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Intelligent Energy Europe

Solar Energy Use in Outdoor Swimming Pools SOLPOOL

National Fact sheet Reports on the state of the Demand and Potential of Solar Heating of Outdoor Swimming Pools

CYPRUS

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1 Data collection in Cyprus

The methodology and strategy used for collecting the data will be presented in the following paragraphs. A number of obstacles met during the survey for data collection have only been accounted to certain particularities of the country.

In specific, most of the swimming pool installations, in Cyprus are not registered. This suggests that any information concerning private swimming pools (belonging to private buildings, houses, etc) cannot be extracted by any official source, a fact that makes it almost impossible to estimate or even consider their total number and by no means imply the existence of a heating system.

As far as it concerns public sector, most of the public pools have no license also. To illustrate this, public swimming pools in Cyprus with and without a licence are presented in the following table.

Table 1: Public pools in Cyprus

Municipality	Total number of public swimming pools	Pools with license	Pools without license
Nicosia	14	1	13
Limasol	16	0	16
Larnaka	19	1	18
Pafos	213	45	168
Paralimni	136	0	136
Ayia Napa	176	14	162
Mesa Geitonia	4	0	4
Germasogeia	48	19	29
Ayios Athanasios	10	1	9
Latsion	2	0	2

[source: Energy Institute of Cyprus]

As this table shows, from a total of 638 swimming pools, only 81 (13%) have a respective license.

Another division of the private sector in Cyprus refers to hotels and other resorts. A heating system for a swimming pool belonging to hotels and resorts is practically desirable, as it may extend the swimming pool usage period to approximately two months before and after summer. Therefore, assuming that most of the big hotels and resorts have indeed installed a heating system for their pools, it is still quite hard to consider and contact all of the owners, as well as extract the required technical data. This may happen either because of their unawareness of technical and economical characteristics or a general distrust regarding economical data of their enterprise.

Important sources of information for the collection of data are the companies that manufacture and/or install either swimming pools or heating systems. Through the data available are very limited. Furthermore, important data were given by the Energy Institute of Cyprus and the Commissioner for the Environment.

2 Environmental conditions for the use of Solar Thermal systems

The climate in Cyprus is hotter than the typical of the Mediterranean climate, it has mild winters with low rainfall, very warm summers with, generally, long sunshine duration almost all the year. In terms of climatology, the year can be broadly divided mainly into two seasons. The cold period, lasting from November until March, and the warm and non -rain season lasting from April until October. Rainfall in Cyprus even in the winter, does not last a lot of days and the sky does not remain cloudy for several consecutive days, as it happens in other regions of the world. During the warm and non-rain period the weather is almost stable, the sky is clear, the sun is bright and generally does not rain. The warmest period is the last ten-day period of July and the first one of August, when the mean maximum temperature lies in the range of 35.0 and 42.0 degrees of Celsius.

The combination of both the geographical latitude and the high levels of sunlight in Cyprus results in an average solar energy intensity of 1925 kWh/m^2 every year (see Figure 1). In the largest part of Cyprus, the sunlight duration exceeds the 2700 hours per year. North east is the area with the lower average sunlight duration (2200 to 2300 hours), whereas on Paphos and Nicosia sunlight lasts for over 3100 hours per year. This means that Cyprus has a large potential for an economical exploitation of solar radiation for heating reasons, what is amply demonstrated by the wide applicability of solar thermal systems designated for domestic water heating.

