solarcombi+

SOLution ® - EAW ® Package
Solution Despcription

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Version 1.0

Institution

SOLution Solartechnik GmbH

AEE INTEC

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Identification of most promising markets and promotion of standardised system configurations for the market entry of small scale combined solar heating & cooling applications
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Intelligent Energy Europe

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1 Introduction

SOLution Solartechnik has been dealing with solar cooling systems since 2005. SOLution has developed standardized solar cooling sets with EAW absorption chillers as well as with adsorption chillers of Sortech AG. These sets have been based on experiences resulting from different realized solar cooling systems by SOLution.

Within the latest price list of 2009 SOLution has provided its clients with an overview of different small scale solar cooling packages beginning with an 8 kW adsorption chiller (also available with 15 kW and 30 kW), and including a 15 kW absorption chiller package and going up to one set with a 54 kW absorption chiller (see annex I “price list 2009 for solar cooling systems”).

The 15 kW absorption chiller (EAW) package has been analysed in this project as part of the virtual case studies work package. The results of this optimization procedure are described in this report.

2 The Chiller

The main component of the SOLution 15 kW solar heating and cooling package is the EAW absorption chiller WEGRACAL SE 15 which has a nominal cooling capacity of 15 kW. The machine uses the working pair LiBr-Water.

Figure 1 – EAW 15 kW absorption chiller

Table 1: Technical data of 15 kW absorption chiller

Cooling capacity		*kW*	15
Coefficient of performance	COP		0,71
Chilled water	Inlet temperature	*°C*	17
	Outlet temperature	*°C*	11
	Flowrate	*m³/h*	1,9
	Leakage of pressure	*mbar*	400
	Rated pressure PN	*bar*	6
	Connection	*DN*	25
Heating water	Thermal output	*kW*	21
	Inlet temperature	*°C*	90
	Outlet temperature	*°C*	80
	Flowrate	*m³/h*	1,8
	Leakage of pressure	*mbar*	400
	Rated pressure PN	*bar*	6
	Connection	*DN*	25
Re-cooling water	Re-cooling capacity	*kW*	35
	Inlet temperature	*°C*	30
	Outlet temperature	*°C*	36
	Flowrate	*m³/h*	5
	Leakage of pressure	*mbar*	900
	Rated pressure PN	*bar*	6
	Connection	*DN*	40
Electrical data	Voltage/Frequency	*V/Hz*	230/50
	Power consumption	*kW*	0,3
Dimensions	Length	*mm*	ca. 1.750
	Width	*mm*	ca. 760
	Height	*mm*	ca. 1.750
Weight	Transportation	*kg*	ca. 500
	Operation	*kg*	ca. 660

3 System Components

3.1 Heat Rejection

An open circuit wet cooling tower with 35 kW nominal heat rejection capacity is used.

Figure 2 – Cooling tower

3.2 Collectors

The package solution includes flat plate collectors with a gross surface area of 2.7 m² each. An external heat exchanger separates the collector field from the heat storage tank.

Figure 3: 2 Flat plate collectors, each with 2.7 m² surface area

3.3 Heat Storage Tank

A heat storage tank with a volume of 3000 l of heating circuit is provided.

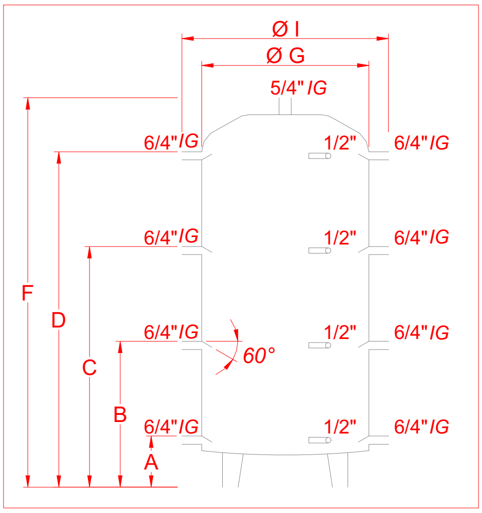


Figure 4: Heat storage tank (exterior view, cross-sectional view)

3.4 Cold Storage Tank

The cold water produced by the machine is stored in a 1000 litre cold storage tank and afterwards distributed by the distribution system on site.

3.5 Distribution system

SOLution recommends its clients to use the same distribution system for cooling in summer and for space heating in winter.

3.6 Backup heater

In most cases, a backup heater on site (either gas, fuel oil, wood or an electrical heating device) is used for the heat storage tank. But if the client wants to switch it off completely during the summer period, in order to realize a solar autonomous cooling system, this can be programmed within the freely programmable control unit which is included in the package solution.

4 System Schematic

The following figure shows the system scheme recommended by SOLution for their solar heating and cooling package with an absorption chiller and a wet cooling tower. The scheme does not include domestic hot water preparation but this can easily be added by connecting an external heat exchanger to the heat storage tank. The system scheme as it was simulated in the virtual case study is shown in

Figure 6. It is very similar to the system scheme recommended by SOLution.

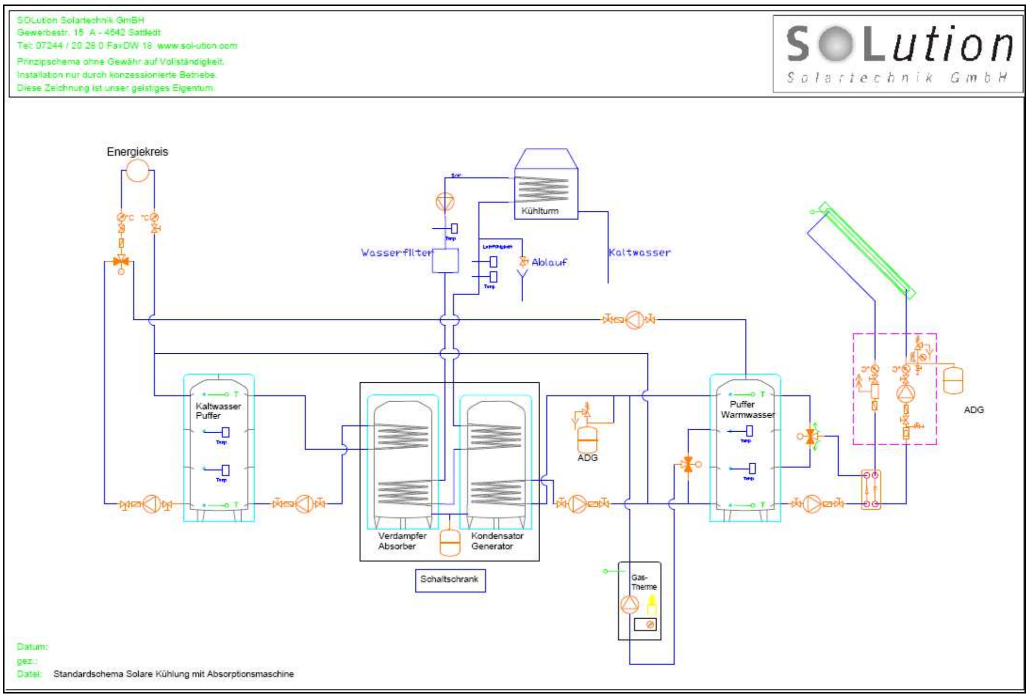


Figure 5: Standard system scheme recommended for the solar heating and cooling package with an absorption chiller and wet cooling tower by SOLution

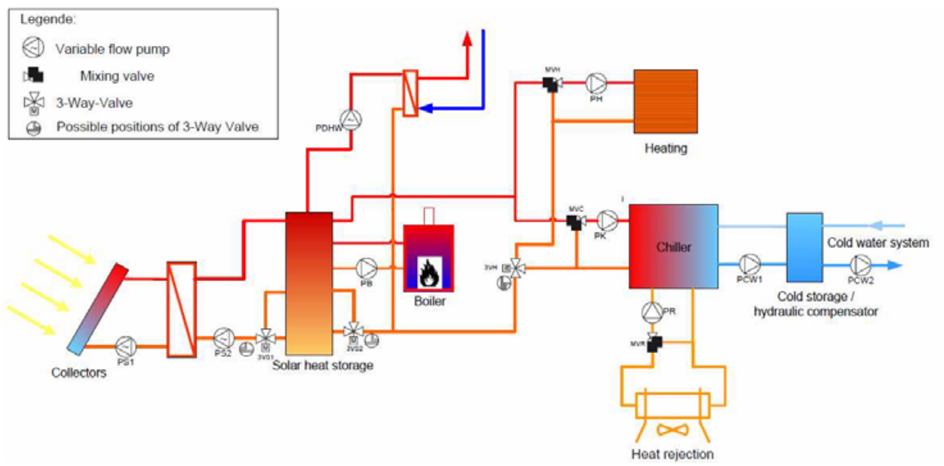


Figure 6: System scheme E1 from the virtual case study

5 Simulation Results for Different Applications

A wide range of applications and systems sizes was simulated as part of the virtual case study of the SolarCombi+ project.

For comparison, a reference system was defined where the heating load is covered by a gas boiler and the cooling load by an electrically driven compression chiller.

The solar combi plus system was calculated on one hand under the condition that 100% of the loads are covered either by solar heat or a heat backup system (gas boiler). On the other hand calculations were carried out without backup for cooling in summer. This can lead to significantly more primary energy savings. However, only cases where 90% or more of the cooling load are covered are taken into account to ensure sufficient summer comfort.

All calculations were carried out using flat plate collectors and a wet cooling tower as this combination is the package solution sold by the company SOLution.

The parameters shown in the result graphs below are defined as follows:

Relative primary energy savings:

Relative savings of the annual primary energy demand of the Solar combi plus system compared to a conventional reference system (gas boiler and electrically driven compression chiller)

Solar fraction cooling:

Share of the annual cooling demand which is covered by solar heat. The remaining part is covered by the heat backup system.

Cost Primary Energy Saved (Cost PE Saved), €/(kWh/a):

Difference in annual cost of the solar combi plus system and the reference system divided by the annual primary energy savings. The annual cost includes capital costs (determined by annuity calculations), operation and maintenance costs. For the costs, average values given by all manufacturers participating in the SolarCombi+ project were taken into account. That means that the costs do not reflect the actual costs of a system bought from the company SOLution. However, the generated curves show the order of magnitude of the costs as well as trends as a function of system size.

Cost of the Useful kWh, €/(kWh/a)

Annual cost of the system (solar combi plus or reference) divided by the annual total final energy demand of the system (cooling, space heating and domestic hot water).

Table 2 shows the assumptions used for the simulations regarding the conventional reference system and cost calculations.

Table 2: Assumptions for cost calculations and performance of reference system

Boiler efficiency	[kWh_{heat}/kWh_{fuel}]	0.9
Fossil conversion factor	[$kWh_{heat, fossil}/kWh_{PE}$]	0.95
Electrical conversion factor	[kWh_{electr}/kWh_{PE}]	0.5
CO_2-conversion factor for fossil generated heat	[$kg_{CO2}/kWh_{heat,useful}$]	0.25
CO_2-conversion factor for electricity generated heat	[$kg_{CO2}/kWh_{heat,useful}$]	0.5
Cost solar thermal system (flat plate)	[€/m²]	650
Installation costs for the solar thermal system	[€/m²]	125
Cost heat- and cold-storage	[€/m³]	1,150
Cost thermally driven chiller	[€]	20,199
Cost reference chiller (compression)	[€]	6,750
Cost heat rejection	[€]	3,268
Installation costs for thermally driven chiller	[€]	6,321
Installation costs for electrically driven chiller	[€]	1,350
Fuel costs	[€/kWh]	0.06
Electricity costs	[€/kWh]	0.15
Water costs	[€/m³]	1.5
Planning costs, reference system	[€]	0
Maintenance costs, reference system	[€]	100
Planning costs, SCS+	[€]	333
Maintenance costs, SCS+	[€]	494
Annuity interest loan "i"	[%]	0.025
Economic life "n"	[a]	20
Annuity factor	[-]	0.0642

5.1 Dependency on Total Energy Demand of the Application

The simulations show clearly that the results depend strongly not only on the system configuration and system size but also on the heating and cooling demand of the particular application. Figure 7 shows the energy demand of the 11 simulated cases. The Naples cases stands for a climate with roughly as much space heating as cooling demand and for the residential applications there is also DHW demand. In Toulouse there is much more space heating demand (about 2-3 times as much as in Naples) and the cooling demand is significantly smaller although the peak cooling capacity is the same. For both climates, simulations were carried out for a chilled ceiling distribution system and for a fan coil system. In addition, two building standards were simulated where 60 stands for the better insulated building and 100 for the one that is not as well insulated.

