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

Italy

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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Lecce	Provincia di Lecce
ENEL	Ente Nazionale per l'Energia Elettrica (National electricity board)
CSTS	Collective Solar Thermal System

1 Introduction

In Italy, especially in the South of Italy where are the most favourable conditions, the solar thermal practically is ignored.

Maybe because, in the eighties, the campaign “Scaldacqua solari” (Solar boyler) promoted from the ENEL caused a contraction of demand by plant engineering lack.

Nevertheless, the last decade, the national government and many regional governments have started a lot of initiative to promote the solar thermal use, same with government grant.

The Province of Lecce, in the 2006, has allocated €.250.000 for the funding the solar thermal installation (1.000 m^2 of solar panel).

The national target of annual installation solar panel is 100.000 m^2 per year with 1,5 millions of m^2 in the 2015 and 3 millions of m^2 in the 2030.

There aren’t statistics for installed and operating systems, but some municipality promote actively the solar installation with reduction of building license’s taxes

In the Province of Lecce there are four solar panel’s manufacturers and one unglazed solar panel’s manufacturers.

The solar systems have to be certified by UNI-EN Norm 12975 and 12976.

Actually, in the South of Italy, only a few outdoor swimming pools are heated, because the weather, usually, is hot, but also the buildings, till fifteen years ago, usually weren’t heated.

The SOLPOOL project can direct the operators to install heating systems whit solar thermal systems instead. Target groups of the SOLPOOL campaign are the owners and operators of swimming pools as well as installers and engineers and as a secondary target group, the guests.

2 Environmental conditions for the use of Solar Thermal systems

The Province of Lecce is located between two sea, Adriatic Sea in East and Ionian Sea in the West, there aren’t hills, the highest reliefs are less 200 m. on sea level.

Climatic conditions in the South of Italy is very sunny from the Mars until October or November, there are a few rainy days in this month, especially close to the coast as is the Province of Lecce.

In the Apulia the annual irradiation is 1.600 kWh/m^2 to 1.800 kWh/m^2, as showed in the following pictures.

The irradiation monthly is in the figure n.3.

