	108,00	4,15	93,90	4,45
LEW092	108,00	4,14	94,00	4,45
LEW111	129,00	4,28	114,00	4,68
LEW112	129,00	4,28	114,00	4,68
LEW131	148,00	4,20	130,00	4,58
LEW132	148,00	4,19	130,00	4,59
LEW141	170,00	4,24	149,00	4,58
LEW142	170,00	4,23	149,00	4,59
LEW144	171,00	4,19	149,00	4,46
LEW161	190,00	4,19	166,00	4,49
LEW162	190,00	4,19	167,00	4,50
LEW164	191,00	4,29	167,00	4,53
LEW181	225,00	4,29	199,00	4,63
LEW182	225,00	4,31	199,00	4,63
LEW184	218,00	4,24	193,00	4,68
LEW204	237,00	4,30	209,00	4,63
LEW214	258,00	4,34	228,00	4,71
LEW243	290,00	4,41	256,00	4,70
LEW244	299,00	4,29	266,00	4,88
LEW283	334,00	4,30	294,00	4,62

LEW284	339,00	4,19	298,00	4,67
LEW314	376,00	4,21	328,00	4,47
LEW344	409,00	4,25	359,00	4,52
LEW374	444,00	4,20	390,00	4,56
LEW424	505,00	4,29	445,00	4,68
LEW484	569,00	4,30	505,00	4,77
LEW485	560,00	4,12	492,00	4,63
LEW535	627,00	4,26	548,00	4,57
LEW576	670,00	4,07	588,00	4,57
LEW636	749,00	4,07	653,00	4,50

Field of application:	Refrigerant:	Supply temperature:
Heating, cooling and DHW	R410A	45 °C

Control: The models 042,052, 062, 072,082,092, 112, 132, 142, 162, 182, have two scroll compressors and one circuit. The models 081, 091, 111, 131, 141, 161, 181 have two scroll compressors and two circuits. The models 144, 164, 184, 204, 214, 244, 284, 314, 344, 374, 424, 484 have four scroll compressors and two circuits. The models 243, 283 have three scroll compressors and one circuit. The models 485, 535 have five scroll compressors and two circuits. The models 576, 636 have six scroll compressors and two circuits.	Cost:
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Strengths & weaknesses

LEW water chillers and reversible heat pumps are air conditioning or process fluid conditioning units conceived for both residential and industrial use and designed to operate 24 hours a day. They cover a wide range of heating capacities, from 40 to 680 kW, guaranteeing a high thermodynamic efficiency and broad configurability, both in terms of accessories and cooling circuits. The LEW units are developed in a completely enclosed version for a low noise operation making it possible to install them in non-segregated environments. The use of R410A as refrigerating fluid and top quality components for the cooling, hydraulic and electric systems guarantees high technical level of the LEW units of the chillers in terms of efficiency, reliability and reduced noise levels. The LEW series is characterised by reduced footprint, high COP during the thermodynamic cycle, no external noise, reduced refrigerant charge. The range of LEW units can be combined with geothermal probes used to dissipate in soil. The LEW series is available as a cooling unit only, combined with a cooling tower or with water from a well or mains, a heat pump only for heating and reversible heat pumps on cooling circuit side. The versions are in turn developed in two different acoustic systems: Standard and Low Noise. Hydraulic modules complete with pumps on user side and dissipation sides are available in a low noise version to be installed alongside the basic unit. All units, irrespective of type of construction, are equipped with electronic expansion valves to maximize efficiency under part load conditions.

Manufacturer: Galletti	Brand name: MCW	Model: MCW 005M, 005, 007M, 007, 010M, 010, 012, 015, 018, 020, 022, 027, 031,039		
Short description of main technology: Heating capacity at 10/7°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
MCW 005M	5,35	3,06	4,97	3,15
MCW 005	5,50	3,09	5,14	3,23
MCW 007M	6,91	3,02	6,28	2,93
MCW 007	7,08	3,00	6,26	2,90
MCW 010M	9,62	3,14	8,99	3,22
MCW 010	9,86	3,15	8,95	3,16
MCW 012	11,90	3,22	10,90	3,19
MCW 015	14,40	3,25	13,50	3,33
MCW 018	17,50	3,39	15,90	3,33
MCW 020	19,50	3,42	18,70	3,52
MCW 022	21,40	3,31	19,60	3,29
MCW 027	26,30	3,21	24,20	3,21
MCW 031	30,60	3,22	27,90	3,16
MCW 039	37,90	3,27	34,50	3,17
Field of application: Heating, cooling and DHW	Refrigerant: R-407C		Supply temperature: 45 °C	
Control: All models have one scroll compressor and one circuit.		Cost:		

Strengths & weaknesses

MCW chillers and heat pumps are designed for residential and light-duty commercial environments, and in some cases for industrial applications, process industries and geothermal energy. The entire range is built with a structure and base made of galvanised sheet paneling in epoxy-polyester paint finish, RAL7035, and there is the possibility of choosing an efficient sound absorbing material which, together with the adoption of scroll type compressors, ensure that the units are exceptionally silent and compact. With an attractive design, a small footprint, the possibility to fit the units with a hydraulic kit complete with circulation pump, expansion tank and buffer tank, means that the machines can even be installed in environments not involved in residential applications. The design philosophy has favoured the development of units having a reduced height with water connections placed on the upper part, which reduce installation time and costs and the need for technical space. The MCW series offers a wide range of configurations in terms of accessories available and consists of a large number of sizes, including several single-phase models, each available as a low noise version, in order to fully respond to all system requirements. Only top quality products are used for the cooling, hydraulic and electric systems guaranteeing high technical level of the MCW chillers in terms of efficiency, reliability and reduced noise levels. Ease of installation and compact dimensions, Scroll compressor, Built-in hydronic units, Vast range of available accessories, Access to the tax incentives provided for energy retrofitting.

11. RHoss

Manufacturer: RHoss	Brand name: TCEEBY	Model: TCEEBY 250, 260, 270, 275, 290, 2100, 2115, 2130, 2145, 2165, 2185, 4180, 4205, 4235, 4260, 4290, 4330, 4360																																																									
Short description of main technology: Water to water. Water system side (in/out) 12°C/7°C. Condensing temperature: 50°C (dew point)																																																											
<table border="1"> <thead> <tr> <th>Model</th><th>Cooling output (kWc)</th><th>EER</th></tr> </thead> <tbody> <tr><td>TCEEBY 250</td><td>47,30</td><td>3,38</td></tr> <tr><td>TCEEBY 260</td><td>53,60</td><td>3,30</td></tr> <tr><td>TCEEBY 270</td><td>61,30</td><td>3,76</td></tr> <tr><td>TCEEBY 275</td><td>67,90</td><td>3,39</td></tr> <tr><td>TCEEBY 290</td><td>80,60</td><td>3,49</td></tr> <tr><td>TCEEBY 2100</td><td>91,70</td><td>3,38</td></tr> <tr><td>TCEEBY 2115</td><td>103,40</td><td>3,34</td></tr> <tr><td>TCEEBY 2130</td><td>115,00</td><td>3,29</td></tr> <tr><td>TCEEBY 2145</td><td>128,20</td><td>3,34</td></tr> <tr><td>TCEEBY 2165</td><td>145,70</td><td>3,26</td></tr> <tr><td>TCEEBY 2185</td><td>162,30</td><td>3,19</td></tr> <tr><td>TCEEBY 4180</td><td>161,20</td><td>3,53</td></tr> <tr><td>TCEEBY 4205</td><td>182,90</td><td>3,50</td></tr> <tr><td>TCEEBY 4235</td><td>205,00</td><td>3,48</td></tr> <tr><td>TCEEBY 4260</td><td>229,40</td><td>3,49</td></tr> <tr><td>TCEEBY 4290</td><td>253,80</td><td>3,50</td></tr> <tr><td>TCEEBY 4330</td><td>287,40</td><td>3,42</td></tr> <tr><td>TCEEBY 4360</td><td>320,90</td><td>3,36</td></tr> </tbody> </table>			Model	Cooling output (kWc)	EER	TCEEBY 250	47,30	3,38	TCEEBY 260	53,60	3,30	TCEEBY 270	61,30	3,76	TCEEBY 275	67,90	3,39	TCEEBY 290	80,60	3,49	TCEEBY 2100	91,70	3,38	TCEEBY 2115	103,40	3,34	TCEEBY 2130	115,00	3,29	TCEEBY 2145	128,20	3,34	TCEEBY 2165	145,70	3,26	TCEEBY 2185	162,30	3,19	TCEEBY 4180	161,20	3,53	TCEEBY 4205	182,90	3,50	TCEEBY 4235	205,00	3,48	TCEEBY 4260	229,40	3,49	TCEEBY 4290	253,80	3,50	TCEEBY 4330	287,40	3,42	TCEEBY 4360	320,90	3,36
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Field of application: Cooling	Refrigerant: R410A	Supply temperature: 7 °C																																																									
Control: Compressor: hermetic rotary scroll complete with thermal protection and casing heater. The models 250 to 2185 have one circuit, two scroll compressors with two steps. The models 4180 to 4360 have two circuits, four scroll compressors with four steps.		Cost:																																																									
Strengths & weaknesses Low noise emission.																																																											

Manufacturer: RHoss	Brand name: TCEEY	Model: TCEEY 115,118, 122, 125, 230, 240																					
Short description of main technology: Water to water. Water system side (in/out) 12°C/7°C. Condensing temperature: 50°C (dew point)																							
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TCEEY 125	23,30	3,76																					
TCEEY 230	26,80	3,12																					
TCEEY 230	36,90	3,69																					
Field of application: Cooling	Refrigerant: R410A	Supply temperature: 7 °C																					
Control: Compressor: hermetic rotary scroll complete with thermal protection and casing heater. All models have one circuit, one compressor and one step. The models 230 and 240 have two scroll compressors with two steps		Cost:																					
Strengths & weaknesses Low noise emission.																							

Manufacturer: RHoss	Brand name: TCEVZ	Model: TCEVZ 1200, 1230, 1280, 1310, 1350, 1410, 1460, 1530																											
Short description of main technology: Water to water. Water system side (in/out) 12°C/7°C. Condensing temperature: 50°C (dew point)																													
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TCEVZ 1530	446,40	3,30																											
Field of application: Cooling	Refrigerant: R134a	Supply temperature: 7 °C																											
Control: Compressor: high energy efficiency semi-hermetic screw compressor, with star-delta or part winding limited start up (depending on models) and complete with integral protection, casing heater and refrigerant gas outlet piping shut-off valve. All models have one circuit, one screw compressor with three steps.		Cost:																											
Strengths & weaknesses Low noise emission.																													