Three cases of office applications were simulated. In addition to Naples and Toulouse climate, a central European climate (Strasbourg) was chosen. All three office buildings have significantly smaller total energy demand than the residential cases. The office buildings have higher cooling demand than the residential buildings, relatively low space heating demand and no DHW demand at all as is typical for office buildings.

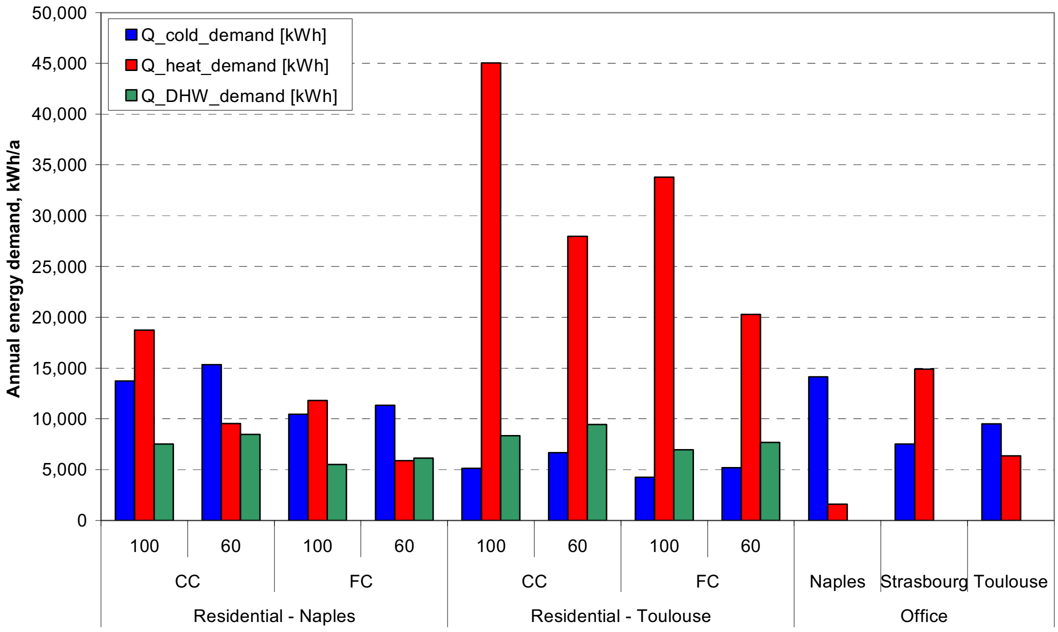


Figure 7: Cold, heat and DHW demand of the simulated cases

The cost of saved primary energy depends strongly on the overall energy demand of the building. If the heat and cold demand of the building is too small, the costs of the saved primary energy are high. Figure 8 shows the calculated cost of the saved primary energy for all simulated cases. Only the cost of the largest system size (which performed best in the simulations) is shown. The strong dependency of costs and total energy demand is evident. The cost of the saved primary energy is highest for the three office applications which have the lowest total energy demand. The reason for this is not that the systems are used for office buildings but because the energy consumption of the buildings is lowest and therefore less primary energy is saved. Office buildings that have significantly more energy demand but the same peak cooling load could be supplied with energy with the same solar combi plus system at significantly lower costs.

Another way of looking at it is to compare the cost per delivered useful final energy (Figure 9). The diagram shows the costs of the delivered final energy of the reference systems compared to the costs of the solar combi plus systems. For solar combi plus systems, two curves are shown: The upper curve is for the largest system size simulated and the lower one for the smallest system size.

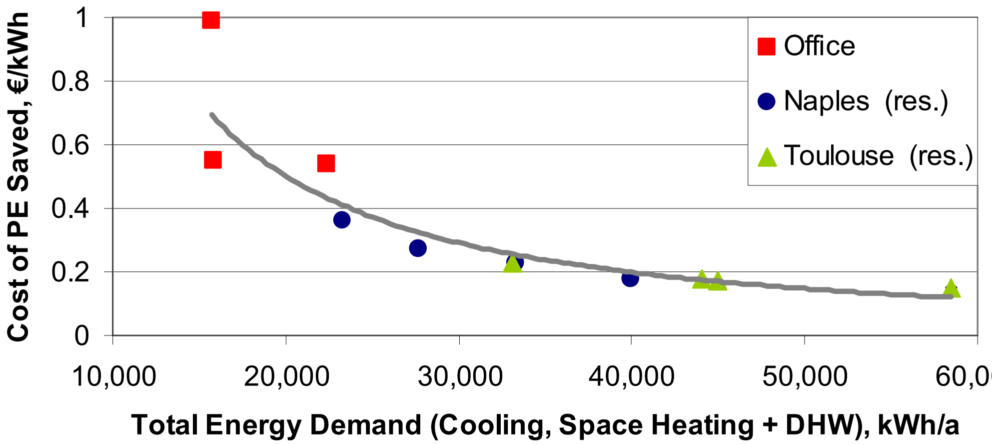


Figure 8: Cost of primary energy saved for the largest system size of all simulated cases as a function of the total energy demand of the application (Red squares: office buildings in all three locations, blue dots: residential buildings in Naples, green triangles: residential buildings in Toulouse)

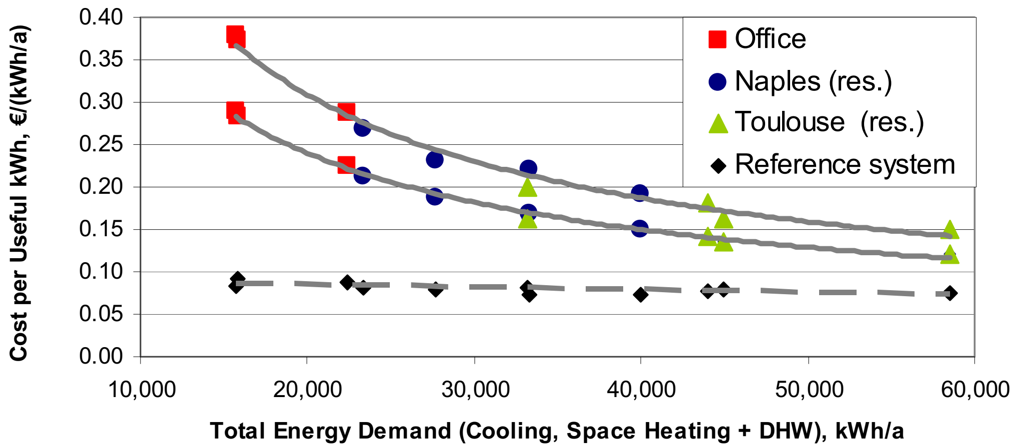


Figure 9: Cost of useful final energy delivered by a solar combi plus system and a conventional reference system. For solar combi plus systems the lowest and the highest costs within the range of simulated system sizes is shown. (Red squares: office buildings in all three locations, blue dots: residential buildings in Naples, green triangles: residential buildings in Toulouse)

Comparing to the costs of energy delivered by the reference system, again applications that consume more energy are more favourable for the use of a solar combi plus system. Investment costs are significantly higher for solar combi plus systems than for the reference systems. However, operating costs are lower. Therefore, the installation of a solar combi plus system only pays off if the system has enough operation hours which means that the energy demand of the application is high enough.

For applications with high total energy demand, energy delivered from a solar combi plus system is less than twice as expensive as from a reference system. In addition, it can be expected that investment costs for solar combi plus systems will decrease in the future and that system efficiency will increase which will reduce energy costs from solar combi plus system further.

Both diagrams show that a certain amount of energy consumption is necessary in order to reduce energy costs of a solar combi plus system. To make solar cooling systems cost effective it is important that the collector system is used not only for cooling but also for other purposes such as DHW preparation and space heating. The application with the highest cost of saved primary energy in this study is the office building in Naples which is almost exclusively used for cooling (and a little bit of space heating). The costs that were calculated from the simulated cases are not representative for the types of applications (office, residential) or climates (Naples, Strasbourg, Toulouse) but rather for the specific energy demand profile chosen for the different cases.

In the following sections, results of some of the simulated cases are shown as examples. While the absolute numbers may vary from one case to another, the general trend to which system size is the best is the same for all simulated cases.

5.2 Residential Applications

5.2.1 Toulouse (large space heating demand)

Figure 10 shows the saved primary energy for the residential building in Toulouse with higher space heating demand for a whole range of storage volumes and collector areas. The example shown in the graphs below uses a chilled ceiling heat distribution system which is more favorable for the chiller because of higher chilled water temperatures.

This example was chosen because it shows the best results of all simulated cases because its total energy demand is highest.

The graph shows that for small collector areas and small storage volumes primary energy savings are very small. For the largest simulated system size (88.5 m^2 of collector area and 6.6 m^3 of storage volume) about 45% of the annual primary energy consumption is saved due to the solar combi plus system. Figure 11 shows the corresponding solar fractions for cooling which are around 65% for the smallest simulated system and up to 98% for the largest system.

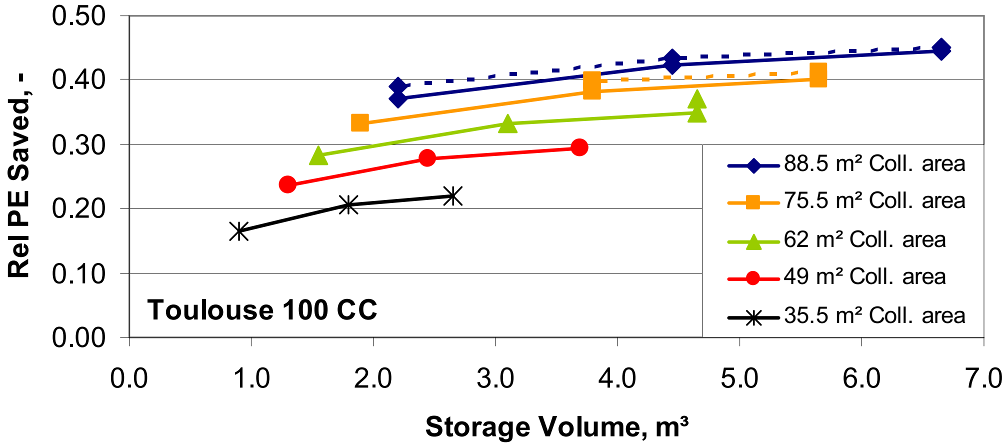


Figure 10: Results of the virtual case study for a solar combi plus system in a residential building with a chilled ceiling distribution system in Toulouse, relative primary energy saved compared to a reference system with gas boiler heating and compression cooling. Solid lines: with gas backup in summer, dotted lines: no backup in summer for cooling

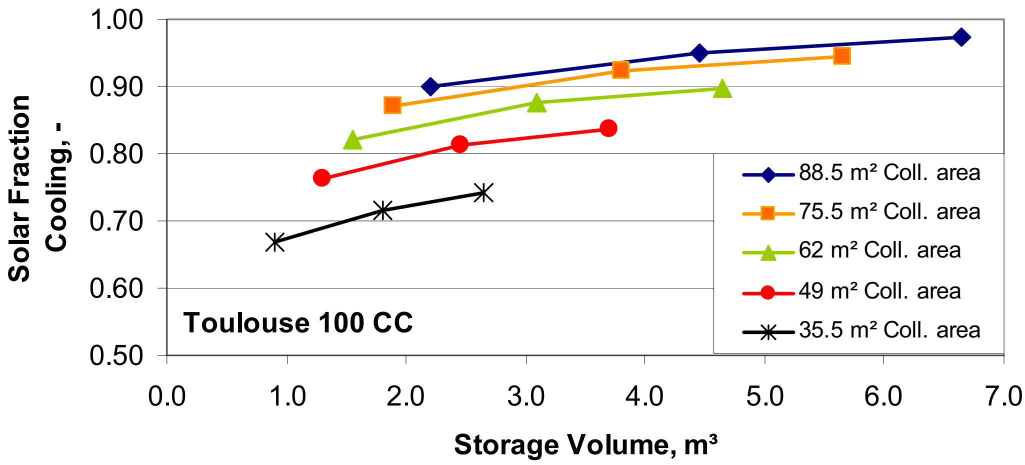


Figure 11: Results of the virtual case study for a solar combi plus system in a residential building with a chilled ceiling distribution system in Toulouse, solar fraction for cooling for simulations with backup for cooling in summer.

The graphs show that the best simulated case is the largest collector area and the largest store size. If there is no backup for cooling in summer, primary energy savings remain high even for slightly smaller system sizes. However, only the five largest system sizes (see dotted lines in Figure 10) lead to cooling load coverage of more than 90%.