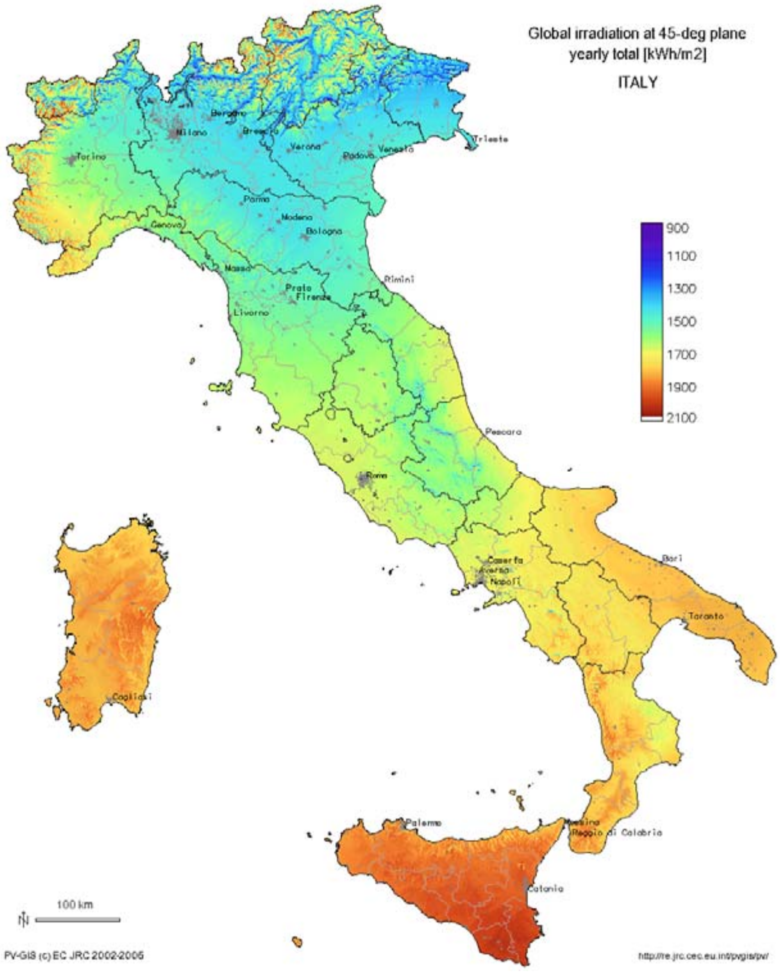


Figure 1: Solar irradiation Italy on 45 deg. plane

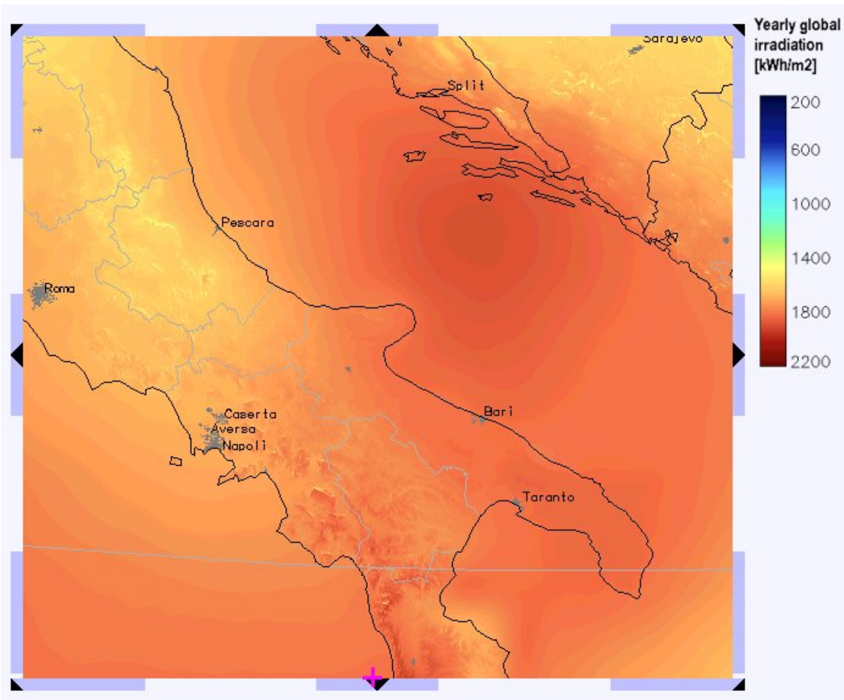


Figure 2: Solar irradiation in the South of Italy on optimal plane

Table 1: Irradiation monthly in some city of Apulia on horizontal plane and 30 deg. plane in kWh/m2

	Bari 0°	Bari 30°	Brindisi 0°	Brindisi 30°	Foggia 0°	Foggia 30°	Lecce 0°	Lecce 30°	Taranto 0°	Taranto 30°
January	56,83	90,72	60,28	96,51	55,11	88,01	58,56	92,06	58,56	92,35
February	78,56	111,39	72,33	99,40	75,44	106,55	76,22	105,53	77,00	107,10
Mars	124,86	152,99	121,42	147,12	119,69	146,09	117,11	140,55	122,28	148,03
April	171,67	183,60	163,33	173,25	162,50	173,31	157,50	166,20	162,50	172,06
May	217,86	209,69	202,36	194,04	204,94	197,45	203,22	194,56	204,94	196,34
June	233,33	213,70	225,00	205,69	214,17	196,93	217,50	198,73	226,67	206,96
July	246,28	230,51	235,94	220,27	229,06	214,93	234,22	218,31	241,97	225,58
August	217,00	223,49	223,03	229,28	199,78	205,07	206,67	210,98	208,39	213,00
Septem-ber	158,33	187,65	153,33	179,79	148,33	174,51	149,17	173,63	152,50	178,31
October	113,67	159,41	111,94	154,87	107,64	149,69	105,92	143,73	108,50	148,40
November	66,67	105,71	65,83	102,45	64,17	101,46	61,67	93,32	65,83	101,91
December	49,08	81,07	50,81	83,38	49,08	82,02	50,81	82,55	51,67	84,71
Annual	**1.734,14**	**1.949,93**	**1.685,61**	**1.886,03**	**1.629,92**	**1.836,00**	**1.638,56**	**1.820,17**	**1.680,81**	**1.874,73**

