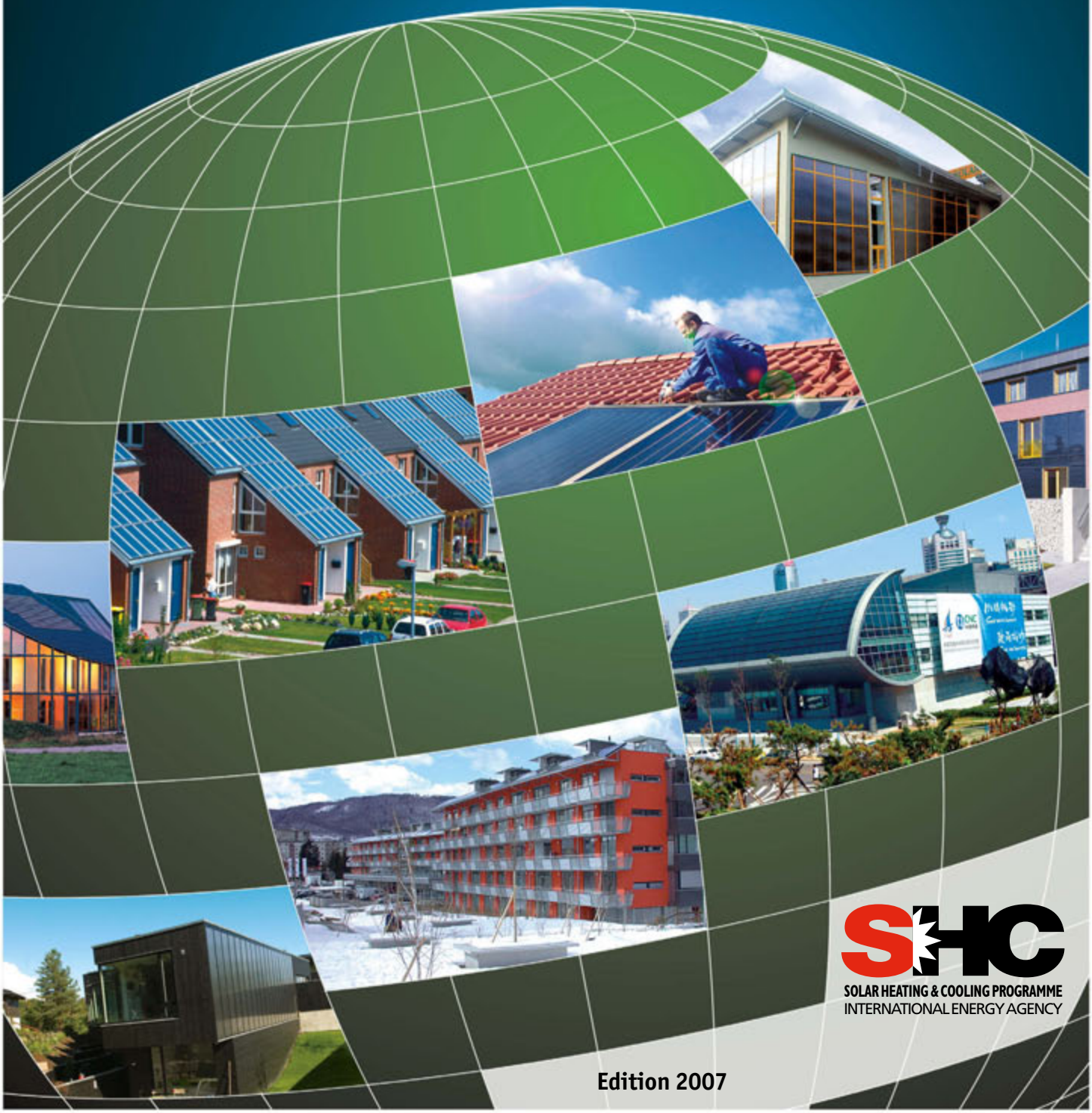
Werner Weiss • Irene Bergmann • Gerhard Faninger

Solar Heat Worldwide

Markets and Contribution to the Energy Supply 2005



SHC
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Edition 2007

SOLAR HEAT WORLDWIDE

Markets and Contribution to the Energy Supply 2005

Werner Weiss • Irene Bergmann • Gerhard Faninger

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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 vacuum 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 45 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 reduction of CO_2 were ascertained.

The 45 countries included in this report represent 3.84 billion people, which is about 59% 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 equaled 111.0 GW_{th} corresponding to 159 million square meters[1] at the end of the year 2005. Of this, 86.3 GW_{th} were accounted for by flat-plate and evacuated tube collectors and 23.9 GW_{th} for unglazed plastic collectors. Air collector capacity was installed to an extent of 0.8 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 (53.5 GW_{th}), Europe (12.1 GW_{th}) and Japan (4.9 GW_{th}) plants with flat-plate and evacuated tube collectors mainly used to prepare hot water and for space heating are dominant while in North America (USA and Canada) swimming pool heating is the dominant application with an installed capacity of 19.3 GW_{th} of unglazed plastic 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 87 large-scale plants in operation in Europe with a total installed capacity of 120 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).

Leading Countries

Flat-plate and evacuated tube collectors

Focusing on the total capacity of flat-plate and evacuated tube collectors installed at the end of the year 2005 – China (52.5 GW_{th}), Turkey (6.3 GW_{th}), Japan (4.9 GW_{th}), Germany (4.6 GW_{th}), Israel (3.3 GW_{th}) and Greece (2.1 GW_{th}) are the leading countries. As can be seen from the figures, China is by far the largest market, representing 48% of the world market.

Focusing on the market penetration – installed capacity per 1,000 inhabitants – then Cyprus (657 kW_{th}), Israel (497 kW_{th}), Austria (205 kW_{th}) and Barbados (200 kW_{th}) are the leading countries. They are followed by Greece (192 kW_{th}), Turkey (86 kW_{th}), Australia (59 kW_{th}), Germany (56 kW_{th}), Denmark (42 kW_{th}), Taiwan (42 kW_{th}) and China (40 kW_{th}) comes in the 11th place.

Unglazed plastic collectors

With regard to the heating of swimming pools with unglazed plastic collectors, the USA leads with a total capacity of 18.8 GW_{th} in operation ahead of Australia with 2.4 GW_{th}, Germany 0.5 GW_{th}, Canada 0.4 GW_{th}, and Austria and South Africa with 0.4 GW_{th}.

1 Making the installed capacity of solar thermal collectors comparable with that of other energy sources, solar thermal experts from 7 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 that was 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.

The market penetration gives a slightly different picture: Australia leads with 120 kW_{th} ahead of the USA with 63 kW_{th} and Austria with 50 kW_{th} per 1,000 inhabitants. In fourth to sixth place there are Switzerland, Canada, and the Netherlands with an installed capacity between 20 and 13 kW_{th} per 1,000 inhabitants.

Market development

The most dynamic markets for flat-plate and evacuated tube collectors worldwide are in China, Australia and New Zealand as well as in Europe. The average annual growth rate between 1999 and 2005 was 22% in China and Taiwan, 18% in Australia and New Zealand and 15% in Europe. The market for flat-plate and evacuated tube collectors has been consistently low in Canada and the USA.

The worldwide market of unglazed collectors for swimming pool heating recorded an increase between 1999 and 2002 and a slight decrease in 2003. In 2004 and 2005 the installed capacity again was increasing.

Installed capacity in 2005

In the year 2005, a total capacity of 14 GW_{th} corresponding to 20.8 million square metres of solar collectors, were installed worldwide. Flat-plate and evacuated tube collectors accounted for 13.1 GW_{th} (18.7 million m^2). Compared to the capacity installed in 2004, the worldwide growth was 10.4%.

The most dynamic markets in Europe with growth rates above 20% were in Belgium 87%, the Czech Republic 83%, France 76% (41% including overseas departments), Austria and Germany with 25%, Italy with 22% and Switzerland with 20%.

Besides the European countries, only the markets in Tunisia (328%), India (250%) and Mexico (25%) increased more than 20% in 2005.
China, the world's largest market, increased in 2005 by only 7%.

Contribution of solar collectors to the supply of energy

The annual collector yield of all solar thermal systems[2] in operation by the end of 2005 in the 45 recorded countries is 66,406 GWh (239,062 TJ). This corresponds to an oil equivalent of 10.7 billion liter and an annual avoidance of 29.3 million tons of CO_2.

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 120,000 worldwide.

Preview 2006

Based on the data available for the year 2006 at the date of publishing this report the total capacity in operation worldwide can be estimated to be 118 GW_{th}, corresponding to 168 million square meters of collector area.
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'. This fact is still underestimated by energy policy.

2 All water based systems excl. air based 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.

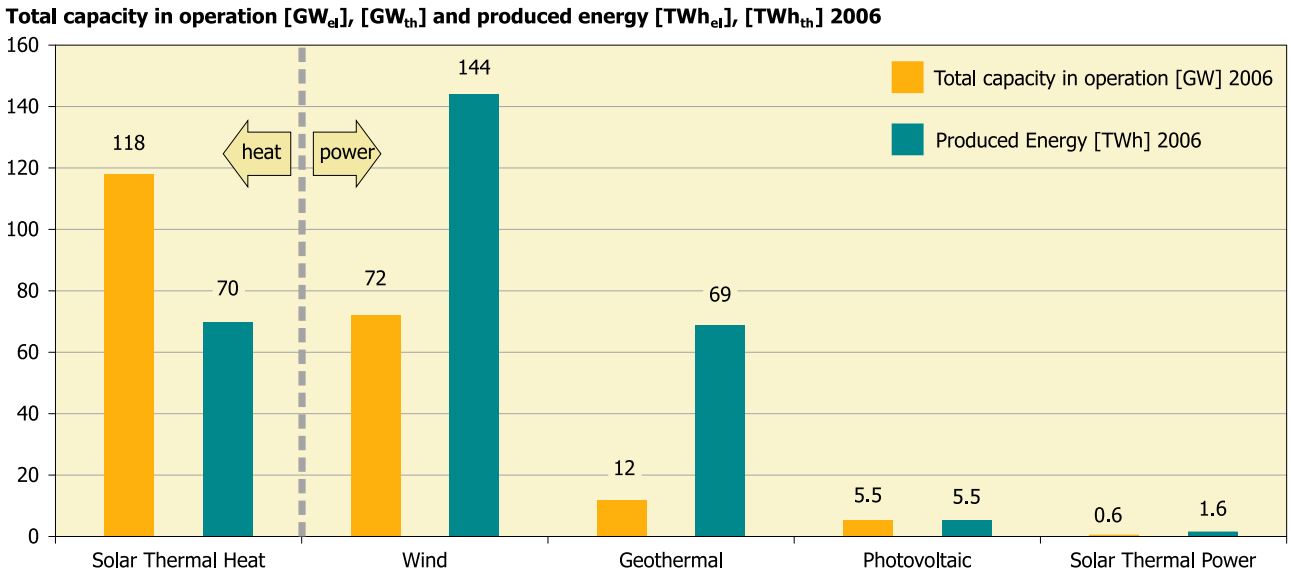


Figure 2: Total capacity in operation [GW_{el}], [GW_{th}] 2006 and annually energy generated [TWh_{el}], [TWh_{th}]. Sources: Fawer, M.: Sarasin Sustainability Report 2006 and IEA SHC, 2007.

3 Total capacity installed by the year 2005

Since the beginning of the 1990s, the solar thermal market has undergone a favorable development. At the end of 2005, a total of 159 million square meters of collector area, corresponding to an installed capacity 111.0 GW_{th} were in operation[3] in the 45 recorded countries. These 45 countries represent 3.84 billion people which is about 59% of the world's population. The installed capacity in these countries represent approximately 85 - 90% of the solar thermal market worldwide.

As shown in Table 1, the installed capacity is divided into 37.8 GW_{th} glazed flat plate collectors (54.01 million square meters) and 48.5 GW_{th} evacuated tube collectors (69.34 million square meters), 23.9 GW_{th} unglazed collectors (34.09 million square meters) and 0.8 GW_{th} glazed and unglazed air collectors (1.19 million square meters).

