EIE-06-085 SOLPOOL

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

Slovenia

D05 National fact sheets on boundary conditions

D06 Requirement sheet for solar thermal use

D07 Funding sheet on existing grant schemes and new approaches

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1 Introduction

The largest part of the solar energy in Slovenia comes from solar thermal systems for heating water. There is no statistic available for installed and operating capacities. More than 95% of the systems were installed on individual buildings. There were also some larger solar systems installed on buildings with higher water consumption such as hotels, buildings for the elderly, swimming pools etc, unfortunately most of them are not any more in operation.

The solar systems have a certain tradition in Slovenia. According to the estimations among professionals (ApE, University in Ljubljana, BCEI ZRMK) and based on some documentation and information by the producers and installers, there are about 100.000 m^2 of solar collectors installed. We have also some of our own Slovenian producers of these systems (IMP Klimat, Stroj) and so far the economical interests for further development of this sector.

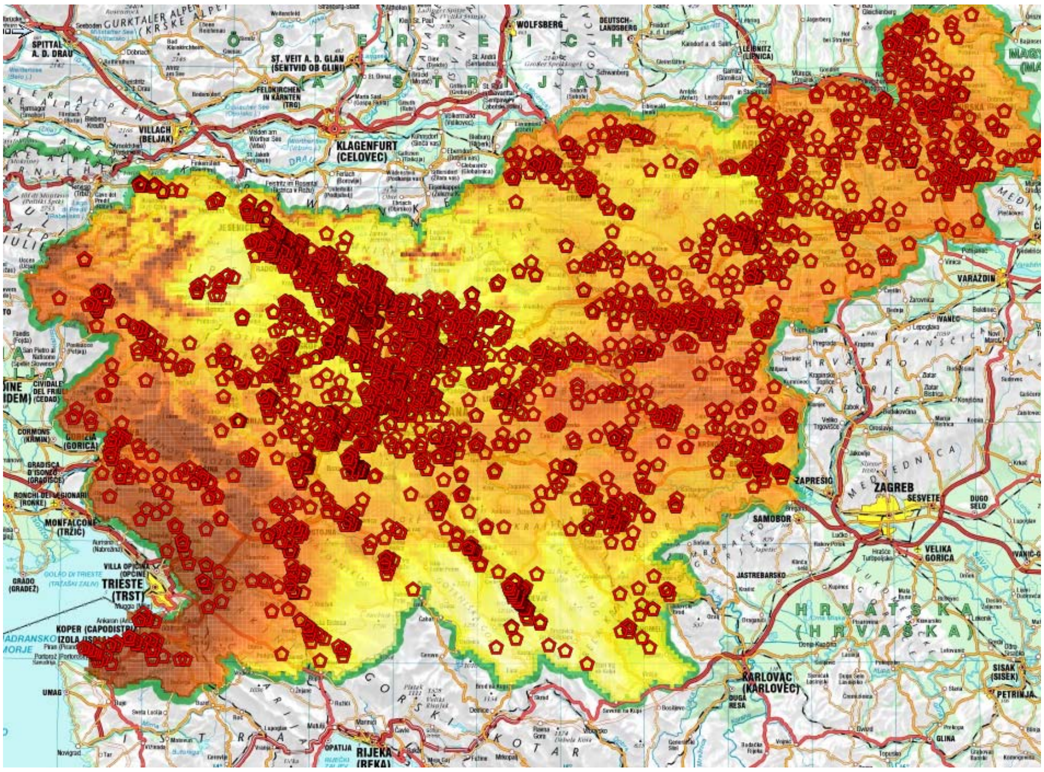


Figure 1: The map of solar irradiation of Slovenia with installed solar thermal systems

In Slovenia there are only around five solar thermal systems for heating of swimming pool water in operation. There is not any common practice in planning and building of these systems, therefore each system is a different and special case. It is very common that systems for heating of swimming pool water are combined with sanitary water heating and space heating. There is no statistics available for installed systems for heating of swimming pools in residential buildings.

Because outdoor swimming pools are big energy consumers and are mostly using fossil fuels, the SOLPOOL project is very interesting also in Slovenia. The overall objective of the SOLPOOL project is to increase the number of outdoor swimming pools equipped with solar thermal installations. Target groups of the SOLPOOL campaign are the owners and operators of swimming pools as well as installers and as a secondary target group, the guests.

2 Environmental conditions for the use of Solar Thermal systems

Climatic conditions in Slovenia vary. There is a Continental climate in the northeast, a severe Alpine climate in the high mountain regions, and a sub-Mediterranean climate in the coastal region. Yet there is a strong interaction between these three climatic systems across most of the country. This variety is also reflected in climatic variability over time and is an important factor determining the impact of global climate change in the country.

In Slovenia the relief has the biggest influence on the received energy of quazi-global irradiation. The average energy of quazi-global irradiation in Slovenia is 4.020 MJ/m^2 with standard deviation 520 MJ/m^2. Regarding solar irradiation the most suitable area is Primorska region together with the part of Karst (above 4.600 MJ/m^2 per year). The area with the highest solar irradiation is coastal region with up to 5.770 MJ/m^2 per year. The irradiation of the central part of Slovenia with Ljubljana varies between 4.200 and 4.500 MJ/m^2 per year. Relatively high irradiation has also the larger area of Celje, 4.800 MJ/m^2 per year. Flat lands in eastern Slovenia (Prekmurje) have the irradiation of 4.400 MJ/m^2 yearly. The lowest solar irradiation has the area on south border with Croatia. Irradiation is low also in mountain areas of Alps. The distribution of solar irradiation in Slovenia is shown on Figure 2.

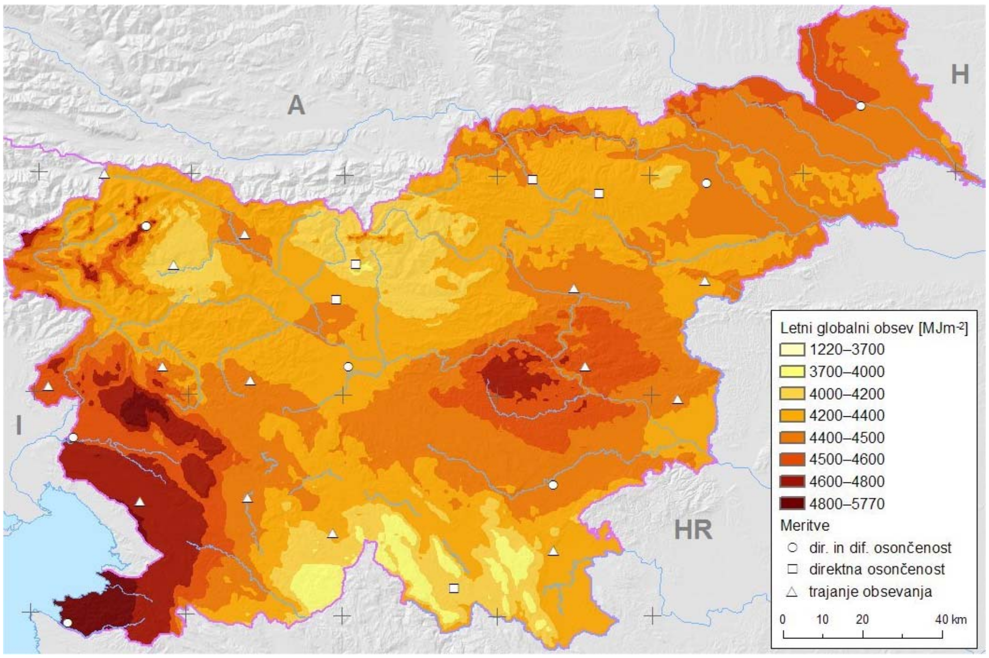


Figure 2: The map of solar irradiation of Slovenia

Slovenia has the highest solar irradiation in July (average energy of quazi-global irradiation is 580 MJ/m^2) and the lowest in December (average 70 MJ/m^2).

