Werner Weiss | Irene Bergmann | Gerhard Faninger

Solar Heat Worldwide

Markets and Contribution to the Energy Supply 2006

EDITION 2008

SHC
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

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1 Background

This report was prepared within the framework of the Solar Heating and Cooling Programme (SHC) of the International Energy Agency (IEA). The goal of the report is to document the solar thermal capacity previously installed in the important markets worldwide, and to ascertain the contribution of solar plants to the supply of energy and the CO_2 emissions avoided as a result of operating these plants. The collectors documented are unglazed collectors, glazed flat-plate and evacuated tube collectors with water as the energy carrier as well as glazed and unglazed air collectors.

The data were collected within the framework of a questionnaire survey of the national delegates of the Executive Committee of the SHC Programme and other national experts active in the field of solar thermal energy. Since some of the 48 countries included in this report have very detailed statistics and others could only provide estimates from experts, the data was checked for its plausibility on the basis of various publications.

Starting with the collector area, the capacity installed, the contributions of solar plants towards the supply of energy and the reduction of CO_2 were ascertained.

The 48 countries included in this report represent 3.87 billion people, which is about 60% of the world's population. The installed capacity in these countries is estimated to represent 85 - 90% of the solar thermal market worldwide.

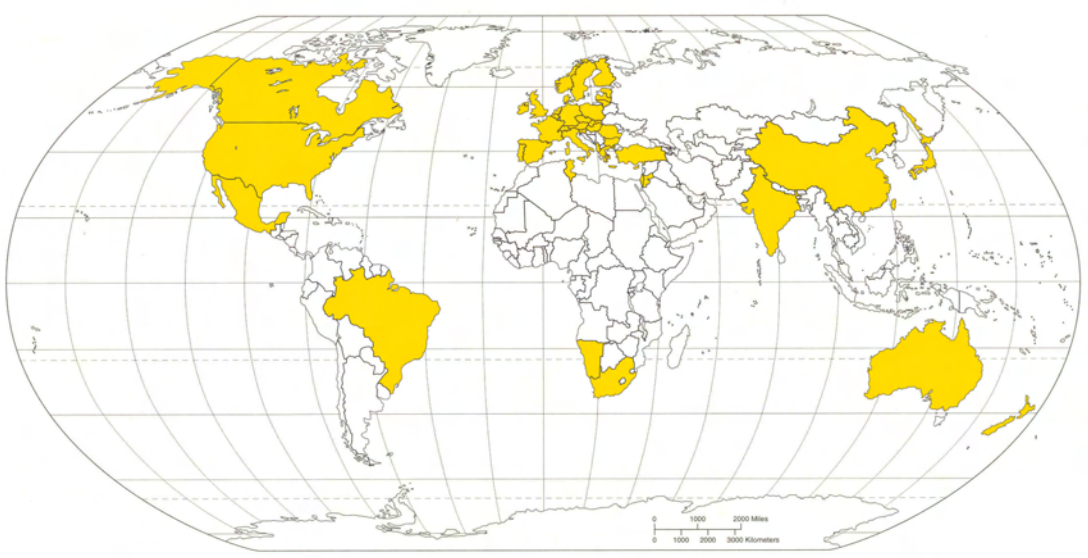


Figure 1: Countries represented in this report (yellow)

2 Summary

Solar Thermal Capacity in Operation Worldwide

The solar thermal collector capacity in operation worldwide equalled 127.8 GW_{th} corresponding to 182.5 million square meters[1] at the end of the year 2006. Of this, 102.1 GW_{th} were accounted for by flat-plate and evacuated tube collectors and 24.5 GW_{th} for unglazed plastic collectors. Air collector capacity was installed to an extent of 1.2 GW_{th}.

Distribution by Application

If one observes the use of solar thermal energy it becomes clear that it greatly varies in the different countries. In China and Taiwan (65.9 GW_{th}), Europe (14.2 GW_{th}) and Japan (4.7 GW_{th}), plants with flat-plate and evacuated tube collectors are mainly used to prepare hot water and to provide space heating, while in North America (USA and Canada) swimming pool heating is the dominant application with an installed capacity of 19.6 GW_{th} of unglazed plastic collectors.

It should be mentioned that there is a growing unglazed solar air heating market in Canada and the USA outside pool heating. Unglazed collectors are also used for commercial and industrial building ventilation, air heating and agricultural applications. It is expected that this market will grow significantly in the near future. A 4 MW_{th} project was recently completed in the USA using unglazed Solarwall collectors.

Europe has the most sophisticated market for different solar thermal applications. It includes systems for hot water preparation, plants for space heating of single- and multi-family houses and hotels, large-scale plants for district heating as well as a growing number of systems for air conditioning, cooling and industrial applications.

In Austria, Germany and Switzerland the share of applications other than hot water preparation in single-family houses is 20% and higher. There are 120 large-scale plants (≥ 500 m^2; 350 kW_{th}) in operation in Europe with a total installed capacity of 137 MW_{th}. The biggest plants are located in Denmark with 13 MW_{th} (18,300 m^2) and Sweden with 7 MW_{th} (10,000 m^2).

Leading Countries

Flat-plate and evacuated tube collectors

Focusing on the total capacity in operation of flat-plate and evacuated tube collectors installed at the end of the year 2006, China (65.1 GW_{th}), Turkey (6.6 GW_{th}), Germany (5.6 GW_{th}), Japan (4.7 GW_{th}) and Israel (3.4 GW_{th}) are the leading countries. They are followed by Greece (2.3 GW_{th}), Brazil (2.2 GW_{th}), Austria (1.9 GW_{th}), the USA (1.6 GW_{th}) and Australia (1.1 GW_{th}). As can be seen from these figures, China is by far the largest market, representing 64% of the world market of flat-plate and evacuated tube collectors.

Focusing on the market penetration—total capacity in operation per 1,000 inhabitants—Cyprus (680 kW_{th}), Israel (506 kW_{th}), Austria (231 kW_{th}), Barbados (208 kW_{th}) and Greece (207 kW_{th}) are the leading countries. They are followed by Jordan (103 kW_{th}), Turkey (90 kW_{th}), Germany (68 kW_{th}), Australia (56 kW_{th}) and China (49 kW_{th}).

1 Making the installed capacity of solar thermal collectors comparable with that of other energy sources, solar thermal experts from seven countries agreed upon a methodology to convert installed collector area into solar thermal capacity at a joint meeting of the IEA SHC Programme and major solar thermal trade associations held September 2004 in Gleisdorf, Austria. The represented associations from Austria, Canada, Germany, the Netherlands, Sweden and the USA as well as the European Solar Thermal Industry Federation (ESTIF) and the IEA SHC Programme agreed to use a factor of 0.7 kW_{th}/m^2 to derive the nominal capacity from the area of installed collectors.

Unglazed plastic collectors

With regard to the heating of swimming pools with unglazed plastic collectors, the USA leads with a total capacity of 19.2 GW_{th} in operation ahead of Australia with 2.7 GW_{th}, Germany and Canada with 0.5 GW_{th} each, and Austria and South Africa with 0.4 GW_{th}.

The market penetration gives a slightly different picture: Australia leads with 132 kW_{th} ahead of the USA with 64 kW_{th} and Austria with 51 kW_{th} per 1,000 inhabitants. In fourth to sixth places there are Switzerland, Canada and the Netherlands with an installed capacity between 21 and 14 kW_{th} per 1,000 inhabitants.

Installed capacity in 2006

In the year 2006, a new capacity of 18.3 GW_{th} corresponding to 26.1 million square metres of solar collectors were installed worldwide. The new installations grew 22% compared to 2005.

Flat-plate and evacuated tube collectors accounted for 16.7 GW_{th}. Compared to the capacity installed in 2005, the worldwide growth of the installed capacity of glazed water collectors was 23%.

The most dynamic markets for water collectors (unglazed, flat-plate and evacuated tube collectors) in Europe with growth rates above 50% compared to the capacity installed in 2005 were in the UK 93%, France 83% (including overseas departments), Spain 64%, Belgium 61%, Germany 56% and Poland 50%. Besides the European countries, the markets in Namibia 73%, Tunisia 52%, Turkey 46% and India 25% have recorded a large growth rate. The new installations in China, the world's largest market, increased in 2006 by 20% compared to installations in 2005.

Market development

The most dynamic markets for flat-plate and evacuated tube collectors worldwide are in China and Europe as well as in Australia and New Zealand. The average annual growth rate between 1999 and 2006 was 22% in China and Taiwan, 20% in Europe and 16% in Australia and New Zealand. The market for flat-plate and evacuated tube collectors has been consistently low in Canada and the USA.

Although the installed capacity of flat-plate and evacuated tube collectors in the USA is very low compared to other countries, especially with regard to the large population in the USA, the market for new installed glazed collectors has been significantly growing in the years 2005 (45 MW_{th}) and 2006 (87 MW_{th}).

The worldwide market of unglazed collectors for swimming pool heating recorded an increase between 1999 and 2002 and a slight decrease in 2003. From 2004 to 2006 the installed capacity again was increasing. The main market for unglazed collectors can mainly be found in the USA (1.0 GW_{th}) and Australia (0.4 GW_{th}). South Africa, Canada, Germany, Mexico, The Netherlands, Sweden, Switzerland, Belgium and Austria also have notable markets, but all with values below 0.1 GW_{th} of new installed unglazed collectors in 2006.

Contribution of solar collectors to the supply of energy

The annual collector yield of all solar thermal systems in operation by the end of 2006 in the 48 recorded countries is 76,959 GWh (277,054 TJ). This corresponds to an oil equivalent of 12.5 billion liters and an annual avoidance of 34.1 million tons of CO_2.

These values have been calculated from all water-based systems excluding the air systems. Since the database of the applications of air collectors is insufficient, the contribution of air collectors to the energy supply and CO_2 reduction was not calculated.

Compared with other forms of renewable energy, solar heating's contribution in meeting global energy demand is, besides the traditional renewable energies like biomass and hydropower, second only to wind power, and has a much larger contribution than photovoltaics (**Figure 2**). This fact is still underestimated by energy policy.

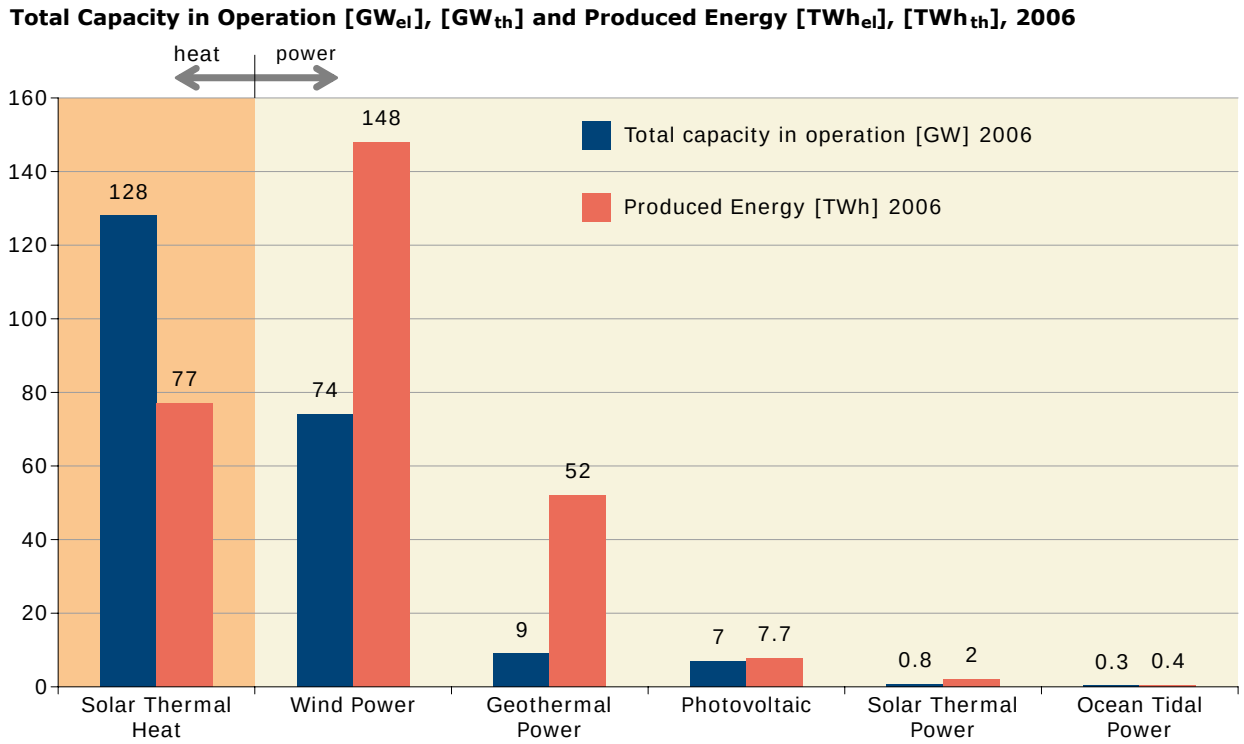


Figure 2: Total capacity in operation [GW_{el}], [GW_{th}] 2006 and annually energy generated [TWh_{el}], [TWh_{th}].
Sources: EPIA, GEWC, EWEA, EGEC, REN21 and IEA SHC 2008

Employment

Based on data collected from detailed country reports, the jobs created by the production, installation and maintenance of solar thermal plants is estimated to be 150,000 worldwide.

Preview 2007

Based on the data available for the year 2006 at the date of publishing this report, the total capacity in operation worldwide in 2007 can be estimated to be 154 GW_{th}, corresponding to 220 million square meters of collector area.

3 Total capacity by the year 2006

Since the beginning of the 1990s, the solar thermal market has undergone a favorable development. At the end of 2006, a total of 182.5 million square meters of collector area, corresponding to an installed capacity 127.8 GW_{th} were in operation in the 48 countries recorded in this report. These 48 countries represent 3.87 billion people which is about 60% of the world's population. The installed capacity in these countries represents approximately 85 - 90% of the solar thermal market worldwide.

As shown in **Table 1**, the total capacity is divided into 42.2 GW_{th} glazed flat-plate collectors (60.3 million square meters) and 59.9 GW_{th} evacuated tube collectors (85.6 million square meters), 24.5 GW_{th} unglazed collectors (35.0 million square meters) and 1.2 GW_{th} glazed and unglazed air collectors (1.6 million square meters). The distribution of the total capacity worldwide in 2006 can also be seen in **Figure 3**.

Figure 4 gives a quick overview of the 10 leading countries based on total capacities in 2006. This Figure clearly shows how the different types of collectors are applied in the different countries. China, as world leader in total capacity, is focussing very much on evacuated tube collectors, whereas the USA is holding the second position due to its high installations of unglazed collectors. Only in Australia is the unglazed collector as important as it is in the USA. The rest of the top 10 countries are clearly focussing on the flat-plate collector.

This report aims to give the actually collector area that is still in operation and not the cumulated collector area that has ever been installed in a country. The reason for this being that there is always a certain amount of collectors replaced by new systems or even taken out of operation. This explains the fact that in some countries—such as Japan—the total capacity published in this report for 2006 decreased compared to the data published for 2005 in the previous report.

To determine the collector area (respectively capacity) in operation, either official country reports on the lifetime base were taken into account or, if such reports were not available, a 25-year lifetime for a system was calculated. The collector area in operation was then calculated with a linear equation.

It must be stated that data of installed unglazed collectors are officially collected in just a few countries. So if there is no data given for this collector type for a country, it means there was no reliable data available. This also applies for glazed and unglazed air collectors.

In **Chapter 5** collector yields, energy savings and the contribution to the CO_2 reduction is calculated based on the total collector area in operation in each country.