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed	glazed	evacuated tube	unglazed	glazed	
Albania		22.88				22.88
Australia	2,412.90	1,190.00	2.10			3,605.00
Austria	415.31	1,665.35	25.38			2,106.03
Barbados		54.13				54.13
Belgium	23.31	45.84	2.10			71.25
Brazil		1,890.32				1,890.32
Canada	449.75	55.29	1.16	69.57	0.02	575.78
China		5,250.00	47,250.00			52,500.00
Cyprus		548.80				548.80
Czech Republic		41.79	4.10			45.89
Denmark	15.31	229.30	0.56		10.50	255.67
Estonia		0.57				0.57
Finland	0.35	6.44	0.48			7.27
France*	63.62	572.59	3.49			639.71
Germany	525.00	4,059.30	596.40			5,180.70
Greece		2,133.04				2,133.04
Hungary	1.96	24.04	0.39			26.39
India		875.00				875.00
Ireland		5.18	1.44		1.96	8.57
Israel	14.00	3,346.00				3,360.00
Italy	11.20	327.60	34.30			373.10
Japan		4,805.22	94.40			4,899.61
Lativa		1.86				1.86
Lithuania		1.51				1.51
Luxembourg		9.38				9.38
Macedonia		10.50				10.50
Malta		13.55				13.55
Mexico	300.01	210.04				510.05
Namibia		1.01				1.01
Netherlands	218.96	215.32				434.28
New Zealand	1.65	62.61	1.51			65.77
Norway	1.05	8.40			1.02	10.47
Poland	1.09	79.36	5.12	2.10	1.75	89.42
Portugal		200.06				200.06
Slovak Republic		44.92				44.92
Slovenia		74.41				74.41
South Africa	379.05	168.00				547.05
Spain		537.50	20.37			557.87
Sweden	35.80	147.43	11.94			195.18
Switzerland**	148.87	241.35	16.84	584.50		991.56
Taiwan		928.01	69.98			997.99
Tunisia		100.10				100.10
Turkey		6,300.00				6,300.00
United Kingdom		140.81				140.81
United States	18,844.70	1,159.78	394.61	0.07	159.57	20,558.71
TOTAL	23,863.87	37,804.57	48,536.65	656.24	174.81	111,036.14

* France: incl. Oversea Departments

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

Table 1: Total capacity in operation at the end of 2005 [MW_{th}]

3 A lifetime of the solar thermal systems of 20 years (installed up to 1990) and 25 years (installed after 1990) are assumed. These figures were taken for all countries, that don't have a national procedure on determining the lifetime in their statistic.

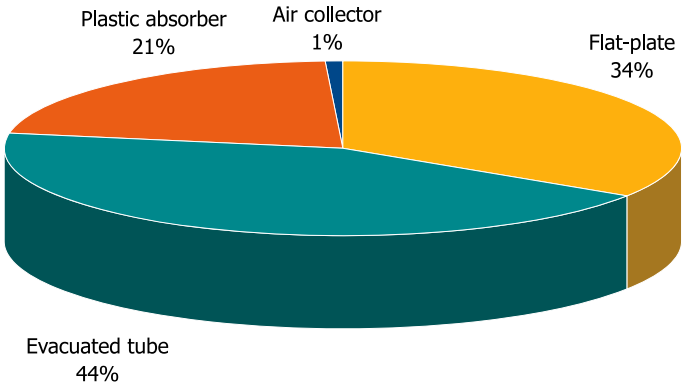


Figure 3: Distribution of the worldwide capacity in operation 2005 by collector type

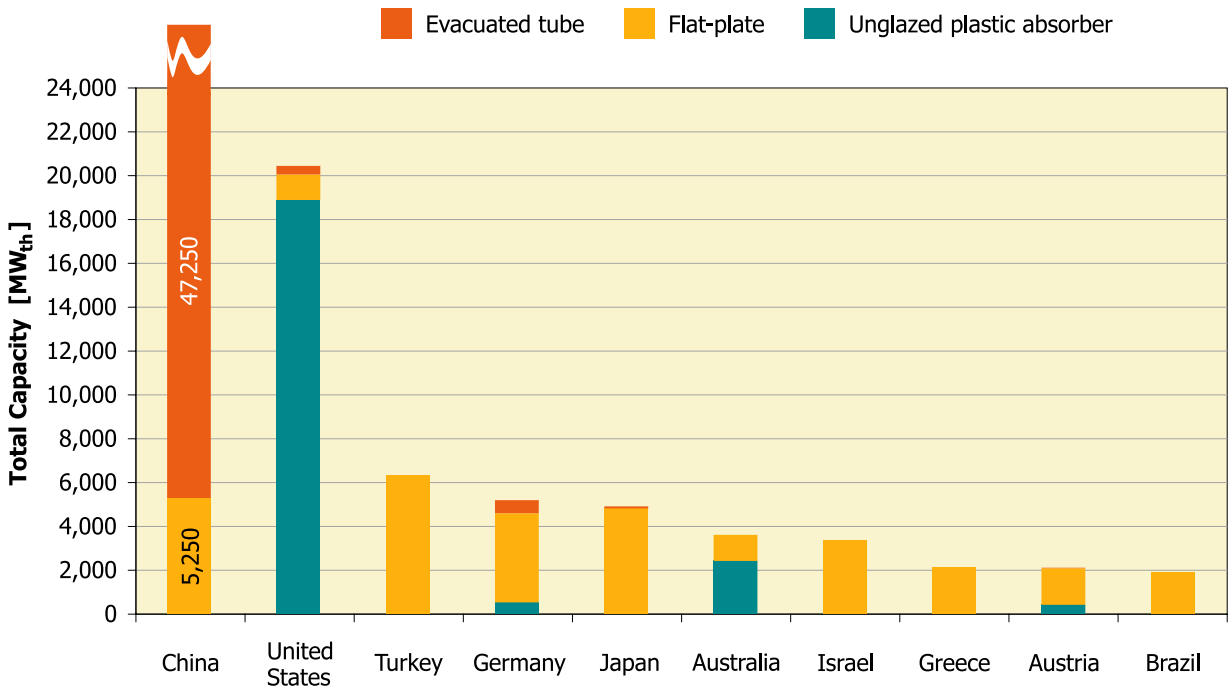
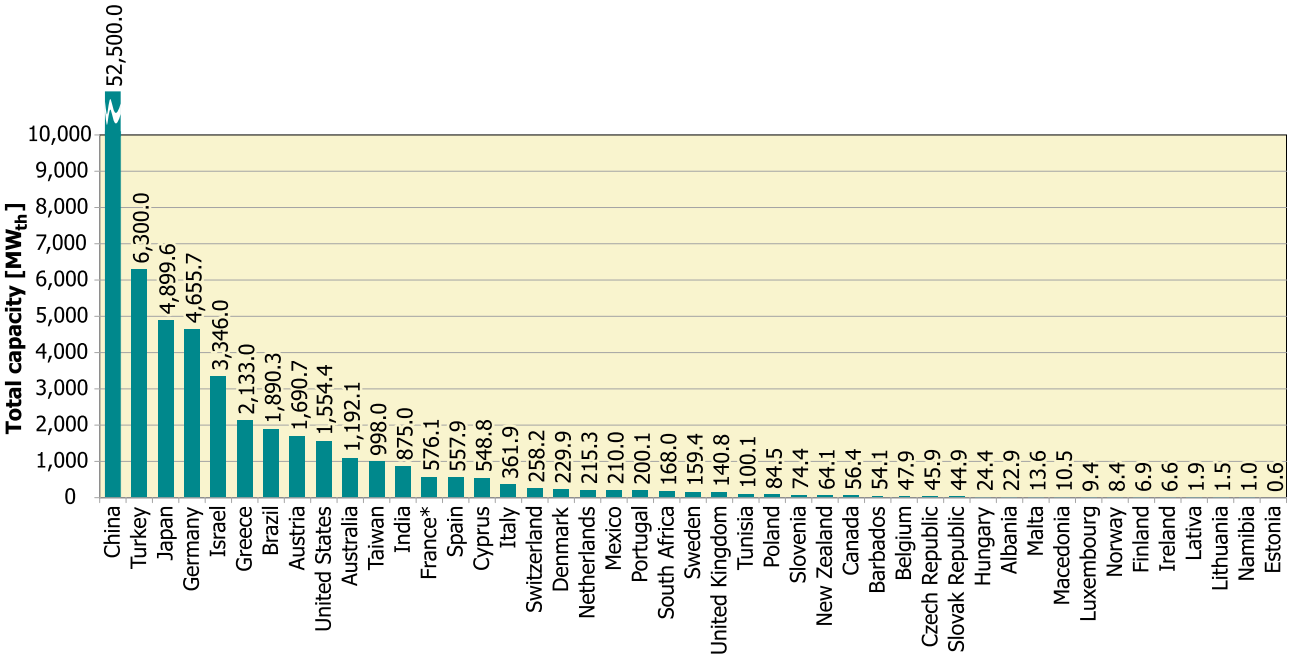


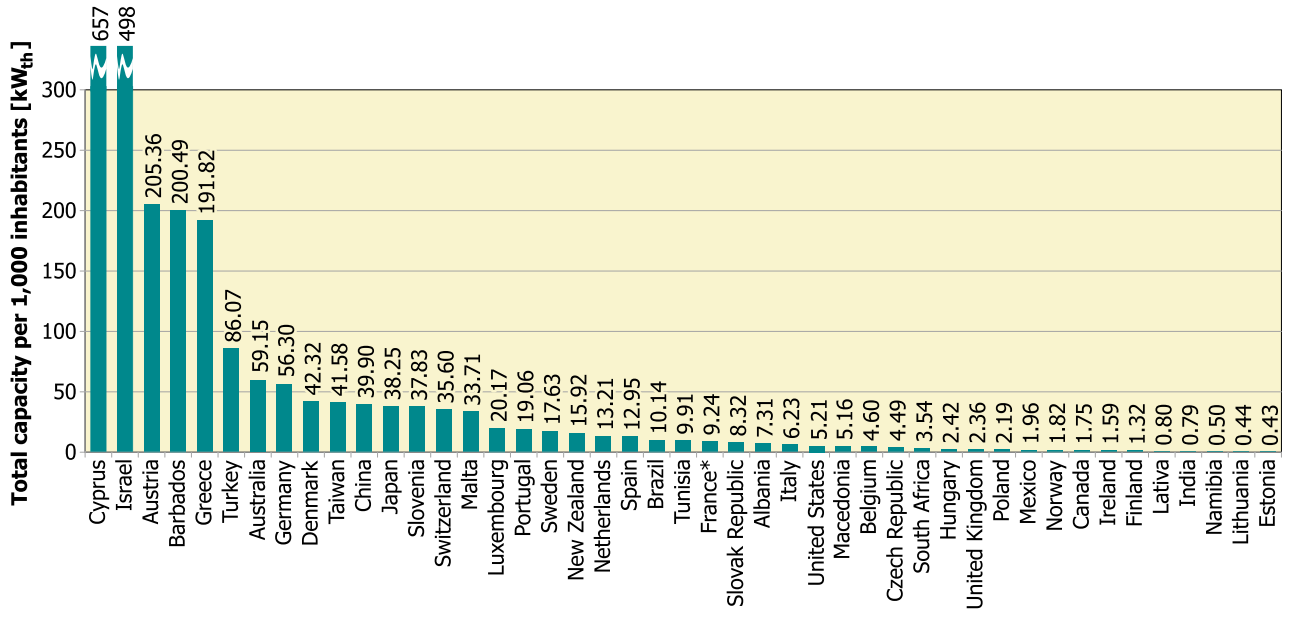
Figure 4: Total capacity in operation of water collectors of the 10 leading countries at the end of 2005

3.1 Total capacity of glazed flat-plate and evacuated tube collectors at the end of 2005



* France: incl. Oversea Departments

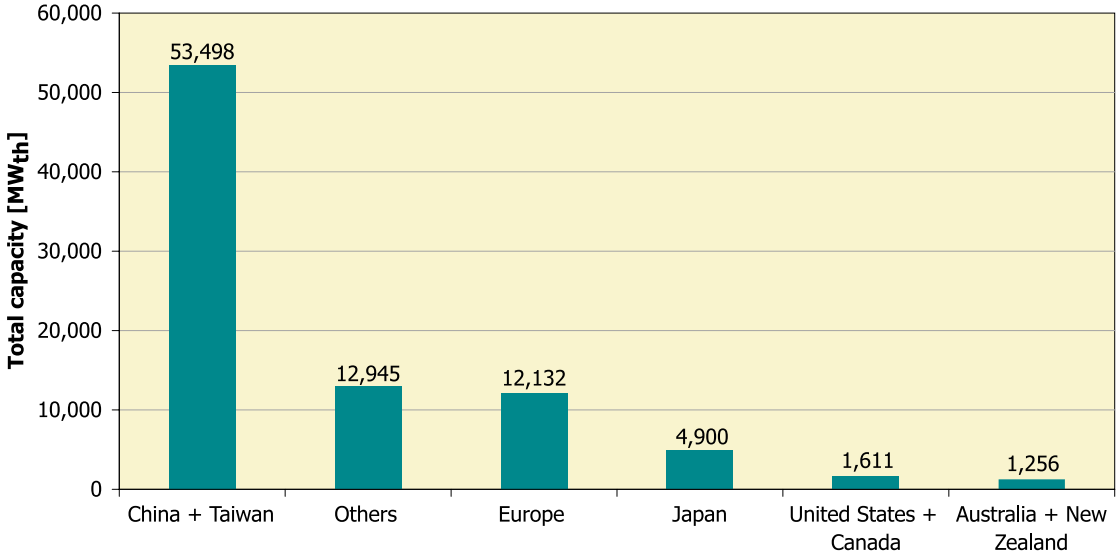
Figure 5: Total capacity of glazed flat plate and evacuated tube collectors in operation at the end of 2005