Looking at the costs for such a system, Figure 12 shows the cost of the saved primary energy as a function of collector area and storage volume. The costs are presented relative to the costs for the medium sized system (3.5 m^2/kW, 50 liter/m^2). For small systems, the relative costs are high because the system leads only to small primary energy savings. Also from this point of view larger system sizes are favourable. Figure 12 shows that the gradient of the cost curves decreases with increasing system sizes. The cost of the medium size system (black dot in the figure) is only 5% higher than of the largest system. But of course more primary energy is saved with a large system.

If investment costs are to be kept relatively low the medium size system would be recommended for this application. However, investing more would lead to more primary energy savings and lower costs for the saved primary energy. Significantly smaller system sizes would mean significantly higher costs and are therefore not recommended.

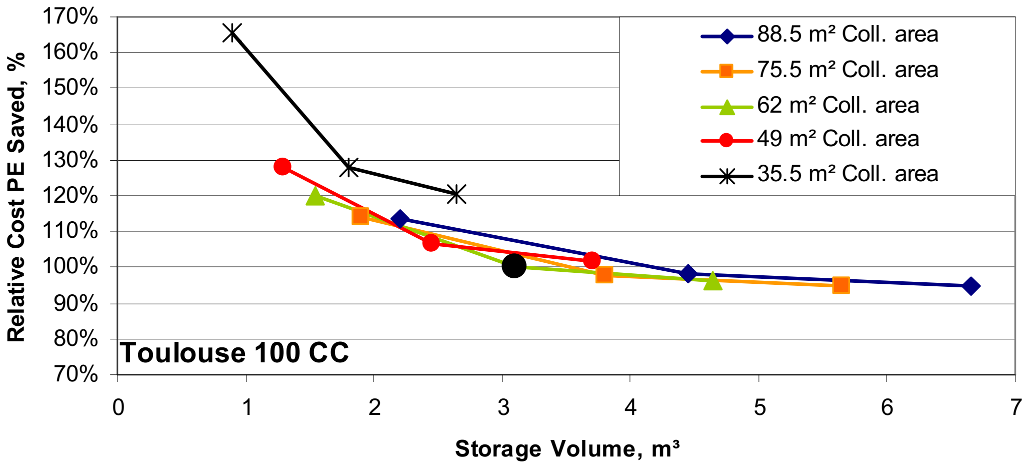


Figure 12: Results of the virtual case study for a solar combi plus system in a residential building with a chilled ceiling distribution system in Naples, cost for saved primary energy relative to the medium sized system (3.5 m²/kW, 50 liter/m²), simulations with backup for cooling in summer.

Three more cases were simulated for Toulouse: The building with less space heating demand and a little bit more cooling demand shows similar results than the one shown. However, the costs of primary energy savings are somewhat higher because the overall heat demand is smaller and therefore also the primary energy savings are smaller. But again, the largest system size shows best performance in terms of both primary energy savings and cost of the primary energy savings.

Two buildings with fan coil distribution system were also simulated. It has to be noted that for the fan coil systems different collector areas and storage volumes were used because the system size was chosen as a function of the nominal cooling capacity of the machine which is a bit less than for a chilled ceiling system if a fan coil system with lower cold water temperatures is used.

The primary energy savings are a bit lower for the fan coil systems than for the chilled ceiling systems. However, a direct comparison is not possible because the energy demand and the system sizes simulated were not identical.

5.2.2 Naples (small space heating demand)

The same simulations were carried out using Naples weather data. In Naples space heating demand is about one half to one third compared to Toulouse, and cooling demand is about twice as much.

The results are similar to the results of the Toulouse case. Again, the largest system leads to the highest primary energy savings (see Figure 13). The absolute primary energy savings are lower than in Toulouse although the primary energy saved relative to the total primary energy consumption is higher. This is largely due to the fact that the system can save significantly less space heating energy simply because there is less space heating demand. This is, of course, unfavourable for the overall primary energy consumption of the system and leads to higher costs of the saved primary energy.

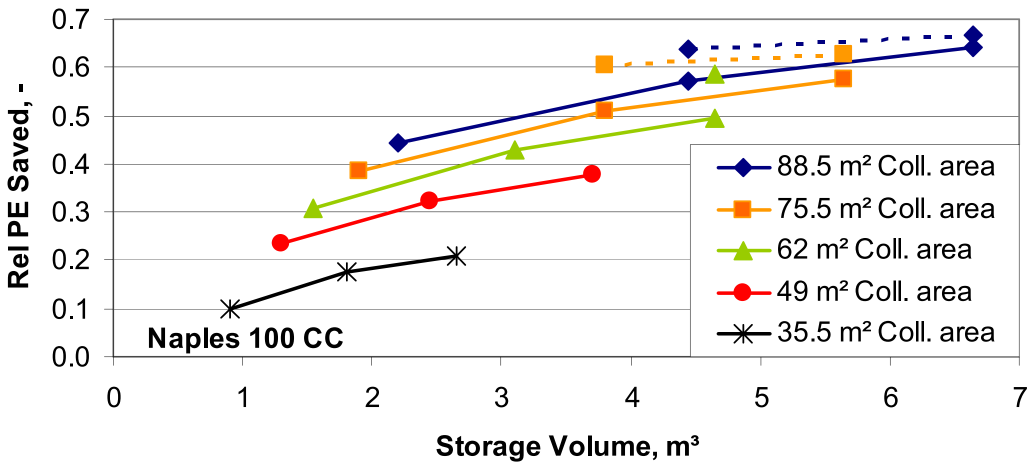


Figure 13: Results of the virtual case study for a solar combi plus system in a residential building with a chilled ceiling distribution system in Naples, relative primary energy saved compared to a reference system with gas boiler heating and compression cooling. Solid lines: with gas backup in summer, dotted line: no backup in summer for cooling

Just like for the Toulouse case, primary energy savings are small for small system sizes. The larger the system, the more primary energy can be saved. Again, if the system is big enough that more than 90% of the cooling demand can be covered without using the backup system in summer, more primary energy can be saved as can be seen in Figure 13.

The solar fractions for cooling are lower than in Toulouse because not only the climate is different but also the cooling demand is significantly higher (see Figure 14).

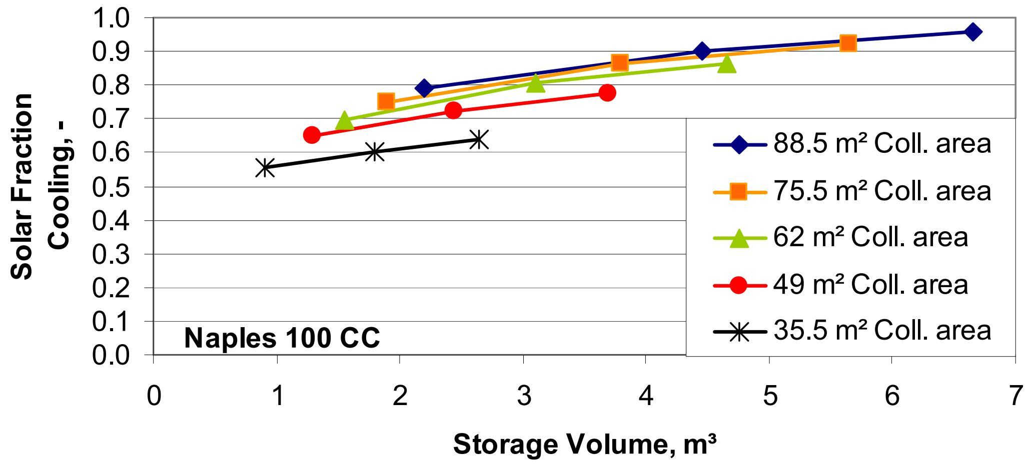


Figure 14: Results of the virtual case study for a solar combi plus system in a residential building with a chilled ceiling distribution system in Naples, solar fraction for cooling for simulations with backup for cooling in summer.

Regarding costs, just like for the Naples case the largest system sizes are best (see Figure 15). The slope of the curves starts to become relatively small starting approximately at the medium size system (black dot). A system should therefore be designed not smaller than this value. Nevertheless, the largest systems have the lowest costs per saved kWh of primary energy.

As the last example of a residential building, the case with the lowest total energy demand (residential building in Naples with better insulation standard and fan coil distribution system, Naples 60 FC) is presented in Figure 16.

For small system sizes, primary energy savings are in this case even negative which means that the solar combi plus system needs more primary energy than the conventional reference system. The reason for that is that with small system sizes the solar fraction for cooling becomes small e.g. 50% for the smallest simulated system. The auxiliary heater is then used to cover the other 50% of the cooling load. A thermally driven chiller driven by a fossil fuel always consumes more primary energy than an electrically driven compression chiller. Therefore, solar fractions need to be high with this system configuration in order to ensure primary energy savings.

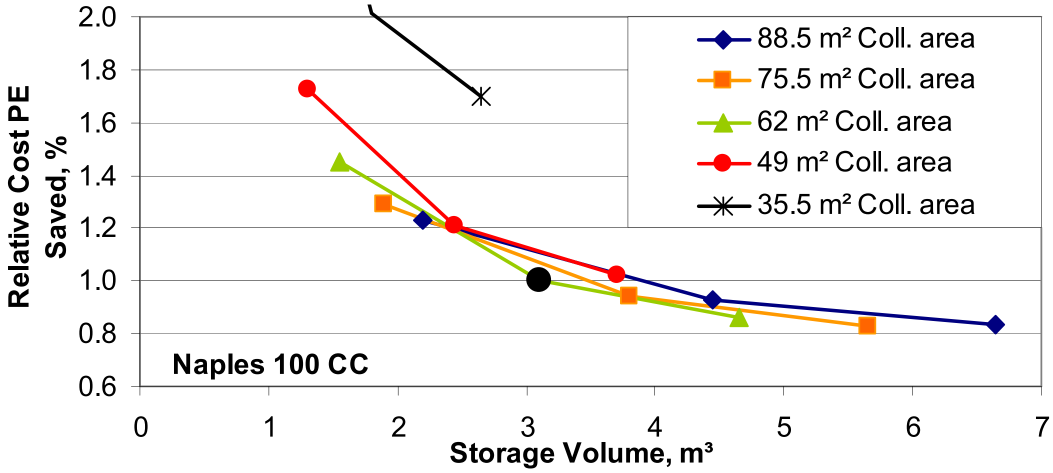


Figure 15: Results of the virtual case study for a solar combi plus system in a residential building with a chilled ceiling distribution system in Naples, cost for saved primary energy relative to the medium sized system (3.5 m²/kW, 50 liter/m²), simulations with backup for cooling in summer.

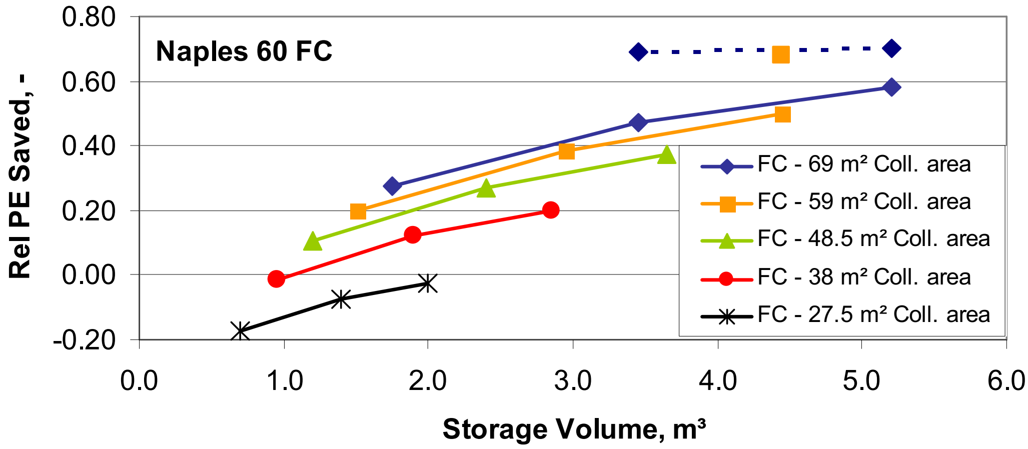


Figure 16: Results for the virtual case study for a solar combi plus system in a residential building with a fan coil distribution system in Naples, relative primary energy saved compared to a reference system with gas boiler heating and compression cooling. Solid lines: with gas backup in summer, dotted line: no backup in summer for cooling

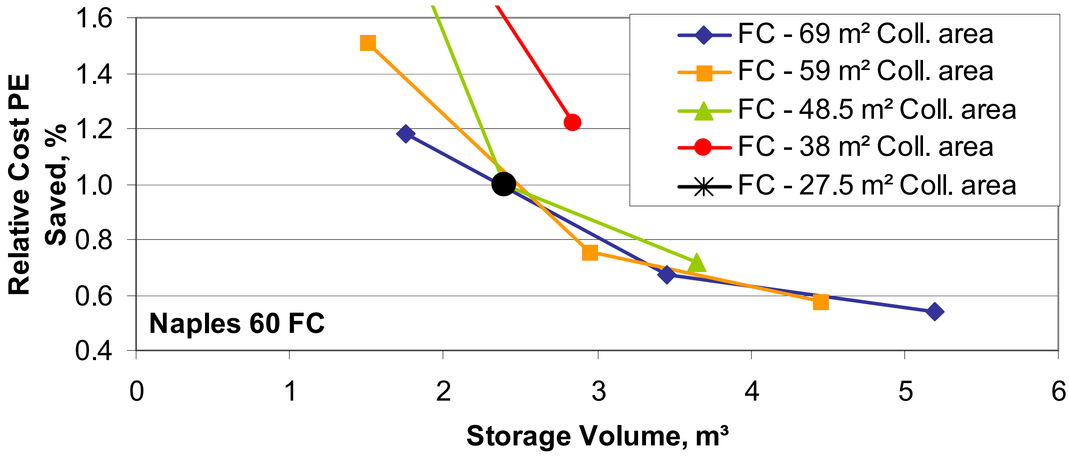


Figure 17: Results for the virtual case study for a solar combi plus system in a residential building with a fan coil distribution system in Naples, cost for saved primary energy relative to the medium sized system (3.5 m^2/kW, 50 liter/m^2), simulations with backup for cooling in summer.