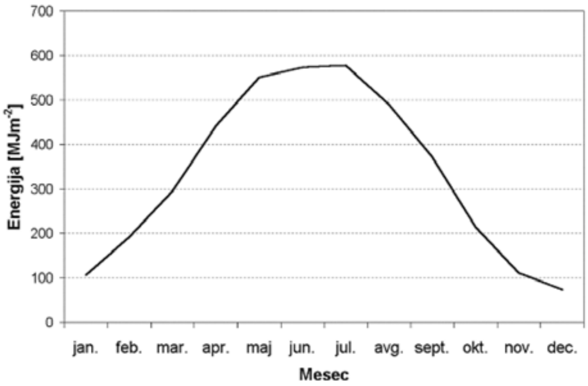


Figure 3: Monthly distribution of average energy of quazi-global irradiation in Slovenia

Table 1: The most favourable orientation of collectors for the Kras region

Period	Azimuth [°]	Inclination [°]
Year	181	32
January	189	66
February	189	57
March	200	42
April	191	22
May	173	10
June	252	7
July	251	15
August	204	20
September	175	34
October	167	49
November	167	62
December	179	67

Swimming pools in central and eastern Slovenia operate between middle of June and end of August, while swimming pools in coastal area with higher solar irradiation and outside temperatures operate between end of May and beginning of October.

3 State of the art of thermal applications for open air swimming pools

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 matches the time of use very well. Commonly at latitudes in Central Europe open-air pools are operated from beginning/middle of May 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 eating

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.

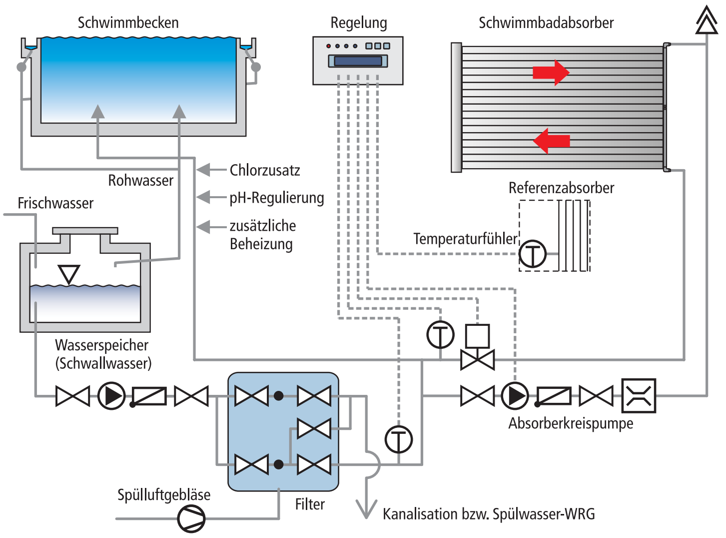


Figure 4: Circuit diagram of open-air swimming pool heating

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.

3.1.2 Integration of auxiliary heating

Conventionally operated auxiliary heating is necessary if the pool water has to be maintained at a constant temperature. Some open-air pools wish to offer their visitors warm swimming pool water independently of the sunshine, which requires auxiliary heating when the solar radiation is insufficient.

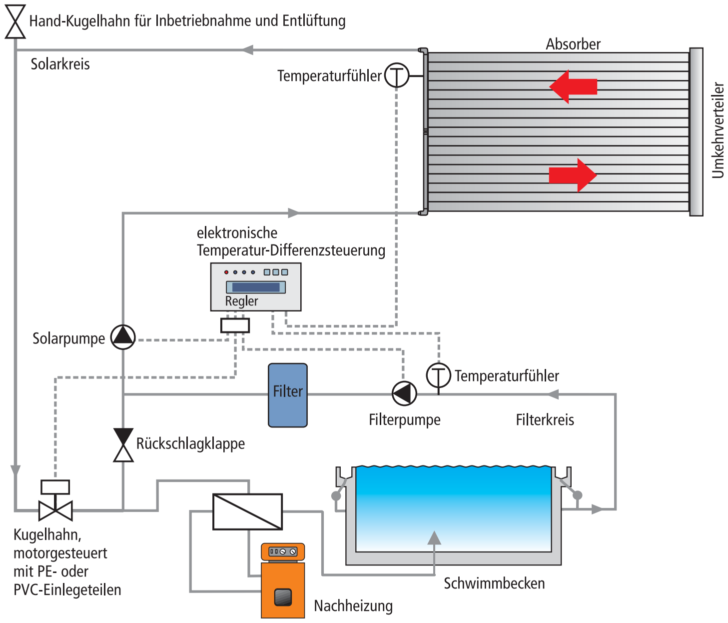


Figure 5: Circuit diagram of large absorber systems with additional heating

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.

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 self-cleaning effect during rain is also better.

