D2.1: Report on market situation & trends about small scale chillers

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In the framework of SolarCombi+ project, a market research was performed to identify the market situation about the commercially available small scale sorption chillers with cooling capacity up to 20 kW. The identification of the most promising markets requires an extensive market research on the main competitive products, i.e. the conventional air conditioning systems with similar capacity.

1 Overview of European Air Conditioning Market

The existing building stock in European countries accounts for over 40% of the final energy consumption in the European Union (EU) member states, while residential use represents 63% of total energy consumption in the buildings sector.

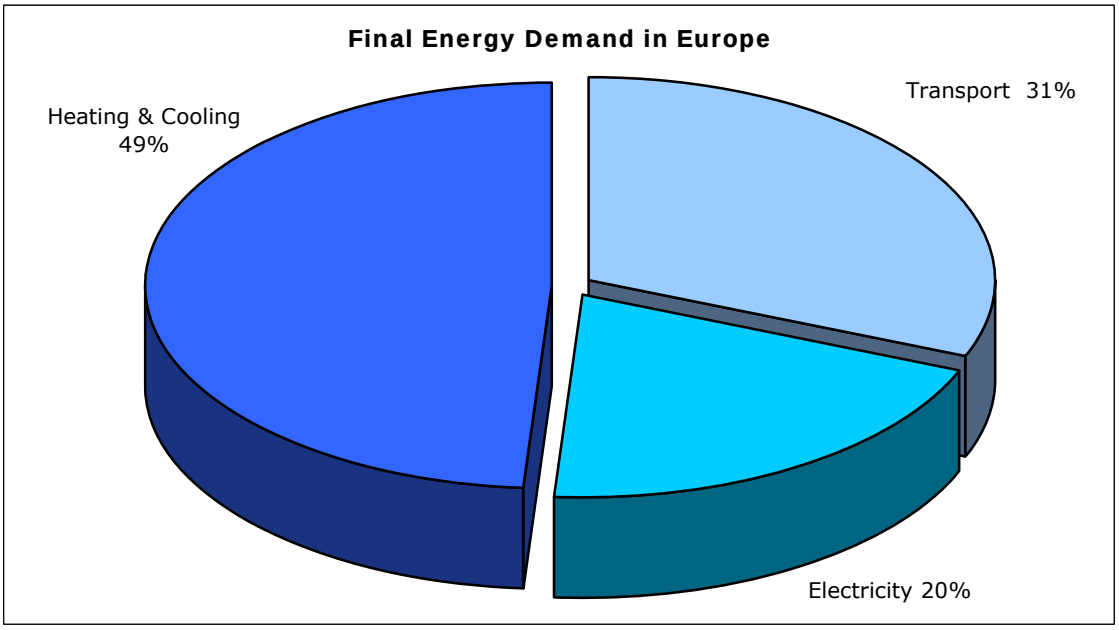

Figure 1: Final Energy demand in the European Union[1]

A share of 49% of the final energy demand refers to heating and cooling purposes, 30-35% of which is found in buildings.

Heat accounts for approximately 70% of all end use energy demand, most of which is covered by fossil fuels (natural gas & oil) and electricity. Cooling demand is more difficult to be identified, since it is incorporated in the electricity use and it is estimated to be up to 8% of the EU-15 annual electricity consumption, with a high annual rate of growth.[2]

The vast majority of the heating and cooling loads/needs are located in the urban areas, since three quarters of the European citizens live there, almost half of the dwellings are multifamily buildings, and most of the demand concerning the service sector is in urban areas.[2]

In recent years, the number of record-breaking hot summer days, especially in those regions with a usually moderate climate (Austria, Germany, Belgium,

[1] EREC 2006
[2] ECOHEATCOOL project recommendations

Ireland, France, UK etc) has been increasing; consequently, this has led to a growing demand for buying systems with cooling load features.

The European AC market has grown rapidly during the last 5 years, becoming simultaneously the main focus of the major Asian manufacturers. The size of AC markets in the seven major European countries (France, Germany, Greece, Italy, Russia, Spain and the UK) expanded rapidly from some 2.4 million units in 2000 to 5 million units in 2004[3]. This owes much to the record-breaking heat in 2003.

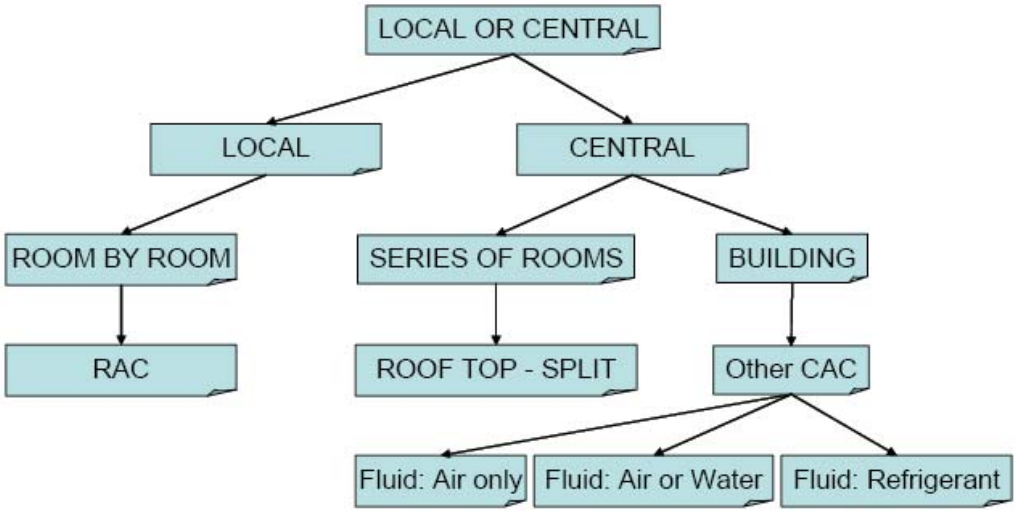

Figure 2: System description of most common Central & Room Air-Conditioning Systems[4]

A further breakdown of the European AC market reveals that Italy and Spain are holding the largest market of about 1.4 to 1.7 million units per year (after 2004), followed by France, Greece and UK at 300,000 to 500,000 units each. Russia has now been added to the major markets of Europe growing rapidly since the February of 2003, now reaching 600,000 to 700,000 units per year.[3]

1.1 Common distribution systems in the European Space Heating and Cooling Market

This paragraph aims to provide a short presentation of common distribution systems used in the European market. The distribution systems presented below are used either for heating or cooling reasons, some of them being more appropriate for one of the functions.

- Fan coils:

  Fan coils belong to central systems and may be used both for heating and for cooling. Although they are rather efficient for space cooling, they are characterized by a relatively high installation cost, which is attributed to the additional cost for drain pipes and plugging as well as the connection to the electricity network.

- Radiant floor – ceiling – walls:

[3] REFRIGE.COM Portal - HVAC & Refrigeration news, events, training, books, magazines and directory online/01/2007
[4] ECOHEATCOOL project/WP2 the European Cold Market

Regarding cooling needs, radiant floor - ceiling and walls are, to a certain extent, inappropriate, as they are not able to provide exceptionally low temperatures, like 16°C. Instead, they are capable only to reduce the room temperature to approximately 26°C. Furthermore, they are rather inflexible and slow in achieving the desired cooling level (it may take up to 2 or 3 days), whereas they do not adjust humidity, like other cooling systems, which makes the installation of an auxiliary fan coil almost necessary. Finally, as the radiant floor is typically used for heating purposes, it is not recommended for cooling, and the additional installation of a chilled ceiling seems required.

- Conventional radiators:

The conventional radiators are heating devices, which are warmed by steam from a boiler, or by hot water being pumped through it from a water heater. Obviously they are not appropriate for space cooling, which means that the cooling demand coverage is normally done by auxiliary installed systems.
Such radiators transfer the majority of their heat by radiation and by convection. The steam radiators have the advantage that steam flows through the pipes under its own pressure without the need for pumping. For this reason, they were adopted and spread very early. Steam is also easily distributed throughout large, tall buildings. Hot-water radiators, on the other hand, operate as follows: hot water enters at the top of the radiator by way of pressure, from a pump elsewhere in the building, or by convection. As the hot water transfers heat it cools down and is forced out of a pipe at the other end of the radiator.
The basic and simple principle characterising conventional radiators makes them really prevalent and contributes to the inhibition of the wide and rapid spread of SC+ systems.

2 AC markets in the participating countries

The data concerning the local ac markets were mainly gathered from the synergy between the IEE SOLAIR & SOLARCOMBI+ projects. It is notable that since there were not sufficient data for conventional ac markets for every participating country besides the given input from the national project partner, data from other sources were also used.

2.1 Austria

The energy demand for cooling is presently 365 GWh in Austria. It is predicted that this value will increase to fivefold until the year 2020 (Energy Economics Group TU Wien). 50% of the cooling devices are installed in offices and other working & non-residential places. Approximately 7% are installed in hospitals and 13% in hotels, restaurants and bars. About 70% of the chilled surface in Austria is chilled with water as distributing media (Austrian Energy Agency, 2003). The cooling load for office buildings in Austrian office buildings are generally 2-3 times bigger than the heating demand of the buildings due to internal heat loads, passive solar gain etc. The heating load for an office building is typically about 30-40 kWh/m²a, which makes the cooling load to about 60-80 kWh/m²a. As far as it concerns residential sector cooling is not yet deployed in a noteworthy level. Furthermore, the new building regulation in Austria will not consider cooling application or load in the guidelines for the residential buildings, revealing minor interest for the small scale cooling market in Austria.[5]

2.2 France

In France, the air-conditioner market has been developing strongly since the heat wave of the year 2003. However, regional differentiations are applicable and different trends for the market are still present, especially in relation to the end-use. More specifically, in 2004, the air-conditioning systems were not very often in the residential sector, in contrary to the service sector, where a high level of penetration had been already achieved.