* France: incl. Oversea Departments

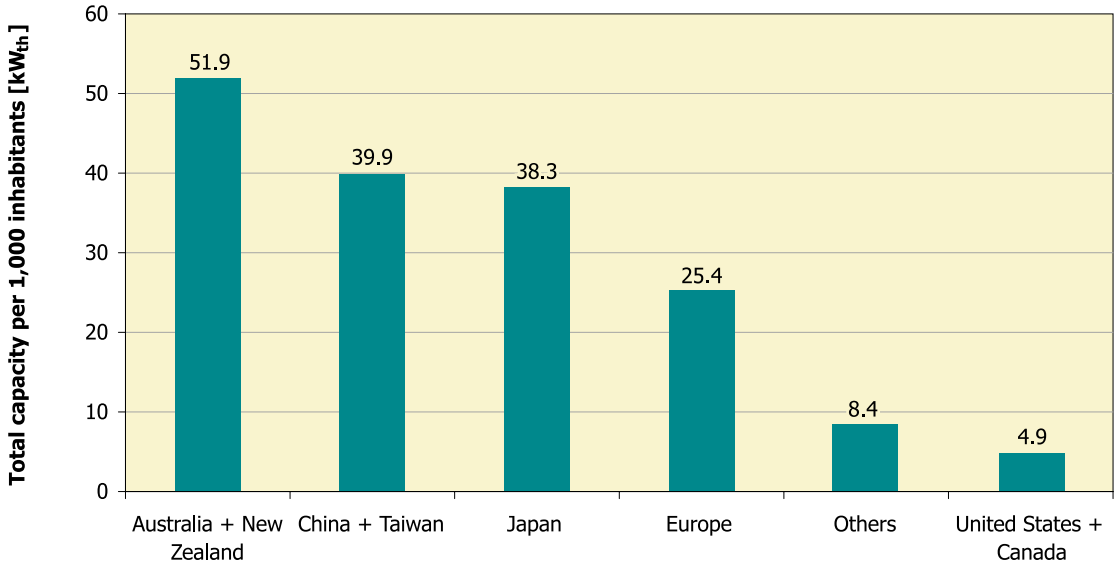
Figure 6: Total capacity of glazed flat plate and evacuated tube collectors in operation at the end of 2005 in kW_{th} per 1,000 inhabitants

3.2 Total capacity of glazed flat plate and evacuated tube collectors in operation at the end of 2005 by economic region



(Europe: EU 27, Switzerland, Norway, Albania, Macedonia, Oversea Departments of France.
Others: Barbados, Brazil, India, Israel, Mexico, Namibia, South Africa, Tunisia, Turkey)

Figure 7: Total capacity of glazed flat plate and evacuated tube collectors in operation by economic region at the end of 2005



(Europe: EU 27, Switzerland, Norway, Albania, Macedonia, Oversea Departments of France.
Others: Barbados, Brazil, India, Israel, Mexico, Namibia, South Africa, Tunisia, Turkey)

Figure 8: Total capacity of glazed flat plate and evacuated tube collectors in operation by economic region at the end of 2005 in kW_{th} per 1,000 inhabitants

3.3 Total capacity of unglazed water collectors in operation at the end of 2005

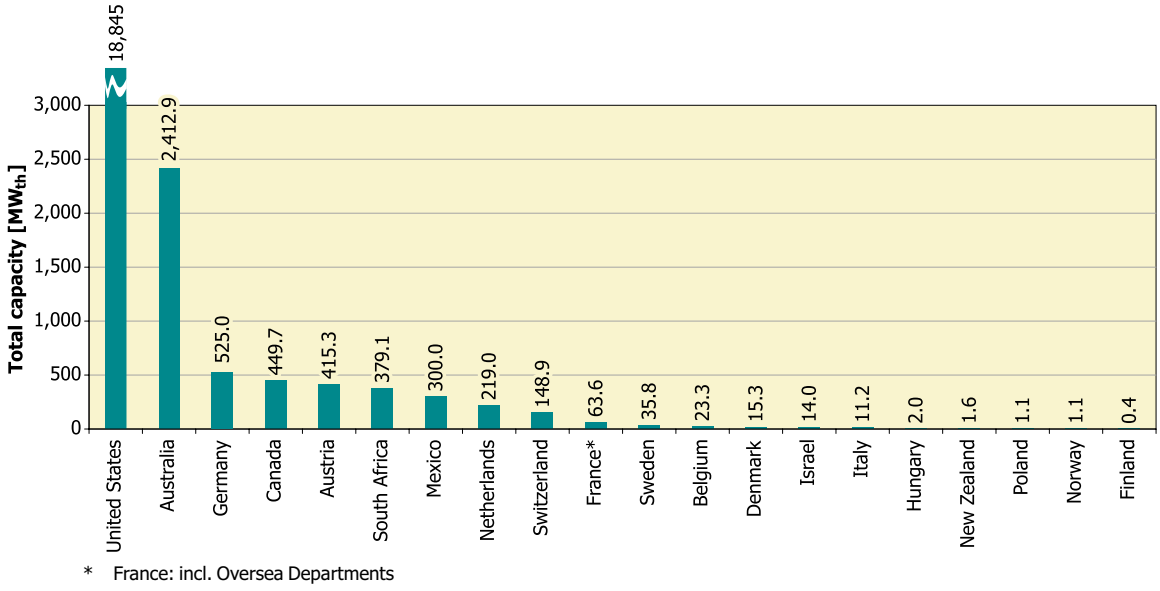


Figure 9: Total capacity of unglazed water collectors in operation at the end of 2005

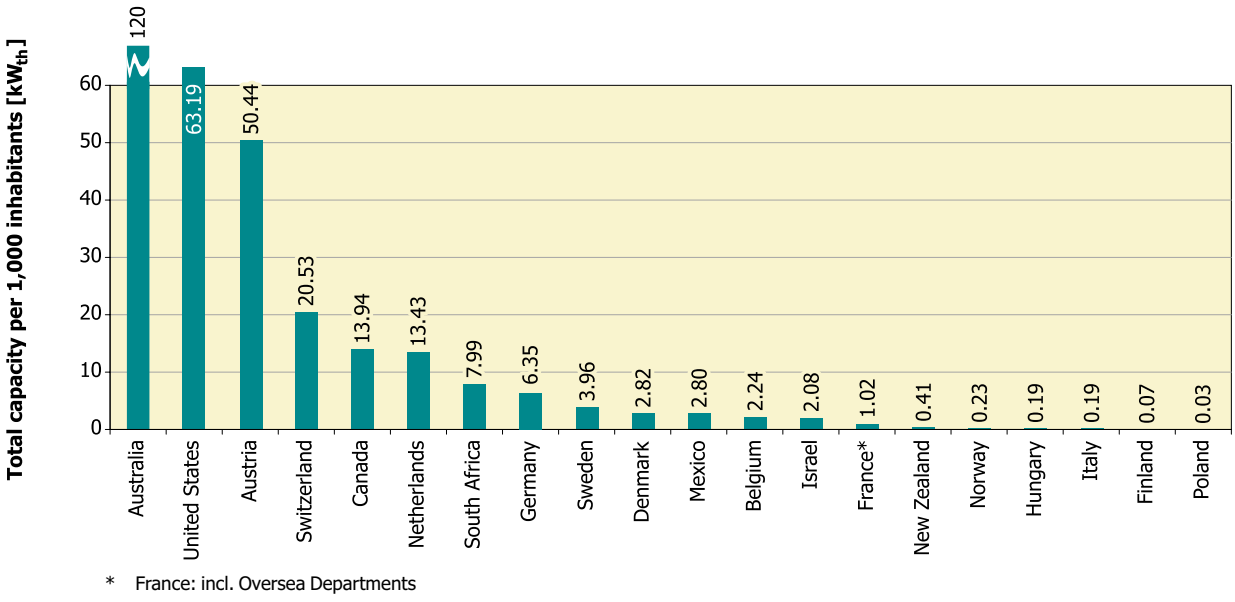


Figure 10: Total capacity of unglazed water collectors in operation at end of 2005 in kW_{th} per 1,000 inhabitants

3.4 Total capacity of unglazed water collectors in operation by economic region at the end of 2005

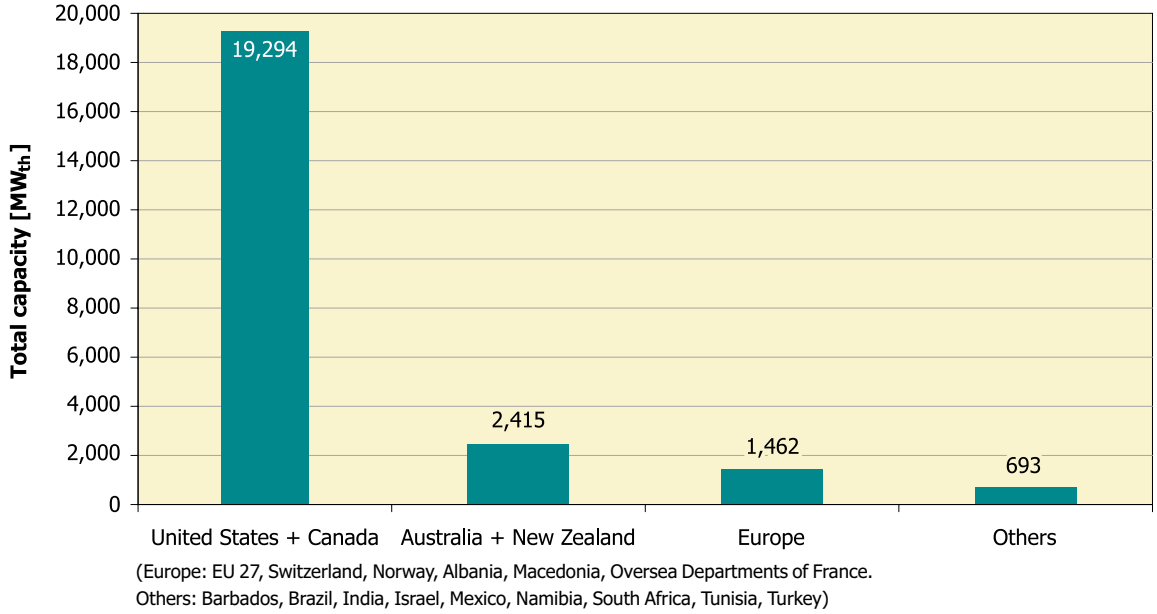


Figure 11: Total capacity of unglazed collectors in operation by economic region at the end of 2005

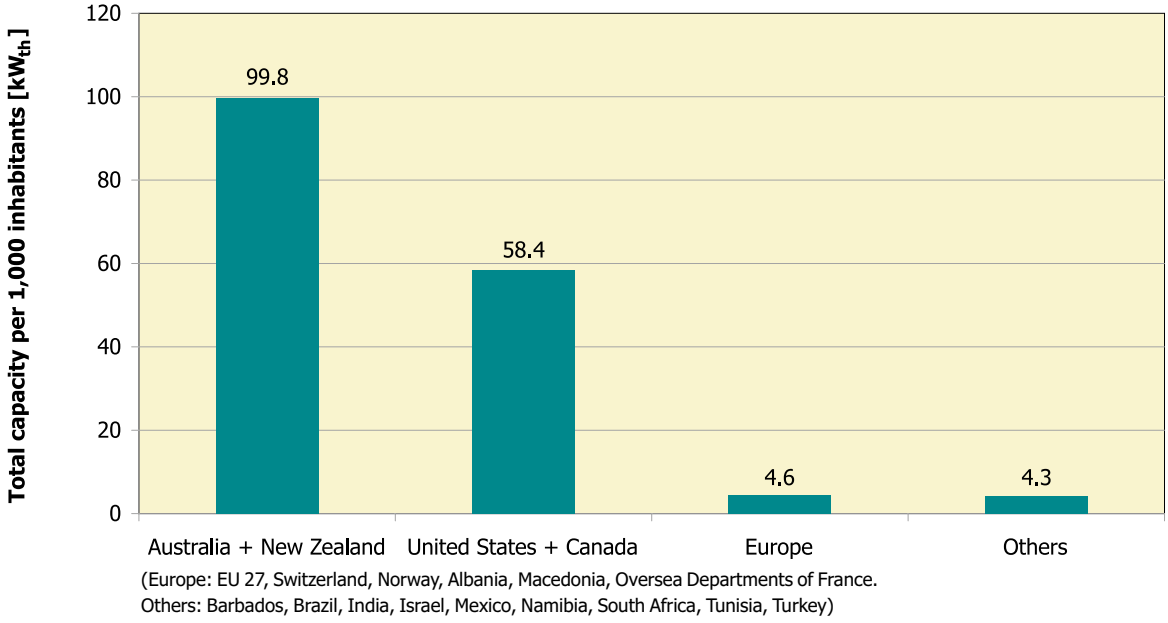


Figure 12: Total capacity of unglazed collectors in operation by economic region at the end of 2005 in kW_{th} per 1,000 inhabitants

4 Market development 1999 to 2005

Analyzing the market development from 1999 to 2005 in the area of hot water preparation and spacing heating, 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, Australia and New Zealand as well as in Europe. The average annual growth rate between 1999 and 2005 was 22% in China and Taiwan, 18% in Australia and New Zealand and 15% in Europe. The market for flat-plate and evacuated tube collectors is constantly low in Canada and the USA (see also chapter 7.1, Annual installed Capacity, Table 5 to Table 10).