Country	Water collectors			Air collectors		TOTAL [MW_{th}]
	unglazed***	glazed	evacuated tube	unglazed***	glazed***	
Albania		28.45	0.11			**28.56**
Australia	2,660.00	1,120.00	12.60			**3,792.60**
Austria	420.16	1,870.36	27.71			**2,318.23**
Barbados		56.04				**56.04**
Belgium	28.00	67.73	5.16			**100.88**
Brazil		2,178.47				**2,178.47**
Bulgaria		17.57				**17.57**
Canada	456.87	56.21	1.65	82.67	0.04	**597.45**
China		6,510.00	58,590.00			**65,100.00**
Cyprus		568.08				**568.08**
Czech Republic	6.46	54.73	6.57			**67.77**
Denmark	14.54	259.60	2.10		10.68	**286.92**
Estonia		0.78				**0.78**
Finland	0.35	9.44	0.48			**10.26**
France*	66.42	734.66	11.19			**812.28**
Germany	525.00	5,078.82	558.98			**6,162.80**
Greece		2,301.04				**2,301.04**
Hungary	1.96	24.74	0.39			**27.09**
India		1,050.00				**1,050.00**
Ireland		8.95	2.18			**11.13**
Israel	16.45	3,406.13				**3,422.58**
Italy	15.83	464.46	47.50			**527.80**
Japan		4,660.84	86.11	304.06		**5,051.01**
Jordan		582.87	2.52			**585.39**
Lativa		2.70				**2.70**
Lithuania		1.93				**1.93**
Luxembourg		11.13				**11.13**
Macedonia		11.98				**11.98**
Malta		16.70				**16.70**
Mexico	308.01	247.55				**555.56**
Namibia		2.22				**2.22**
Netherlands	230.69	221.80				**452.49**
New Zealand	4.11	66.66	3.71			**74.48**
Norway	0.98	7.35	0.07		0.84	**9.24**
Poland	1.19	103.97	9.53	2.10	1.75	**118.53**
Portugal		169.82				**169.82**
Romania		48.37				**48.37**
Slovak Republic		50.93				**50.93**
Slovenia		76.51				**76.51**
South Africa	392.92	163.58				**556.49**
Spain		639.22	24.22			**663.43**
Sweden	44.10	150.50	14.00			**208.60**
Switzerland**	149.00	268.16	17.17	585.20		**1,019.54**
Taiwan		708.34	75.96			**784.31**
Tunisia		124.27	0.33			**124.60**
Turkey		6,615.00				**6,615.00**
United Kingdom		175.64				**175.64**
United States	19,165.44	1,243.34	390.71	0.07	159.96	**20,959.51**
TOTAL	**24,508.48**	**42,237.62**	**59,890.96**	**974.10**	**173.27**	**127,784.43**

* France: includes Overseas Departments

** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying purposes

*** If no data is given: no reliable data base for this collector type available

Table 1: Total capacity in operation at the end of 2006 [MW_{th}]

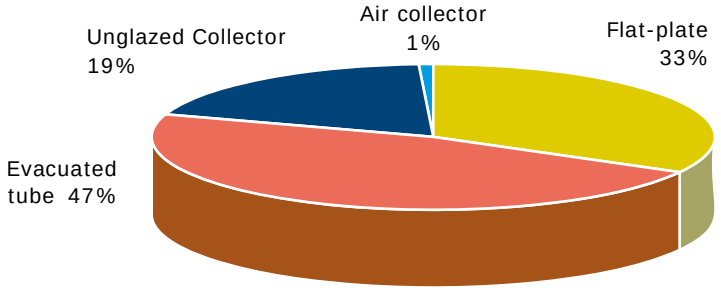


Figure 3: Distribution of the worldwide capacity in operation 2006 by collector type

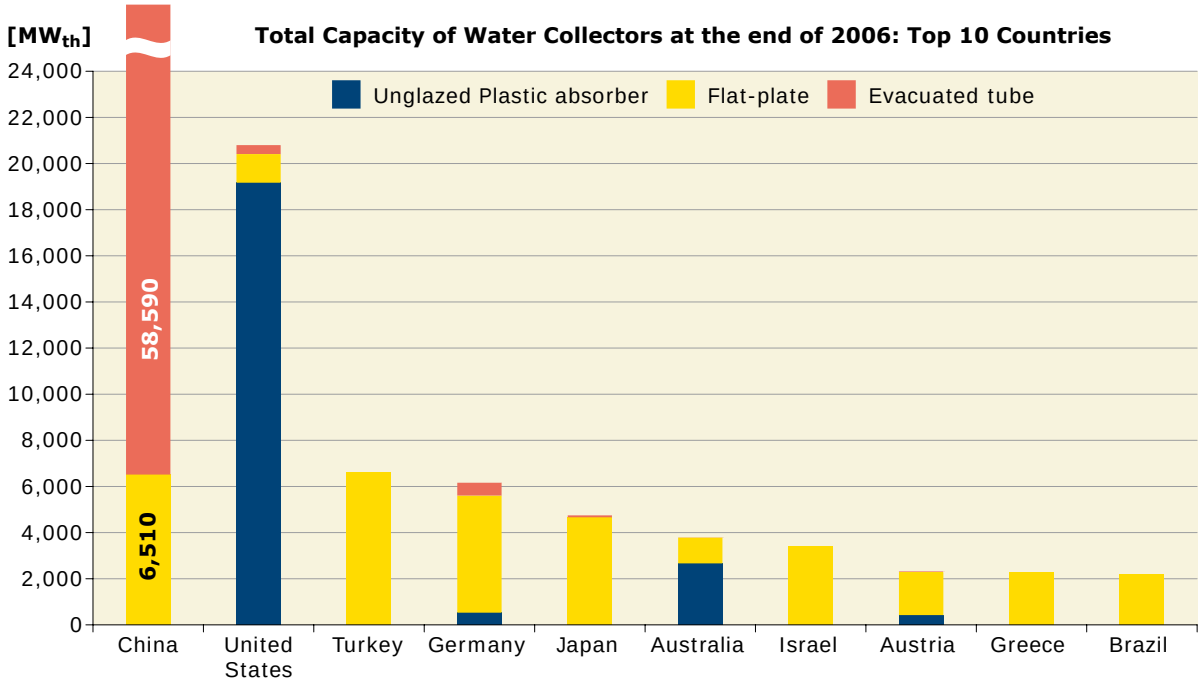
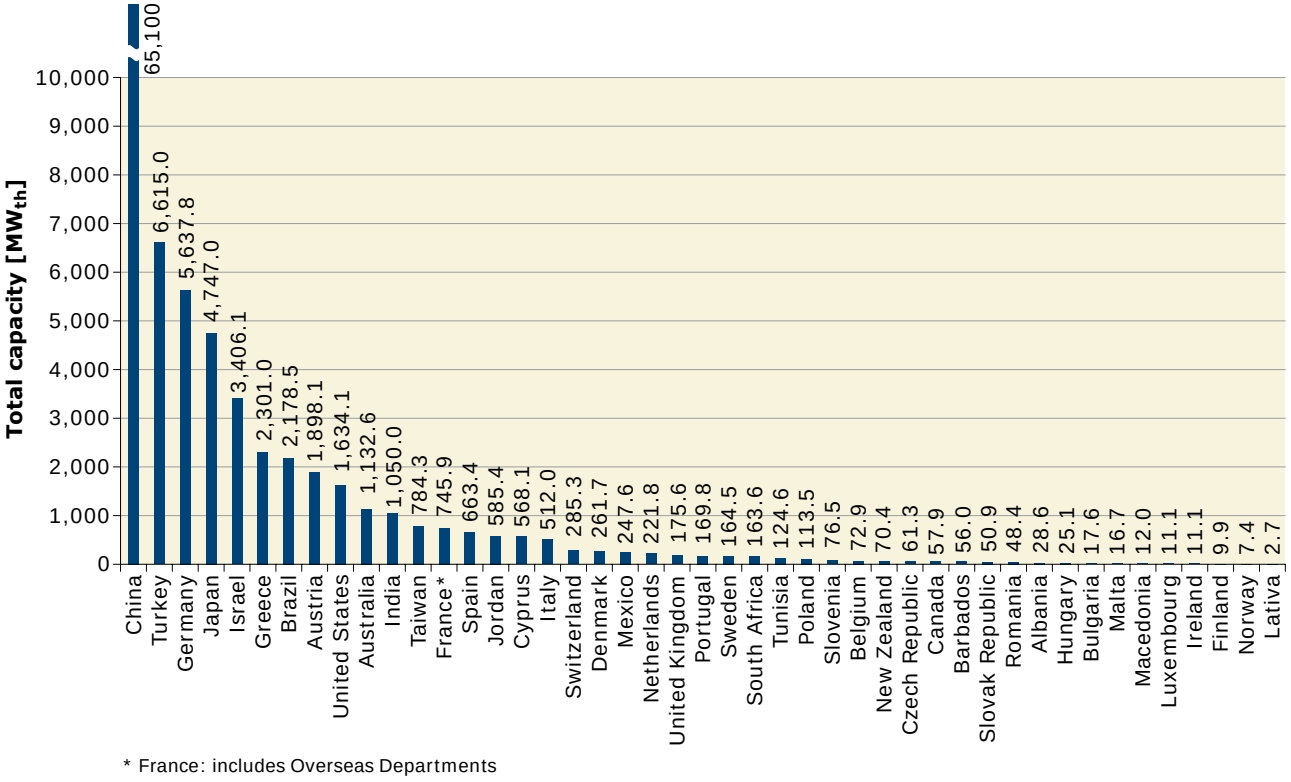


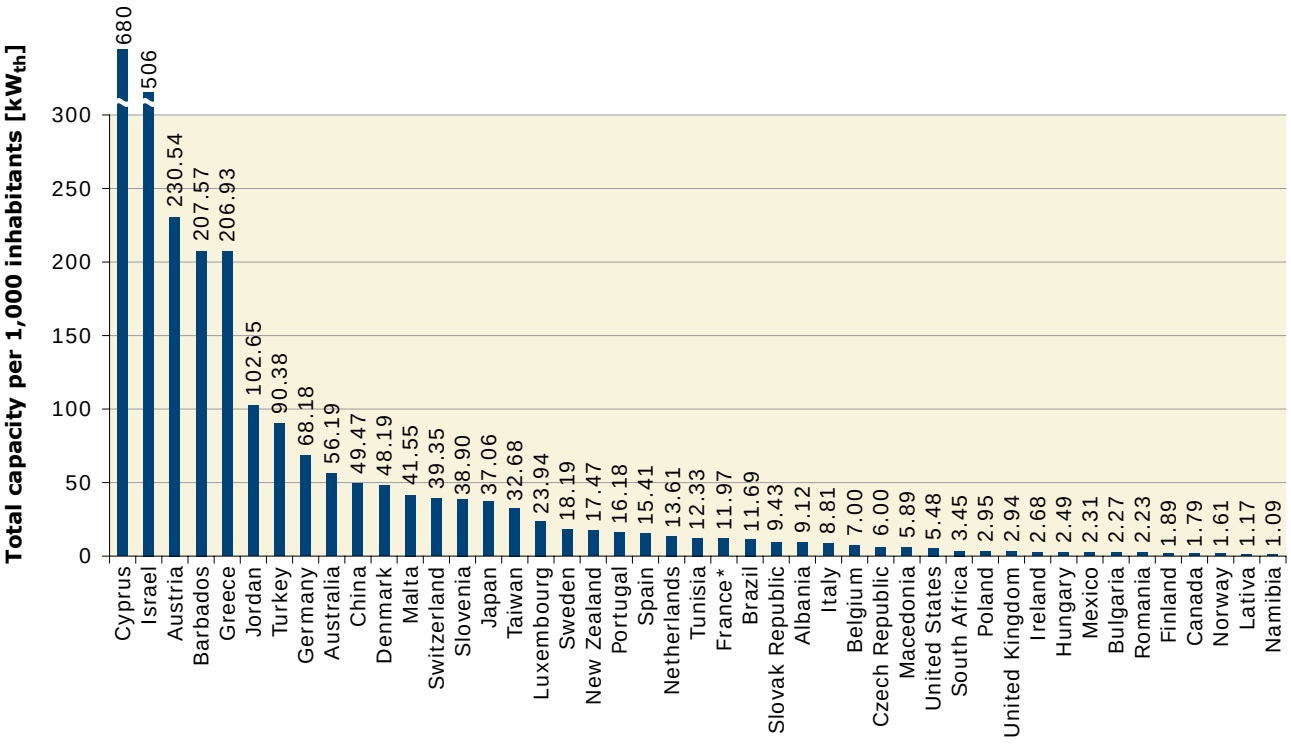
Figure 4: Total capacity in operation of water collectors of the 10 leading countries at the end of 2006

3.1 Total capacity of glazed flat-plate and evacuated tube collectors at the end of 2006



* France: includes Overseas Departments

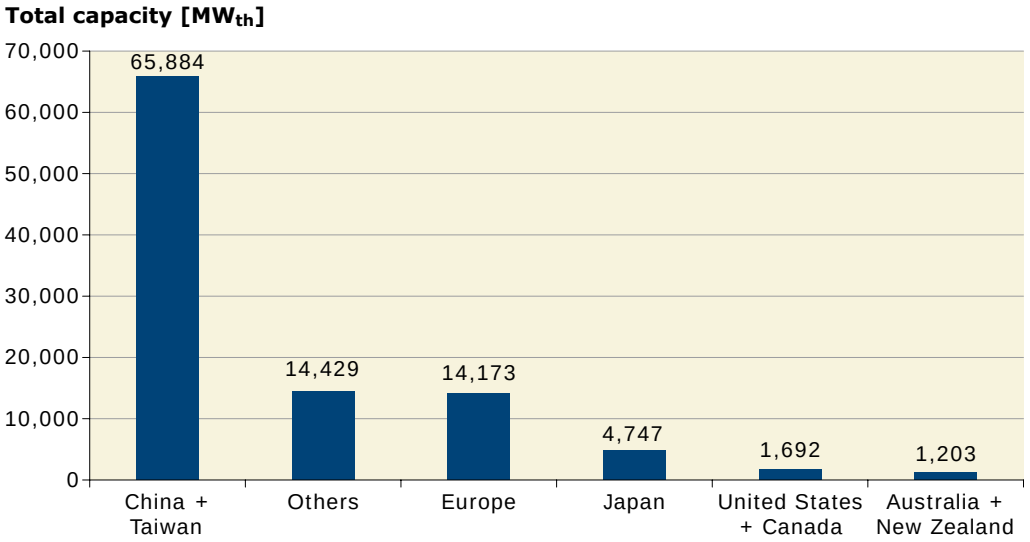
Figure 5: Total capacity of glazed flat-plate and evacuated tube collectors in operation at the end of 2006



* France: includes Overseas Departments

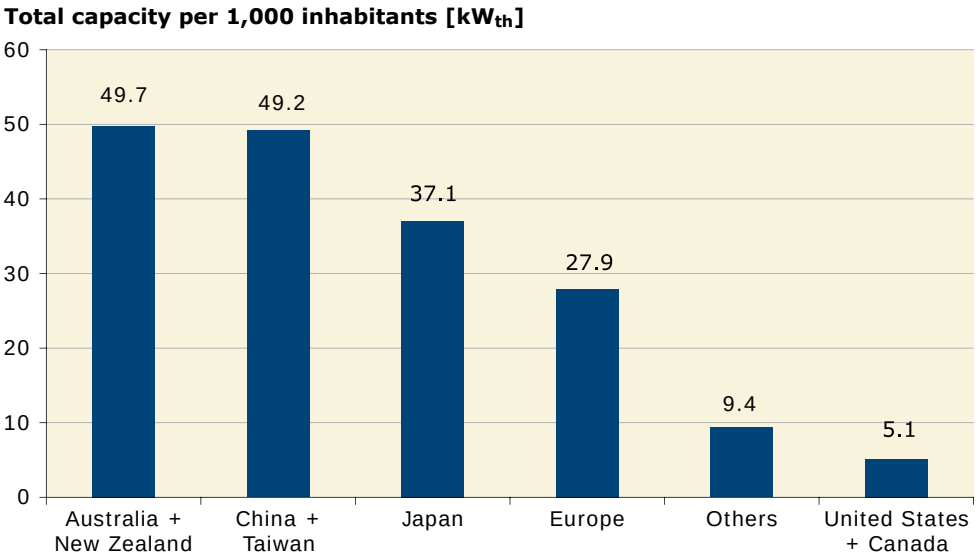
Figure 6: Total capacity of glazed flat-plate and evacuated tube collectors in operation at the end of 2006 in kW_{th} per 1,000 inhabitants

3.2 Total capacity of glazed flat-plate and evacuated tube collectors in operation at the end of 2006 by economic region



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 7: Total capacity of glazed flat-plate and evacuated tube collectors in operation by economic region at the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 8: Total capacity of glazed flat-plate and evacuated tube collectors in operation by economic region at the end of 2006 in kW_{th} per 1,000 inhabitants

3.3 Total capacity of unglazed water collectors in operation at the end of 2006

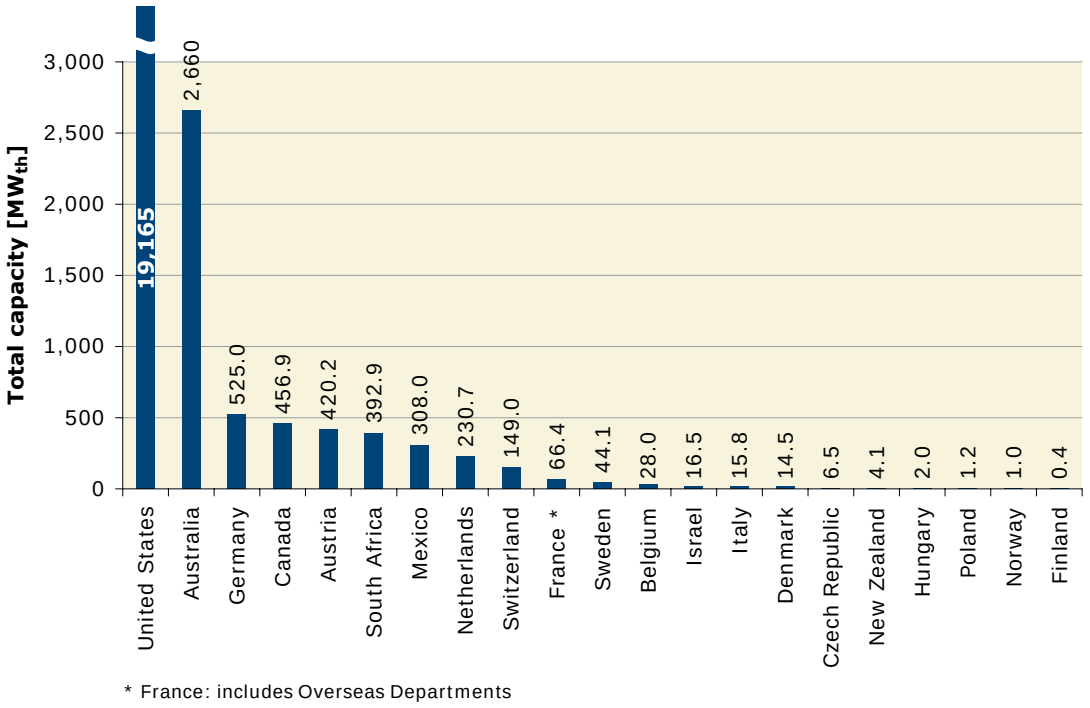


Figure 9: Total capacity of unglazed water collectors in operation at the end of 2006