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 6: Unglazed absorber field

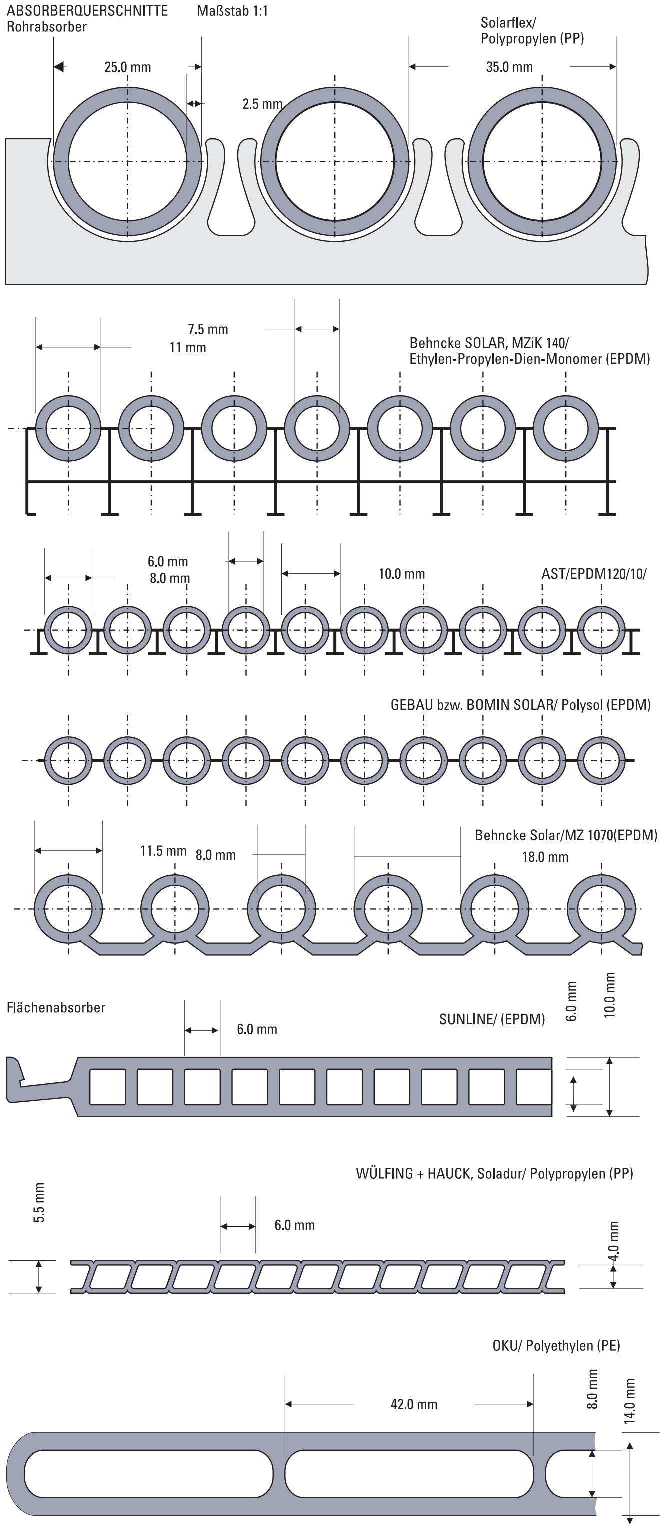


Figure 7: Different designs of absorber in cross-section

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.

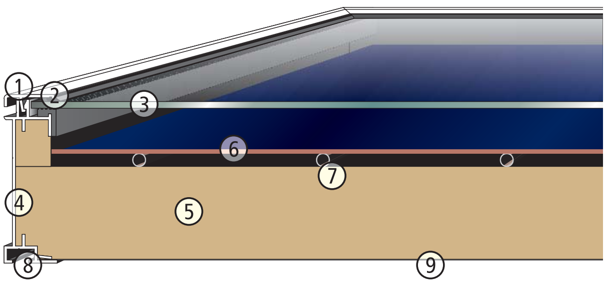
Plastics are also used for pipelines. These are however made from rigid materials.

The following plastics are basically the ones that can be used:

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 8: 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 Vacuum tube collectors

In special cases, e.g. if there is not enough area for the required absorber surface or additional applications like cooling are desired vacuum tube collectors may be chosen.

To reduce the thermal losses in a collector, glass cylinders with internal absorbers are evacuated in a similar way to Thermos flasks. For evacuated tube collectors the absorber is installed as either flat or upward-vaulted metal strips or as a coating applied to an internal glass bulb in an evacuated glass tube. An evacuated tube collector consists of a number of tubes that are connected together and which are linked at the top by an insulated distributor or collector box, in which the feed and return lines run. There are two main sorts of evacuated tube collector: the direct flow-through type and the heat-pipe type.

Direct flow –through evacuated tube collectors

In this design the heat transfer medium is either led via a tube-in-tube system (coaxial tube) to the base of the glass bulb, where it flows back in the return flow and thereby takes up the heat from the highly spectral-selective absorber, or flows through a U-shaped tube.

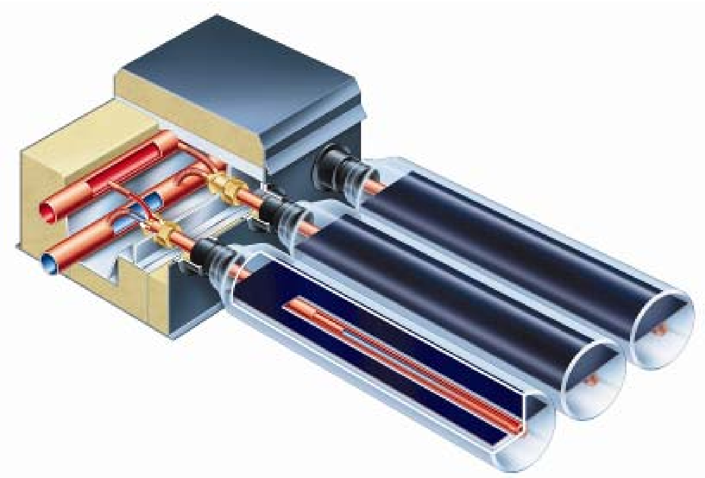


Figure 9: Cross-section of direct flow-through evacuated tube collector

Heat-pipe evacuated tube collectors

In this type of collector a selectively coated absorber strip, which is metallically bonded to a heat pipe, is plugged into the evacuated glass tube.

The heat pipe is filled with alcohol or water in a vacuum, which evaporates at temperatures as low as 25°C. The vapour thus occurring rises upwards. At the upper end of the heat pipe the heat released by condensation of the vapour is transferred via a heat exchanger (condenser) to the heat transfer medium as it flows by. The condensate flows back down into the heat pipe to take up the heat again.

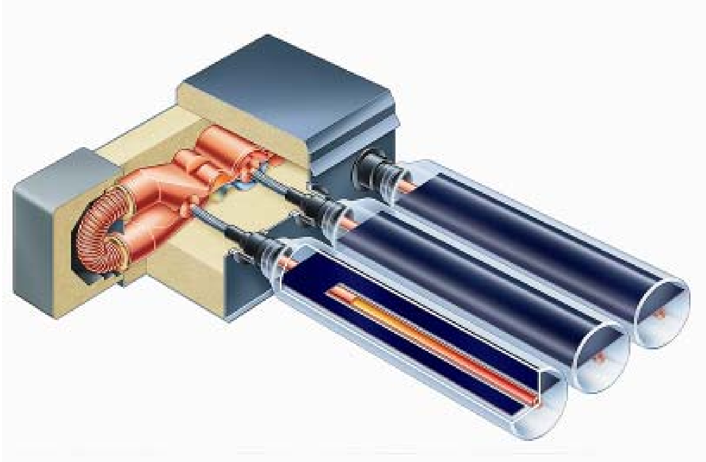


Figure 10: Cross-sectional view of a heat-pipe evacuated tube collector

3.4 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:

