The **GHP** range

Thanks to its wide experience in the climate control and cogeneration sectors, Accorroni has put on the market a truly exhaustive range of gas heat pumps able to meet all requirements and suitable for all the most recent applications in terms of energy saving. The gas endothermic engine that operates the refrigeration compressor is the element common to all models. This range works with refrigerating gas that do not damage the ozone layer and has been integrated by particular versions offering technical solutions suitable for a number of system requirements.

GC 60 Split - GHP 60 Split

This version is available in two models: refrigeration unit GC (summer conditioning + simultaneous production of thermal energy from the engine) and heat pump GHP (summer conditioning and winter heating + simultaneous production of thermal energy from the engine). The appliance is made up of two separate elements - the basic unit and the remote unit - for maximum installation flexibility, even in very small areas. Both units have been designed for outside installation and have a protection rating IP44. The basic unit can also be installed inside a heat generating system in compliance with applicable regulations. The refrigerant used is R134a.
The basic unit houses the following main components: endothermic engine complete with recovery exchangers, compressor, water/water exchanger, water/R134a exchanger, cycle reversal valve (only model GHP), electric control panel, and electronic management system. The remote unit is made up of the following elements: engine cooling water/air exchanger, air/R134a exchanger, propeller fans. The piping connecting it to the basic unit can be as long as 10 metres maximum and have a difference in height of 5 metres.

GHPA 60 water/water

This is the best model in terms of both efficiency and energy saving. The groundwater it uses as an external source allows for a coefficient of performance of the refrigeration cycle that is higher than the air/water version. Further heat can be recovered from the condenser during the summer.
The appliance comprises one single compact unit that can be installed both outside (protection rating IP44) and inside a heat generating system. It is made up of the following elements: endothermic engine complete with recovery exchangers, compressor, water/water exchanger, two water/R134a exchangers, cycle reversal valve, electric control panel, and electronic management system.

GHP 60 Basic

It is the first of the 7 package models, with extremely easy installation. The refrigeration cycle is of the air/water kind and operates with the refrigerant R407C. The appliance has been designed to be installed outdoor in a specific space or on the roof of the building. It is made up of a single unit very similar to an electric refrigeration assembly.

GHP 60 Idro 1

This model has the same technical and manufacturing characteristics as the Basic model with the addition of a factory-assembled hydraulic kit comprising: a 300-litre tank for hot sanitary water (A.C.S.), a manifold for mixed water from engine cooling hot water and the refrigeration cycle, a 3-way mixing valve, a pump for hot sanitary water, a pump for exchange/manifold water (gas side), a safety valve 3 bar, an air valve, an expansion tank, a water inlet tank.

GHP 60 Idro 2

This model has the same technical and manufacturing characteristics as the Idro 1 model without the tank for hot sanitary water for those situations when hot sanitary water is not needed or vice versa the system needs greater quantities to be specifically dimensioned.

GHP 60 Total Energy Module

An evolution of the Basic model, this appliance alone is able to meet all the most advanced system requirements. This version permits giving priority to hot water production for sanitary use, combining all the advantages typical of the GHP models in one compact ready-to-use appliance that is extremely easy to install.
It is supplied standard with a factory-assembled hydraulic kit comprising: a 300-litre tank for hot sanitary water (A.C.S.), a manifold for mixed water from engine cooling hot water and the refrigeration cycle, a 3-way mixing valve, a pump for hot sanitary water, a pump for exchange/manifold water (gas side), a safety valve 3 bar, an air valve, an expansion tank, a water inlet tank.

GHP 60 FP Idro 1

This model, which has been developed to be used for floor radiant heating systems, testifies to the high versatility of the GHP range. It is a system technology that has been gaining an ever greater share of the market, its supply requirements at low temperatures being thoroughly met by the use of the GHP 60 FP.
During the winter this model makes it possible to manage the set temperature by modifying it according to both changing outside temperature and the heat exchange coefficient of the floor based on specific curves predetermined by a special software integrated into the electronic controls of the appliance.
During the summer time the GHP 60 FP is able to produce refrigerating energy to supply a system with traditional hydronic terminals such as fan coils, unit heaters, air treatment units, etc. Hot sanitary water can be produced according to one's needs in both seasons. The appliance is supplied standard with a factory-assembled hydraulic kit comprising: a 300-litre tank for hot sanitary water (A.C.S.), a manifold for mixed water from engine cooling hot water and the refrigeration cycle, a 3-way mixing valve, a pump for hot sanitary water, a pump for exchange/manifold water (gas side), a safety valve 3 bar, an air valve, an expansion tank, a water inlet tank.

GHP 60 FP Idro 2

This model has the same technical and manufacturing characteristics as the Idro 1 model without the tank for hot sanitary water for those situations when hot sanitary water is not needed or vice versa the system needs greater quantities to be specifically dimensioned.