After a peak in 1980s because of the second oil crisis, the market in Japan went down rapidly. The Ministry of Economy, Trade and Industry stopped the subsidies, which caused a break in of the marked.

The worldwide market of unglazed collectors for swimming pool heating recorded an increase between 1999 and 2002 and a decrease in 2003. In 2004 and 2005, the installed capacity again achieved an increase.

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

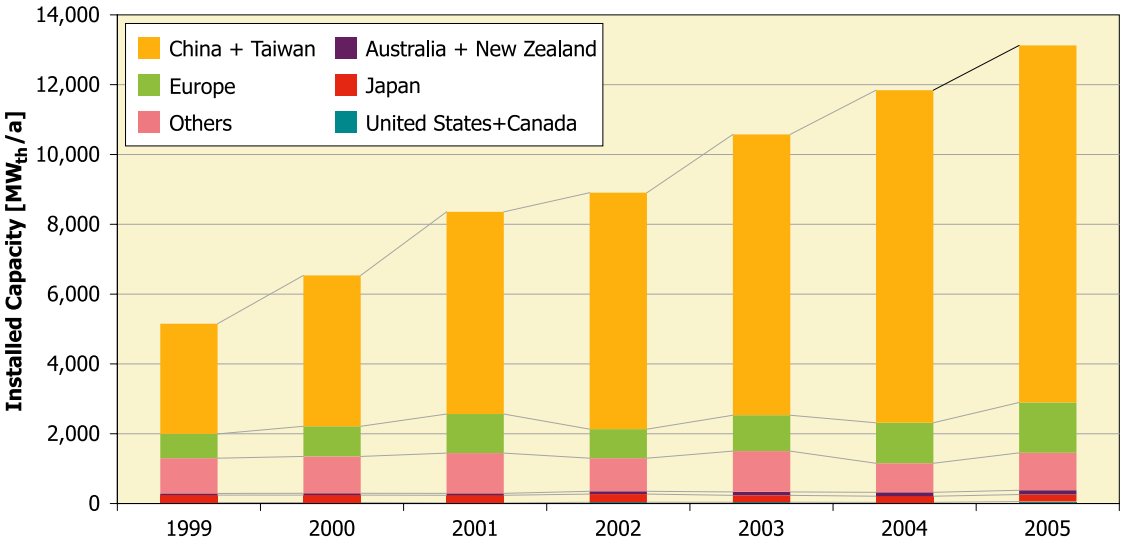


Figure 13a: Annual installed capacity of flat plate and evacuated tube collectors

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 Table 1). Other large markets in 2005 for evacuated tube collectors were Germany, Italy, USA, United Kingdom and Taiwan.

Figure 13b shows a completely different picture of the market development. Comparing the yearly installed capacity per 1,000 inhabitants, the Australian and the European markets turns out to be more dynamic, whereas China looses its absolute dominance due to the large population figure.

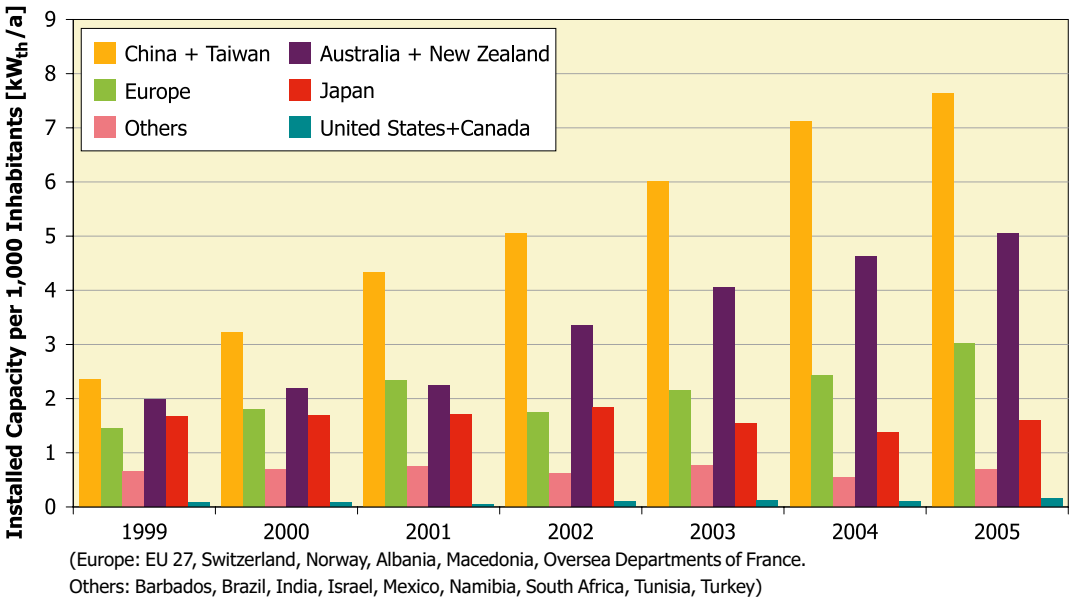


Figure 13b: Annual installed capacity of flat plate and evacuated tube collectors in kW_{th} per 1,000 inhabitants

4.2 Market development of unglazed plastic collectors by economic region

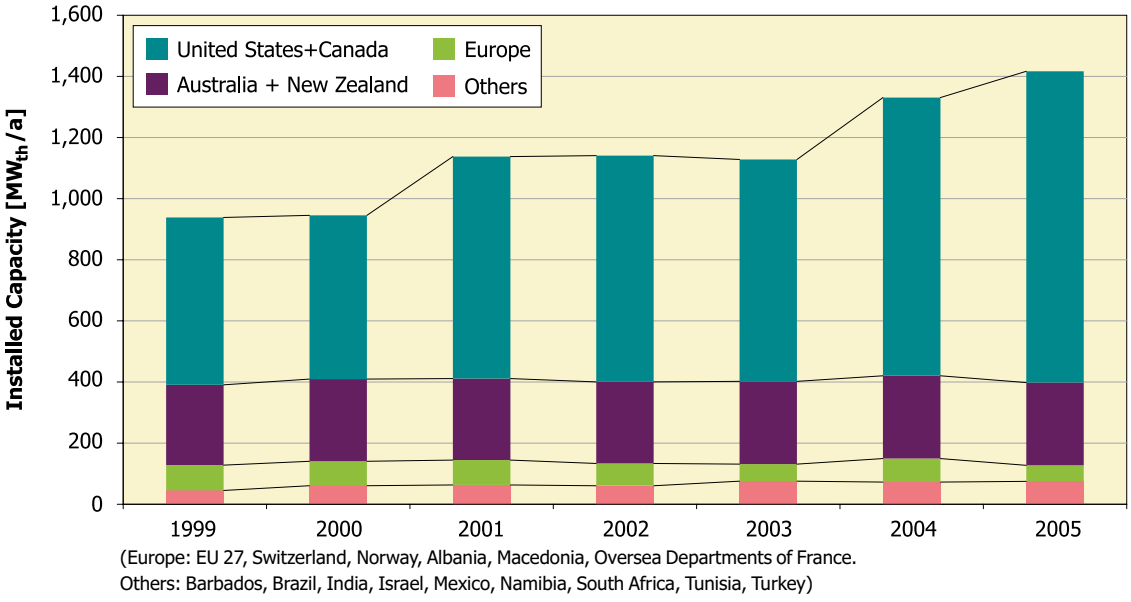


Figure 14: Annual installed capacity of unglazed water collectors

5 Contribution to the energy supply and CO_2 reduction

In this section, the contribution of the 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.
As shown in Table 1, a flat plate and evacuated tube collector capacity of 86.3 GW_{th} and unglazed plastic collector capacity of 23.9 GW_{th} was installed by the end of the year 2005 in the recorded countries. The annual yield of these collectors is calculated to be 66,406 GWh (239,062 TJ). This corresponds to a calculated oil equivalent of 10.7 billion liter and an annual CO_2 reduction of 29.3 million tons of CO_2.

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:

  Collector area for:
  - swimming pool heating
  - domestic hot water systems for single family houses
  - domestic hot water systems for multi-family houses and district heating
  - solar combi systems 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[4] 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.

Results

The annual collector yield per square meter of collector area lies, depending on the application (domestic hot water preparation, space heating ...), the local climatic conditions and the plant dimensioning (high or low solar fraction), between 400 kWh/kW_{th} for solar combi systems for hot water preparation and space heating at high latitudes and 900 kWh/kW_{th} 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.

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

4 T-Sol, Version 4.03, dynamic simulation program to design and optimize thermal solar plants, Valentin Energiesoftware, www.valentin.de

report, the energy savings and the CO_2 emissions avoided relate to 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[5].

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	32,680	22.9	13,072	15.0	54.0	2,980,416	8,131
Australia	5,150,000	3,605.0	435,151	1,971.1	7,095.8	346,415,802	954,305
Austria	3,008,612	2,106.0	294,737	994.6	3,580.6	149,840,997	408,868
Barbados	77,332	54.1	19,333	63.0	226.9	11,251,749	30,681
Belgium	101,783	71.2	17,287	32.1	115.5	4,660,737	12,716
Brazil	2,700,458	1,890.3	675,115	1,186.2	4,270.2	211,310,860	576,548
Canada	723,124	506.2	16,060	175.4	631.5	28,747,657	78,437
China	75,000,000	52,500.0	18,750,000	32,043.8	115,357.5	5,062,500,000	13,818,750
Cyprus	784,000	548.8	192,394	491.8	1,770.4	84,348,678	229,992
Czech Rep.	65,550	45.9	10,829	20.7	74.6	3,022,117	8,202
Denmark	350,240	245.2	71,782	116.9	420.7	16,523,312	45,081
Estonia	820	0.6	205	0.3	0.9	34,850	95
Finland	10,380	7.3	2,359	3.2	11.6	423,732	1,156
France*	913,868	639.7	198,271	303.4	1,092.4	55,104,320	150,166
Germany	7,401,000	5,180.7	967,702	2,636.7	9,491.9	382,345,857	1,043,229
Greece	3,047,200	2,133.0	1,195,721	1,601.3	5,764.8	336,576,648	918,296
Hungary	37,700	26.4	5,779	14.8	53.1	2,261,174	6,169
India	1,250,000	875.0	312,500	1,121.3	4,036.5	187,812,500	512,500
Ireland	9,444	6.6	2,361	3.1	11.2	410,814	1,119
Israel	4,800,000	3,360.0	1,173,112	3,514.1	12,650.7	563,191,200	1,535,406
Italy	533,000	373.1	129,330	225.0	810.1	35,587,903	97,088
Japan	6,999,449	4,899.6	1,694,333	3,339.3	12,021.3	501,549,746	1,368,350
Lativa	2,650	1.9	663	0.9	3.2	122,563	335
Lithuania	2,150	1.5	538	0.7	2.6	100,513	274
Luxembourg	13,400	9.4	3,350	4.6	16.6	643,200	1,759
Macedonia	15,000	10.5	3,750	6.5	23.4	1,346,250	3,671
Malta	19,360	13.6	4,840	6.0	21.7	2,211,880	6,035
Mexico	728,644	510.1	27,468	327.2	1,178.0	61,650,551	168,211
Namibia	1,448	1.0	362	0.7	2.6	167,279	454
Netherlands	620,400	434.3	88,358	150.9	543.1	20,707,038	56,476
New Zealand	93,950	65.8	21,858	28.1	101.2	4,456,146	12,162
Norway	13,500	9.5	1,976	4.3	15.4	563,080	1,536
Poland	122,240	85.6	19,946	39.1	140.9	5,719,532	15,592
Portugal	285,800	200.1	68,163	179.5	646.2	29,313,463	79,978
Slovak Rep.	64,170	44.9	10,695	25.7	92.5	3,850,200	10,502
Slovenia	106,300	74.4	17,405	38.3	138.0	5,631,476	15,357
South Africa	781,500	547.1	62,708	206.8	744.4	35,188,515	95,967
Spain	796,951	557.9	190,073	486.5	1,751.5	73,313,037	200,041
Sweden	278,825	195.2	19,988	109.8	395.1	12,444,289	33,941
Switzerland	581,510	407.1	36,964	166.9	601.0	24,235,748	66,115
Taiwan	1,425,700	998.0	356,425	715.0	2,574.0	126,530,875	345,732
Tunisia	143,000	100.1	35,750	95.4	343.4	21,092,500	57,593
Turkey	9,000,000	6,300.0	2,043,000	5,365.0	19,314.0	852,597,000	2,328,683
United Kingd.	201,160	140.8	50,290	67.0	241.2	9,590,303	26,171
United States	29,141,546	20,399.1	504,697	8,508.1	30,629.3	1,460,695,468	3,985,484
Total	157,435,845	110,205	29,746,698	66,406	239,062	10,739,071,974	29,308,354

