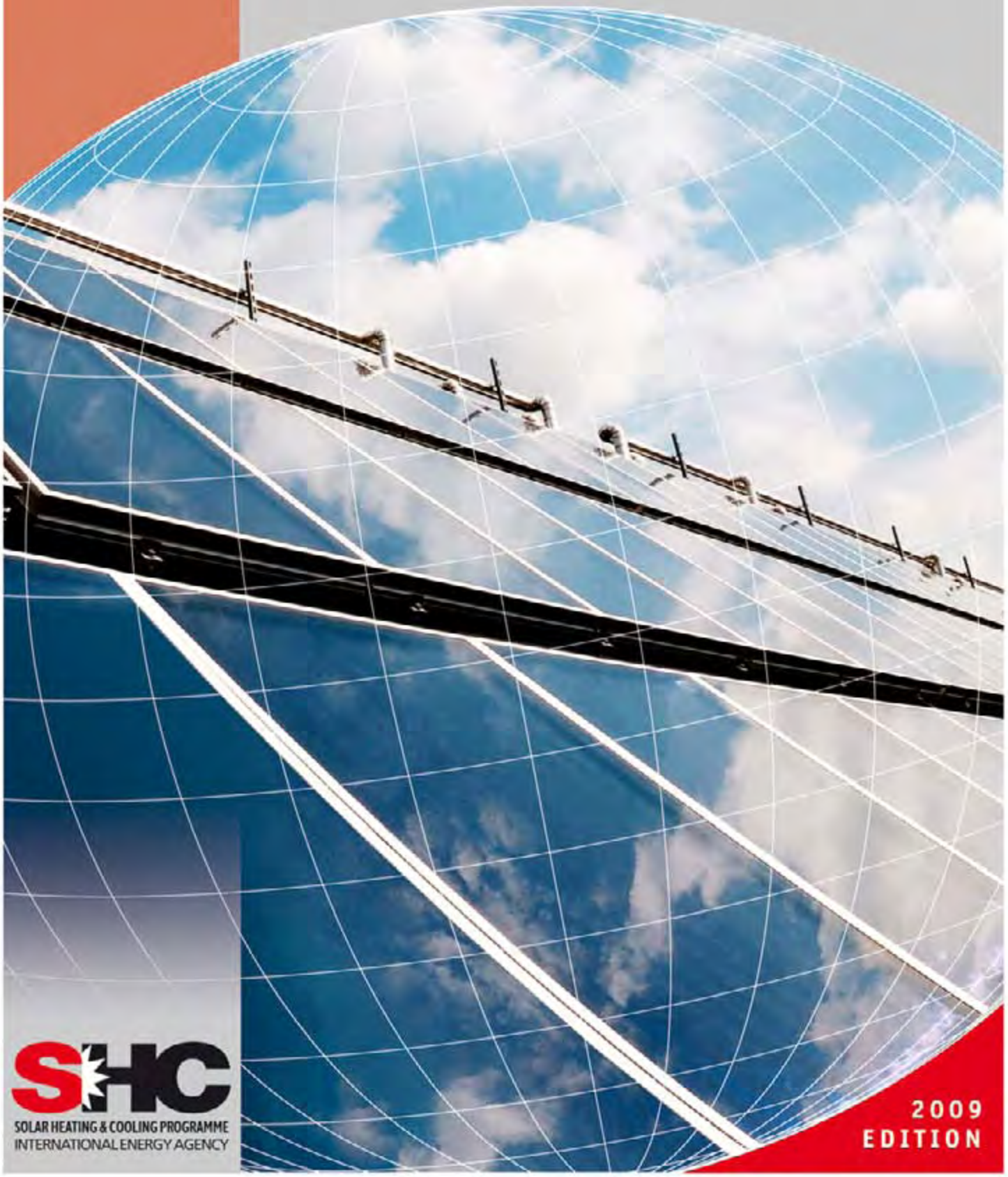
Werner Weiss | Irene Bergmann | Roman Stelzer

Solar Heat Worldwide

Markets and Contribution to the Energy Supply 2007



SHC
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

2009
EDITION

SOLAR HEAT WORLDWIDE

Markets and Contribution to the Energy Supply 2007

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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 49 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 49 countries included in this report represent 4 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.

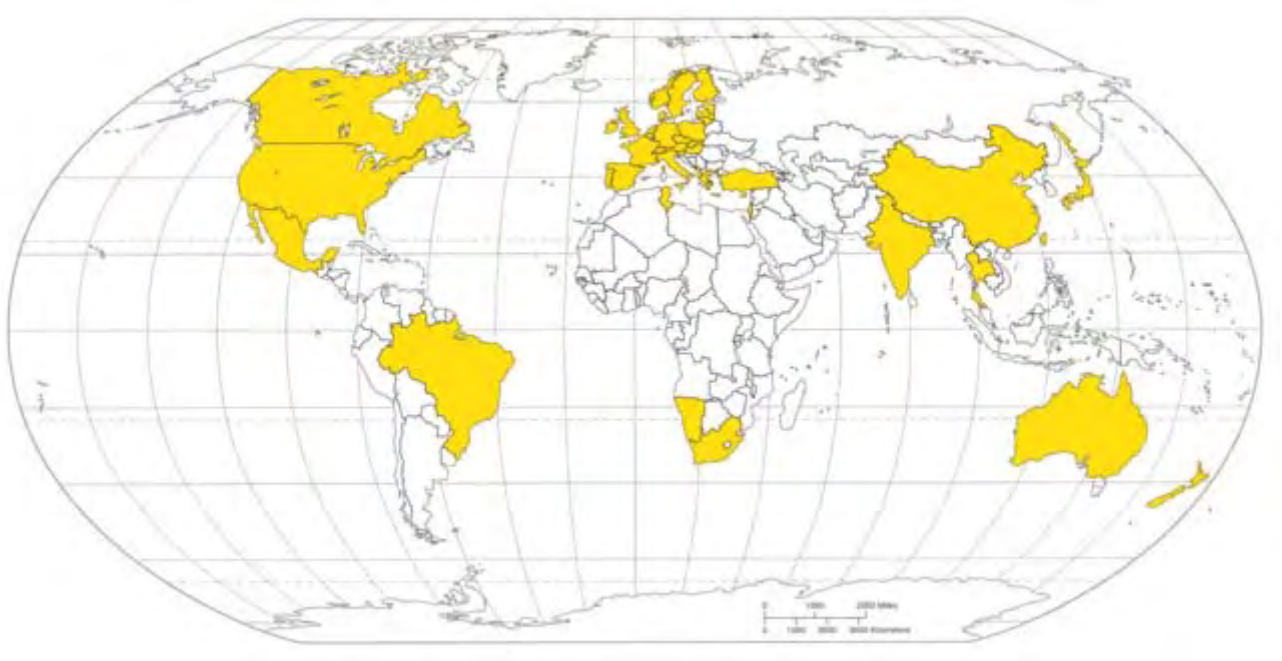


Figure 1: Countries represented in this report

2 Summary

Solar Thermal Capacity in Operation Worldwide

The solar thermal collector capacity in operation worldwide equaled 146.8 GW_{th} corresponding to 209.7 million square meters[1]1 at the end of the year 2007. Of this, 120.5 GW_{th} were accounted for by flat-plate and evacuated tube collectors and 25.1 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 (80.8 GW_{th}), Europe (15,9 GW_{th}) and Japan (4.9 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 still the dominant application with an installed capacity of 19.8 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. These unglazed air collectors are used for commercial and industrial building ventilation, air heating and agricultural applications.

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. There are about 130 large-scale plants (≥ 500 m²; 350 kW_{th}) in operation in Europe with a total installed capacity of 140 MW_{th}. The biggest plants for solar assisted district heating are located in Denmark with 13 MW_{th} (18,300 m²) and Sweden with 7 MW_{th} (10,000 m²). The biggest reported solar thermal system for providing industrial process heat was installed in 2007 in China. This 9 MW_{th} (13,000 m²) plant generates heat for a textile company.

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 2007, China (79.9 GW_{th}), Turkey (7.1 GW_{th}), Germany (6.1 GW_{th}), Japan (4.9 GW_{th}) and Israel (3.5 GW_{th}) are the leading countries. They are followed by Brazil (2.51 GW_{th}), Greece (2.50 GW_{th}), Austria (2.1 GW_{th}), the USA (1.7 GW_{th}) and India (1.5 GW_{th}). As can be seen from these figures, China is by far the largest market, representing 66% of the world market of flat-plate and evacuated tube collectors. Here it should also be mentioned that China extended its market share by 2% in 2007 compared to 2006.

Focusing on market penetration – total capacity in operation per 1,000 inhabitants – Cyprus (651 kW_{th}), Israel (499 kW_{th}), Austria (252 kW_{th}), Greece (224 kW_{th}) and Barbados (197 kW_{th}) are the leading countries. They are followed by Jordan (100 kW_{th}), Turkey (95 kW_{th}), Germany (73 kWt_{th}), China (60 kW_{th}) and Australia (57 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 19.3 GW_{th} in operation ahead of Australia with 2.8 GW_{th}, Germany and Canada with 0.5 GW_{th} each, and South Africa and Austria with 0.4 GW_{th}.

The market penetration – total capacity in operation per 1,000 inhabitants – gives a slightly different picture: Australia leads with 137 kW_{th} ahead of the USA with 63 kW_{th} and Austria with 51 kW_{th} per 1,000 inhabitants. In fourth to sixth places there are Switzerland, the Netherlands and Canada with an installed capacity between 20 and 14 kW_{th}.

Installed capacity in 2007

In the year 2007, a new capacity of 19.9 GW_{th} corresponding to 28.4 million square metres of solar collectors was installed worldwide. The overall new installations grew 8.7% compared to 2006. This represents a decrease of the growth rate compared to 2005/2006 when the market grew 22%. The main reasons for this were the market slumps of unglazed plastic collectors in the USA and of flat plate and evacuated tube collectors in Germany.

In 2007, flat-plate and evacuated tube collectors accounted for 18.4 GW_{th}.

It is remarkable that the global market of evacuated tube collectors grew 23.4% compared to the year 2006, whereas the markets of flat plate collectors and unglazed collectors decreased 18.3% and 7.2% respectively.

The most dynamic markets for water collectors (unglazed, flat-plate and evacuated tube collectors) in Europe, with growth rates near and above 100% compared to the capacity installed in 2006, were in Hungary 700%, Ireland 293%, Slovak Republic 200%, UK 93% and Portugal 80%. Besides the European countries, the markets in Namibia 74.5%, Mexico 60% and Brazil 32% have recorded a large growth rate. The number of new installations in China, the world's largest market, increased in 2007 by 17.4% compared to the number of installations in 2006.

The main markets for unglazed collectors can be found in the USA (0.79 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 2007.

Market development 1999 - 2007

The main 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 2007 was 23.6% in China, 20% in Europe, 26% in Canada and the USA and 16% in Australia and New Zealand. 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 recent years.

The worldwide market of unglazed collectors for swimming pool heating recorded an increase between 1999 and 2002 and a slight decrease in 2003. After a slight increase from 2004 to 2006, the installed capacity rate declined again in 2007.

Contribution of solar collectors to the supply of energy

The annual collector yield of all solar thermal systems in operation by the end of 2007 in the 49 recorded countries is 88,845 GWh (319.841 TJ). This corresponds to an oil equivalent of 12.09 million tons and an annual avoidance of 39.3 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.

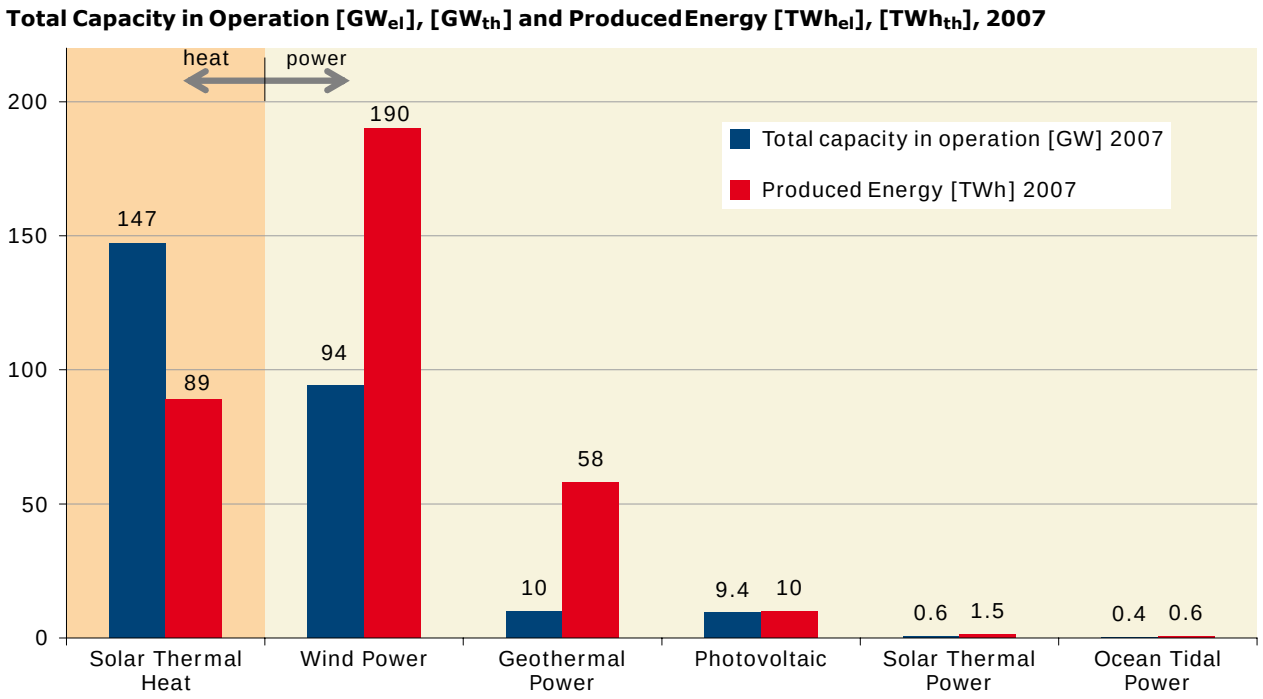


Figure 2: Total capacity in operation [GW_{el}], [GW_{th}] 2006 and annually energy generated [TWh_{el}], [TWh_{th}].
Sources: EPIA, GEWC, EWEA, EGEC, REN21 and IEA SHC 2008

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 200,000 worldwide.

Preview 2008

Based on the data available for the year 2007 at the date of publishing this report, the total capacity in operation worldwide in 2008 can be estimated to be 165 GW_{th}, corresponding to 236 million square meters of collector area.

3 Total capacity by the year 2007

Since the beginning of the 1990s, the solar thermal market has undergone a favorable development. At the end of 2007, a total of 209.2 million square meters of collector area, corresponding to an installed capacity 146.8 GW_{th} were in operation in the 49 countries recorded in this report. These 49 countries represent 4 billion people or 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 46.39 GW_{th} glazed flat-plate collectors (66.3 million square meters) and 74.11 GW_{th} evacuated tube collectors (105.9 million square meters), 25 GW_{th} unglazed collectors (35.8 million square meters) and 1.2 GW_{th} glazed and unglazed air collectors (1.7 million square meters). The distribution of the total capacity worldwide in 2007 can also be seen in **Figure 3**.