Manufacturer: RHoss	Brand name: TCHVZ	Model: TCHVZ 1201, 1231, 1281, 1311, 1351, 1421, 1481, 1531																											
Short description of main technology: Water to water. Water system side (in/out) 12°C/7°C Water condenser (in/out) 30°C/35°C																													
<table border="1"> <thead> <tr> <th>Model</th><th>Cooling output (kWc)</th><th>EER</th></tr> </thead> <tbody> <tr> <td>TCHVZ 1201</td><td>203,30</td><td>4,95</td></tr> <tr> <td>TCHVZ 1231</td><td>230,20</td><td>4,96</td></tr> <tr> <td>TCHVZ 1281</td><td>282,10</td><td>4,97</td></tr> <tr> <td>TCHVZ 1311</td><td>308,00</td><td>4,96</td></tr> <tr> <td>TCHVZ 1351</td><td>352,80</td><td>4,95</td></tr> <tr> <td>TCHVZ 1421</td><td>416,40</td><td>4,93</td></tr> <tr> <td>TCHVZ 1481</td><td>478,20</td><td>4,94</td></tr> <tr> <td>TCHVZ 1531</td><td>533,00</td><td>4,94</td></tr> </tbody> </table>			Model	Cooling output (kWc)	EER	TCHVZ 1201	203,30	4,95	TCHVZ 1231	230,20	4,96	TCHVZ 1281	282,10	4,97	TCHVZ 1311	308,00	4,96	TCHVZ 1351	352,80	4,95	TCHVZ 1421	416,40	4,93	TCHVZ 1481	478,20	4,94	TCHVZ 1531	533,00	4,94
Model	Cooling output (kWc)	EER																											
TCHVZ 1201	203,30	4,95																											
TCHVZ 1231	230,20	4,96																											
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TCHVZ 1421	416,40	4,93																											
TCHVZ 1481	478,20	4,94																											
TCHVZ 1531	533,00	4,94																											
Field of application: Cooling	Refrigerant: R410A	Supply temperature: 7 °C																											
Control: Compressor: high energy efficiency semi-hermetic screw compressor, with star-delta or part winding limited start up (depending on models) and complete with integral protection, casing heater and refrigerant gas outlet piping shut-off valve. All models have one circuit, one compressor and three steps.		Cost:																											
Strengths & weaknesses Low noise emission.																													

Manufacturer:	Brand name:	Model:		
RHoss	THHEY	THHEY 105, 107, 109, 112, 115, 118,122, 125, 230, 240, 245, 250, 260, 270, 275, 290, 2100		
Short description of main technology:				
Water to water.				
(1) Water system side (in/out) 12°C/7°C Water condenser (in/out) 30°C/35°C				
(2) Water system side (in/out) 40°C/45°C Water evaporator (in/out) 10°C/7°C				
Model	Cooling output (kWc) (1)	EER	Heating output (kWth) (2)	COP
THHEY 105	5,30	3,31	6,58	3,16
THHEY 107	6,80	3,11	8,10	2,89
THHEY 109	9,20	3,30	10,90	3,03
THHEY 112	11,90	3,24	14,00	3,10
THHEY 115	13,90	3,81	17,40	4,40
THHEY 118	16,30	4,13	20,20	4,58
THHEY 122	20,00	4,15	25,10	4,49
THHEY 125	23,10	4,19	28,90	4,59
THHEY 230	27,30	3,79	35,90	4,46
THHEY 240	35,90	4,09	45,10	4,46
THHEY 245	41,30	4,57	50,20	4,12
THHEY 250	48,50	4,64	59,00	4,24
THHEY 260	55,20	4,57	67,80	4,27
THHEY 270	63,00	4,59	75,70	4,28
THHEY 275	69,20	4,57	84,00	4,23
THHEY 290	82,00	4,65	102,10	4,29
THHEY 2100	95,90	4,59	116,60	4,23
Field of application:		Refrigerant:	Supply temperature:	
Heating and Cooling		R410A	7-65 °C	
Control: Compressor: hermetic, rotary scroll type, complete with thermal protection. All models have one circuit. The models 230 to 2100 have two scroll compressors and two steps.				Cost:
Strengths & weaknesses				
Low noise emission.				

12. BLUE BOX

Manufacturer:	Brand name:	Model:
BLUE BOX	Core & Core Max	Core & Core Max 7M, 9M, 10M, 11M, 14M, 18M, 7, 9, 10, 11, 14, 18, 19, 22, 25, 27, 32, 37, 43, 50, 55, 63, 74, 84, 95, 111

Short description of main technology:				
Heating capacity at 10/7°C and 40/45°C and COP				
Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
7M	7,50	3,93	6,00	4,02
9M	9,00	3,99	7,00	4,08
10M	10,00	3,97	7,90	4,09
11M	11,40	4,04	9,10	4,09
14M	13,40	4,16	10,70	4,20
18M	17,00	4,20	13,50	4,24
7	7,50	3,95	6,00	4,05
9	9,00	3,94	7,20	4,04
10	9,80	4,05	7,90	4,22
11	11,00	4,06	9,00	4,10
14	14,00	4,20	10,60	4,27
18	18,00	4,24	13,50	4,33
19	19,20	4,25	15,10	4,16
22	22,00	4,13	17,20	4,08
25	25,00	4,18	19,50	4,12
27	27,00	4,49	22,00	4,31
32	32,00	4,49	25,10	4,31

37	37,00	4,64	29,90	4,56
43	43,90	4,11	32,60	3,93
50	50,70	4,19	37,60	4,04
55	55,70	4,45	41,80	4,07
63	65,00	4,53	48,30	4,17
74	76,30	4,58	57,10	4,31
84	86,80	4,70	65,40	4,37
95	97,10	4,72	72,80	4,36
111	114,10	4,63	84,60	4,17
Field of application: Heating, cooling and DHW		Refrigerant: R410A		Supply temperature: 45 °C
Control: Scroll compressor (on/off). All models have one scroll compressor and one circuit. The models 7M, 9M, 10M, 11M, 14M, 18M have single phases power supply.		Cost:		
Strengths & weaknesses Integrated pumps for user and source (options), Low noise emission: sound power levels from 49 dB(A), Integrated anti-vibration system, Domestic hot water management through external 3-way valve (option).				

Manufacturer: BLUE BOX	Brand name: Mu Echos A	Model: Mu Echos A 6, 8, 11, 16, 19, 22, 24, 28, 32, 35, 42, 48																																																																			
Short description of main technology: Heating capacity at 10/7°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER																																																																					
<table><tr><td>Model</td><td>Heating capacity (kWth)</td><td>COP</td><td>Cooling capacity (kWc)</td><td>EER</td></tr><tr><td>Mu Echos A 6</td><td>7,00</td><td>3,78</td><td>5,90</td><td>3,90</td></tr><tr><td>Mu Echos A 8</td><td>9,50</td><td>3,73</td><td>8,30</td><td>4,27</td></tr><tr><td>Mu Echos A 11</td><td>11,80</td><td>3,83</td><td>10,40</td><td>4,21</td></tr><tr><td>Mu Echos A 16</td><td>17,00</td><td>3,60</td><td>15,40</td><td>4,09</td></tr><tr><td>Mu Echos A 19</td><td>20,50</td><td>3,60</td><td>17,90</td><td>3,96</td></tr><tr><td>Mu Echos A 22</td><td>23,70</td><td>3,61</td><td>20,80</td><td>3,96</td></tr><tr><td>Mu Echos A 24</td><td>26,90</td><td>3,76</td><td>23,30</td><td>4,03</td></tr><tr><td>Mu Echos A 28</td><td>31,40</td><td>3,77</td><td>26,50</td><td>3,93</td></tr><tr><td>Mu Echos A 32</td><td>35,50</td><td>3,81</td><td>32,20</td><td>4,22</td></tr><tr><td>Mu Echos A 35</td><td>38,70</td><td>3,76</td><td>34,90</td><td>4,17</td></tr><tr><td>Mu Echos A 42</td><td>45,30</td><td>3,98</td><td>41,40</td><td>4,39</td></tr><tr><td>Mu Echos A 48</td><td>51,00</td><td>3,98</td><td>46,20</td><td>4,33</td></tr></table>					Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER	Mu Echos A 6	7,00	3,78	5,90	3,90	Mu Echos A 8	9,50	3,73	8,30	4,27	Mu Echos A 11	11,80	3,83	10,40	4,21	Mu Echos A 16	17,00	3,60	15,40	4,09	Mu Echos A 19	20,50	3,60	17,90	3,96	Mu Echos A 22	23,70	3,61	20,80	3,96	Mu Echos A 24	26,90	3,76	23,30	4,03	Mu Echos A 28	31,40	3,77	26,50	3,93	Mu Echos A 32	35,50	3,81	32,20	4,22	Mu Echos A 35	38,70	3,76	34,90	4,17	Mu Echos A 42	45,30	3,98	41,40	4,39	Mu Echos A 48	51,00	3,98	46,20	4,33
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER																																																																	
Mu Echos A 6	7,00	3,78	5,90	3,90																																																																	
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Mu Echos A 48	51,00	3,98	46,20	4,33																																																																	
Field of application: Heating, cooling and DHW	Refrigerant: R410A		Supply temperature: 45 °C																																																																		
Control: Scroll compressor (on/off). All models have one scroll compressor and one circuit.		Cost:																																																																			
Strengths & weaknesses Very small footprint: < 0,5 m ² , low noise emission: sound power levels from 59 dB(A), split version available.																																																																					

Manufacturer: BLUE BOX	Brand name: Mu Echos A LC	Model: Mu Echos A LC 6, 8, 11, 16, 19, 22, 24, 28, 32, 35, 42, 48		
Short description of main technology: Heating capacity at 10/7°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
Mu Echos A LC 6	6,10	3,44	5,20	2,86
Mu Echos A LC 8	8,20	3,23	6,70	2,57
Mu Echos A LC 11	10,50	3,42	9,20	2,82
Mu Echos A LC 16	14,00	3,25	13,20	3,06
Mu Echos A LC 19	17,00	3,25	15,50	2,99
Mu Echos A LC 22	19,60	3,20	18,00	2,94
Mu Echos A LC 24	22,90	3,47	21,20	3,16
Mu Echos A LC 28	26,80	3,49	24,00	3,08
Mu Echos A LC 32	30,00	3,49	28,90	3,23
Mu Echos A LC 35	32,70	3,42	31,50	3,19
Mu Echos A LC 42	37,50	3,57	37,20	3,38
Mu Echos A LC 48	42,30	3,51	42,00	3,36
Field of application: Heating, cooling and DHW	Refrigerant: R410A	Supply temperature: 45 °C		
Control: Scroll compressor (on/off). All models have one scroll compressor and one circuit. All models have remote source-side heat exchanger			Cost:	
Strengths & weaknesses Very small footprint: < 0,5 m², low noise emission: sound power levels from 59 dB(A), split version available.				