Looking at the costs of the saved primary energy, costs are not only significantly higher than for systems with higher total energy demand (Figure 8) but the slope of the curves is much steeper. Figure 17 shows that the saved primary energy is roughly twice as expensive for a medium size system compared to the largest system. Systems with small total energy demand are in general less cost effective than system with higher energy demand. When sizing such a system, large collector areas and tank sizes are recommended in order to keep costs of the saved primary energy as low as possible.

5.3 Office Buildings

For office buildings only systems with a fan coil distribution system were simulated. All three office buildings have significantly smaller total energy demand than the residential cases. The office buildings have higher cooling demand than the residential buildings, relatively low space heating demand and no DHW demand at all as is typical for office buildings.

The results for office buildings are again similar to those for residential buildings: The large system sizes perform best. Relative primary energy savings are highest. For the Strasbourg case, a significant amount of extra primary energy can be saved if no backup system for cooling is used. For small system sizes, there are no primary energy savings but already a medium size system can lead to significant primary energy savings and still ensure adequate summer comfort.

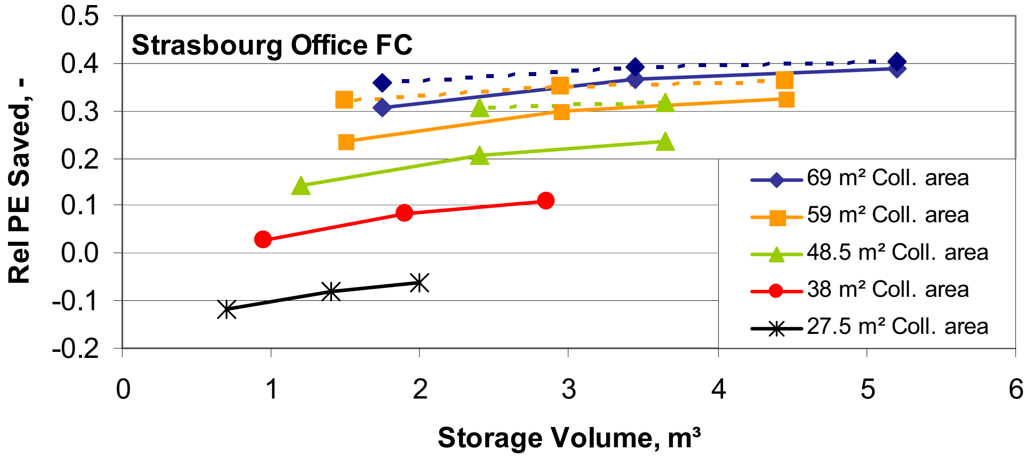


Figure 18: Results of the virtual case study for a solar combi plus system in an office building in Strasbourg, relative primary energy saved compared to a reference system with gas boiler heating and compression cooling. Solid lines: with gas backup in summer, dotted line: no backup in summer for cooling

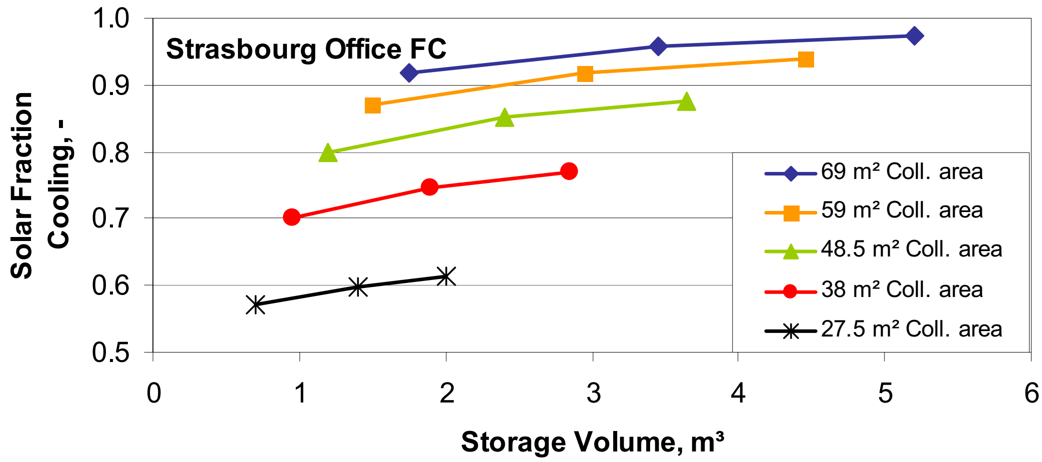


Figure 19: Results for the virtual case study for a solar combi plus system in an office building in Strasbourg, solar fraction for cooling for simulations with backup for cooling in summer.

6 Proposed Package Solution

The following components are included in the SOLution solar heating and cooling package:

- 15 kW absorption chiller
- 35 kW cooling tower (wet, open circuit)
- 54 m² collector area
- Collector mounting components
- Collector loop pumping station with primary pump
- External collector loop heat exchanger
- 300 l collector loop expansion vessel
- Antifreeze concentrate
- 3-way motor switch valve
- Secondary collector loop pump
- Freely programmable controller
- 3000 l heat storage tank with insulation
- 500 l expansion vessel in hot water circuit of the absorption chiller
- 3-way fixed value control
- 500 l expansion vessel in chilled water circuit of absorption chiller
-1000 l cold storage tank (price special cold insulation on demand)
- 150 l expansion vessel in cooling water circuit of absorption chiller

These components are not part of the package:
- Pumps in three circuits of the chiller (these are dimensioned in case of command)
- Cold distribution system (must be provided by the client)

A ***standard offer*** for the package which describes the different components in detail and which can be quickly adapted to each interested client is included in annex II "standard offer A23805".

7 Summary and Recommendations

This document describes in detail one of the solar heating and cooling packages offered by the company SOLution.

The design of a particular application depends very much on the local load and weather data as well as building aspects (especially concerning the heat and cold distribution system).

However, some general recommendations that should be kept in mind when designing a solar heating and cooling system are summarized below:

- **Choose chilled ceiling distribution system**

Chilled ceiling distribution systems are always favourable because of higher cold water temperatures.

- **Large system size performs best**

For all simulated cases, the largest system size is always best in terms of both primary energy savings and the cost of these primary energy savings.

- **System size should be at least 3.5 m^2/kW_{cold} and 50 $liters/m^2$**

If the collector area and storage volume of a system is too small, in some cases no primary energy is saved at all. The solar fraction for cooling should always be as high as possible to avoid that the thermally driven chiller operates on fossil fuels too often. Simulations showed that for all cases with a reasonable total energy demand of the application at a system size of 3.5 m^2/kW_{cold} and 50 $liters/m^2$ cost curves start to flatten out. Therefore, it is recommended to design the system not smaller than these values. Larger system sizes lead to even higher primary energy savings and costs of these primary energy savings. But if investment costs need to be limited, 3.5 m^2/kW_{cold} and 50 $liters/m^2$ are a reasonable value which is also recommended to their customers by SOLution.

- **Design of system size depends on total energy demand of the application**

The recommendation of at least 3.5 m^2/kW_{cold} and 50 $liters/m^2$ is only a general guideline. The best system size for each installed system depends on the total energy demand as well as on the load characteristics of the application. Applications with a very small total energy demand should be avoided.

- **Consider solar autonomous system for cooling**

To maximize primary energy savings it should always be considered to design a system without backup for cooling in summer. If a system is designed large enough, solar fractions for cooling can be above 90% and using the backup system for cooling can be avoided.

- **Avoid fossil fuel backup system for cooling**

Other options to reduce fossil fuel consumption are to install a biomass boiler or to use waste heat as heat backup system or an electrically driven compression chiller as cold backup. This will increase primary energy savings but also increase investment costs.

8 Annex I - SOLution price list 2009 for solar cooling systems

Klimatisieren.

Solare Kühlung

Heizen und Klimatisieren mit der Sonne von SOLution

Kühlen, Heizen und Warmwasser in Einem!
Ein System für alle Anwendungen
Optimale Nutzung sommerlicher Solarenergie
Im **Sommer** kühlen, im **Winter** heizen
Klimatisierung **mit niedrigsten Energiekosten**

SOLution-Innovation

ENERGY GLOBE
Ausgezeichnet mit dem Energy Globe Österreich Kategorie Feuer

Der Energiebedarf im Bereich Kälte und Klimatisierung steigt ständig. Klimatisierung ist ein großes Zukunftsthema in der Haustechnik. Um dabei die Energiekosten in den Griff zu bekommen, ist die solare Kühlung eine optimale Variante.
Durch die solare Kühlung werden die sommerlichen Solarenergieüberschüsse in Ab- bzw. Adsorptionskälteanlagen in Kälte für Prozesse und Klimatisierung umgewandelt.
Die gleiche Solaranlage wird für die Warmwasserbereitung und in der Übergangs- und Winterzeit zur Raumheizung verwendet. Somit steigt der Nutzungsgrad der Solaranlage enorm, da es keinen Stillstand im Sommer gibt.

Kurz gesagt: **Eine höchst wirtschaftliche Solartechnik!**

Prinzipschema

Optional:
Mit Frischwassereinheit auch zur Warmwasserbereitung geeignet.

Hinweis:
Bei der Absorptionskältemaschine muss ein Pufferspeicher für Kaltwasser berücksichtigt werden.

Besichtigen Sie die Demonstrationsanlage im Haus der Solartechnik · www.hausdersolartechnik.at

SOLution Alaskalösung zur solaren Kühlung und solarem Heizen

Paketlösung bestehend aus Flachkollektoren, Befestigung, Solarkreiskomponenten primär und sekundär zur Schichtladung, Rücklaufgruppe, Ausdehnungsgefäß, Frostschutz und externer Plattenwärmetauscher. Pufferspeicheranlage bestehend aus einem Heizungspuffer und einem Kältepuffer** inkl. Isolierungen. Ad- bzw. Absorptionskältemaschine. Freiprogrammierbare Regelung. Exkl. Transport, Montage und Inbetriebnahme.

AL7,532 Pinguin	Alaskaset für eine Kühllast von 7,5 kW Adsorptionskälteanlage 7,5 kW, Rückkühler 20 kW, Flachkollektoranlage 32,4 m², Heizungspufferspeicher 1.500 L Kälteanlage ohne Pumpen in den drei Kreisläufen der Kältemaschine (diese werden entsprechend der Anlage dimensioniert)	33.950,00*
AL1564 Alaska	Alaskaset für eine Kühllast von 15 kW Adsorptionskälteanlage 15 kW, Rückkühler 40 kW Flachkollektoranlage 64,8 m², Heizungspufferspeicher 3.000 L Kälteanlage ohne Pumpen in den drei Kreisläufen der Kältemaschine (diese werden entsprechend der Anlage dimensioniert)	56.500,00*
AL1564-AB Grönland	Alaskaset für die Kühllast von 15 kW, Absorptionskälteanlage 15 kW, Rückkühler 35 kW, Flachkollektoranlage 64,8 m², Heizungspufferspeicher 3.000 L, Kältepufferspeicher 1.000 L, Kälteanlage ohne Pumpen in den drei Kreisläufen der Kältemaschine (diese werden entsprechend der Anlage dimensioniert)	NEU 60.120,00*
AL30124 Polarfuchs	Alaskaset für eine Kühllast von 30 kW, Adsorptionskälteanlage 30 kW, Flachkollektoranlage 124,2 m², Heizungspufferspeicher 6.000 L, Kälteanlage ohne Rückkühler und ohne Pumpen, in den drei Kreisläufen der Kältemaschine (diese werden entsprechend der Anlage dimensioniert)	90.045,00*
AL50221-AB Eisbär	Alaskaset für eine Kühllast von 50 kW, Absorptionskälteanlage 50 kW Rückkühler 126 kW, Flachkollektoranlage 221,4 m² Heizungspufferspeicher 10.000 L, Kältepufferspeicher 4.000 L Kälteanlage ohne Pumpen in den drei Kreisläufen der Kältemaschine (diese werden entsprechend der Anlage dimensioniert)	194.027,00*

* Richtpreis für Angebotserstellung € 500,00. Wird bei Kauf abgezogen.
** nur bei Alaskaset AL50221-AB und AL 1564-AB

Quelle Foto Adsorptionskälteanlage: Sortech AG.
Montagepreis auf Anfrage. Rohrleitungsmaterial ist gesondert zu bestellen (siehe Seite 62).