Figure 4 gives an overview of the 10 leading countries based on total capacities in 2007. This figure clearly shows how the different types of collectors are applied in the different countries. China, as world leader in total capacity, is focusing 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 focusing 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 Cyprus – the total capacity published in this report for 2007 decreased compared to the data published for 2006 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		34.95	0.17			**35.12**
Australia	2,849	1,162.00	16.10			**4,027.10**
Austria	426.22	2,064.69	30.09			**2,521.00**
Barbados		57.96				**57.96**
Belgium	34.18	93.63	8.66			**136.46**
Brazil	68.21	2,511.25	0.25			**2,579.70**
Bulgaria		19.32				**19.32**
Canada	466.14	57.23	3.32	90.97	0.13	**617.80**
China		7,280.00	72,618.00			**79,898.00**
Cyprus		556.32	0.67			**557.00**
Czech Republic	10.66	67.96	10.84			**89.47**
Denmark	14.96	275.70	2.38	2.38	13.13	**308.55**
Estonia		1.03				**1.03**
Finland	0.35	10.91	0.91			**12.17**
France *	73.15	991.55	23.10			**1,087.80**
Germany	525.00	5,448.87	604.79			**6,578.65**
Greece		2,496.34	4.76			**2,501.10**
Hungary	1.96	28.94	1.79			**32.69**
India		1,505.00			11.90	**1,516.90**
Ireland		19.36	5.54			**24.90**
Israel	16.94	3,455.83				**3,472.77**
Italy	18.39	611.46	72.00			**701.86**
Japan		4,777.20	88.95	304.06	8.76	**5,178.96**
Jordan		588.23	5.04			**593.27**
Lativa		3.75				**3.75**
Lithuania		2.42				**2.42**
Luxembourg		13.23				**13.23**
Macedonia		13.35	0.14			**13.49**
Malta		20.55				**20.55**
Mexico	327.31	310.72				**638.03**
Namibia		4.19	0.13			**4.32**
Netherlands	240.47	230.65				**471.12**
New Zealand	4.35	72.04	7.03			**83.42**
Norway	1.12	7.85	0.11		0.84	**9.92**
Poland	0.91	138.51	25.71	2.10	1.75	**168.98**
Portugal	0.42	193.23	3.83			**197.48**
Romania		48.72				**48.72**
Slovak Republic		61.81	6.94			**68.75**
Slovenia		81.07	0.81			**81.88**
South Africa	440.03	173.38				**613.40**
Spain	2.10	814.92	31.92			**848.93**
Sweden	56.00	156.10	20.30			**232.40**
Switzerland **	148.68	303.44	17.79	586.60		**1,056.52**
Taiwan		795.84	82.89			**878.74**
Thailand		49.00				**49.00**
Tunisia		151.57	1.03			**152.60**
Turkey		7,105.00				**7,105.00**
United Kingdom		194.54	18.90			**213.44**
United States	19,347.55	1,329.19	404.86	0.07	160.82	**21,242.49**
TOTAL	**25,074.11**	**46,390.78**	**74,119.76**	**986.18**	**197.33**	**146,768.15**

* 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 2007 [MW_{th}]

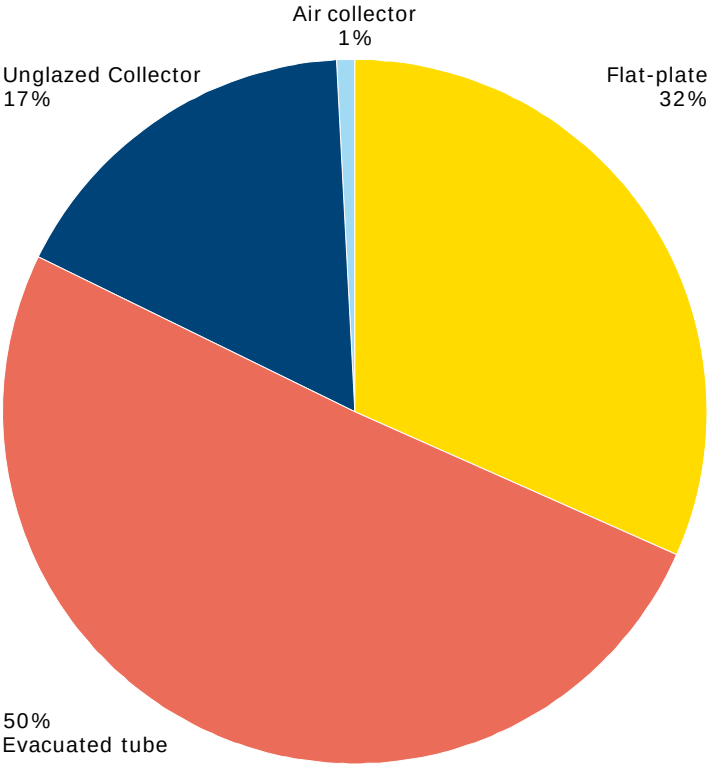


Figure 3: Distribution of the worldwide capacity in operation 2007 by collector type

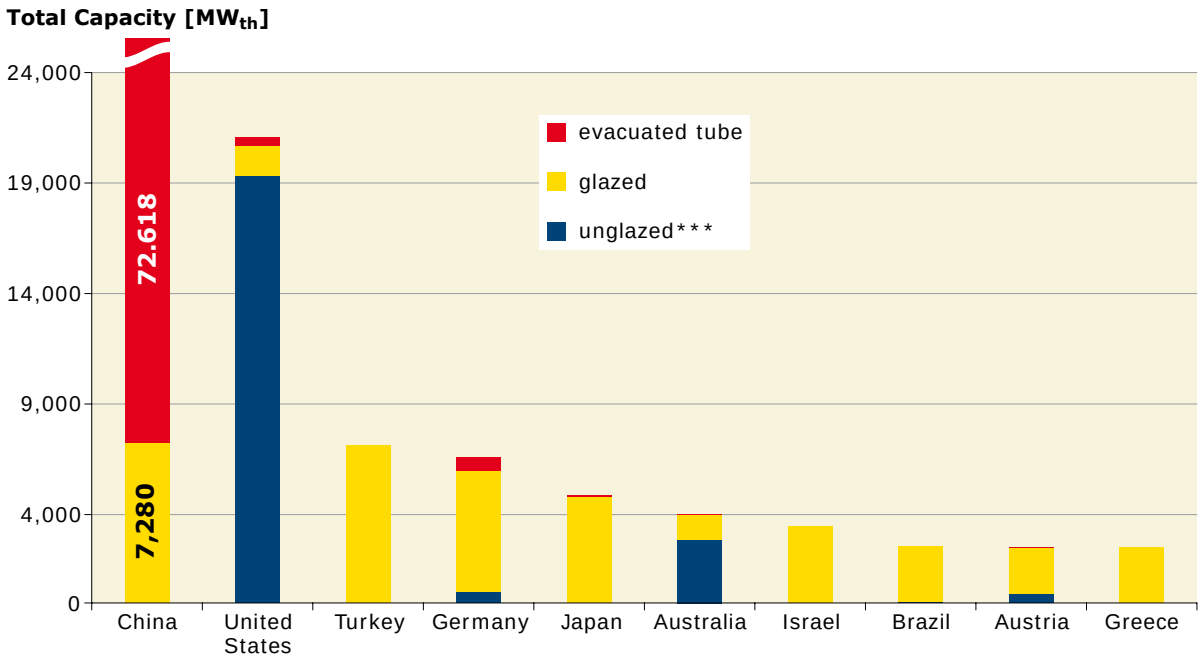
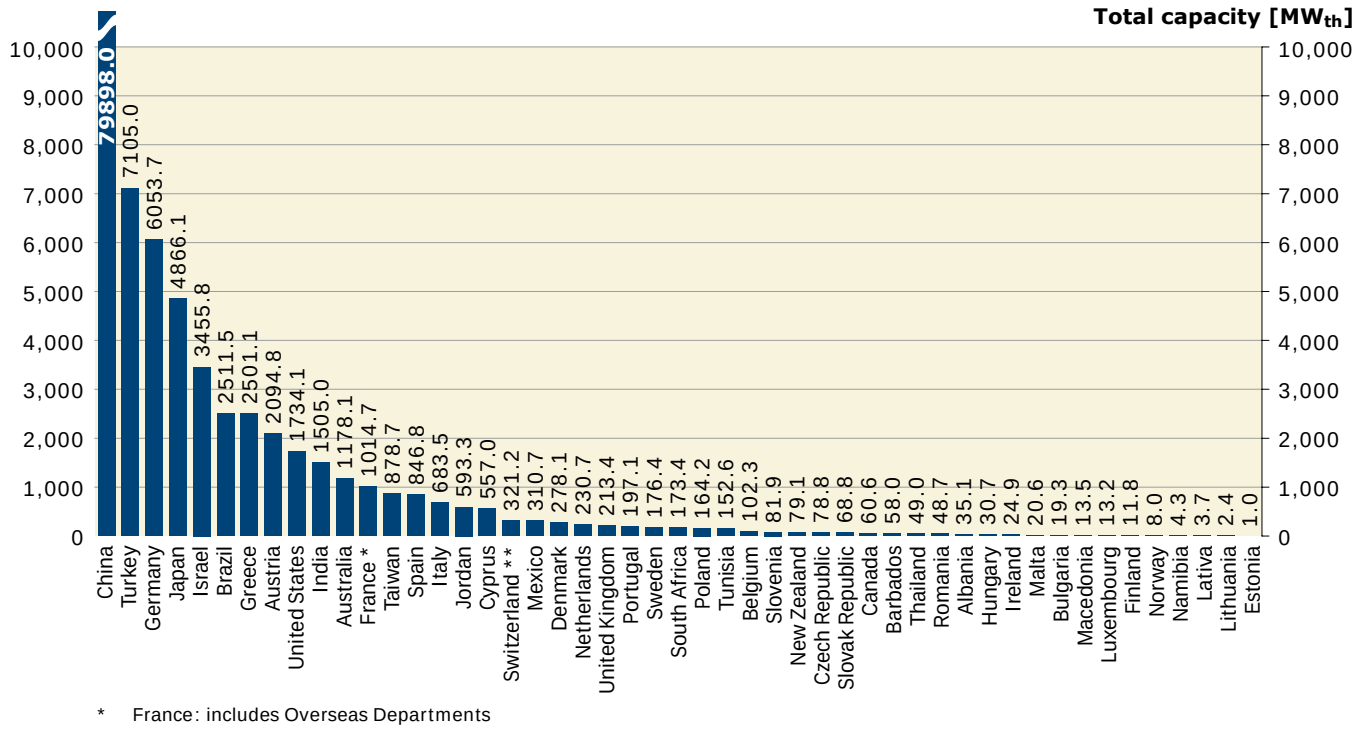


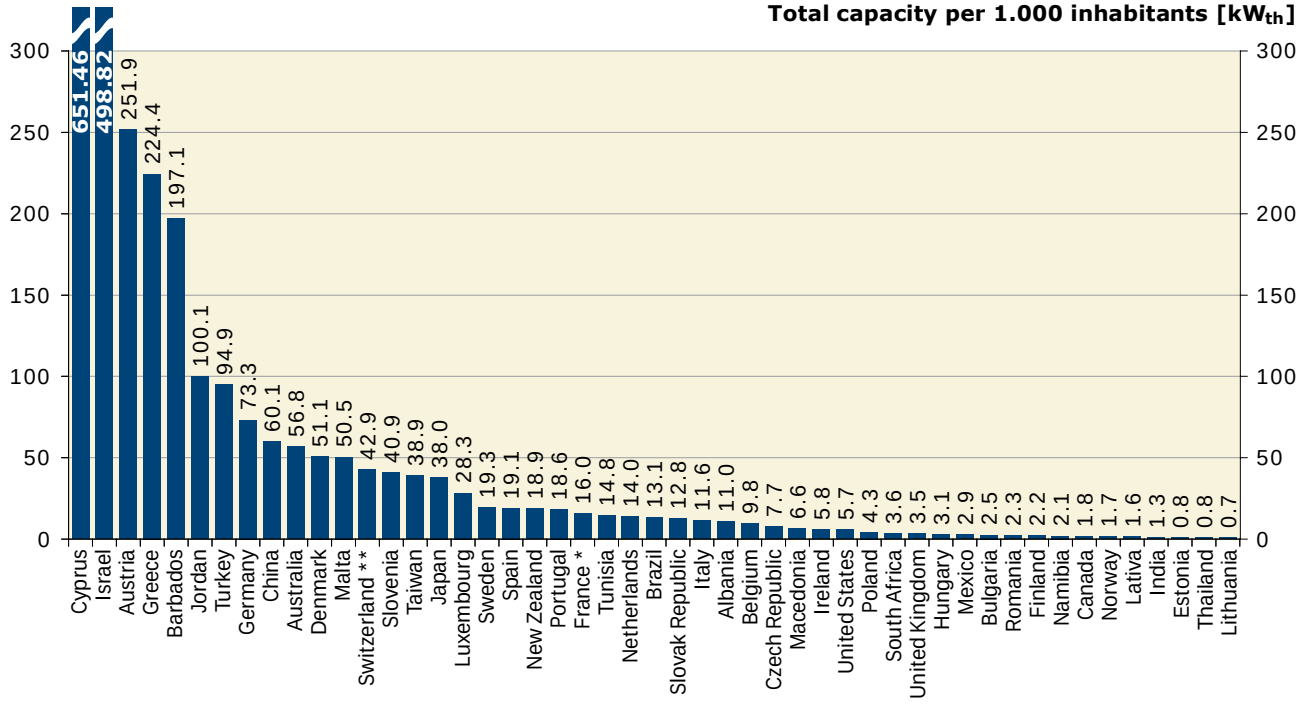
Figure 4: Total capacity in operation of water collectors of the 10 leading countries at the end of 2007