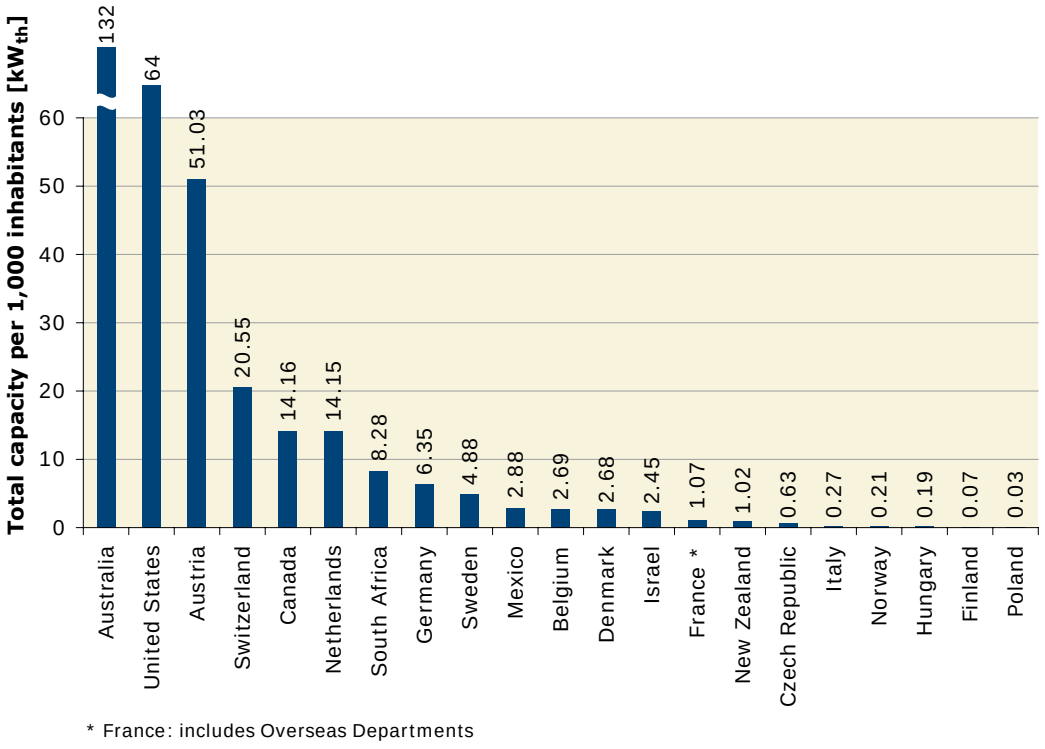
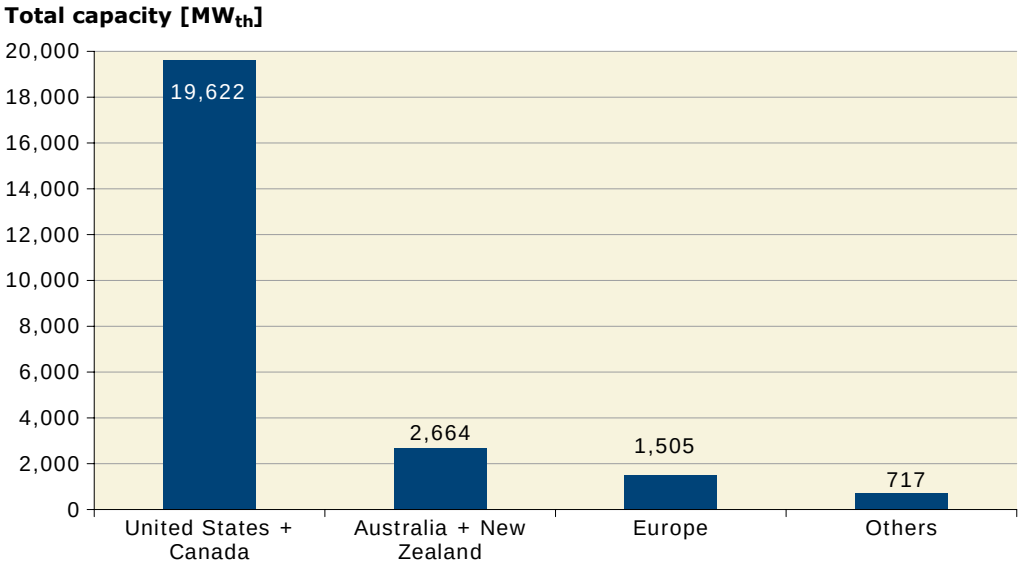


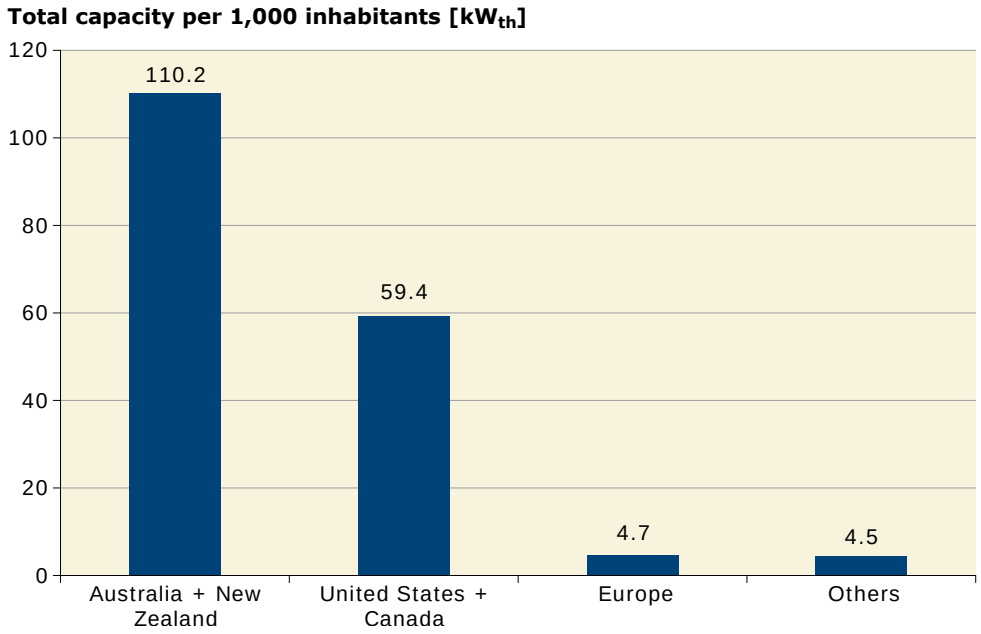
Figure 10: Total capacity of unglazed water collectors in operation at end of 2006 in kW_{th} per 1,000 inhabitants

3.4 Total capacity of unglazed water collectors in operation by economic region at the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 11: Total capacity of unglazed collectors in operation by economic region at the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 12: Total capacity of unglazed collectors in operation by economic region at the end of 2006 in kW_{th} per 1,000 inhabitants

4 Market development

4.1 Annual installed capacity

In the year 2006, a capacity of 18.3 GW_{th} corresponding to 26.1 million square metres of solar collectors, were installed worldwide. Flat-plate and evacuated tube collectors accounted for 16.7 GW_{th}. The main market for unglazed collectors can mainly be found in the USA (1.0 GW_{th}) and Australia (0.4 GW_{th}). South Africa, Canada, Germany, Mexico, The Netherlands, Sweden, Switzerland, Belgium and Austria also have a notable market, but all with values below 0.1 GW_{th} of new installed unglazed collectors in 2006.

Data of installed unglazed collectors are officially collected in just a few countries. So if there is no data given for this collector type for a country, it means there was no reliable data available. This also applies for glazed and unglazed air collectors.

The following table shows the capacity installed yearly in the recorded countries in 2006 (see **Table 14** for the capacity installed in 2005 in **Chapter 7.5**; the installed collector area in m^2 is given in **Tables 15** and **16** in **Chaper 7.6**).

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed***	glazed	evacuated tube	unglazed***	glazed***	
Albania		5.57	0.05			**5.63**
Australia	385.00	109.20	10.50			**504.70**
Austria	4.85	202.82	2.05			**209.72**
Barbados		1.91				**1.91**
Belgium	6.18	21.89	3.06			**31.12**
Brazil		304.03				**304.03**
Bulgaria		1.54				**1.54**
Canada	25.40	0.92	0.50	16.41	0.03	**43.26**
China		1,260.00	11,340.00			**12,600.00**
Cyprus		42.00				**42.00**
Czech Republic	4.20	12.94	2.48			**19.62**
Denmark	1.12	19.95	0.70		4.90	**26.67**
Estonia		0.21				**0.21**
Finland		2.38				**2.38**
France *	4.20	198.80	7.70			**210.70**
Germany	21.00	945.00	105.00			**1,071.00**
Greece		174.30				**174.30**
Hungary		0.70				**0.70**
India		350.00				**350.00**
Ireland		2.87	0.63			**3.50**
Israel	2.66	155.40				**158.06**
Italy	2.56	109.06	18.59			**130.20**
Japan		183.87	0.97	12.21		**197.04**
Jordan		5.37	2.52			**7.89**
Lativa		0.84				**0.84**
Lithuania		0.42				**0.42**
Luxembourg		1.75				**1.75**
Macedonia		1.48	0.03			**1.51**
Malta		3.15				**3.15**
Mexico	20.32	47.41				**67.73**
Namibia		1.20				**1.20**
Netherlands	17.09	10.46				**27.55**
New Zealand	0.42	6.72	2.35			**9.49**
Norway		0.49	0.07			**0.56**
Poland	0.11	24.61	4.38			**29.09**
Portugal		19.81				**19.81**
Romania		0.28				**0.28**
Slovak Republic		5.39	0.56			**5.95**
Slovenia		4.41	0.42			**4.83**
South Africa	45.57	9.66				**55.23**
Spain		113.31	9.19			**122.50**
Sweden	9.39	13.88	6.10			**29.37**
Switzerland **	6.27	35.25	1.06	0.70		**43.27**
Taiwan		79.55	5.99			**85.54**
Tunisia		24.17	0.33			**24.50**
Turkey		490.00				**490.00**
United Kingdom		18.90	18.90			**37.80**
United States	1,010.99	83.57	3.58		0.39	**1,098.52**
TOTAL	**1,567.33**	**5,107.43**	**11,547.67**	**29.31**	**5.32**	**18,257.07**

* France: includes Overseas Departments

** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying purposes.

*** If no data is given: no reliable data base for this collector type available

Table 2: Installed capacity in 2006, MW_{th}/a

4.2 Market development of glazed flat-plate and evacuated tube collectors by economic region

Analyzing the market development of hot water preparation and spacing heating, from 1999 to 2006, it can be seen that the market of flat-plate and evacuated tube collectors grew significantly during this time period.

The most dynamic markets for flat-plate and evacuated tube collectors worldwide are in China and Europe as well as in Australia and New Zealand. The average annual growth rate between 1999 and 2006 was 22% in China and Taiwan, 20% in Europe and 16% in Australia and New Zealand. The market for flat-plate and evacuated tube collectors has been consistently low in Canada and the USA.

Although the market for flat-plate and evacuated tube collectors has been growing significantly in the USA since 2004, it is still almost not noticeable in comparison with worldwide installations. Nevertheless, it should be positively pointed out, that the installations in 2006 have almost doubled compared to 2005.

After a peak in 1980s because of the second oil crisis, the market in Japan went down rapidly. The Japanese Ministry of Economy, Trade and Industry stopped the subsidies for solar thermal systems. This caused a break in of the marked, because without subsidies less systems were sold.

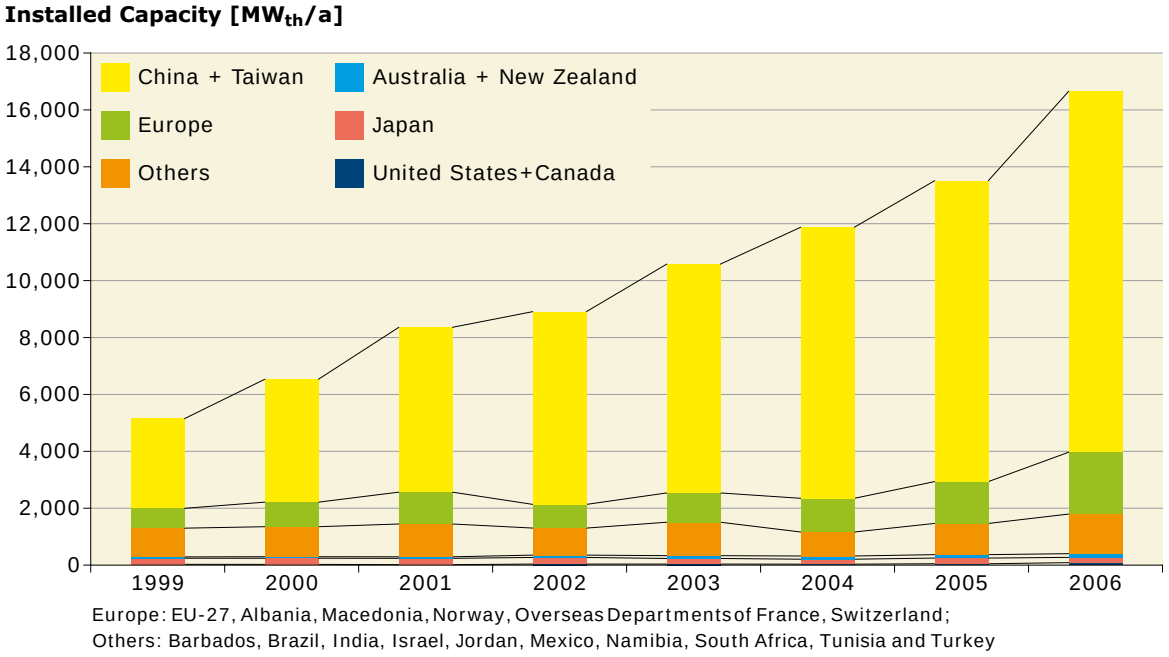


Figure 13: Annual installed capacity of flat-plate and evacuated tube collectors from 1999 to 2006

It should be mentioned here that the Chinese market is dominated by evacuated tube collectors, whereas in all other markets the flat-plate collectors are predominant (see **Figure 4**). Other important markets in 2006 for evacuated tube collectors were in Germany, Italy, USA, United Kingdom and Taiwan.

Figure 14 shows a different picture of the market development. Comparing the yearly installed capacity per 1,000 inhabitants, the European market turns out to be the most dynamic one, whereas China looses absolute dominance due to its large population.

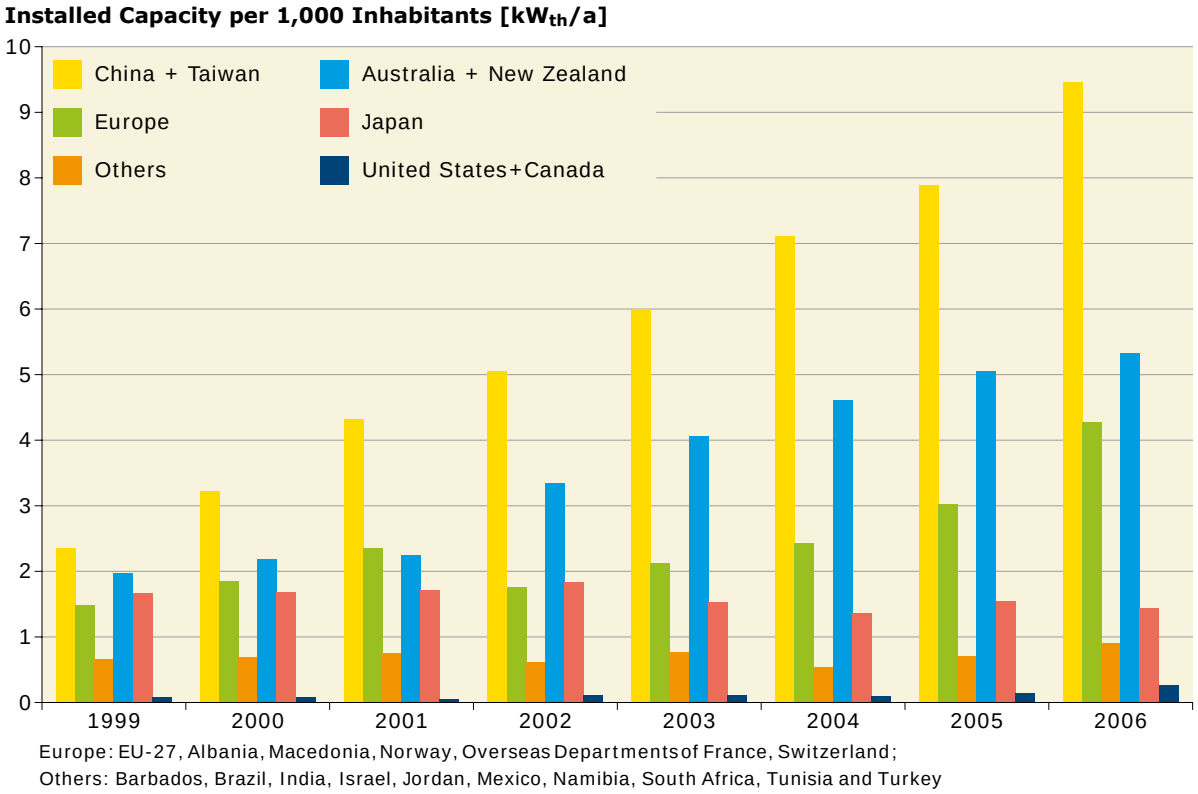


Figure 14: Annual installed capacity of flat-plate and evacuated tube collectors in kW_{th} per 1,000 inhabitants from 1999 to 2006

4.3 Market development of unglazed plastic collectors by economic region

In the USA and Australia, the unglazed collectors play an important role. In other big markets like China, Turkey, India and Japan, unglazed collectors almost do not exist. In Europe, the installation of unglazed collectors is almost at a constant level of about 1 GW_{th}.

The worldwide market of unglazed collectors for swimming pool heating recorded an increase between 1999 and 2002 and a decrease in 2003. From 2004 to 2006, the installed capacity again achieved an increase.

It must be declared that data of installed unglazed collectors are officially collected in just a few countries. So if there is no data given for this technology for a country, it means there was no reliable data available. This also applies for glazed and unglazed air collectors.

It should be mentioned that there is a growing unglazed solar air heating market in Canada and the USA outside pool heating. Unglazed collectors are also used for commercial and industrial building ventilation, air heating and agricultural applications. It is expected that this market will grow significantly in the near future. A 4 MW_{th} project was recently completed in the USA using unglazed Solarwall collectors.