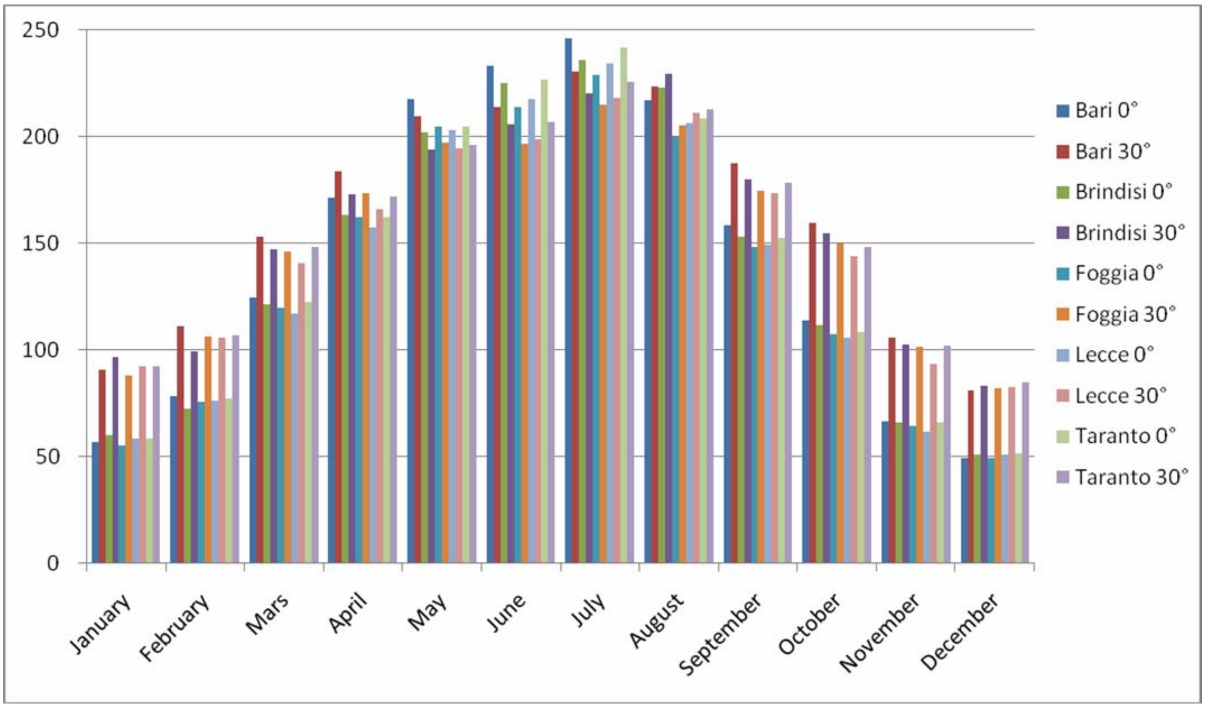


Figure 3: Irradiation monthly in some city of Apulia on horizontal plane and 30 deg. plane in kWh/m^2

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 the South of Europe open-air pools are operated from beginning/middle of April until the end of September. During this period approximately 65 – 75% of the annual solar radiation occurs.

- <u>Simple system design</u>: 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. Most of all, this technology is practically ignored in the South of Europe.

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 re-placed 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 ab-sorber circuit pump. The hydraulic construction is much more complex than for private swim-ming 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.

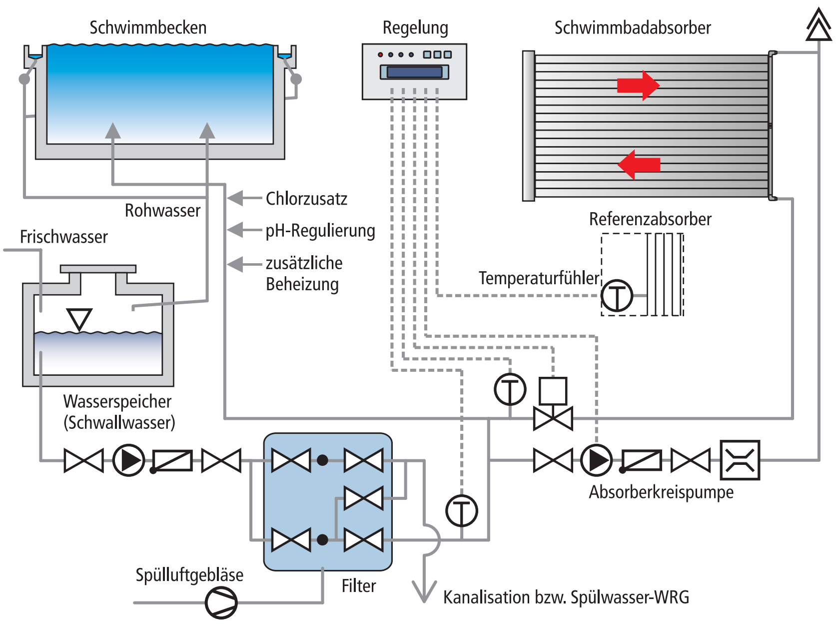


Figure 4: Circuit diagram of open-air swimming pool heating

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.