3.1 Total capacity of glazed flat-plate and evacuated tube collectors at the end of 2007



* France: includes Overseas Departments

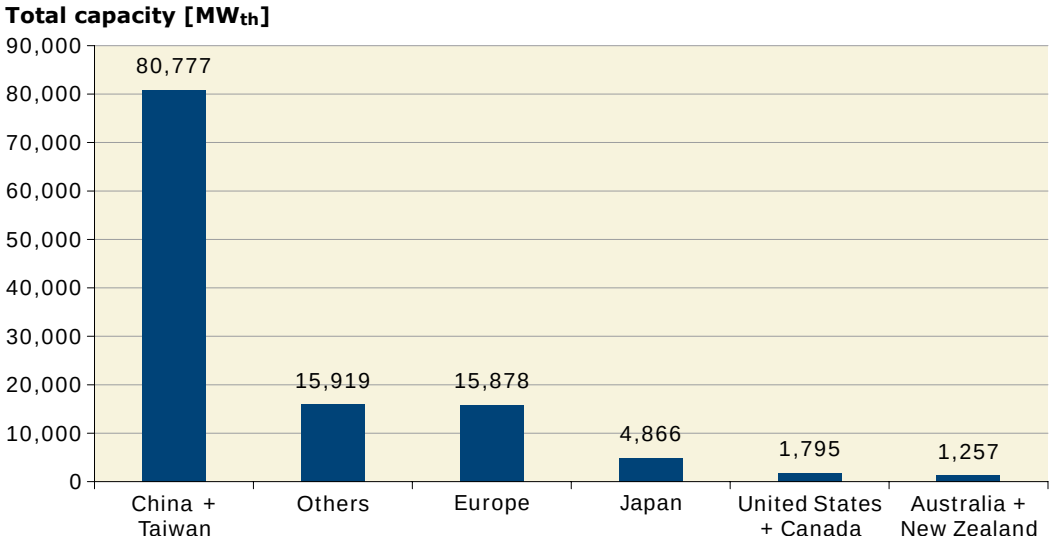
Figure 5: Total capacity of glazed flat-plate and evacuated tube collectors in operation at the end of 2007



* France: includes Overseas Departments

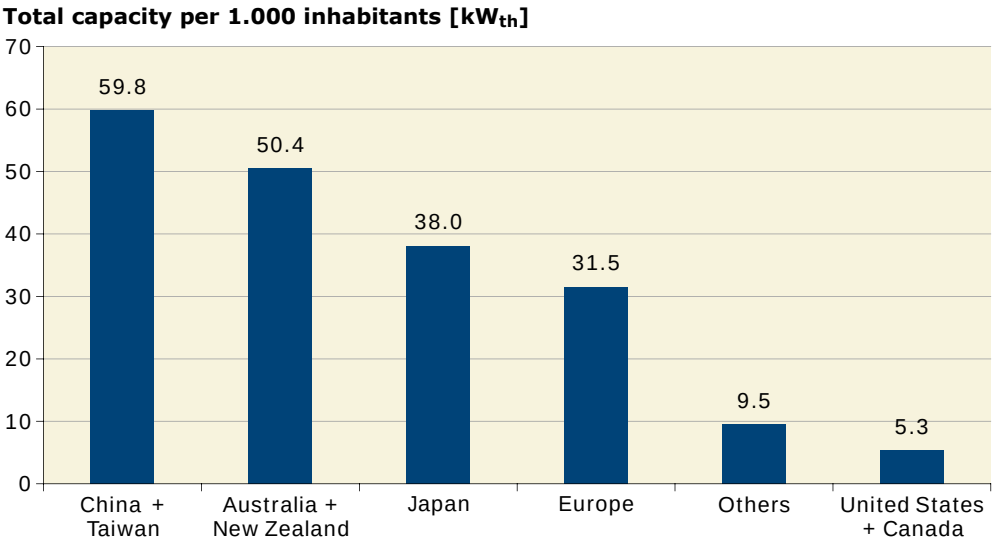
Figure 6: Total capacity of glazed flat-plate and evacuated tube collectors in operation at the end of 2007 in kW_{th} per 1,000 inhabitants

3.2 Total capacity of glazed flat-plate and evacuated tube collectors in operation at the end of 2007 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, Thailand and Turkey

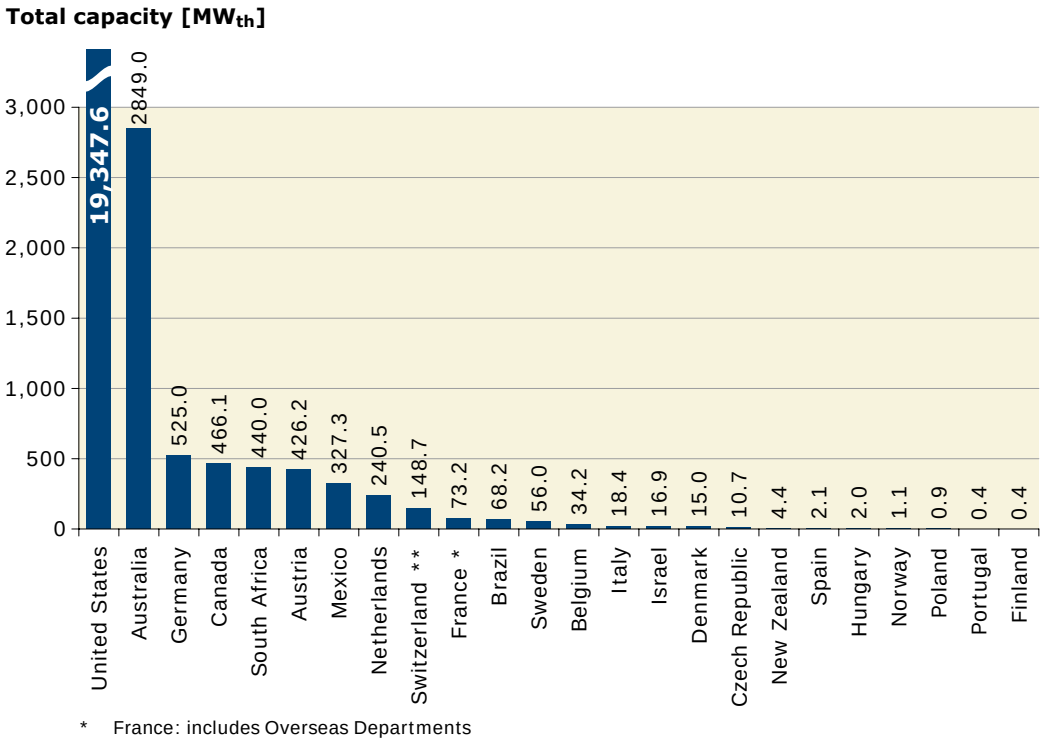
Figure 7: Total capacity of glazed flat-plate and evacuated tube collectors in operation by economic region at the end of 2007



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

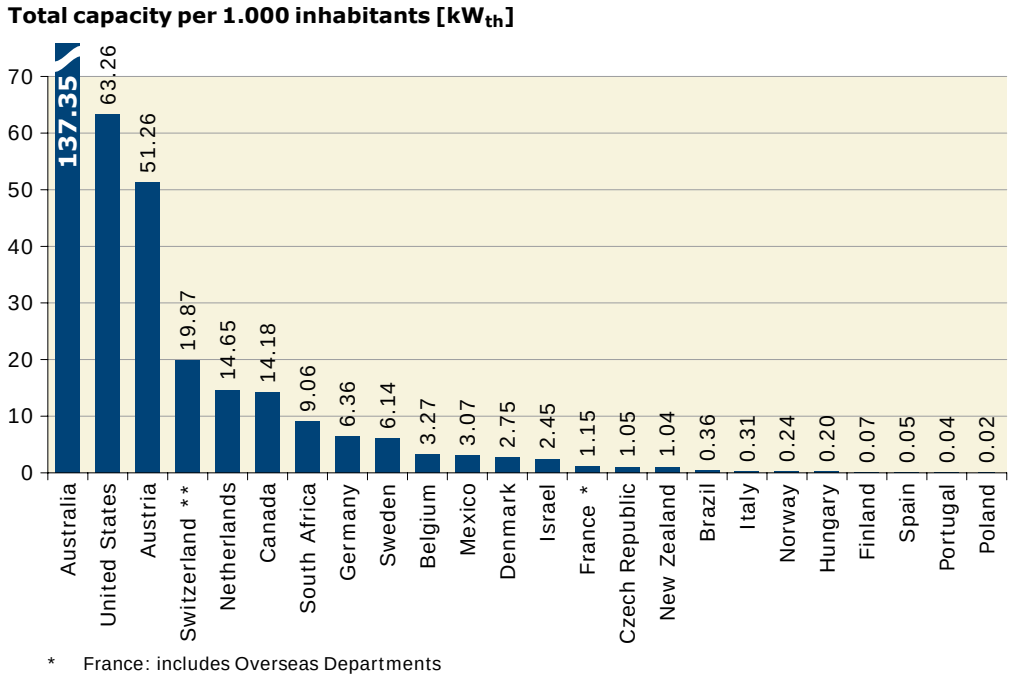
Figure 8: Total capacity of glazed flat-plate and evacuated tube collectors in operation by economic region at the end of 2007 in kW_{th} per 1,000 inhabitants

3.3 Total capacity of unglazed water collectors in operation at the end of 2007



* France: includes Overseas Departments

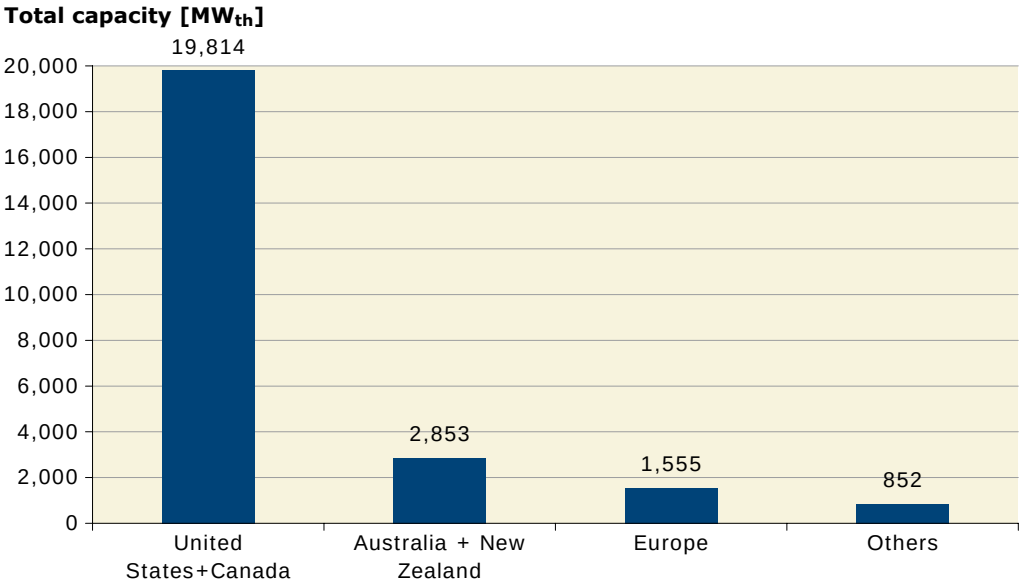
Figure 9: Total capacity of unglazed water collectors in operation at the end of 2007



* France: includes Overseas Departments

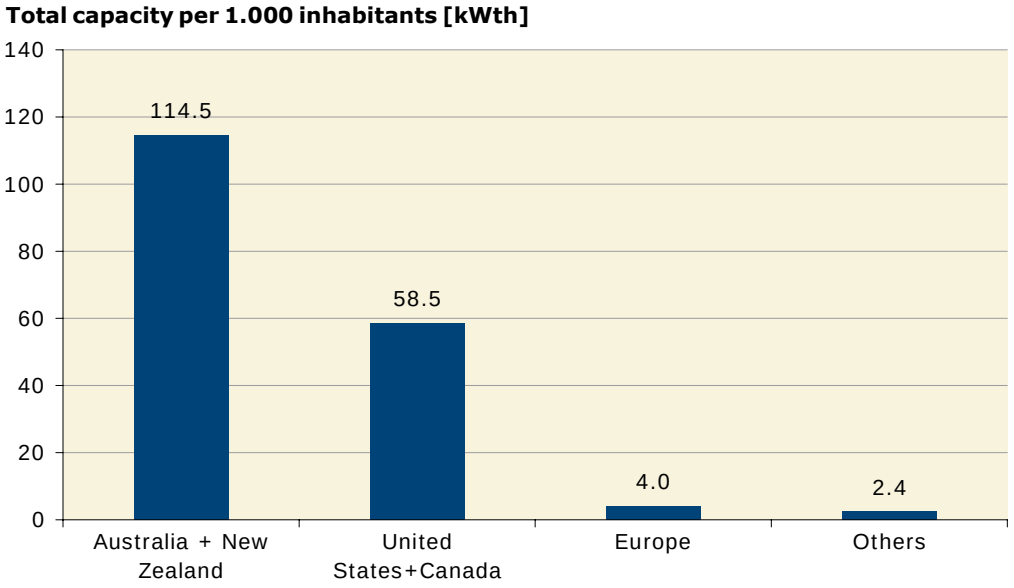
Figure 10: Total capacity of unglazed water collectors in operation at end of 2007 in kW_{th} per 1,000 inhabitants

3.4 Total capacity of unglazed water collectors in operation by economic region at the end of 2007



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 2007



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

Figure 12: Total capacity of unglazed collectors in operation by economic region at the end of 2007 in kW_{th} per 1,000 inhabitants

4 Market development

4.1 In 2007 installed capacity

In the year 2007, a capacity of 19.9 GW_{th} corresponding to 28.4 million square metres of solar collectors, were installed worldwide. Flat-plate and evacuated tube collectors accounted for 18.4 GW_{th}, which is 92.5% of the overall market. The main markets for unglazed collectors can be found in the USA (0.8 GW_{th}) and Australia (0.4 GW_{th}). South Africa, Canada, Mexico, The Netherlands, Sweden, Switzerland and Austria also have a notable market, but all with values below 0.1 GW_{th} of new installed unglazed collectors in 2007.

It is remarkable that the market of evacuated tube collectors grew 23.4% compared to the year 2006, whereas the markets of flat plate collectors and unglazed collectors decreased 18.3% and 7.2% respectively.

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 2007 (see **Table 14** for the capacity installed in 2006 in **Chapter 7.5**; the installed collector area in m^2 is given in **Tables 15** and **16** in **Chapter 7.6**).