- VDI 2089/Part 1 Heating, ventilation, water supply, sewage water treatment in indoor and open air swimming pools – Indoor swimming pools
- DIN 19643 – 2 Treatment of water of swimming pools and baths – Combination of process ; adsorption, flocculation, filtration, chlorination
- DIN 19643 – 3 Combination of process: flocculation, filtration, ozonization, absorbing filtration, chlorination
- DGfdB B 66 Wintering pools in open-air pools
- DGfdB 25.03 List of criteria for assessing pool cover installations on swimming pools
- DGfdB 60.07 Maintenance of technical installations in swimming pools
- DGfdB 64.01 Prevention of Legionnaire´s disease in swimming pools
- DGfdB 65.01 pH value adjustment
- DGfdB 94.04 Hygiene, cleaning and disinfection in swimming pools

Solar thermal applications:

- En 12975 – Part 1 and 2 Thermal solar systems and components – Solar collectors
- EN 12976 – Part 1 and 2 Thermal solar systems and components – Factory made systems

- EN 12977 – Part 1, 2 and 3 Thermal solar systems and components - Custom made systems
- DIN 4751 T1-2 Heating systems for domestic hot water
- DIN 4753 T1-11 Heaters and heating systems for domestic hot water
- DIN 1988 T1-5 T7-8 Technical norms for domestic water installations
- DVGW W 551, W 553, G677 Prevention of Legionnaires´s desease in domestic hot water applications
- VDI 6002 Solar heating of domestic hot water

Outdoor pool operation concerning ST heating:

- VDI 2089/Part 3 Heating, ventilation, water supply, sewage water treatment in indoor and open air swimming pools – Open air swimming pools
- DVGW G 677 Heating of open air swimming pool water with gas heaters

DGfdB B 66 Wintering pools in open-air pools.

4 Market analysis

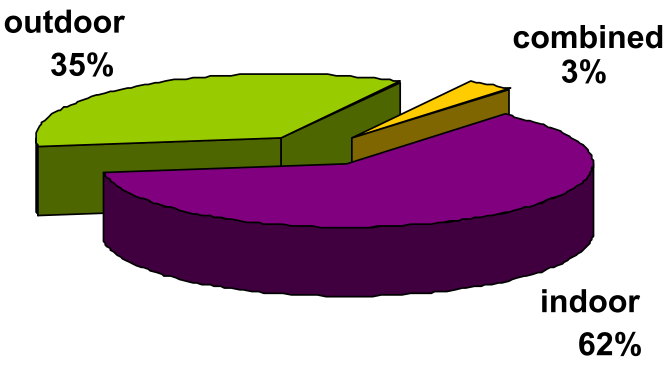
Statistical Office of the Republic of Slovenia, which is the main institution in charge of carrying out programs of statistical surveys, is not recording data about number of swimming pools or their heating systems. The only data available in statistical office is data about number of swimming pools visitors.

The only institution in Slovenia, which is collecting some data about swimming pools, is Slovenian Health Protection institute, which is monitoring the quality of swimming pool water. Because of lack of data, the market analysis in Slovenia is presented together for public and private sector.

4.1 Public and private sector

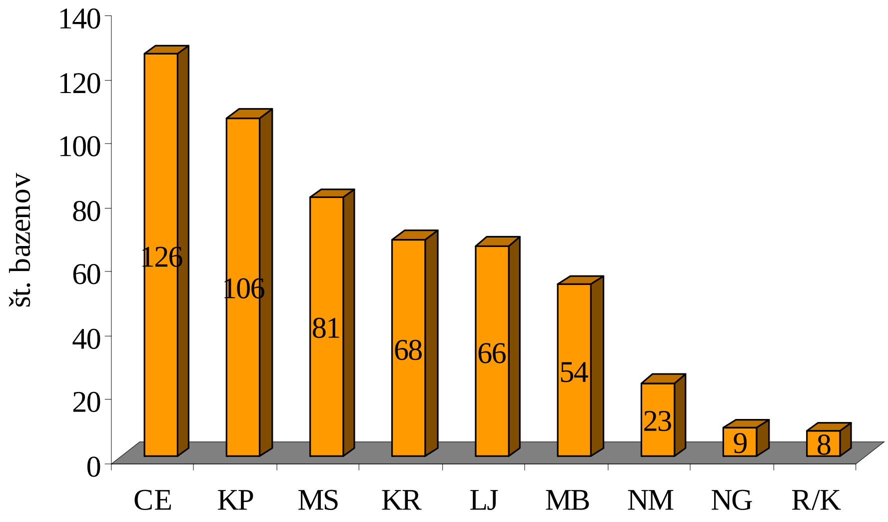
4.1.1 Number of pools

According to Slovenian Health Protection institute, there are 174 swimming facilities with 581 swimming pools in Slovenia in 2007, from which **191** are **outdoor swimming pools**. Regional distribution of swimming pools is: Celje (126), Koper (106), Murska Sobota (81), Kranj (68), Ljubljana (66), Maribor (54), Novo mesto (23), Nova Gorica (9) and Ravne na Koroškem (8).



(Source: IVZ, 2008)

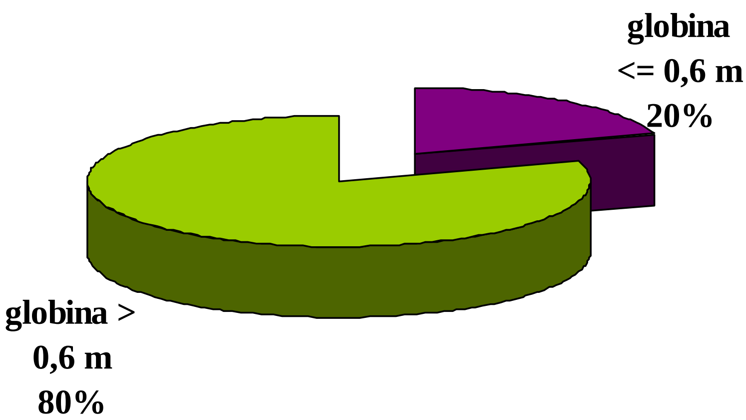
Figure 11: Percentage of types of swimming pools, Slovenia, 2007



(Source: IVZ, 2008)

Figure 12: Regional distribution of swimming pools, Slovenia, 2007

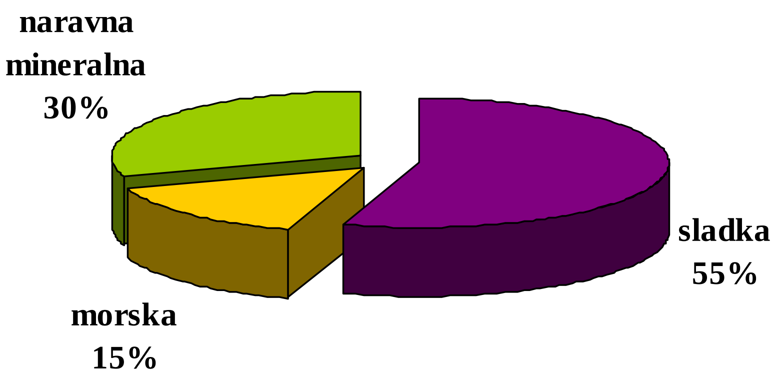
80% of Slovenian swimming pools are deeper than 0,6 meters.