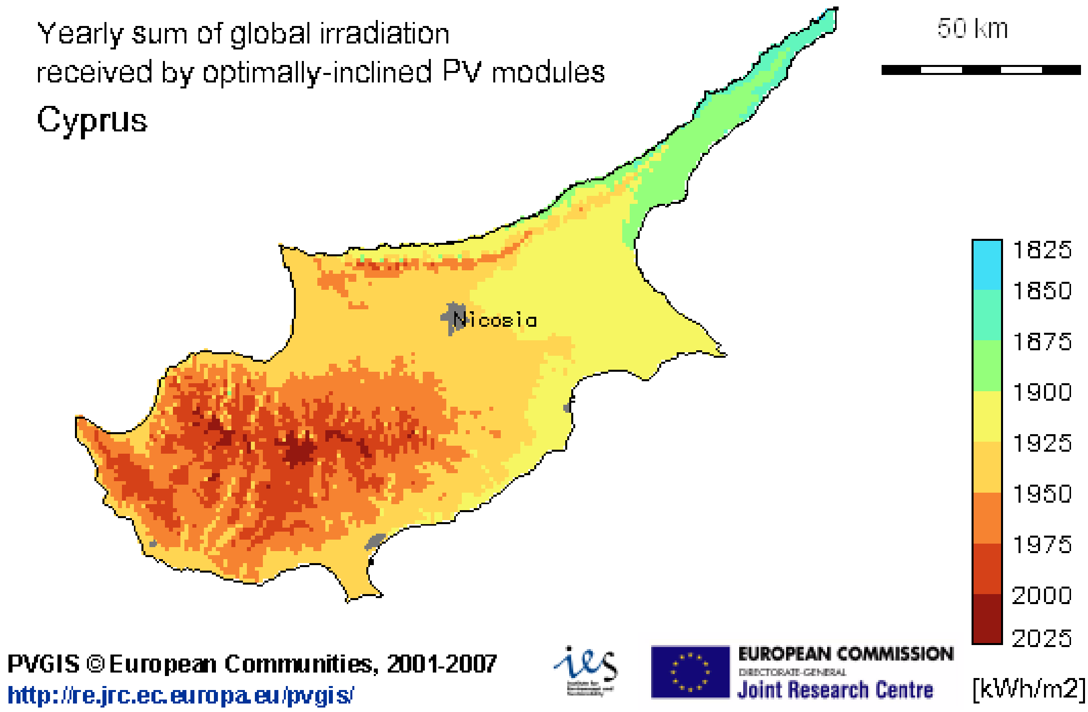


Figure 1 Solar radiation map in Cyprus Source: JRC

All of the factors mentioned above imply that the outdoor swimming pool usage period in Cyprus is rather extended in the course of the year, compared with other European countries. The average usage period is from June until September and when the swimming pool is heated it is extended for 3 to 4 months, i.e. April to October. The average usage period is from June until September. During this period the temperature of the water in the swimming pool is above 20°C (due to the high solar radiation and external temperatures), thus no heating is required. Even when the swimming pool is heated, the actual energy requirement is very low as the water temperature is close to 20°C. In fact, in some areas, an when the swimming pool is covered during the night period, the actual heating needs last for less than 10 days, making any heating system not cost effective.

3 State of the Art of Solar Thermal Applications

Solar heating of open-air swimming pool water has some decisive advantages over other methods of using solar energy thermally:

- Temperature level: The required temperature level is comparatively low at 18°C to 25°C. This permits the use of inexpensive plastic absorbers.

- Solar radiation and time of use: The time of the highest solar radiation in many cases matches the time of use. Commonly at latitudes in Central Europe open-air pools are operated from beginning/middle of April until the middle of September. During this period approximately 65 – 75% of the annual solar radiation occurs.

- Simple system design: The pool water flows directly through the absorber. The storage tanks normally required for solar energy systems are not required since the pool itself takes over this function.

Solar heating for open-air swimming pools have been used for several decades now and are a well- established technology. However, this does not mean that this application of solar thermal energy has reached its limits yet.

According to statistics in Sun in Action II, about 3-4.000 m^2 of unglazed collectors have been placed yearly in the 90's. The estimated production and sales for 2000 and 2001 is 10.000 m^2 yearly.

If we look at the developments over recent years, heating of the pool is too costly for most swimming pool owners. Existing older conventional heating systems are however often replaced either by absorber systems or the owners do without heating altogether.