Preise in Euro exklusive MWSt.

Adsorptionskälteanlage für AL7,532, AL1564, AL30124

Adsorptionskälteanlage für AL50221-AB, AL1564-AB

Top umweltfreundlich mit Nutzung von alternativen Stromquellen!
Info unter www.oekostrom.at
oekostrom

32 | 33 www.sol-ution.com
Die bessere Zukunft.
SOLution Solartechnik

9 Annex II - Data Sheets of Components

Data sheets of:

Flat plate collector UNISOL27

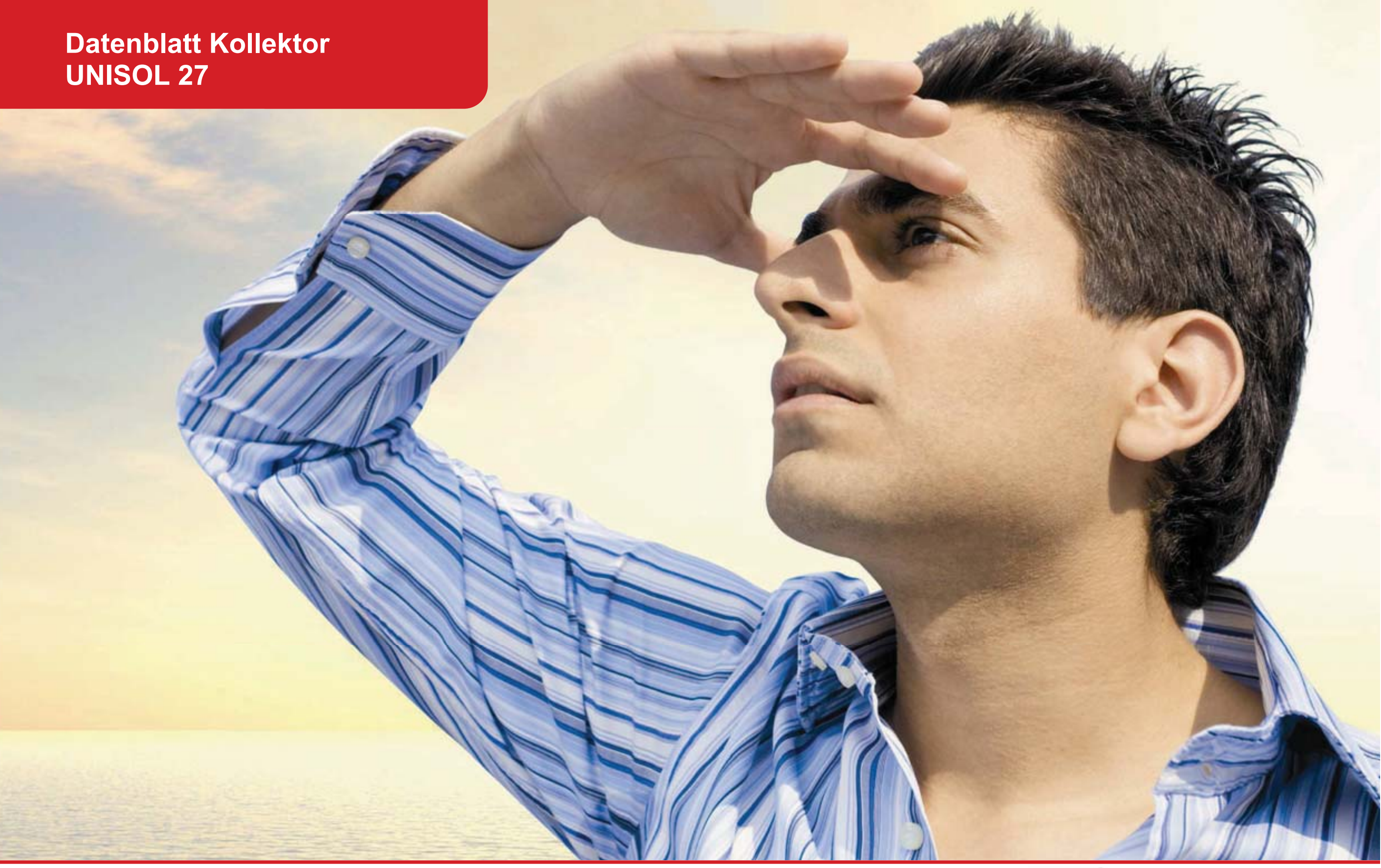
Hot water storage tank (model number: HPS3000)

15 kW absorption chiller

35 kW cooling tower

Cold water storage tank (model number: HPS1000)

Datenblatt Kollektor UNISOL 27



Kollektor UNISOL 27
(mit ALU - Absorber)

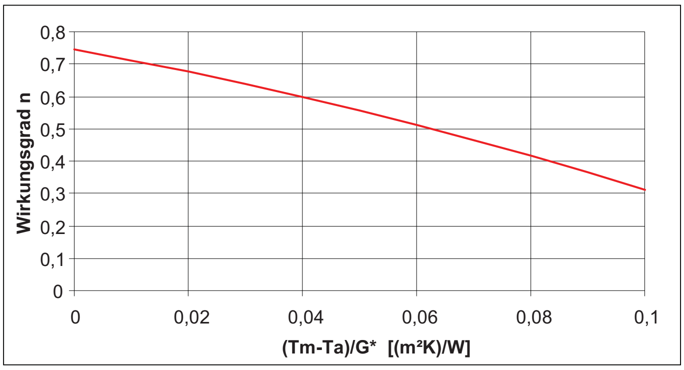
Alle unsere Kollektoren und Komponenten sind qualitätsgeprüft!

Vers. 03 / Mai 2008

Technische Daten UNISOL 27

Bezugsflächen	
Bruttofläche	2,66 m²
Aperturfläche	2,49 m²
Absorberfläche	2,50 m²
Kollektor/Gehäuse	
Kollektorart	Flachkollektor
Länge	2136 mm
Breite	1246 mm
Tiefe	98 mm
Material	Aluminium blank
Gewicht	47 kg
Montageart	Aufdach
Absorber	
Art des Absorbers	Vollflächenabsorber
Dicke	0,5 mm (Alu)
Oberflächenbehandlung	hochselektiv vakuumbeschichtet
Wärmeträgerinhalt	1,26 Liter
Durchmesser der Anschlüsse	CU 18
Absorptionsgrad	95 %
Emissionsgrad	5 %
Max. Betriebsdruck	10 bar
Stillstandstemperatur	208 ℃
Empfohl. Durchflussmenge	20 – 40 l/m²h
Transparente Abdeckung	
Material	GLAS ESG
Wärmedämmung	
Material	Steinwolle
Dicke	50 mm
Prüfberichtsnummer	06COL482/2OEM06
Keymark-Registriernummer	011-7S359F

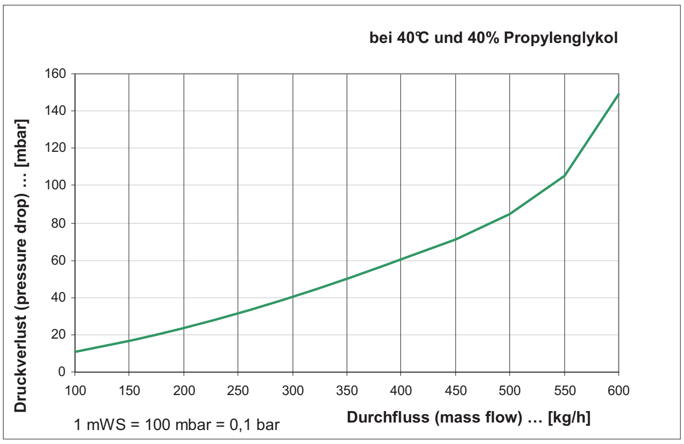
Wirkungsgraddiagramm



Prüfergebnisse Wärmeleistung

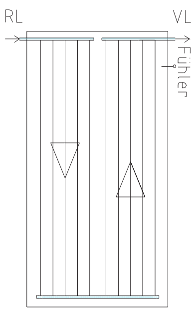
Konversionsfaktor η_0 / $\eta_{0,05}$	74,6 % / 55,6 %
Wärmedurchgangskoeffizient a_1	3,232 [W/(m²K)]
therm. Wärmedurchgangsk. a_2	0,014 [W/(m²K²]
Einfallswinkel-Korrekturfaktor $K_0(50°)$	0,92

Druckverlustkurve



Verschaltung

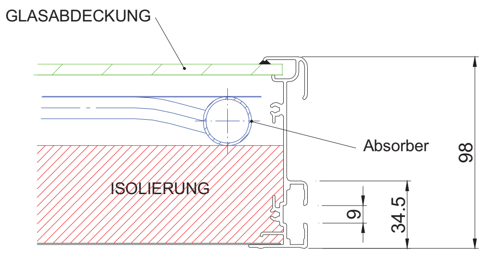
UNISOL 27 - max. 6 Stück in Serie
(dann Dehnungsschleife)
Siehe Dokument „Max. Serienverschaltung",
zum download auf der Homepage



Einsatzgrenzen

Kollektorneigung zwischen 15° und 70°
Zusatzneigung (seitlich gedreht) max. 30°
Horizontaler Abstand zw. 2 Modulen nebeneinander: 50 mm

Schnitt



Stockschraubenbefestigung Aufdach für Eternit- und Biberdächer (SSB)

Mindestsparrenbreite von **80 mm** erforderlich.
Bei Eternit-Einfachdeckung nicht einsetzbar.

SSB 0	Stockschraubenbefestigung PARALLEL
SSB 20	Stockschraubenbef. 20° ANGEHOBEN
SSB 45	Stockschraubenbef. 45° ANGEHOBEN
SSB 60	Stockschraubenbef. 60° ANGEHOBEN

Dachbügelbefestigung Aufdach für Ziegeldächer (DBB)

Maximale Überlappung der Dachziegel 10 cm

DBB 0	Dachbügelbefestigung PARALLEL
DBB 20	Dachbügelbef. 20° ANGEHOBEN
DBB 45	Dachbügelbef. 45° ANGEHOBEN

Falzklemmenbefestigung Aufdach für verzinkte Blechdächer (FKB)

Falzrichtung entlang der Kollektorenausrichtung (Falzklemmen in Edelstahl). Spezialklemmen für Blechdächer auf Anfrage.