GHP 60 FP Total Energy Module

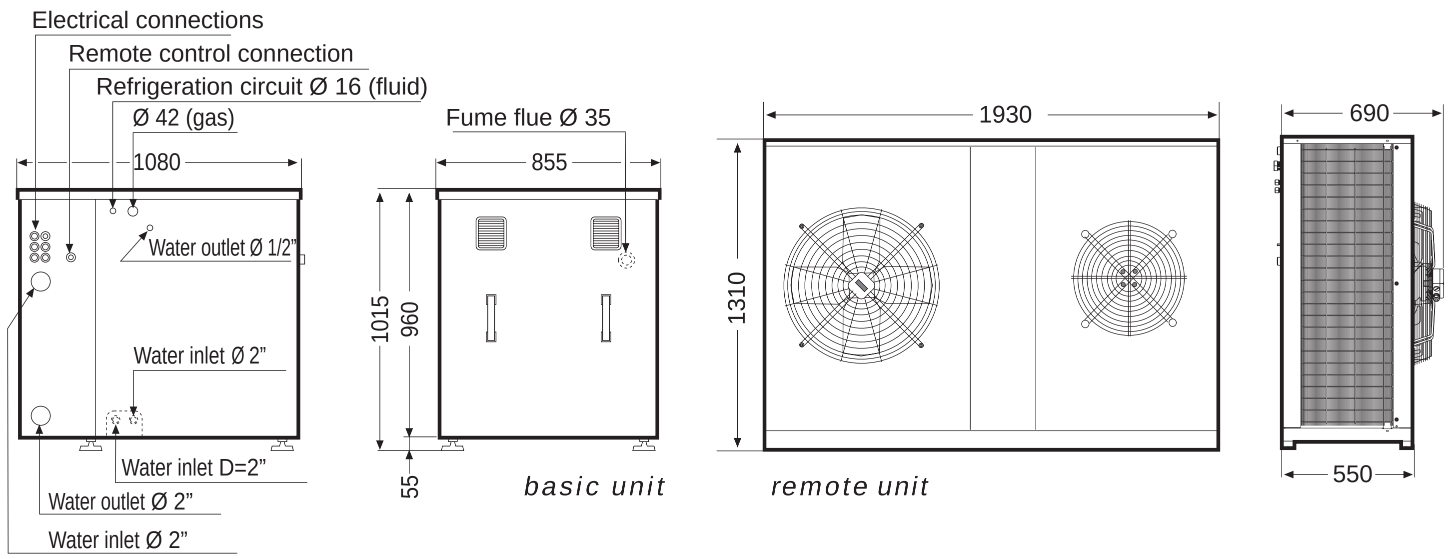
This models adds the versatility typical of the Total Energy Module unit to the functionalities dedicated to floor systems. That is why this version too permits giving priority to hot water production for sanitary use, for instance between seasons. The factory-assembled hydraulic kit supplied standard with this model comprises: a 300-litre tank for hot sanitary water (A.C.S.), a manifold for mixed water from engine cooling hot water and the refrigeration cycle, a 3-way mixing valve, a pump for hot sanitary water, a pump for exchange/manifold water (gas side), a safety valve 3 bar, an air valve, an expansion tank, a water inlet tank inside the appliance.

	Models		Summer operation		Winter operation	
			Cooling power	therm. power	thermal power	
			kW	kW	kW	
	GC 60 Split (cooling only)	Remote unit code70500100 Basic unit code 70500000	32,0	30,0		31.480,00
	GHP 60 Split (heat pump)	Remote unit code70550100 Basic unit code 70550000	32,0	30,0	62,0	33.540,00
	GHPA 60 water/water	code 70650000	29,0	30,0 + 37,2	64,6	30.440,00
	GHP 60 Basic	code 70700000	27,0	28,0	55,0	28.570,00
(a)	GHP 60 Idro 1 Hydro sanitary kit and installation included	code 70720000	27,0	28,0	55,0	31.490,00
(b)	GHP 60 Idro 2 Hydraulic kit for installation included	code 70740000	27,0	28,0	55,0	30.140,00
(a)	GHP 60 Total Energy Module Hydro sanitary kit and installation included	code 70760000	27,0	28,0	55,0	35.540,00
(a)	GHP 60 FP Idro 1 per floor installation Hydro sanitary kit included	code 70780000	27,0	28,0	55,0	33.100,00
(b)	GHP 60 FP Idro 2 per floor installation Hydraulic kit for installation included	code 70800000	27,0	28,0	55,0	31.270,00
(a)	GHP 60 FP Total Energy Module for floor installation Hydro sanitary kit and installation included	code 70820000	27,0	28,0	55,0	36.180,00

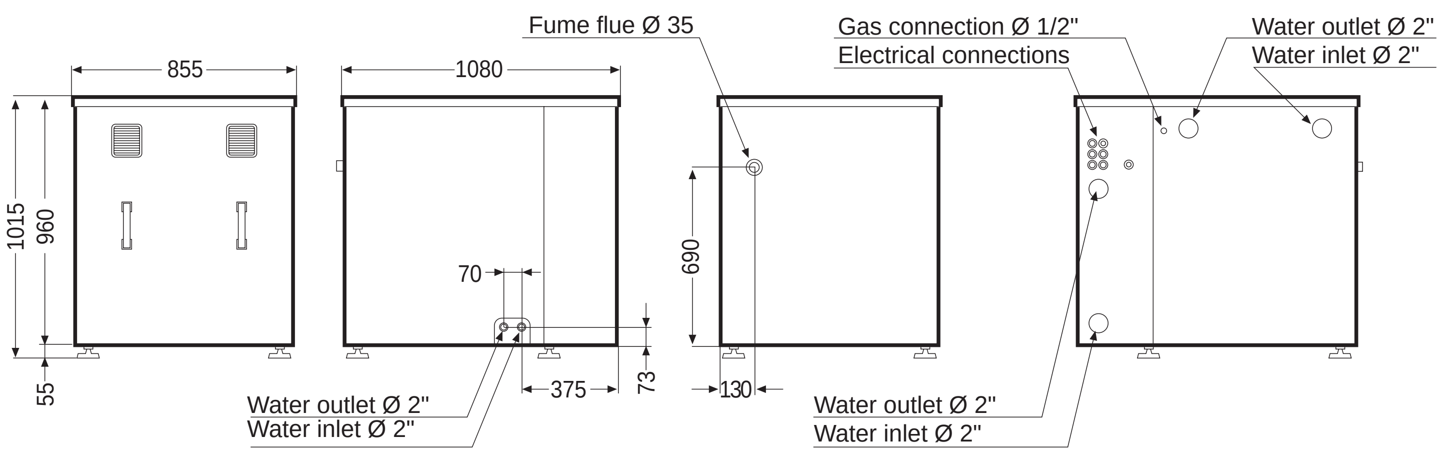
(c)	Super-silent operation	code 70709000		1.590,00
(d)	Remote control	code 70705000		420,00