3.1 Absorber Systems

3.1.1 Systems without auxiliary heating

Solar circuits in public open-air baths are normally operated with a separate solar circuit or absorber circuit pump. The hydraulic construction is much more complex than for private swimming pools because of the hygiene requirements.

A system in a large open-air pool functions according to the following principle:

The wastewater is led from the pool into a central water storage tank. This tank acts as a "water level display" for the whole swimming pool water circuit. Evaporated water is replaced here by fresh water. The water is pumped through the filter from the water tank. One (or according to the design of the filter system) several parallel-connected filter pumps are responsible for this. After this the water is returned to the pool via the water treatment system.

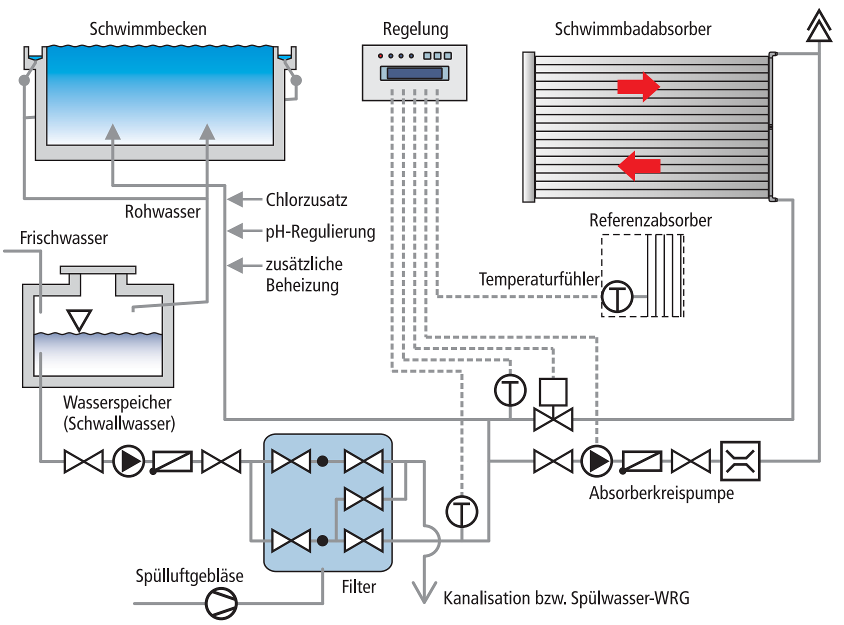


Figure 2 Circuit diagram of open-air swimming pool heating

In front of the water treatment system, the absorber field is connected to the circuit in a by-pass system. The solar loop pump diverts part of the volumetric flow and pumps it through the absorber field. The size of the partial volumetric flow depends on the size of the absorber field. The solar heated water is led to the main flow again after the diversion and finally arrives back in the pool.

A motorized valve should be installed in the absorber circuit feed line and a non-return valve after the solar pump. These two fittings prevent the absorber field from running empty when the system is not in operation.

Before the water reaches the pool the hygiene parameters are set. Chlorine and chemicals are introduced to regulate the pH value as necessary. The chlorine injection point should always be integrated behind the absorber field diverter since the chlorine concentration in the absorber circuit must not exceed 0.6 mg/l. If there is a pulse of chlorine (under certain circumstances up to 10 mg/l) the absorber may be damaged.

When flat plate collectors are used instead of unglazed, then the water of the swimming pool does not pass directly through the collectors, but the collector circuit is separated from the swimming pool water with a heat exchanger.

In small scale systems (usually used for private swimming pools), the system construction is much simpler. In this case, only a single pump circuit is used. The excess water is fed to a central storage tank where the lever of water is monitored and the evaporated water is re-filled as with the large scale swimming pools. The water is taken from the central storage tank and is pumped to the water treatment unit (single unit). At this point the temperature level of the water is measured and if required, it is send to the solar collectors for heating through a triode valve as in the previous case (but not with a separate pump).