FKB 0	Blechdachbefestigung PARALLEL
FKB 20	Blechdachbefestigung 20° ANGEHOBEN
FKB 45	Blechdachbefestigung 45° ANGEHOBEN
FKB-QUER	Blechdachbefestigung 45° ANGEHOBEN

Trägerplattenbefestigung Aufdach für Blechdächer (TPB)

TPB0	Trägerplattenbefestigung PARALLEL
TPB20	Trägerplattenbefestigung 20° ANGEHOBEN
TPB45	Trägerplattenbefestigung 45° ANGEHOBEN

Betonfundament Aufdach

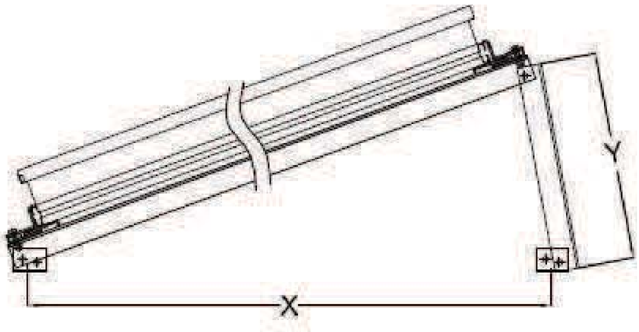
Betonfertigteilelemente zur Kollektorbefestigung auf Flachdächern.
Gewicht je Element 180 kg - Abmessungen: L x B x H = 180 cm x 26 cm x 16 cm

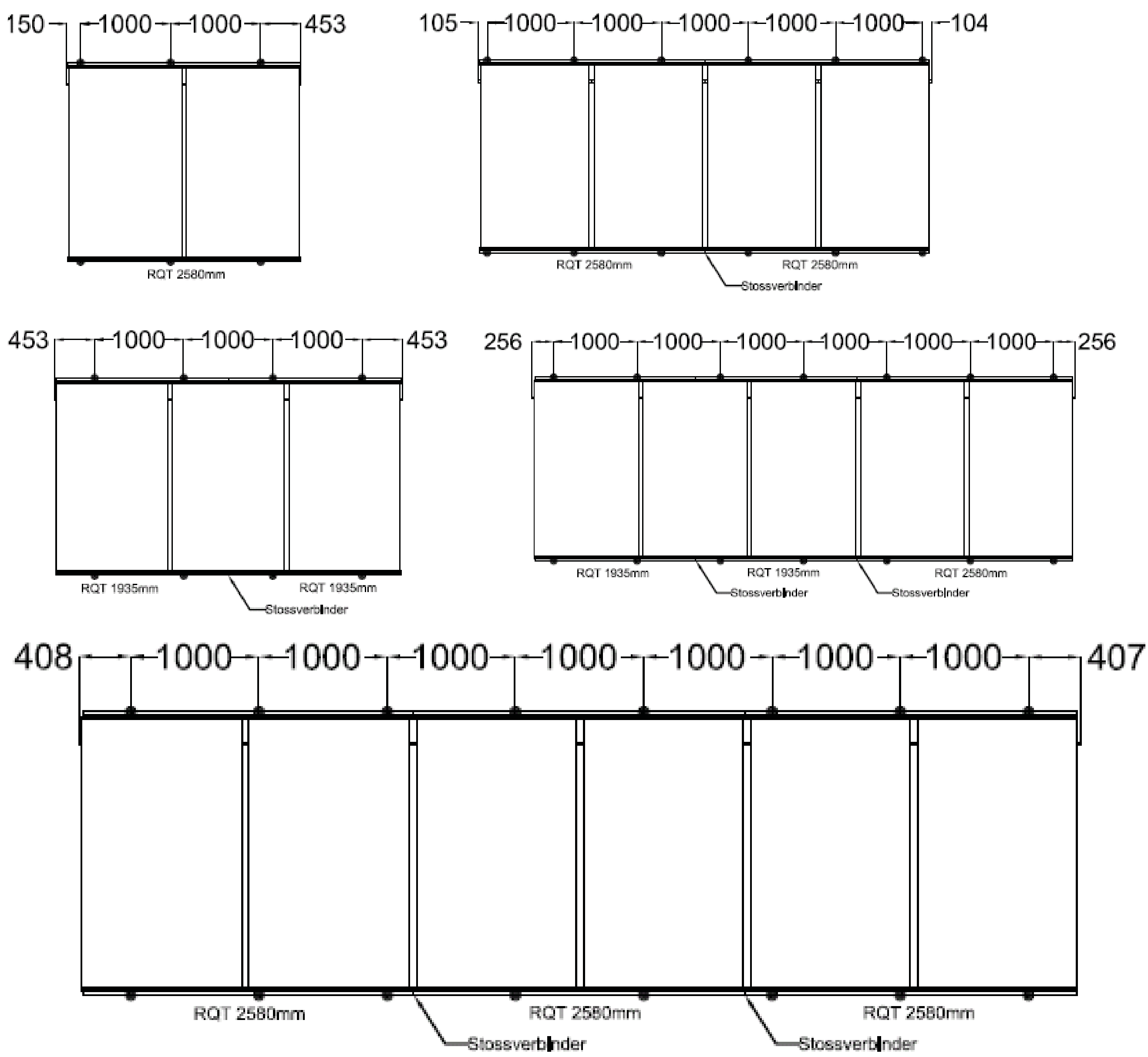
SPEZIALBEFESTIGUNGEN

FK-FIX2000	Solarklemme für Trapezdächer, nur für Parallelmontage
FKGBS	Solarklemme für Gleitbügeldächer, Länge 450 mm, 5x verschraubt
SPA-PREFA	PREFA-Solarhalter, inkl. Schrauben, Bedarf: 2 Bügel/m² Kollektorfläche

Befestigungsabstände

UNISOL 27		Parallel	20°	45°
	x	2211	2050	1580
	y	-	800	1550





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Datenblatt

Pufferspeicher
HPS 3000
HPS 4000
HPS 5000

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SYSTEM CERTIFIED
ISO 9001:2000 NR.04943/1
ISO 9001:2000 NR.04943/2

Vers. V01 / Juni 2009

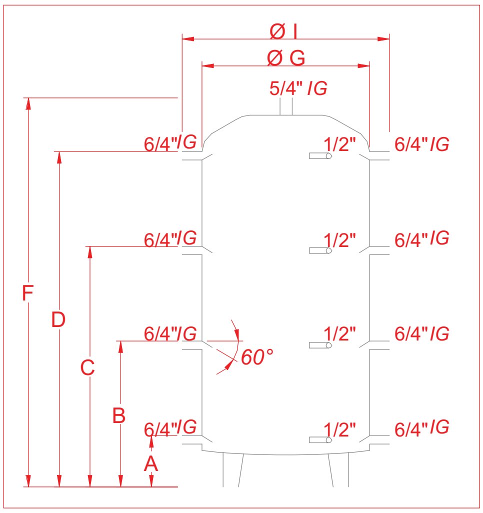
[redacted]

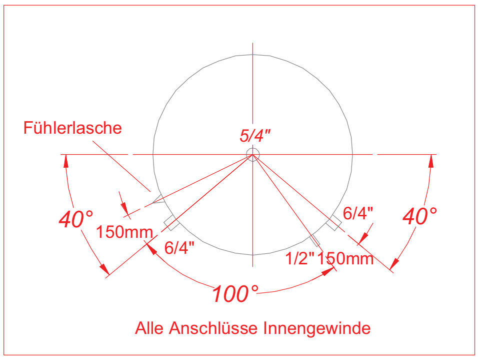
Technische Daten SOLution Pufferspeicher

SOLution Pufferspeicher sind aus 4 mm starkem Stahlblech DIN 4753 gefertigt, innen schwarz und wahlweise mit **eingeschweißtem Glattrohrregister** erhältlich. Alle 6/4"-Anschlüsse sind mit Prallblechen zur Erhaltung der Speicherschichtung ausgestattet.

		Heizungspuffer ohne Register		
		HPS3000	**HPS4000**	**HPS5000**
Inhalt	l	3000	4000	5000
Durchmesser	mm	1250	1400	1600
Höhe	mm	2660	2840	2935
Kipmaß	mm	2850	3040	3140
Gewicht	kg	300	380	450
Zul. Betriebs-druck Heizung	bar	3	3	3
Zul. Betriebs-temp. Heizung	°C	95	95	95
Abmessungen				
A	mm	380	505	400
B	mm	1020	1110	1100
C	mm	1680	1860	1810
D	mm	2330	2410	2520
F	mm	2705	2835	2870
G	dm	1250	1400	1600
I	dm	1450	1600	1800

Technische Änderungen vorbehalten.





Vers. V01 / Juni 2009

Absorption chilling plant
WEGRACAL SE 15 - 30
for the usage with heating water

Level: May 2008

EAW Energieanlagenbau Westenfeld GmbH
Oberes Tor 106
98631 Westenfeld
Germany

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E-mail	info@eaw-energieanlagenbau.de
Web	www.eaw-energieanlagenbau.de

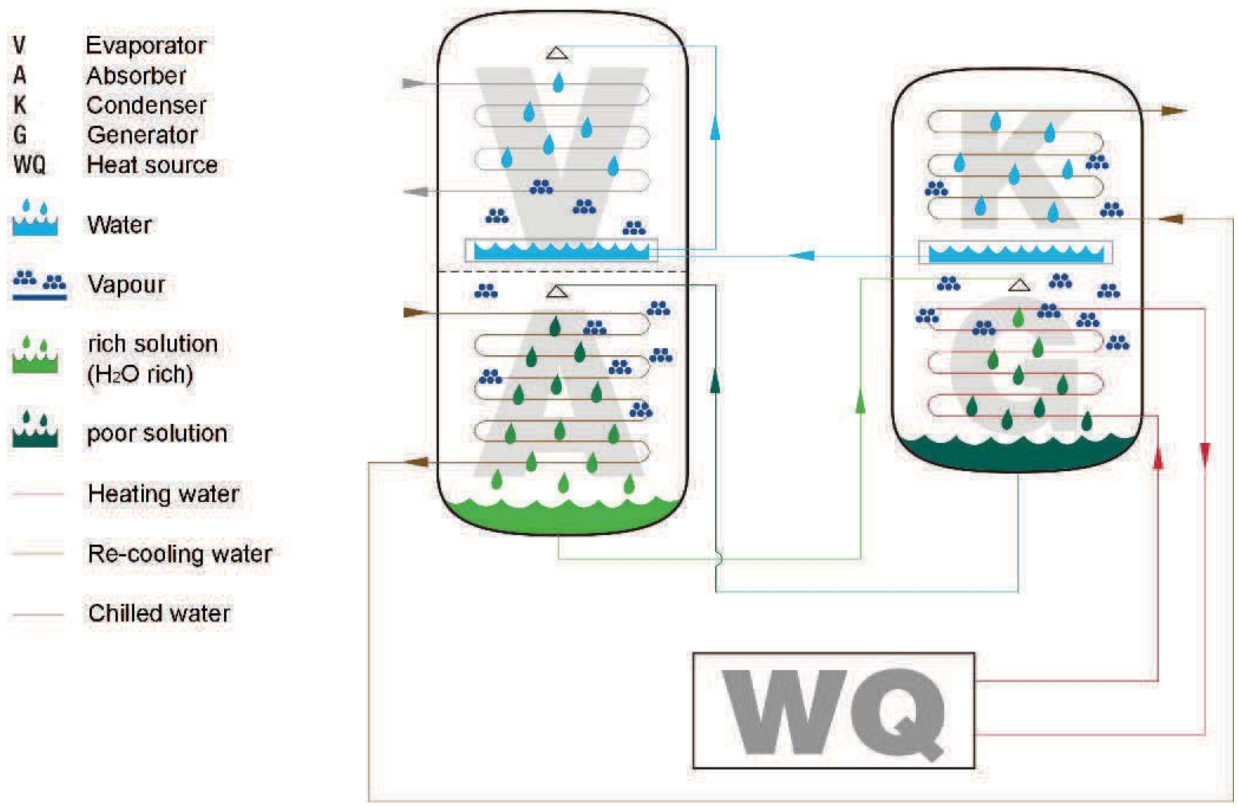
Table of contents:

Absorption chilling plant WEGRACAL SE

1. Characteristics of equipment, capacity data

The absorption chilling plant, type WEGRACAL SE, described in the following is operated with heating water in a temperature range from 80 °C – 90 °C. The operating mode is based on a continuous process of absorption with the lubricants lithium-bromide / water.

1.1 Scheme / Operating mode of the plant



EAW Energieanlagenbau Westenfeld GmbH – Oberes Tor 106 – 98631 Westenfeld
phone 036948 84132 fax 036948 84152 E-mail info@eaw-energieanlagenbau.de www.eaw-energieanlagenbau.de

1.2 Operating mode of the plant

In case of the circular process occurring at the WEGRACAL absorption chiller, it is the matter of a continuous process which in order to be represented in a simplified way, can be separated into single steps as follows:

Solution pump: The rich solution containing cooling solvent is then being transported through a heat exchanger to the generator.

Generator: The solution containing cooling solvent is evenly spread over the generator. By the input of heating water, the cooling solvent is evaporated out of the solution. The lithium-bromide solution, which is now concentrated again is transported back to the absorber.

Condenser: The cooling solvent steam evaporated in the generator is now streaming to the condenser in order to be fluidified. The fluidified solvent is decompressed by a restrictor and applied to the evaporator.