(Source: IVZ, 2008)

Figure 13: Percentage of swimming pools according to depth, Slovenia, 2007

55 % of swimming pools use fresh water, 15% sea water and 30% natural mineral water.



(Source: IVZ, 2008)

Figure 14: Percentage of swimming pools according to used water, Slovenia, 2007

The potential for the use of solar heating in swimming pools in Slovenia is quite big due to high solar irradiation. The majority of swimming pools are suitable for solar thermal applications. The potential varies with the source of existing heating, heat demand and period of opening. Only swimming pools which are using geothermal energy are excluded. The most appropriate are swimming pools with longer period of opening and higher heat demand, while potential in swimming pools which are open only in short summer period is limited and should be further estimated from case to case. A smaller potential exists in the private houses.

4.1.2 Used heating systems

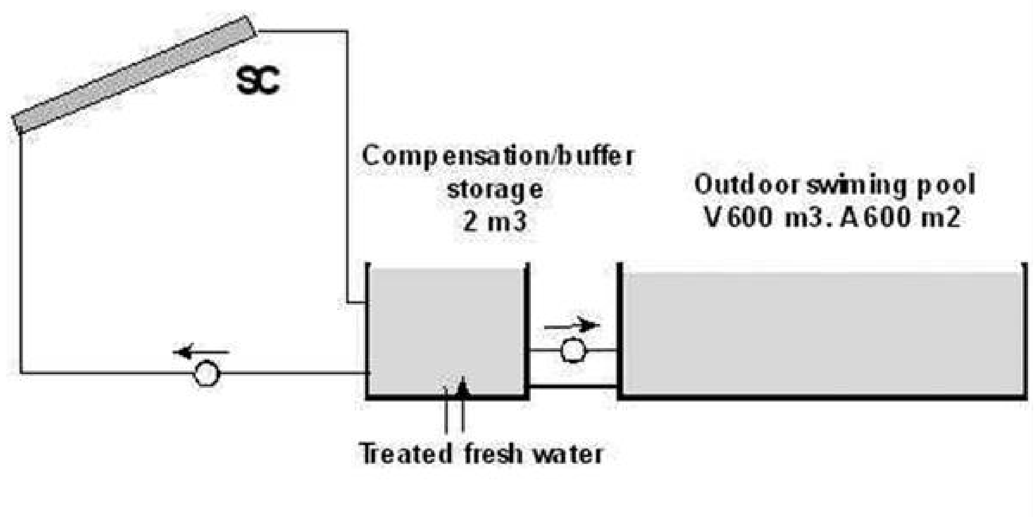
The technologies used for external swimming pools heating in Slovenia are boilers, heat pumps, geothermal heat pumps and heat exchangers and solar thermal systems with uncovered, flat plate and vacuum tube collectors. Fuels used are fuel oil, gas, geothermal energy and solar energy.

23 spas and recreation centers with 36.000 m^2 or 50.750 m^3 of swimming pools are using geothermal energy directly or indirectly through heat exchangers and geothermal heat pumps. The temperature of water is varying from 22 to 68 ^{o}C. The estimated total use of geothermal energy is 221 TJ. The biggest users are Terme Moravci (140 TJ) and Terme Čatež (173 TJ).

In the case of solar heating solar thermal collectors are used to heat the swimming pool water. In Slovenia the use of solar thermal systems for heating of swimming pools is not widespread. Therefore four cases of solar thermal systems with different types of solar collectors are presented below: uncovered, flat plate and vacuum tube collectors.

Terme Čatež, Žusterna- uncovered collectors

In Terme Čatež uncovered collectors are used for outdoor swimming pool heating only during the warm period of the year. The water in the solar collector flows into the open concrete buffer storage, where it is chemically treated and then flows into the swimming pool. No heat exchanger and expansion vessels are used. During the cold period the water as heat carrier is drained down.

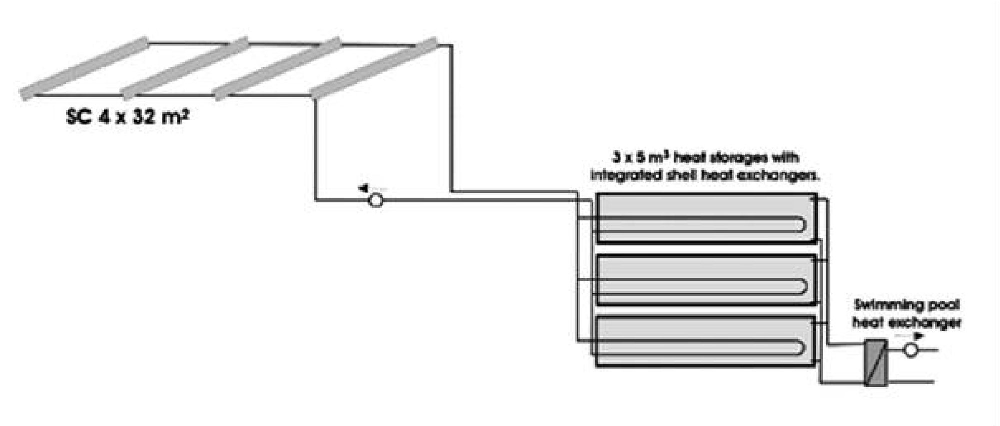


Source: www.solarge.org

Figure 15: Swimming pool heating with unglazed collectors in Terme Čatež

Hotel Delfin, Izola- flat plate collectors

In hotel Delfin flat plate collectors are divided in four arrays, each with an aperture area of 32 m^2. They are connected in parallel. Heated water-antifreeze solution flows through an integrated tube heat exchanger in all of the three heat storages. Heat storages have a total volume of 15 m^3. Swimming pool water is heated in a compensation pool via an external heat exchanger. No heating of hot tap water with the solar system is provided.



Source: www.solarge.org

Figure 16: Swimming pool heating with flat plate collectors in Hotel Delfin

Terme Snovik, Kamnik- vacuum tube collectors

In Terme Snovik two heat pumps and solar system are installed. The solar system has vacuum solar collectors with 81 m^2 area. Buffer storage has volume of 1.200 m^3 and hot tap water storage volume of 5,4 m^3. System is used for preheating of pool water only.