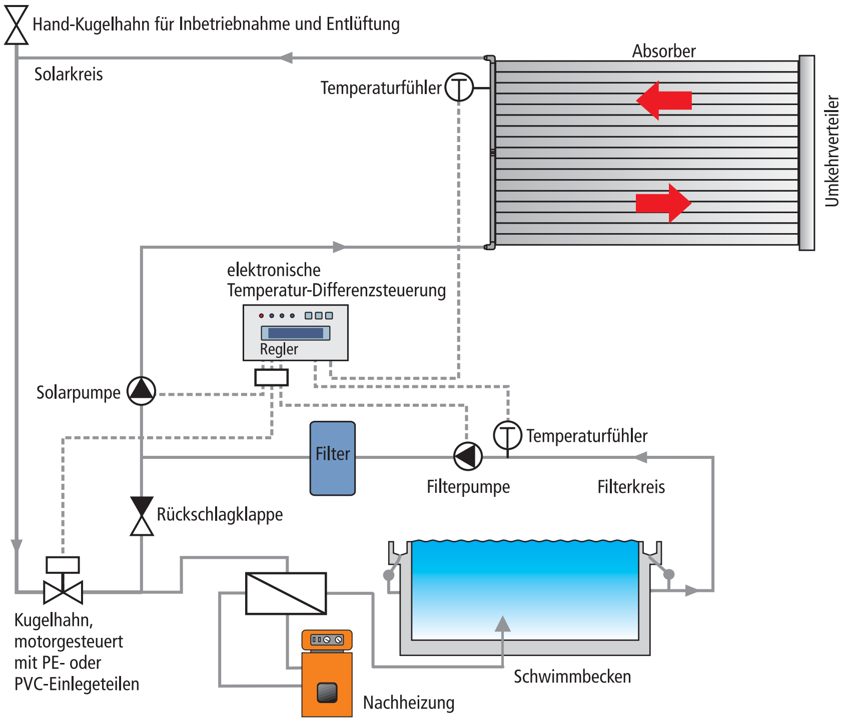


Figure 5: Circuit diagram of large absorber systems with additional heating

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 be-

tween 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

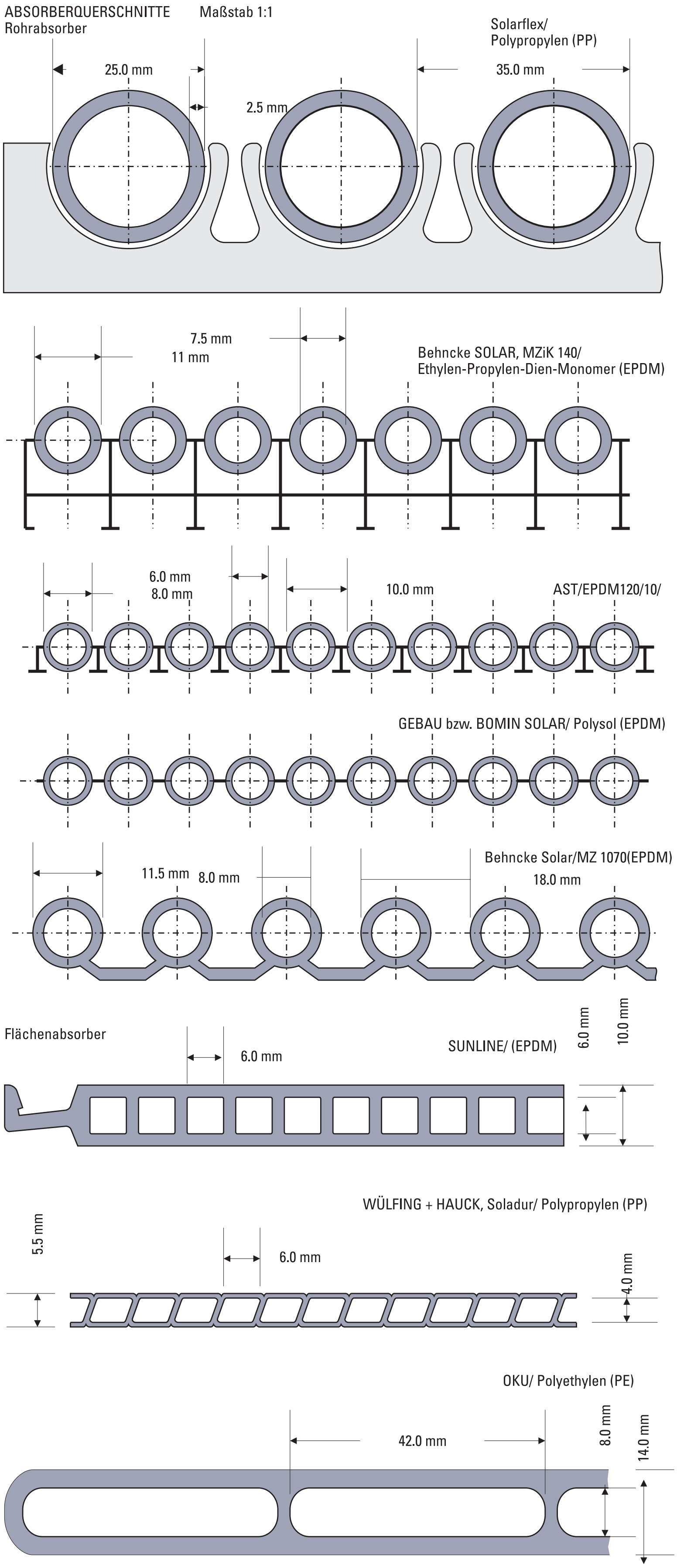


Figure 7: Different designs of absorber in cross-section

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.

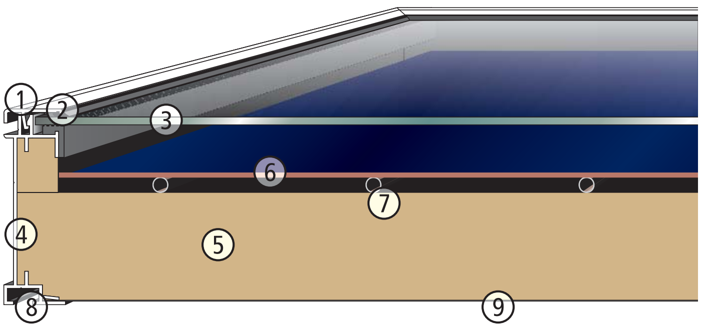
Plastics are also used for pipelines. These are however made from rigid materials.

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 solar 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.

a) **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.