3.1.2 Integration of auxiliary heating

Unglazed collectors are mainly used in small private swimming pools or in seasonal hotels. The dimensioning of the unglazed collectors is made in order to cover more than 90% of the heating demands, therefore a backup system is not used in combination with unglazed collectors.

In large professional pools, where a large collector field cannot be installed to cover 100% the swimming pool needs, conventionally operated auxiliary heating is installed to maintain a constant water temperature.

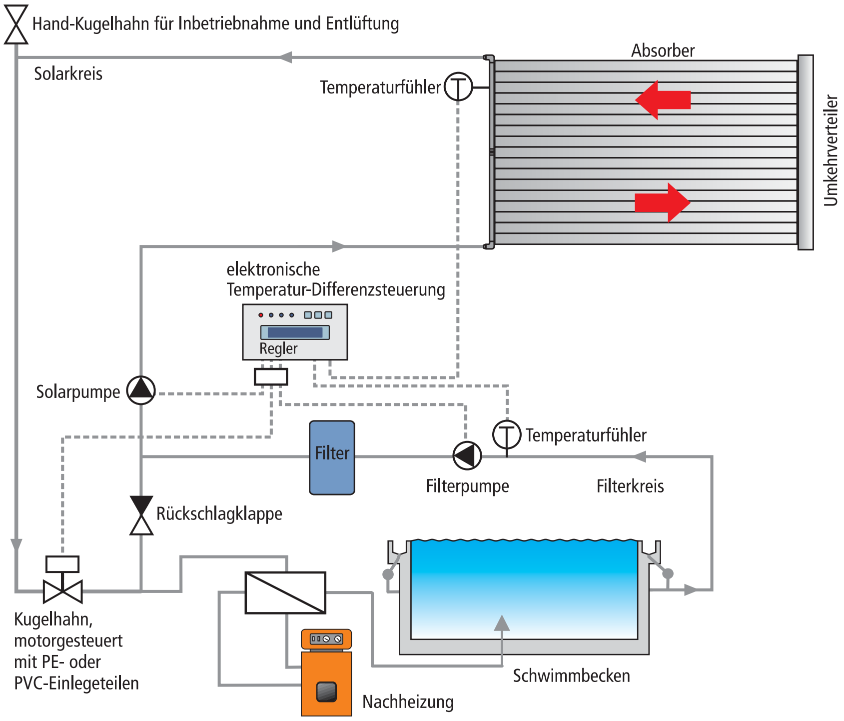


Figure 3 Circuit diagram of large absorber systems with additional heating

Auxiliary heating is operated by means of a conventional system (preferably gas heating systems) and an additional heat exchanger. In a dual-heated system, the auxiliary heating should always follow solar heating. If the water is not of the required temperature after recirculation to the filter circuit the auxiliary heating covers the residual heat requirement.

3.1.3 Unglazed absorbers

Solar open-air pool heating uses absorbers to collect the energy. The collector design is characterized by the lack of transparent cover and housing as well as thermal insulation. This simple construction is possible since the systems operate with low temperature differences between the absorber and the surroundings and with relatively uniform return temperatures (10°C – 18°C).

The swimming pool absorber is always made from plastic compound.

The use of unglazed and un-insulated absorbers for solar open-air pool water heating has some advantages due to the special operating conditions:

In the typical operating range, with a temperature difference $\Delta\vartheta$ between the outside temperature and the mean absorber temperature of 0-20 K, absorbers often operate with a higher efficiency than glazed collectors. This can be explained by the fact that the optical losses (normally about 10 to 15% with respect to the amount of solar radiation) through a transparent cover do not arise and that the thermal losses are not so significant because of the low temperature difference $\Delta\vartheta$. These thermal losses increase with operating temperatures, which however rarely occur due to the moderate absorber temperatures found under normal operating conditions. The wind speed is the decisive factor, which causes losses and hence has a negative effect on the absorber efficiency. This was established in an investigation of absorber testing and test results of solar open-air pool heating.