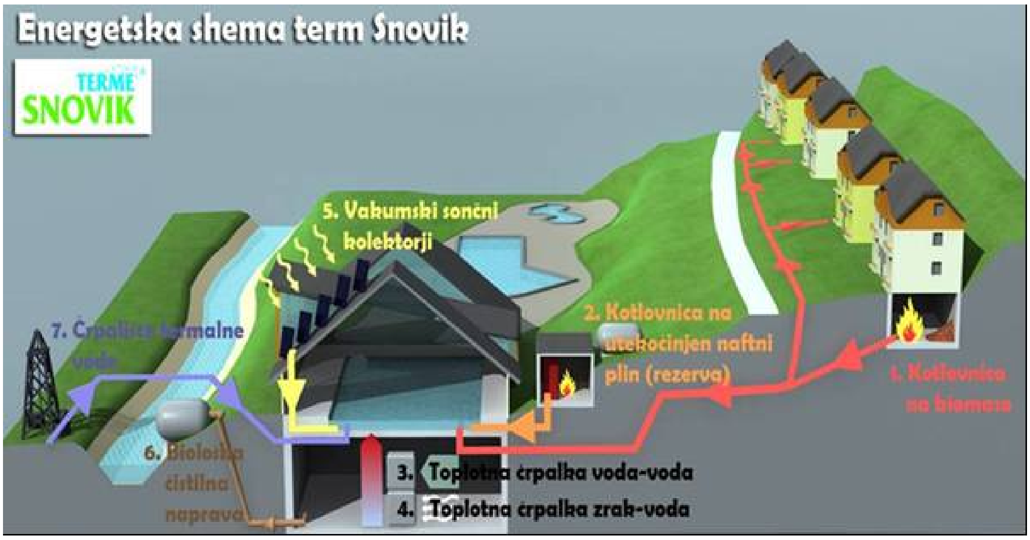
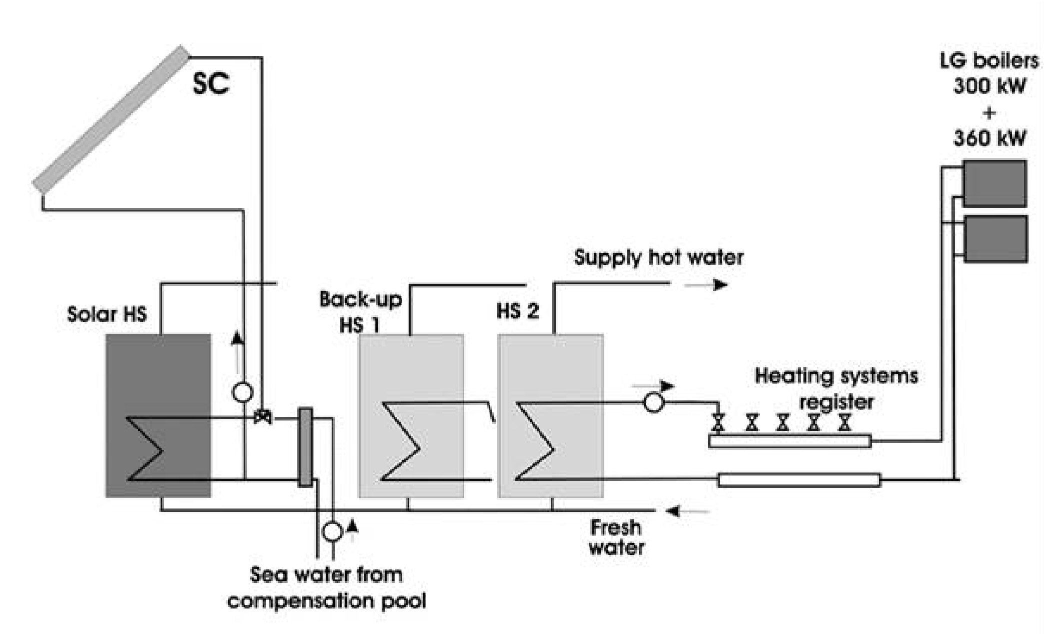


Figure 17: Swimming pool heating with vacuum collectors in Terme Snovik

Dom paraplegikov Pacug, Pacug- flat plate collectors

Two liquid gas high temperature boilers are installed for space and hot tap water heating. Rooms are heated by radiators with thermostatic valves. Some parts of the building – therapy, congress room, and restaurant – have air-conditioning systems. Hot tap water as well as sea water is pumped into the pool and preheated by the solar system. It consists of two sections of solar collectors with a total aperture area of 72 m^2. Water heated in the solar collectors flows through a tube heat exchanger of 4 m^3, integrated in the heat storage (2 cm^2), or through two plate heat exchangers for sea water preheating.



Source: www.solarge.org

Figure 18: Swimming Pool Heating With Flat Plate Collectors in Dom paraplegikov Pacug

4.1.3 Cost comparison of the different heating systems

Two heating methods are compared in the following table (conventional heating and single-source solar heating). The assumed boundary conditions were 1,620 m² pool surfaces, 900 m² absorber surface, period considered 15 years, interest 6% per annum and standard assumptions for maintenance and operating costs.

Table 2: Comparison of total annual costs (gross) for the single-source systems solar and gas heating

	Conventional heating (gas)	Solar heating
Investment	36,000 EUR	81,800 EUR
Capital cost	3,708 EUR/a	8,425 EUR/a
Usable energy	325,000 kWh/a	315,000 kWh/a
Auxiliary energy	1,625 kWh/a	11,625 kWh/a
Fuel consumption	342,000 kWh/a	-
Gas & electricity costs	32,037 EUR/a	1,163 EUR/a
Maintenance	715 EUR/a	818 EUR/a
Total annual costs	36,460 EUR/a	10,406 EUR/a
Heat price	0.112 EUR/kWh	0.032 EUR/kWh

The comparison with conventional energy costs shows that even without a grant solar open-air pool heating is cheaper than conventional heating.

5 Best practices

5.1 Swimming pool of Dom paraplegikov in Pacug, Slovenia

Figure 19: Swimming pool of Dom paraplegikov in Pacug, Slovenia

Technical Data of the Absorber System

Flat Absorber surface area (for sanitary and pool water)	$72m^2$
Year of installation	2006
Owner and operator	Dom paraplegikov d.o.o.
Supervising company	Gradbena družba Vič
Auxiliary heating system	Gas heating system
Costs for the solar system	34,000 € (incl. planning and installation)

Short description of the system

The health resort is designed for invalids and offers them an option for healthy and relax vacations. Invalid sportsmen can use the resort for preparation for sport competitions. The decision to build a solar system results from the desire to reduce pressure on the environment as low as possible in first place, following with potential energy cost saving. The solar system consists of two solar fields with a total area of 72 m^2. The system is used for tap water heating and preheating of swimming pool water. The tap water is heated and stored in heat storage with integrated tube heat exchanger and the pool water is heated with two plate heat exchangers. This health resort operates a whole year and the same holds for the solar system.