(a) **Hydraulic kit 1** comprising: 300-litre tank for hot sanitary water (A.C.S.), a manifold for mixed water from engine cooling hot water and the refrigeration cycle, a 3-way mixing valve, a pump for hot sanitary water, a pump for exchange/manifold water (gas side), a safety valve 3 bar, an air valve, an expansion tank, a water inlet tank.
(b) **Hydraulic kit 2** comprising the same elements as the previous kit without the tank for hot sanitary water for those situations when hot sanitary water is not needed or vice versa the system needs greater quantities to be specifically dimensioned.
(c) The surcharge for super-silent operation is valid for all versions, except for GC 60 Split, GHP 60 Split, GHPA 60 water/water.
(d) Available for all versions, except for GC 60 Split, GHP 60 Split, GHPA 60 water/water.

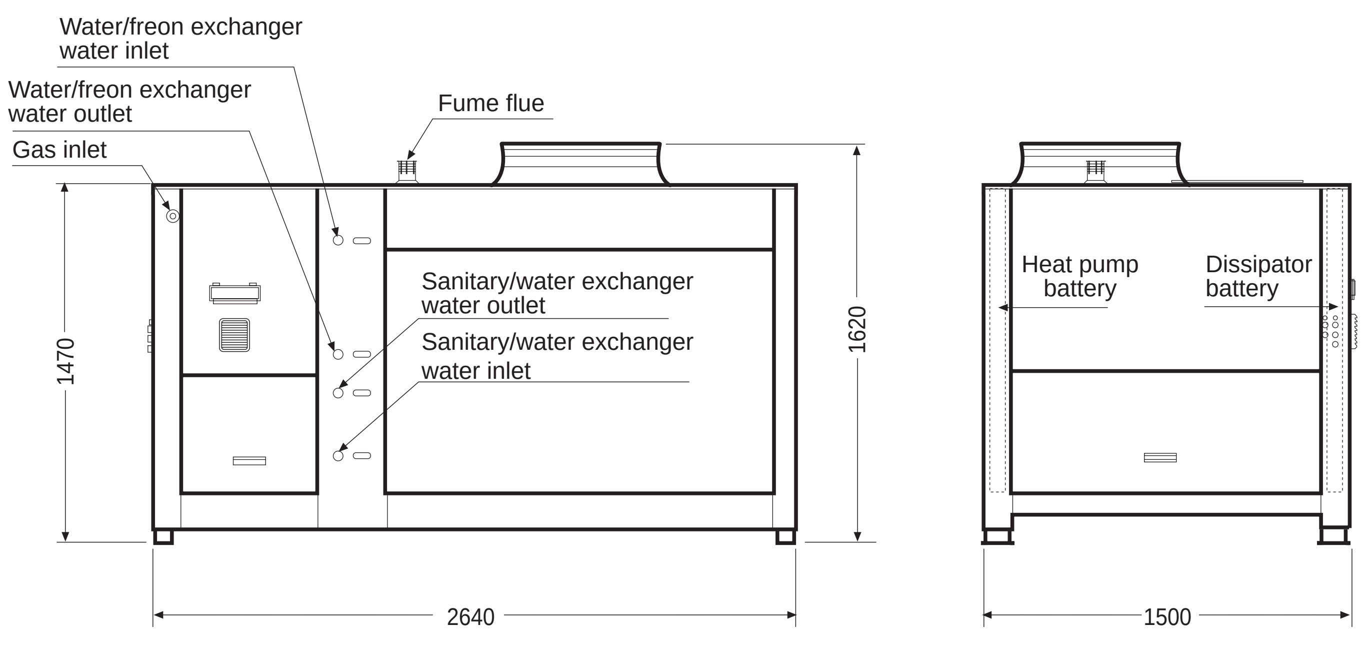
Dimensions GHP 60 split



Dimensions GHPA water/water



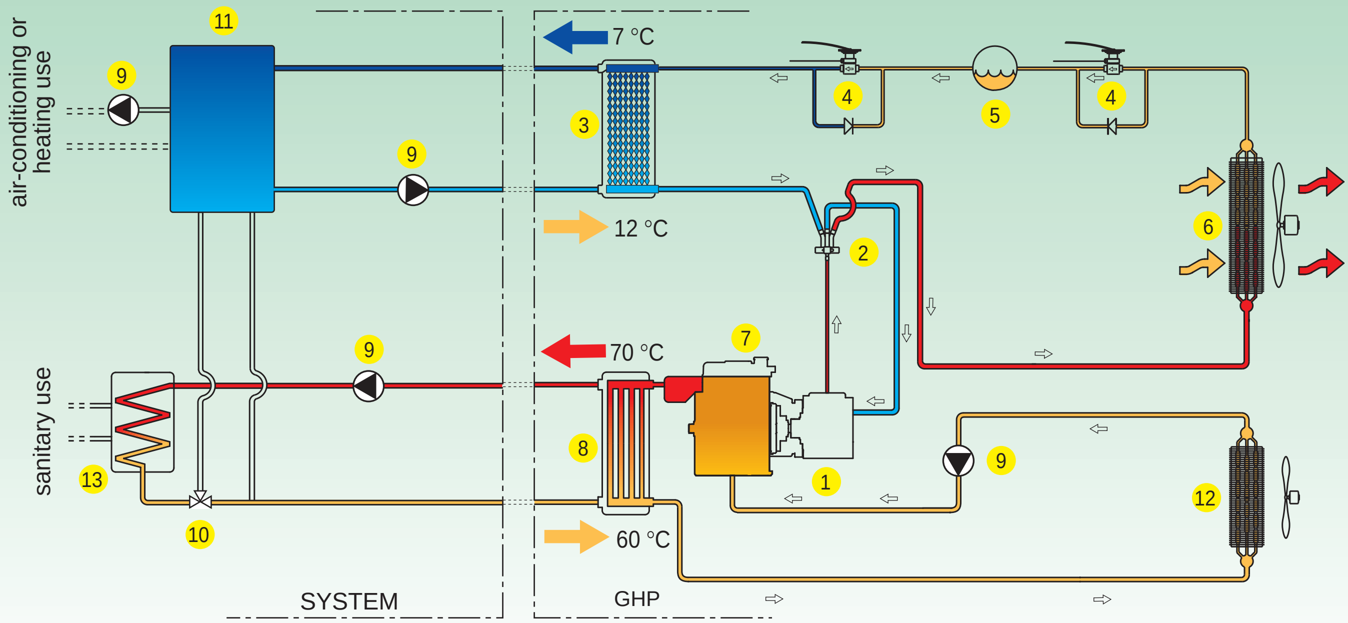
Dimensions GHP 60 basic



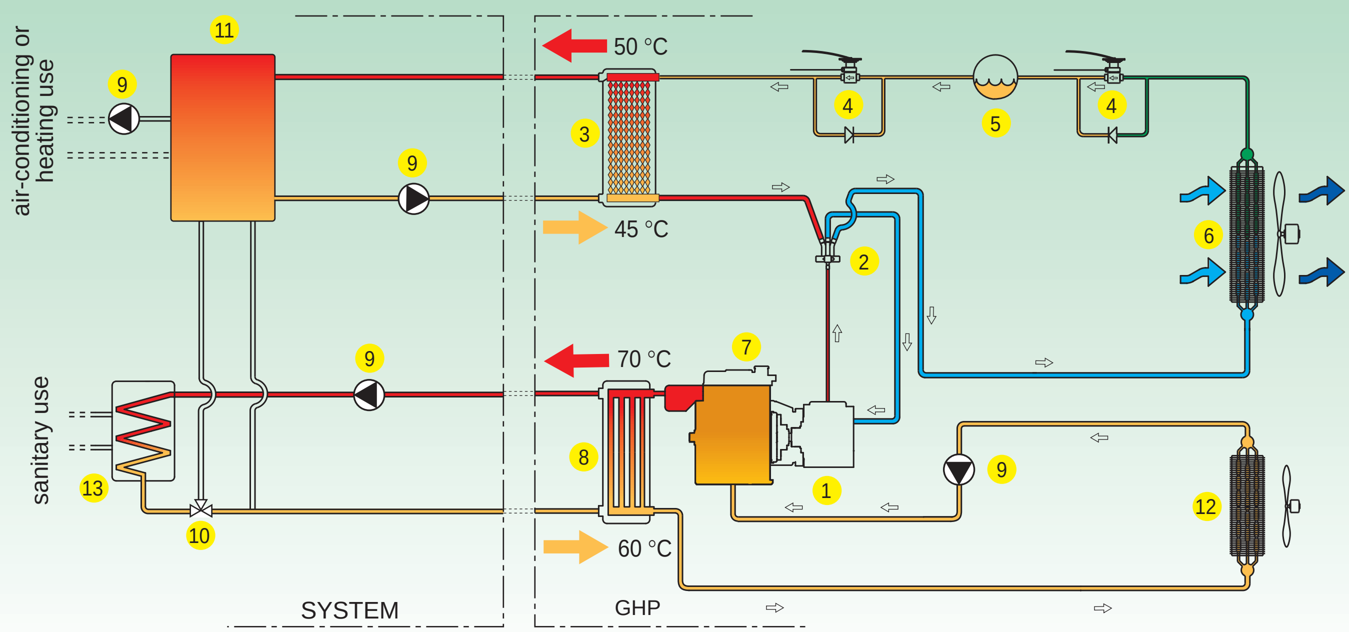
GHP - Gas heat pump

Thanks to a simple and efficient solution, in the GHP model the mechanical energy needed to operate the compressor is not generated by an electric motor - as happens in traditional heat pumps - but by a gas-fired Otto endothermic engine. The refrigeration cycle principle is not altered, while some important advantages are introduced.

Cooling



Heating



1) Compressor
2) Cycle reversal valve
3) Water/refrigerant exchanger
4) Thermal expansion valve
5) Fluid receiver
6) Water/refrigerant exchanger
7) Engine
8) Water/water exchanger
9) Pump
10) Deflecting valve
11) Manifold
12) Radiator
13) Inertial tank
⊳|) Non-return valve