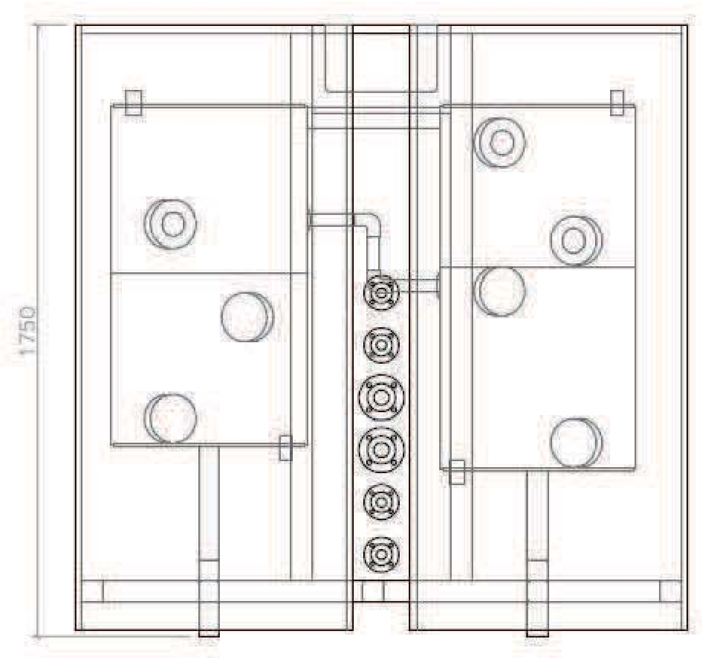
Evaporator: The cooling solvent, arriving from the condenser streams to the evaporation vat. There it is aspirated by a cooling solvent pump, pumped upwards into an affusion system and spread over the evaporator tubes. Due to the high vacuum, a part of the cooling solvent evaporates already at a very low temperature. The cooling solvent takes the heat required for the evaporation out of the cold water flowing through the evaporator tubes, which is now cooling down from 15 °C to 9 °C.

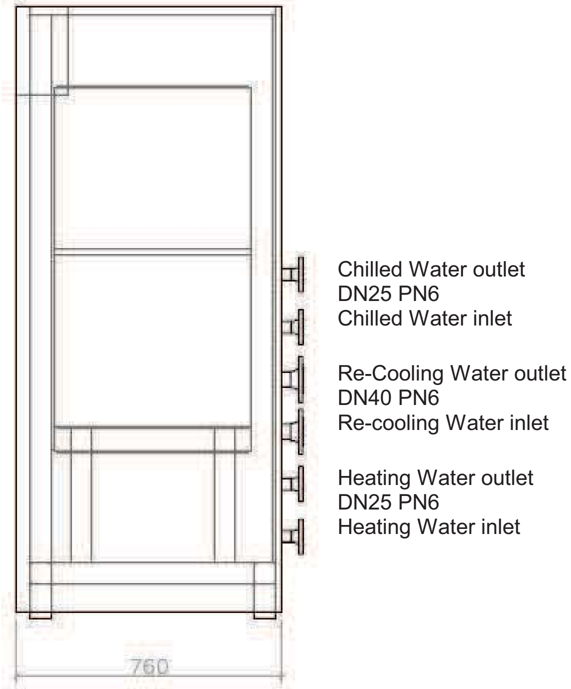
Absorber: Inside the absorber the cooling solvents vapour, arriving from the evaporator gets in contact with concentrated solution at the time when the solution is also spread by an affusion system. During this action, the cooling solvents steam is being absorbed from the solution. The heat which is set free by this is absorbed by the re-cooling water and released to the environment by a re-cooling tower. The cooling solvents solution occurring collects on the bottom of the absorber and is being aspirated by a solution pump.

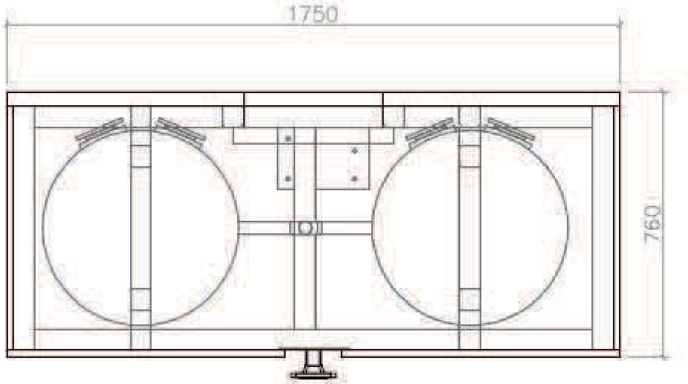
2.1 Technical data WEGRACAL SE 15

Cooling capacity		*kW*	15
Coefficient of performance	COP		0,71
Chilled water	Inlet temperature	*°C*	17
	Outlet temperature	*°C*	11
	Flowrate	*m³/h*	1,9
	Leakage of pressure	*mbar*	400
	Rated pressure PN	*bar*	6
	Connection	*DN*	25
Heating water	Thermal output	*kW*	21
	Inlet temperature	*°C*	90
	Outlet temperature	*°C*	80
	Flowrate	*m³/h*	1,8
	Leakage of pressure	*mbar*	400
	Rated pressure PN	*bar*	6
	Connection	*DN*	25
Re-cooling water	Re-cooling capacity	*kW*	35
	Inlet temperature	*°C*	30
	Outlet temperature	*°C*	36
	Flowrate	*m³/h*	5
	Leakage of pressure	*mbar*	900
	Rated pressure PN	*bar*	6
	Connection	*DN*	40
Electrical data	Voltage/Frequency	*V/Hz*	230/50
	Power consumption	*kW*	0,3
Dimensions	Length	*mm*	ca. 1.750
	Width	*mm*	ca. 760
	Height	*mm*	ca. 1.750
Weight	Transportation	*kg*	ca. 500
	Operation	*kg*	ca. 660

2.1 Dimension, weight and circuit points WEGRACAL SE 15





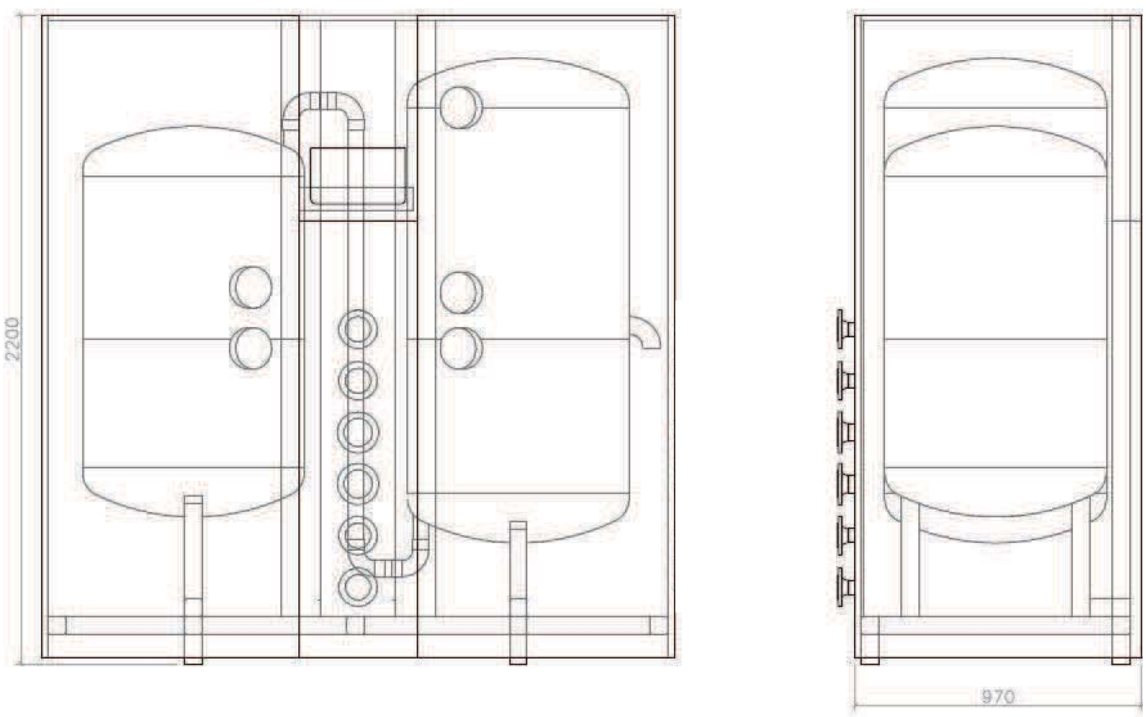


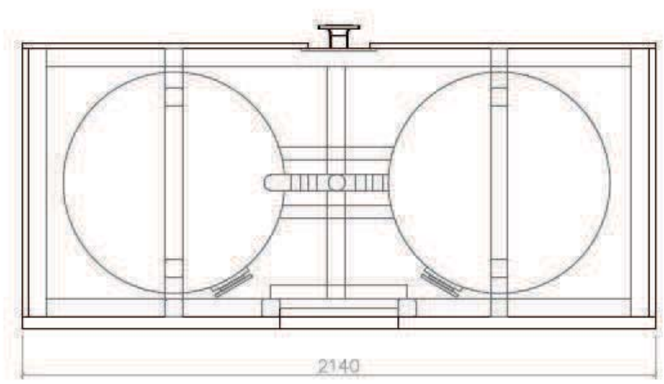
Transportation weight	600	kg	Connection:	Chilled water	DN 25 / PN 6
Operation weight	700	kg		Re-cooling water	DN 40 / PN 6
				heating water	DN 25 / PN 6

2.2 Technical data WEGRACAL SE 30

Cooling capacity		*kW*	30
Coefficient of performance	COP		0,75
Chilled water	Inlet temperature	*°C*	17
	Outlet temperature	*°C*	11
	Flowrate	*m³/h*	4,3
	Leakage of pressure	*mbar*	400
	Rated pressure PN	*bar*	6
	Connection	*DN*	40
Heating water	Heating capacity	*kW*	40
	Inlet temperature	*°C*	90
	Outlet temperature	*°C*	80
	Flowrate	*m³/h*	3,5
	Leakage of pressure	*mbar*	400
	Rated pressure PN	*bar*	6
	Connection	*DN*	40
Re-cooling water	Re-cooling capacity	*kW*	70
	Inlet temperature	*°C*	30
	Outlet temperature	*°C*	35
	Flowrate	*m³/h*	12
	Leakage of pressure	*mbar*	500
	Rated pressure PN	*bar*	6
	Connection	*DN*	50
Electrical data	Voltage/Frequency	*V/Hz*	230/50
	Power input	*kW*	0,5
Dimensions	Length	*mm*	ca. 2.140
	Width	*mm*	ca. 970
	Height	*mm*	ca. 2200
Weight	Transportation	*kg*	ca. 1.100
	Operation	*kg*	ca. 1.400