Apart from a few special designs plastic absorbers can be subdivided into two groups:

- Tube absorbers (small tube absorbers)
- Flat absorbers

The tube absorber is the simplest design. A number of smooth or ribbed tubes (small tubes) are arranged in parallel and according to the design are connected together with intermediate webs or by retainers at a given spacing. Absorber lengths of up to 100 m can be achieved and obstructions like chimneys or rooflights can easily be circumvented.

In the case of flat absorbers, sometimes also called plate or cushion absorbers, the channels are linked together structurally. This produces plates of different dimensions with a smooth surface. This has the advantage that there are no grooves in which dirt or leaves can accumulate and solidify.

The influence of the design form on the conversion factor with different inclination angles can be measured but it is minimal. Variations of the angle of incidence lead to small differences in the conversion factor only for flat collectors. In the case of ribbed tube absorbers they lead to larger variations than with normal tube absorbers.

All absorbers are very easy to handle (see also the installation chapter), thus for example all common types can be walked on.

The following figures show a summary of the absorbers available on the market and the different methods of connecting the absorber to the collecting and distributing pipes.

Figure 4 Unglazed absorber field

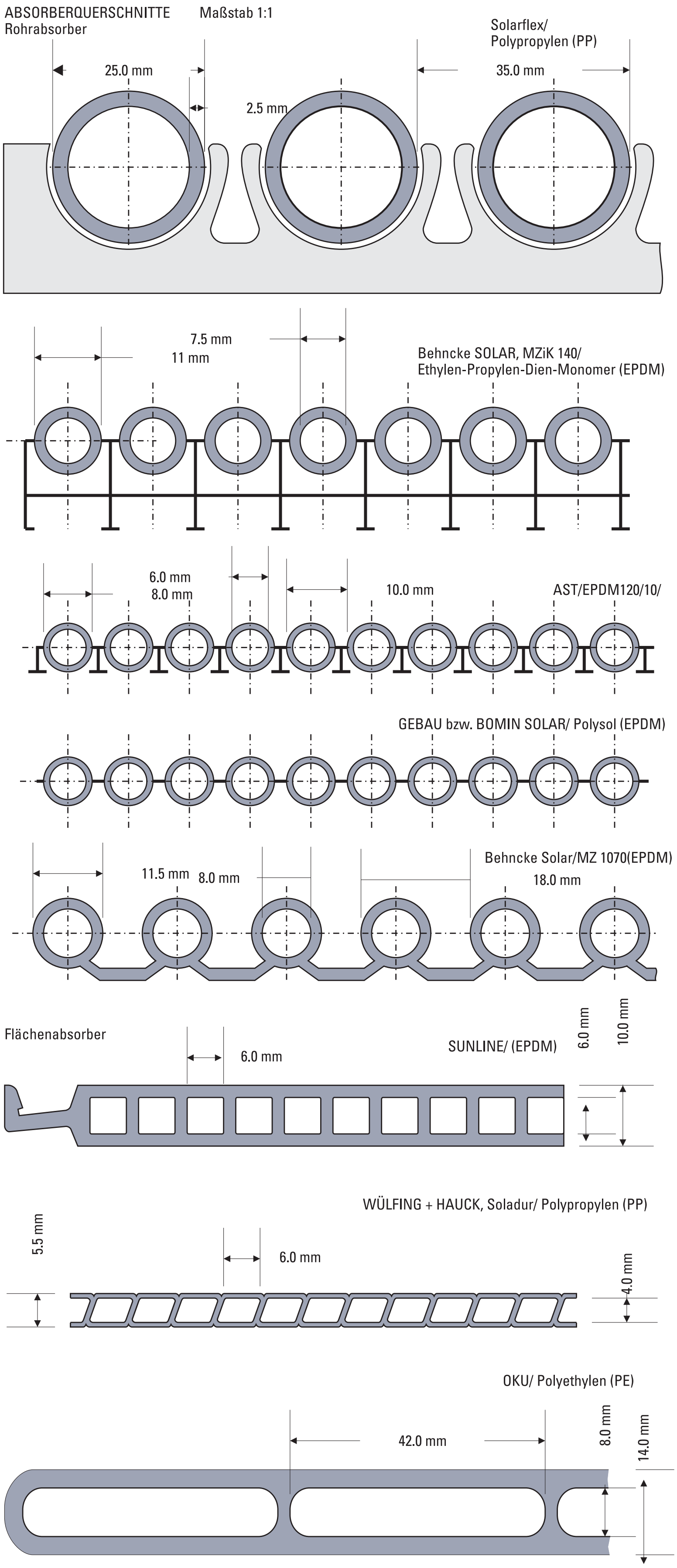

ABSORBERQUERSCHNITTE
Rohrabsorber
Maßstab 1:1
Solarflex/
Polypropylen (PP)
25.0 mm
35.0 mm
2.5 mm
7.5 mm
11 mm
Behncke SOLAR, MZiK 140/
Ethylen-Propylen-Dien-Monomer (EPDM)
6.0 mm
8.0 mm
10.0 mm
AST/EPDM120/10/
GEBAU bzw. BOMIN SOLAR/ Polysol (EPDM)
Behncke Solar/MZ 1070(EPDM)
11.5 mm
8.0 mm
18.0 mm
Flächenabsorber
6.0 mm
SUNLINE/ (EPDM)
6.0 mm
10.0 mm
WÜLFING + HAUCK, Soladur/ Polypropylen (PP)