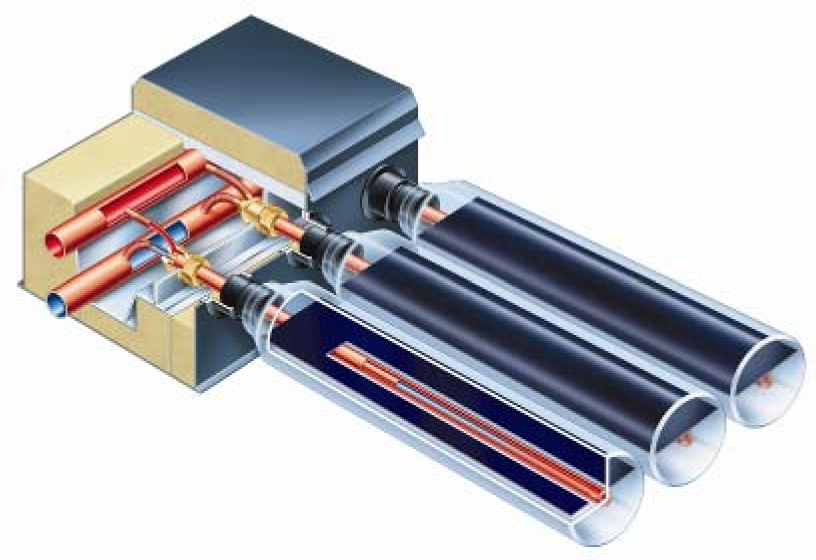


Figure 9: Cross-section of direct flow-through evacuated tube collector

b) **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.

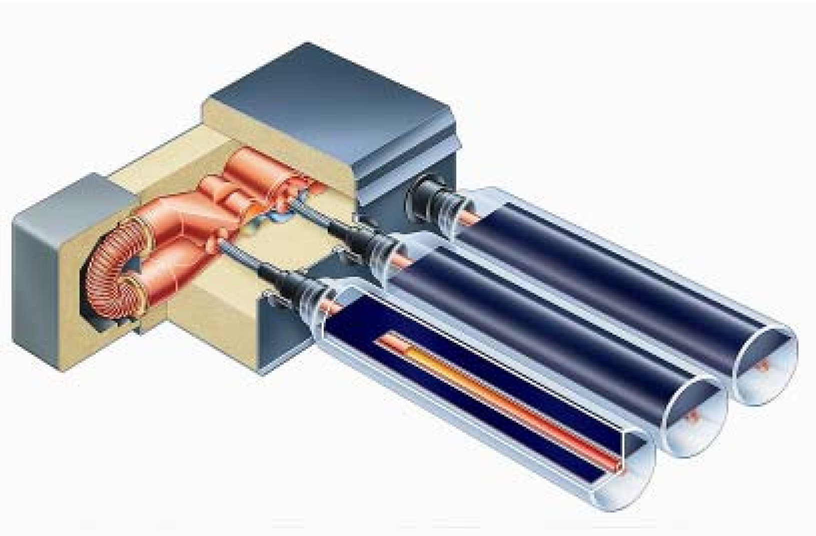


Figure 10: Cross-sectional view of a heat-pipe evacuated tube collector

4 Market analysis

In the Province of Lecce there isn't statistical data about number of swimming pool or their heating system.

The only data available are from Tourism Office of Province of Lecce (Hotel, Camping, etc.).

The outdoor swimming pools located in this buildings are about 100 and some hotel are yet equipped whit a solar system to heating sanitary water (La Giurlita, Ugento – LE; Masseria Bosco, Avetrana – TA; Terme di Santa Cesarea, Santa Cesarea Terme – LE; Athena, Calimera - LE) so is more simple use the same solar thermal installation for the pools water.

4.1 Public and private sector

4.1.1 Number of pools

Further the about 100 outdoor swimming pool located in touristic building there is about ten public outdoor swimming pool and a undefined number a small private outdoor swimming pools that are very difficult finding.

The Province of Lecce has built four indoor swimming pools that are equipped with a conventional heating system (two with gas, one with oil and one with electricity)

4.1.2 Used heating systems

In the Province of Lecce there isn't outdoor swimming pool equipped whit a heating system.

The only swimming pools with the heating system are the indoor swimming pool that have a conventional heating system.

But, actually, also the indoor swimming pool have tended to using the solar thermal system to heating the pool's water.

4.1.3 Cost comparison of the different heating systems

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	78.750 EUR
Capital cost	3.708 EUR/a	8.110 EUR/a
Usable energy	325.000 kWh/a	240.000 kWh/a
Auxiliary energy	1.625 kWh/a	11.625 kWh/a
Fuel consumption	342.000 kWh/a	-

Gas & electricity costs	22.736 EUR/a	2.092 EUR/a
Maintenance	715 EUR/a	788 EUR/a
Total annual costs	27.159 EUR/a	10.990 EUR/a
Heat price	0,084 EUR/kWh	0,035 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 Example n.1 – Swimming pool of Melegnano-Italy