At the end of December 2005, the air-conditioning market was equal to 302 000 unit sold (exterior Split unit). The heatwave of 2003 boosted the market in 2004, that's why the market in 2005 experienced a decrease of about 36% in comparison to 2004, but an increase of about 15% in comparison to the 2003 market.

It is notable that the sales of inverter air-conditioning products sustain a huge increase. In fact, in 2005, 60% of the air-conditioner had this technology, and only 45% in 2004 and 10% in 2000.

[5] Country data provided by AEE-INTEC, SOLAIR& SOLARCOMBI+ project partner

Figure 4 presents the increase of sales of ac systems with the respective capacity of SOLARCOMBI+ systems, highlighting the high and growing share of split air-conditioning units.[6]

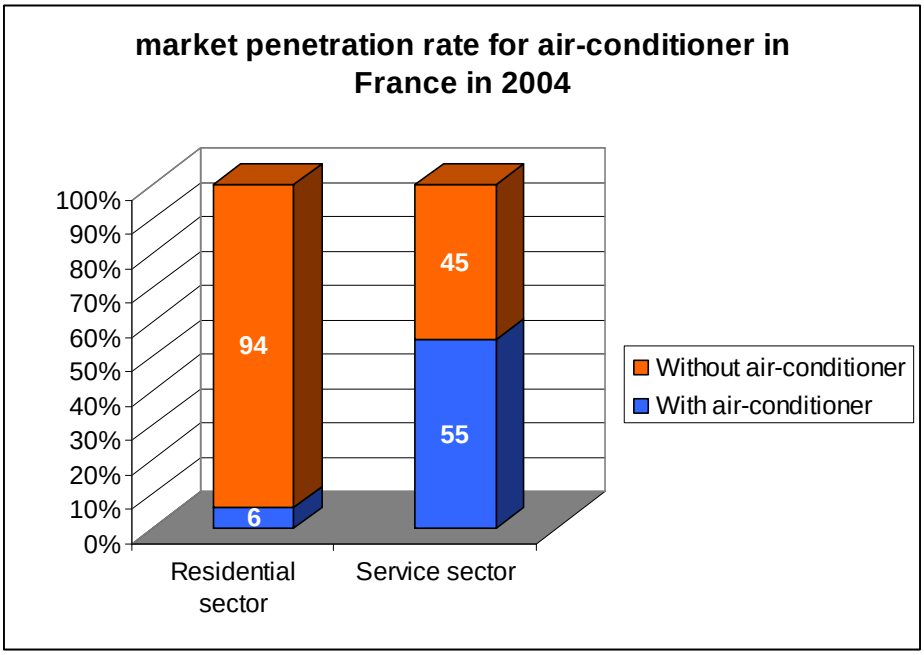

Figure 3: Penetration of AC systems per different market sector at 2004 in France[7]

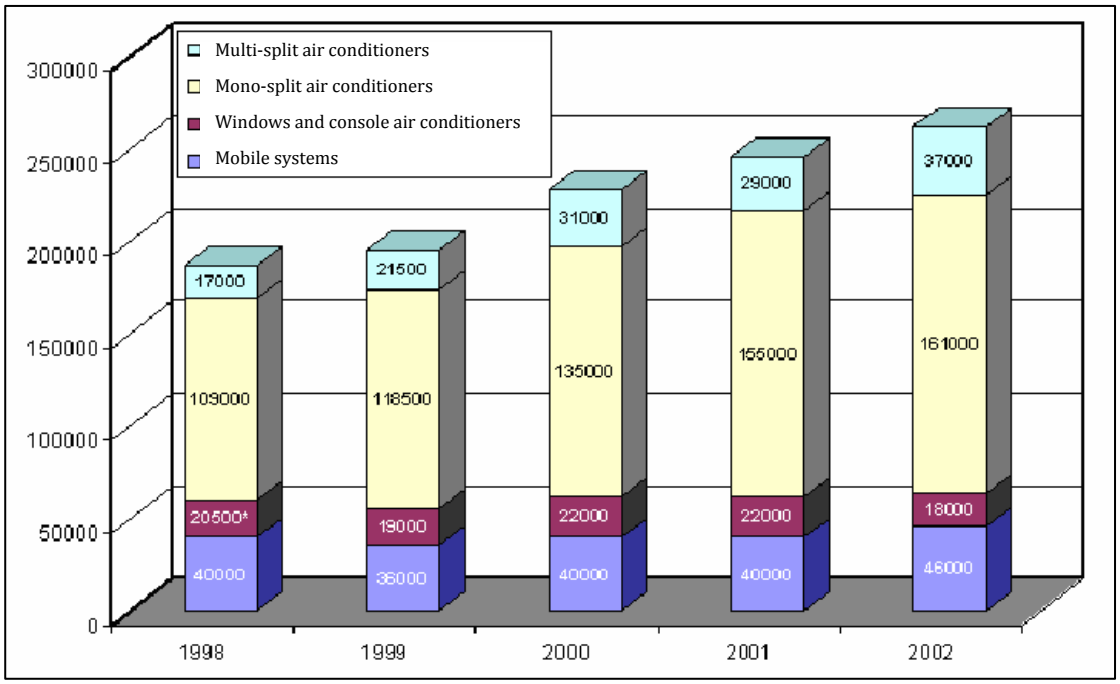

Figure 4: Evolution of the number of individual air-conditioner (<17.5 kW) in France (by type)[8]

[6] Country data provided by TECSOL, SOLAIR & SOLARCOMBI+ partner
[7] Source by TECSOL, SOLAIR & SOLARCOMBI+ partner
[8] Source: TECSOL, SOLAIR & SOLARCOMBI+ partner

2.3 Germany

The database for cooling and air-conditioning market in the residential sector in Germany is not detailed and not very up-to-date; the accessible data is at least 4 years old. The following presented data may have increased distinctly in between; nevertheless, air-conditioning in the residential sector in Germany is small in comparison to south European markets.

In 2001, the number of installations in the residential sector was estimated to be approx. 300,000 units. The dominating technology is room air-conditioners, e.g. small-scale split systems. Air-conditioning in Germany is responsible for 22% of the energy use for cooling. Mainly electrically driven compression processes are applied; less than 1% of the cooling demand in this sector is covered by thermally driven absorption chillers. The sector is divided into stationary systems (buildings) and mobile systems (individual and public transport: street, railway, navigation, aviation). In the stationary sector, 230 Million m² of air-conditioned building area is operated by air-handling units, of which 30% to 40% are equipped with centralized cooling units. Approx. 23% of the cooling installations are operated by chilled water distribution systems, using fan coils. Concerning central air-handling systems, the dominating technology in the past was AHU's with high ventilation rates to cover both, cooling demand and fresh air demand. The supply for air cooling is done by using electrically compression chillers. It is reported that exists a tendency to install in new buildings, with central systems, air-handling units to cover the minimum required air change rate with dehumidification, and then additionally to equip the rooms with cooling installations, covering the remaining cooling loads. Thus, air supply with treatment of latent loads is more or less separated from the purpose of covering the sensible/ required cooling loads.

The sales rate of room air-conditioning units is approx. 100,000 units per year, exhibiting an annual growth of 10% to 15%. The majority of the sold systems are large split and mulit-split units.[9]

2.4 Greece

In general, the technologies used for cooling in the residential sector are split units, central systems (VRVs) and geothermal heat pumps. The majority of those are split-units followed by VRVs, both operating with electricity. As far as it concerns the technologies used for cooling in the commercial sector, they are central systems (VRVs), heat pumps in combination with fan-coils and split units. Split-units are mainly used in small hotels and summer apartments or bungalows. Hotels with high number of beds as well as industrial buildings prefer the use of central systems.

The main characteristic of the Greek market demand is the seasonality, since the purchase of air-conditioning systems, for the residential sector occurs during the summer period and especially in periods with high temperatures. This is also credited by the fact that the installation of an air-conditioning system -when it is not centralized- is not included nor in the design phase neither during the construction phase like other "first priority" machines like fridge, cooker etc.

[9] Country data provided by ISE , SOLAIR & SOLARCOMBI+ project partner

The biggest share in the Greek AC market is held by the split-unit systems, as it is shown in Figure 5. According to the key actors of the air-conditioning sector, the purchase of a small scale cooling system (especially nowadays with very low cost products imported from China and other cheap markets) takes high priority in the needs of a building compared to previous years. One should also notice the ease of installing such systems even at the smallest / oldest apartments in multi-flat buildings, which anyway have a big share in the Greek building stock. Nevertheless, even in a country like Greece where the heat during the summer period is expected and accustomed, when heatwaves occur the AC market is also experiencing differentiations. As a noteworthy example, the 2007 summer should be noticed where, because of the especially high temperatures for quite a big period the volume of sales for AC systems exploded to over 500.000 systems, resulting to market shortage (no system was left unsold, and significant delays in delivering was also experienced). Furthermore, the market stakeholders foresee that this number of sold split systems in Greece will remain stable in the next years.[10]