Manufacturer: BLUE BOX	Brand name: Mu Echos A LE	Model: Mu Echos A LE 6, 8, 11, 16, 19, 22, 24, 28, 32, 35, 42, 48		
Short description of main technology: Heating capacity at 15/10°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
Mu Echos A LE 6	7,70	5,39	7,20	5,16
Mu Echos A LE 8	10,40	5,36	9,80	5,52
Mu Echos A LE 11	12,80	5,15	12,40	5,50
Mu Echos A LE 16	19,30	5,60	17,80	5,23
Mu Echos A LE 19	23,40	5,69	20,60	5,01
Mu Echos A LE 22	27,10	5,61	23,90	4,96
Mu Echos A LE 24	29,70	5,54	26,70	5,04
Mu Echos A LE 28	34,70	5,57	30,60	4,92
Mu Echos A LE 32	39,20	5,46	36,10	5,16
Mu Echos A LE 35	42,90	5,43	39,40	5,12
Mu Echos A LE 42	51,10	5,71	47,30	5,37
Mu Echos A LE 48	57,40	5,66	53,40	5,36
Field of application: Heating, cooling and DHW	Refrigerant: R410A	Supply temperature: 45 °C		
Control: Scroll compressor (on/off). All models have one scroll compressor and one circuit. All models have remote user-side heat exchanger			Cost:	
Strengths & weaknesses Very small footprint: < 0,5 m ² , low noise emission: sound power levels from 59 dB(A), split version available.				

13. CIAT

Manufacturer: CIAT	Brand name: DYNACIAT ILG	Model: DYNACIAT ILG 120V, 150V, 200V, 240V, 300V		
Short description of main technology: Heating capacity at 10/7°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
DYNACIAT ILG 120V	39,20	3,98	29,00	3,53
DYNACIAT ILG 150V	51,20	4,02	37,80	3,61
DYNACIAT ILG 200V	68,30	3,95	50,50	4,31
DYNACIAT ILG 240V	79,00	4,16	58,90	4,38
DYNACIAT ILG 300V	101,90	4,15	76,70	4,34
Field of application: Heating, cooling and DHW	Refrigerant: R410A		Supply temperature: 45 °C	
Control: Single or three phases Scroll compressor (on/off). The models 120V and 150V have one compressor (0-100%). The models 200V, 240V and 300V have two compressors (0-50-100%). All models have one circuit.			Cost:	
Strengths & weaknesses These units are designed to be installed as standard in rooms that are protected against freezing temperatures and inclement weather. High energy efficiency, compact and quiet scroll compressors, brazed – plate heat exchangers, self-adjusting electronic control, hydraulic module linked with aqua term module				

Manufacturer:	Brand name:	Model:		
CIAT	DYNACIAT LG	DYNACIAT LG 80A, 90A, 100A, 120A, 130A, 150A, 180A, 200A, 240A, 260A, 300A, 360A, 390A, 450A, 480A, 520A, 600A		
Short description of main technology:				
Heating capacity at 10/7°C and 30/35°C and COP				
Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
DYNACIAT LG 80A	30,00	5,53	25,00	4,72
DYNACIAT LG 90A	35,00	5,53	29,00	4,72
DYNACIAT LG 100A	38,00	5,49	32,00	4,69
DYNACIAT LG 120A	44,00	5,52	37,00	4,73
DYNACIAT LG 130A	50,00	5,49	42,00	4,69
DYNACIAT LG 150A	56,00	5,51	47,00	4,72
DYNACIAT LG 180A	70,00	5,58	58,00	4,72
DYNACIAT LG 200A	77,00	5,48	63,00	4,65
DYNACIAT LG 240A	89,00	5,53	74,00	4,69
DYNACIAT LG 260A	101,00	5,46	84,00	4,65
DYNACIAT LG 300A	114,00	5,50	95,00	4,68
DYNACIAT LG 360A	137,00	5,63	115,00	4,79
DYNACIAT LG 390A	156,00	5,61	130,00	4,77
DYNACIAT LG 450A	172,00	5,53	144,00	4,70
DYNACIAT LG 480A	183,00	5,67	153,00	4,83
DYNACIAT LG 520A	206,00	5,62	172,00	4,78
DYNACIAT LG 600A	230,00	5,59	192,00	4,79
Field of application:		Refrigerant:	Supply temperature:	
Heating, cooling and DHW		R410A	45 °C	
Control: Hermetic SCROLL type, electronic motor overheating protection, crankcase heater, mounted on anti-vibration mounts				
Model	No Circuit	No Compressor	No of control stage	Minimum Power %
DYNACIAT LG 80A	1	1	1	100
DYNACIAT LG 90A	1	1	1	100
DYNACIAT LG 100A	1	1	1	100

DYNACIAT LG 120A	1	1	1	100
DYNACIAT LG 130A	1	1	1	100
DYNACIAT LG 150A	1	1	1	100
DYNACIAT LG 180A	1	2	2	50
DYNACIAT LG 200A	1	2	2	50
DYNACIAT LG 240A	1	2	2	50
DYNACIAT LG 260A	1	2	2	50
DYNACIAT LG 300A	1	2	2	50
DYNACIAT LG 360A	1	3	3	33
DYNACIAT LG 390A	1	3	3	33
DYNACIAT LG 450A	1	3	3	33
DYNACIAT LG 480A	2	4	4	25
DYNACIAT LG 520A	2	4	4	25
DYNACIAT LG 600A	2	4	4	25

Strengths & weaknesses

These units are designed to be installed as standard in rooms that are protected against freezing temperatures and inclement weather. High energy efficiency, compact and quiet scroll compressors, brazed – plate heat exchangers, self-adjusting electronic control, hydraulic module linked with aqua term module.

Manufacturer:	Brand name:	Model:
CIAT	DYNACIAT ^{POWER} LG	DYNACIAT ^{POWER} LG 700V, 800V, 900V, 1000V, 1100V, 1200V, 1400V, 1600V, 1800V, 2100V, 2400V

Short description of main technology:

Cooling capacity at 12/7°C and 30/35°C and EER

Model	Cooling capacity (kWc)	EER
DYNACIAT ^{POWER} LG 700V	217,00	4,50
DYNACIAT ^{POWER} LG 800V	251,00	4,55
DYNACIAT ^{POWER} LG 900V	288,00	4,48
DYNACIAT ^{POWER} LG 1000V	327,00	4,48
DYNACIAT ^{POWER} LG 1100V	356,00	4,48
DYNACIAT ^{POWER} LG 1200V	385,00	4,49
DYNACIAT ^{POWER} LG 1400V	443,00	4,5
DYNACIAT ^{POWER} LG 1600V	449,00	4,55
DYNACIAT ^{POWER} LG 1800V	582,00	4,52
DYNACIAT ^{POWER} LG 2100V	657,00	4,66
DYNACIAT ^{POWER} LG 2400V	713,00	4,51

Field of application: Cooling	Refrigerant:	Supply temperature:
	R410A	7°C

Control: Hermetic scroll type, built-in electric motor cooled by suction gases, motor protected by internal winding thermostat, anti-vibration mounts.

Model	No Circuit	No Com-pressor	No of con-trol stage	Capacity Control %
DYNACIAT ^{POWER} LG 700V	2	4	6	100-78-71-50-28-21-0
DYNACIAT ^{POWER} LG 800V	2	4	4	100-75-50-25-0
DYNACIAT ^{POWER} LG 900V	2	4	6	100-78-71-50-28-21-0
DYNACIAT ^{POWER} LG 1000V	2	4	4	100-75-50-25-0
DYNACIAT ^{POWER} LG 1100V	2	4	6	100-78-71-50-28-21-0
DYNACIAT ^{POWER} LG 1200V	2	4	4	100-75-50-25-0
DYNACIAT ^{POWER} LG 1400V	2	4	6	100-78-71-50-28-21-0
DYNACIAT ^{POWER} LG 1600V	2	4	4	100-75-50-25-0
DYNACIAT ^{POWER} LG 1800V	2	6	6	100-78-71-50-28-21-0
DYNACIAT ^{POWER} LG 2100V	2	6	8	100-84-66-48-36-30-18-15-0
DYNACIAT ^{POWER} LG 2400V	2	6	6	100-78-71-50-28-21-0

Strengths & weaknesses

These units are designed to be installed as standard in rooms that are protected against freezing temperatures and inclement weather. High energy efficiency, compact and quiet scroll compressors, brazed – plate heat exchangers, self-adjusting electronic control, hydraulic module linked with aqua term module.

Manufacturer: CIAT	Brand name: GeoCIAT	Model: GEOCIAT 18H, 20H, 33H, 45H, 45HT, 50H, 50HT, 65HT, 90HT, 120HT Modular, Power, Access																																													
Short description of main technology: Heating capacity at 10 °C/7°C and 40/45°C and COP: <table border="1"> <thead> <tr> <th>Model</th><th>Heating output (kWth)</th><th>COP</th></tr> </thead> <tbody> <tr><td>GeoCIAT 18H</td><td>5,77</td><td>4,08</td></tr> <tr><td>GeoCIAT 20H</td><td>6,81</td><td>4,43</td></tr> <tr><td>GeoCIAT 33H</td><td>8,84</td><td>4,53</td></tr> <tr><td>GeoCIAT 45H</td><td>12,29</td><td>4,33</td></tr> <tr><td>GeoCIAT 45HT</td><td>12,29</td><td>4,68</td></tr> <tr><td>GeoCIAT 50H</td><td>15,85</td><td>4,22</td></tr> <tr><td>GeoCIAT 50HT</td><td>15,74</td><td>4,25</td></tr> <tr><td>GeoCIAT 65HT</td><td>20,03</td><td>4,15</td></tr> <tr><td>GeoCIAT 90HT</td><td>26,21</td><td>4,04</td></tr> <tr><td>GeoCIAT 120HT</td><td>35,39</td><td>4,23</td></tr> </tbody> </table> Heating capacity at 0/-3°C and 30/35°C and COP: <table border="1"> <thead> <tr> <th>Model</th><th>Heating output (kWth)</th><th>COP</th></tr> </thead> <tbody> <tr><td>GEOCIAT Modular</td><td>6,0-9,0</td><td>4,55</td></tr> <tr><td>GEOCIAT Power</td><td>12,5-27,0</td><td>4,24</td></tr> <tr><td>GEOCIAT Access</td><td>4,6</td><td>4,16</td></tr> </tbody> </table>			Model	Heating output (kWth)	COP	GeoCIAT 18H	5,77	4,08	GeoCIAT 20H	6,81	4,43	GeoCIAT 33H	8,84	4,53	GeoCIAT 45H	12,29	4,33	GeoCIAT 45HT	12,29	4,68	GeoCIAT 50H	15,85	4,22	GeoCIAT 50HT	15,74	4,25	GeoCIAT 65HT	20,03	4,15	GeoCIAT 90HT	26,21	4,04	GeoCIAT 120HT	35,39	4,23	Model	Heating output (kWth)	COP	GEOCIAT Modular	6,0-9,0	4,55	GEOCIAT Power	12,5-27,0	4,24	GEOCIAT Access	4,6	4,16
Model	Heating output (kWth)	COP																																													
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GeoCIAT 45HT	12,29	4,68																																													
GeoCIAT 50H	15,85	4,22																																													
GeoCIAT 50HT	15,74	4,25																																													
GeoCIAT 65HT	20,03	4,15																																													
GeoCIAT 90HT	26,21	4,04																																													
GeoCIAT 120HT	35,39	4,23																																													
Model	Heating output (kWth)	COP																																													
GEOCIAT Modular	6,0-9,0	4,55																																													
GEOCIAT Power	12,5-27,0	4,24																																													
GEOCIAT Access	4,6	4,16																																													
Field of application: Heating	Refrigerant: R410A	Supply temperature: 62 °C																																													
Control: Single or three phases Scroll compressor (on/off). One circuit and one compressor		Cost:																																													
Strengths & weaknesses Ultra-compact, integrated double hydraulic module.																																															