Figure 11: Swimming pool of Melegnano

Table 3: Description of Melegnano's system

Building	
Type of building	Sports centre
Number of dwellings, floors	90.000 users/year
Year of construction	1983
Total effective area (heated)	./.
Hot tap water consumption (measured/estimated)	not available
Whole energy consumption for heating purpose after CSTS implementation (Collective Solar Thermal System)	112.000 kWh/a
System engineering	
Year of construction of CSTS	1999
Type of collectors	Flat plate collectors
Thermal power	130 kWtherm.
Aperture area of collectors*)	184 m^2
Buffer storage	./.
Hot tap water storage	12,0 m^3
Total capacity of boilers with energy source	350 kW, natural gas
Type of hot tap water heating	Centralised
Type of heating system	./.
Costs	
Total cost solar system	110.000 Euro
Cost of the CSTS/gross area of collectors	550 Euro/m^2
Subsidies	40 %
Output	
Output of solar heat**)	123.000 kWh/a
Reduction of final energy***)	164.000 kWh/a
CO2-emissions avoided	37,7 t CO_2/a
Solar performance guarantee	Yes
*) Aperture area = light transmitting area of the front glass **) measured, between storage and piping to taps (solar system output) ***) related to the measured output mentioned before	

Table 4: Technical Date of the Melegnano's Absorber System

Description of the CSTS	
Year of construction of CSTS	1999
Thermal power	130 kWtherm.
Gross area of collectors	200 m^2
Aperture area of collectors	184 m^2
Type of collectors	Flat plate collectors
Type of assembly	On flat roof
Orientation of collectors	South (0°)
Inclination angle to horizon	45
Freezing protection	Glycol
Overheating protection	Expansion vessel
Operation mode	Low flow
Use of CSTS for	Hot tap water heating, swimming pool heating
Buffer storage	./.
Hot tap water storage	12.0 m^3 (2×6 m^3)
Control of backup-system/CSTS	Separated control

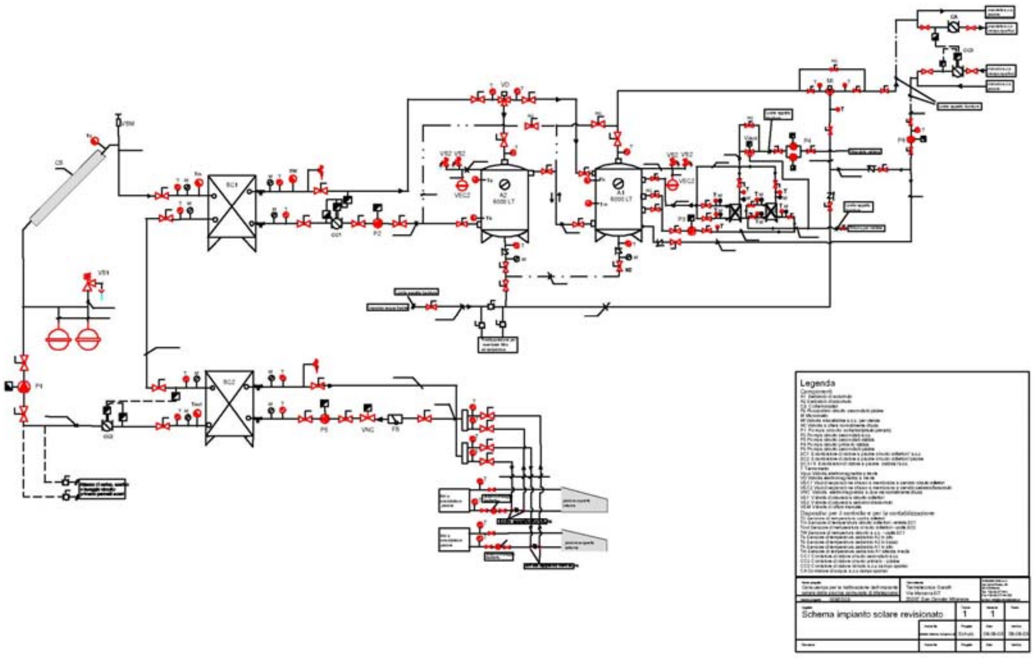


Figure 12: Melegnano's installation scheme

Short description of the system

The pilot plant in Melegnano (Milano) was installed in 1999 on a public swimming pool and partially financed by the European Community. 200 square metres of solar collectors provide heat for both, the hot water system (81 MWh/a) and the swimming pool (42 MWh/a). The performance of the plant has been monitored accurately during the first year. A solar performance guarantee (at least 500 kWh/sqm) was available for the first twelve months of operation, whereas the calculated heat production had been estimated to about 615 kWh/sqm.

The plant has been planned according to large scale criteria (large collector modules, low flow).

The total system costs amount to about 625 EUR/sqm.

Partners :

- MEA s.p.a.
- via Zuavi, 70
- Melegnano, Italy
- Phone: +39 02 982271
- Fax: +39 02 98231087
- mea(at)pmp.it

5.2 Example n.2 – Solar system of swimming pool of Osimo

Figure 13: Swimming pool of Osimo

Table 5: Description of Osimo's system

Building	
Type of building	Sports centre: swimming pool
Number of users / dwellings, floors	400 users/day 1 floor
Year of construction	1996
Total effective area (heated)	1.400 m^2
Hot tap water consumption (measured/estimated)	not available
Whole energy consumption for heating purpose after CSTS implementation	500.000 kWh/a
System engineering	
Year of construction of CSTS	2007
Type of collectors	Vacuum tube collectors
Thermal power	190 kWtherm.
Aperture area of collectors*)	270 m2
Buffer storage	6 m^3
Hot tap water storage	2 m^3
Total capacity of boilers with energy source	district heating, capacity not available
Type of hot tap water heating	Centralised
Type of heating system	Centralised
Costs	
Total cost solar system	365.000 Euro
Cost of the CSTS / gross area of collectors	1.352 Euro/m^2