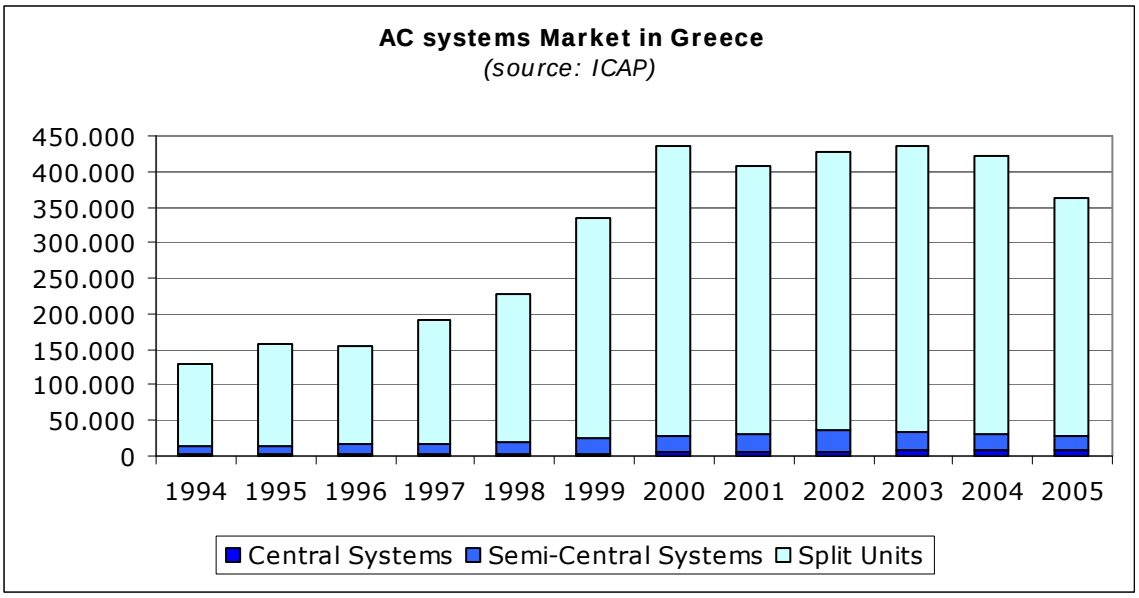

Figure 5: Number of systems sold in Greece until 2005[11]

2.5 Italy

Italy is the largest market in Europe and it is estimated that alone accounts for 25% of the total cooled floor area in the EU. The market of RAC has boomed after year 2000, with average sales for about 1,300,000 units per year.

It is estimated that the stock of RAC below 7 kW will reach 14,000,000 units by year 2011. For what central air conditioners concerns, trade and offices are the most growing sector. In the trade and offices sector, about 50 % of the cooling demand is covered by chillers. Considering an average of 75 kW cooling capacity per unit and specific capacity of 200 W/m2, it is estimated that about 11,000 units are sold every year.

[10] Country data provided by CRES, SOLAIR & SOLARCOMBI+ project partner
[11] Source : CRES, SOLAIR & SOLARCOMBI+ project partner

In the Italian residential sector the most commonly adopted air conditioning systems are room air conditioners and split systems. Even though a clear segmentation of the sector is not available, according to COAER (2006) the market is dominated by mono-split conditioners in the range below 7 kW cooling power. This type of system covers alone nearly 75% of the stock. Large split and multi-split systems account for nearly 15%, the remaining 10% being covered by small capacity room air conditioners. The absolute sum of the installed air conditioners is electricity driven.[12]

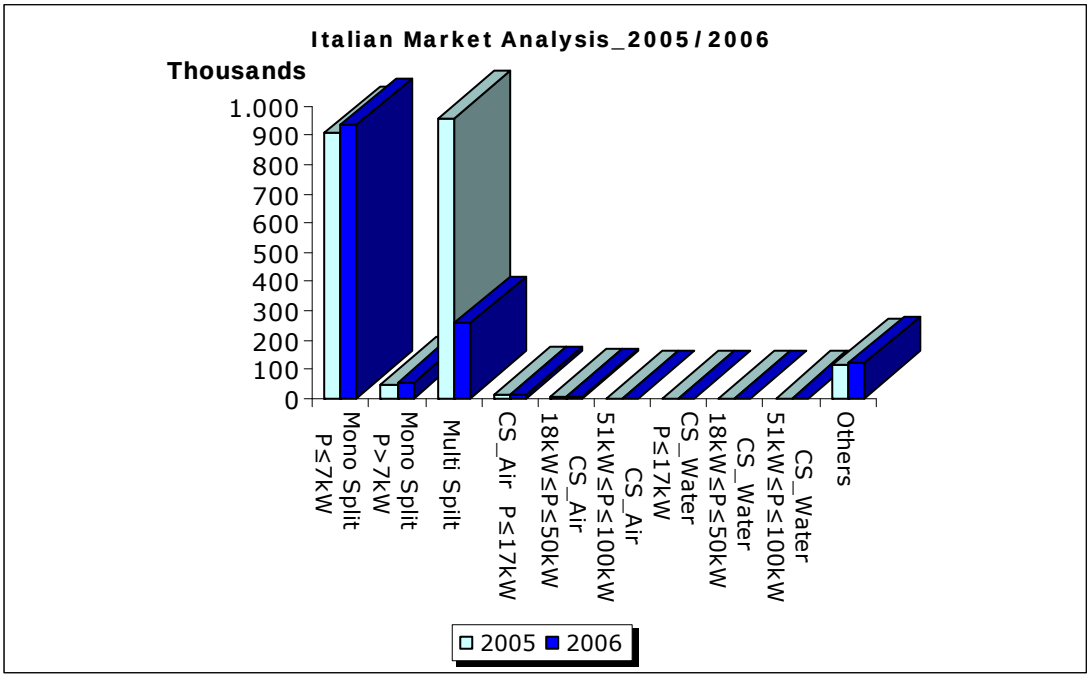

Figure 6: Italian AC market analysis by CO.AER[13]

2.6 Spain

In the last two years, the Spanish air conditioning industry has grown 25 percent, reaching the numbers already achieved by the heating sector, reports "Clima Notícias". The reasons for this increase are the good Spanish climate, the lack of air conditioners in the homes and the rising standard of living in the country. In 2006, the sector had a turnover of 1.600 million euro, similar to the results of the heating industry.

According to AFEC (Association of HVAC equipment manufacturers), FEGECA (Association of the Spanish manufacturers of heat and hot water generators) and ANEFRYC (Spanish Association of Industrial Refrigeration), the HVAC sector, which includes the manufacturers and installers of air conditioning, heating and refrigeration equipments, had, last year, a turnover of 6.000 million euro.[14]

[12] Country data provided by Ambiente Italia, SOLAIR project partner
[13] Source : l'Associazione Costruttori di Apparecchiature ed Impianti Aeraulici
[14] Country data provided by REFRIGE.COM Portal - HVAC & Refrigeration news, events, training, books, magazines and directory online

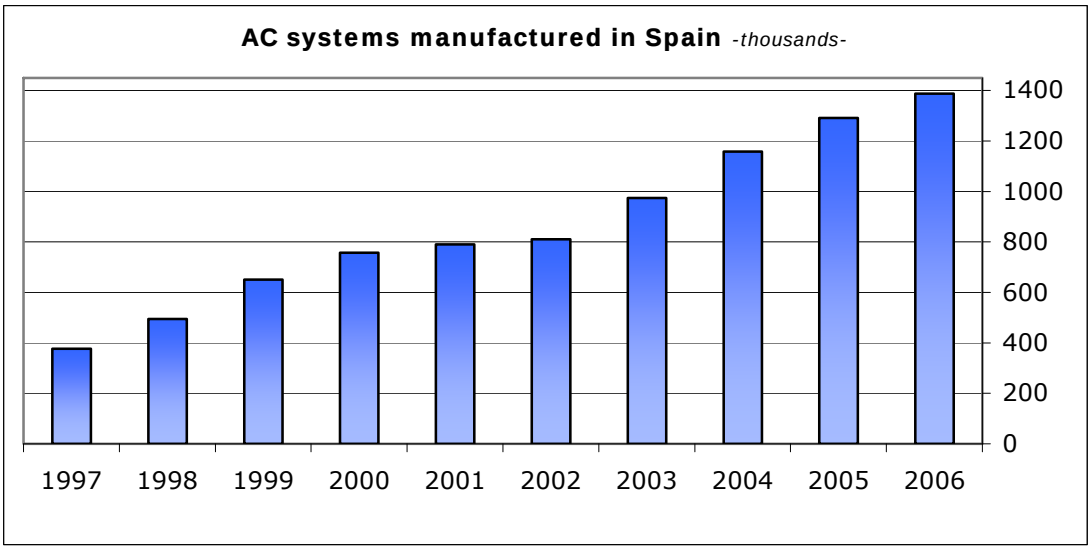

Figure 7: Thousands of ac systems manufactured in Spain [15]

[15] Source: Spanish Association of Manufacturers of Air Conditioning Equipment

3 Solar Combi+ Systems

The aim of SOLAR COMBI+ project is to take the newly commercially available small scale sorption chillers and identify and promote standardised Solar Combi+ systems for small applications: i.e. combined solar water and space heating and cooling up to a cooling load of 20 kW. Among the 12 partners of the project there are 5 leading European small scale sorption chiller producers with special expertise on the relevant technological sectors. In the framework of the market analysis a survey on the available small scale sorption chillers was conducted. The survey was based on the determination of the existing technologies, number of the installed systems, type of systems and utilizations.

CRES elaborated a questionnaire (Appendix I) and distributed to the industrial partners (chiller producers) of the project which are: SorTech, SonnenKlima, SOLution, IKERLAN & ROTARTICA, ClimateWell.

The basic structure of the questionnaire was divided in 3 distinguished sections.