Manufacturer:	Brand name:	Model:
CIAT	HYDROCIAT LW ST	HYDROCIAT LW 708, 858, 1008, 1300, 1302, 1500, 1508, 1900, 2100, 2300, 2308, 2800, 3000, 3008, 3400, 4200, 4600, 4408, 4608, 1328HE, 1528HE, 1928HE, 2128HE, 2328HE, 2628HE, 3028HE, 3428HE, 3828HE, 4228HE, 4628HE

Short description of main technology:**Heating capacity at 10/7°C & 40/45°C and COP. Cooling capacity at 12/7°C & 30/35°C and EER**

Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
708	316,00	4,80	273,00	5,32
858	357,00	4,78	307,00	5,30
1008	419,00	4,84	359,00	5,24
1300	514,00	4,74	459,00	5,21
1302	527,00	4,79	473,00	5,35
1500	597,00	4,70	532,00	5,21
1508	629,00	4,78	538,00	5,17
1900	748,00	4,78	677,00	5,39
2100	810,00	4,73	730,00	5,30
2300	883,00	4,73	792,00	5,19
2308	964,00	4,93	839,00	5,39
2800	1134,00	4,76	1017,00	5,26
3000	1186,00	4,74	1060,00	5,21
3008	1314,00	4,89	1141,00	5,30
3400	1380,00	5,02	1257,00	5,69
3800	1476,00	4,88	1342,00	5,51
4200	1606,00	4,81	1453,00	5,36
4600	1710,00	4,80	1547,00	5,29
4408	1884,00	5,10	1654,00	5,59
4608	1962,00	5,15	1728,00	5,60
1328HE	583,00	4,91	509,00	5,71
1528HE	662,00	4,84	577,00	5,64
1928HE	842,00	4,97	737,00	5,83
2128HE	904,00	4,80	786,00	5,62
2328HE	982,00	4,85	861,00	5,65
2628HE	1191,00	4,90	1039,00	5,73
3028HE	1320,00	4,86	1157,00	5,78
3428HE	1509,00	4,89	1323,00	5,80
3828HE	1663,00	4,71	1452,00	5,58
4228HE	1846,00	4,89	1626,00	5,87
4628HE	1989,00	4,87	1756,00	5,79

Field of application: Heating, cooling and DHW	Refrigerant: R134a	Supply temperature: 7°C-45 °C
Control: Semi-hermetic screw compressors		Cost:
Strengths & weaknesses These units are designed to be installed in mechanical rooms that are protected against freezing temperatures and inclement weather. They feature the latest technological advances: accessible twin-screw hermetic compressors, continuous capacity control, XTRACONNECT2 microprocessor for networked control and management, and components optimized for ozone-friendly refrigerant R134a.		

Manufacturer: CIAT	Brand name: HYDROCIAT LW	Model: HYDROCIAT LW 1800BX, 1800BX HPS, 2150BX, 2150BX HPS, 2500BX, 2500BX HPS, 2800BX, 2800BX HPS, 3050BX HPS, 3500BX HPS, 3600BX HPS, 3900BX HPS, 4200BX HPS, 4500BX HPS, 4800 BX HPS
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Short description of main technology:		
Cooling capacity at 12/7°C and 30/35°C and EER		
Model	Cooling capacity (kWc)	EER
1800BX	417,00	4,41
1800BX HPS	432,00	4,42
2150BX	490,00	4,35
2150BX HPS	531,00	4,45
2500BX	585,00	4,51
2500BX HPS	622,00	4,49
2800BX	657,00	4,53
2800BX HPS	688,00	4,53
3050BX HPS	811,00	4,77
3500BX HPS	918,00	4,64
3600BX HPS	953,00	4,75
3900BX HPS	1040,00	4,71
4200BX HPS	1075,00	4,69
4500BX HPS	1129,00	4,55
4800 BX HPS	1164,00	4,52

Field of application: Cooling-only or heating only models with water-cooled condenser.	Refrigerant: R134a	Supply temperature: 7°C
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Control: Accessible hermetic twin screw type, shell and tube direct expansion evaporator			
Model	No Circuit	No Compressor	Capacity Control %
1800BX	2	2	0-25-50-100
1800BX HPS	2	2	0-25-50-100
2150BX	2	2	0-25-50-100
2150BX HPS	2	2	0-25-50-100
2500BX	2	2	0-25-50-100
2500BX HPS	2	2	0-25-50-100
2800BX	2	2	0-25-50-100
2800BX HPS	2	2	0-25-50-100
3050BX HPS	2	2	0-25-50-100

3500BX HPS	2	2	0-25-50-100
3600BX HPS	2	2	0-25-50-100
3900BX HPS	2	2	0-25-50-100
4200BX HPS	2	2	0-25-50-100
4500BX HPS	2	2	0-25-50-100
4800BX HPS	2	2	0-25-50-100

Cost:**Strengths & weaknesses**

These units are designed to be installed in mechanical rooms that are protected against freezing temperatures and inclement weather. They feature the latest technological advances: accessible twin-screw hermetic compressors, continuous capacity control, XTRACONNECT2 microprocessor for networked control and management, and components optimized for ozone-friendly refrigerant R134a.

14. De Dietrich

Manufacturer:	Brand name:	Model:		
De Dietrich	GSHP	GSHP		
Short description of main technology:				
Heating capacity at 10/7°C and 30/35°C and COP				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
GSHP	5,70 to 27,90	4,70 to 5,60		
Field of application:		Refrigerant:	Supply temperature:	
Heating and DHW		R410A	45 °C	
Control: All models scroll compressors, one circuit and the electricity supply is single phase.		Cost:		
Strengths & weaknesses				
Thanks to its silent running and a hard-wearing design, this geothermal heat pump will simply blend into the background.				

Manufacturer: De Dietrich	Brand name: GSHP B200 GHL	Model: GSHP B200 GHL								
Short description of main technology: Heating capacity at 10/7°C and 30/35°C and COP										
<table><tr><td>Model</td><td>Heating capacity (kWth)</td><td>COP</td><td>Cooling capacity (kWc)</td><td>EER</td></tr><tr><td>GSHP B200 GHL</td><td>8,20</td><td>4,70 to 5,60</td><td></td><td></td></tr></table>	Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER	GSHP B200 GHL	8,20	4,70 to 5,60		
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER						
GSHP B200 GHL	8,20	4,70 to 5,60								
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 45 °C								
Control: All models scroll compressors, one circuit and the electricity supply is single phase.	Cost:									
Strengths & weaknesses Thanks to its silent running and a hard-wearing design, this geothermal heat pump will simply blend into the background.										

Manufacturer: De Dietrich	Brand name: GSHP B200 GSHL	Model: GSHP B200 GSHL		
Short description of main technology: Heating capacity at 10/7°C and 30/35°C and COP				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
GSHP B200 GSHL	11,40	4,70 to 5,60		
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 45 °C		
Control: All models scroll compressors, one circuit and the electricity supply is three phases.		Cost:		
Strengths & weaknesses Thanks to its silent running and a hard-wearing design, this geothermal heat pump will simply blend into the background. This model have solar back up				

Manufacturer: De Dietrich	Brand name: GSHP V200 GHL	Model: GSHP V200 GHL		
Short description of main technology: Heating capacity at 10/7°C and 30/35°C and COP				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
GSHP V200 GHL	5,70 to 17,10	4,70 to 5,60		
Field of application: Heating and DHW		Refrigerant: R410A	Supply temperature: 45 °C	
Control: All models scroll compressors, one circuit and the electricity supply is single phase.		Cost:		
Strengths & weaknesses Thanks to its silent running and a hard-wearing design, this geothermal heat pump will simply blend into the background.				

Manufacturer: De Dietrich	Brand name: GSHP V200 GSHL	Model: GSHP V200 GSHL										
Short description of main technology: Heating capacity at 10/7°C and 30/35°C and COP												
<table><tr><td>Model</td><td>Heating capacity (kWth)</td><td>COP</td><td>Cooling capacity (kWc)</td><td>EER</td></tr><tr><td>GSHP V200 GSHL</td><td>11,40</td><td>4,70 to 5,60</td><td></td><td></td></tr></table>	Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER	GSHP V200 GSHL	11,40	4,70 to 5,60				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER								
GSHP V200 GSHL	11,40	4,70 to 5,60										
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 45 °C										
Control: All models scroll compressors, one circuit and the electricity supply is three phases.		Cost:										
Strengths & weaknesses Thanks to its silent running and a hard-wearing design, this geothermal heat pump will simply blend into the background. This model have solar back up												

15. DAIKIN

Manufacturer:	Brand name:	Model:		
DAIKIN	WRA	036, 048, 060, 072, 120, 150		
Short description of main technology:				
Heating capacity at 0/4°C and 35/40°C and COP				
Cooling capacity at 16/12°C and 25/30°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
036	9,14	2,90	9,52	2,50
048	10,99	3,00	11,72	2,61
060	12,75	2,90	12,89	3,19
072	1,64	2,90	17,14	4,40
120	24,47	2,90	26,22	6,22
150	32,38	3,10	34,13	8,44
Field of application:	Refrigerant:	Supply temperature:		
Heating, cooling and DHW	R410A	50 °C		
Control: Scroll compressor (on/off)		Cost:		
Strengths & weaknesses				
Bi-flow Thermal Expansion Valve (TXV) for precise metering of refrigerant flow under all expected operating conditions. High efficiency coaxial water-to-refrigerant coils, fully insulated with polyurethane foam to maximize performance while helping to prevent condensate build-up in unit base pan. High pressure and low pressure equipment protection built into the source side refrigeration circuit to guard against abnormal unit operation.				

16. Mitsubishi Electric

Manufacturer: Mitsubishi Electric	Brand name: CRHV-P600YA-HPB	Model: 60, 45															
Short description of main technology: Heating capacity at 0/-3°C and 30/35°C and COP																	
<table><tr><td>Model</td><td>Heating capacity (kWth)</td><td>COP</td><td>Cooling capacity (kWc)</td><td>EER</td></tr><tr><td>60</td><td>60,00</td><td>4,33</td><td></td><td></td></tr><tr><td>45</td><td>45,00</td><td>4,41</td><td></td><td></td></tr></table>	Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER	60	60,00	4,33			45	45,00	4,41				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER													
60	60,00	4,33															
45	45,00	4,41															
Field of application: Heating	Refrigerant: R410A	Supply temperature: 45 °C															
Control: Inverter scroll hermetic compressor		Cost:															
Strengths & weaknesses The inverter driven Ecodan CRHV can operate singularly, or be banked together to create a system that can modulate and cascade available units on and off to meet the load from a building. This level of modulation is unprecedented within the heating industry and with cascade and rotation built in as standard, the Ecodan CRHV system is perfectly suited to a wide range of commercial applications.																	