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed***	glazed	evacuated tube	unglazed***	glazed***	
Albania		6.50	0.06			**6.56**
Australia	403.20	142.10	2.10			**547.40**
Austria	6.06	194.33	2.38			**202.78**
Barbados		1.91				**1.91**
Belgium	6.18	25.90	3.50			**35.58**
Brazil	68.21	332.78	0.25			**401.23**
Bulgaria		1.75				**1.75**
Canada	27.92	1.02	1.67	11.94	0.09	**42.64**
China		770.00	14,028.00			**14,798.00**
Cyprus		10.50	0.70			**11.20**
Czech Republic	4.20	13.23	4.27			**21.70**
Denmark	0.42	16.10	0.28	2.38	2.45	**21.63**
Estonia		0.25				**0.25**
Finland		1.47	0.44			**1.91**
France *	3.71	213.50	8.89			**226.10**
Germany	21.00	588.00	70.00			**679.00**
Greece		195.30	2.80			**198.10**
Hungary		4.20	1.40			**5.60**
India		175.00			4.90	**179.90**
Ireland		10.41	3.36			**13.77**
Israel	0.49	49.70				**50.19**
Italy	2.56	147.00	24.50			**174.06**
Japan		116.36	2.84		8.76	**127.95**
Jordan		5.37	2.52			**7.89**
Lativa		1.05				**1.05**
Lithuania		0.49				**0.49**
Luxembourg		2.10				**2.10**
Macedonia		1.37	0.14			**1.51**
Malta		3.85				**3.85**
Mexico	32.40	75.59				**107.99**
Namibia		1.97	0.13			**2.10**
Netherlands	19.41	13.94				**33.35**
New Zealand	0.42	8.26	3.61			**12.29**
Norway	0.14	0.50	0.04			**0.68**
Poland		32.92	14.78			**47.70**
Portugal	0.43	31.14	3.99			**35.56**
Romania		0.35				**0.35**
Slovak Republic		10.89	6.94			**17.83**
Slovenia		4.56	0.81			**5.37**
South Africa	47.11	9.80				**56.91**
Spain	2.10	175.70	7.70			**185.50**
Sweden	14.30	10.89	6.94			**32.13**
Switzerland **	7.22	44.12	1.79	1.40		**54.53**
Taiwan		87.50	6.93			**94.43**
Thailand		5.60				**5.60**
Tunisia		27.30	0.70			**28.00**
Turkey		490.00				**490.00**
United Kingdom		18.90	18.90			**37.80**
United States	787.53	90.73	14.36		0.89	**893.51**
TOTAL	**1,455.00**	**4,172.20**	**14,247.69**	**15.72**	**17.08**	**19,907.69**

* 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

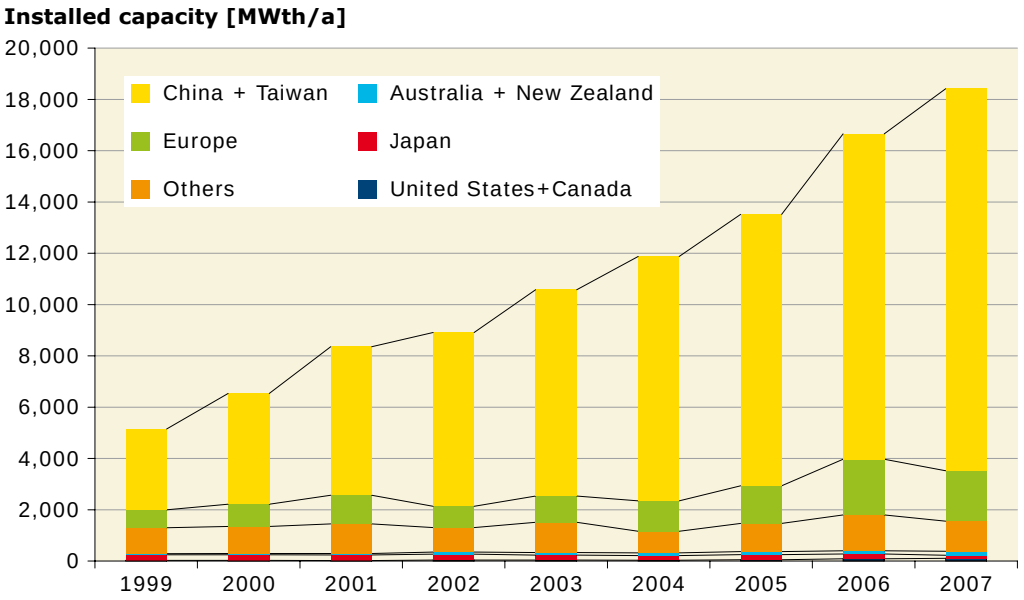
Table 2: Installed capacity in 2007, MW_{th}/a

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 2007, it can be seen that the market of flat-plate and evacuated tube collectors grew significantly during this time period.

The main 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 2007 was 23.6% in China and Taiwan, 20% in Europe, and 16% in Australia and New Zealand. The market for flat-plate and evacuated tube collectors is slightly growing in Canada and the USA. The European market decreased in 2007 mainly due to the negative sales in Germany.

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

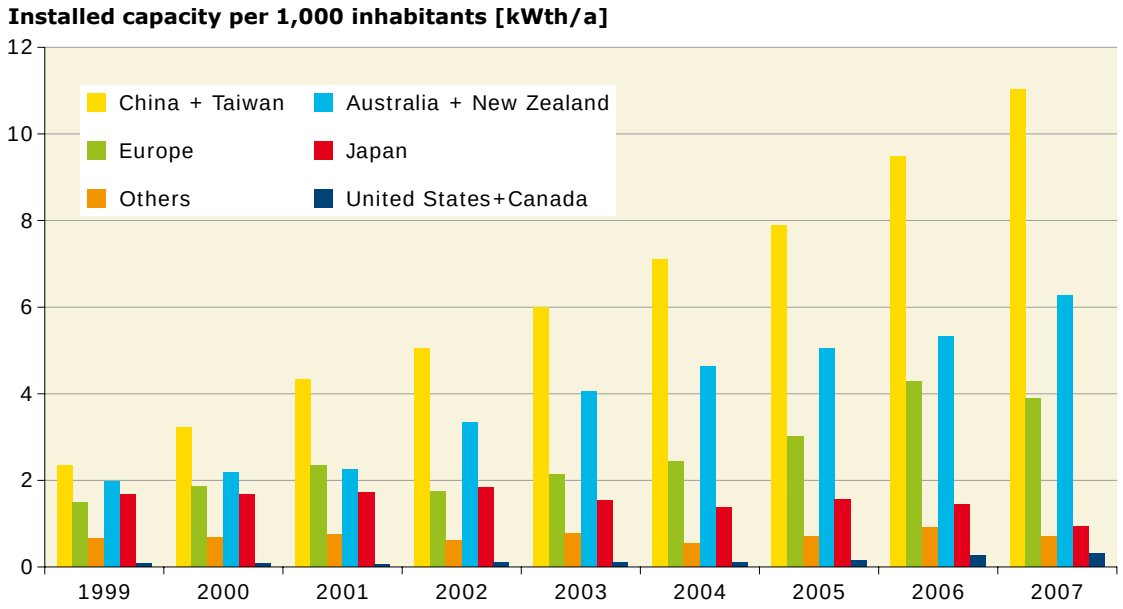


Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Thailand, Tunisia and Turkey

Figure 13: Annual installed capacity of flat-plate and evacuated tube collectors from 1999 to 2007

It should be mentioned here that the Chinese market is dominated by evacuated tube collectors, whereas in all other markets flat-plate collectors are predominant (see **Figure 4**). Other markets in 2007 with a significant share of evacuated tube collectors were in Germany, Italy, Poland, USA and United Kingdom.

Figure 14 shows a different picture of the market development. In this figure the yearly installed capacity per 1,000 inhabitants is shown. Even if China looses absolute dominance due to its large population, the Chinese and Taiwanese markets are also leading in the specific collector area installed (capacity/inhabitant), ahead of Australia and New Zealand. Europe comes in at third place.



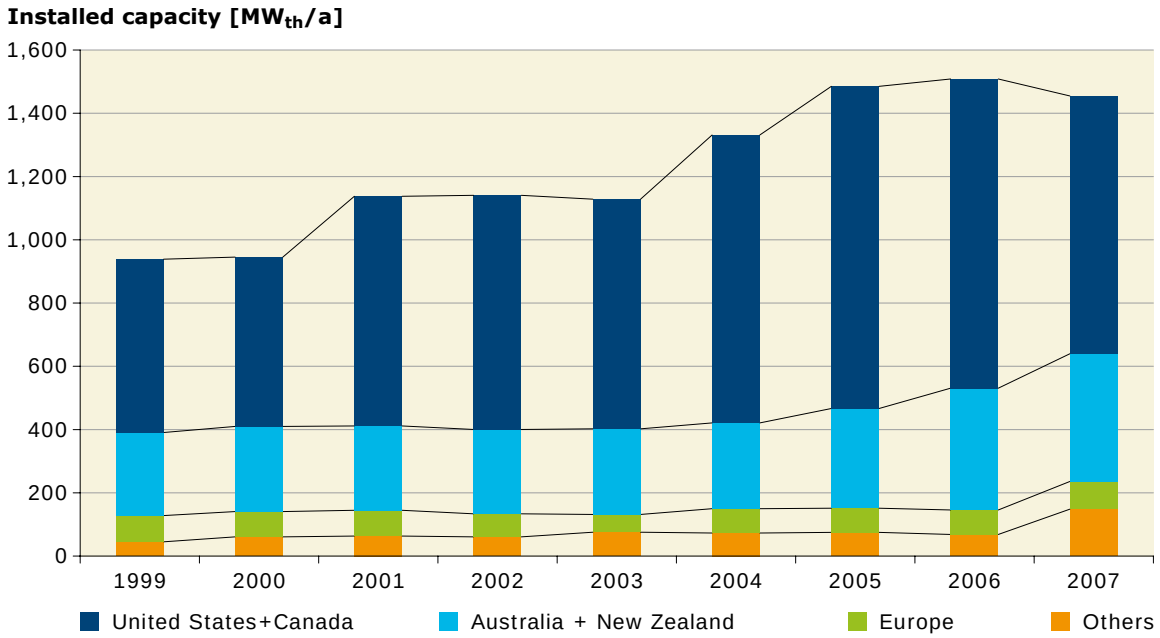
Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Thailand, Tunisia and Turkey

Figure 14: Annual installed capacity of flat-plate and evacuated tube collectors in kW_{th} per 1,000 inhabitants from 1999 to 2007

4.3 Market development of unglazed plastic collectors by economic region

In the USA and Australia, 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 100 MW_{th}.

The worldwide market of unglazed collectors for swimming pool heating recorded an increase between 1999 and 2002 and a decrease in 2003. After a slight increase from 2004 to 2006 the installed capacity rate declined again in 2007, mainly caused by the major market decline in the USA and Canada (see figure 15).



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

Figure 15: Annual installed capacity of unglazed water collectors from 1999 to 2007

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 120.5 GW_{th} and unglazed plastic collector capacity of 25.1 GW_{th} was installed by the end of the year 2007 in the recorded countries.

The annual yield of these collectors is calculated to be 88,845 GWh (319.841 TJ). This corresponds to an oil equivalent of 12.09 million tons and an annual avoidance of 39.3 million tons of CO_2.

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 optimize 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 at 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 [t/a]	CO_2 reduction [t/a]
Albania	50,176	35.1	6,724	6.9	24.9	1,153.16	**3,745**
Australia	5,753,000	4,027.1	433,358	2,192.3	7,892.3	323,918.09	**1,052,261**
Austria	3,601,431	2,521.0	360,154	1,204.5	4,336.0	152,306.53	**494,756**
Barbados	82,794	58.0	20,698	67.5	242.9	10,119.03	**32,848**
Belgium	194,946	136.5	36,774	64.7	233.1	7,824.17	**25,412**
Brazil	3,685,291	2,579.7	897,449	1,598.0	5,753.0	238,859.04	**775,847**
Bulgaria	27,600	19.3	6,900	12.0	43.2	2,074.97	**6,734**
Canada	752,422	526.7	17,112	183.1	659.3	25,187.30	**81,813**
China	114,140,000	79,898.0	27,484,912	49,217.2	177,181.8	6,596,378.88	**21,467,451**
Cyprus	795,710	557.0	195,267	499.1	1,796.9	71,911.17	**233,427**
Czech Republic	127,810	89.5	18,674	40.1	144.4	4,794.89	**15,509**
Denmark	418,630	293.0	86,815	140.6	506.2	16,680.50	**54,178**
Estonia	1,470	1.0	368	0.5	1.7	52.48	**171**
Finland	17,385	12.2	4,030	5.4	19.6	602.18	**1,956**
France*	1,554,000	1,087.8	331,274	516.4	1,858.9	76,849.96	**249,321**
Germany	9,398,077	6,578.7	1,246,190	3,457.0	12,445.1	420,310.09	**1,365,272**
Greece	3,573,000	2,501.1	1,374,890	1,883.1	6,779.0	331,672.27	**1,078,740**
Hungary	46,700	32.7	7,266	15.9	57.3	2,511.43	**8,162**
India	2,150,000	1,505.0	537,500	1,928.6	6,942.8	271,351.50	**881,500**
Ireland	35,567	24.9	8,892	11.8	42.3	1,299.62	**4,215**
Israel	4,961,100	3,472.8	1,177,572	3,643.9	13,117.9	492,169.12	**1,597,153**
Italy	1,002,650	701.9	241,981	424.3	1,527.5	56,449.91	**183,336**
Japan	6,951,638	4,866.1	1,682,760	3,316.5	11,939.2	418,423.96	**1,359,003**
Jordan	847,532	593.3	207,984	594.7	2,140.9	103,247.20	**335,330**
Lativa	5,350	3.7	1,338	1.8	6.5	207.85	**677**
Lithuania	3,450	2.4	863	1.1	4.1	135.48	**439**
Luxembourg	18,900	13.2	4,725	6.5	23.5	762.05	**2,481**
Macedonia	19,270	13.5	4,198	7.2	25.9	1,250.80	**4,061**
Malta	29,360	20.6	7,340	9.2	33.0	2,817.68	**9,153**
Mexico	911,473	638.0	39,801	435.8	1,568.9	69,380.28	**225,359**
Namibia	6,169	4.3	1,542	3.1	11.0	598.52	**1,932**
Netherlands	673,033	471.1	94,693	162.9	586.3	18,809.35	**61,072**
New Zealand	119,177	83.4	26,972	35.4	127.4	4,723.21	**15,346**
Norway	12,970	9.1	1,873	4.1	14.7	451.53	**1,467**
Poland	235,897	165.1	28,737	76.5	275.4	9,794.75	**31,795**
Portugal	282,109	197.5	67,144	176.9	637.0	24,275.33	**78,848**
Jordan	69,600	48.7	17,400	32.2	115.9	5,086.37	**16,530**
Slovak Republic	98,215	68.8	16,369	39.3	141.6	4,950.04	**16,075**
Slovenia	116,965	81.9	19,151	42.2	151.8	5,205.04	**16,898**
South Africa	876,290	613.4	65,063	226.5	815.4	32,345.38	**105,018**
Spain	1,212,764	848.9	288,544	739.4	2,661.9	93,614.35	**304,089**
Sweden	332,000	232.4	22,240	124.6	448.6	11,976.46	**38,887**
Switzerland	671,310	469.9	60,690	195.9	705.4	23,663.94	**76,853**
Taiwan	1,255,340	878.7	313,835	629.6	2,266.4	93,585.60	**304,420**
Thailand	70,000	49.0	17,500	47.7	171.7	9,937.20	**31,483**
Tunisia	218,000	152.6	54,500	145.4	523.5	27,010.20	**87,800**
Turkey	10,150,000	7,105.0	2,304,050	6,050.5	21,781.9	807,693.56	**2,626,236**
United Kingdom	304,920	213.4	76,230	101.6	365.6	12,211.13	**39,670**
United States	30,116,580	21,081.6	551,066	8,848.3	31,854.1	1,275,575.53	**4,143,322**
TOTAL	**207,978,070**	**145,585**	**40,471,410**	**89,168**	**321,004**	**12,162,209**	**39,548,052**