Section A: Technology-Characteristics

- Technical info about the system and/or products (chiller technology, refrigerant, cooling capacity, COP, dimensions)
- Operational Parameters (Temperature & flow rate)
- Solar System
- Compatibility with other energy sources & external systems
- Other technical parameters

Section B: Costs / Market Description

- System's cost breakdown (Components or products cost)
- Selling method
- Volume of sales
- Recommended use of the given system regarding the dwelling type (single family house, multi flat apartments etc)
- Markets of interest
- Projections (of sales, costs and turn-key price)

Sections C: Other

- Customers' opinions about the overall system operation, the provided services and costs
- New products foreseen

3.1 Questionnaire Results Assessment

3.1.1 Available technologies

According to the data from SC+ industrial partners, their available systems use either the adsorption or absorption technology for the small scale chillers. The refrigerant and sorption media used vary according to the kind of sorption (liquid sorption medium for absorption and solid for adsorption). The two technologies

differ in available cooling output, required thermal input and hot water inlet temperature, as well as heat efficiencies of condensation (coefficients of performance, COP), which correspond to the ratio of cooling output to thermal input. Sorption chillers use heat instead of mechanical energy to provide cooling. For the sorption process a refrigerant medium and a sorption medium is needed.

Absorption Chiller

The absorption technology could be summarized as follows. An evaporator produces refrigerant vapour which gets absorbed by the sorption medium in the absorber. This absorbent mixture is then pumped to the generator, where the refrigerant medium re-vaporizes due to heat transfer from a heat source and gets separated from the sorption medium. Cooling water and throttling devices are used to lower the pressure and the temperature of the refrigerant and the sorption medium. The sorption mixture returns to the absorber and the refrigerant reproduces chilled water. Electric energy is only needed for pumps, fans and controls units.

A heat exchanger that might be placed between the absorber and the generator raises the efficiency of the process.

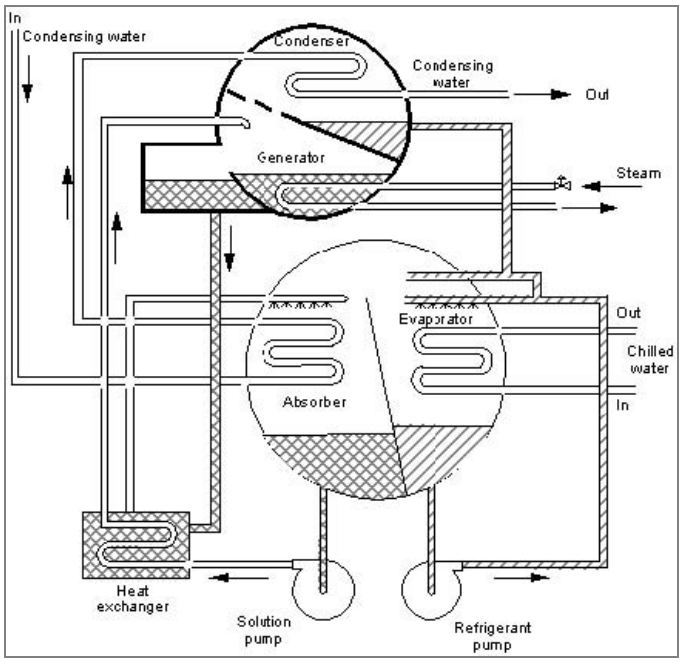

Figure 8: Schematic of a single – effect absorption chiller[16]

Absorption chillers are divided into single-effect and double-effect. In a single-effect absorption chiller (see Figure 8) all condensing heat cools and condenses in the condenser and from there it is released to the cooling water. A double-effect chiller adopts a higher heat efficiency of condensation and divides the generator into a high-temperature and a low-temperature generator.

The two most common absorbent mixtures used in absorption chillers are water/lithium bromide for small absorption chillers and ammonia/water.[17]

[16] Roberto Best, "Recent Developments in Thermal Driven Cooling and Refrigeration Systems", 1st European Conference on Polygeneration
[17] ProEcoPolyNet

Adsorption chiller

The adsorption chiller uses water as refrigerant medium and silica-gel as (solid) sorption medium. The water is first adsorbed by silica gel and then with the use of hot water, the adsorbed water on the carrier material (silica-gel) is re-evaporated and the sorption medium is regenerated. Finally the evaporated water (off the carrier material) is condensed again.

The fact that silica-gel has the property of adsorbing water without causing a structural change or volume expansion and that of releasing the stored water with a temperature increase makes this process reversible and infinitely repeatable.

Moreover the adsorption chiller is a closed system. In contrary to open systems, the evaporated water is not released as steam into the surroundings, but recondensed within the machine.

The adsorption chiller is a pressure vessel, divided into four chambers (Figure 9). The evaporator is located in the lower chamber, where the cooling of the chilling water circuit takes place. The generator and the receiver are placed in the two middle chambers. The condenser is placed in the upper chamber.

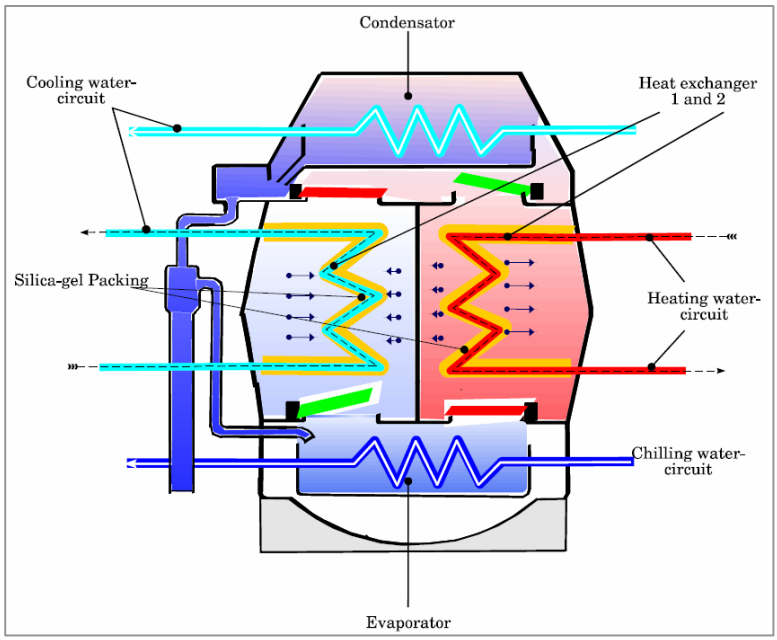

Figure 9: Scheme of the NAK Adsorption Chiller from GBU company[18]

The generator and receiver are each connected both to the condenser above and the evaporator below by flap valves. A heat exchanger is installed in each chamber. The tubes of the heat exchangers placed in the generator/receiver are additionally packed with silica-gel granulated material.

During the initial start-up of the adsorption chiller the entire pressure vessel is evacuated with the help of a small evacuation pump that is permanently installed for this purpose.

[18] GBU mbH 1999

The operation of the adsorption chiller is fully automatic with an operation cycle of approximately 10 minutes that consists of four steps:

1. Water is brought into the evaporator and evaporates. Through this, the cooling circuit cools down.
2. The water is then adsorbed at the receiver. During the adsorption process produced heat is cooled down by the cooling water circuit.
3. The adsorbed water is de-adsorbed with the supply of thermal energy. The receiver turns into the generator.
4. The de-adsorbed water is condensed in the condenser and the cycle is completed with the return of the condensed water into the evaporator.

It is important to note that the adsorption chiller works in two operation cycles where the two modes of receiver and generator are interchanged periodically.[17]

Table 1 summarizes the technical characteristics of the two different categories of small scaled chillers described above. In addition, the basic features of open cycle cooling systems, which are also present in the European market, are briefly presented. However, no further description of such systems' technology is taking place in this report, as the project's industrial partners only design and manufacture closed cycle systems.

Table 1: Overview of the most common solar assisted air conditioning technologies.[19]

Method	Closed cycle		Open cycle	
Refrigerant cycle	Closed refrigerant cycle		Refrigerant (water) is in contact with the atmosphere	
Principle	Chilled water		Dehumidification of air and evaporative cooling	
Phase of sorbent	solid	liquid	solid	liquid
				
Typical material pairs	water - silica gel	water - lithium bromide ammonia - water	water - silica gel, water - lithium chloride	water - calcium chloride, water - lithium chloride
Market available technology	Adsorption chiller	Absorption chiller	Desiccant cooling	Close to market introduction
Typical cooling capacity (kW cold)	50 – 430 kW	15 kW – 5 MW	20 kW – 350 kW (per module)	
Typical COP	0.5 – 0.7	0.6 – 0.75 (single effect)	0.5 – >1	> 1
Driving temperature	60 – 90 °C	80 – 110 °C	45 – 95 °C	45 – 70 °C
Solar collectors	Vacuum tubes, flat plate collectors	Vacuum tubes	Flat plate collectors, solar air collectors	Flat plate collectors, solar air collectors

[19] Solar air conditioning guide, Climasol project

3.1.2 System characteristics

The following discussion is being conducted on the basis of the information that was provided by the project's industrial partners as regards the technologies and their system's characteristics.

According to the partner's input as well as further data elaboration, the cooling capacity varies between 4.5 kW to 15kW (Figure 10); however 3 of the industrial partners are considering or have already entered the pilot phase of up-scaling their systems. The volume of the main system is between 1 to 1.8 m^3.