Manufacturer: Mitsubishi Electric	Brand name: CRHV-P600YA-HPB	Model: 60, 45 high temperature															
Short description of main technology: Heating capacity at 12/7°C and 30/35°C and COP <table border="1"> <thead> <tr> <th>Model</th> <th>Heating capacity (kWth)</th> <th>COP</th> <th>Cooling capacity (kWc)</th> <th>EER</th> </tr> </thead> <tbody> <tr> <td>60</td> <td>60,00</td> <td>5,08</td> <td></td> <td></td> </tr> <tr> <td>45</td> <td>45,00</td> <td>5,11</td> <td></td> <td></td> </tr> </tbody> </table>			Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER	60	60,00	5,08			45	45,00	5,11		
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER													
60	60,00	5,08															
45	45,00	5,11															
Field of application: Heating	Refrigerant: R410A	Supply temperature: 65 °C															
Control: Inverter scroll hermetic compressor		Cost:															
Strengths & weaknesses <p>The inverter driven high temperature Ecodan CRHV can operate singularly, or be banked together to create a system that can modulate and cascade available units on and off to meet the load from a building. This level of modulation is unprecedented within the heating industry and with cascade and rotation built in as standard; the Ecodan CRHV system is perfectly suited to a wide range of commercial applications.</p>																	

Manufacturer: Mitsubishi Electric	Brand name: PQRY-P ...YLM-A	Model: 200, 250, 300, 350, 400, 450, 500, 550, 600		
Short description of main technology: Heating: Indoor 20 °C (D.B.), water temperature 20 °C Cooling: Indoor 27 °C (D.B.)/19 °C (D.B.), water temperature 30 °C				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
200	25,00	6,29	22,40	6,03
250	31,50	6,20	28,00	5,71
300	37,50	6,00	33,50	5,54
350	45,00	5,97	40,00	5,60
400	50,00	5,97	45,00	5,60
450	56,00	5,72	50,00	5,38
500	63,00	5,51	56,00	5,01
550	69,00	5,62	63,00	5,02
600	76,50	5,27	69,00	4,76
Field of application: Heating and cooling	Refrigerant: R410A		Supply temperature: 45 °C	
Control: Inverter scroll hermetic compressor		Cost:		
Strengths & weaknesses The inverter driven can operate singularly, or be banked together to create a system that can modulate and cascade available units on and off to meet the load from a building.				

Manufacturer: Mitsubishi Electric	Brand name: PQRY-P ...YSLM-A	Model: 700, 750, 800		
Short description of main technology: Heating: Indoor 20 °C (D.B.), water temperature 20 °C Cooling: Indoor 27 °C (D.B.)/19 °C (D.B.), water temperature 30 °C				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
700	88,00	5,97	80,00	5,43
750	95,00	5,97	85,0	5,43
800	100,00	5,97	90,00	5,43
Field of application: Heating and cooling	Refrigerant: R410A	Supply temperature: 45 °C		
Control: Inverter scroll hermetic compressor		Cost:		
Strengths & weaknesses The inverter driven can operate singularly, or be banked together to create a system that can modulate and cascade available units on and off to meet the load from a building.				

17. DIMPLEX

Manufacturer:	Brand name:	Model:
DIMPLEX	SIH... ME/TE/TU	6, 9, 11, 20TE, 90ME
Short description of main technology:		
Heating capacity at B0/W45 and COP B0/W45		
Model	Heating capacity (kWth)	COP
SIH 6ME	5,80	3,39
SIH 9ME	8,60	3,40
SIH 11ME	10,00	3,50
SIH 20TE (2 levels)	10,50/20,50	3,40/3,40
SIH 40TE (2 levels)	13,50/31,70	2,50/3,20
SIH 90TU (2 levels)	46,40/86,50	3,80/3,50
Field of application:	Refrigerant:	Supply temperature:
Heating and DHW	R134a	70 °C
Control:		Cost:
Strengths & weaknesses		
<p>Due to their universal design with integrated heat pump manager, the heat pumps can be adapted to numerous customer requirements: These heat pumps can be used as monovalent heat pump heating systems or in combination with other heat generators, if necessary, they can supply several heating circuits at different temperature levels and they can even be used for domestic hot water and swimming pool water preparation. The control panel is removable and can be installed at the optimal operating height using our wall mounting set.</p> <p>The integrated regulation enables permanent heating or cooling operation with parallel domestic hot water or swimming pool water preparation. In cooling operation, the waste heat is transferred to a heat consumer via an additional heat exchanger or discharged via the borehole heat exchanger. The cooling capacity generated can be utilised for dew-point-controlled silent cooling (e.g. cooled ceiling) as well as for dynamic cooling (e.g. fan convectors).</p>		

Manufacturer:	Brand name:	Model:
DIMPLEX	SI... ME	5, 7, 9, 11, 14
Short description of main technology:		
Heating capacity at B0/W45 and COP B0/W45		
Model	Heating capacity (kWth)	COP
SI 5ME	4,60	2,70
SI 7ME	5,70	2,70
SI 9ME	8,50	2,80
SI 11ME	10,00	2,90
SI 14ME	14,70	2,90
Field of application:	Refrigerant:	Supply temperature:
Heating and DHW	R407C	58 °C
Control:	Cost:	
Strengths & weaknesses		
<p>Due to their universal design with integrated heat pump manager, the heat pumps can be adapted to numerous customer requirements: These heat pumps can be used as monovalent heat pump heating systems or in combination with other heat generators, if necessary, they can supply several heating circuits at different temperature levels and they can even be used for domestic hot water and swimming pool water preparation. The control panel is removable and can be installed at the optimal operating height using our wall mounting set.</p> <p>The integrated regulation enables permanent heating or cooling operation with parallel domestic hot water or swimming pool water preparation. In cooling operation, the waste heat is transferred to a heat consumer via an additional heat exchanger or discharged via the borehole heat exchanger. The cooling capacity generated can be utilised for dew-point-controlled silent cooling (e.g. cooled ceiling) as well as for dynamic cooling (e.g. fan convectors).</p>		

Manufacturer: DIMPLEX	Brand name: SIK...ME	Model: SIK 11, 16ME									
Short description of main technology: Heating capacity at B0/W45 and COP B0/W45 <table border="1"> <thead> <tr> <th>Model</th> <th>Heating capacity (kWth)</th> <th>COP</th> </tr> </thead> <tbody> <tr> <td>SIK 11ME</td> <td>11,20</td> <td>3,20</td> </tr> <tr> <td>SIK 16ME</td> <td>15,20</td> <td>3,00</td> </tr> </tbody> </table>			Model	Heating capacity (kWth)	COP	SIK 11ME	11,20	3,20	SIK 16ME	15,20	3,00
Model	Heating capacity (kWth)	COP									
SIK 11ME	11,20	3,20									
SIK 16ME	15,20	3,00									
Field of application: Heating and DHW	Refrigerant: R407C	Supply temperature: 55 °C									
Control:		Cost:									
Strengths & weaknesses <p>Due to their universal design with integrated heat pump manager, the heat pumps can be adapted to numerous customer requirements: These heat pumps can be used as monovalent heat pump heating systems or in combination with other heat generators, if necessary, they can supply several heating circuits at different temperature levels and they can even be used for domestic hot water and swimming pool water preparation. The control panel is removable and can be installed at the optimal operating height using our wall mounting set.</p> <p>The integrated regulation enables permanent heating or cooling operation with parallel domestic hot water or swimming pool water preparation. In cooling operation, the waste heat is transferred to a heat consumer via an additional heat exchanger or discharged via the borehole heat exchanger. The cooling capacity generated can be utilized for dew-point-controlled silent cooling (e.g. cooled ceiling) as well as for dynamic cooling (e.g. fan convectors).</p>											

Manufacturer: DIMPLEX	Brand name: WI...ME	Model: 9, 14									
Short description of main technology: Heating capacity at W10/W45 and COP W10/W45 <table border="1"> <thead> <tr> <th>Model</th> <th>Heating capacity (kWth)</th> <th>COP</th> </tr> </thead> <tbody> <tr> <td>WI 9ME</td> <td>7,70</td> <td>3,70</td> </tr> <tr> <td>WI 14ME</td> <td>13,40</td> <td>3,80</td> </tr> </tbody> </table>			Model	Heating capacity (kWth)	COP	WI 9ME	7,70	3,70	WI 14ME	13,40	3,80
Model	Heating capacity (kWth)	COP									
WI 9ME	7,70	3,70									
WI 14ME	13,40	3,80									
Field of application: Heating and DHW	Refrigerant: R407C	Supply temperature: 55 °C									
Control:		Cost:									
Strengths & weaknesses <p>Due to their universal design with integrated heat pump manager, the heat pumps can be adapted to numerous customer requirements: These heat pumps can be used as monovalent heat pump heating systems or in combination with other heat generators, if necessary, they can supply several heating circuits at different temperature levels and they can even be used for domestic hot water and swimming pool water preparation. The control panel is removable and can be installed at the optimal operating height using our wall mounting set.</p> <p>The integrated regulation enables permanent heating or cooling operation with parallel domestic hot water or swimming pool water preparation. In cooling operation, the waste heat is transferred to a heat consumer via an additional heat exchanger or discharged via the borehole heat exchanger. The cooling capacity generated can be utilized for dew-point-controlled silent cooling (e.g. cooled ceiling) as well as for dynamic cooling (e.g. fan convectors).</p>											

Manufacturer: DIMPLEX	Brand name: SI MER	Model: 10												
Short description of main technology: Heating capacity at B0/W45 and COP B0/W45 Cooling capacity at B10/W7 and EER B10/W7														
<table border="1"> <tr> <th>Model</th> <th>Heating capacity (kWth)</th> <th>COP</th> <th>Cooling capacity (kWc)</th> <th>EER</th> </tr> <tr> <td>SI 10MER</td> <td>9,30</td> <td>3,30</td> <td>12,70</td> <td>7,90</td> </tr> </table>					Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER	SI 10MER	9,30	3,30	12,70	7,90
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER										
SI 10MER	9,30	3,30	12,70	7,90										
Field of application: Heating, cooling and DHW	Refrigerant: R410A	Supply temperature: 62 °C												
Control:		Cost:												
Strengths & weaknesses <p>Due to their universal design with integrated heat pump manager, the heat pumps can be adapted to numerous customer requirements: These heat pumps can be used as monovalent heat pump heating systems or in combination with other heat generators, if necessary, they can supply several heating circuits at different temperature levels and they can even be used for domestic hot water and swimming pool water preparation. The control panel is removable and can be installed at the optimal operating height using our wall mounting set.</p> <p>The integrated regulation enables permanent heating or cooling operation with parallel domestic hot water or swimming pool water preparation. In cooling operation, the waste heat is transferred to a heat consumer via an additional heat exchanger or discharged via the borehole heat exchanger. The cooling capacity generated can be utilized for dew-point-controlled silent cooling (e.g. cooled ceiling) as well as for dynamic cooling (e.g. fan convectors).</p>														