Subsidies	39 %
Output	
Output of solar heat**)	235.000 kWh/a
Reduction of final energy***)	235.000 kWh/a
CO2-emissions avoided	63.5 t CO_2/a
*) Aperture area = light transmitting area of the front glass **) measured, between storage and piping to taps (solar system output) ***) related to the measured output mentioned before	

Table 6: Technical Date of the Osimo's Absorber System

Description of the CSTS	
Year of construction of CSTS	2007
Thermal power	170 kWtherm.
Gross area of collectors	270 m^2
Aperture area of collectors	246 m^2
Type of collectors	Vacuum tube collectors
Type of assembly	partially on inclined and flat roof
Orientation of collectors	South (0°)
Inclination angle to horizon	45°
Freezing protection	aqua system, only water
Overheating protection	through electronic
Operation mode	Low flow
Use of CSTS for	Hot tap water heating, swimming pool heating, partially space heat-ing
Buffer storage	6 m^3 (4 × 1.5 m^3)
Hot tap water storage	2 m^3 (2 × 1.0 m^3)
Control of backup-system / CSTS	not available

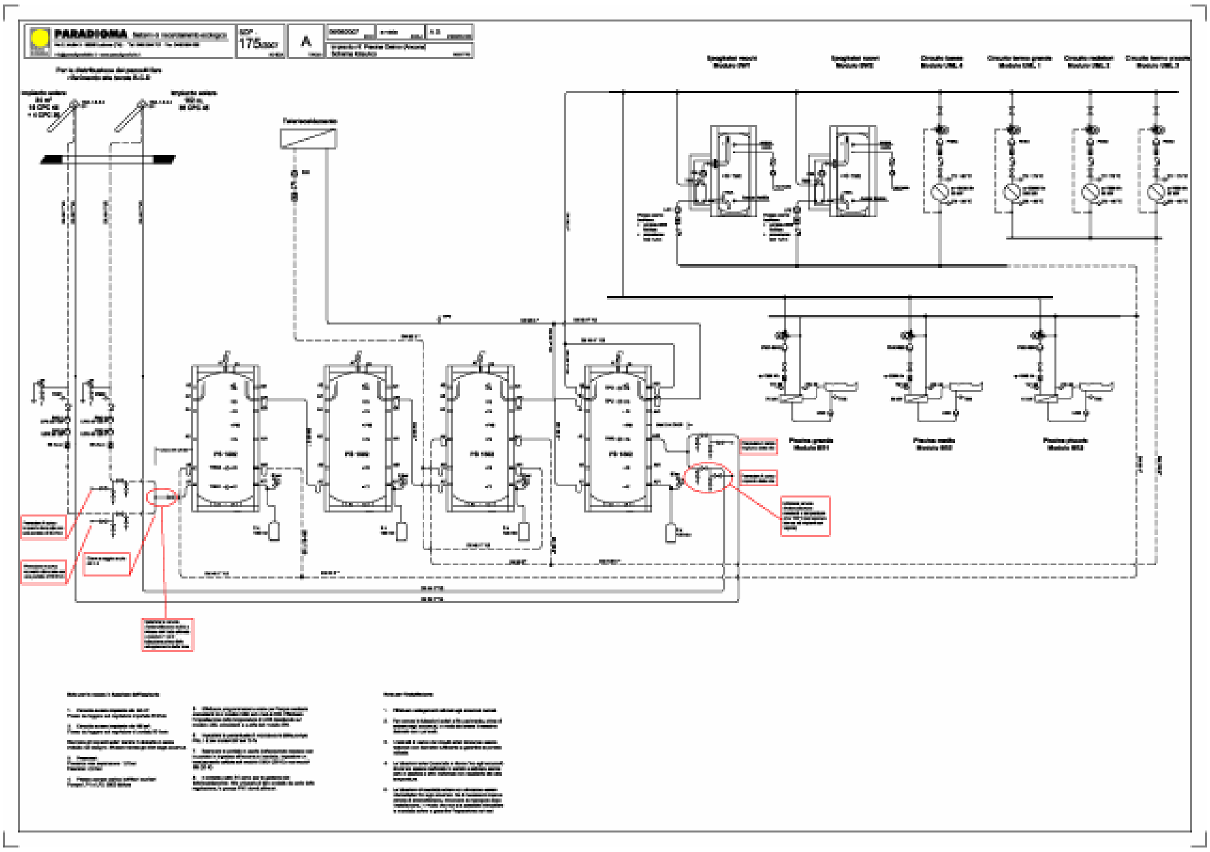


Figure 14: Osimo's Hydraulic scheme

Short description of the system

ASD Osimo Nuoto, operator of this sport centre, decided to install a solar thermal plant for domestic hot water preparation, space heating and pool heating. The Municipality of Osimo, owner of the sports centre, approved the project and participated in the investment