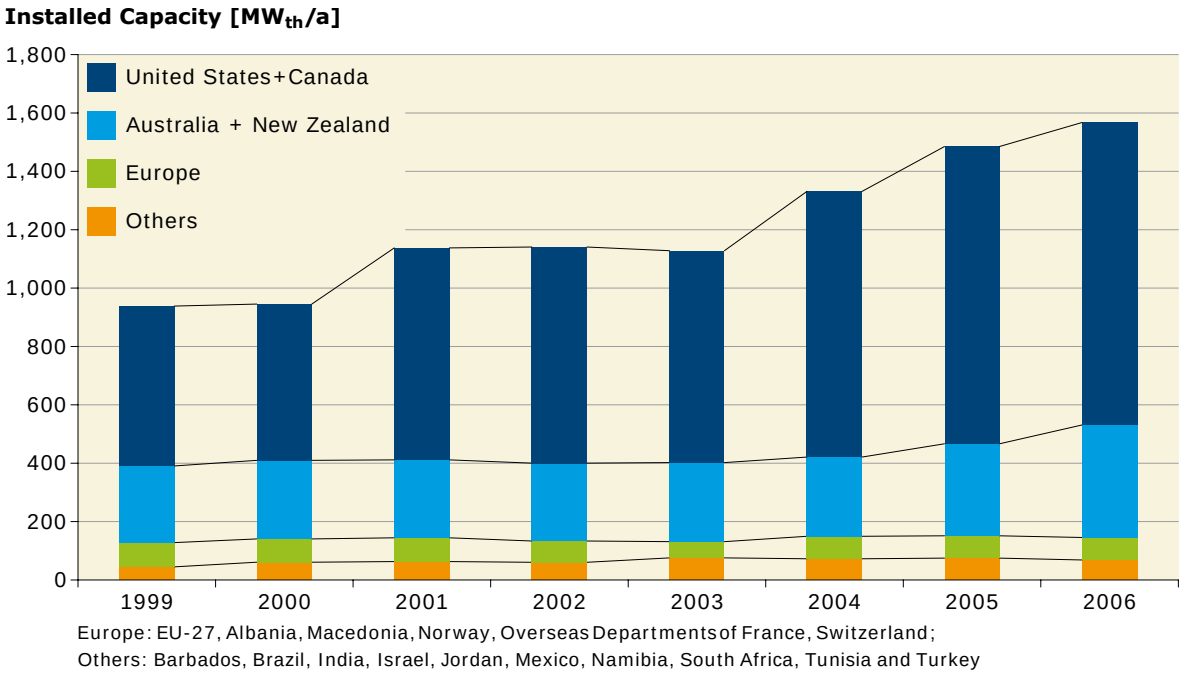


Figure 15: Annual installed capacity of unglazed water collectors from 1999 to 2006

5 Contribution to the energy supply and CO_2 reduction

In this section, the contribution of installed water collectors to the energy supply and CO_2 reduction is shown. The data for air collector applications was insufficient, therefore, the contribution of air collectors to the energy supply and CO_2 reduction was not calculated.

The basis for these calculations is the total collector area in operation in each country. As shown in **Table 1**, a flat-plate and evacuated tube collector capacity of 102.1 GW_{th} and an unglazed plastic collector capacity of 24.5 GW_{th} was installed by the end of the year 2006 in the recorded countries.

The annual yield of these collectors is calculated to be 76,959 GWh (277,054 TJ). This corresponds to a calculated oil equivalent of 12.5 billion liter and an annual CO_2 reduction of 34.1 million tons of CO_2 (**Table 3**).

5.1 Basis for calculation

In order to ascertain the energy yield of thermal solar plants, the oil equivalent saved and the CO_2 emissions avoided, the following procedure was used:

- Only water collectors were used for the calculations (unglazed, flat-plate and evacuated tube collectors). Air collector plants were not considered.
- For each country, the overall collector area installed (water collectors) was allocated to the four plant types:
  - swimming pool heating
  - domestic hot water systems for single family houses
  - domestic hot water systems for multi-family houses and district heating
  - solar combisystems for domestic hot water and space heating
- Reference plants were defined for each country for each type of plant.
- The number of plants for each country was ascertained from the share of collector area for each plant type and the collector area per reference system.

Reference collectors and a reference climate were determined for each country apart from the reference plants. On the basis of these reference conditions simulations were performed with the simulation program T-Sol [T-Sol, Version 4.2 Expert, dynamic simulation program to design and optimise solar thermal plants, Valentin Energiesoftware, www.valentin.de] and in this way the solar yields, energy savings and CO_2 emissions were ascertained. The reference conditions, which formed the basis for the simulation, can be found in the appendix.

5.2 Results

The annual collector yield per square meter of collector area, depending on the application (domestic hot water preparation, space heating, etc.), the local climatic conditions and the plant dimensioning (high or low solar fraction), is between 250 kWh/m² for solar combisystems for hot water preparation and space heating at high latitudes and 600 kWh/m² for plants used to prepare hot water low latitudes.

The energy savings were ascertained from the energy equivalent of the fuel used and the rate of efficiency of the auxiliary heating system. For the auxiliary heating system, oil was taken as the fuel for all plants and the energy equivalent per liter of oil 36,700 kJ respectively 10.2 kWh was used in all countries in order to achieve comparable results.

To obtain an exact statement about the CO_2 emissions avoided, the substituted energy medium would have to be ascertained for each country. Since this could only be done in a very detailed survey, which goes beyond the scope of this report, the energy savings and the CO_2 emissions avoided relate to oil. It is obvious that not all solar thermal systems worldwide just replace systems running on oil. This represents a simplification since gas, coal, biomass or electricity can be used as the energy source for the auxiliary heating system instead of oil.

The CO_2 emissions avoided by solar plants were ascertained from the energy savings (oil equivalent). As the emission factor 2.73 kg CO_2 per liter oil was used.

Country	Total collector area** [m²]	Total capacity [MW_{th}]	Calculated number of systems	Collector yield [GWh/a]	Collector yield [TJ/a]	Energy savings / oil equivalent [l/a]	CO_2 reduction [t/a]
Albania	40,798	28.6	16,319	18.7	67.4	3,720,778	10,151
Australia	5,418,000	3,792.6	416,057	2,066.1	7,437.9	363,366,687	991,548
Austria	3,311,750	2,318.2	330,553	1,101.7	3,966.0	165,780,327	452,362
Barbados	80,063	56.0	20,016	65.3	234.9	11,649,109	31,765
Belgium	144,118	100.9	26,230	47.0	169.2	6,784,724	18,511
Brazil	3,112,105	2,178.5	778,026	1,367.0	4,921.2	243,522,216	664,434
Bulgaria	25,100	17.6	6,275	10.9	39.3	2,246,450	6,124
Canada	735,333	514.7	16,433	178.5	642.7	29,251,465	79,812
China	93,000,000	65,100.0	22,608,300	40,009.8	144,035.1	6,368,175,000	17,402,393
Cyprus	811,538	568.1	199,152	509.1	1,832.6	87,311,475	238,070
Czech Republic	96,810	67.8	14,514	30.4	109.5	4,351,608	11,820
Denmark	394,630	276.2	81,705	132.4	476.7	18,705,151	51,034
Estonia	1,120	0.8	280	0.4	1.3	47,600	130
Finland	14,663	10.3	3,380	4.6	16.5	602,971	1,645
France*	1,160,400	812.3	256,588	388.4	1,398.2	70,567,879	192,303
Germany	8,804,000	6,162.8	1,171,043	3,158.8	11,371.8	457,112,401	1,247,230
Greece	3,287,200	2,301.0	1,289,897	1,727.5	6,218.9	363,085,704	990,621
Hungary	38,700	27.1	5,945	13.2	47.4	2,470,099	6,743
India	1,500,000	1,050.0	375,000	1,345.5	4,843.8	225,375,000	615,000
Ireland	15,896	11.1	3,974	5.3	18.9	691,476	1,884
Israel	4,889,400	3,422.6	1,194,209	3,577.4	12,878.7	573,524,136	1,563,577
Italy	754,000	527.8	182,958	318.3	1,146.0	50,344,290	137,345
Japan	6,781,363	4,747.0	1,641,542	3,235.2	11,646.8	485,922,652	1,325,716
Jordan	836,266	585.4	205,220	586.8	2,112.4	121,279,477	330,873
Lativa	3,850	2.7	963	1.3	4.7	178,063	487
Lithuania	2,750	1.9	688	0.9	3.3	128,563	350
Luxembourg	15,900	11.1	3,975	5.5	19.7	763,200	2,087
Macedonia	17,118	12.0	4,280	7.4	26.7	1,536,341	4,190
Malta	23,860	16.7	5,965	7.4	26.8	2,726,005	7,438
Mexico	793,662	555.6	32,048	366.8	1,320.4	69,294,194	189,066
Namibia	3,168	2.2	792	1.6	5.7	365,939	992
Netherlands	646,410	452.5	91,054	156.5	563.4	21,512,894	58,674
New Zealand	106,394	74.5	24,005	31.6	113.7	5,016,855	13,692
Norway	12,000	8.4	1,746	3.8	13.7	499,075	1,362
Poland	163,830	114.7	26,792	52.5	189.0	7,670,038	20,909
Portugal	242,596	169.8	57,859	152.4	548.5	24,882,202	67,888
Jordan	69,100	48.4	17,275	32.0	115.1	6,011,700	16,411
Slovak Rep.	72,750	50.9	12,125	29.1	104.9	4,365,000	11,907
Slovenia	109,300	76.5	17,896	39.4	141.9	5,790,408	15,791
South Africa	794,990	556.5	61,227	207.7	747.8	35,332,007	96,359
Spain	947,764	663.4	226,042	578.6	2,082.9	87,186,611	237,896
Sweden	298,000	208.6	20,682	114.6	412.7	13,055,728	35,609
Switzerland	620,480	434.3	54,028	178.2	641.6	25,714,455	70,151
Taiwan	1,120,440	784.3	280,110	561.9	2,022.8	99,439,050	271,707
Tunisia	178,000	124.6	44,500	118.7	427.4	26,255,000	71,690
Turkey	9,450,000	6,615.0	2,145,150	5,633.2	20,279.7	895,226,850	2,445,117
UK	250,920	175.6	62,730	83.6	300.9	11,962,611	32,645
United States	29,713,560	20,799.5	525,956	8,696.5	31,307.5	1,492,822,565	4,073,144
TOTAL	**180,910,095**	**126,637**	**34,561,502**	**76,959**	**277,054**	**12,493,624,027**	**34,116,651**

* France: includes Overseas Departments

** Unglazed, Glazed Flat-Plate and Evacuated Tube Water Collectors

Table 3: Calculated collector yield and corresponding oil equivalent as well as CO_2 reduction of all solar thermal systems (systems for hot water, space heating and swimming pool heating) at the end of 2006

Country	Total collector area** [m²]	Total capacity [MW_{th}]	Number of systems	Collector yield [GWh/a]	Collector yield [TJ /a]	Energy savings /oil equivalent [l/a]	CO2 reduction [t/a]
Albania	40,798	28.6	16,319	18.7	67.4	3,720,778	10,151
Australia	1,618,000	1,132.6	397,057	666.4	2,398.9	115,547,787	315,388
Austria	2,711,522	1,898.1	327,552	965.6	3,476.3	143,562,888	391,742
Barbados	80,063	56.0	20,016	65.3	234.9	11,649,109	31,765
Belgium	104,118	72.9	26,030	40.3	145.1	5,651,004	15,417
Brazil	3,112,105	2,178.5	778,026	1,367.0	4,921.2	243,522,216	664,434
Bulgaria	25,100	17.6	6,275	10.9	39.3	2,246,450	6,124
Canada	82,655	57.9	13,170	37.8	136.1	5,330,167	14,544
China	93,000,000	65,100.0	22,608,300	40,009.8	144,035.1	6,368,175,000	17,402,393
Cyprus	811,538	568.1	199,152	509.1	1,832.6	87,311,475	238,070
Czech Republic	87,580	61.3	14,468	27.7	99.7	4,037,788	10,958
Denmark	373,860	261.7	81,601	129.2	465.2	18,166,097	49,563
Estonia	1,120	0.8	280	0.4	1.3	47,600	130
Finland	14,163	9.9	3,378	4.5	16.2	592,705	1,617
France*	1,065,512	745.9	256,114	369.7	1,331.0	67,337,560	183,489
Germany	8,054,000	5,637.8	1,167,293	2,997.6	10,791.4	429,201,526	1,171,077
Greece	3,287,200	2,301.0	1,289,897	1,727.5	6,218.9	363,085,704	990,621
Hungary	35,900	25.1	5,931	12.4	44.5	2,332,143	6,367
India	1,500,000	1,050.0	375,000	1,345.5	4,843.8	225,375,000	615,000
Ireland	15,896	11.1	3,974	5.3	18.9	691,476	1,884
Israel	4,865,900	3,406.1	1,194,092	3,576.0	12,873.8	571,937,886	1,559,250
Italy	731,380	512.0	182,845	313.6	1,128.9	49,496,142	135,031
Japan	6,781,363	4,747.0	1,641,542	3,235.2	11,646.8	485,922,652	1,325,716
Jordan	836,266	585.4	205,220	586.8	2,112.4	121,279,477	330,873
Lativa	3,850	2.7	963	1.3	4.7	178,063	487
Lithuania	2,750	1.9	688	0.9	3.3	128,563	350
Luxembourg	15,900	11.1	3,975	5.5	19.7	763,200	2,087
Macedonia	17,118	12.0	4,280	7.4	26.7	1,536,341	4,190
Malta	23,860	16.7	5,965	7.4	26.8	2,726,005	7,438
Mexico	353,647	247.6	29,848	239.1	860.9	46,542,558	126,990
Namibia	3,168	2.2	792	1.6	5.7	365,939	992
Netherlands	316,856	221.8	89,406	106.7	384.3	13,308,977	36,290
New Zealand	100,529	70.4	23,976	30.3	108.9	4,791,366	13,077
Norway	10,600	7.4	1,739	3.6	12.9	467,575	1,276
Poland	162,130	113.5	26,784	52.1	187.7	7,610,674	20,747
Portugal	242,596	169.8	57,859	152.4	548.5	24,882,202	67,888
Romania	69,100	48.4	17,275	32.0	115.1	6,011,700	16,411
Slovac Rep.	72,750	50.9	12,125	29.1	104.9	4,365,000	11,907
Slovenia	109,300	76.5	17,896	39.4	141.9	5,790,408	15,791
South Africa	233,680	163.6	58,420	102.2	368.0	17,701,260	48,255
Spain	947,764	663.4	226,042	578.6	2,082.9	87,186,611	237,896
Sweden	235,000	164.5	20,367	106.2	382.5	11,751,880	32,051
Switzerland	407,620	285.3	52,963	141.3	508.8	19,630,384	53,551
Taiwan	1,120,440	784.3	280,110	561.9	2,022.8	99,439,050	271,707
Tunisia	178,000	124.6	44,500	118.7	427.4	26,255,000	71,690
Turkey	9,450,000	6,615.0	2,145,150	5,633.2	20,279.7	895,226,850	2,445,117
UK	250,920	175.6	62,730	83.6	300.9	11,962,611	32,645
United States	2,334,359	1,634.1	389,060	1,338.4	4,818.1	223,125,821	608,840
TOTAL	**145,897,976**	**102,129**	**34,386,441**	**67,395**	**242,623**	**10,837,968,665**	**29,599,276**

* France: includes Overseas Departments

** Flat-plate and evacuated tube collectors

Table 4: Calculated collector yield and corresponding oil equivalent as well as CO_2 reduction of solar thermal systems for hot water preparation and space heating with flat-plate and evacuated tube collectors at the end of 2006

Country	Total collector area** [m²]	Total capacity [MW_{th}]	Calculated number of systems	Collector yield [GWh/a]	Collector yield [TJ/a]	Energy savings / oil equivalent [l/a]	CO_2 reduction [t/a]
Albania							
Australia	3,800,000	2,660.0	19,000	1,399.7	5,039.0	247,818,900	676,161
Austria	600,228	420.2	3,001	136.0	489.7	22,217,439	60,619
Barbados							
Belgium	40,000	28.0	200	6.7	24.1	1,133,720	3,093
Brazil							
Bulgaria							
Canada	652,678	456.9	3,263	140.7	506.6	23,921,297	65,268
China							
Cyprus							
Czech Republic	9,230	6.5	46	2.7	9.9	313,820	862
Denmark	20,770	14.5	104	3.2	11.5	539,054	1,471
Estonia							
Finland	500	0.4	3	0.1	0.2	10,266	28
France*	94,888	66.4	474	18.7	67.2	3,230,320	8,814
Germany	750,000	525.0	3,750	161.2	580.4	27,910,875	76,153
Greece							
Hungary	2,800	2.0	14	0.8	2.9	137,956	376
India							
Ireland							
Israel	23,500	16.5	118	1.4	4.9	1,586,250	4,326
Italy	22,620	15.8	113	4.8	17.1	848,148	2,314
Japan							
Jordan							
Lativa							
Lithuania							
Luxembourg							
Macedonia							
Malta							
Mexico	440,015	308.0	2,200	127.6	459.5	22,751,636	62,076
Namibia							
Netherlands	329,554	230.7	1,648	49.8	179.1	8,203,917	22,384
New Zealand	5,865	4.1	29	1.3	4.8	225,489	615
Norway	1,400	1.0	7	0.2	0.7	31,500	86
Poland	1,700	1.2	9	0.4	1.3	59,364	162
Portugal							
Romania							
Slovak Rep.							
Slovenia							
South Africa	561,310	392.9	2,807	105.5	379.8	17,630,747	48,104
Spain							
Sweden	63,000	44.1	315	8.4	30.3	1,303,848	3,557
Switzerland	212,860	149.0	1,064	36.9	132.8	6,084,071	16,600
Taiwan							
Tunisia							
Turkey							
UK							
United States	27,379,201	19,165.4	136,896	7,358.2	26,489.4	1,269,696,744	3,464,304
TOTAL	**35,012,119**	**24,508.5**	**175,061**	**9,564.2**		**1,655,655,362**	**4,517,375**