* France: incl. Oversea Departments

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

Table 2: 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 2005

5 It is obvious that not all solar thermal systems worldwide just replace oil. But to investigate the energy mix substituted in all reported countries would be beyond the scope of this report.

Country	Total collector area** [m²]	Total capacity [MW_{th}]	Number of systems	Collector yield [GWh/a]	Collector yield [TeraJ /a]	Energy savings - oil equivalent [l/a]	CO_2 reduction [t/a]
Albania	32,680	22.9	13,072	15.0	54.0	2,980,416	8,131
Australia	1,703,000	1,192.1	417,916	701.4	2,524.9	121,617,974	331,956
Austria	2,415,318	1,690.7	291,770	860.2	3,096.6	127,880,219	348,949
Barbados	77,332	54.1	19,333	63.0	226.9	11,251,749	30,681
Belgium	68,483	47.9	17,121	26.5	95.4	3,716,915	10,141
Brazil	2,700,458	1,890.3	675,115	1,186.2	4,270.2	211,310,860	576,548
Canada	80,631	56.4	12,847	36.9	132.8	5,199,646	14,188
China	75,000,000	52,500.0	18,750,000	32,043.8	115,357.5	5,062,500,000	13,818,750
Cyprus	784,000	548.8	192,394	491.8	1,770.4	84,348,678	229,992
Czech Rep.	65,550	45.9	10,829	20.7	74.6	3,022,117	8,202
Denmark	328,370	229.9	71,672	113.5	408.6	15,955,708	43,532
Estonia	820	0.6	205	0.3	0.9	34,850	95
Finland	9,880	6.9	2,356	3.1	11.3	413,466	1,128
France*	822,980	576.1	197,817	285.6	1,028.1	52,010,174	141,724
Germany	6,651,000	4,655.7	963,952	2,475.4	8,911.6	354,434,982	967,076
Greece	3,047,200	2,133.0	1,195,721	1,601.3	5,764.8	336,576,648	918,296
Hungary	34,900	24.4	5,765	14.0	50.2	2,123,218	5,792
India	1,250,000	875.0	312,500	1,121.3	4,036.5	187,812,500	512,500
Ireland	9,444	6.6	2,361	3.1	11.2	410,814	1,119
Israel	4,780,000	3,346.0	1,173,012	3,512.9	12,646.5	561,841,200	1,531,724
Italy	517,000	361.9	129,250	221.7	798.0	34,987,975	95,451
Japan	6,999,449	4,899.6	1,694,333	3,339.3	12,021.3	501,549,746	1,368,350
Lativa	2,650	1.9	663	0.9	3.2	122,563	335
Lithuania	2,150	1.5	538	0.7	2.6	100,513	274
Luxembourg	13,400	9.4	3,350	4.6	16.6	643,200	1,759
Macedonia	15,000	10.5	3,750	6.5	23.4	1,346,250	3,671
Malta	19,360	13.6	4,840	6.0	21.7	2,211,880	6,035
Mexico	300,058	210.0	25,325	202.9	730.4	39,489,849	107,747
Namibia	1,448	1.0	362	0.7	2.6	167,279	454
Netherlands	307,600	215.3	86,794	103.6	373.0	12,920,195	35,230
New Zealand	91,600	64.1	21,847	27.6	99.3	4,365,803	11,915
Norway	12,000	8.4	1,968	4.1	14.7	529,330	1,444
Poland	120,690	84.5	19,938	38.8	139.7	5,665,406	15,444
Portugal	285,800	200.1	68,163	179.5	646.2	29,313,463	79,978
Slovac Rep.	64,170	44.9	10,695	25.7	92.5	3,850,200	10,502
Slovenia	106,300	74.4	17,405	38.3	138.0	5,631,476	15,357
South Africa	240,000	168.0	60,000	105.0	378.0	18,180,000	49,560
Spain	796,951	557.9	190,073	486.5	1,751.5	73,313,037	200,041
Sweden	227,679	159.4	19,732	102.9	370.6	11,385,771	31,053
Switzerland	368,840	258.2	35,900	130.1	468.3	18,157,108	49,530
Taiwan	1,425,700	998.0	356,425	715.0	2,574.0	126,530,875	345,732
Tunisia	143,000	100.1	35,750	95.4	343.4	21,092,500	57,593
Turkey	9,000,000	6,300.0	2,043,000	5,365.0	19,314.0	852,597,000	2,328,683
United Kingd.	201,160	140.8	50,290	67.0	241.2	9,590,303	26,171
United States	2,220,553	1,554.4	370,092	1,273.1	4,583.2	212,247,864	579,157
Total	123,344,604	86,341	29,576,242	57,117	205,621	9,131,431,719	24,921,991

* France: incl. Oversea Departments

** Flat-plate and vacuum tube collectors.

Table 3: 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 2005

Country	Total collector area** [m²]	Total capacity [MW_{th}]	Calculated number of systems	Collector yield [GWh/a]	Collector yield [Tera J/a]	Energy savings – oil equivalent [l/a]	CO_2 reduction [t/a]
Albania							
Australia	3,447,000	2,419.9	17,235	1,269.7	4,570.9	224,797,829	613,349
Austria	593,294	415.3	2,966	134.4	484.0	21,960,777	59,919
Barbados							
Belgium	33,300	23.3	167	5.6	20.1	943,822	2,575
Brazil							
Canada	642,493	449.7	3,212	138.5	498.7	23,548,011	64,249
China							
Cyprus							
Czech Rep.							
Denmark	21,870	15.3	109	3.4	12.1	567,603	1,549
Estonia							
Finland	500	0.4	3	0.1	0.2	10,266	28
France*	90,888	63.6	454	17.9	64.3	3,094,146	8,442
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	20,000	14.0	100	1.2	4.2	1,350,000	3,682
Italy	16,000	11.2	80	3.4	12.1	599,928	1,637
Japan							
Lativa							
Lithuania							
Luxembourg							
Macedonia							
Malta							
Mexico	428,586	300.0	2,143	124.3	447.6	22,160,703	60,464
Namibia							
Netherlands	312,800	219.0	1,564	47.2	170.0	7,786,843	21,246
New Zealand	2,350	1.6	12	0.5	1.9	90,343	246
Norway	1,500	1.1	8	0.2	0.8	33,750	92
Poland	1,550	1.1	8	0.3	1.2	54,126	148
Portugal							
Slovak Rep.							
Slovenia							
South Africa	541,500	379.1	2,708	101.8	366.4	17,008,515	46,407
Spain							
Sweden	51,146	35.8	256	6.8	24.6	1,058,518	2,888
Switzerland	212,670	148.9	1,063	36.9	132.7	6,078,640	16,585
Taiwan							
Tunisia							
Turkey							
United Kingd.							
United States	26,920,993	18,844.7	134,605	7,235.0	26,046.1	1,248,447,604	3,406,327
Total	34,091,241	23,864	170,456	9,289		1,607,640,255	4,386,363

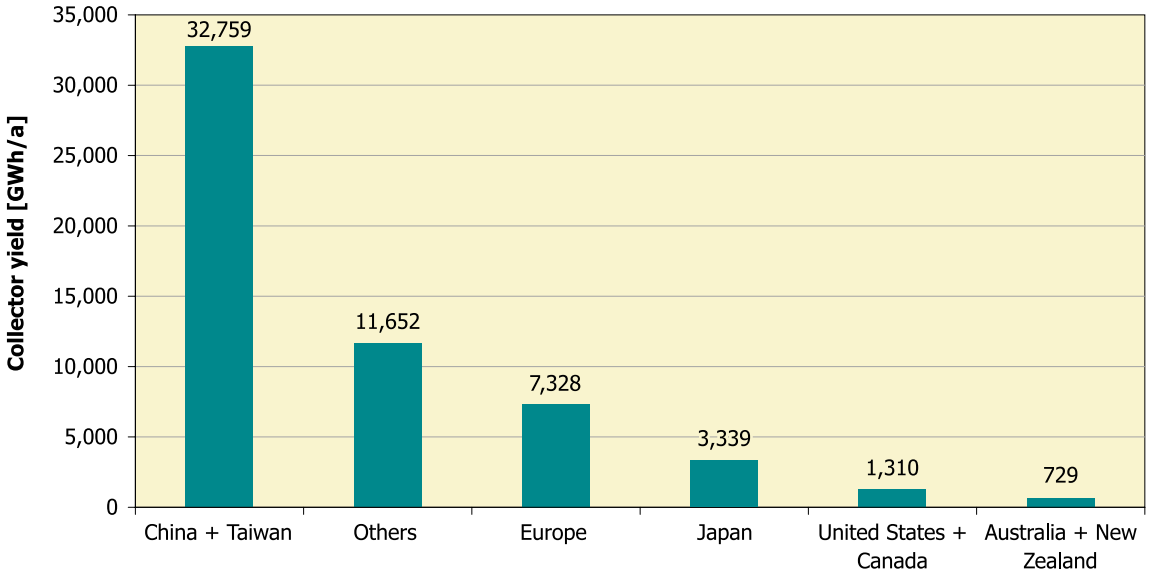
* France: incl. Oversea Departments

** Unglazed Water Collectors

Table 4: 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 2005

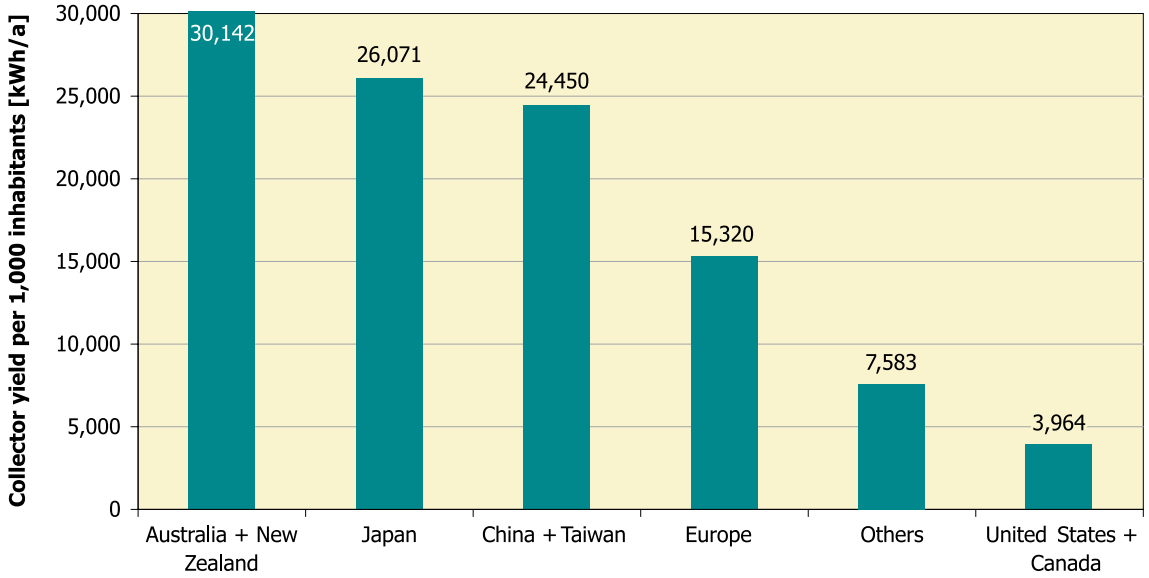
5.1 Collector yield by economic region at the end of 2005