Partners :

- Owner and operator: Dom paraplegikov d.o.o.
- Supervising company: Gradbena družba Vič

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www.domparaplegikov.si

5.2 Swimming pool of Hotel Žusterna in Slovenia

Izbrisano: ¶

Oblikovano: Označevanje in oblikovanje


Figure 20: Swimming pool of Hotel Žusterna, Slovenia (Source: www.solarge.org)

Technical Data of the Absorber System

Absorber surface area (for pool water)	600m²
Year of installation	2001
Owner and operator	Terme Čatež d.d., Hotel Žusterna
Installation	Trimo d.d.
Planning	Makro 5
Auxiliary heating system	Without auxiliary system
Specific yield	165 kWh/m² and season
Environmental gain	25 tons / year of CO_2
Costs for the solar system	24,100 € (incl. planning and installation)

Short description of the system

This solar system is built at hotel Zusterna at the seaside. It is used for heating of an outdoor swimming pool and was installed during the renovation of the hotel in 2001. The whole roof of the indoor swimming pool is used as solar roof with unglazed solar collectors (600 sqm). The solar system operates, when the outdoor swimming pool is used (May–September). Buffer storage with a volume of 2 cbm is made by concrete and used for chemical preparation of pool water and for maintaining a constant level of water in the swimming pool as well. The cost of the solar collector was only 40,2 €/sqm due to the fact, that only additional cost for stainless steel piping and pump was paid. As absorbers large panel roof elements are used and they are not representing any additional costs as the replacement of old roof should be made anyway.

Partners

- Owner and operator: Terme Čatež d.d., Hotel Žusterna
- Installation: Trimo d.d.
- Planning: Makro 5

Contact Address

Terme Čatež d.d., Hotel Žusterna

Istrska 67
SI-6000 Koper
tel: +386 5 610 03 00
E-mail: info@terme-catez.si
www.terme-catez.si

5.3 Swimming pool of Terme Snovik in Kamnik, Slovenia

Figure 21: Swimming pool of Terme Snovik in Kamnik, Slovenia

Technical Data of the Absorber System

Vacuum collector surface area (for pool water)	81m^2
Year of installation	2004
Investor, owner and operator	Zarja kovis d.o.o.
Planner, producer and installer	Auxillia 2000 d.o.o.
Architect	Studio Šilc s.p.
Monitoring	Zarja kovis d.o.o.
Auxiliary heating system	Heat pumps and biomass
Specific yield	703 kWh/m² and season
Environmental gain	14 tons/year of CO_2
Costs for the solar system	49,500 €
Subsidies	40%

Short description of the system

From the beginning geothermal water (26 °C) and liquid gas were used. In 2004 improvement of heating system was made. Two heat pumps and solar system were installed. Larger heat pump is used for preheating of tap water. Smaller heat pump is used for cooling boiler room and preheating of tap water as well. The solar system is used for preheating of indoor and outdoor pools. Vacuum collectors were selected according to available space with adequacy orientation and consultation with architect. In 2007 wood biomass boiler of 500 kW started with operation. In the year 2005 the National award „Most energy efficient system“ was grant to Company Zarja-Kovis d.o.o. for concept of energy supply of Therme Snovik turistic and recreation center. In 2008 Terme Snovik were awarded with the European Eco-label for tourist accommodation service.

Partners

- Investor, owner and operator: Zarja kovis d.o.o.
- Planner, producer and installer: Auxillia 2000 d.o.o.
- Monitoring: Zarja kovis d.o.o.

Contact Address
Zarja kovis d.o.o.
Mr. France Stele
Molkova pot 5
SI-1240 Kamnik
Tel.: +386 1 830 86 16
E-mail: franc.stele@zarja-kovis.si
www.zarja-kovis.si

6 Finances

6.1 Specific System costs in Slovenia

	Small – Large Pools
Absorber systems	
Investment cost range in EUR/m²	100-300
Operation costs in EUR/year	1% of the investment
Flat plate collectors	
Investment cost range in EUR/m²	400-600
Operation costs in EUR/year	1% of the investment
Vacuum tube collectors	
Investment cost range in EUR/m²	700-900
Operation costs in EUR/year	1% of the investment

Source: internal calculation and estimation made by ApE d.o.o.

6.2 Funding and Financing schemes

6.2.1 Investment subsidies for solar thermal systems

Programme Name	**Investment subsidies for solar thermal systems installation**
Organisation	Slovenian Environmental Public Fund
Street	Tivolska cesta 30
Postal code	1000
City	Ljubljana
Email	ekosklad@ekosklad.si
Telephone	+386 (0)1 241 48 20
Type of Support	Investment subsidies for households
Available Money	7,5 m. EUR for 2007 (total budget together for solar thermal systems, complete renovation of residential buildings and passive buildings)
Share of total budget	▪ 25 % of the investment, but not more than: ▪ 150 € per m^2 for flat plate collectors ▪ 200 € per m^2 for vacuum collectors

	▪ 75 € per m² for do it yourself collectors ▪ additional 10 € per m² for collectors with quality standard »Solar Keymark«
Who can apply	Owners of residential buildings
Requirements for application	Applicants have to provide application, pictures, copies of installation invoices
Targeted areas	Solar thermal systems in residential buildings
Short description	Eco fund provides subsidies for investments in solar thermal systems for households, which are available yearly.
Documents	www.ekosklad.si
Source of information	www.ekosklad.si
Year of beginning	2007, before at Ministry of the environment and spatial planning from 1996
Information website	www.ekosklad.si

6.2.2 Programme 2 – Soft loans

Title	**Soft loans**
Street	Slovenian Environmental Public Fund
Postal code	Tivolska cesta 30
City	1000
Email	Ljubljana
Telephone	ekosklad@ekosklad.si
Homepage	+386 (0)1 241 48 20
Type of Support	Soft loans
Available Money	Last actual calls: - environmental investments for households 41OB09, 20.3.2009: 12 mill. € (together for all environmental investments), annual interest rate for credits: 3,9 % - environmental investments for legal entities 42PO009, 26.5.2009: 15 mill. € (together for all environmental investments), annual interest rate for credits: EURIBOR+1 %
Share of total budget	Last actual calls: - environmental investments for households 41OB09: max. 20.000 € - environmental investments for legal entities 42PO009, max 2 mill. €
Who can apply	Last actual calls: - environmental investments for households 41OB09: owners of residential buildings and their family members - environmental investments for legal entities 42PO009: municipalities, firms and private entrepreneurs
Requirements for application	Last actual calls: - environmental investments for households 41OB09: max payback period 10 years - environmental investments for legal entities 42PO009: max payback period 15 years and environmental criteria
Targeted areas	Environmental investments
Short description	Eco fund encourages sustainable development projects with loans and guarantees with environmental investments and other forms of subsidies. Fund encourages investments that are in accordance with national environment protection programme and EU environmental policy.
Documents	www.ekosklad.si
Source of information	www.ekosklad.si
Year of beginning	N.A.
Information website	www.ekosklad.si

6.3 Cost Benefit Analysis

Because in Slovenia there are only around five solar thermal systems for heating of swimming pool water in operation and there is not any common practice in planning and building of these systems we used only one the most representative case of solar heated swimming pool for the representation of cost benefit analysis.

The average solar energy yield of the system per swimming season (mid-May to mid-September) is approx. 250 – 350 kWh/m², i.e. the system operates with a solar radiation of approx. 650-700 kWh/m² per season with an average system utilization of about 40 – 50%.