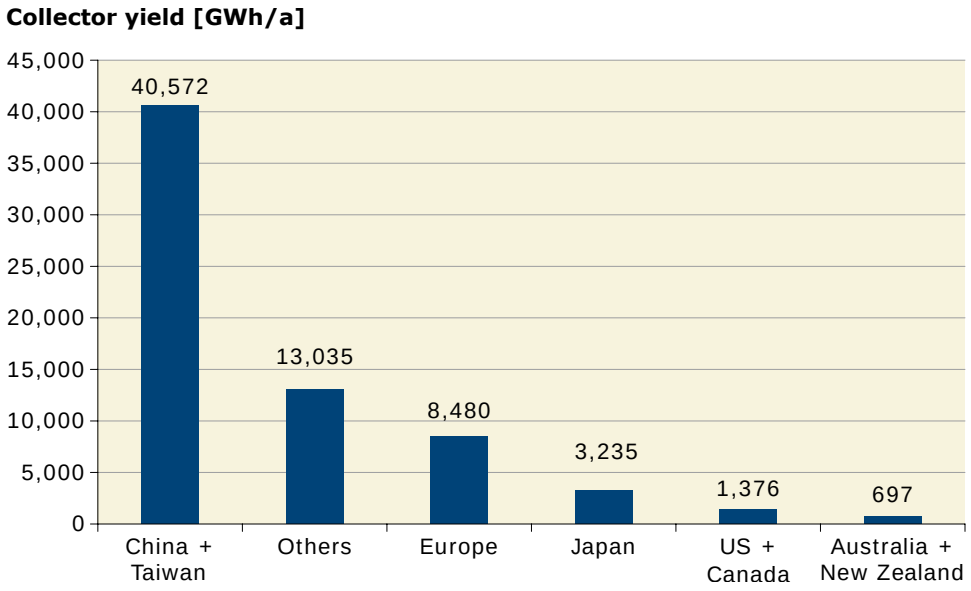
* France: includes Overseas Departments

** Unglazed Water Collectors. If no data is given: no reliable data base for this collector type available

Table 5: Calculated collector yield and corresponding oil equivalent as well as CO_2 reduction of solar thermal systems for swimming pool heating with unglazed collectors at the end of 2006

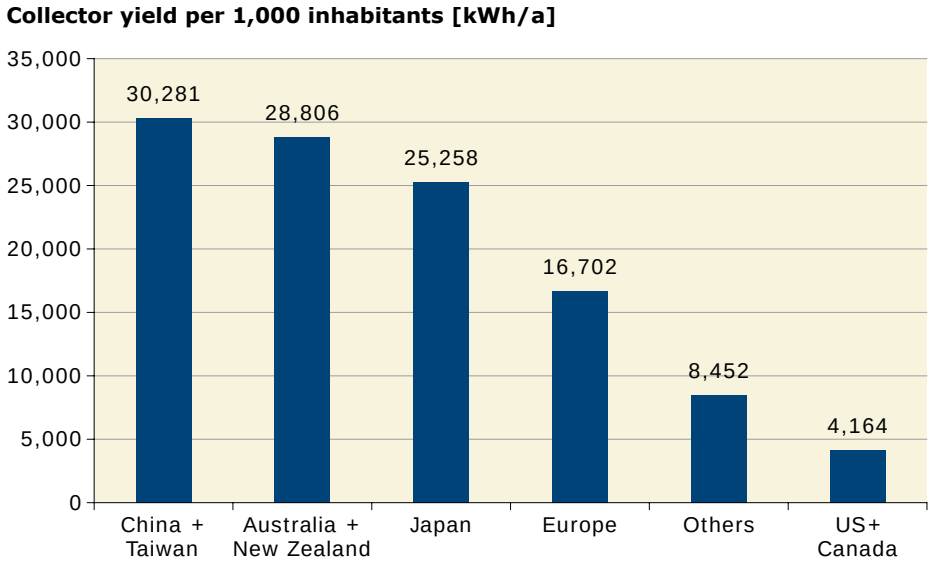
5.3 Collector yield by economic region at the end of 2006

5.3.1 Collector yield of glazed flat-plate and evacuated tube collectors by economic region at the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

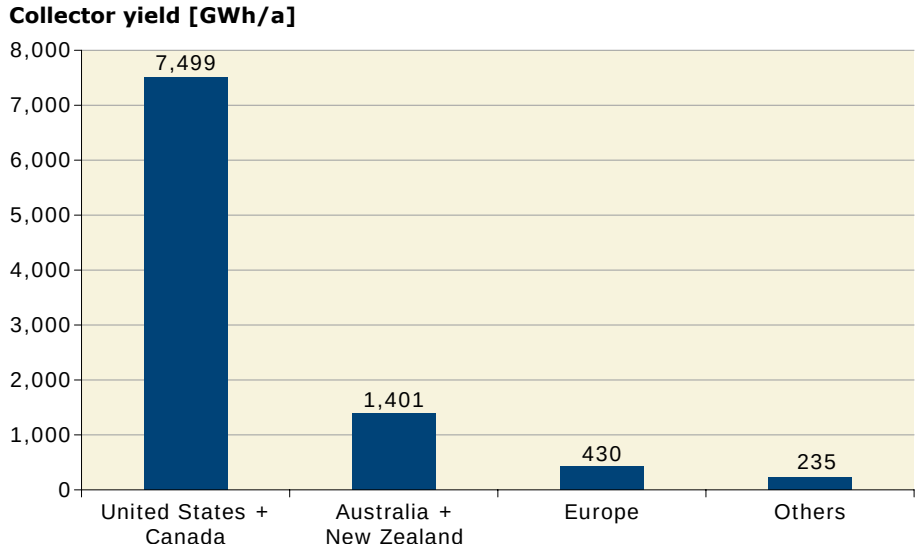
Figure 16: Annual collector yield of glazed flat-plate and evacuated tube collectors in operation by economic region at the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

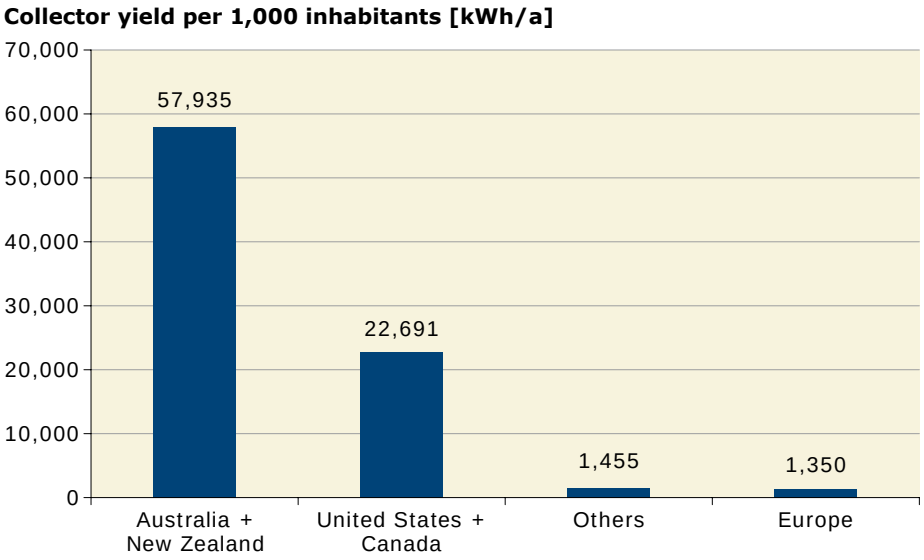
Figure 17: Annual collector yield of glazed flat-plate and evacuated tube collectors in operation by economic region at the end of 2006 in kWh per 1,000 inhabitants

5.3.2 Collector yield of unglazed collectors by economic region at the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 18: Annual collector yield of unglazed collectors in operation by economic region at the end of 2006

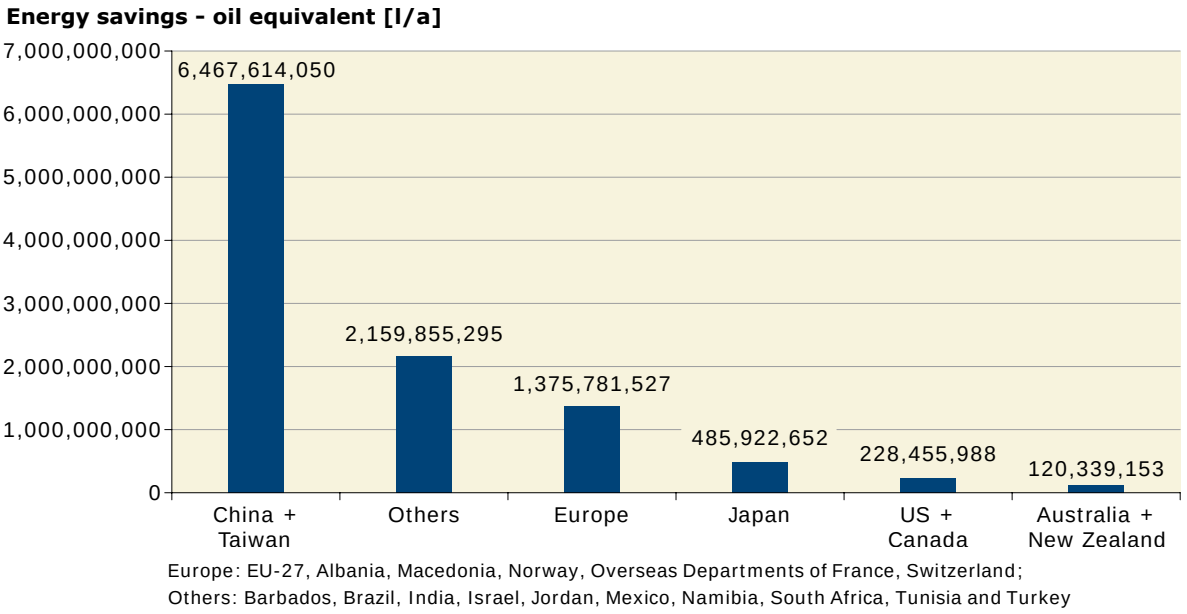


Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 19: Annual collector yield of unglazed collectors in operation by economic region at the end of 2006 in kWh per 1,000 inhabitants

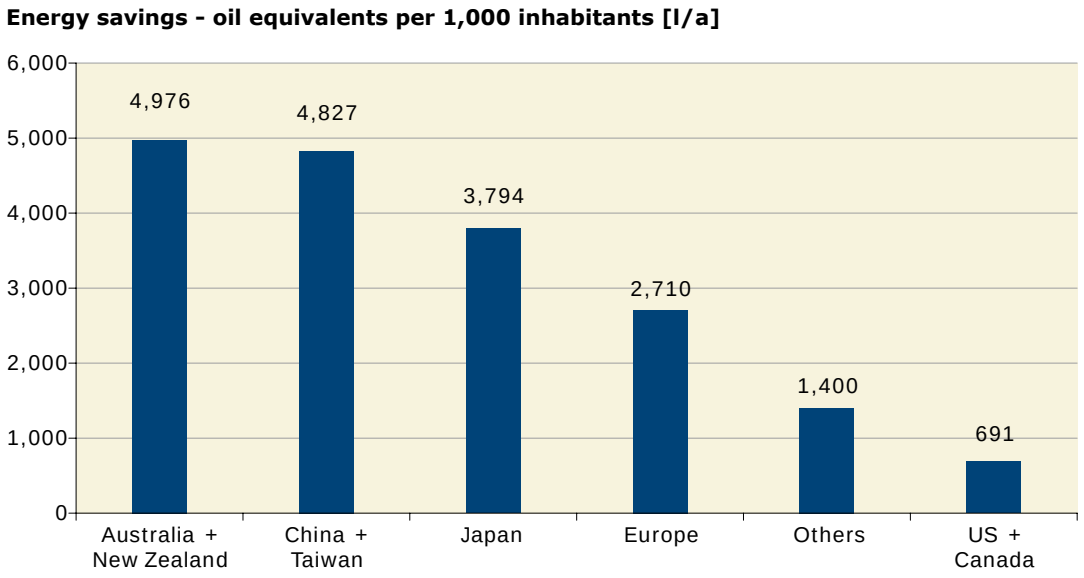
5.4 Energy savings by economic region at the end of 2006

5.4.1 Energy savings in oil equivalent by glazed flat-plate and evacuated tube collectors by economic region at the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

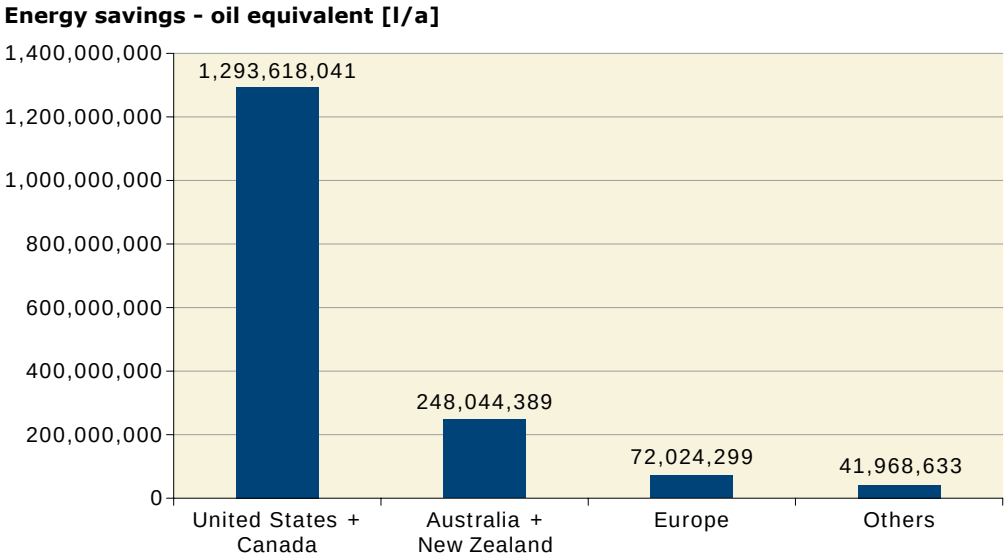
Figure 20: Annual energy savings in oil equivalent by glazed flat-plate and evacuated tube collectors by economic region at the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

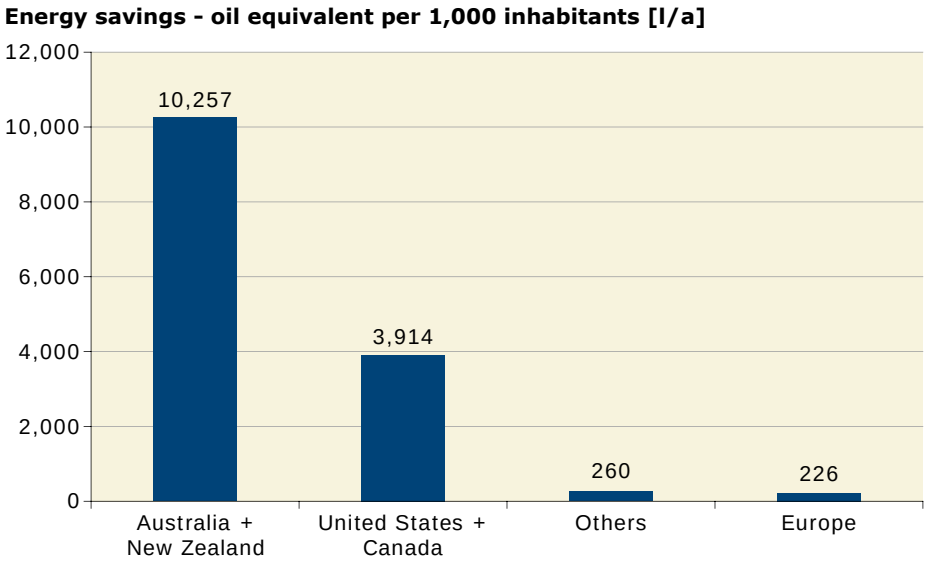
Figure 21: Annual energy savings in oil equivalent by glazed flat-plate and evacuated tube collectors in operation by economic region at the end of 2006 per 1,000 inhabitants

5.4.2 Energy savings in oil equivalent by unglazed collectors by economic region at the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 22: Annual energy savings in oil equivalent by unglazed collectors by economic region at the end of 2006

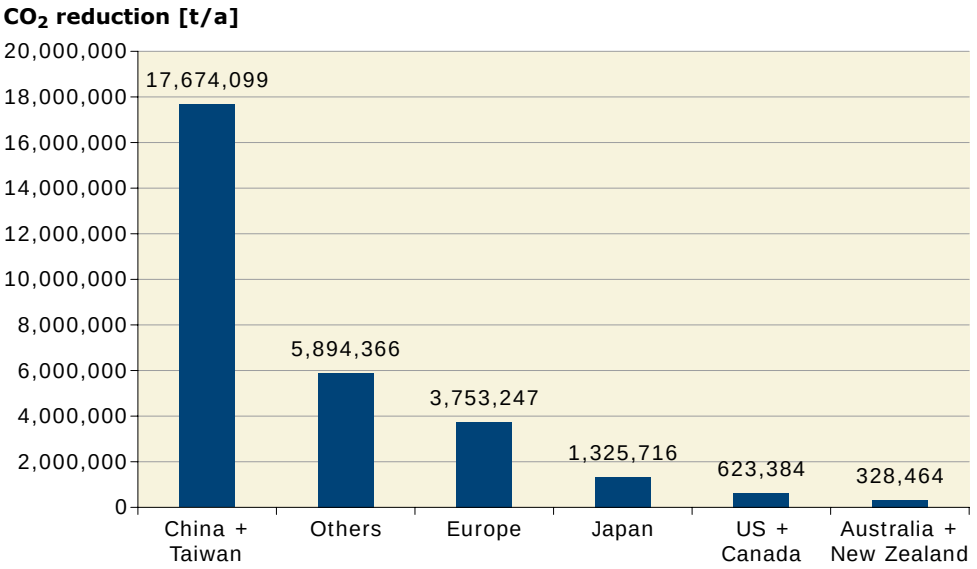


Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 23: Annual energy savings in oil equivalent by unglazed collectors by economic region at the end of 2006 per 1,000 inhabitants