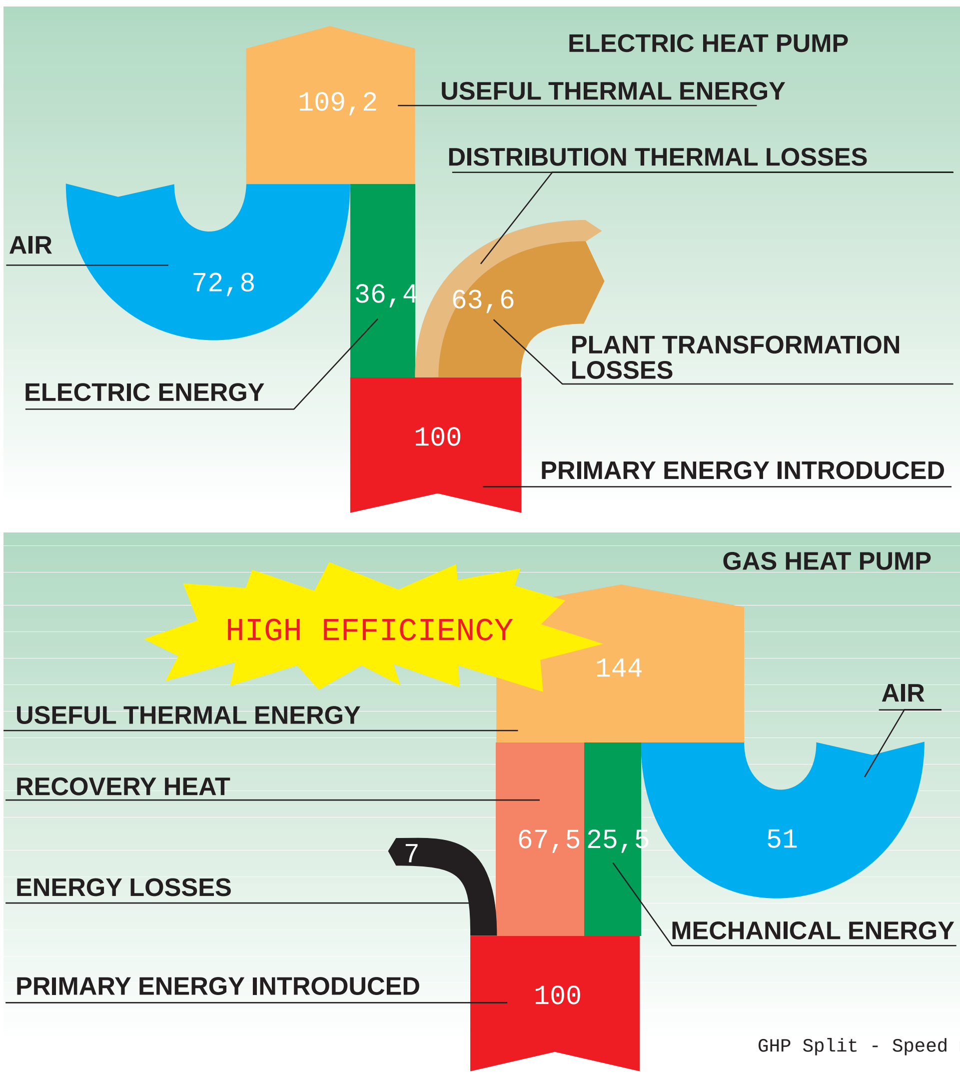
N.B. Several main elements of the "system" section are included in the different GHP versions with a kit

Great efficiency and low pollution

An average primary energy share of approximately 2.74 kWh is required in Italy in order to produce energy in thermoelectric power plants and distribute 1kWh of electric energy.
This means that, starting from the thermoelectric power plants, only 36.4% of fuel primary energy is used in order to actually produce electric energy, while the remaining 63.6% is dispersed as unused heat and the following losses due to its transfer to the final users - amounting to 6.4% according to the Thermoelectric Production data for 2000 (GRTN).
The purpose of cogeneration is to use the heat that would otherwise be lost in the surrounding environment and therefore completely wasted. This should be done though a higher overall yield.
Cogeneration is a system that converts the primary energy of fuel used in the joint production of electric or mechanical energy and thermal energy (heat). It is characterised by operating self-sufficiency, which recovers and is able to use a part of the thermal energy that is given off to the environment in traditional processes of production of electric energy only (Authority for gas and electric energy, 2001). "In particular, the systems based on internal-combustion engines - regardless of whether they are reciprocating engines or gas turbines - whose mechanical efficiency is not altered by cogeneration, can make large quantities of thermal energy available that would otherwise be dispersed into the environment and that can therefore be considered as almost free." (Professor/Engineer R. Lazzarin - Padua University - Refrigeration in Cogeneration - CDA no.2/2000).
In the GHP models this principle translates into the direct use of gas primary energy and its transformation into mechanical energy for refrigeration compressor operation and recovery of most thermal energy produced by the engine. This increases the energy advantage over what can be obtained from an electric heat pump.

Great efficiency and low pollution

How can the efficiency of an electric heat pump be compared with that of a gas heat pump? Machines requiring different types of energy (mechanical/electric/thermal) may be compared by relating the energy input to the primary fuel consumption.
To this end the Fuel Use Coefficient (CUC) is introduced defined as the ratio between useful heat yielded to the users and the primary energy required.
This parameter relates performance to consumption data considering backwards all the energy transformation chain that links incoming energy to energy obtained from a primary energy source.
Based on the same performance as the refrigeration cycles (coefficient of performance), the GHP - thanks to the heat recovered from the engine - makes it possible to save as much primary energy as 25-30% compared to an electric heat pump of the same power.
"Compression refrigeration machines powered by an endothermic engine are the most energy-efficient among today's available gas refrigeration machines." (SNAM S.p.A. - Gas refrigeration machines for air conditioning ... - 6th National Convention ATIG - 1997).

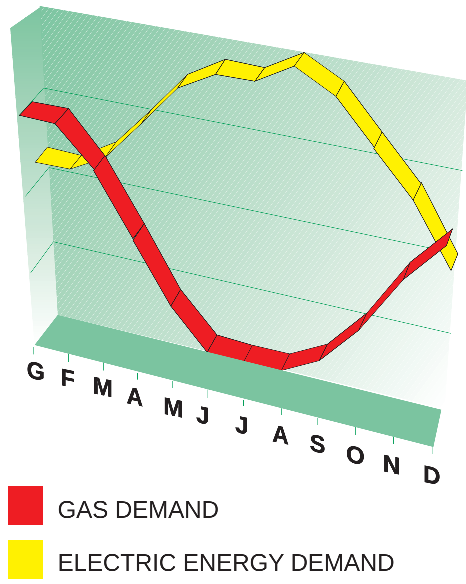


GHP Split - Speed min.