Manufacturer: DIMPLEX	Brand name: SI TUR	Model: 130		
Short description of main technology: Heating capacity at B0/W55 and COP B0/W55 Cooling capacity at B20/W18 and EER B20/W18				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
SI 10MER (2 levels)	51,80/103,10	2,83/2,82	89,40/168,20	7,40/6,70
Field of application: Heating, cooling and DHW	Refrigerant: R410A	Supply temperature: 58 °C		
Control:		Cost:		
Strengths & weaknesses <p>Due to their universal design with integrated heat pump manager, the heat pumps can be adapted to numerous customer requirements: These heat pumps can be used as monovalent heat pump heating systems or in combination with other heat generators, if necessary, they can supply several heating circuits at different temperature levels and they can even be used for domestic hot water and swimming pool water preparation. The control panel is removable and can be installed at the optimal operating height using our wall mounting set.</p> <p>The integrated regulation enables permanent heating or cooling operation with parallel domestic hot water or swimming pool water preparation. In cooling operation, the waste heat is transferred to a heat consumer via an additional heat exchanger or discharged via the borehole heat exchanger. The cooling capacity generated can be utilised for dew-point-controlled silent cooling (e.g. cooled ceiling) as well as for dynamic cooling (e.g. fan convectors).</p>				

Manufacturer:	Brand name:	Model:
DIMPLEX	SI...TU	6, 8, 11, 14, 18, 22, 26, 35, 50, 75, 90, 130
Short description of main technology:		
Heating capacity at B0/W45 and COP B0/W45		
Model	Heating capacity (kWth)	COP
SI 6TU	5,80	3,60
SI 8TU	7,50	3,60
SI 11TU	10,40	3,70
SI 14TU	13,30	3,80
SI 18TU	17,00	3,60
SI 22TU	22,30	3,60
SI 26TU (2 performance levels)	13,20/25,40	4,10/3,80
SI 35TU (2 performance levels)	17,30/33,10	4,00/3,70
SI 50TU (2 performance levels)	25,10/47,80	4,00/3,70
SI 75TU (2 performance levels)	36,70/70,20	3,90/3,70
SI 90TU (2 performance levels)	42,50/81,70	3,80/3,60
SI 130TU (2 performance levels)	67,20/132,10	3,70/3,70
Field of application:	Refrigerant:	Supply temperature:
Heating and DHW	R410A	62 °C
Control:	Cost:	
Strengths & weaknesses		
<p>Due to their universal design with integrated heat pump manager, the heat pumps can be adapted to numerous customer requirements: These heat pumps can be used as monovalent heat pump heating systems or in combination with other heat generators, if necessary, they can supply several heating circuits at different temperature levels and they can even be used for domestic hot water and swimming pool water preparation. The control panel is removable and can be installed at the optimal operating height using our wall mounting set.</p> <p>The integrated regulation enables permanent heating or cooling operation with parallel domestic hot water or swimming pool water preparation. In cooling operation, the waste heat is transferred to a heat consumer via an additional heat exchanger or discharged via the borehole heat exchanger. The cooling capacity generated can be utilised for dew-point-controlled silent cooling (e.g. cooled ceiling)</p>		

Manufacturer: DIMPLEX	Brand name: SIK...TE	Model: 6, 8, 11, 14															
Short description of main technology: Heating capacity at B0/W45 and COP B0/W45 <table border="1"> <thead> <tr> <th>Model</th><th>Heating capacity (kWth)</th><th>COP</th></tr> </thead> <tbody> <tr> <td>SIK 6TE</td><td>5,60</td><td>3,60</td></tr> <tr> <td>SIK 8TE</td><td>7,30</td><td>3,70</td></tr> <tr> <td>SIK 11TE</td><td>10,10</td><td>3,80</td></tr> <tr> <td>SIK 14TE</td><td>12,80</td><td>3,70</td></tr> </tbody> </table>			Model	Heating capacity (kWth)	COP	SIK 6TE	5,60	3,60	SIK 8TE	7,30	3,70	SIK 11TE	10,10	3,80	SIK 14TE	12,80	3,70
Model	Heating capacity (kWth)	COP															
SIK 6TE	5,60	3,60															
SIK 8TE	7,30	3,70															
SIK 11TE	10,10	3,80															
SIK 14TE	12,80	3,70															
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 62 °C															
Control:		Cost:															
Strengths & weaknesses <p>Due to their universal design with integrated heat pump manager, the heat pumps can be adapted to numerous customer requirements: These heat pumps can be used as monovalent heat pump heating systems or in combination with other heat generators, if necessary, they can supply several heating circuits at different temperature levels and they can even be used for domestic hot water and swimming pool water preparation. The control panel is removable and can be installed at the optimal operating height using our wall mounting set.</p> <p>The integrated regulation enables permanent heating or cooling operation with parallel domestic hot water or swimming pool water preparation. In cooling operation, the waste heat is transferred to a heat consumer via an additional heat exchanger or discharged via the borehole heat exchanger. The cooling capacity generated can be utilised for dew-point-controlled silent cooling (e.g. cooled ceiling) as well as for dynamic cooling (e.g. fan convectors).</p>																	

Manufacturer: DIMPLEX	Brand name: SIW...TE	Model: 6, 8, 11												
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Model	Heating capacity (kWth)	COP												
SIW 6TE	5,60	3,60												
SIW 8TE	7,30	3,70												
SIW 11TE	9,90	3,80												
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 62 °C												
Control: <ul style="list-style-type: none"> • With integrated domestic hot water cylinder for minimal space requirements. • Can also be optionally used for passive cooling. 		Cost:												
Strengths & weaknesses <p>Due to their universal design with integrated heat pump manager, the heat pumps can be adapted to numerous customer requirements: These heat pumps can be used as monovalent heat pump heating systems or in combination with other heat generators, if necessary, they can supply several heating circuits at different temperature levels and they can even be used for domestic hot water and swimming pool water preparation. The control panel is removable and can be installed at the optimal operating height using our wall mounting set.</p> <p>The integrated regulation enables permanent heating or cooling operation with parallel domestic hot water or swimming pool water preparation. In cooling operation, the waste heat is transferred to a heat consumer via an additional heat exchanger or discharged via the borehole heat exchanger. The cooling capacity generated can be utilized for dew-point-controlled silent cooling (e.g. cooled ceiling) as well as for dynamic cooling (e.g. fan convectors).</p>														

Manufacturer: DIMPLEX	Brand name: WI...TU	Model: 10, 14, 18, 22, 35, 45, 65																														
Short description of main technology: Heating capacity at W10/W45 and COP W10/W45 <table border="1"> <thead> <tr> <th>Model</th><th>Heating capacity (kWth)</th><th>COP</th></tr> </thead> <tbody> <tr> <td>WI 10TU</td><td>9,10</td><td>4,30</td></tr> <tr> <td>WI 14TU</td><td>12,20</td><td>4,40</td></tr> <tr> <td>WI 18TU</td><td>15,60</td><td>4,40</td></tr> <tr> <td>WI 22TU</td><td>21,10</td><td>4,40</td></tr> <tr> <td>WI 35TU (2 levels)</td><td>16,50/33,60</td><td>4,70/4,70</td></tr> <tr> <td>WI 45TU (2 levels)</td><td>23,00/43,90</td><td>4,80/4,60</td></tr> <tr> <td>WI 65TU (2 levels)</td><td>33,80/63,70</td><td>5,00/4,70</td></tr> <tr> <td>WI 95TU (2 levels)</td><td>65,60/121,10</td><td>4,70/4,40</td></tr> <tr> <td>WI 120TU (2 levels) (R134a)</td><td>65,60/121,10 (70 °C)</td><td>4,70/4,40</td></tr> </tbody> </table>			Model	Heating capacity (kWth)	COP	WI 10TU	9,10	4,30	WI 14TU	12,20	4,40	WI 18TU	15,60	4,40	WI 22TU	21,10	4,40	WI 35TU (2 levels)	16,50/33,60	4,70/4,70	WI 45TU (2 levels)	23,00/43,90	4,80/4,60	WI 65TU (2 levels)	33,80/63,70	5,00/4,70	WI 95TU (2 levels)	65,60/121,10	4,70/4,40	WI 120TU (2 levels) (R134a)	65,60/121,10 (70 °C)	4,70/4,40
Model	Heating capacity (kWth)	COP																														
WI 10TU	9,10	4,30																														
WI 14TU	12,20	4,40																														
WI 18TU	15,60	4,40																														
WI 22TU	21,10	4,40																														
WI 35TU (2 levels)	16,50/33,60	4,70/4,70																														
WI 45TU (2 levels)	23,00/43,90	4,80/4,60																														
WI 65TU (2 levels)	33,80/63,70	5,00/4,70																														
WI 95TU (2 levels)	65,60/121,10	4,70/4,40																														
WI 120TU (2 levels) (R134a)	65,60/121,10 (70 °C)	4,70/4,40																														
Field of application: Heating and DHW	Refrigerant: R410A	Supply temperature: 62 °C																														
Control:		Cost:																														
Strengths & weaknesses <p>Due to their universal design with integrated heat pump manager, the heat pumps can be adapted to numerous customer requirements: These heat pumps can be used as monovalent heat pump heating systems or in combination with other heat generators, if necessary, they can supply several heating circuits at different temperature levels and they can even be used for domestic hot water and swimming pool water preparation. The control panel is removable and can be installed at the optimal operating height using our wall mounting set.</p> <p>The integrated regulation enables permanent heating or cooling operation with parallel domestic hot water or swimming pool water preparation. In cooling operation, the waste heat is transferred to a heat consumer via an additional heat exchanger or discharged via the borehole heat exchanger. The cooling capacity generated can be utilized for dew-point-controlled silent cooling (e.g. cooled ceiling) as well as for dynamic cooling (e.g. fan convectors).</p>																																

18. JC-Hitachi

Manufacturer:	Brand name:	Model:		
JC-Hitachi	2 x RCME-...WH1	40, 50, 60, 70		
Short description of main technology:				
Heating capacity at 12/7°C and 40/45°C and COP				
Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
2xRCME-40WH1	319,80	4,79	280,00	5,00
2xRCME-50WH1	411,80	4,76	360,00	4,96
2xRCME-60WH1	505,80	4,67	440,00	4,85
2xRCME-70WH1	594,20	4,69	500,00	4,87
Field of application:		Refrigerant:	Supply temperature:	
Heating, cooling and DHW		R134a	45 °C	
Control:		Cost:		
Two semi-hermetic twin screw compressors with infinite capacity control. The working range is 12,50 to 100%				
Strengths & weaknesses				
The HITACHI Samurai range incorporates a new twin screw compressor optimized for R134a refrigerant and the latest development of HITACHI's screw compressor technology with the HITACHI's Infinite Capacity Control from 25% to 100%. Thanks to this modulation the compressor load is always matching with the requested load, and thus accurate chilled water temperature is achieved without expensive inverter devices.				
<ul style="list-style-type: none">• Cyclonic oil separator to reduce oil carry over and increase efficiency• The bearing has been improved and the recommended overhaul timing is now expanded from 24.000 h to 40.000 h.• Additional oil port.• New rotor• Light casing				

With new series chiller it is not necessary to request the option to get a safety element for the compressor. Safety valve is assembled to the compressor as a standard feature.