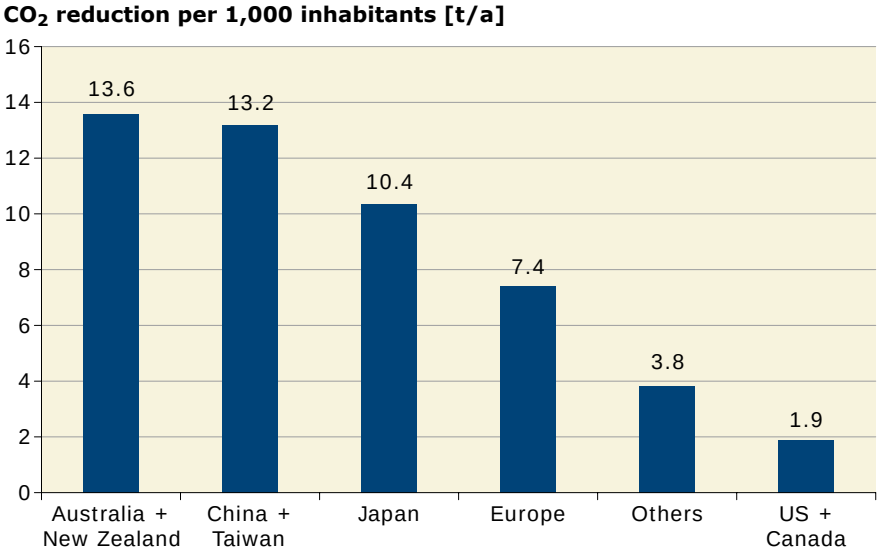
5.5 Contribution to CO_2 reduction by economic region at the end of 2006

5.5.1 Contribution to CO_2 reduction by flat-plate and evacuated tube collectors by economic region at the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

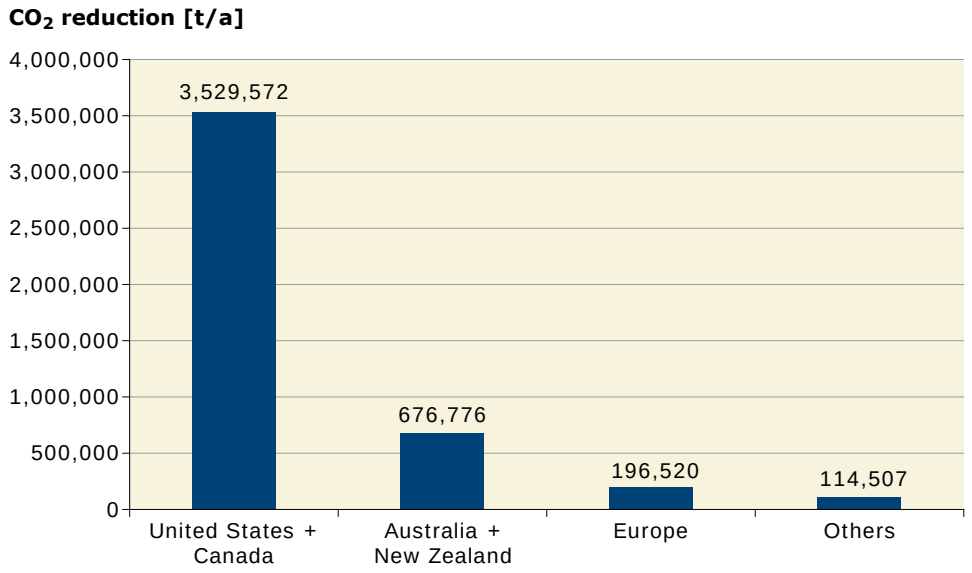
Figure 24: Annual contribution to CO_2 reduction by flat-plate and evacuated tube collectors by economic region the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

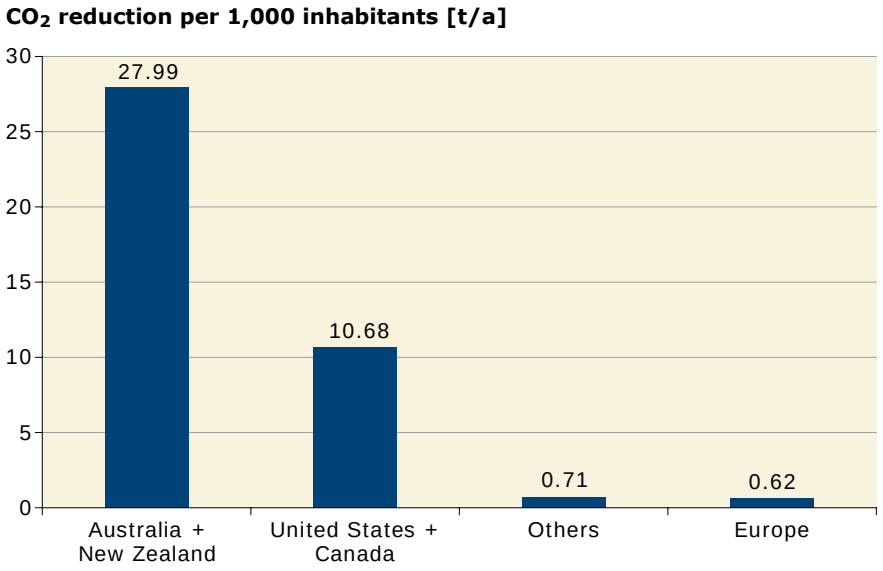
Figure 25: Annual contribution to CO_2 reduction by flat-plate and evacuated tube collectors by economic region at the end of 2006 per 1,000 inhabitants

5.5.2 Contribution to CO_2 reduction by unglazed collectors by economic region at the end of 2006



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 26: Annual contribution to CO_2 reduction by unglazed collectors by economic region at the end of 2006



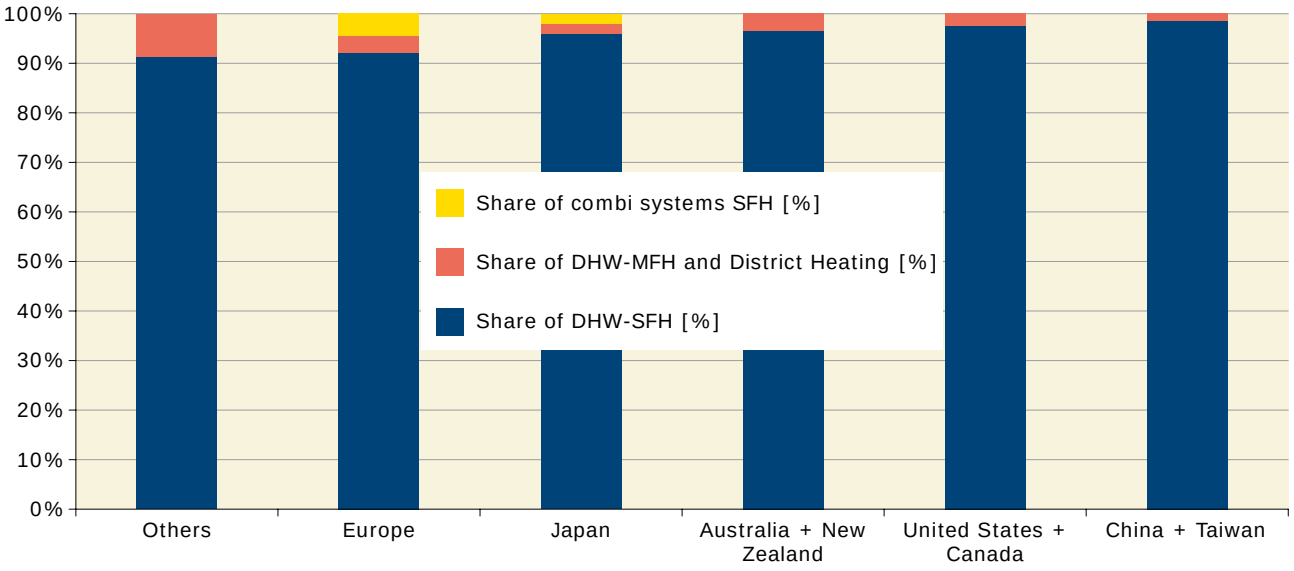
Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 27: Annual contribution to CO_2 reduction by unglazed collectors by economic region at the end of 2006 per 1,000 inhabitants

6 Distribution of Systems by Application

If one observes the use of solar thermal energy, it becomes clear that it greatly varies in the different countries. In China and Taiwan (65.9 GW_{th}), Europe (14.2 GW_{th}) and Japan (4.7 GW_{th}) plants with flat-plate and evacuated tube collectors mainly used to prepare hot water and to provide space heating are dominant while in North America (USA and Canada) swimming pool heating is the dominant application with an installed capacity of 19.6 GW_{th} of unglazed plastic collectors. Another important market for unglazed collectors for swimming pool heating is Australia and New Zealand with an installed capacity of 2.7 GW_{th}.

Figure 28 shows the distribution of the different applications in the total collector area in operation in the different economic regions. In this figure only applications with glazed flat-plate and evacuated tube collectors have been taken into consideration. Unglazed collectors and air collectors are not included. The figure shows the dominance of systems that are installed to produce hot water for single-family houses. The share of solar combisystems for hot water production and space heating is only relevant in Europe and Japan. **Figure 29** gives the distribution of the applications for the 10 countries in the world with the largest collector area in operation.

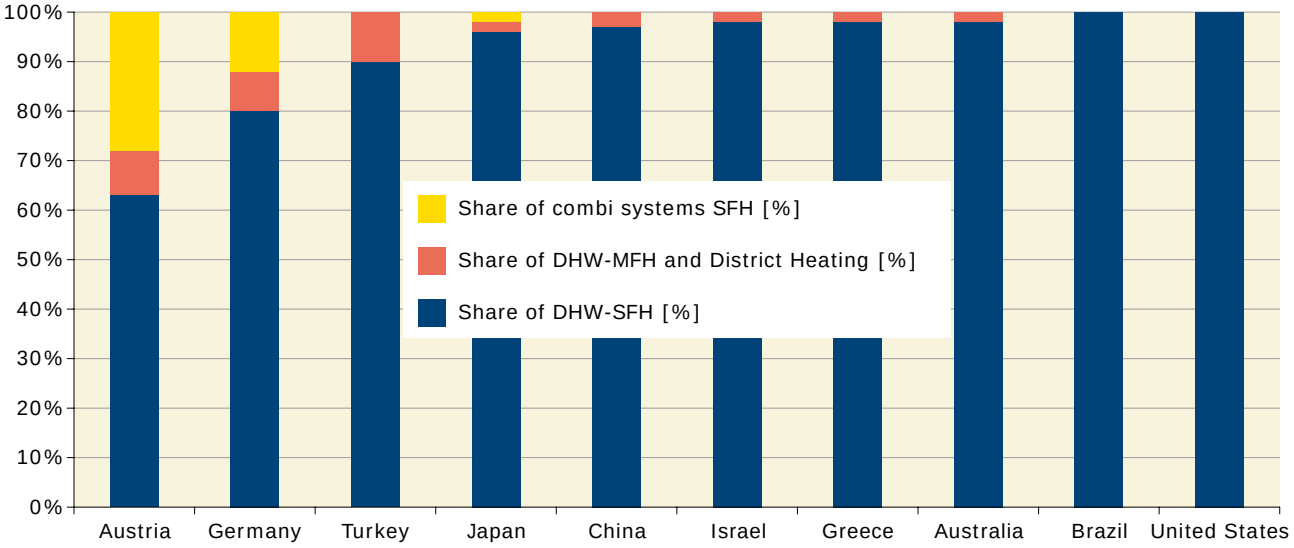


Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey;
Combisystems: Systems for hot water preparation and space heating; DHW: Domestic hot water systems;
MFH: Multi family house; SFH: Single family house

Figure 28: Distribution of different applications by economic region for the total capacity in operation of glazed and evacuated tube collectors in 2006

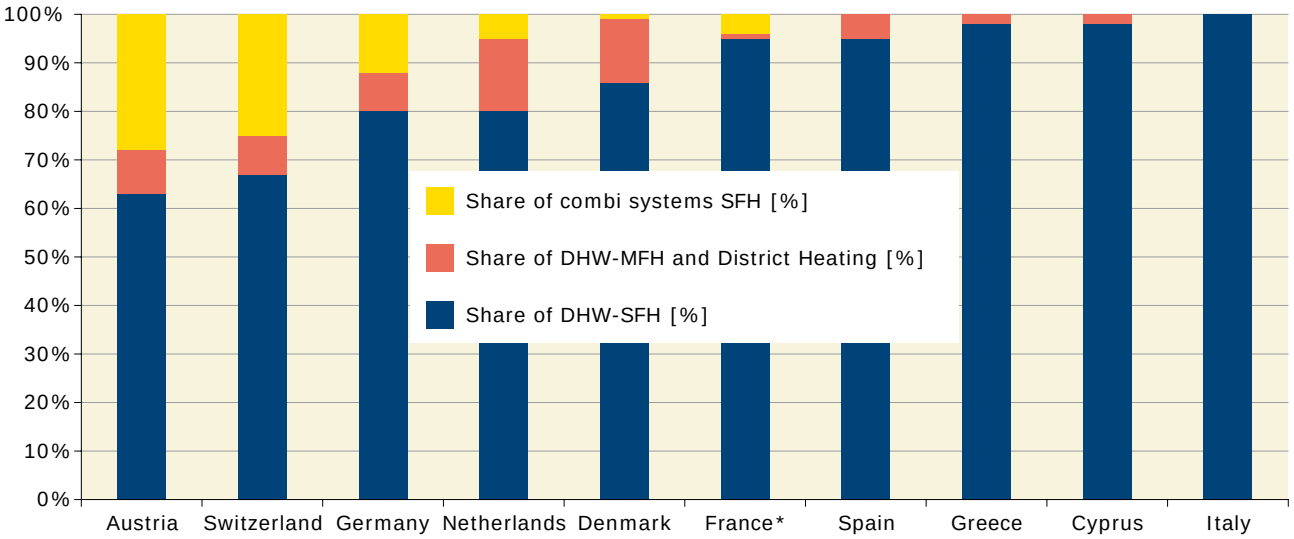
Europe has the most sophisticated market for different solar thermal applications. It includes systems for hot water preparation, plants for space heating of single- and multi-family houses and hotels, large-scale plants for district heating as well as a growing number of systems for air conditioning, cooling and industrial applications.

In Austria, Germany, Switzerland and the Netherlands the share of applications other than hot water preparation in single-family houses is 20% and higher. **Figure 30** gives the distribution of the applications for the 10 countries in Europe with the largest collector area in operation.



Combisystems: Systems for hot water preparation and space heating; DHW: Domestic hot water systems; MFH: Multi-family house; SFH: Single-family house

Figure 29: Distribution of different applications of the world's top-10-countries related to the total capacity in operation of glazed and evacuated tube collectors in 2006



Combisystems: Systems for hot water preparation and space heating; DHW: Domestic hot water systems; MFH: Multi-family house; SFH: Single-family house

Figure 30: Distribution of different applications in the European top-10-countries related to the total capacity in operation of glazed and evacuated tube collectors in 2006

Large-scale Plants

There are 120 large-scale plants (≥ 500 m²; 350 kW_{th}) in operation in Europe at the end of 2007 with a total installed capacity of 137 MW_{th}. The biggest plants are located in Denmark with 13 MW_{th} (18,300 m²) and Sweden with 7 MW_{th} (10,000 m²).

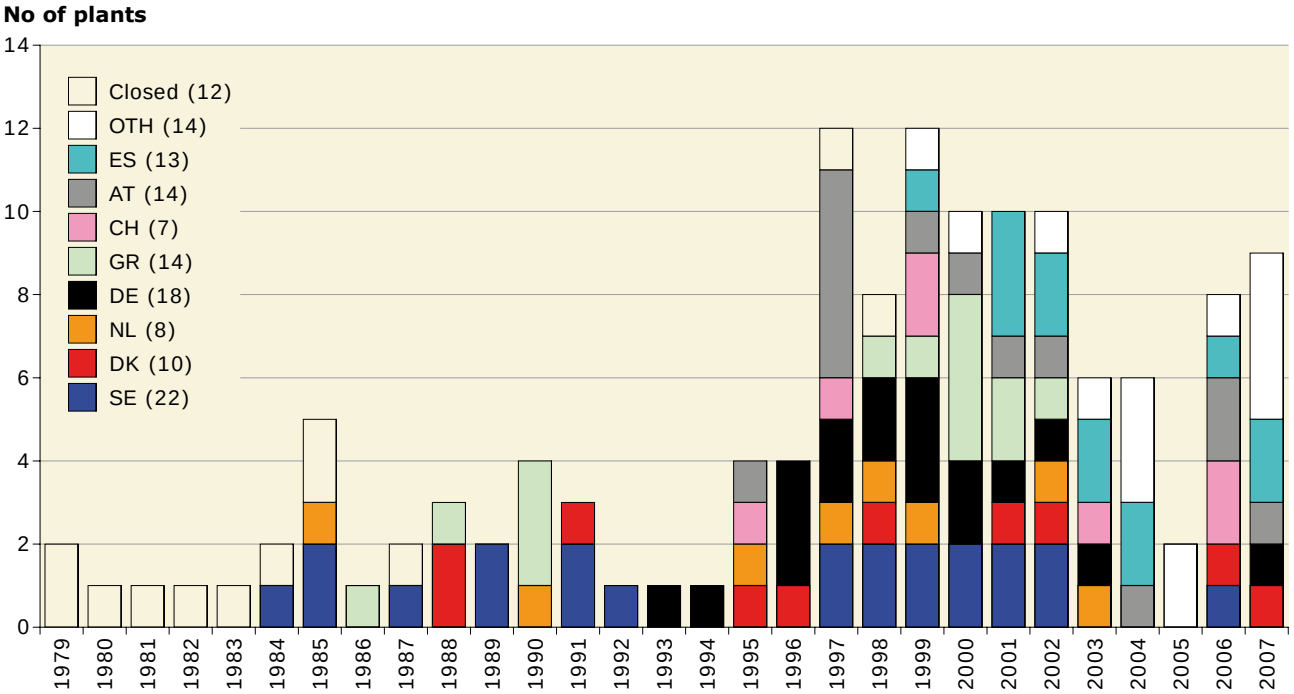


Figure 31: Large-scale solar heating and cooling plants in Europe at the end of 2007
(Source: Jan-Olof Dalenbäck, ESTTP report on solar district heating and cooling, 2007)

7 Appendix

7.1 Reference systems

To make the simulations to determine the energy output of a solar thermal heating system, it was necessary to define reference systems for different applications and countries (regions).

Based on the reference systems, hot water demand, heat load (only for solar combisystems) and weather data, the energy output of the systems and the resulting energy savings in oil equivalent were calculated.

Solar combisystems are solar heating installations providing space heating as well as domestic hot water for the inhabitants of the building. The primary energy sources are solar energy as well as an auxiliary source such as biomass, gas, oil and electricity.