5.1.1 Collector yield of glazed flat plate and evacuated tube collectors by economic region at the end of 2005



(Europe: EU 27, Switzerland, Norway, Albania, Macedonia, Oversea Departments of France.
Others: Barbados, Brazil, India, Israel, Mexico, Namibia, South Africa, Tunisia, Turkey)

Figure 15: Annual collector yield of glazed flat plate and evacuated tube collectors in operation by economic region at the end of 2005



(Europe: EU 27, Switzerland, Norway, Albania, Macedonia, Oversea Departments of France.
Others: Barbados, Brazil, India, Israel, Mexico, Namibia, South Africa, Tunisia, Turkey)

Figure 16: Annual collector yield of glazed flat plate and evacuated tube collectors in operation by economic region at the end of 2005 per 1,000 inhabitants

5.1.2 Collector yield of unglazed collectors by economic region at the end of 2005

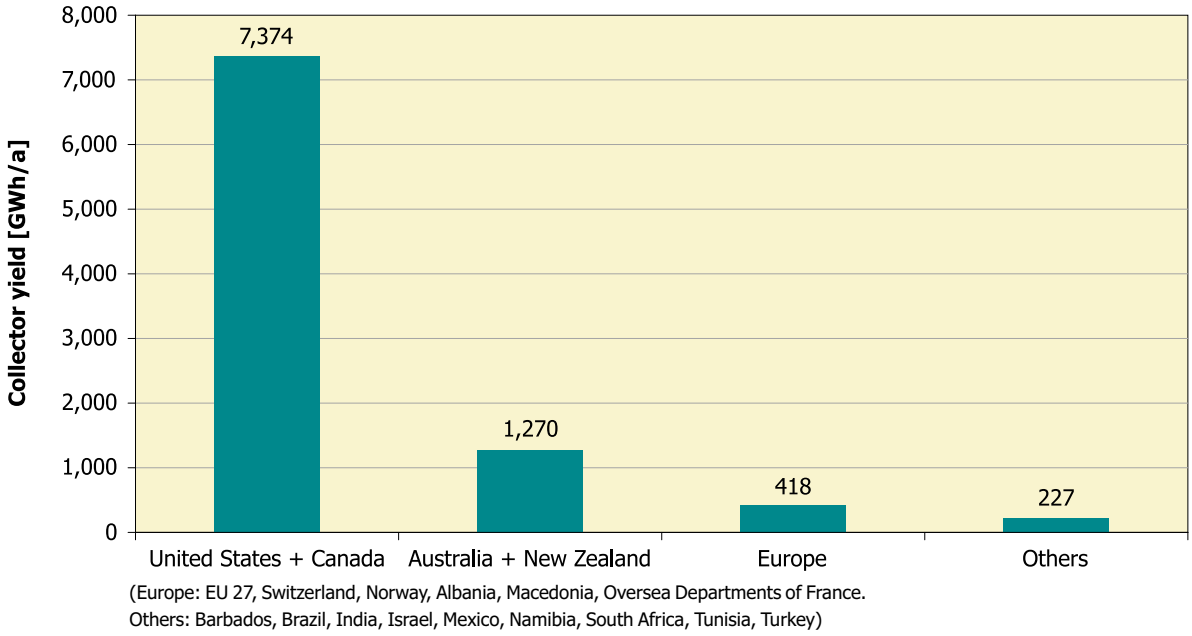


Figure 17: Annual collector yield of unglazed collectors in operation by economic region at the end of 2005

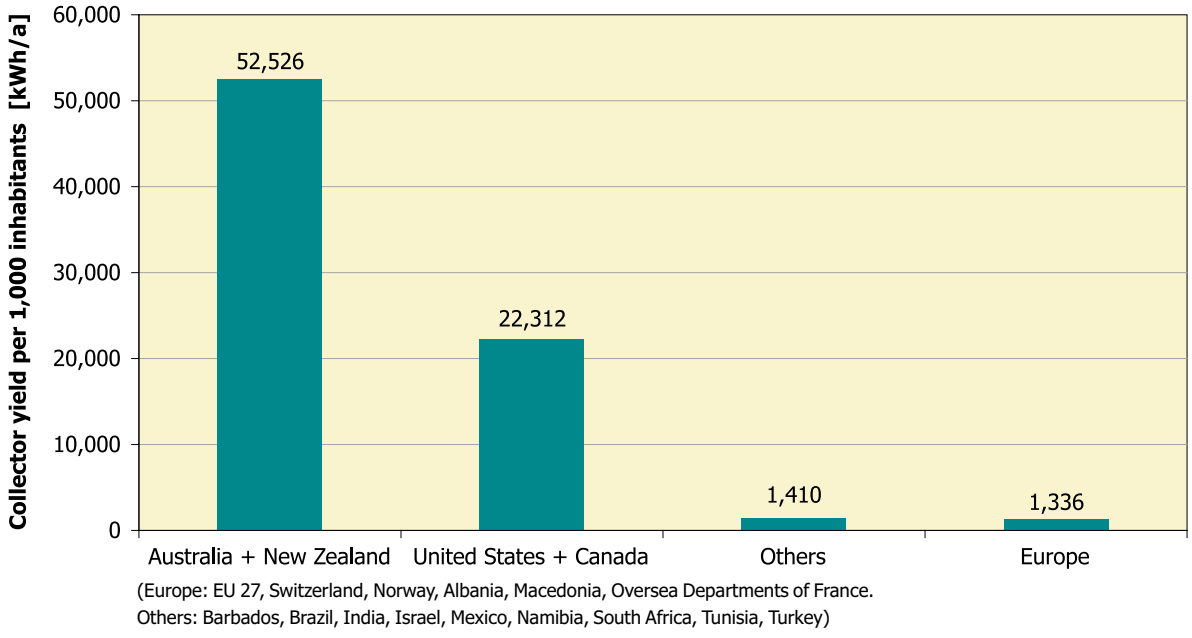
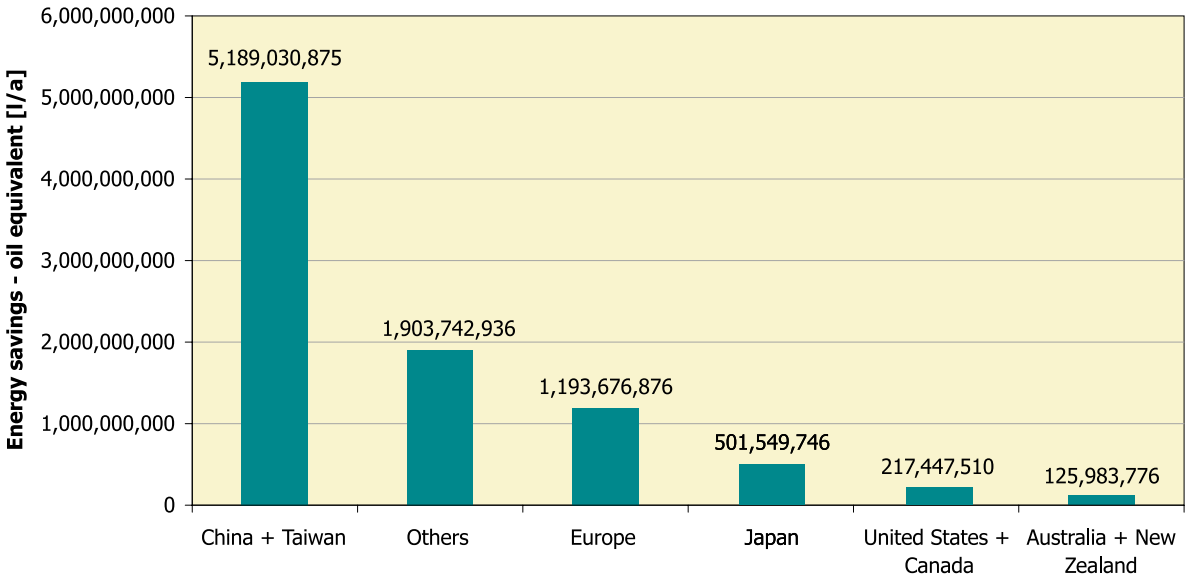


Figure 18: Annual collector yield of unglazed collectors in operation by economic region at the end of 2005 per 1,000 inhabitants

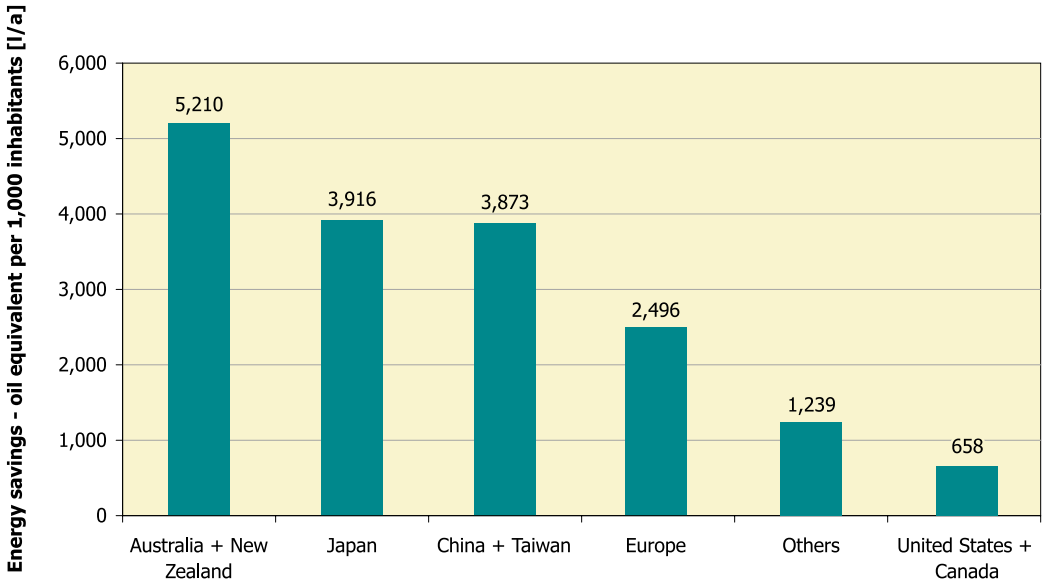
5.2 Energy savings by economic region at the end of 2005

5.2.1 Energy savings in oil equivalent – glazed flat plate and evacuated tube collectors by economic region at the end of 2005



(Europe: EU 27, Switzerland, Norway, Albania, Macedonia, Oversea Departments of France.
Others: Barbados, Brazil, India, Israel, Mexico, Namibia, South Africa, Tunisia, Turkey)

Figure 19: Annual energy savings in oil equivalent – glazed flat plate and evacuated tube collectors by economic region at the end of 2005



(Europe: EU 27, Switzerland, Norway, Albania, Macedonia, Oversea Departments of France.
Others: Barbados, Brazil, India, Israel, Mexico, Namibia, South Africa, Tunisia, Turkey)

Figure 20: Annual energy savings in oil equivalent – glazed flat plate and evacuated tube collectors operation by economic region at the end of 2005 per 1,000 inhabitants