5.5 mm
6.0 mm
4.0 mm
OKU/ Polyethylen (PE)
42.0 mm
8.0 mm
14.0 mm

Figure 5 Different designs of absorber in cross-section

Solar absorbers are exclusively made from plastic. They can be hard and rigid or soft and flexible according to the plastic mixture. The use of plastic permits operation of the solar system with chlorinated swimming pool water. It is however necessary to consider the chlorine content. A high dose (from about 5 mg/l) can damage the absorber. The exact limits, from which damage can occur, depend on the plastic composition.

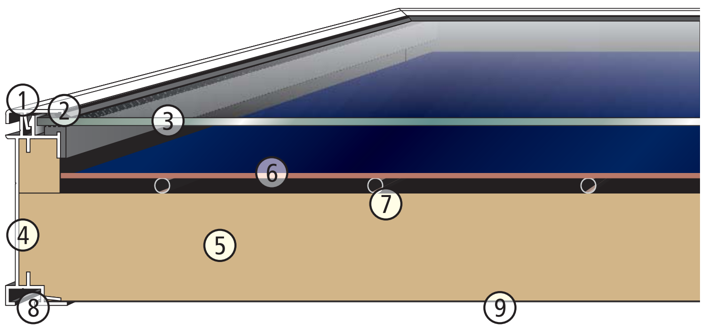
Plastics are also used for pipelines. These are however made from rigid materials.

The main plastic compounds used in unglazed absorbers are:

EPDM	Ethyl Propylene Diene Monomer
PP	Polypropylene
PE	Polyethylene
ABS	Acrylnitrile Butadiene Styrene copolymer
PVC	Polyvinyl Chloride (hard or soft)

3.2 Flat plate collectors

In open air swimming pools flat plate collectors may be installed if also a solar heating of domestic hot water for showers is required. Almost all glazed flat-plate collectors currently available on the market consist of a metal absorber in a flat rectangular housing. The collector is thermally insulated on its back and edges, and is provided with a transparent cover on the upper surface. Two pipe connections for the supply and return of the heat transfer medium are fitted, usually to the side of the collector.



1. Frame
2. Seal
3. Transparent cover
4. Frame-side-wall profile
5. Thermal insulation
6. Full-surface absorber
7. Fluid channel
8. Rear wall

Figure 6 **Section through a glazed flat-plate collector**

Because of the risk of corrosion of thermal collectors with copper absorbers, these can only be operated in solar systems for swimming pool heating if a separate solar loop is installed (i.e. indirect) including an external heat exchanger.