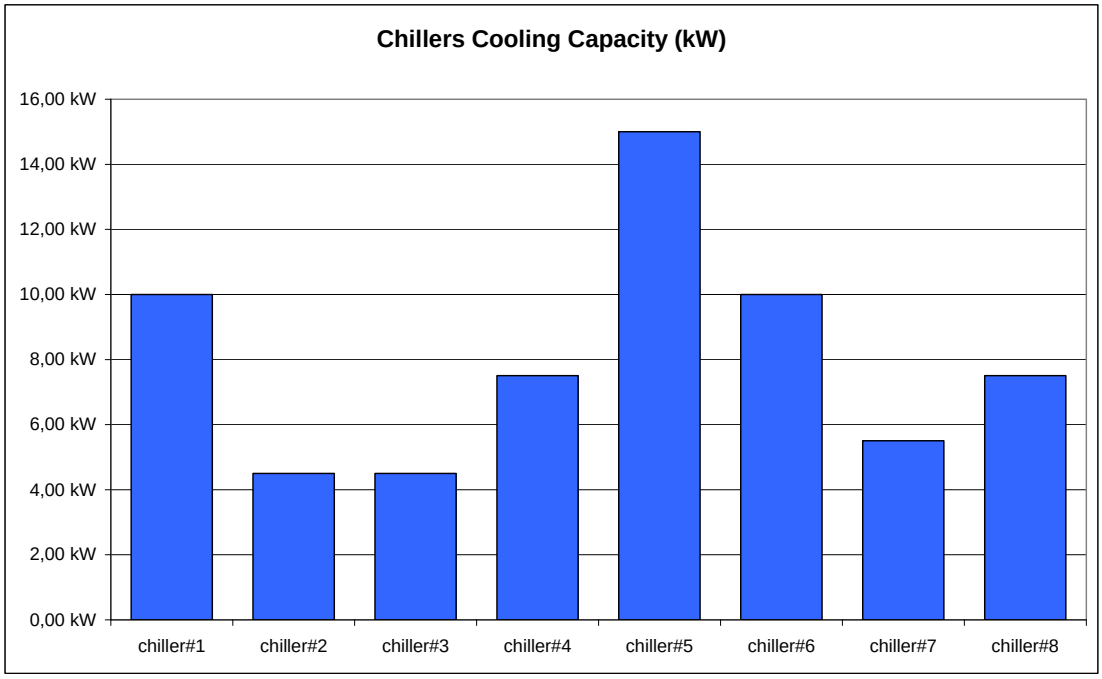

Figure 10: Available cooling capacity of systems up to 20kW among the SC+ industrial partners

The solar thermal systems that accompany the chillers consist of flat plate or vacuum tube collectors which range between 3.5-4.5 m^2/kW and 3.0-3.5 m^2/kW respectively, depending on the region of the installation.

The compatibility of the systems with additional energy type depends on the system's design. The chillers' manufacturers suggest that these systems could also operate with further energy sources like gas, electricity or oil, taking into account the required temperature for the boilers. Figure 11 presents two graphs that were exclusively based on the responses obtained by the industrial partners, concerning the compatibility of their systems with other energy sources.

However, as also reported among all partners, in principle all considered SC+ systems could be backed-up by other fuel sources in order to achieve 100% cooling and thermal load coverage with minor technical adjustments.

Another critical issue for the market projection and share of SC+ systems is their level of operation with the existing and most commonly used energy distribution systems. Specifically, the small scale SC+ systems could easily be integrated to an existing central system for heating and/or cooling, if the existing system consists of either fan coils, radiant floor or ceiling, as presented in Figure 12. However, all of the above mentioned parameters are related and depending on

the user requirements and the existing system's conditions and technical specifications. Figure 12 illustrates the answers taken by the industrial partners and their view on the compatibility of SC+ systems with various distribution systems. However, the SC+ systems cannot be plugged in with the old-type (commonly used in some countries) radiator-type systems, because these are only set for heating and also require a mush higher inner operational temperature. Therefore, are not presented at these graphs.

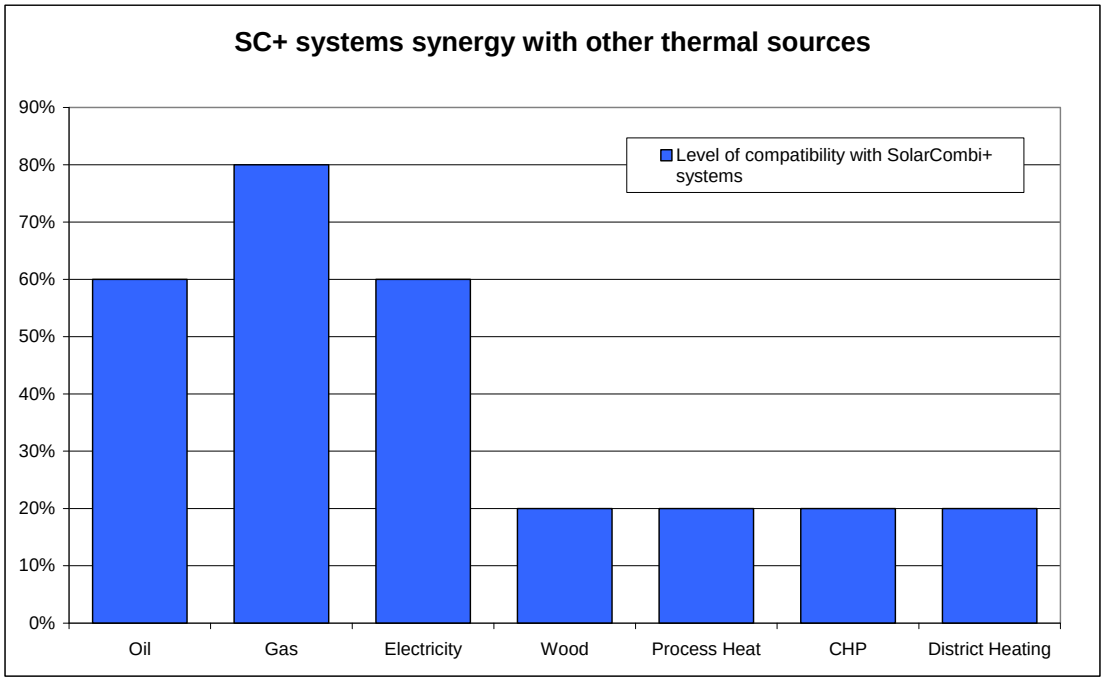

Figure 11: Compatibility SC+ systems with other primary energy sources as reported by the SC+ industrial partners

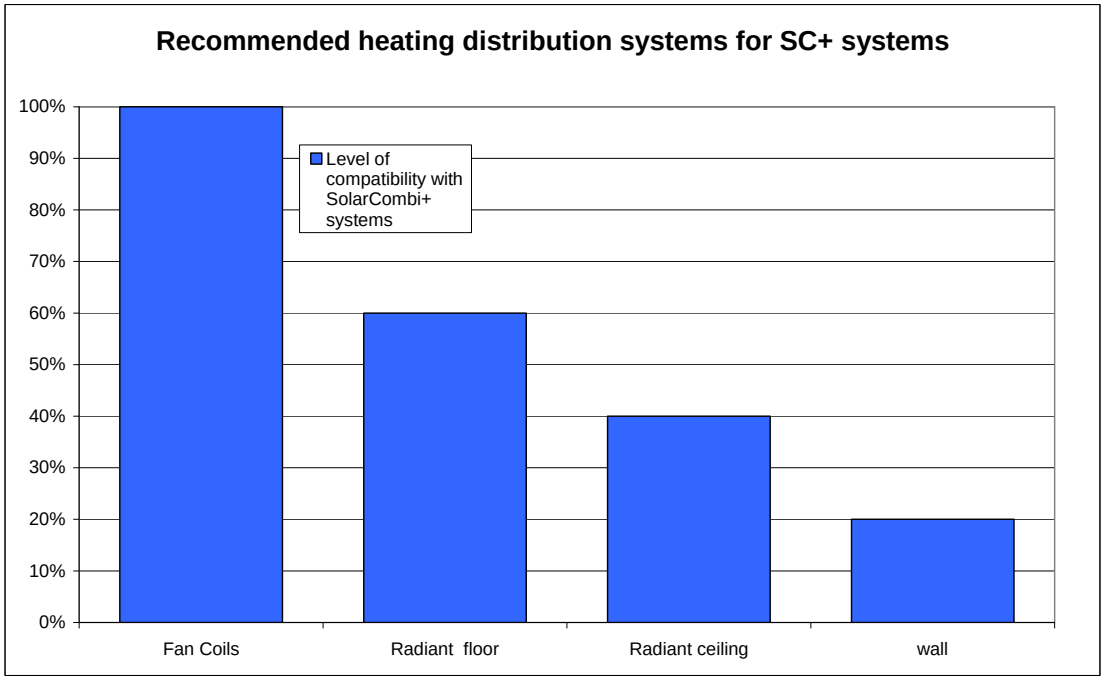

Figure 12: SC+ systems compatibility with existing systems as reported by the SC+ industrial partners

Figure 13 and Figure 14 present the operational diagram of two commercially available typical SC+ systems of 4,5 kW and 10 kW of cooling capacity,

respectively (the Rotarica 0.45 V system does not include cooling tower) provided by the SC+ industrial partners.