5.2.2 Energy savings in oil equivalent – unglazed collectors by economic region at the end of 2005

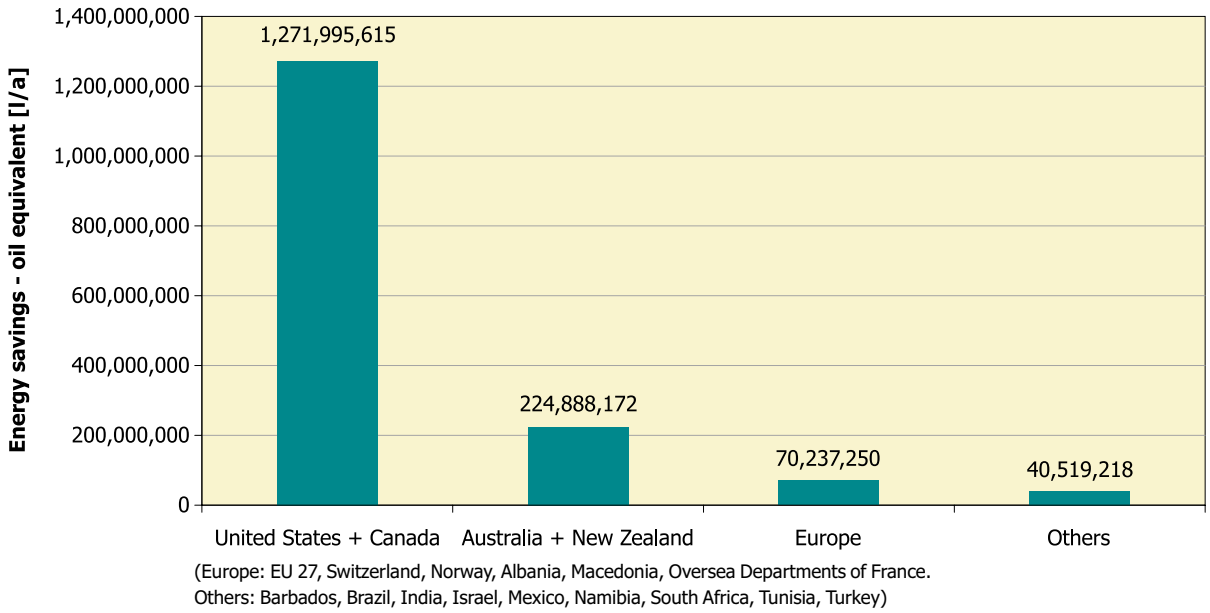


Figure 21: Annual energy savings in oil equivalent – unglazed collectors by economic region at the end of 2005

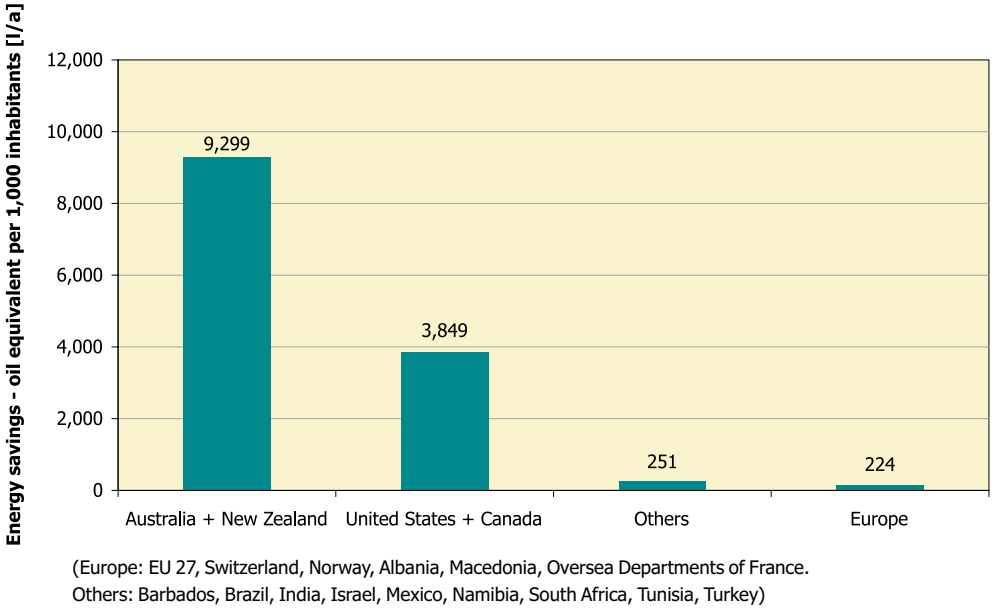
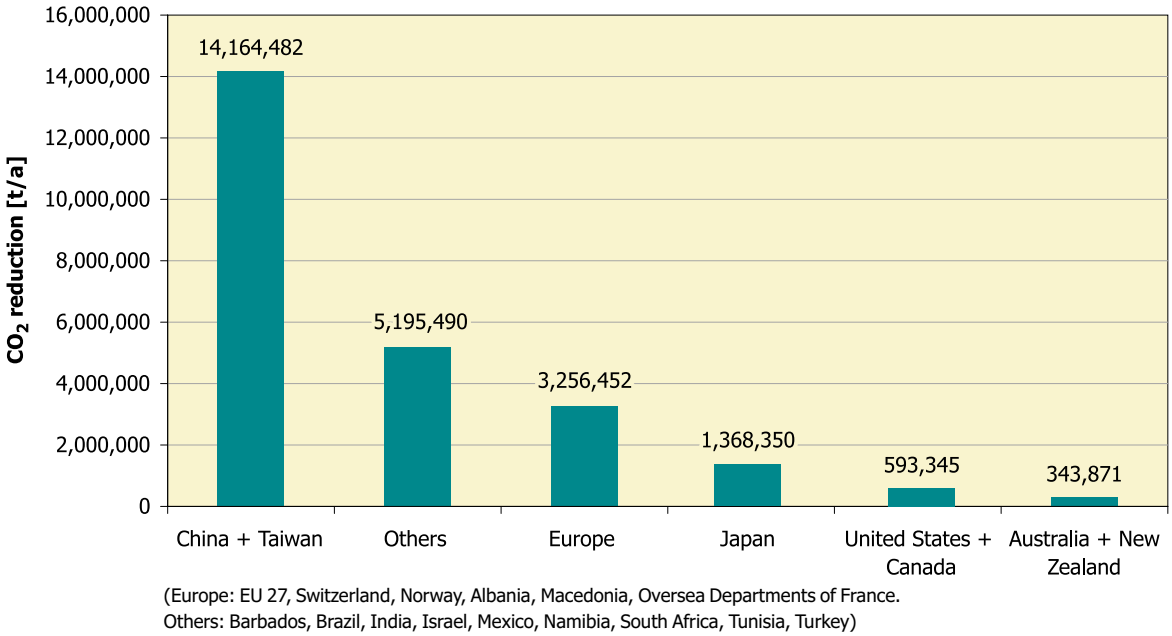


Figure 22: Annual energy savings by economic region at the end of 2005 per 1,000 inhabitants in oil equivalent – unglazed collectors

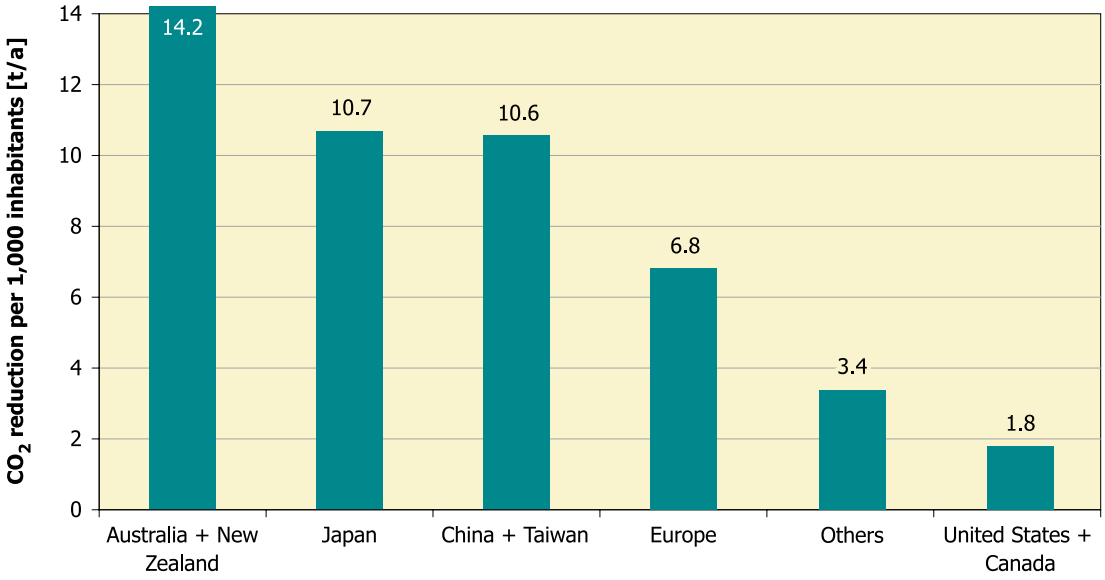
5.3 Contribution to CO_2 reduction by economic region at the end of 2005

5.3.1 Contribution to CO_2 reduction: Flat plate and evacuated tube collectors by economic region at the end of 2005



(Europe: EU 27, Switzerland, Norway, Albania, Macedonia, Oversea Departments of France.
Others: Barbados, Brazil, India, Israel, Mexico, Namibia, South Africa, Tunisia, Turkey)

Figure 23: Annual contribution to CO_2 reduction – flat plate and evacuated tube collectors by economic region the end of 2005



(Europe: EU 27, Switzerland, Norway, Albania, Macedonia, Oversea Departments of France.
Others: Barbados, Brazil, India, Israel, Mexico, Namibia, South Africa, Tunisia, Turkey)

Figure 24: Annual contribution to CO_2 reduction by economic region at the end of 2005 per 1,000 inhabitants – flat plate and evacuated tube collectors

5.3.2 Contribution to CO_2 reduction: Unglazed collectors by economic region at the end of 2005

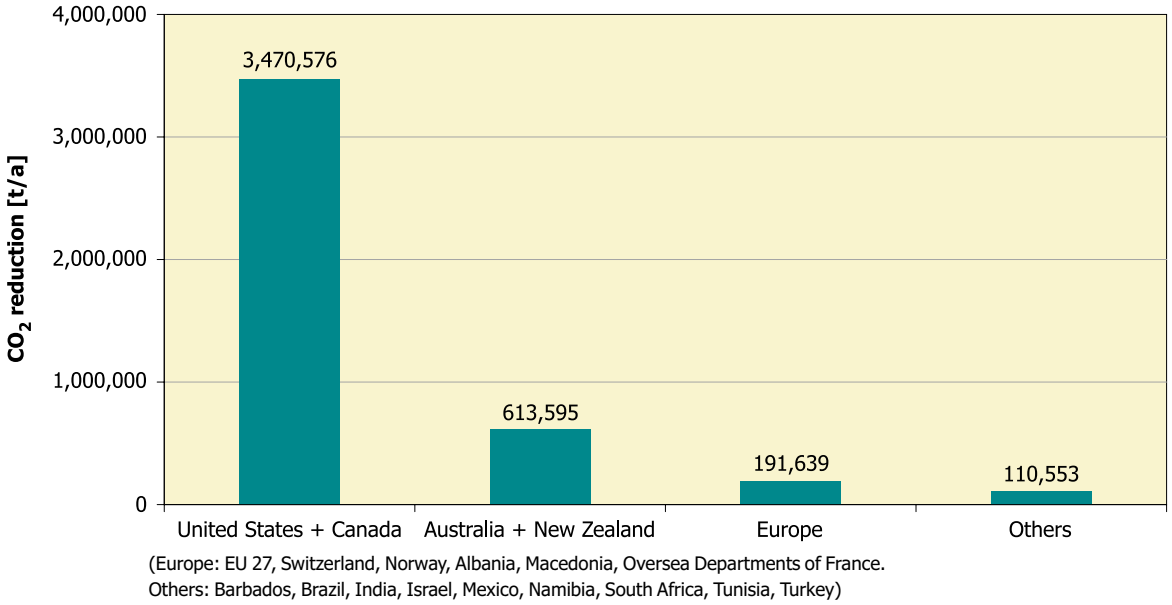


Figure 25: Annual contribution to CO_2 reduction – unglazed collectors by economic region at the end of 2005