3.3 Existing norms and standards

In the following there will be a reference to all existing standards and norms for the installation and use of solar thermal heating devices, as well as any additional outdoor swimming pool norms and standards concerning solar thermal heating systems. A list of all important standards, which impact the installation and usage of a solar thermal system cited here, will be furthermore considered during the development of the campaign strategies.

Solar Thermal pool heating:

- ISO/TR 12596:1995

Solar thermals applications:

- Solar Key mark
- EN 12975-1:2006
- EN 12975-2:2006
- EN 12976-1:2006
- EN 12976-2:2006
- EN ISO 9488:1999
- ENV 12977-1:2001
- ENV 12977-2:2001
- ENV 12977-3:2001

4 Market analysis

As mentioned in the introduction, the collection of data has been insufficient and consisted mostly of estimates that were done through generalization of the already collected information because of the various obstacles met in the Cyprus market.

4.1 Public sector

A complete list of data for outdoor swimming pools with installed heating system is hard to be obtained, as most of the swimming pools are not registered.

4.1.1 Number of pools

The total number of outdoor public swimming pools is not known as explained earlier. The only reliable data about the number of swimming pools is the number of applications for funding. Since up to 2008 there was a very attractive funding scheme for solar swimming pool heating systems, almost all of the legal swimming pools were heated by solar systems. According to the data from the Energy Institute of Cyprus, the number of applications for funding swimming pool solar heating systems in 2007 was 24 (both public and private). In 2008, the number of applications was 7.

4.1.2 Used heating systems

From interviews with several installers and manufacturers, it was indicated that the maim technologies used for outdoor swimming pool heating are:

- boilers
- flat plate solar thermal collectors
- vacuum tube solar thermal collectors

In the case of boilers, the most commonly used technology; the water for the swimming pool is heated from the main house heating boiler through a heat exchanger, as shown in the next schematic diagram [Figure 7]. The main fuel used to supply these boilers is oil, with the exemption of very few gas burners installed in the last years that gas became available to the consumers.

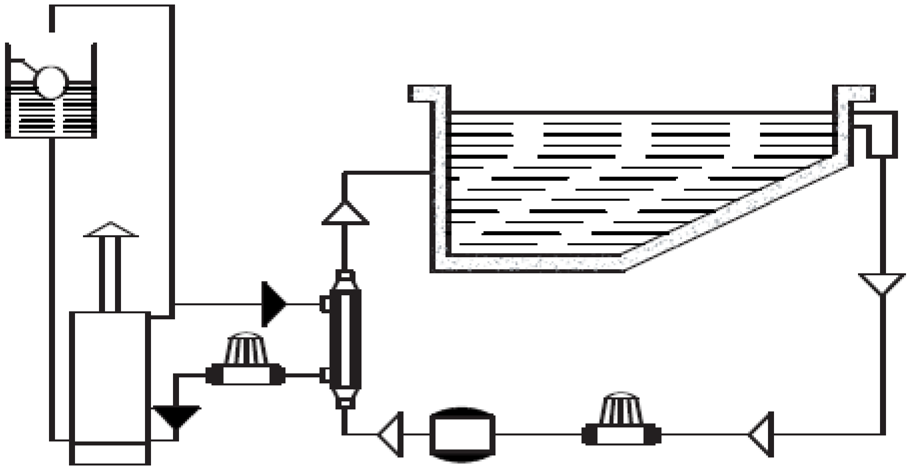


Figure 7: Swimming Pool Heating With Boiler and Heat Exchanger Source: BOWMAN

The second method used is the solar heating. In this case, solar thermal collectors are used to heat the water for the swimming pool. The cost of installation is more expensive than the cost of the boiler. More specifically, the system costs per collector m² including installation is

- for flat plate collector: 300€/m² (VAT excluded)
- for unglazed collector: 200€/m² (VAT excluded)

4.2 Private sector

The private sector in Cyprus is not considerably diversified from the public one in terms of the uncertainty regarding the information collected for outdoor swimming pools. Particularly for swimming pools belonging to houses or private buildings, which are exclusively used by private individuals or just the pool owners, it was extremely difficult to obtain information. As with the public swimming pools, the only data available is the number of applications for solar heating.