Four major applications and reference systems (see tables below) were chosen for the simulations. For these reference systems, the daily hot water demand, the space heating demand (only for solar combisystems) and the weather data (location) were defined. The reference systems are those systems, which are most common in the respective country.

The following tables describe the key data of the reference systems in different countries, the location of the reference climate used and the share of the total collector area (glazed flat-plate and evacuated tube collectors) in use for the respective application. Furthermore, a hydraulic scheme is shown for each reference system.

7.1.1 Solar thermal systems for swimming pool heating with unglazed collectors

Country	Reference system	Total collector area [m²]	Number of systems	Reference climate
Australia	C: 200 m² unglazed plastic absorber	3,800,000	19,000	Sydney
Austria	C: 200 m² unglazed plastic absorber	600,228	3,001	Graz
Belgium	C: 200 m² unglazed plastic absorber	40,000	200	Brussels
Canada	C: 200 m² unglazed plastic absorber	652,678	3,263	Montreal
Czech Republic	C: 200 m² unglazed plastic absorber	9,230	46	Praha
Denmark	C: 200 m² unglazed plastic absorber	20,770	104	Copenhagen
Finland	C: 200 m² unglazed plastic absorber	500	3	Helsinki
France*	C: 200 m² unglazed plastic absorber	94,888	474	Paris
Germany	C: 200 m² unglazed plastic absorber	750,000	3,750	Würzburg
Hungary	C: 200 m² unglazed plastic absorber	2,800	14	Budapest
Israel	C: 200 m² unglazed plastic absorber	23,500	118	Jerusalem
Italy	C: 200 m² unglazed plastic absorber	22,620	113	Bologna
Mexico	C: 200 m² unglazed plastic absorber	440,015	2,200	Mexico City
Netherlands	C: 200 m² unglazed plastic absorber	329,554	1,648	De Bilt
New Zealand	C: 200 m² unglazed plastic absorber	5,865	29	Wellington
Norway	C: 200 m² unglazed plastic absorber	1,400	7	Oslo
Poland	C: 200 m² unglazed plastic absorber	1,700	9	Warsaw
South Africa	C: 200 m² unglazed plastic absorber	561,310	2,807	Johannisburg
Sweden	C: 200 m² unglazed plastic absorber	63,000	315	Gothenburg
Switzerland	C: 200 m² unglazed plastic absorber	212,860	1,064	Zurich
United States	C: 200 m² unglazed plastic absorber	27,379,201	136,896	Denver, Los Angeles
TOTAL		**35,012,119**	**175,061**	

C: collector area

* France: includes Overseas Departments

** Countries not listed in this table: no reliable data base for unglazed collectors available

Table 6: Reference systems for swimming pool systems**

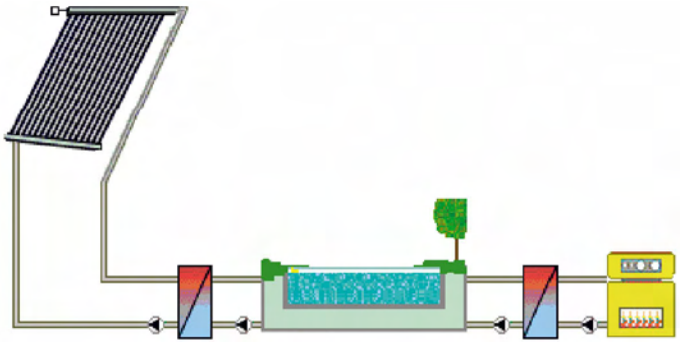


Figure 32: Hydraulic scheme of the swimming pool reference system

7.1.2 Solar domestic hot water systems for single family houses

The market share in the following table is referring to the total capacity in operation of flat-plate and evacuated tube collectors at the end of 2006 for each country.
It must be pointed out that the market share of the new installed capacity in the year 2006 can differ significantly from the total market share.

Country	reference system	reference climate	% of total market
Albania	C: 2.5 m² / ST: 150 l / HWD: 150 l/d / TS	Tirana	100
Australia	C: 4 m² / ST: 300 l / HWD: 170 l/d / TS	Sydney	98
Austria	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Graz	63
Barbados	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Raizet	100
Belgium	C: 4 m² / ST: 200 l / HWD: 150 l/d / PDS	Brussels	100
Brazil	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Rio de Janeiro	100
Bulgaria	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Sofia	100
Canada	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Montreal	95
China	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Shanghai	97
Cyprus	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Cyprus	98
Czech Republic	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Praha	99
Denmark	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Copenhagen	86
Estonia	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Tallin	100
Finland	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Helsinki	95
France	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Paris	95
Germany	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Würzburg	80
Greece	C: 2.5 m² / ST: 150 l / HWD: 150 l/d / TS	Athens	98
Hungary	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Budapest	99
Indien	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Bombay	100
Irland	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Dublin	100
Israel	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Jerusalem	98
Italy	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Bologna	100
Japan	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Tokyo	96
Jordan	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Amman	98
Lativa	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Riga	100
Lithuania	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Vilnius	100
Luxembourg	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Luxembourg	100
Macedonia	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Skopje	100
Malta	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Valletta	100
Mexico	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Mexico City	28
Namibia	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Windhoek	100
Netherlands	C: 3 m² / ST: 100 l / HWD: 110 l/d / PDS	De Bilt	80
New Zealand	C: 4 m² / ST: 300 l / HWD: 150 l/d / TS	Wellington	95
Norway	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Oslo	98
Poland	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Warsaw	99
Portugal	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Lisbon	95
Romania	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Bucharest	100
Slovac Republic	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Bratislawa	100
Slovenia	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Ljubliana	98
South Afrika	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Johannisburg	100
adjustrightSpain	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Madrid	95
Sweden	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Gothenburg	10
Switzerland	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Zurich	67
Taiwan	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Taipei	100
Tunisia	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Tunis	100
Turkey	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	Ankara	90
United Kingdom	C: 4 m² / ST: 200 l / HWD: 150 l/d / PS	London	100
United States	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Denver / Los Angeles	100

C: collector area; ST: hot water storage; HWD: hot water demand / day with 60°C;
TS: thermosiphon system; PS: pumped system; PDS: pumped, drain back system

Table 7: Reference systems for domestic hot water systems for single family houses and the percentage of the total collector area in operation (flat-plate and evacuated tube collectors)

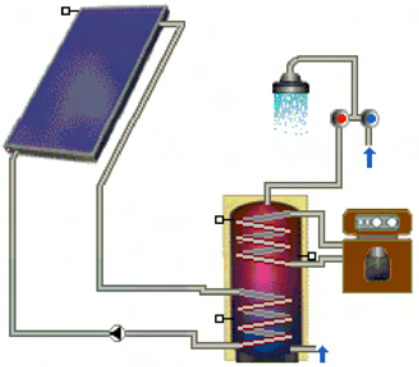


Figure 33: Hydraulic scheme of the DHW reference system

7.1.3 Solar domestic hot water systems for multi-family houses, hotels and district heating

The market share in the following table refers to the total capacity in operation of flat-plate and evacuated tube collectors at the end of 2006 for each country.

It must be pointed out, that the market share of the new installed capacity in the year 2006 can differ a lot from the total market share.

Country	reference system	reference climate	% of total market
Australia	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Sydney	2
Austria	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Graz	9
Canada	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Montreal	5
China	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Shanghai	3
Cyprus	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Cyprus	2
Czech Republic	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Praha	1
Denmark	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Copenhagen	13
Finland	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Helsinki	5
France	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Paris	1
Germany	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Würzburg	8
Greece	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Athens	2
Hungary	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Budapest	1
Israel	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Jerusalem	2
Japan	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Tokyo	2
Jordan	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Amman	2
Mexico*	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Mexico City	72
Netherlands	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PDS	De Bilt	15
New Zealand	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Wellington	5
Norway	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Oslo	1
Poland	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Warsaw	1
Portugal	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Lisbon	5
Slovenia	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Ljubliana	2
Spain	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Madrid	5
Sweden	C: 1000 m² / ST: 50000 l / HWD: 40000 l/d / PS	Gothenburg	25
Switzerland	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Zurich	8
Turkey	C: 50 m² / ST: 2500 l / HWD: 2000 l/d / PS	Ankara	10

* Industry

C: collector area; ST: hot water storage; HWD: hot water demand / day with 60°C;
TS: thermosiphon system; PS: pumped system; PDS: pumped, drain back system

Table 8: Reference systems for domestic hot water systems for multi-family houses, hotels and district heating and the percentage of the total collector area in operation (flat-plate and evacuated tube collectors)

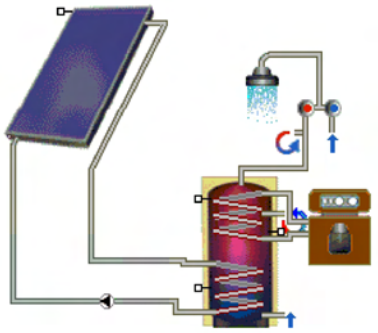


Figure 34: Hydraulic scheme of the DHW system for multi family houses

7.1.4 Solar combisystems for domestic hot water and space heating for single family houses

The market share in the following table is referring to the total capacity in operation of flat-plate and evacuated tube collectors at the end of 2006 for each country.

It must be pointed out that the market share of the new installed capacity in the year 2006 can differ significantly from the total market share.

The reference system is designed for a single-family house with 140 m² gross area.

Country	reference system	reference climate	% of total market
Austria	C: 20 m² / ST: 2000 l / HWD: 160 l/d / SHD: 80 kWh/m² / PS	Graz	28
Denmark	C: 15 m² / ST: 800 l / HWD: 160 l/d SHD: 80 kWh/m² / PS	Copenhagen	1
France	C: 15 m² / ST: 250 l / HWD: 160 l/d SHD: 80 kWh/m² / PS	Paris	4
Germany	C: 12 m² / ST: 750 l / HWD: 160 l/d SHD: 80 kWh/m² / PS	Würzburg	12
Japan	C: 12 m² / ST: 750 l / HWD: 160 l/d SHD: 80 kWh/m² / PS	Tokyo	2
Netherlands	C: 4 m² / ST 240 l / HWD: 160 l/d SHD: 80 kWh/m² / PDS	De Bilt	5
Norway	C: 10 m² / ST: 1500 l / HWD: 160 l/d SHD: 100 kWh/m² / PS	Oslo	1
Sweden	C: 12 m² / ST: 1000 l / HWD: 160 l/d SHD: 100 kWh/m² / PS	Gothenburg	65
Switzerland	C: 15 m² / ST: 1000 l / HWD: 160 l/d SHD: 80 kWh/m² / PS	Zurich	25

C: collector area; ST: hot water storage; TS: thermosiphon system; PS: pumped system; PDS: pumped, drain back system; HWD: hot water demand / day with 60°C; SHD: space heat demand [kWh/m² a]

Table 9: Reference systems for combisystems for single-family houses and the percentage of the total collector area in operation (flat-plate and evacuated tube collectors)

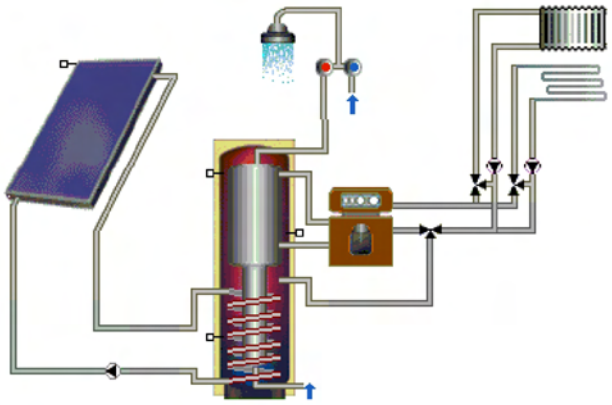


Figure 35: Hydraulic scheme of the solar combi reference system

7.2 Reference collector

7.2.1 Data of the reference absorber for swimming pool heating

$\eta = 0.85$ $a_1 = 20$ [W/m²K] $a_2 = 0.1$ [W/m² K²]

7.2.2 Data of the reference collector for all other applications

$\eta = 0.8$ $a_1 = 3.69$ [W/m²K] $a_2 = 0.007$ [W/m² K²]

7.3 Reference climates

Country	Reference Climate
Albania	Tirana
Australia	Sydney
Austria	Graz
Barbados	Raizet
Belgium	Brussels
Brazil	Rio de Janeiro
Bulgaria	Sofia
Canada	Montreal
China	Shanghai
Cyprus	Cyprus
Czech Republic	Praha
Denmark	Copenhagen
Estonia	Tallin
Finland	Helsinki
France	Paris
Germany	Würzburg

Country	Reference Climate
Greece	Athens
Hungary	Budapest
Indien	Bombay
Irland	Dublin
Israel	Jerusalem
Italy	Bologna
Japan	Tokyo
Jordan	Amman
Lativa	Riga
Lithuania	Vilnius
Luxembourg	Luxembourg
Macedonia	Skopje
Malta	Valletta
Mexico	Mexico City
Namibia	Windhoek
Netherlands	De Bilt

Country	Reference Climate
New Zealand	Wellington
Norway	Oslo
Poland	Warsaw
Portugal	Lisbon
Romania	Bucharest
Slovac Republic	Bratislawa
Slovenia	Ljubliana
South Afrika	Johannisburg
Spain	Madrid
Sweden	Gothenburg
Switzerland	Zurich
Taiwan	Taipei
Tunisia	Tunis
Turkey	Ankara
United Kingdom	London
United States	Denver, L. A.

Table 10: Reference climates for the 48 countries surveyed

7.4 Population data

Country	Inhabitants
Albania	3.130.000
Australia	20.155.000
Austria	8.233.000
Barbados	270.000
Belgium	10.419.000
Brazil	186.405.000
Bulgaria	7.726.000
Canada	32.268.000
China	1.315.844.000
Cyprus	835.000
Czech Republic	10.220.000
Denmark	5.431.000
Estonia	1.330.000
Finland	5.249.000
France*	62.329.000
Germany	82.689.000
Greece	11.120.000

Country	Inhabitants
Hungary	10.098.000
India	1.103.371.000
Ireland	4.148.000
Israel	6.725.000
Italy	58.093.000
Japan	128.085.000
Jordan	5.703.000
Lativa	2.307.000
Lithuania	3.431.000
Luxembourg	465.000
Macedonia	2.034.000
Malta	402.000
Mexico	107.029.000
Namibia	2.031.000
Netherlands	16.299.000
New Zealand	4.028.000
Norway	4.620.000

Country	Inhabitants
Poland	38.530.000
Portugal	10.495.000
Romania	21.711.000
Slovak Republic	5.401.000
Slovenia	1.967.000
South Africa	47.432.000
Spain	43.064.000
Sweden	9.041.000
Switzerland	7.252.000
Taiwan	24.000.000
Tunisia	10.102.000
Turkey	73.193.000
United Kingdom	59.668.000
United States	298.213.000
TOTAL	**3.872.591.000**

Table 11: Inhabitants of the 48 surveyed countries in alphabetic order
Data source: Statistisches Jahrbuch Österreich, 2007, http://www.statistik.at

*France	62.329.000
Guadeloupe	440.000
Martinique	393.000
Réunion	756.000
Polynésie	244.000
France métropole	60.496.000

Table 12: Inhabitants of France including overseas departments

Economic Region	Inhabitants
United States + Canada	330.481.000
Japan	128.085.000
China + Taiwan	1.339.844.000
Europe	507.737.000
Australia + New Zealand	24.183.000
Others	1.542.261.000
TOTAL	**3.872.591.000**

Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland.
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Table 13: Inhabitants per economic region

7.5 Installed capacity in 2005

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed***	glazed	evacuated tube	unglazed***	glazed***	
Albania		5.89	0.04			**5.93**
Australia	315.00	112.70	1.40			**429.10**
Austria	4.25	162.41	1.02			**167.68**
Barbados		1.91				**1.91**
Belgium	5.11	14.16				**19.27**
Brazil		276.26				**276.26**
Bulgaria		1.40				**1.40**
Canada	28.32	1.82	0.32	12.63	0.02	**43.09**
China		1,050.00	9,450.00			**10,500.00**
Cyprus		35.00				**35.00**
Czech Republic	2.26	9.24	1.65			**13.15**
Denmark	0.98	14.70	0.18		2.80	**18.66**
Estonia		0.18				**0.18**
Finland	0.35	1.46	0.21			**2.02**
France *	4.20	107.42	3.45			**115.07**
Germany	21.00	598.50	66.50			**686.00**
Greece		154.35				**154.35**
Hungary		0.70				**0.70**
India		280.00				**280.00**
Ireland		3.22	0.28			**3.50**
Israel	0.73	140.00				**140.73**
Italy	1.78	76.51	10.68			**88.97**
Japan		196.10	2.98	14.15		**213.23**
Lativa		0.70				**0.70**
Lithuania		0.35				**0.35**
Luxembourg		1.33				**1.33**
Macedonia		1.40				**1.40**
Malta		2.80				**2.80**
Mexico	30.10	30.10				**60.20**
Namibia		0.70				**0.70**
Netherlands	20.11	14.11				**34.22**
New Zealand	0.42	7.14	0.84			**8.40**
Norway		0.70				**0.70**
Poland	0.08	16.44	2.83			**19.36**
Portugal		13.27				**13.27**
Romania		0.28				**0.28**
Slovak Republic		4.62	0.63			**5.25**
Slovenia		3.15	0.21			**3.36**
South Africa	44.10	9.73				**53.83**
Spain		71.00	3.82			**74.82**
Sweden	8.73	12.26	3.85			**24.84**
Switzerland **	7.50	26.23	1.16	2.10		**36.99**
Taiwan		73.17	5.51			**78.68**
Tunisia		16.10				**16.10**
Turkey		336.00				**336.00**
United Kingdom		12.60	7.00			**19.60**
United States	990.05	45.20	0.20	0.07	0.20	**1,035.70**
TOTAL	**1,485.07**	**3,943.32**	**9,564.74**	**28.94**	**3.01**	**15,025.07**

* France: includes Overseas Departments

** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying purposes

*** If no data is given: no reliable data base for this collector type available

Table 14: Installed capacity in 2005, MW_{th}/a

7.6 2005 and 2006 data in m²

The data presented in **Chapters 3** to **5** were originally collected in square meters. Through an agreement of international experts the collector areas of these solar thermal applications have been converted and are shown in installed capacity.