* 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 2007

Country	Total collector area** [m²]	Total capacity [MW_{th}]	Number of systems	Collector yield [GWh/a]	Collector yield [TJ/a]	Energy savings - oil equivalent [t/a]	CO_2 reduction [t/a]
Albania	50,176	35.1	6,724	6.9	24.9	1,153	**3,745**
Australia	1,683,000	1,178.1	413,008	693.1	2,495.2	100,959	**328,058**
Austria	2,992,541	2,094.8	357,110	1,066.5	3,839.3	133,375	**433,262**
Barbados	82,794	58.0	20,698	67.5	242.9	10,119	**32,848**
Belgium	146,118	102.3	36,530	56.6	203.7	6,662	**21,636**
Brazil	3,587,849	2,511.5	896,962	1,576.0	5,673.5	235,829	**766,006**
Bulgaria	27,600	19.3	6,900	12.0	43.2	2,075	**6,734**
Canada	86,502	60.6	13,783	39.6	142.5	4,686	**15,221**
China	114,140,000	79,898.0	27,484,912	49,217.2	177,181.8	6,596,379	**21,467,451**
Cyprus	795,710	557.0	195,267	499.1	1,796.9	71,911	**233,427**
Czech Republic	112,580	78.8	18,598	35.6	128.1	4,360	**14,086**
Denmark	397,260	278.1	86,709	137.3	494.3	16,215	**52,665**
Estonia	1,470	1.0	368	0.5	1.7	52	**171**
Finland	16,885	11.8	4,027	5.4	19.4	594	**1,928**
France*	1,449,500	1,014.7	330,752	495.8	1,784.9	73,862	**239,615**
Germany	8,648,077	6,053.7	1,242,440	3,295.8	11,864.7	396,865	**1,289,119**
Greece	3,573,000	2,501.1	1,374,890	1,883.1	6,779.0	331,672	**1,078,740**
Hungary	43,900	30.7	7,252	15.1	54.4	2,396	**7,786**
India	2,150,000	1,505.0	537,500	1,928.6	6,942.8	271,352	**881,500**
Ireland	35,567	24.9	8,892	11.8	42.3	1,300	**4,215**
Israel	4,936,900	3,455.8	1,177,451	3,642.4	13,112.8	490,797	**1,592,698**
Italy	976,380	683.5	241,849	418.8	1,507.6	55,622	**180,648**
Japan	6,951,638	4,866.1	1,682,760	3,316.5	11,939.2	418,424	**1,359,003**
Jordan	847,532	593.3	207,984	594.7	2,140.9	103,247	**335,330**
Lativa	5,350	3.7	1,338	1.8	6.5	208	**677**
Lithuania	3,450	2.4	863	1.1	4.1	135	**439**
Luxembourg	18,900	13.2	4,725	6.5	23.5	762	**2,481**
Macedonia	19,270	13.5	4,198	7.2	25.9	1,251	**4,061**
Malta	29,360	20.6	7,340	9.2	33.0	2,818	**9,153**
Mexico	443,880	310.7	37,463	300.2	1,080.6	49,071	**159,392**
Namibia	6,169	4.3	1,542	3.1	11.0	599	**1,932**
Netherlands	329,506	230.7	92,976	111.0	399.6	11,626	**37,739**
New Zealand	112,960	79.1	26,941	34.0	122.4	4,522	**14,694**
Norway	11,370	8.0	1,865	3.9	13.9	421	**1,369**
Poland	234,597	164.2	28,730	76.2	274.4	9,757	**31,671**
Portugal	281,515	197.1	67,141	176.8	636.5	24,254	**78,779**
Romania	69,600	48.7	17,400	32.2	115.9	5,086	**16,530**
Slovac Republic	98,215	68.8	16,369	39.3	141.6	4,950	**16,075**
Slovenia	116,965	81.9	19,151	42.2	151.8	5,205	**16,898**
South Africa	247,680	173.4	61,920	108.4	390.1	15,760	**51,146**
Spain	1,209,764	846.8	288,529	738.5	2,658.7	93,482	**303,660**
Sweden	252,000	176.4	21,840	113.9	410.1	10,586	**34,370**
Switzerland	458,910	321.2	59,628	159.1	572.8	18,564	**60,289**
Taiwan	1,255,340	878.7	313,835	629.6	2,266.4	93,586	**304,420**
Thailand	70,000	49.0	17,500	47.7	171.7	9,937	**31,483**
Tunisia	218,000	152.6	54,500	145.4	523.5	27,010	**87,800**
Turkey	10,150,000	7,105.0	2,304,050	6,050.5	21,781.9	807,694	**2,626,236**
United Kingdom	304,920	213.4	76,230	101.6	365.6	12,211	**39,670**
United States	2,477,217	1,734.1	412,869	1,420.3	5,113.0	198,896	**646,099**
TOTAL	**172,157,916**	**120,511**	**40,292,309**	**79,375**	**285,750**	**10,738,296**	**34,922,955**

* 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 2007.

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 [t/a]	CO_2 reduction [t/a]
Albania							
Australia	4,070,000	2,849.00	20,350.00	1,499.18	5,397.06	222,958.75	**724,203.59**
Austria	608,890	426.22	3,044.45	137.98	496.73	18,931.97	**61,494.24**
Barbados							
Belgium	48,828	34.18	244.14	8.18	29.44	1,162.50	**3,775.97**
Brazil	97,442	68.21	487.21	22.08	79.49	3,029.73	**9,841.06**
Bulgaria							
Canada	665,920	466.14	3,329.60	143.57	516.86	20,501.57	**66,592.01**
China							
Cyprus							
Czech Republic	15,230	10.66	76.15	4.52	16.27	434.97	**1,422.25**
Denmark	21,370	14.96	106.85	3.29	11.83	465.89	**1,513.28**
Estonia							
Finland	500	0.35	2.50	0.06	0.23	8.62	**28.01**
France *	104,500	73.15	522.50	20.55	73.98	2,988.34	**9,706.59**
Germany	750,000	525.00	3,750.00	161.21	580.37	23,445.14	**76,153.13**
Greece							
Hungary	2,800	1.96	14.00	0.80	2.87	115.88	**376.40**
India							
Ireland							
Israel	24,200	16.94	121.00	1.42	5.10	1,372.14	**4,455.22**
Italy	26,270	18.39	131.35	5.53	19.89	827.41	**2,687.54**
Japan							
Jordan							
Lativa							
Lithuania							
Luxembourg							
Macedonia							
Malta							
Mexico	467,592	327.31	2,337.96	135.65	488.33	20,309.15	**65,966.99**
Namibia							
Netherlands	343,527	240.47	1,717.64	51.87	186.74	7,183.48	**23,333.04**
New Zealand	6,217	4.35	31.08	1.40	5.05	200.76	**652.09**
Norway	1,600	1.12	8.00	0.23	0.82	30.24	**98.22**
Poland	1,300	0.91	6.50	0.27	0.98	38.13	**123.86**
Portugal	594	0.42	2.97	0.14	0.51	21.23	**68.97**
Romania							
Slovak Republic							
Slovenia							
South Africa	628,610	440.03	3,143.05	118.15	425.33	16,585.50	**53,871.88**
Spain	3,000	2.10	15.00	0.90	3.22	132.02	**428.82**
Sweden	80,000	56.00	400.00	10.67	38.42	1,390.77	**4,517.40**
Switzerland **	212,400	148.68	1,062.00	36.82	132.55	5,099.58	**16,564.01**
Taiwan							
Thailand							
Tunisia							
Turkey							
United Kingdom							
United States	27,639,364	19,347.55	138,196.82	7,428.08	26,741.08	1,076,679.81	**3,497,222.51**
TOTAL	**35,820,154.05**	**25,074.11**	**179,100.77**	**9,792.55**	**35,253.18**	**1,423,913.57**	**4,625,097.08**

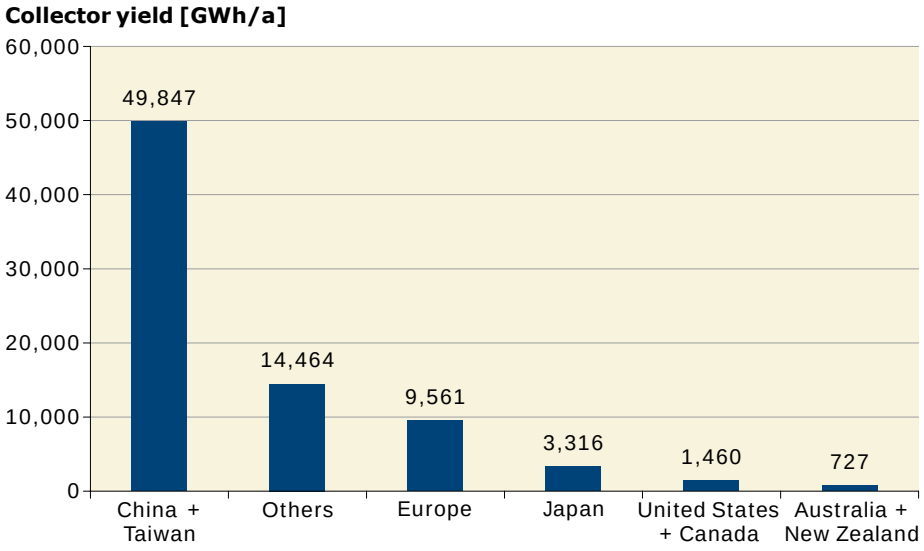
* France: includes Overseas Departments

** 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 2007

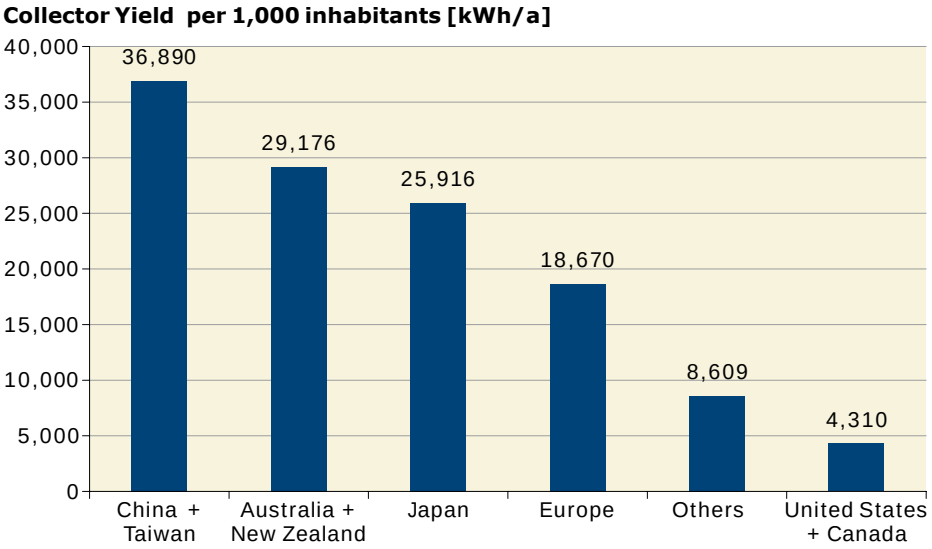
5.3 Collector yield by economic region at the end of 2007

5.3.1 Collector yield of glazed flat-plate and evacuated tube collectors by economic region at the end of 2007



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

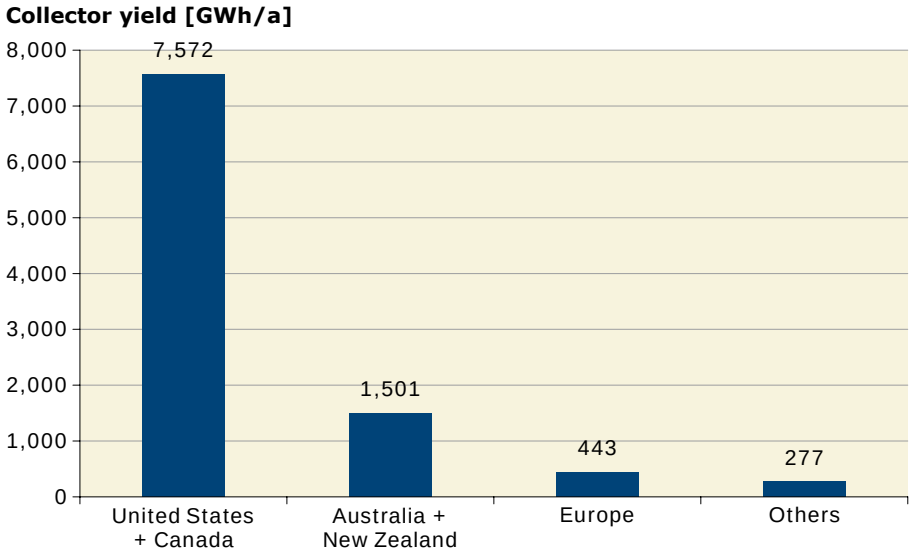
Figure 16: Annual collector yield of glazed flat-plate and evacuated tube collectors in operation by economic region at the end of 2007



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

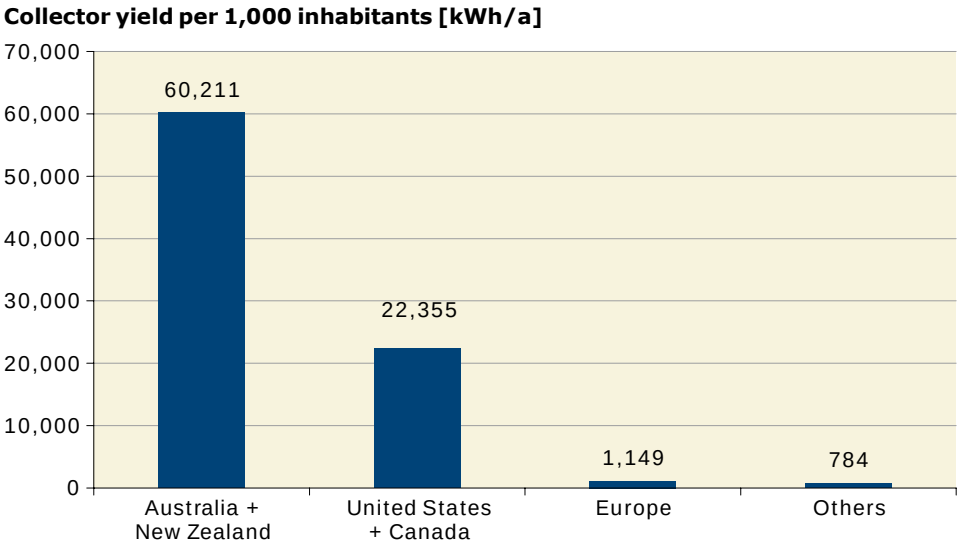
Figure 17: Annual collector yield of glazed flat-plate and evacuated tube collectors in operation by economic region at the end of 2007 in kWh per 1,000 inhabitants