4.2.1 Number of pools

According to the data of the Energy Institute of Cyprus, for 2008, 27 applications for solar heating of swimming pools were submitted.

4.2.2 Used heating systems

The main heating system used in the private sector of Cyprus is solar, mainly due to the attractive funding scheme that existed in Cyprus till 2008.

5 Best practices

5.1 Pool 1 – Public Swimming pool at Municipality of Geroskipou, ADIRA project

Figure 8: Solar collectors next to the swimming pool Source: CRES

Table 2: Technical data of the absorber system of Geroskipou's pool

Flat Absorber surface area	100 m² for solar cooling (selective plat plate)
Pool surface area and volume	180 m^2
Year of installation	25/01/2002
Operator	Municipality of Geropskipou
System Installer	Kafson LTD, Tinox GmbH
Type of collector(s)	Selective flat plate
Auxiliary heating system	None
Desalination	1000lt/day
Costs for the solar system	50.000 € (incl. planning and installation)

Source: ADIRA Project

Short description of the system

The system has been installed at the public swimming pool of the municipality of Geroskipou. The purpose is to demonstrate alternative solution to the water supply of the swimming pools (which composes one of the major problems in Cyprus due to high water shortage). The system used a MED desalination unit supplied by hot water from the solar thermal collectors to generate fresh water for the pool. When the MED unit is not in operation, the heat from the solar collectors is used to heat the swimming pool's water. The system has been installed in the framework of the ADIRA project.

Partners:

- Kafson LTD
- National Center for Scientific Research "Demokritos", Greece
- Municipality of Geroskipou, Cyprus

Contact Address

George PAPADAKIS
ADIRA coordinator
Agricultural University of Athens, Greece

6 Finances

6.1 Specific System costs in Cyprus

Table 3: Specific costs of solar thermal heating systems for outdoor pools in Cyprus

Absorber systems	
Investment cost range in EUR/m² (incl. installation cost)	150
Flat plate collectors	
Investment cost range in EUR/m² (incl. installation cost)	300

6.2 Funding and Financing schemes

Up to 2008, there was a national funding program for the promotion of RES systems in Cyprus that included the use of solar systems for the heating of swimming pools. From 2009, due to the major problem of water shortage, the funding of swimming pool heating was terminated.

6.2.1 Programme 1 – Funding Program for Energy Saving and use of R.E.S.

Programme Name	**Funding Program for Energy Saving and use of R.E.S.**
Organisation	Energy Institute of Cyprus
Street	Agapinoros 2 & Makariou C
Postal code	1076
City	Nicosia
Email	cie@cytanet.com.cy
Telephone	+357-22606060
Type of Support	Subsidy Investment
Available Money	unlimited
Share of total budget	Up to 45% investment costs up to 25.630 for physical persons Up to 30% investment costs up to 17.087 for legal persons
Who can apply	all
Requirements for application	None
Targeted areas	all
Short description	Renewable energy sources, energy saving,
Documents	
Source of information	
Year of beginning	Ended 2008
Information website	http://www.cie.org.cy/index.htm

7 References

1. Bowman - Heat exchangers (2008). URL: http://www.ejbowman.co.uk/

2. Calorex - Heat pumps and dehumidifiers (2008). URL: http://www.calorex.com/

3. JRC - Joint Research Centre, European Commission (2007).
URL: http://re.jrc.ec.europa.eu/pvgis/

Interviews

1. Charalambos Theopemptou, Commissioner for the Environment, Cyprus [phone interview]