The better use of the fuel in the GHP translates into a smaller quantity of CO_2 emitted, as less primary energy is needed to obtain the same thermo-refrigerating capacity.
The high efficiency of the GHP models falls within the scope of the energy certification for buildings, to be designed with great accuracy from the quality point of view. Energy-saving performance, environmental protection and comfort standards must be taken into account for the buildings as well as for the systems therein installed.
That is why applicable regulations (D.P.R. 412/93 - Attachment D; proposal for a European Parliament and Council Directive on energy efficiency in the building sector - G.U.C.E. no.213 of 31/07/2001) require designers to evaluate using heat pumps - also internal-combustion engine heat pumps - in large office buildings o similar constructions.

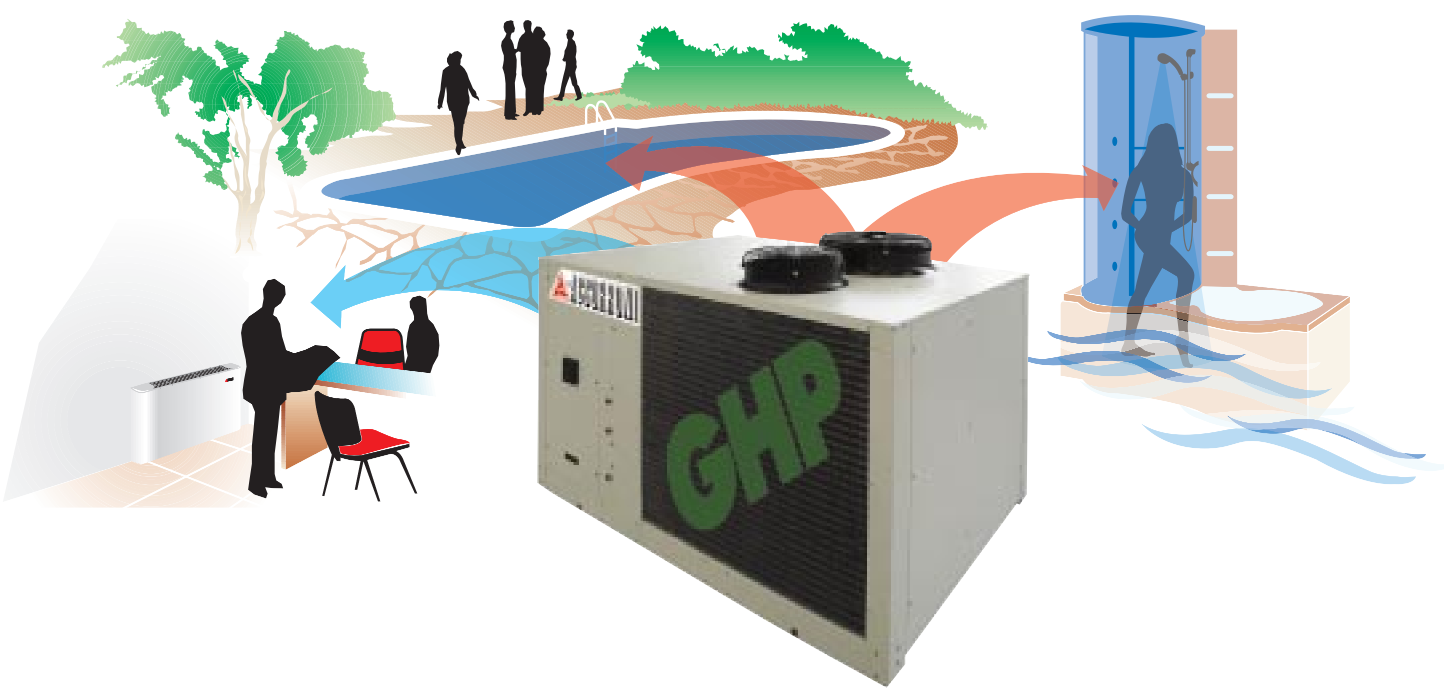
Independence from electric energy requirements

It often happens in the services-producing sector that the considerable electric energy requirements for the climate-control system are responsible for higher costs for contractual power demand or even the need to have a transformer room built. The maximum electric power absorbed by the various models of the GHP series - dedicated only to the operation of fans, pumps and auxiliary circuits - ranges from 300 W to 1.050 W. This makes the installation of these units possible also in existing buildings, with no need to ask the energy supplying body for an increase in electric power. This advantage is enormously higher if the electric heat pumps use additional resistances, when environmental conditions are particularly severe during the winter.
Of course, these positive features are even more evident when the electric-energy distribution network can be developed only with very high costs in poorly serviced areas. GHP units make it possible to transfer a share of the air-conditioning market from traditional electric machines to systems based on the use of gaseous fuels, whose advantages translate into the possible use of alternative energy sources in the summer too - when sales of gaseous fuels are so reduced that distributors apply special prices and incentives.