2.2 Dimension, weight and circuit points WEGRACAL SE 30

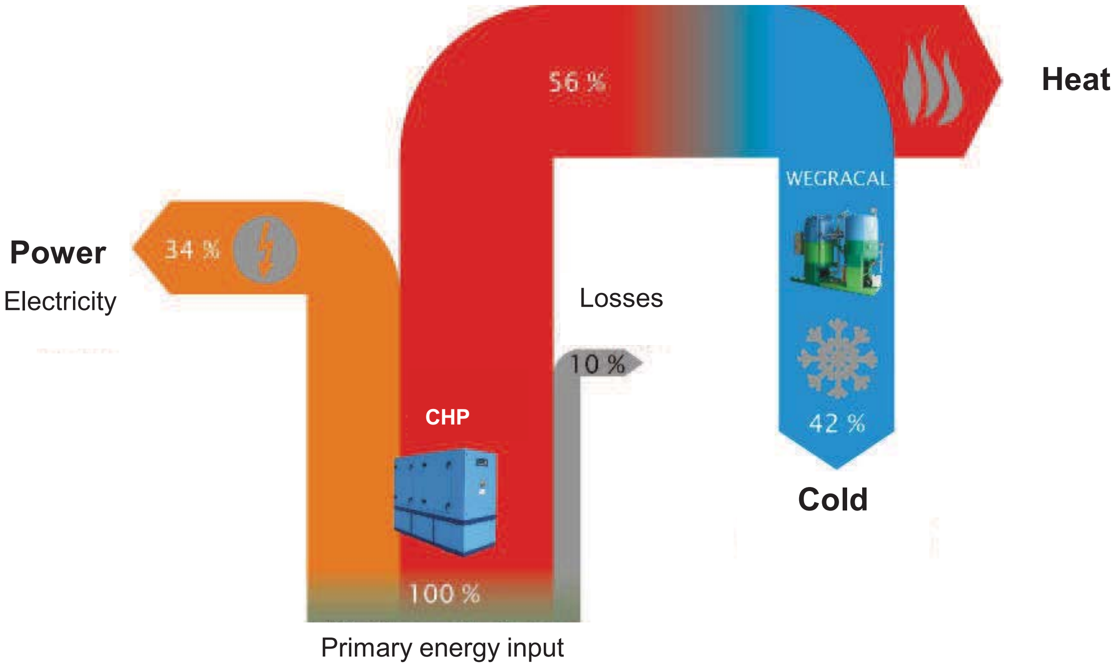




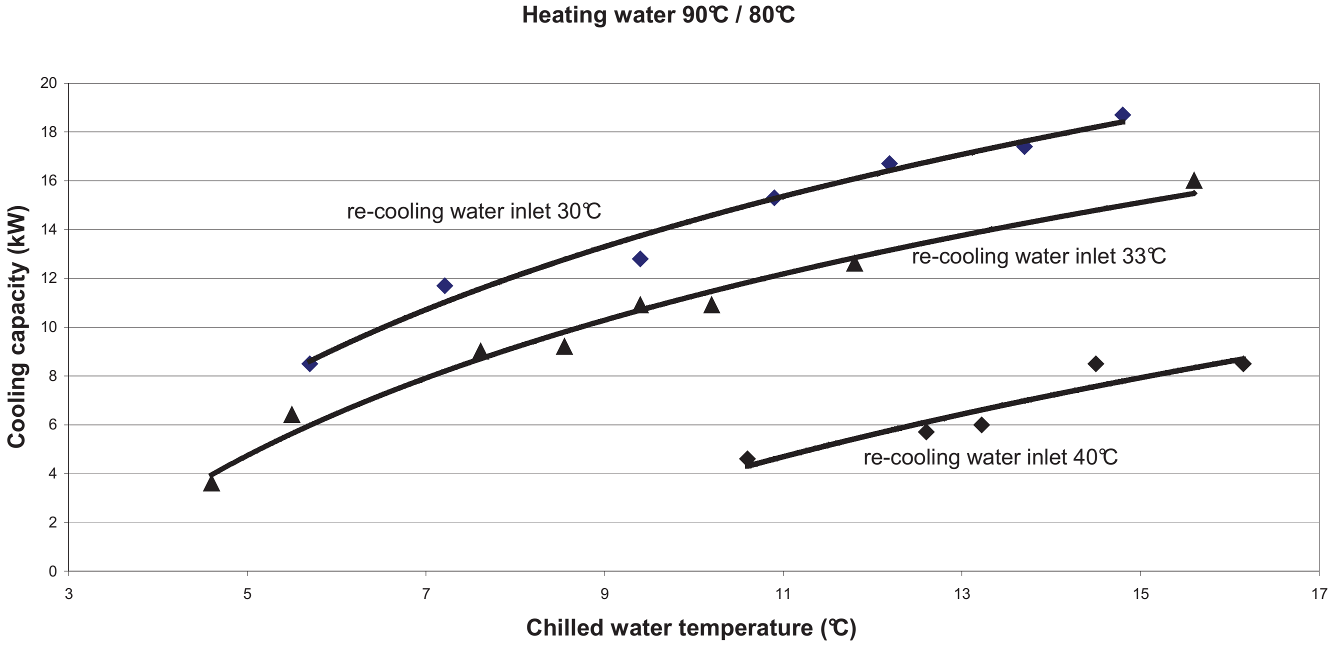
Transportation weight	1.300	kg	Connection:	Chilled water	DN 40 / PN 6
Operation weight	1.600	kg		Re-cooling water	DN 50 / PN 6
				heating water	DN 40 / PN 6

3.1 Image of the energy flowing process

e.g. Cogeneration (CHP, natural-gas) and Absorption-Chiller

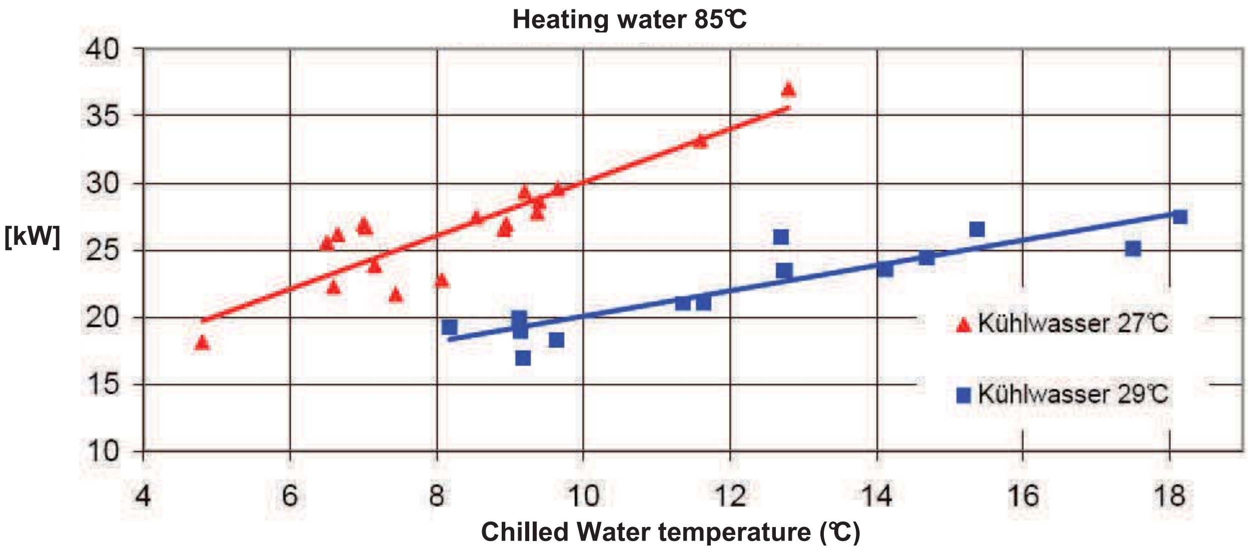


3.2 Performance diagrams WEGRACAL SE 15



Performance diagram for the 15 kW plant at different re-cooling water temperatures and a heating water inlet temperature of 90 °C

3.3 Performance diagrams WEGRACAL SE 30



Performance diagram for the 30 kW plant at different re-cooling water temperatures and a heating water inlet temperature of 85 °C

4. Structure and scope of delivery

4.1 Structure

The cooling module consists of two main devices, the evaporator – absorber – unit and the generator – condenser - unit. Both devices are fully installed, tubed and wired and will be interlinked by a quick connection at the installation location. Due to this there will be no wasteful assembly work necessary for the customer. The measurement and control unit, necessary for fully automatic operation, is integrated inside a switchboard and completely wired at the factory. The tube connections on the plant are executed as flanges DIN 2631 (PN6).

4.2 Standard scope of delivery

Main devices	evaporator - absorber - unit and generator – condenser - unit completely welded including one bursting disk per unit
Pipes	evaporator, absorber, generator and condenser made of seamless copper tubing; solution- and cooling solvent tubes made of seamless steel tube
Solution- and cooling solvent pumps	hermetically sealed motor pumps, cooling and lubrication of the pumps is supplied by the delivered fluid
Recuperator	between cold and heated solution – executed as plate recuperator
Ventilation unit	electrical vacuum pump for periodical exhaustion of not condensable gases, completely installed and wired at the factory – controlling by changeable time settings
Switchboard	switchboard installed in operating position at the evaporator – absorber – unit, wired suitable for VDE, front plate with controlling elements, keys for start-stop-manual-automatic, error confirmation, entries and display for cold water inlet and outlet temperature, cooling water inlet and outlet temperature, heating water inlet and outlet temperature, solution temperature, evaporation and condensation pressure, number of starts and operating hours, monitoring of cooling solvent and solution pumps, displaying of errors on an LCD – display with date and time, potential-free exits for the messages: ready for operation, operating, error

Pressure tests	recuperator tubes at double operation pressure, coat pressure test with air, pressure tightness test as mass spectrometer test with helium
Dispatch	The plant will be delivered as one piece. evacuation and filling will be executed at the installation location.
Accessories	quantity of lithium – bromide – solution necessary for the first filling

4.3 Delivery options

- isolation of cold unit parts with Armaflex
- fitting recooling device
- hydraulic integration of the plant – at request
- power element for external mediums – at request

4.4 Delivery limits

The delivery limits of the cooling plant are defined as follows:

Water side: - the connecting flanges for heating-, recooling- and chilled water
Electricity supply: - the connecting terminal strips inside the switchboard

Not included in the standard scope of delivery are:

- connection work for pipelines and electrical installations
- heating-, recooling- und chilled water pumps and mixer

Technisches Datenblatt EWK

1 Vollkunststoff-Kühlturm EWK 036/06

Aufstellung: auf bauseitigem Stahl-Trägerfundament gemäß unseren Angaben
Ausführung: mit Wasserauffangschale

Auslegungsdaten:

Gesamte Wärmeübertragungsleistung	47,2	kW
Gesamter Wasserdurchsatz	6,8	m³/h
Wärmeübertragungsleistung je Kühlturm	47,2	kW
Wasserdurchsatz je Kühlturm	6,8	m³/h
Wasservorlauftemperatur	36,0	°C
Wasserrücklauftemperatur	30,0	°C
Kühlgrenztemperatur	22,5	°C

Den Auslegungsdaten liegt die DIN EN 13741 zugrunde.
Bezüglich der Betriebsweise verweisen wir auf unsere Betriebsanleitung.

Betriebsdaten je Kühlturm:

Zusatzwasserbedarf ohne Abschlämmen ca.	0,1	m³/h
Anzahl der Düsen	1	
Düsentyp	EW 8	
Düsenvordruck	0,48	bar

Motor- und Ventilatordaten je Kühlturm:

Anzahl der Ventilatoren / Motoren	1	
Motorleistung je Ventilator	0,4	kW
Motordrehzahl	1.430	min^{-1}
Ventilatordrehzahl	1.430	min^{-1}
Betriebsspannung	400	V
Frequenz	50	Hz
Schutzart des Motors	IP 54	
Schaltung	direkt	

Datenblatt Pufferspeicher
HPR & HPS

Pufferspeicher HPR & HPS

Alle SOLution Solarspeicher sind qualitätsgeprüft!

GEPRÜFTE QUALITÄT austria solar SOL 02 2004 PROVED QUALITY

ÖQS SYSTEM CERTIFIED ISO 9001:2000 NO. 4943/0

- Energiespeicher für Solarenergie
- Pufferspeicher mit oder ohne Register erhältlich
- Deckel aus FCKW- freier Weichschaumisolierung und mit 150 mm Stärke.

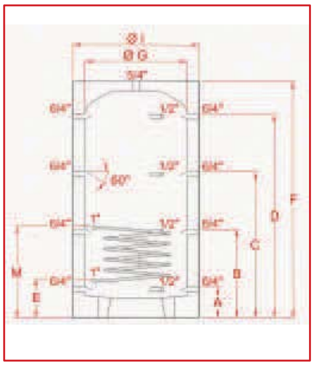
Technische Daten

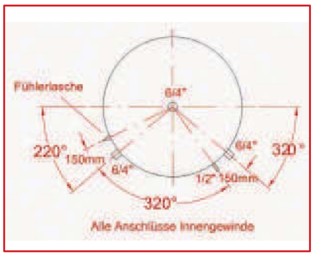
SOLution Pufferspeicher sind aus 4 mm starkem Stahlblech DIN 4753 gefertigt, innen schwarz und wahlweise mit **eingeschweißtem Glattrohrregister** erhältlich. Alle 6/4“-Anschlüsse sind mit Prallblechen zur Erhaltung der Speicherschichtung ausgestattet.

		Heizungspuffer mit Register			Heizungspuffer ohne Register			
		HHPR800	**HPR1000**	**HPR1500**	**HPS800**	**HPS1000**	**HPS1500**	**HPS2000**
Inhalt	**l**	800	1000	1500	800	1000	1500	2000
Durchmesser	**mm**	790	790	1000	790	790	1000	1100
Höhe	**mm**	1730	2080	2180	1730	2080	2180	2410
Kipmaß	**mm**	1740	2100	2215	1740	2100	2215	2440
Gewicht	**kg**	141	156	185	141	156	185	211
Zul. Betriebs-druck Heizung	**bar**	3	3	3	3	3	3	3
Zul. Betriebs-temp. Heizung	**°C**	95	95	95	95	95	95	95
Max. Betriebs-druck Register	**Bar**	8	8	8	-	-	-	-
Register	**m²**	2,4	3	3,6	-	-	-	-

Abmessungen

		Heizungspuffer mit Register			Heizungspuffer ohne Register			
		HHPR800	**HPR1000**	**HPR1500**	**HPS800**	**HPS1000**	**HPS1500**	**HPS2000**
A	**mm**	260	310	372	260	310	372	317
B	**mm**	630	745	817	630	745	817	900
C	**mm**	1030	1250	1342	1030	1250	1342	1490
D	**mm**	1430	1710	1752	1430	1710	1752	2020
E	**mm**	260	310	372	-	-	-	-
F	**mm**	1730	2080	2180	1730	2080	2180	2410
G	**mm**	790	790	1000	790	790	1000	1100
I	**mm**	990	990	1200	990	990	1200	1300
M	**mm**	930	1030	1172	-	-	-	-





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