The electronic expansion valve provides reduced power consumption compared to the classical system of thermostatic expansion valve types, and combined with sophisticated control it offers an accurate adjustment of the refrigerant circuit at any condition. The double electronic expansion valves system ensures equal distribution to both inlets of the plate heat exchanger. HITACHI furnishes electronic expansion valves as standard, whereas it is usually an optional extra in the case of competitors.

Manufacturer:	Brand name:	Model:		
JC-Hitachi	3 x RCME-...WH1	40, 50, 60, 70		
Short description of main technology:				
Heating capacity at 12/7°C and 40/45°C and COP				
Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
3xRCME-40WH1	479,70	4,79	420,00	5,00
3xRCME-50WH1	617,70	4,76	540,00	4,96
3xRCME-60WH1	758,70	4,67	660,00	4,85
3xRCME-70WH1	891,30	4,69	750,00	4,87
Field of application:	Refrigerant:	Supply temperature:		
Heating, cooling and DHW	R134a	45 °C		
Control:		Cost:		
Three semi-hermetic twin screw compressors with infinite capacity control. The working range is 8,30 to 100%				
Strengths & weaknesses				
The HITACHI Samurai range incorporates a new twin screw compressor optimized for R134a refrigerant and the latest development of HITACHI’s screw compressor technology with the HITACHI’s Infinite Capacity Control from 25% to 100%. Thanks to this modulation the compressor load is always matching with the requested load, and thus accurate chilled water temperature is achieved without expensive inverter devices.				
<ul style="list-style-type: none">• Cyclonic oil separator to reduce oil carry over and increase efficiency• The bearing has been improved and the recommended overhaul timing is now expanded from 24.000 h to 40.000 h.• Additional oil port.• New rotor• Light casing				

With new series chiller it is not necessary to request the option to get a safety element for the compressor. Safety valve is assembled to the compressor as a standard feature.

The electronic expansion valve provides reduced power consumption compared to the classical system of thermostatic expansion valve types, and combined with sophisticated control it offers an accurate adjustment of the refrigerant circuit at any condition. The double electronic expansion valves system ensures equal distribution to both inlets of the plate heat exchanger. HITACHI furnishes electronic expansion valves as standard, whereas it is usually an optional extra in the case of competitors.

Manufacturer:	Brand name:	Model:		
JC-Hitachi	4 x RCME-...WH1	40, 50, 60, 70		
Short description of main technology:				
Heating capacity at 12/7°C and 40/45°C and COP				
Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
4xRCME-40WH1	639,60	4,79	560,00	5,00
4xRCME-50WH1	823,60	4,76	720,00	4,96
4xRCME-60WH1	1011,60	4,67	880,00	4,85
4xRCME-70WH1	1188,40	4,96	1000,00	4,87
Field of application:	Refrigerant:	Supply temperature:		
Heating, cooling and DHW	R134a	45 °C		
Control:		Cost:		
Four semi-hermetic twin screw compressors with infinite capacity control. The working range is 6,20 to 100%				
Strengths & weaknesses				
The HITACHI Samurai range incorporates a new twin screw compressor optimized for R134a refrigerant and the latest development of HITACHI's screw compressor technology with the HITACHI's Infinite Capacity Control from 25% to 100%. Thanks to this modulation the compressor load is always matching with the requested load, and thus accurate chilled water temperature is achieved without expensive inverter devices.				
<ul style="list-style-type: none">• Cyclonic oil separator to reduce oil carry over and increase efficiency• The bearing has been improved and the recommended overhaul timing is now expanded from 24.000 h to 40.000 h.• Additional oil port.• New rotor• Light casing				

With new series chiller it is not necessary to request the option to get a safety element for the compressor. Safety valve is assembled to the compressor as a standard feature.

The electronic expansion valve provides reduced power consumption compared to the classical system of thermostatic expansion valve types, and combined with sophisticated control it offers an accurate adjustment of the refrigerant circuit at any condition. The double electronic expansion valves system ensures equal distribution to both inlets of the plate heat exchanger. HITACHI furnishes electronic expansion valves as standard, whereas it is usually an optional extra in the case of competitors.

Manufacturer:	Brand name:	Model:		
JC-Hitachi	5 x RCME-...WH1	40, 50, 60, 70		
Short description of main technology:				
Heating capacity at 12/7°C and 40/45°C and COP				
Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
5xRCME-40WH1	799,50	4,79	700,00	5,00
5xRCME-50WH1	1029,50	4,76	900,00	4,96
5xRCME-60WH1	1264,50	4,67	1100,00	4,85
5xRCME-70WH1	1485,50	4,69	1250,00	4,87
Field of application:	Refrigerant:	Supply temperature:		
Heating, cooling and DHW	R134a	45 °C		
Control:		Cost:		
Five semi-hermetic twin screw compressors with infinite capacity control. The working range is 5,00 to 100%				
Strengths & weaknesses				
The HITACHI Samurai range incorporates a new twin screw compressor optimized for R134a refrigerant and the latest development of HITACHI's screw compressor technology with the HITACHI's Infinite Capacity Control from 25% to 100%. Thanks to this modulation the compressor load is always matching with the requested load, and thus accurate chilled water temperature is achieved without expensive inverter devices.				
<ul style="list-style-type: none">• Cyclonic oil separator to reduce oil carry over and increase efficiency• The bearing has been improved and the recommended overhaul timing is now expanded from 24.000 h to 40.000 h.• Additional oil port.• New rotor• Light casing				
With new series chiller it is not necessary to request the option to get a safety element for the com-				

pressor. Safety valve is assembled to the compressor as a standard feature.

The electronic expansion valve provides reduced power consumption compared to the classical system of thermostatic expansion valve types, and combined with sophisticated control it offers an accurate adjustment of the refrigerant circuit at any condition. The double electronic expansion valves system ensures equal distribution to both inlets of the plate heat exchanger. HITACHI furnishes electronic expansion valves as standard, whereas it is usually an optional extra in the case of competitors.

Manufacturer: JC-Hitachi	Brand name: 6 x RCME-...WH1	Model: 40, 50, 60, 70		
Short description of main technology: Heating capacity at 12/7°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
6xRCME-40WH1	959,40	4,79	840	5,00
6xRCME-50WH1	1235,40	4,76	1080	4,96
6xRCME-60WH1	1517,40	4,67	1320	4,85
6xRCME-70WH1	1782,60	4,69	1500	4,87
Field of application: Heating, cooling and DHW	Refrigerant: R134a	Supply temperature: 45 °C		
Control: Six semi-hermetic twin screw compressors with infinite capacity control. The working range is 4,20 to 100%		Cost:		
Strengths & weaknesses The HITACHI Samurai range incorporates a new twin screw compressor optimized for R134a refrigerant and the latest development of HITACHI's screw compressor technology with the HITACHI's Infinite Capacity Control from 25% to 100%. Thanks to this modulation the compressor load is always matching with the requested load, and thus accurate chilled water temperature is achieved without expensive inverter devices. <ul style="list-style-type: none">• Cyclonic oil separator to reduce oil carry over and increase efficiency• The bearing has been improved and the recommended overhaul timing is now expanded from 24.000 h to 40.000 h.• Additional oil port.• New rotor• Light casing				

With new series chiller it is not necessary to request the option to get a safety element for the compressor. Safety valve is assembled to the compressor as a standard feature.

The electronic expansion valve provides reduced power consumption compared to the classical system of thermostatic expansion valve types, and combined with sophisticated control it offers an accurate adjustment of the refrigerant circuit at any condition. The double electronic expansion valves system ensures equal distribution to both inlets of the plate heat exchanger. HITACHI furnishes electronic expansion valves as standard, whereas it is usually an optional extra in the case of competitors.

Manufacturer:	Brand name:	Model:		
JC-Hitachi	7 x RCME-...WH1	40, 50, 60, 70		
Short description of main technology:				
Heating capacity at 12/7°C and 40/45°C and COP				
Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
7xRCME-40WH1	1119,30	4,79	980	5,00
7xRCME-50WH1	1441,30	4,76	1260	4,96
7xRCME-60WH1	1770,30	4,67	1540	4,85
7xRCME-70WH1	2079,70	4,69	1750	4,87
Field of application:		Refrigerant:	Supply temperature:	
Heating, cooling and DHW		R134a	45 °C	
Control:		Cost:		
Seven semi-hermetic twin screw compressors with infinite capacity control. The working range is 3,60 to 100%				
Strengths & weaknesses				
The HITACHI Samurai range incorporates a new twin screw compressor optimized for R134a refrigerant and the latest development of HITACHI's screw compressor technology with the HITACHI's Infinite Capacity Control from 25% to 100%. Thanks to this modulation the compressor load is always matching with the requested load, and thus accurate chilled water temperature is achieved without expensive inverter devices.				
<ul style="list-style-type: none">• Cyclonic oil separator to reduce oil carry over and increase efficiency• The bearing has been improved and the recommended overhaul timing is now expanded from 24.000 h to 40.000 h.• Additional oil port.• New rotor• Light casing				

With new series chiller it is not necessary to request the option to get a safety element for the compressor. Safety valve is assembled to the compressor as a standard feature.

The electronic expansion valve provides reduced power consumption compared to the classical system of thermostatic expansion valve types, and combined with sophisticated control it offers an accurate adjustment of the refrigerant circuit at any condition. The double electronic expansion valves system ensures equal distribution to both inlets of the plate heat exchanger. HITACHI furnishes electronic expansion valves as standard, whereas it is usually an optional extra in the case of competitors.

Manufacturer:	Brand name:	Model:		
JC-Hitachi	8 x RCME-...WH1	40, 50, 60, 70		
Short description of main technology:				
Heating capacity at 12/7°C and 40/45°C and COP				
Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
8xRCME-40WH1	1279,20	4,79	1120	5,00
8xRCME-50WH1	1647,20	4,76	1440	4,96
8xRCME-60WH1	2023,20	4,67	1760	4,85
8xRCME-70WH1	2376,80	4,69	2000	4,87
Field of application:		Refrigerant:	Supply temperature:	
Heating, cooling and DHW		R134a	45 °C	
Control:		Cost:		
Eight semi-hermetic twin screw compressors with infinite capacity control. The working range is 3,10 to 100%				
Strengths & weaknesses				
The HITACHI Samurai range incorporates a new twin screw compressor optimized for R134a refrigerant and the latest development of HITACHI’s screw compressor technology with the HITACHI’s Infinite Capacity Control from 25% to 100%. Thanks to this modulation the compressor load is always matching with the requested load, and thus accurate chilled water temperature is achieved without expensive inverter devices.				
<ul style="list-style-type: none">• Cyclonic oil separator to reduce oil carry over and increase efficiency• The bearing has been improved and the recommended overhaul timing is now expanded from 24.000 h to 40.000 h.• Additional oil port.• New rotor• Light casing				
With new series chiller it is not necessary to request the option to get a safety element for the				

compressor. Safety valve is assembled to the compressor as a standard feature.