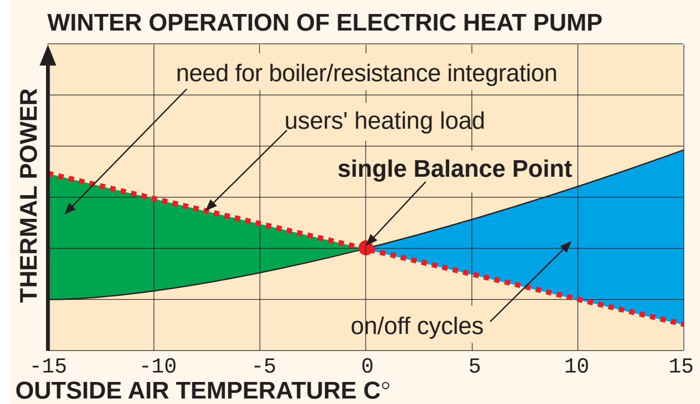
Simultaneous availability of thermal and refrigerating energy

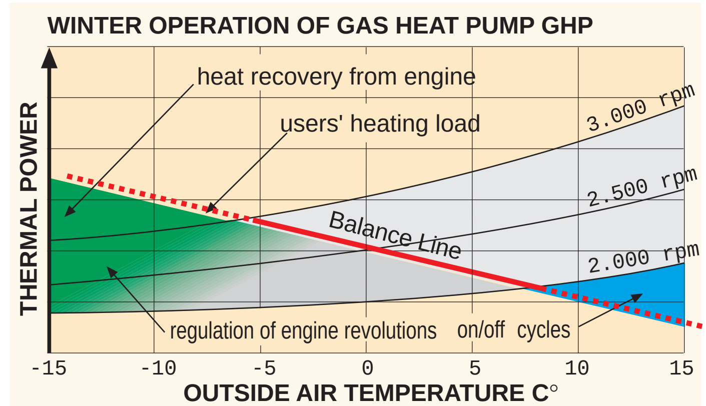
The special system of patented exchangers permits using the heat contained in the engine exhaust gas, and in the engine cooling and lubrication circuits. This recovery makes it possible to use free additional thermal energy besides energy supplied by the refrigeration cycle, thus allowing for great flexibility.
During the summer air-conditioning requirements and sanitary hot water production needs can be met at the same time. During the winter greater thermal power will be available than that supplied by the refrigeration cycle alone, besides the production of sanitary hot water and without the disadvantages typical of electric systems.
Today those areas that are exposed to the outside - as in widely glazed office buildings - often need cooling, while the other areas - with a different exposure - need heating. Or vice versa, according to the season. The GHP units make it possible to use one appliance to service a whole sophisticated 4-pipe system and guarantee maximum comfort on all



Technical aspects of GHP units' advantages

The excellent capacity division of the GHP is due to the possibility of modulating the load in a wide interval of values by regulating the number of revolutions of the engine - both in winter and in summer operation. It must also be mentioned that, if a comparison is made between an electric heat pump and a GHP unit, they give off the same heating power but the latter involves a smaller contribution from the refrigerating section condenser thanks to the recovery from the endothermic engine. Consequently, a smaller power will be required from the evaporator and the outside thermal carrier (air) and the refrigerant will show a smaller difference in temperature based on the same evaporator exchange areas.
It is during the winter that electric heat pumps show their limits, as outside temperature goes down. The thermal recovery from the GHP engine permits overcoming these typical limits and allows for its optimum application at latitudes with more severe weather conditions, when comparing efficiency parameters both in nominal steady conditions and on an average seasonal scale. The GHP can operate in equilibrium conditions with the required heating load - and does not need supplementing boilers or on/off operation - in a wide interval of outside temperature values and users' requirements.
Experimental data derived from on-site tests and scientific research show that GHP units are more efficient and flexible. "The GHP's performance is always better than the other systems'. The improvement ranges from 20% to 25% with respect to the electric heat pump EHP and is always 50% higher than the boiler." (Dentice d'Accadia, Sasso, Sibilio, Vanoli, Energetics Applications, Liguori Editor, 1999)





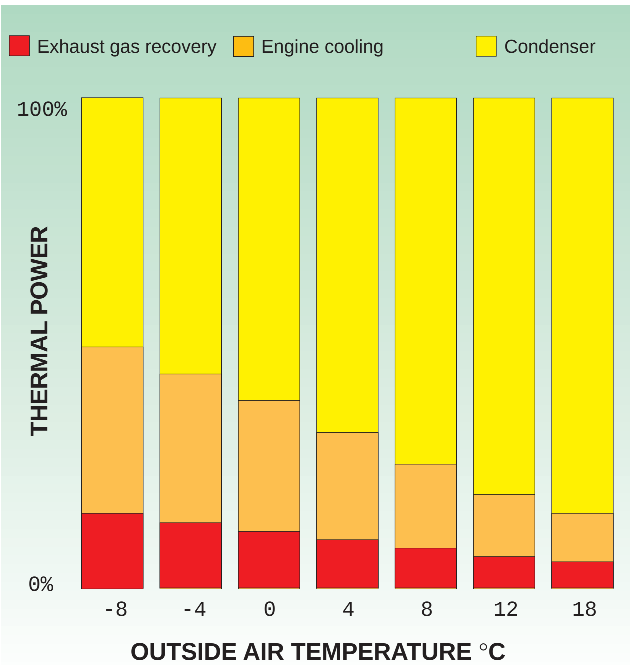
These diagrams show that the GHP - by modulating the power obtained by regulating engine revolutions - can meet users' requirements in a wide operating range, while electric heat pumps could meet them only by using the inverter technology. One typical feature of GHP is the ability to guarantee the power required even at very low temperatures as a consequence of heat recovery from the engine, with no need to have boilers or auxiliary resistances.