5.3.2 Collector yield of unglazed collectors by economic region at the end of 2007



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 2007

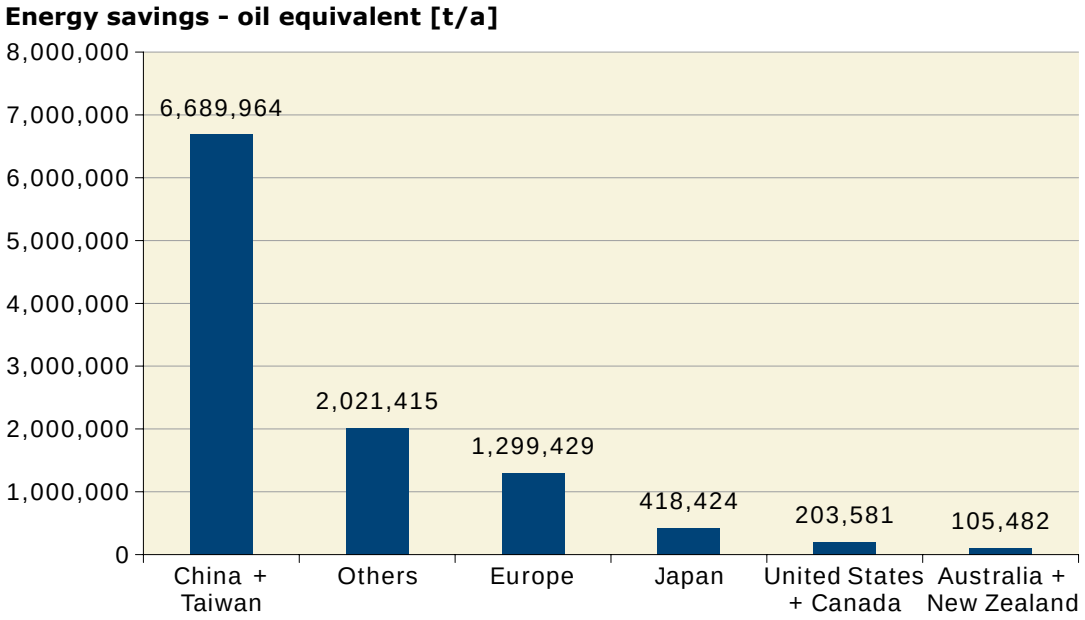


Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 19: Annual collector yield of unglazed collectors in operation by economic region at the end of 2007 in kWh per 1,000 inhabitants

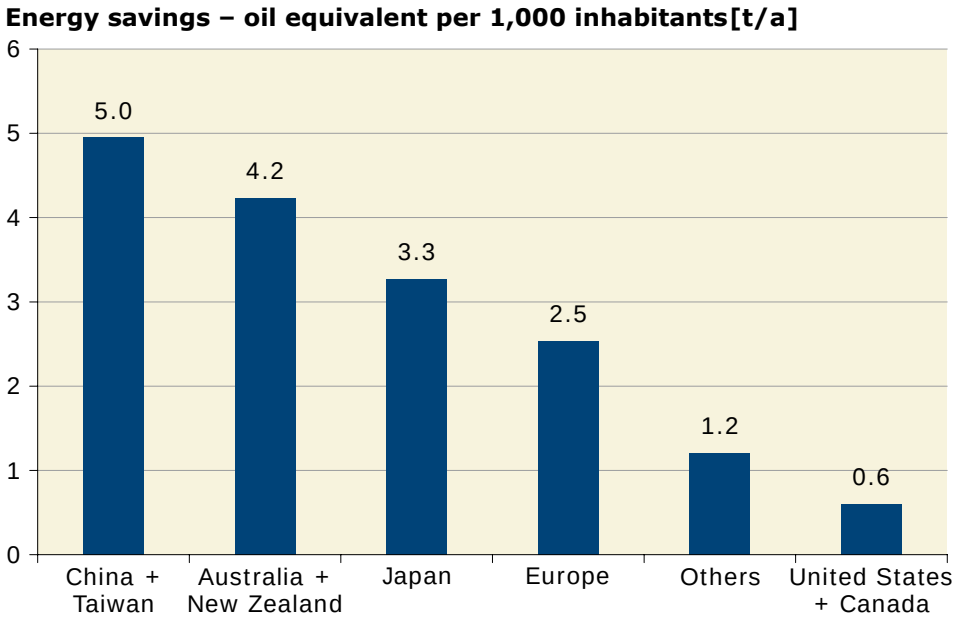
5.4 Energy savings by economic region at the end of 2007

5.4.1 Energy savings in oil equivalent by glazed flat-plate and evacuated tube collectors by economic region at the end of 2007



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

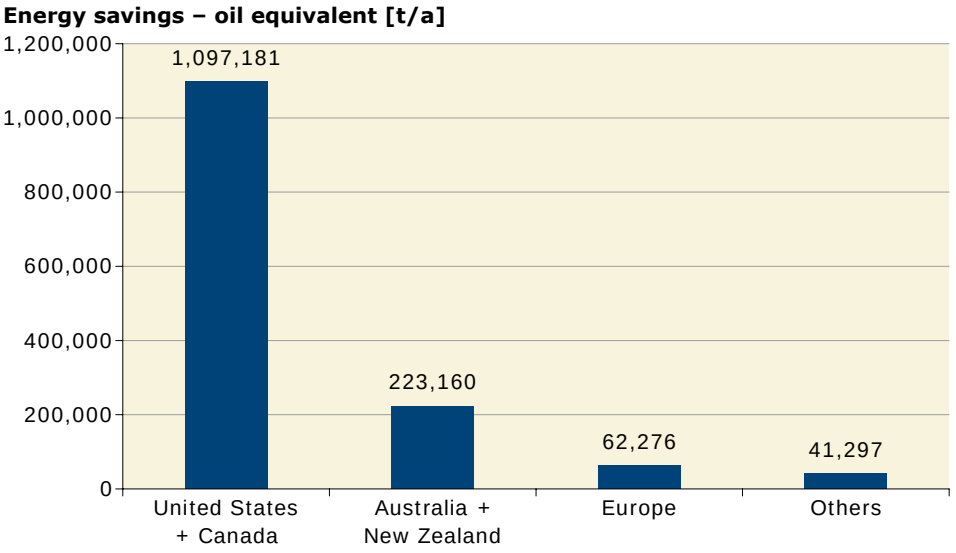
Figure 20: Annual energy savings in oil equivalent by glazed flat-plate and evacuated tube collectors by economic region at the end of 2007



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

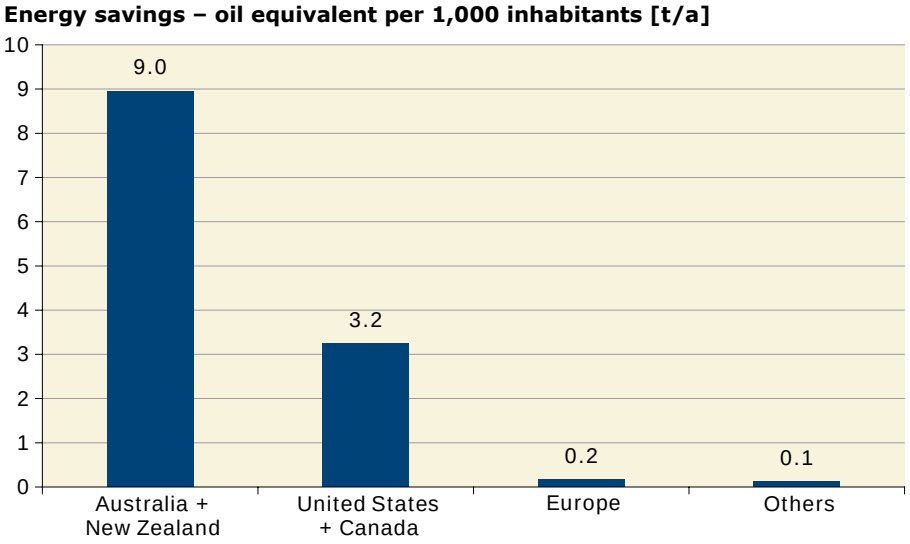
Figure 21: Annual energy savings in oil equivalent by glazed flat-plate and evacuated tube collectors in operation by economic region at the end of 2007 per 1,000 inhabitants

5.4.2 Energy savings in oil equivalent by unglazed collectors by economic region at the end of 2007



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 2007

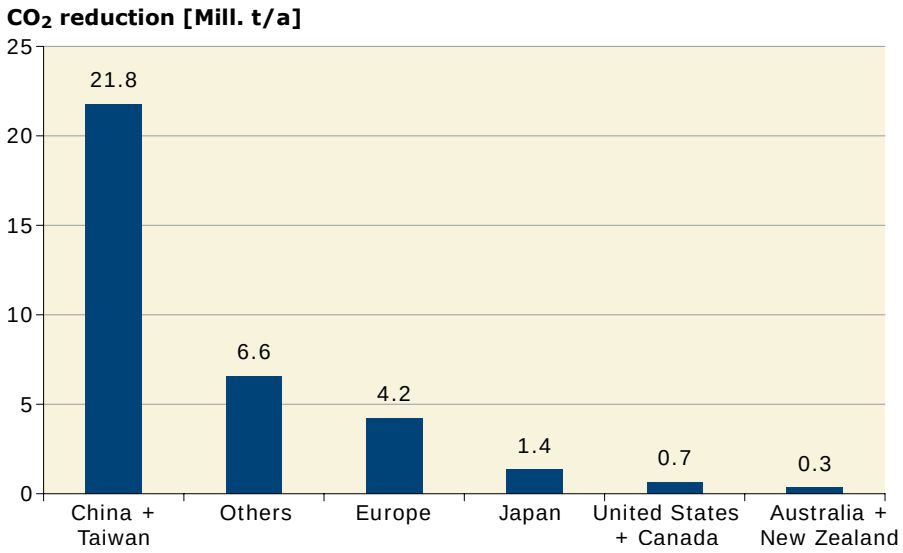


Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

Figure 23: Annual energy savings in oil equivalent by unglazed collectors by economic region at the end of 2007 per 1,000 inhabitants

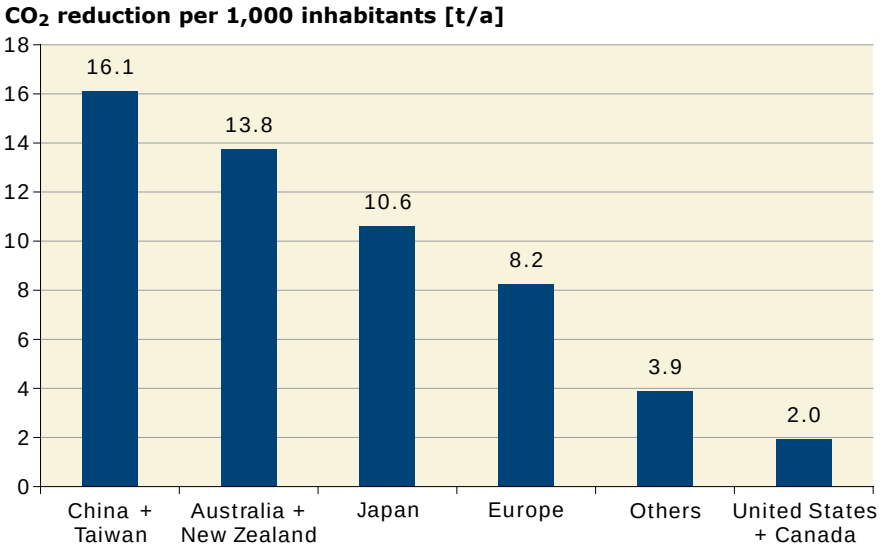
5.5 Contribution to CO_2 reduction by economic region at the end of 2007

5.5.1 Contribution to CO_2 reduction by flat-plate and evacuated tube collectors by economic region at the end of 2007



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

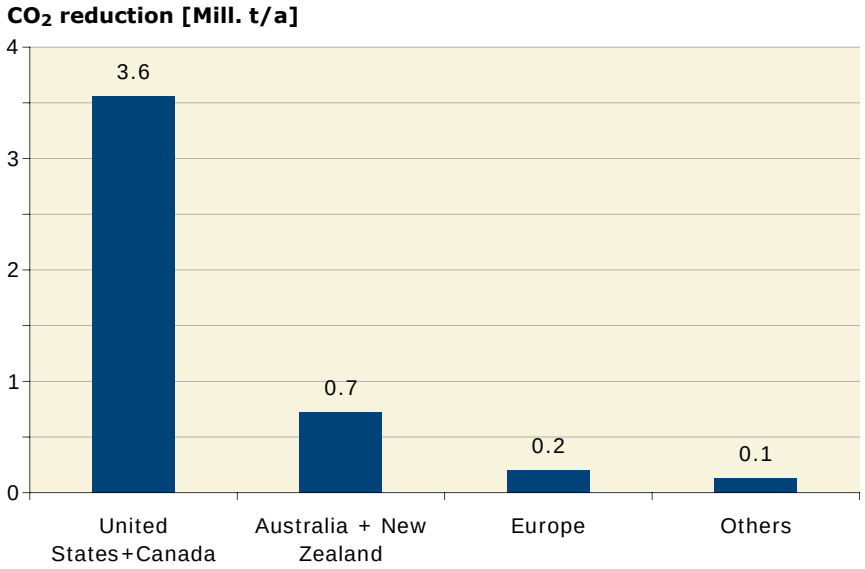
Figure 24: Annual contribution to CO_2 reduction by flat-plate and evacuated tube collectors by economic region the end of 2007



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

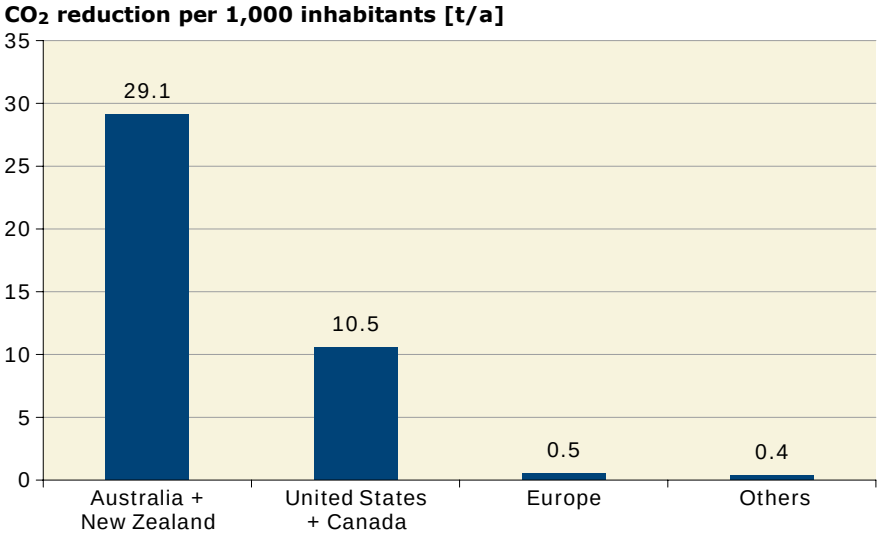
Figure 25: Annual contribution to CO_2 reduction by flat-plate and evacuated tube collectors by economic region at the end of 2007 per 1,000 inhabitants