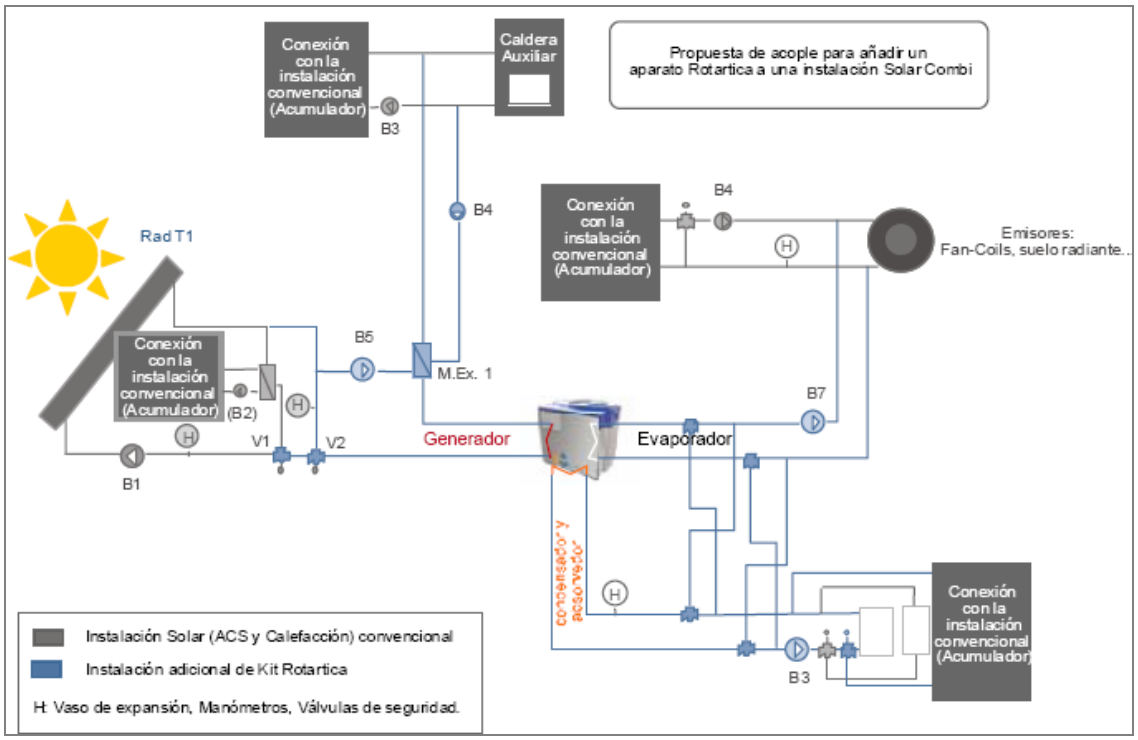

Figure 13: Operational diagram of Rotartica 0.45 V system

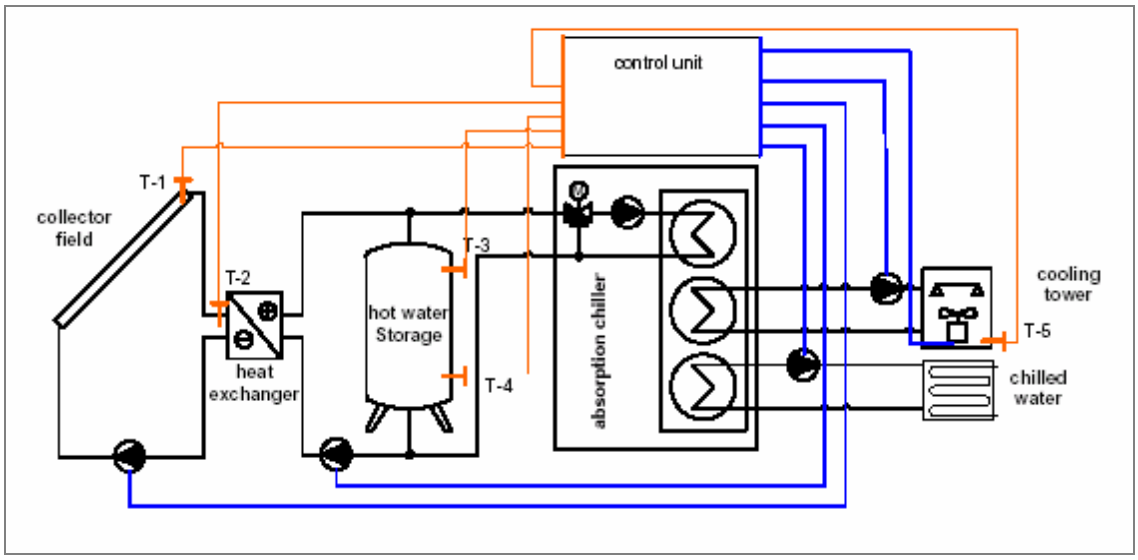

Figure 14: Operational diagram of Suninverse 10 kW, SK Sonnenklima GmbH

Even though the small scale SC+ systems are just recently introduced to the market, the industrial partners of the project have already installed more than 130 systems in the various countries. These systems are mainly located in single family houses and office buildings. (Figure 15).

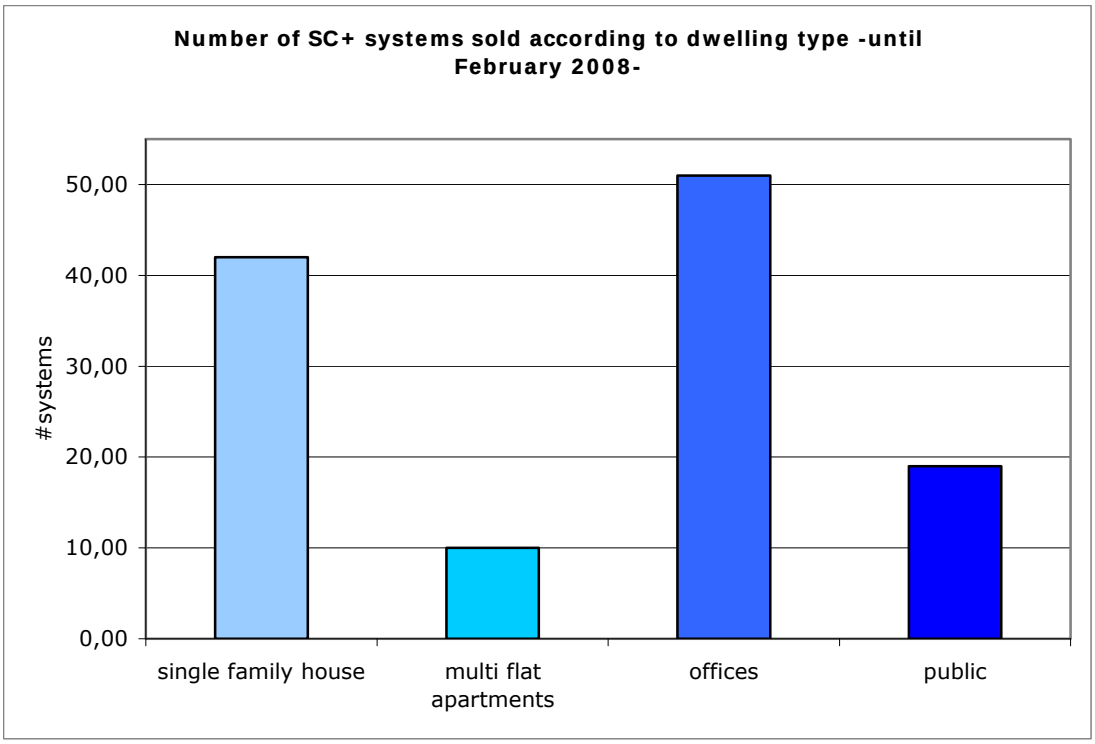

Figure 15: Number of sold systems until the market research period, as reported by the SC+ industrial partners.

According to the producers, these systems are highly recommended for installations in single family houses and office buildings. On the contrary, installing small scale systems in multi flat buildings could be sufficient only under certain conditions.

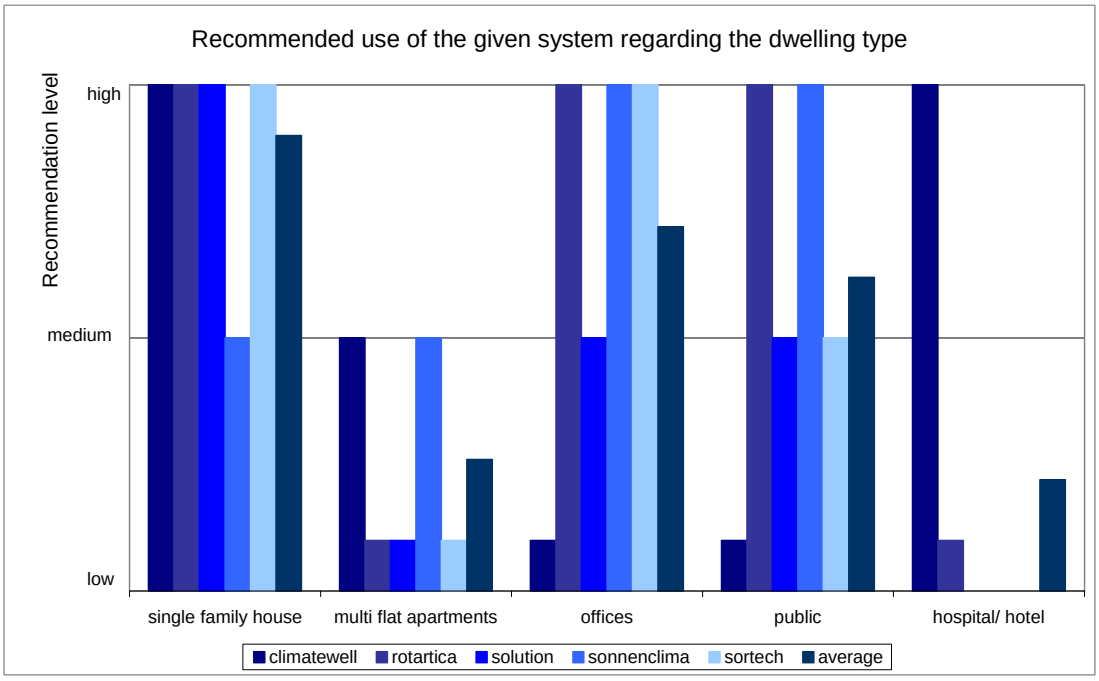

Figure 16: Recommended use of the partner's systems regarding the type of building

In fact, the availability of a large unoccupied area for setting up solar collectors is one of the first prerequisites for the installation of a SC+ system in a building.