Making the installed capacity of solar thermal collectors comparable with that of other energy sources, solar thermal experts from seven countries agreed upon a methodology to convert installed collector area into solar thermal capacity. The methodology was developed during a meeting with IEA SHC Programme and major solar thermal trade associations in Gleisdorf, Austria in September 2004. The represented associations from Austria, Canada, Germany, the Netherlands, Sweden and the USA as well as the European Solar Thermal Industry Federation (ESTIF) and the IEA SHC Programme agreed to use a factor of 0.7 kW_{th}/m^2 to derive the nominal capacity from the area of installed collectors.

Nevertheless, solar thermal collectors are traditionally quoted in square meters and therefore **Tables 15 - 18** provide the 2005 and 2006 data in m².

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed***	glazed	evacuated tube	unglazed***	glazed***	
Albania		8,420	58			**8,478**
Australia	450,000	161,000	2,000			**613,000**
Austria	6,070	232,020	1,450			**239,540**
Barbados		2,731				**2,731**
Belgium	7,300	20,234				**27,534**
Brazil		394,658				**394,658**
Bulgaria		2,000				**2,000**
Canada	40,455	2,593	450	18,036	25	**61,559**
China		1,500,000	13,500,000			**15,000,000**
Cyprus		50,000				**50,000**
Czech Republic	3,230	13,200	2,350			**18,780**
Denmark	1,400	21,000	250		4,000	**26,650**
Estonia		250				**250**
Finland	500	2,083	300			**2,883**
France *	6,000	153,459	4,930			**164,389**
Germany	30,000	855,000	95,000			**980,000**
Greece		220,500				**220,500**
Hungary		1,000				**1,000**
India		400,000				**400,000**
Ireland		4,600	400			**5,000**
Israel	1,045	200,000				**201,045**
Italy	2,542	109,306	15,252			**127,100**
Japan		280,141	4,262	20,209		**304,612**
Lativa		1,000				**1,000**
Lithuania		500				**500**
Luxembourg		1,900				**1,900**
Macedonia		2,000				**2,000**
Malta		4,000				**4,000**
Mexico	43,000	43,000				**86,000**
Namibia		994				**994**
Netherlands	28,728	20,159				**48,887**
New Zealand	600	10,200	1,200			**12,000**
Norway		1,000				**1,000**
Poland	120	23,485	4,048			**27,653**
Portugal		18,956				**18,956**
Romania		400				**400**
Slovak Republic		6,600	900			**7,500**
Slovenia		4,500	300			**4,800**
South Africa	63,000	13,900				**76,900**
Spain		101,434	5,451			**106,885**
Sweden	12,469	17,520	5,501			**35,490**
Switzerland **	10,715	37,472	1,660	3,000		**52,847**
Taiwan		104,532	7,868			**112,400**
Tunisia		22,997	3			**23,000**
Turkey		480,000				**480,000**
United Kingdom		18,000	10,000			**28,000**
United States	1,414,356	64,568	279	93	279	**1,479,575**
TOTAL	**2,121,530**	**5,633,311**	**13,663,912**	**41,338**	**4,304**	**21,464,396**

* France: includes Overseas Departments

** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying purposes

*** If no data is given: no reliable data base for this collector type available

Table 15: Collector area installed in 2005, m²/a

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed***	glazed	evacuated tube	unglazed***	glazed***	
Albania		7,960	76			**8,036**
Australia	550,000	156,000	15,000			**721,000**
Austria	6,935	289,745	2,924			**299,604**
Barbados		2,731				**2,731**
Belgium	8,828	31,267	4,369			**44,464**
Brazil		434,331				**434,331**
Bulgaria		2,200				**2,200**
Canada	36,292	1,312	712	23,441	38	**61,795**
China		1,800,000	16,200,000			**18,000,000**
Cyprus		60,000				**60,000**
Czech Republic	6,000	18,490	3,540			**28,030**
Denmark	1,600	28,500	1,000		7,000	**38,100**
Estonia		300				**300**
Finland		3,400				**3,400**
France *	6,000	284,000	11,000			**301,000**
Germany	30,000	1,350,000	150,000			**1,530,000**
Greece		249,000				**249,000**
Hungary		1,000				**1,000**
India		500,000				**500,000**
Ireland		4,100	900			**5,000**
Israel	3,800	222,000				**225,800**
Italy	3,650	155,798	26,552			**186,000**
Japan		262,665	1,382	17,436		**281,483**
Jordan		7,666	3,600			**11,266**
Lativa		1,200				**1,200**
Lithuania		600				**600**
Luxembourg		2,500				**2,500**
Macedonia		2,118	36			**2,154**
Malta		4,500				**4,500**
Mexico	29,029	67,735				**96,764**
Namibia		1,720				**1,720**
Netherlands	24,419	14,937				**39,356**
New Zealand	600	9,600	3,350			**13,550**
Norway		700	100			**800**
Poland	150	35,150	6,250			**41,550**
Portugal		28,300				**28,300**
Romania		400				**400**
Slovak Republic		7,700	800			**8,500**
Slovenia		6,300	600			**6,900**
South Africa	65,100	13,800				**78,900**
Spain		161,875	13,125			**175,000**
Sweden	13,416	19,825	8,713			**41,954**
Switzerland **	8,953	50,355	1,508	1,000		**61,816**
Taiwan		113,646	8,554			**122,200**
Tunisia		34,526	474			**35,000**
Turkey		700,000				**700,000**
United Kingdom		27,000	27,000			**54,000**
United States	1,444,271	119,380	5,110		557	**1,569,318**
TOTAL	**2,239,043**	**7,296,332**	**16,496,675**	**41,877**	**7,595**	**26,081,522**

* France: includes Overseas Departments

** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying purposes

*** If no data is given: no reliable data base for this collector type available

Table 16: Collector area installed in 2006, m²/a

Country	Water collectors			Air Collectors		TOTAL [m²]
	unglazed***	glazed	evacuated tube	unglazed***	glazed***	
Albania		32,680	82			**32,762**
Australia	3,400,000	1,569,000	3,000			**4,972,000**
Austria	593,294	2,379,065	36,253			**3,008,612**
Barbados		77,332				**77,332**
Belgium	33,300	65,483	3,000			**101,783**
Brazil		2,700,458				**2,700,458**
Bulgaria		22,900				**22,900**
Canada	642,493	78,981	1,650	99,388	25	**822,537**
China		7,500,000	67,500,000			**75,000,000**
Cyprus		784,000				**784,000**
Czech Republic	3,230	59,700	5,850			**68,780**
Denmark	20,870	343,555	2,000		8,250	**374,675**
Estonia		820				**820**
Finland	500	10,083	680			**11,263**
France *	90,888	817,988	4,992			**913,868**
Germany	750,000	5,799,000	852,000			**7,401,000**
Greece		3,047,200				**3,047,200**
Hungary	2,800	34,340	560			**37,700**
India		1,200,000				**1,200,000**
Ireland		10,385	2,211		2,800	**15,396**
Israel	20,000	4,793,400				**4,813,400**
Italy	17,430	511,280	52,290			**581,000**
Japan		6,957,696	134,853	416,935		**7,509,484**
Jordan		825,000				**825,000**
Lativa		2,650				**2,650**
Lithuania		2,150				**2,150**
Luxembourg		13,400				**13,400**
Macedonia		15,000				**15,000**
Malta		19,360				**19,360**
Mexico	428,586	300,058				**728,644**
Namibia		1,448				**1,448**
Netherlands	312,840	307,586				**620,426**
New Zealand	5,500	89,440	2,160			**97,100**
Norway	1,400	10,000			1,200	**12,600**
Poland	1,550	113,372	7,318	3,000	2,500	**127,740**
Portugal		224,000				**224,000**
Romania		68,700				**68,700**
Slovak Republic		64,170				**64,170**
Slovenia		106,300				**106,300**
South Africa	541,500	240,000				**781,500**
Spain		767,857	29,094			**796,951**
Sweden	51,000	203,000	11,500			**265,500**
Switzerland **	212,670	344,780	24,060	835,000		**1,416,510**
Taiwan		966,033	99,967			**1,066,000**
Tunisia		142,997	3			**143,000**
Turkey		9,000,000				**9,000,000**
United Kingdom		201,160				**201,160**
United States	26,920,993	1,656,824	553,045	93	227,953	**29,358,908**
TOTAL	**34,050,845**	**54,480,631**	**69,326,568**	**1,354,416**	**242,728**	**159,455,188**

* France: includes Overseas Departments

** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying purposes

*** If no data is given: no reliable data base for this collector type available

Table 17: Total collector area in operation at the end of 2005, m²

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed	glazed	evacuated tube	unglazed	glazed	
Albania		40,640	158			**40,798**
Australia	3,800,000	1,600,000	18,000			**5,418,000**
Austria	600,228	2,671,938	39,584			**3,311,750**
Barbados		80,063				**80,063**
Belgium	40,000	96,750	7,368			**144,118**
Brazil		3,112,105				**3,112,105**
Bulgaria		25,100				**25,100**
Canada	652,678	80,293	2,362	118,105	63	**853,501**
China		9,300,000	83,700,000			**93,000,000**
Cyprus		811,538				**811,538**
Czech Republic	9,230	78,190	9,390			**96,810**
Denmark	20,770	370,860	3,000		15,250	**409,880**
Estonia		1,120				**1,120**
Finland	500	13,483	680			**14,663**
France*	94,888	1,049,520	15,992			**1,160,400**
Germany	750,000	7,255,459	798,541			**8,804,000**
Greece		3,287,200				**3,287,200**
Hungary	2,800	35,340	560			**38,700**
India		1,500,000				**1,500,000**
Ireland		12,785	3,111			**15,896**
Israel	23,500	4,865,900				**4,889,400**
Italy	22,620	663,520	67,860			**754,000**
Japan		6,658,345	123,018	434,371		**7,215,735**
Jordan		832,666	3,600			**836,266**
Lativa		3,850				**3,850**
Lithuania		2,750				**2,750**
Luxembourg		15,900				**15,900**
Macedonia		17,118				**17,118**
Malta		23,860				**23,860**
Mexico	440,015	353,647				**793,662**
Namibia		3,168				**3,168**
Netherlands	329,554	316,856				**646,410**
New Zealand	5,865	95,231	5,298			**106,394**
Norway	1,400	10,500	100		1,200	**13,200**
Poland	1,700	148,522	13,608	3,000	2,500	**169,330**
Portugal		242,596				**242,596**
Romania		69,100				**69,100**
Slovak Republic		72,750				**72,750**
Slovenia		109,300				**109,300**
South Africa	561,310	233,680				**794,990**
Spain		913,164	34,600			**947,764**
Sweden	63,000	215,000	20,000			**298,000**
Switzerland**	212,860	383,090	24,530	836,000		**1,456,480**
Taiwan		1,011,919	108,521			**1,120,440**
Tunisia		177,523	477			**178,000**
Turkey		9,450,000				**9,450,000**
United Kingdom		250,920				**250,920**
United States	27,379,201	1,776,204	558,155	93	228,510	**29,942,163**
TOTAL	**35,012,119**	**60,339,463**	**85,558,513**	**1,391,569**	**247,523**	**182,549,187**

* France: includes Overseas Departments

** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying purposes

*** If no data is given: no reliable data base for this collector type available

Table 18: Total collector area in operation at the end of 2006, m²

7.7 References to reports and persons that have supplied the data

The following persons and members of the Executive Committee of the IEA Solar Heating and Cooling Programme supplied the data and the reference systems for their respective countries:

Albania	**Edmond Hido**	Albania-EU Energy Efficiency Centre
Australia	**Ken Guthrie**	Sustainability Victoria, Melbourne
	John Ballinger	Solar Efficient Architecture, Kangaroo Valley
Austria	**Gerhard Faninger**	University Klagenfurt
Barbados	**David Ince**	Fair Trading Commission Barbados
Belgium	**André De Herde**	Université Catholique de Louvain, Lauvain-la-Neuve
Brazil	**Carlos Faria**	President Resolver Energy Solutions
	Samuel Luna de Abreu	Universidade Federal de Santa Catarina
	ABRAVA-DASOL	National Depto of Solar Industries
Canada	**Doug McClenahan**	CANMET - Natural Resources Canada, Ottawa
	Science Applications International Corporation SAIC Canada	
China	**Huo Zhichen,** **Lou Zhen Tao**	Chinese Solar Thermal Industry Federation(CSTIF) Solar thermal utilization Division Of China Association Of Rural Energy Industry
	Jiang Xinian	Guangzhou Institute of Energy Conservation, Chinese Academy of Sciences, Beijing
	Luguang Yan, **Li Zhongming**	China Solar Energy Society (CSES)
Cyprus	**Soteris Kalogirou**	Higher Technical Institute, Nicosia
	Christodoulos Pharconides	Renewable Energy Systems Engineer, Cyprus Institute of Energy
Czech Republic	**Eva Kudrnová**	Technology Centre AS CR, Prague
Denmark	**Jan Erik Nielsen**	DSF
	Jens Windeleff	ENS, Copenhagen
Finland	**Peter Lund**	Helsinki University of Technology, Espoo
	Solpros	Finnish Solar Industries
France	**Richard Loyen**	Association de Professionnels pour le Developpement des Énergies Renouvelables, Castellet
Germany	**Gerhard Stry-Hipp**	Bundesverband Solarindustrie e.V. – Bsi, Berlin

Greece	**Vassiliki Drosou**	Solar Thermal Systems Section, CRES - Centre for Renewable Energy Sources
	Costas Travasaros	Greek Solar Industry Association
Hungary	**Istvan Farkas**	Hungarian Solar Energy Society
India	**Amit Kumar**	Coordinator, Energy Environment Technology Division, TERI
	C. Palaniappan	Planters Energy Network – PEN
Ireland	**Neil Cammish**	Renewable Energy Information Office, Sustainable Energy Ireland
Israel	**Asher Vaturi**	ICTAF, Tel Aviv University
	Ministry of National Infrastructures	Solel and Israel Manufacturing Association, Tel Aviv
	ICBS	Israel Central Bureau of Statistics
Italy	**Riccardo Battisti**	Department of Mechanical and Aeronautical Engineering, University of Rome "La Sapienza"
	Paolo Zampetti	ENEA, Rome
	Giacobbe Braccio	ENEA, C.R. Trisaia, Rotondella, Matera
Japan	**Noriaki Yamashita**	Takuo Yamaguchi, Institute for Sustainable Energy Policies (ISEP)
	Solar System Development Association(SSDA)	
	OM Solar Association, Japan, www.omsolar.net	
	Kazuki Yoshimura	National Institute of Advanced Industrial Science and Technology, Nagoya
Jordan	**Walid Shahin**	National Energy Research Center NERC
Macedonia	**Dejan Zrmanovski**	Ministry of Economy, Department of Energy, Energy Efficiency and Renewable Energy Sources Unit
	Sanja Popovska-Vasilevska	Solar Macedonia - Macedonian Association for solar energy
Mexico	**Wilfrido Rivera Gomez-Franco**	Centro de Investigacion en Energia, Universidad Nacional Autonoma de Mexico
	Claudio Estrada	Centro de Investigacion en Energia, Temixco, Morelos
	Asociación Nacional de Energía Solar, A.C.	
Namibia	**Ministry of Mines & Energy**	
	Kudakwashe Ndhlukula	Renewable Energy & Energy Efficiency Institute-REEE
	Brita Emmermacher	The Desert Research Foundation of Namibia, Energy Desk
Netherlands	**Reinoud Segers**	Statistics Netherlands
	Lex Bosselaar	SenterNovem, Utrecht

New Zealand	**Michael Donn**	School of Architecture, Victoria University of Wellington
	Brian Cox	Solar Industries Association New Zealand
Norway	**Fritjof Salvesen**	KanEnergi AS, Oslo
Poland	**Grzegorz Wiśniewski**	EC BREC Institute for Renewable Energy Ltd., Poland
	Stanislaw Golebiowski	Krystian Kurowski, EC BREC / IBMER, Warzawa
Portugal	**João Farinha Mendes**	DER/INETI - Edificio G, Lisbon
	ADENE	Agência para a Energia (www.adene.pt)
Slovenia	**Gradbeni Institut**	ZRMK, Ljubliana
South Africa	**Dieter Holm**	Sustainable Energy Society of Southern Africa, Pretoria
	Nadia Hamid, Mark Tanton	Energy Development Corporation (EDC) of the Central Energy Fund (CEF)
Spain	**Manuel Romero**	Renewable Energy Division, CIEMAT, Madrid
Sweden	**Jan-Olof Dalenbäck**	Chalmers University of Technology, Göteborg Solar Energy Association – SEAS
Switzerland	**Urs Wolfer**	Federal Office of Energy, Bern
Taiwan	**Shyi-min Lu, Tsung-Chi Chen**	Energy and Environment Research Laboratories (EEL), Industrial Technology Research Institute (ITRI)
Tunisia	**Sami Marrouki**	Directeur ANME, Directeur Exécutif MEDREC (Centre Méditerranéen des Energies Renouvelables)
	Ghazi Ben Salem	ANME
Turkey	**A. Kutay Ülke**	Export Department, EZINC Metal San. ve Tic. A.S.
	Sebahattin Öz	Solar Energy Division, Electrical Power Survey and Development Administration in Turkey
	Gulsun Erkul	First Secretary (Energy Adviser), Permanent Delegation of Turkey to the OECD
	Mehmet Çağlar	Ministery of Energy and Natural Resources of TURKEY
United States	**Drury Crawley**	U.S. Department of Energy, Washington D.C.

7.8 Reports and Statistics

The following reports and statistics were used in this report:

- European Solar Thermal Industry Federation (ESTIF): Solar Thermal Markets in Europe, Trends and Market Statistics 2006, 2007
- Solar Thermal Barometer, EurObserv'ER, October 2007
- Renewables 2007, Global Status Report, 2008, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
- National Energy Balance 2006, Mexico, 2008
- Dalenbäck, Jan-Olof: Solar District Heating and Cooling, 1st draft report for the European Solar Thermal Technology Platform, 2007
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