Very favourable relationships thus arise for the economy of the system. An operating advantage of solar open-air pool heating arises mainly for single-source heating. Two heating methods are compared in the following table (conventional heating and single-source solar heating). The assumed boundary conditions were 1,620 m² pool surface, 900 m² absorber surface, period considered 15 years, interest 6% per annum and standard assumptions for maintenance and operating costs:

Table 3: Amortisation of a absorber system for a outdoor pools with 1600 m² pool surface

Heating system	Gas	Absorber	Unit
Investment costs	36,000	81,800	€
Capital costs	3,708	8,425	€/a
Net Energy	325,000	315,000	kWh/a
Auxiliary energy	1,625	11,625	kWh/a
Fuel demand	342,000	0	kWh/a
Gas- and Electricity costs	32,037	1,163	€/a[1]
Maintenance	715	818	€/a
Total yearly costs	36,460	10,406	€/a
Heat price	0,112	0,032	€/kWh
Amortisation time		3,8	a
Calculation assumptions:			
Electricity costs:		0,1	€/kWh
Gas costs		0,09	€/kWh
Absorber surface		900	m²
Time frame		15	years
Interest rates		6	%

The comparison with conventional energy costs shows that even without a grant solar open-air pool heating is cheaper than conventional heating. For a time frame of 15 years and interest rates of 6 % the investment in an absorber system for a 1600 m² outdoor swimming pool would be amortised in 3,8 years already, see Table 3. In the payback time savings with the use of solar thermal system instead of LPG are calculated.

6.3.1 Overview

Izbrisano: ¶

Oblikovano: Označevanje in oblikovanje

Parameter	Small pools	Medium pools	Large pools

	Dom paraplegikov	Terme Snovik	Hotel Žusterna
Specific System costs (EUR/m²)	440	611	40
Specific Yield (kWh/m² year)	N.A.	625	165
Heat price (EUR/kWh)	N.A.	N.A.	N.A.
Amortisation time (static)	N.A.	N.A.	N.A.

6.3.2 Conclusion

The specific system costs for solar swimming pool installations vary from 100-300 EUR/m² for absorber systems, 400-600 EUR/m² for flat plate collectors and 700-900 EUR/m² for vacuum tube collectors. Operation costs are very low, up to 1% of the investment per year.

The investment costs for solar heating systems for outdoor pools are higher than for conventional systems. But the comparison with conventional energy costs shows that even without a grant solar open-air pool heating is cheaper than conventional heating.

Further market penetration of solar collectors in these systems is connected to a decrease of their prices in the future years and of course of the prices of competitive fuels (natural gas and oil). For these reasons the financial support would be required for producers of equipment for better market penetration. A special attention should be given also to further technology development, new materials, assembling equipment and collaboration of institutes, producers and installers. This collaboration would enable technical guides, decrease of prices, appropriate subventions and detailed information for better market penetration. Attention is required for (even forced) integration of solar collector systems in the construction of new swimming pools as for their integration in existing. This represents a very high potential.

7 Boundaries and requirements to a good solar heating system for outdoor pools

7.1 Boundaries for the implementation of Solar Heating systems for outdoor swimming pools

The list shows the national and regional barriers, which must be overcome to improve the awareness of the end users and the implementation of solar thermal heating systems. This includes technical or climate barriers, but also as governmental, financial and societal boundary conditions.

Technical or climatic barriers:

- lack of knowledge in solar thermal design and operation
- relatively disorganized domestic industry
- lack of adequate surfaces due to the fact that solar thermal systems are not planned in the phase of construction
- existent boiler rooms are not suitable for solar thermal equipment

Financial Barriers:

- national granting system supports only small solar systems
- low price of fossil fuels and therefore low competitiveness of RES
- relatively high investment costs in case system operates only in summer
- heat is not used through the whole year

Governmental barriers:

- national granting system supports only small solar systems

Social barriers:

- awareness of consumers and installers
- wrongly informed consumers
- strong oil company lobby.

7.2 Five steps to get a good pool absorber

First Step – Collecting basic information

Within the frame of the SOLPOOL project several information materials have been developed. The brochures provide basic information on the technique, dimensioning, mounting, costs and benefits of solar thermal systems. The fact sheets show good practice examples and offer the opportunity to contact the owner / operator of a swimming pool for exchanging experiences. At least information help desks have been set up to provide everyone who is interested with helpful information. In addition information has been uploaded to the project web site www.solpool.info like the presentations of the experts during the several information seminars and workshops.

Second Step – Using the Check list

Getting the idea more concrete one may use the checklist under www.solpool.info. The basic parameters will be collected for getting not only information about the energy consumption of the swimming pool but also being later used as input data for the Impact Advisor. This Excel-based tool calculates the necessary collector area for a desired water temperature as well as the energy savings and CO_2 reduction amounts.

Third step – Calculation with the Impact Advisor

The Impact Advisor is a neutral decision tool for the application of solar heating of outdoor swimming pools. It offers owner/operators as well as installers the main information for preparing the realization of a project. Based on the results of the Impact Advisor calculation one can decide whether the investment in a solar thermal system makes sense or not. The parameters investment costs and amortisation time gave clear information about the most important economical facts. For details a manual is provided under www.solpool.info.

The Impact Advisor can be downloaded under: www.solpool.info.

Fourth step – Ordering an offer

Based on the results of the Impact Advisor the owner / operator of a swimming pool may order an offer from a solar company skilled in planning and installing of solar thermal systems for open air swimming pools. For this purpose the SOLPOOL data-base may be used, check under www.solpool.info.

Fifth step – The decision

After comparing the offers from the solar companies the owner/operator may use the service of the help desks to perform a last prove from independent site. This check will lead to a recommendation for a specific solution. In addition possible financial subsidies can be checked under www.solpool.info. Finally the decision will be made and the solar system is ready to install.

8 Summary

The potential for the use of solar heating in swimming pools in Slovenia is quite big due to high solar irradiation. The majority of swimming pools are suitable for solar thermal applications. The potential varies with the source of existing heating, heat demand and period of opening. Only swimming pools which are using geothermal energy are excluded. The most appropriate are swimming pools with longer period of opening and higher heat demand, while potential in swimming pools which are open only in short summer period is limited and should be further estimated from case to case. A smaller potential exists in the private houses.

The investment costs for solar heating systems for outdoor pools are higher than for conventional systems. But the comparison with conventional energy costs shows that even without a grant solar open air pool heating is cheaper than conventional heating.

Further market penetration of solar collectors in these systems is connected to a decrease of their prices in the future years and of course of the prices of competitive fuels. For these reasons the financial support would be required for producers of equipment for better market penetration. A special attention should be given also to further technology development, new materials, assembling equipment and collaboration of institutes, producers and installers. This collaboration would enable technical guides, decrease of prices, appropriate subventions and detailed information for better market penetration.

9 References

www.aure.si

www.ekosklad.si

www.ivz.si

www.solarge.org