Efficiency is less dependent on outside temperature

Efficiency can be further improved thanks to the GHPA model, which uses groundwater as its cold source. The use of water as a source for the heat pump is much better than the use of air in that the system is easier and thermal exchanges more efficient. Besides that, groundwater temperature is both higher than outside air temperature - especially in those areas where the weather conditions are severe - and almost steady throughout the year.
This technology has been the object of recent in-depth studies and energy-economic evaluations - one of the most distinguished Italian studies being the project for the energy recovery of Milan metropolitan area groundwater.
"Finally mention must be made of a possible alternative to the electric operation of the heat pumps. The compressor can be operated directly by an internal-combustion engine that would bring about an increase in overall efficiency by recovering the heat dispersed by the engine. That means combining the considerable advantages of heat pumps and those of cogeneration."
(II - Groundwater Heat Pumps for Climate Control in the Building Sector - 1999/2000)

Better performance in defrosting cycles

Especially in severe and humid climates, the operation of the heat pump cycle causes frost to form on the evaporator. Frost must be removed not to hinder the heat exchange process between outside air and the refrigerant.
Compression heat pumps defrost the evaporator by reversing the cycle. During this procedure the traditional electric heat pump not only does not give off any thermal power but acts as a refrigeration assembly, giving rise to severe thermal discomfort. This procedure should be repeated at regular intervals - more often in those areas where outside temperature is low.
In the GHP the defrosting problem plays a minor role and the procedure can be carried out quickly and without bothering its users. Since a part of the thermal power required by users is given off by the engine and not by the refrigeration circuit condenser, evaporation pressure is higher than that of an electric heat pump as a consequence of the modulation of the number of engine revolutions.
In any case, even when the defrosting procedure is needed, it can be carried out in the GHP more quickly and above all without interrupting thermal energy supply through the recovery of heat from the engine.



Winter operation: contribution of heat recovery from the engine and exhaust gas based on outside temperature variation and as a function of engine revolution modulation.

Electronic management system of operation and maintenance

The operation of the GHP is thoroughly managed by a microprocessor system that permits controlling all the main parameters of the refrigeration cycle.
Contrary to electric heat pumps, this software makes it possible to constantly monitor the optimum operation of the endothermic engine by regulating its speed and controlling its temperature, pressure, lubrication level, etc.
All operation stages are therefore monitored. Maintenance intervals are programmed by the system according to use of the appliance. The high reliability of the endothermic engine ensures a long life, provided that simple maintenance actions are carried out such as the replacement of oil, filters and ignitors. As a matter of fact the engine is based on the same technology as the cogeneration applications for the production of electric energy. Its target of 24-hour-a-day operation for approximately 8,000 hours a year is much more challenging than the 2,000 hours a year of operation of a GHP for climate control on an average.

Description			GC 60 Split	GHP 60 Split	GHPA	GHP 60 Basic	GHP 60 M.E.T.	GHP 60 FP	GHP 60 FP M.E.T.
Winter useful power									
Total thermal power	max.	kW		62,0	64,6	55,0			
	min.	kW		49,0	51,2	41,0			
Refrigeration cycle thermal power	max.	kW		32,0	34,6	27,0			
	min.	kW		26,0	28,2	20,0			
Water flow (˘T 5 ¡C)		kg/h		5.504	4.991	4.644			
Engine recovery thermal power	max.	kW		30,0	30,0	28,0			
	min.	kW		23,0	23,0	21,0			
Water flow (˘T 10 ¡C)		kg/h		2.580	2.580	2.408			
Summer useful power									
Refrigeration power	max.	kW	32,0	32,0	29,0	27,0			
	min.	kW	26,0	26,0	23,6	20,0			
Water flow (˘T 5 ¡C)		kg/h	5.504	5.504	4.991	4.644			
Engine recovery thermal power	max.	kW	30,0	30,0	30,0	28,0			
	min.	kW	23,0	23,0	23,0	21,0			
Water flow (˘T 10 ¡C)		kg/h	2.580	2.580	2.580	2.408			
Condenser recovery thermal power	max.	kW	/	/	37,2	/			
	min.	kW	/	/	30,2	/			
Water flow (˘T 5 ¡C)		kg/h	/	/	6.398	/			
Nominal thermal power (Hi)	max.	kW	50,0	50,0	52,0	48,0			
	min.	kW	34,0	34,0	35,0	31,0			
Methane flow G20 - p 20 mbar (15 ¡C - 1.013,25 mbar)	max.	Nm^3/h	5,37	5,25	5,47	5,06			
	min.	Nm^3/h	3,74	3,58	3,74	3,26			
Propane flow G31 - p 37 mbar (15 ¡C - 1.013,25 mbar)	max.	kg/h	4,00	3,85	4,01	3,72			
	min.	kg/h	2,79	2,63	2,74	2,39			
Propane flow G30 - p 28-30 mbar (15 ¡C - 1.013,25 mbar)	max.	kg/h	3,94	3,91	4,08	3,77			
	min.	kg/h	2,74	2,67	2,78	2,43			
Gas inlet diameter			1/2"						
No. of compressor cylinders		n¡	4			2			
Refrigerant type			R 134a			R 407C			
Power supply			230 V - / 1 / 50 Hz						
IP protection rating			44						
Protection class			Class I according to CEI - ENA						
Operating climatic class									
Max electric absorbtion		W	1.050		300	1.050	1.440		
Sound pressure (5 metres free field)	max.	dB(A)	61		58	59			
	min.	dB(A)	53		52	53			
Max weight		kg	430+196		450	660	850		

The data refers to the following operating conditions:

Summer: outside air temperature: 35°C dry bulb, 24°C wet bulb
Water temperature: incoming 12°C, outgoing 7°C
Winter:outside air temperature: 7°C dry bulb, 6°C wet bulb
Water temperature: incoming 45°C, outgoing 50°C

Engine recovery: max temperature of outgoing water 70°C