Moreover, the larger the building is, the higher are the cooling and heating needs, which leads to a necessity for a larger chiller capacity and collector area. Multi-flat apartment buildings are characterized by a rather small horizontal free surface, i.e. they do not usually have a large area available other that their roof, which is only a small percentage of the actual requirements for energy in the whole of the apartments. However, even if the available surface was large enough for the whole of solar collectors, the energy demand could not be covered by a small-scaled chiller (with a capacity lower than 25 kW) handled in this project. Figure 16, presents the different market sectors that the various SC+ industrial partners target, which relates also with the different capacity systems that have or are about to develop.

The producers admit that the cost of the small scale sc+ systems remains high, as a consequence of the market's small size and the individual design of each system according to different characteristics of the location, preferences, etc. However, they anticipate a significant increase of the volume of sales in the near future (until 2010), which will lead to a subsequent drop at the system's price. The correlation between the volume of sales and the commercial price indicates that, in order to reach 25% lower prices the volume of sales should be over 2.5 times more compared to nowadays (Figure 17), allowing therefore a significant reduction of the manufacturing costs and absorption of the related R&D expenses. However, the latter statements are only industry's estimations and no safe conclusion on the effects of an economy of scale for SC+ systems can be documented at this early (immature) market situation.

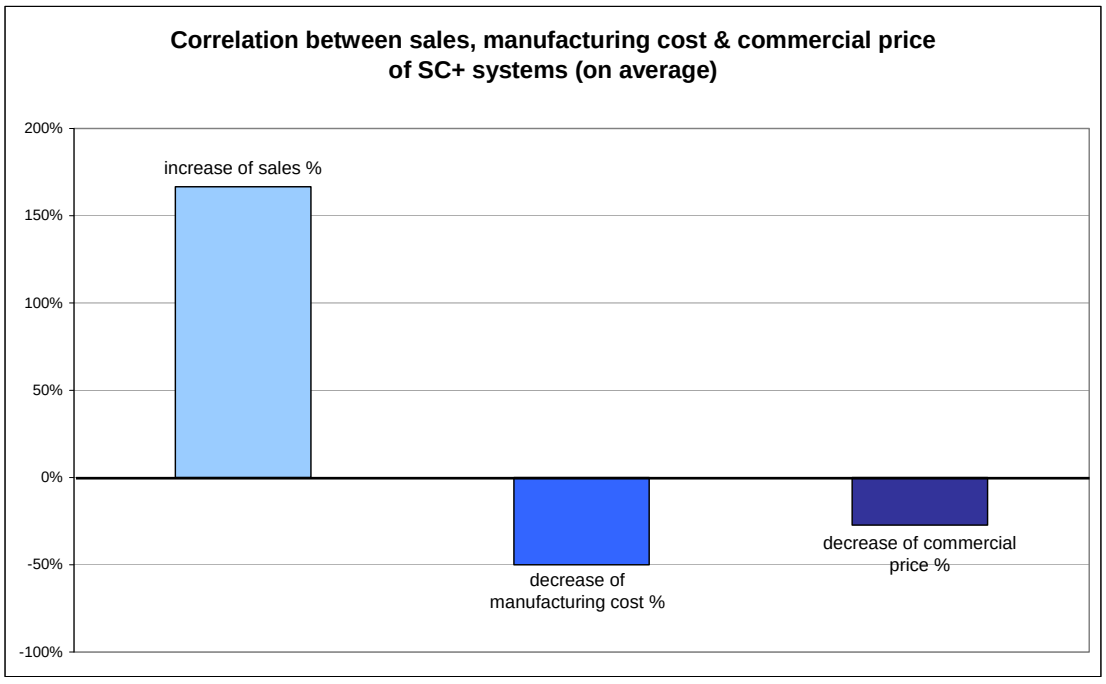

Figure 17: Correlation between sales, manufacturing cost & commercial price. (Estimations given by the SC+ industrial partners)

Strong and rapidly growing European AC markets, privileged with high solar irradiation, such as southern European countries, are the main target countries for the small scale sorption chiller producers (Figure 18). Surprisingly, as reported by the partners, Greece due to logistics issues and market unknown characteristics is not yet considered to be a target country. More specifically, the lack of retailers located in Greece, the fact that no training has been performed on local actors, as well as the relatively low electricity prices that still make the installation of conventional systems affordable have contributed to the delay of

the market opening and have also add to the industry perspective that this is not a first priority market. For those reasons, Greece (like other south Mediterranean countries with same market restrictions. i.e. Turkey, Balkan countries) ranks along with countries like Germany and Austria in market hierarchy. Moreover, it is obvious from the industry responses that these systems (at least for the given time frame) are not targeted for developing countries even with high cooling needs and solar irradiation and somehow extend use of solar thermal systems (i.e. North Africa countries), as the cost factor (along with local representation and training) is totally prohibiting.

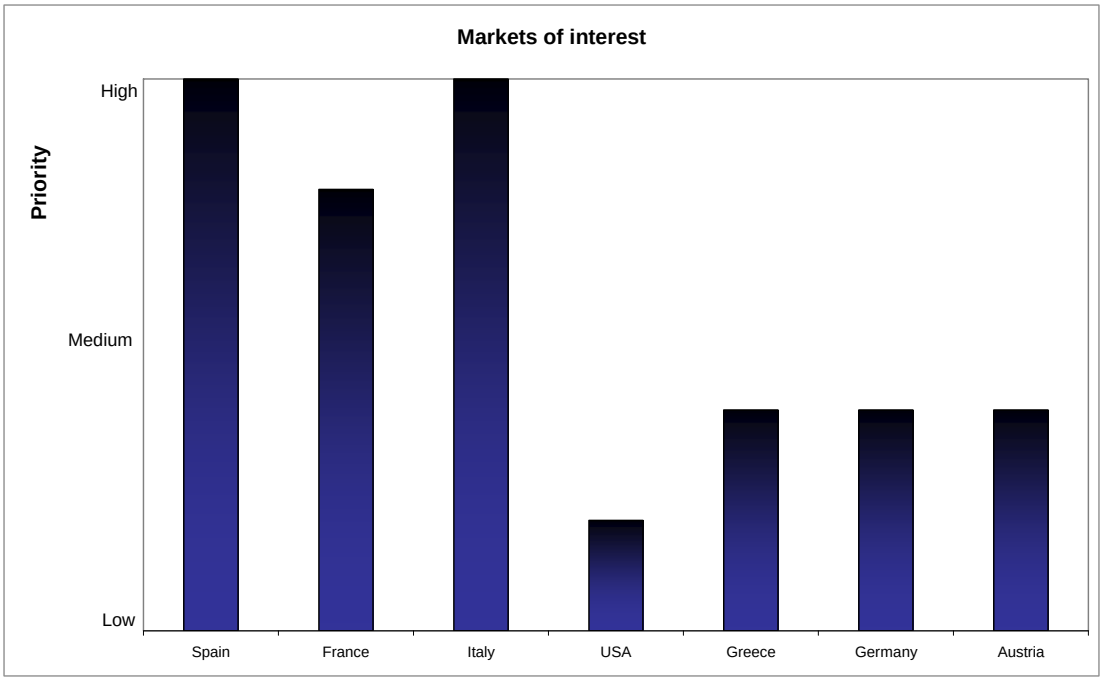

Figure 18:Targeted markets for the SC+ partners

4 Conclusions

The rapid expansion of conventional AC systems is indubitable and the factors that strengthen this market growth are referring to both technical and economical characteristics (climate changes also affect the market and should start being considered as well). The manifested increased internal heat loads, enhance further the need of using AC systems. The variability of the conventional AC systems is large; they are getting more and more affordable, incorporate different customers' needs and contribute to the achievement of the desirable comfort conditions. The consumers at the end of the day are left to select among cheap, efficient and easily installed and operating products.

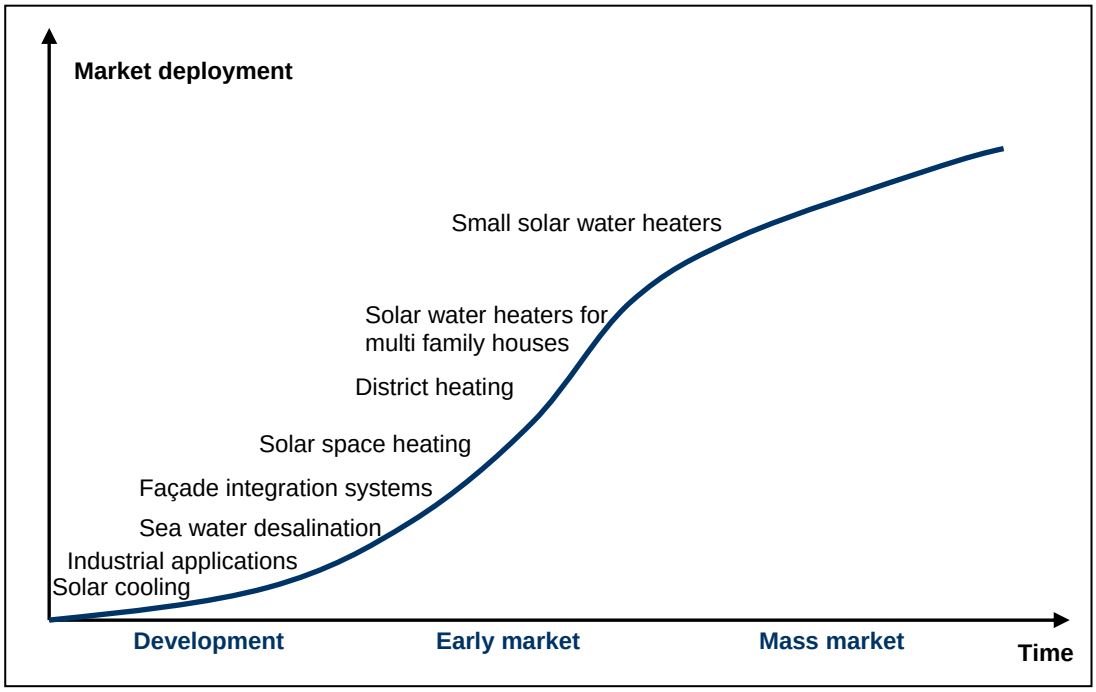

Figure 19: Market deployment of ST applications [Source: AEE INTEC]

On the other hand, the exhaustion of conventional energy sources, the climate change and the environmental protection are major priorities for all. Behavioural culture is changing to environmental friendly energy technologies selection. The lifestyle and growing wealth require high comfort conditions in every day activities which are very difficult to be neglected and given up by the end-users. The small scale solar combi systems could combine both of them and address properly all the worries and needs.