5.5.2 Contribution to CO_2 reduction by unglazed collectors by economic region at the end of 2007



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

Figure 26: Annual contribution to CO_2 reduction by unglazed collectors by economic region at the end of 2007



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

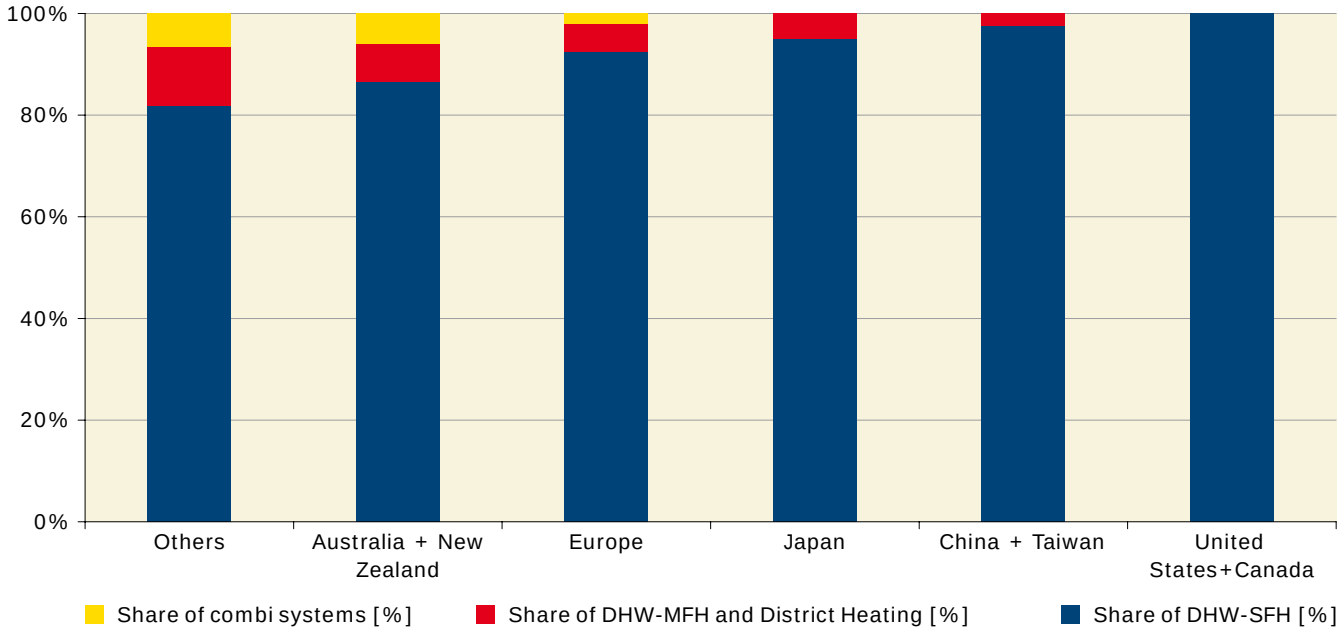
Figure 27: Annual contribution to CO_2 reduction by unglazed collectors by economic region at the end of 2007 per 1,000 inhabitants

6 Distribution of systems by application

6.1 Distribution by application - total capacity in operation

If one observes the use of solar thermal energy, it becomes clear that it greatly varies in the different countries. In China and Taiwan (76.5 GW_{th}), Europe (15.9 GW_{th}) and Japan (4.9 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 19.8 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 2.9 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 prepare 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.

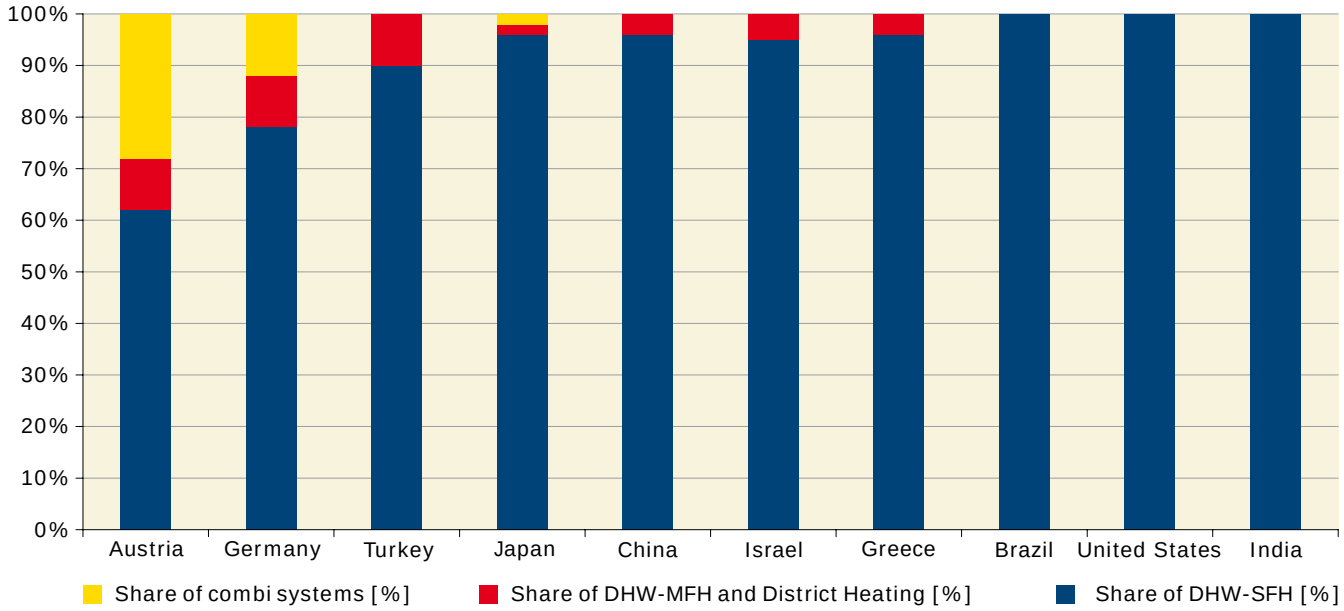


Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Thailand, Tunisia and Turkey;
Combisystems: Systems for hot water preparation and space heating; DHW: Domestic hot water systems;
MFH: 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 2007

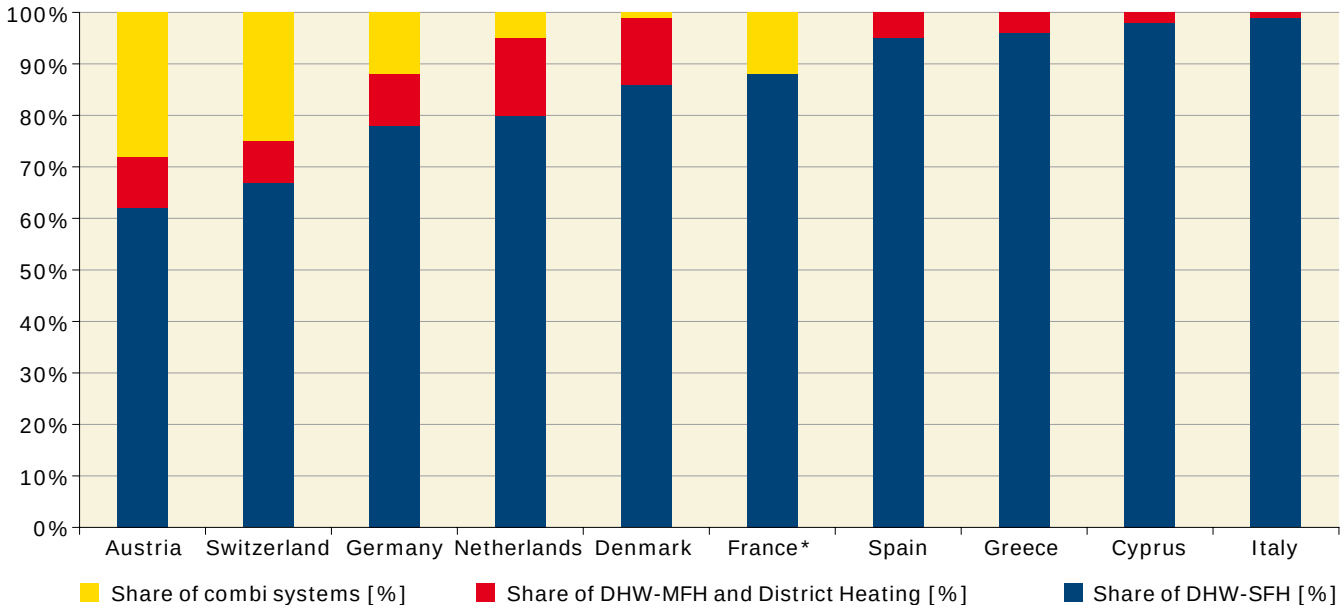
Europe has the most sophisticated market for different solar thermal applications. It includes systems for hot water preparation, plants for space heating of single- and multi-family houses and hotels, large-scale plants for district heating as well as a growing number of systems for air conditioning, 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 2007

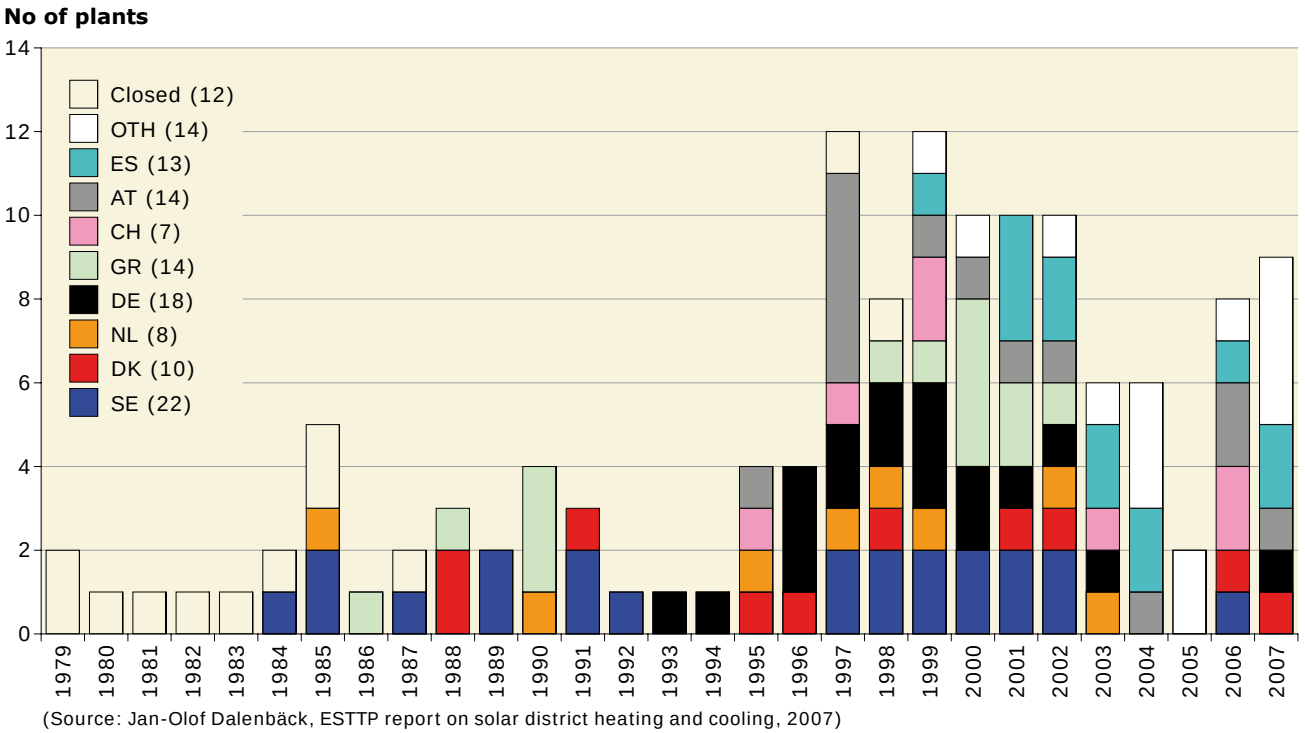


Combisystems: Systems for hot water preparation and space heating; DHW: Domestic hot water systems;
MFH: Multi-family house; SFH: Single-family house

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 2007

Large-scale Plants

There are 130 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).



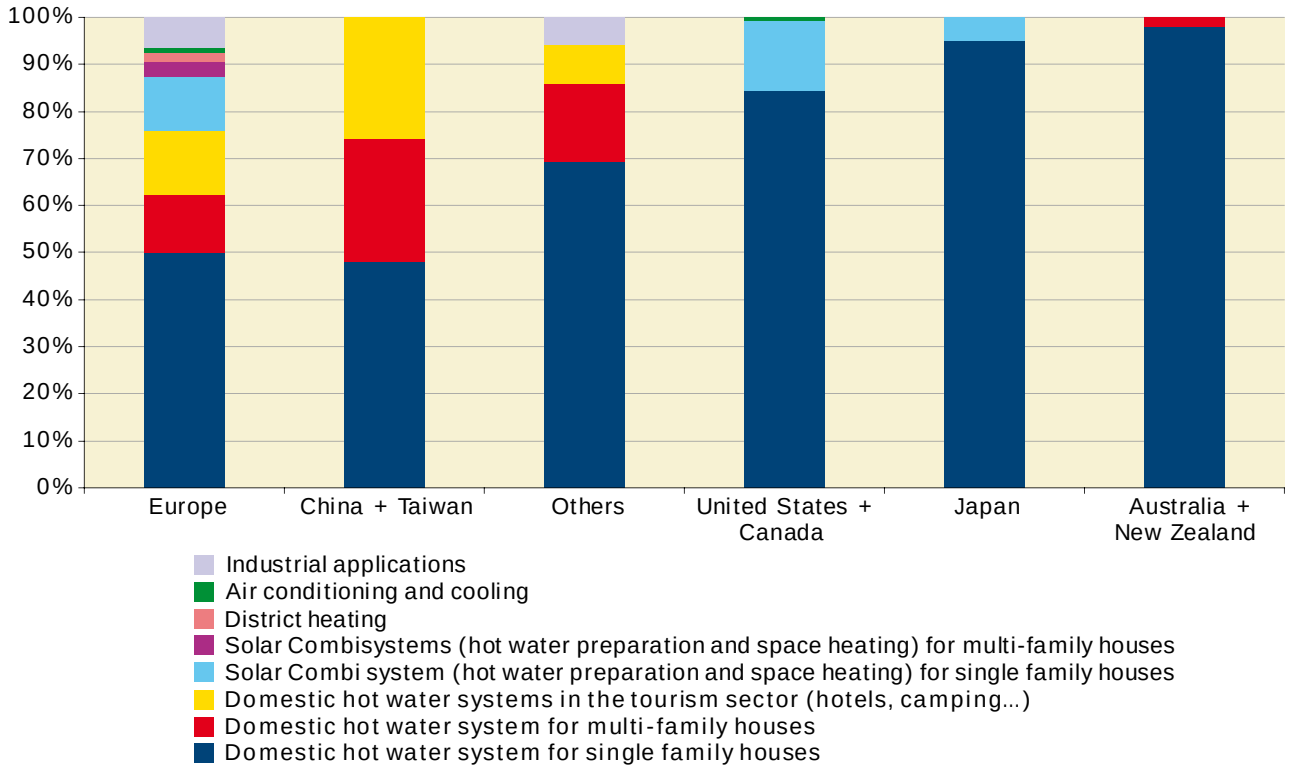
(Source: Jan-Olof Dalenbäck, ESTTP report on solar district heating and cooling, 2007)

Figure 31: Large-scale solar heating and cooling plants in Europe at the end of 2007

Most of these large-scale solar thermal systems are connected to district heating. The heat is used for hot water preparation and space heating. In recent years also large-scale solar heating systems were installed in order to provide heat for industrial applications and air conditioning.