The electronic expansion valve provides reduced power consumption compared to the classical system of thermostatic expansion valve types, and combined with sophisticated control it offers an accurate adjustment of the refrigerant circuit at any condition. The double electronic expansion valves system ensures equal distribution to both inlets of the plate heat exchanger. HITACHI furnishes electronic expansion valves as standard, whereas it is usually an optional extra in the case of competitors.

Manufacturer: JC-Hitachi	Brand name: RCME-...WH1	Model: 40, 50, 60, 70		
Short description of main technology: Heating capacity at 12/7°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
RCME-40WH1	159,90	4,79	140	5,00
RCME-50WH1	205,90	4,76	180	4,96
RCME-60WH1	252,90	4,67	220	4,85
RCME-70WH1	297,10	4,69	250	4,87
Field of application: Heating, cooling and DHW	Refrigerant: R134a	Supply temperature: 45 °C		
Control: One semi-hermetic twin screw compressor with infinite capacity control. The working range is 25 to 100%		Cost:		
Strengths & weaknesses The HITACHI Samurai range incorporates a new twin screw compressor optimized for R134a refrigerant and the latest development of HITACHI’s screw compressor technology with the HITACHI’s Infinite Capacity Control from 25% to 100%. Thanks to this modulation the compressor load is always matching with the requested load, and thus accurate chilled water temperature is achieved without expensive inverter devices. <ul style="list-style-type: none">• Cyclonic oil separator to reduce oil carry over and increase efficiency• The bearing has been improved and the recommended overhaul timing is now expanded from 24.000 h to 40.000 h.• Additional oil port.• New rotor• Light casing				

With new series chiller it is not necessary to request the option to get a safety element for the compressor. Safety valve is assembled to the compressor as a standard feature.

The electronic expansion valve provides reduced power consumption compared to the classical system of thermostatic expansion valve types, and combined with sophisticated control it offers an accurate adjustment of the refrigerant circuit at any condition. The double electronic expansion valves system ensures equal distribution to both inlets of the plate heat exchanger. HITACHI furnishes electronic expansion valves as standard, whereas it is usually an optional extra in the case of competitors.

19. CARRIER

Manufacturer:	Brand name:	Model:
CARRIER	GW Hydronic	024, 036, 048, 060, 120, 072

Short description of main technology:

Models	Water loop Heat pump				Ground Water				Ground Loop			
	Cooling 30oC		Heating 20oC		Cooling 30oC		Heating 20oC		Cooling 30oC		Heating 20oC	
	Capacity kW	EER	Capacity kW	COP	Capacity kW	EER	Capacity kW	COP	Capacity kW	EER	Capacity kW	COP
GW024	6,15	3,92	9,08	4,4	7,18	6,21	7,33	3,5	6,59	4,66	5,71	3,0
GW036	8,49	3,69	12,60	4,3	9,96	5,92	9,96	3,5	8,79	4,28	7,91	3,0
GW048	11,43	3,78	16,99	4,1	13,19	5,77	13,77	3,5	12,01	4,37	10,99	3,0
GW060	14,36	3,78	21,83	4,2	16,26	5,83	17,43	3,5	14,94	4,34	14,06	3,0
GW120	33,41	4,04	47,11	4,6	38,09	6,24	37,94	3,8	35,01	4,72	30,03	3,0
GW072	16,85	3,81	25,34	4,2	18,75	5,51	20,51	3,4	17,58	4,34	15,68	3,0

Field of application:	Refrigerant:	Supply temperature:
Heating, cooling and DHW	PURON	80 °C

Control:	Cost:
Two-stage unloading scroll	

Strengths & weaknesses

Microprocessor control: Precise sequencing for optimum performance, ease of service.

Smart Start (optional feature): Factory installed electronic start assist device for compressor that reduces start-up amperage to reduce noise, eliminate light flicker, and increase compressor life.

Fully insulated cabinet: Closed cell and fiberglass insulation inside cabinet provides additional insulation against the normal operating sound of the compressor.

SmartEvap Technology: This Carrier® patented technology operates after a dehumidification cycle in cooling and turns off the blower for five minutes to allow condensate to drain from the evaporator coil, and not re-evaporate into the home.

20. MAYEKAWA

Manufacturer: MAYEKAWA	Brand name: MYCOM	Model: 40, 50, 60, 70															
Short description of main technology: Heating capacity at 12/7°C and 40/45°C and COP Cooling capacity at 12/7°C and 30/35°C and EER <table border="1"> <thead> <tr> <th>Model</th><th>Heating capacity (kWth)</th><th>COP</th></tr> </thead> <tbody> <tr> <td>PH-W125</td><td>487</td><td>4,50</td></tr> <tr> <td>RCME-50WH1</td><td>205,90</td><td>4,76</td></tr> <tr> <td>RCME-60WH1</td><td>252,90</td><td>4,67</td></tr> <tr> <td>RCME-70WH1</td><td>297,10</td><td>4,69</td></tr> </tbody> </table>			Model	Heating capacity (kWth)	COP	PH-W125	487	4,50	RCME-50WH1	205,90	4,76	RCME-60WH1	252,90	4,67	RCME-70WH1	297,10	4,69
Model	Heating capacity (kWth)	COP															
PH-W125	487	4,50															
RCME-50WH1	205,90	4,76															
RCME-60WH1	252,90	4,67															
RCME-70WH1	297,10	4,69															
Field of application: Heating and DHW	Refrigerant: R717	Supply temperature: 85 °C															
Control: N6HK (Reciprocating Compressor)		Cost:															
Strengths & weaknesses <p>Product belongs to the MAYEKAWA 'NATURAL 5' program, and introduces herewith a new generation of energy saving equipment, using the MAYEKAWA N6HK high pressure compressor (50 bar) with natural refrigerant NH3 (GWP=0). The MAYEKAWA Plus+HEAT unit can produce hot water maximum 85 °C by using different heat sources such as condenser heat from existing refrigeration plants, waste heat from industrial plants, renewable geothermal energy, and many more. The MAYEKAWA Plus+HEAT system directly contributes to fossil fuel reduction, what means also CO2 emission reduction resulting in fuel- and CO2 emission cost reduction. Additional energy savings are possible by applying frequency invertors for compressor speed control for high efficiency operation. The MAYEKAWA Plus+HEAT unit is design compact with small footprint and maintenance friendly so that contracting work at site is minimized.</p>																	

21. PHNIX

Manufacturer:	Brand name:	Model:		
PHNIX	PTWSHW	250S, 500S		
Short description of main technology:				
Water Source Inlet/Outlet: 20/15°C				
Heating Side Inlet/Outlet: 65/75°C				
Model	Heating capacity (kWth)	COP	Cooling capacity (kWc)	EER
250S	64,00	3,20	40,00	5,20
500S	129,00	3,22	80,00	5,20
Field of application:		Refrigerant:	Supply temperature:	
Heating, cooling and DHW		R134a	80 °C	
Control:		Cost:		
EVI scroll compressor. The model 250S has two compressors and the model 500S has one compressor.				
Strengths & weaknesses				
The unit is capable of producing high temperature outlet water and simultaneously performs free cooling. The double effects that it brings use the same amount of energy but providing you with both hot water and cool air which add to greater cost-savings. The unit can adjust to various installation locations, such as inside a basement, on the ground floor and even on the roof, which makes it so flexible for fast, low-cost installation.				

22. B Cool

Manufacturer:		Brand name:		Model:	
B Cool		GEO		GEO 008, 010, 015, 020, 030, 040, 050, 060, 080, 090, 100	
Short description of main technology:					
Water to water.					
(1) Water system side (in/out) 15°C/10°C Water condenser (in/out) 40°C/45°C					
(2) Water system side (in/out) 20°C/16°C Water evaporator (in/out) 12°C/7°C					
Model	Cooling output (kWc) (2)	EER	Heating output (kWth) (1)	COP	
GEO008	7,65	4,78	9,00	5,63	
GEO010	10,55	5,02	12,20	5,81	
GEO015	15,20	4,90	17,80	5,74	
GEO020	20,60	5,02	24,00	5,85	
GEO030	30,90	5,33	35,40	6,10	
GEO040	39,10	5,21	44,90	5,99	
GEO050	45,90	5,08	52,90	5,85	
GEO060	61,80	5,33	70,90	6,11	
GEO080	78,20	5,21	89,70	5,98	
GEO090	91,80	5,10	105,80	5,88	
GEO100	100,40	5,28	113,00	5,95	
Field of application:		Refrigerant:		Supply temperature:	
Heating and Cooling		R410A		70 °C	
Control:				Cost:	
The models GEO008 to GEO050 have one scroll compressor with capacity step 0-100%. The models GEO060 to GEO100 have two scrolls compressors (1 tandem) with capacity step 0-50-100%					

Strengths & weaknesses

All units use low-noise, maintenance free, Hermetic Scroll compressors with low vibration levels, especially optimized for use with R410a refrigerant, provided from world class suppliers. They are equipped with a crankcase electrical heater for oil and are internally protected against potential overloading or electrical spikes. The compressors are mounted on special anti-vibration rubber mounts, to absorb and eliminate any vibration from the unit's operation. All units are equipped with a sophisticated controller that combines intelligence with operating simplicity. The controller constantly monitors all machine parameters and precisely manages among others: Automatic compressor control function through return water temperature, Frost protection, Hydraulic circuits pump control, Compressor start-up time delay function, Compressor running time records, Over 150 programmable parameters, Auto diagnostic stop function due to low water circulation, high/low operating pressure and compressor thermal overload, Auto diagnostic stop function and digital display of approximately 30 possible error codes, including thermistor faults, Digital displays of inlet/outlet source and load water, Remote cool/heat selector switch, Remote on/off switch, Phase sequence - phase failure - reverse phase and voltage monitoring.

23. ROTEX

Manufacturer:	Brand name:	Model:				
ROTEX	HPU	RGSQH10S18AA9W				
Short description of main technology:						
Water to water.						
(1) B0 / W35						
<table><tr><td>Heating output (kWth) (1)</td><td>COP</td></tr><tr><td>13,00</td><td>4,35</td></tr></table>			Heating output (kWth) (1)	COP	13,00	4,35
Heating output (kWth) (1)	COP					
13,00	4,35					
Field of application:	Refrigerant:	Supply temperature:				
Heating and Cooling	R410A	65 °C				
Control:		Cost:				
Scroll compressor, Inverter controlled						
Strengths & weaknesses						
<p>The ground source heat pump delivers exceptional performance thanks to its highly efficient inverter technology. When the building does not require heating at full capacity, the heat pump reduces its output, making it much more efficient. Boost function for maximum heating output if the building requires a greater heating capacity, ROTEX HPU ground uses its integrated boost function to increase the output without the need for an additional immersion heater. The HPU ground is factory-fitted with an integrated 180 l stainless steel domestic hot water tank, which considerably reduces installation time. The pipe connections ready fitted on the upper section of the unit additionally minimize connection work. The ground source heat pump is impressively compact and requires only a small installation area, because all the key components are housed within the unit itself. This gives you plenty of options in terms of where to install it in your home.</p>						