Partners

Owner of the building

- Comune di OSIMO
- Assessore all'ambiente Franceso Pirani
- Piazza del Comune n.1
- Osimo (AN), Italy
- Phone: +39 071 72491
- Fax: +39 071 7133254
- www.comune.osimo.an.it

Operator of the plant

- A.S.D. Osimo Nuoto
- Laura Broggi
- via Flaminia 1° n.24
- Osimo (AN), Italy
- Phone: +39 347 3659516
- l.broggi(at)tin.it
- http://www.osimonuoto.com/

Contact Address

6 Finances

6.1 System costs in Italy

- Flat not glazed panel from 150 a 250 €/m^2
- Flat glazed panel from 500 to 900 €/m^2
- Vacuum panel from 1.000 a 1.500 €/m^2 (the vacuum solar collectors are suggested if the installation with a solar cooling system)

The cost depends from the solar thermal system's size and from the position.

6.1.1 Small and Medium Pools

Normally the small and medium pool's solar thermal system have a specific cost higher than a system for big pools but also the conventional system have a specific cost higher than a system for big pools, so the pay back period is similar.

6.1.2 Big pools

The investment cost for solar heating systems for outdoor pools are higher than for conventional systems. But the low operation costs induce a very quick amortisation. 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 4,9 years already, see table below.

Table 7: Amortisation of a absorber system for a outdoor pools with 1600 m² pool surface

Heating system	Gas	Absorber	Unit
Investment costs	36.000	78.750	€
Capital costs	3.708	8.110	€/a
Energy use	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	22.736	2.092	€/a[1]
Maintenance	715	788	€/a
Total yearly costs	27.159	10.990	€/a
Heat price	0,084	0,035	€/kWh
Amortisation time		4,9	a
Calculation assumptions:			
Electricity costs:		0,18	€/kWh
Gas costs		0,065	€/kWh
Absorber surface		525	m²
Time frame		15	years
Interest rates		6	%

6.2 Funding and Financing schemes

6.2.1 Programme 1 – Example

Funding sheet		
Contact information	**Title**	Ing.
	First name	Quintino
	Last name	Cavalera
	Position	Energy Manager of Province of Lecce
	Email	cavalera@provincia.le.it
	Telephone	+39 338 8916949
Financing Information	**Organisation**	Ministry of Ambient and Protection of Territory and Sea
	Type of Support	Financing of costs
	Available Money	€.10.334.422,17
	Share of total budget	50% 65% if realized by ESCO
	Who can apply	Public Administration
	Requirements for application	Installation on public building Collector surface more than 20 m^2
	Targeted areas	Promotion of use solar thermal energy heating water
	Short description	"Il sole negli Enti pubblici", is destinated to Public Administrations and Public Agency, finalized to realizing solar thermal system on public building (www.minambiente.it).
	Documents	Preliminary project
	Source of information	Ministry of Ambient and Protection of Territory and Sea
	Year of beginning	2007
	Information website	www.minambiente.it

6.3 Cost Benefit Analysis

Table 8: Amortisation of a absorber system for a outdoor pools with 1600 m² pool surface

Heating system	Gas	Absorber	Unit
Investment costs	36.000	78.750	€
Capital costs	3.708	8.110	€/a
Energy use	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	22.736	2.092	€/a[1]
Maintenance	715	788	€/a
Total yearly costs	27.159	10.990	€/a
Heat price	0,084	0,035	€/kWh
Amortisation time		4,9	a
Calculation assumptions:			
Electricity costs:		0,18	€/kWh
Gas costs		0,065	€/kWh
Absorber surface		525	m²
Time frame		15	years
Interest rates		6	%

7 Summary

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

Technical or climatic barriers:

The lack in awareness of this technology from the operators.

Actually, in the South of Italy, only a few outdoor swimming pools are heated, because the weather, usually, is hot, but also the buildings, till fifteen years ago, usually weren't heated.

So, probably, in a few years, there will be many swimming pools with the heating system and the hope is the heating is with a solar system.

Financial Barriers:

The economical barrier depends from four factors:

- the first is the solar thermal collector's cost in comparison with the time plant utilization;
- the second is the prevalent use of the outdoor swimming pools in the summer, when don't need to heating the water
- the third is lack in information of the incentives from national or regional government for solar swimming pool installation;
- a lot of outdoor swimming pools are located in the hotel which are opened from May until September.

Social barriers:

- lack in demand of ecological tourism, even if, in the last years, there are more people who are sensitive towards these aspects;

7.2 Requirements for the implementation of Solar Heating systems for outdoor swimming pools

Requirements of the End Users	Very Important	Less Important
Power gain for heating system	X	
Saving of energy costs	X	
Cost benefit from installing ST system	X	
Long time durability of the system	X	
Low effort for installation	X	
Low effort and costs for maintenance	X	
Low required space for collectors	X	
Integration in existent heating systems	X	
No problems with the pool hygiene	X	
Plant safety, no risk for pool users	X	
Easy handling of the system	X	
Availability of grants /subsidies	X	
Independency from increasing energy costs	X	
Environmental protection	X	
Other		

8 References

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