6.2 Distribution by application – systems installed in 2007

In this chapter the distribution of solar thermal systems in different applications of the collector area, which were installed in 2007 is presented. **Figure 32** shows the distribution of the different applications 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 prepare hot water for single-family houses. The share of solar combisystems (hot water preparation and space heating) for different applications is only relevant in Europe, China and Taiwan.



Europe: EU-27, Albania, Macedonia, Norway, Overseas Departments of France, Switzerland;
Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Thailand, 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 32: Distribution of different solar thermal applications by economic region, which were installed in the year 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	4,070,000	20,350	Sydney
Austria	C: 200 m² unglazed plastic absorber	608,890	3,044	Graz
Belgium	C: 200 m² unglazed plastic absorber	48,828	244	Brussels
Canada	C: 200 m² unglazed plastic absorber	665,920	3,330	Montreal
Czech Republic	C: 200 m² unglazed plastic absorber	15,230	76	Praha
Denmark	C: 200 m² unglazed plastic absorber	21,370	107	Copenhagen
Finland	C: 200 m² unglazed plastic absorber	500	3	Helsinki
France*	C: 200 m² unglazed plastic absorber	104,500	523	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	24,200	121	Jerusalem
Italy	C: 200 m² unglazed plastic absorber	26,270	131	Bologna
Mexico	C: 200 m² unglazed plastic absorber	467,592	2,338	Mexico City
Netherlands	C: 200 m² unglazed plastic absorber	343,527	1,718	De Bilt
New Zealand	C: 200 m² unglazed plastic absorber	6,217	31	Wellington
Norway	C: 200 m² unglazed plastic absorber	1,600	8	Oslo
Poland	C: 200 m² unglazed plastic absorber	1,300	7	Warsaw
South Africa	C: 200 m² unglazed plastic absorber	628,610	3,143	Johannisburg
Sweden	C: 200 m² unglazed plastic absorber	80,000	400	Gothenburg
Switzerland	C: 200 m² unglazed plastic absorber	212,400	1,062	Zurich
United States	C: 200 m² unglazed plastic absorber	27,639,364	138,197	Denver, Los Angeles
TOTAL		**35,719,118**	**178,596**	

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**

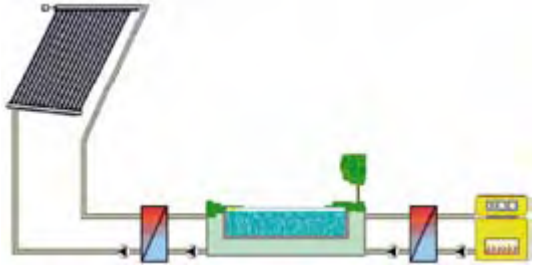


Figure 33: Hydraulic scheme of the swimming pool reference system

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 2007 for each country.
It must be pointed out that the market share of the new installed capacity in the year 2007 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	Prague	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	Tallinn	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
India	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Mumbay	100
Ireland	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
Latvia	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
toMacedonia	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
Slovak Republic	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Bratislava	100
Slovenia	C: 6 m² / ST: 300 l / HWD: 150 l/d / PS	Ljubljana	98
South Africa	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Johannesburg	100
Spain	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
Thailand	C: 4 m² / ST: 200 l / HWD: 150 l/d / TS	Bangkok	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: thermo siphon 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)

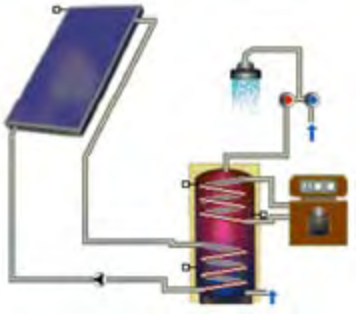


Figure 34: Hydraulic scheme of the DHW reference system

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 2007 for each country.

It must be pointed out, that the market share of the new installed capacity in the year 2007 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	Prague	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	Ljubljana	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: thermo siphon 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 35: 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 2007 for each country.
It must be pointed out that the market share of the new installed capacity in the year 2007 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: thermo siphon system; PS: pumped system; PDS: pumped, drain back system; HWD: hot water demand per 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)

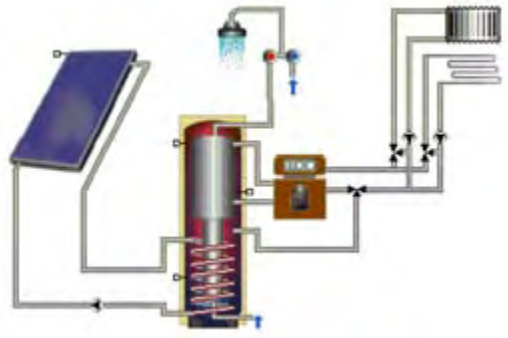


Figure 36: Hydraulic scheme of the solar combi reference system

7.2 Reference collector

7.2.1 Data of the reference absorber for swimming pool heating

$\eta = 0.85$ $a_1 = 20\ [W/m^2K]$ $a_2 = 0.1\ [W/m^2K^2]$

7.2.2 Data of the reference collector for all other applications

$\eta = 0.8$ $a1 = 3.69\ [W/m^2K]$ $a_2 = 0.007\ [W/m^2K^2]$

7.3 Population data

Country	Inhabitants
Albania	3.190.000
Australia	20.743.000
Austria	8.315.000
Barbados	294.000
Belgium	10.457.000
Brazil	191.791.000
Bulgaria	7.639.000
Canada	32.876.000
China	1.328.630.000
Cyprus	855.000
Czech Republic	10.186.000
Denmark	5.442.000
Estonia	1.335.000
Finland	5.277.000
France*	63.561.000
Germany	82.599.000
Greece	11.147.000

Country	Inhabitants
Hungary	10.030.000
India	1.169.016.000
Ireland	4.301.000
Israel	6.928.000
Italy	58.877.000
Japan	127.967.000
Jordan	5.924.000
Latvia	2.277.000
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
Thailand	24.000.000
Tunisia	10.102.000
Turkey	73.193.000
United Kingdom	59.668.000
United States	298.213.000
TOTAL	**4.035.141.000**

Table 10: Inhabitants of the 48 surveyed countries in alphabetic order

Data source: Statistisches Jahrbuch Österreich, 2008, http://www.statistik.at

*France	63.561.000
Guadeloupe	445.000
Martinique	399.000
Réunion	807.000
Polynesia	263.000
France métropole	61.647.000

Table 11:

Inhabitants of France including Overseas Departments

Economic Region	Inhabitants
United States + Canada	338.702.000
Japan	127.967.000
China + Taiwan	1.351.230.000
Europe	512.093.000
Australia + New Zealand	24.922.000
Others	1.680.227.000
TOTAL	**4.035.141.000**

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

Table 12: Inhabitants per Economic Region

Population data source: Statistisches Jahrbuch Österreich, 2008, http://www.statistik.at

7.4 Installed capacity in 2006

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			3.50	**353.50**
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**
Thailand		4.76				**4.76**
Tunisia		24.17	0.33			**24.50**
Turkey		490.00				**490.00**
United Kingdom		9.80	9.80			**19.60**
United States	951.85	78.68	3.37		0.37	**1,034.26**
TOTAL	**1,508.19**	**5,098.20**	**11,538.36**	**29.31**	**8.79**	**18,182.86**

* 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 13: Installed capacity in 2006, MW_{th}/a

7.5 2006 and 2007 data in square meters collector area

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} /m² to derive the nominal capacity from the area of installed collectors. Nevertheless, solar thermal collectors are traditionally quoted in square meters and therefore **Tables 15–17** provide the 2006 and 2007 data in m².

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			5,000	**505,000**
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**
Thailand		6,800				**6,800**
Tunisia		34,526	474			**35,000**
Turkey		700,000				**700,000**
United Kingdom		14,000	14,000			**28,000**
United States	1,359,781	112,396	4,811		524	**1,477,513**
TOTAL	**2,154,553**	**7,283,148**	**16,483,376**	**41,877**	**12,562**	**25,975,517**

* 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: Collector Area installed in 2006, m² / a

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed***	glazed	evacuated tube	unglazed***	glazed***	
Albania		9,290	88			**9,378**
Australia	576,000	203,000	3,000			**782,000**
Austria	8,662	277,620	3,399			**289,681**
Barbados		2,731				**2,731**
Belgium	8,828	37,000	5,000			**50,828**
Brazil	97,442	475,394	350			**573,186**
Bulgaria		2,500				**2,500**
Canada	39,879	1,462	2,385	17,056	128	**60,910**
China		1,100,000	20,040,000			**21,140,000**
Cyprus		15,000	1,000			**16,000**
Czech Republic	6,000	18,900	6,100			**31,000**
Denmark	600	23,000	400	3,400	3,500	**30,900**
Estonia		350				**350**
Finland		2,100	622			**2,722**
France *	5,300	305,000	12,700			**323,000**
Germany	30,000	840,000	100,000			**970,000**
Greece		279,000	4,000			**283,000**
Hungary		6,000	2,000			**8,000**
India		250,000			7,000	**257,000**
Ireland		14,872	4,799			**19,671**
Israel	700	71,000				**71,700**
Italy	3,650	210,000	35,000			**248,650**
Japan		166,223	4,051		12,509	**182,783**
Jordan		7,666	3,600			**11,266**
Lativa		1,500				**1,500**
Lithuania		700				**700**
Luxembourg		3,000				**3,000**
Macedonia		1,952	200			**2,152**
Malta		5,500				**5,500**
Mexico	46,281	107,989				**154,270**
Namibia		2,810	190			**3,001**
Netherlands	27,722	19,920				**47,642**
New Zealand	600	11,800	5,150			**17,550**
Norway	200	720	50			**970**
Poland		47,032	21,115			**68,147**
Portugal	618	44,483	5,696			**50,797**
Romania		500				**500**
Slovak Republic		15,554	9,911			**25,465**
Slovenia		6,515	1,150			**7,665**
South Africa	67,300	14,000	0			**81,300**
Spain	3,000	251,000	11,000			**265,000**
Sweden	20,435	15,554	9,911			**45,900**
Switzerland **	10,320	63,022	2,554	2,000		**77,896**
Taiwan		125,000	9,900			**134,900**
Thailand		8,000				**8,000**
Tunisia		39,000	1,000			**40,000**
Turkey		700,000				**700,000**
United Kingdom		27,000	27,000			**54,000**
United States	1,125,038	129,620	20,520		1,267	**1,276,445**
TOTAL	**2,078,575**	**5,960,280**	**20,353,841**	**22,456**	**24,403**	**28,439,555**

* 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 2007, m² / a

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed***	glazed	evacuated tube	unglazed***	glazed***	
Albania		49,930	246			50,176
Australia	4,070,000	1,660,000	23,000			5,753,000
Austria	608,890	2,949,558	42,983			3,601,431
Barbados		82,794				82,794
Belgium	48,828	133,750	12,368			194,946
Brazil	97,442	3,587,499	350			3,685,291
Bulgaria		27,600				27,600
Canada	665,920	81,755	4,747	129,962	191	882,575
China		10,400,000	103,740,000			114,140,000
Cyprus		794,749	962			795,710
Czech Republic	15,230	97,090	15,490			127,810
Denmark	21,370	393,860	3,400	3,400	18,750	440,780
Estonia		1,470				1,470
Finland	500	15,583	1,302			17,385
France *	104,500	1,416,500	33,000			1,554,000
Germany	750,000	7,784,095	863,982			9,398,077
Greece		3,566,200	6,800			3,573,000
Hungary	2,800	41,340	2,560			46,700
India		2,150,000			17,000	2,167,000
Ireland		27,657	7,910			35,567
Israel	24,200	4,936,900				4,961,100
Italy	26,270	873,520	102,860			1,002,650
Japan		6,824,569	127,069	434,371	12,509	7,398,518
Jordan		840,332	7,200			847,532
Lativa		5,350				5,350
Lithuania		3,450				3,450
Luxembourg		18,900				18,900
Macedonia		19,070	200			19,270
Malta		29,360				29,360
Mexico	467,592	443,880				911,473
Namibia		5,979	190			6,169
Netherlands	343,527	329,506				673,033
New Zealand	6,217	102,914	10,046			119,177
Norway	1,600	11,220	150		1,200	14,170
Poland	1,300	197,874	36,723	3,000	2,500	241,397
Portugal	594	276,038	5,477			282,109
Romania		69,600				69,600
Slovak Republic		88,304	9,911			98,215
Slovenia		115,815	1,150			116,965
South Africa	628,610	247,680				876,290
Spain	3,000	1,164,164	45,600			1,212,764
Sweden	80,000	223,000	29,000			332,000
Switzerland **	212,400	433,490	25,420	838,000		1,509,310
Taiwan		1,136,919	118,421			1,255,340
Thailand		70,000				70,000
Tunisia		216,523	1,477			218,000
Turkey		10,150,000				10,150,000
United Kingdom		277,920	27,000			304,920
United States	27,639,364	1,898,841	578,376	93	229,744	30,346,417
TOTAL	**35,820,154**	**66,272,546**	**105,885,370**	**1,408,827**	**281,894**	**209,668,790**

* 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: Total Collector Area in operation at the end of 2007, m²

7.6 References to persons and institutions 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
	Werner Weiss	AEE INTEC
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	Instituto 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	
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	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	
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Germany	**Gerhard Stry-Hipp**	Bundesverband Solarindustrie e.V. – Bsi, Berlin
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	Costas Travasaros	Greek Solar Industry Association

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	Michele Zinzi	ENEA TER-ENESIST s.p., Rome
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	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, Aneta Wiecka**	EC BREC Institute for Renewable Energy Ltd., Warsaw
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	**Esther Rojas Bravo**	Renewable Energy Division, CIEMAT, Madrid
	Asociación Solar De La Industria Térmica (ASIT)	
Sweden	**Jan-Olof Dalenbäck**	Chalmers University of Technology, Göteborg
	Solar Energy Association of Sweden – SEAS	
Switzerland	**Urs Wolfer and Andreas Eckmanns**	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**	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.

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