Figure 19 illustrates the current market deployment of solar thermal applications. Even though some solar thermal technologies are mature and already experiencing a mass production phase, the immature technology of solar cooling places it in an early stage. However, a significant portion of the existing SC+ customers list already acknowledge the good performance and the attractive design of the given systems, in combination with the provided energy autonomy and zero carbon emissions, which makes the potential of a further market opening is rather high. A more detailed description of the adoption of new technologies by the market is presented in SC+ deliverable, D2.3.

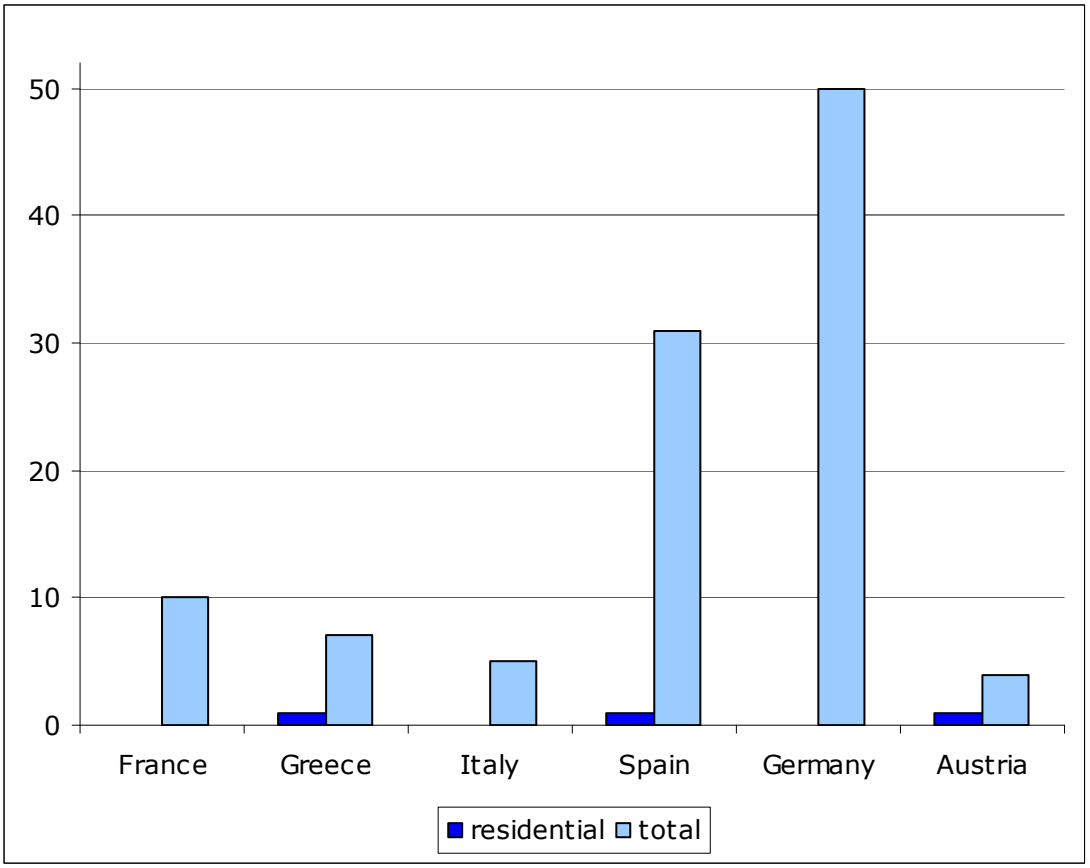

Figure 20: Installed SAC systems in the participating countries[20]

According to ESTTP (European Solar Thermal Technological Platform), about 200 solar cooling installations are operating in Europe, small capacity systems included[21], out of which more than a hundred are operating in the participating countries (Figure 20).

The industrial partners of the project, make the projection for thousands installations in the following years. The system's good performance and the quality of the provided after sales services are the key points, at this early stage, for establishing a growing market share. However it seems that no solid marketing strategy exists for these systems (sales are commonly achieved on ad hoc special circumstances or needs).

The weak point of these systems is that the reported small volume of sales and the required custom designed installations keep the commercial price relatively high and the production capacity low. The next steps should include a more generic approach, whereas typical design systems have to be developed in order to reach higher systems' production capacity and to assist their competitiveness in market terms (lower prices and enhanced features). Since, the establishment of a growing market share for the SC+ systems should also consider behavioural parameters (like the after-sale and mouth-to-mouth performance indicators), intensive training of the planners and installers to ensure the tuned operation and keep the customers satisfaction level high must also be ensured. At the moment, SC+ systems are still at the introduction phase of the market adaptation. For them to transit to the next phases of market development, SC+ systems have to

[20] SOLARCOMBI+ & SOLAIR projects
[21] ESTTP/ Hans-Martin Henning, Fraunhofer-Institut für Solare Energiesysteme ISE, Freiburg/GERMANY/January 2008

be integrated into an appropriate retailers' network, since it is the retailers, who have a direct contact with the end users and, therefore, the possibility to promote different technologies. Lastly, a thorough analysis of the Life Cycle Cost (LCC) of these systems should be made in order to spot their weaknesses or advantages in respect to the existing competition.

Questionnaire for the Industrial Partners of the IEE Project SolarCombi+

Questionnaire Distribution & Assessment by CRES

Intelligent Energy Europe

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Section O– General info

Company Name	
Contact person	
e-mail	

Section A- Technology-Characteristics

Technology	**chiller**	**process**	**Comments/additional info**
Adsorption			
Absorption			
other			

Please use ☑

A0-Are you		**Comments/additional info**
System manufacturer?		
Product producer?		
Other (please specify)		

☑

A1- Type of systems/products			
Name/code	**Cooling Capacity (kW)**	**COP**	**Typical dimensions (m)**

Please note: *if more than one system, please reply questions A2-A8 for each one system/product separately*

A2- Type of refrigerant	
Name/code	**Comments/additional info**

System/Operational Diagram

A3 – Other components		
Name	**Technical Characteristics**	**Short Description**
1. Boiler (It or specify)		
2. Heat sink (please specify)		
3. Cooling tower (kW)		
4.		
5.		
6.		

A4 – Solar System *(estimation for your country/region)*		
Collectors	**Specifications**	**Barriers/comments**
1.	(m^2/kW)	
2.		
3.		
A5 - Type of energy sources that operates with (besides solar) if any		
Thermal source	**Specifications**	**Barriers/comments**
4. Oil		
5. Gas		
6. Electricity		
7.		
8.		

A6 - Temperature and flow rate parameters			
System:			
Circuit	**T in (°C)**	**T out (°C)**	**Flow Rate (m^3/h)**
Heat supply			
Heat rejection			
Chilled water			

A7- Compatibility with existing systems (external)		
Type	**Type of external system**	**specifications**
1. Fan Coils		
2.		
3.		

A8- special parameters/ requirements for installation	
Parameters or Requirements	**Description**
1.	
2.	
3.	
4.	
5.	

Section A: Comments/additional info

Section B– Costs / Market Description

B1 –Cost breakdown (average)					
System	**Energy (€)**	**Components (€)**	**Maintenance (€/y)**	**Other (€)**	**Total (€)**
1.					
2.					
3.					
4.					

B2 –Components / products cost (reply if you sell components of the referred system separately)	
Component /product	**cost (€/kW)** *(or indicate)*
(boiler)	
(cooling tower)	

B3- How do you sell your products/systems?		
	%	**Comments**
using retailers		
e-commerce		
Exhibitions/trade fairs		
other		

B4-Recommended use for the given system (scale 1 to 3) *(1:highly recommended, 3: not recommended)*					
Reference name	**Type of building**				
	Single family houses	**multi-flat apartments**	**offices**	**public**	**other**

☑

B5- Volume of sales per system			
name	**# of items**	**type of installation**	**# of items** *(if known)*
		Single family houses	
		multi-flat apartments	
		office buildings	
		public buildings	
		Single family houses	
		multi-flat apartments	
		office buildings	
		public buildings	

B6- Volume of sales per product		
name	**# of items**	**Comments/additional info**

B7- against competition of similar systems / products					
system	Market share (%)	Avg. price	**product**	Market share (%)	Avg. price

B8- **Markets of interest** *(for your company)*	
Country	**Type of building**
1.	**1.**
2.	**2.**
3.	**3.**
4.	**4.**

B9- Projections					
	Increase (%)		**Decrease (%)**		**N/A**
	Prod.	**Syst.**	**Prod.**	**Syst.**	
of sales					
of manufacturing cost					
of commercial price					

Section B: Comments/additional info

Section C– Other issues

C1- Customer satisfaction		
In scale from 0 to 5 how satisfied are your customers about		
	Level of satisfaction	**comments**
the overall operation of the system?		
the cost of the system?		
the services that you provide?		

C2- New products		
Type of new product	**Progress**	**comments**
	Under consideration ☐ Research level ☐ Pilot ☐ Demo ☐	

General comments on the market assessment and targets of your company