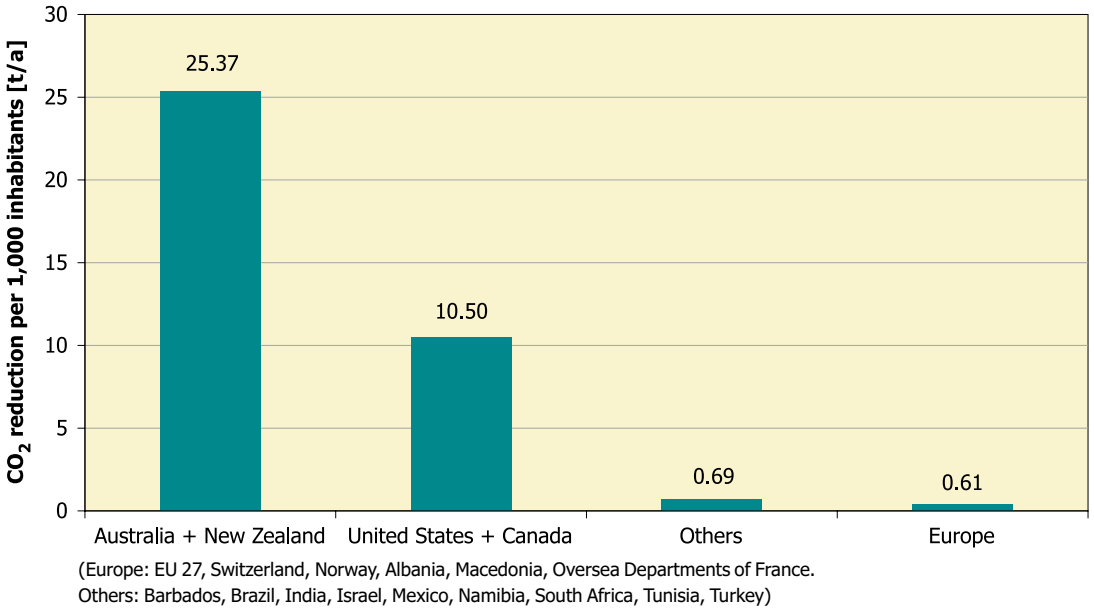
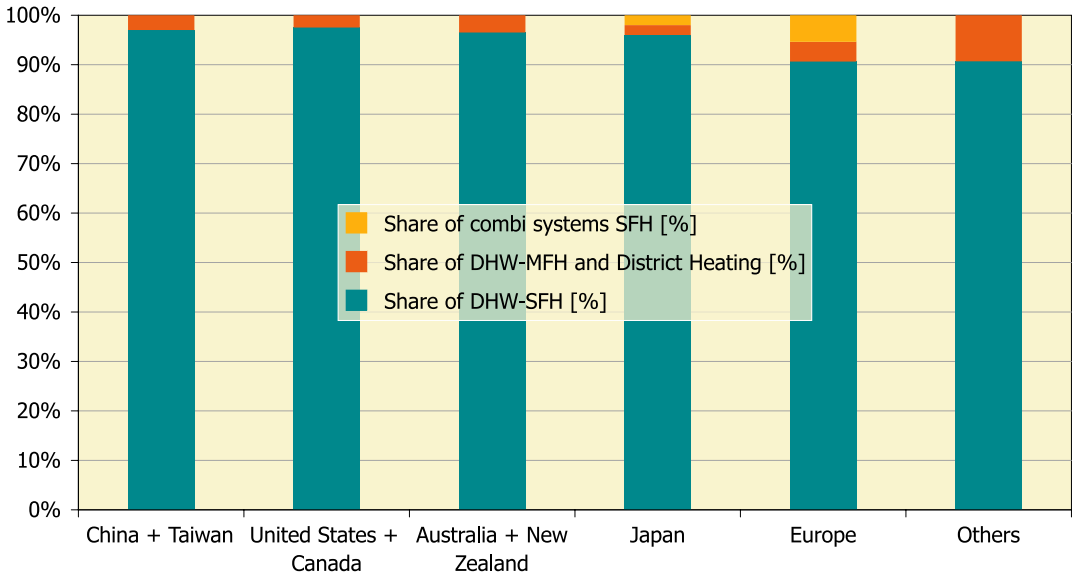


Figure 26: Annual contribution to CO_2 reduction by economic region at the end of 2005 per 1,000 inhabitants – unglazed collectors

6 Distribution of Systems by Application

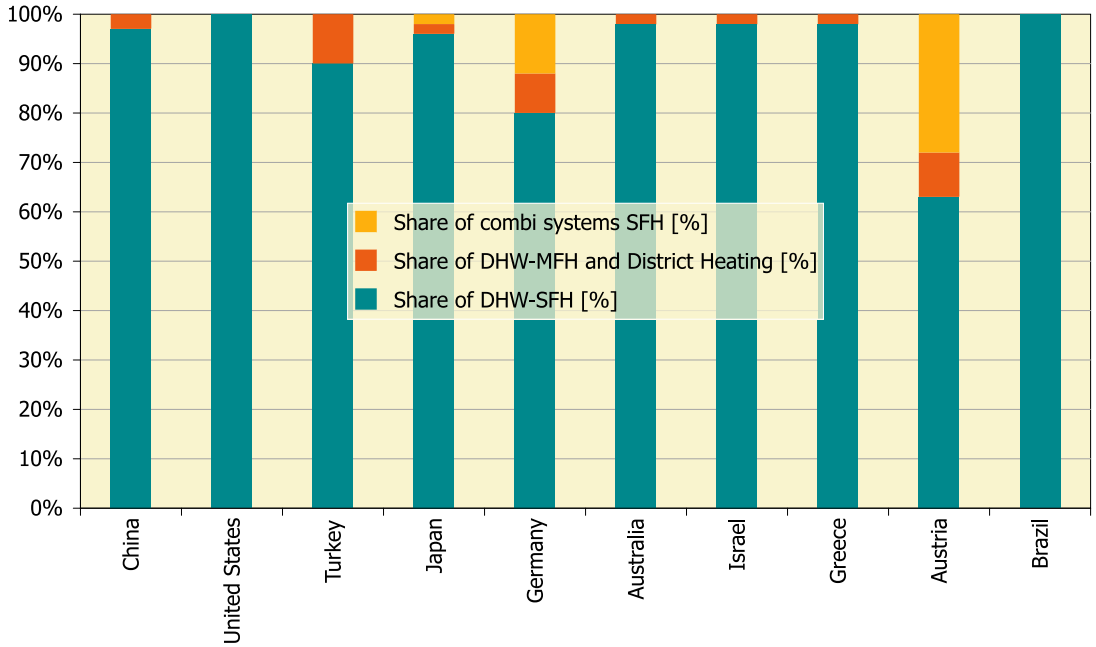
If one observes the use of solar thermal energy it becomes clear that it greatly varies in the different countries. In China and Taiwan (53.5 GW_{th}), Europe (12.1 GW_{th}) and Japan (4.9 GW_{th}) plants with flat-plate and evacuated tube collectors mainly used to prepare hot water and for space heating are dominant while in North America (USA and Canada) swimming pool heating is the dominant application with an installed capacity of 19.3 GW_{th} of unglazed plastic 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 87 large-scale plants in operation in Europe with a total installed capacity of 120 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).



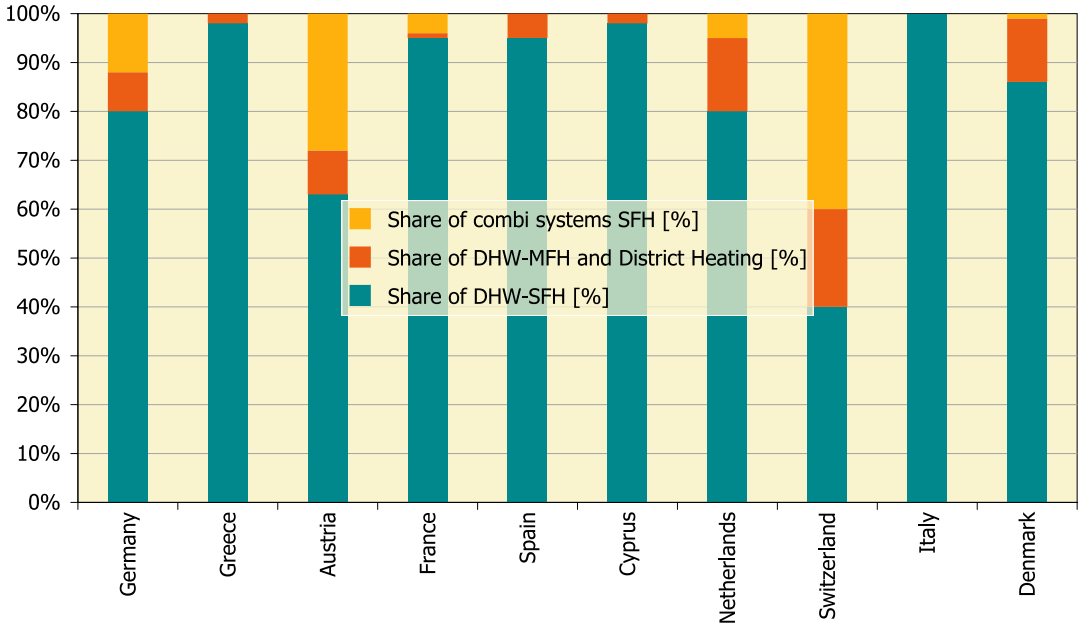
Caption:
Combi systems: Systems for hot water preparation and space heating
DHW: Domestic hot water systems
MFH: Multi family house
SFH: Single family house

Figure 27: Distribution of different applications by Economic Region
(Glazed and Evacuated Tube Collectors, total Capacity in Operation)



Caption:
Combi systems: 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 World Top 10 Countries



Caption:
Combi systems: 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 by European Top 10 Countries

Large-scale Plants

There are 87 large-scale plants are in operation in Europe with a total installed capacity of 120 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).

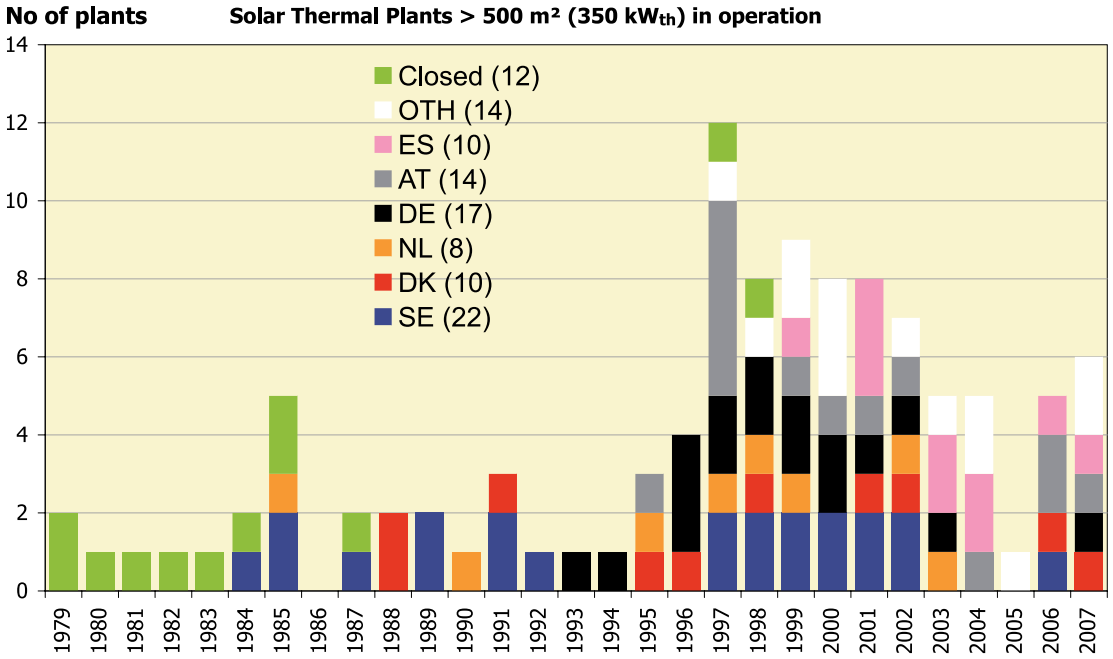


Figure 30: Large-scale solar heating and cooling plants in Europe.
Source: Jan-Olof Dalenbäck, ESTTP report on solar district heating and cooling, 2007

7 APPENDIX

7.1 Annual installed capacity

The following tables show the capacity installed yearly in the recorded countries from 1999 to 2005. It has to be mentioned here, that the number of countries who made data available increased from 21 countries in 1999 to 45 countries in 2005 (including Oversea Departments of France). Therefore the total numbers of the different years can not be compared directly.

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed	glazed	evacuated	unglazed	glazed	
Austria	11.84	97.13	1.68		0.35	111.00
Belgium	0.88	0.91	0.14			1.93
Canada	17.50	0.16	0.02	1.39		19.07
Denmark	0.17	10.71	0.07			10.95
Finland		1.05	0.07	0.35		1.47
France*	4.90	16.10	0.70			21.70
Germany	35.00	252.00	42.00		3.50	332.50
Greece		129.50				129.50
Italy	2.10	31.50	2.10	0.35	0.35	36.40
Japan		208.93	5.80			214.73
Mexico	15.09	3.77				18.87
Netherlands	5.60	19.60		0.21		25.41
New Zealand	2.80	2.80				5.60
Norway	0.07	0.70			0.07	0.84
Portugal	0.35	5.60	0.35			6.30
Spain		15.11				15.11
Sweden	2.05	6.55	0.10		0.06	8.76
Switzerland**	12.27	19.92	0.81			32.99
Turkey		525.00				525.00
United Kingdom		2.10	4.20			6.30
United States	530.14	26.92	0.39		0.72	558.17
TOTAL	640.76	1,376.06	58.43	2.30	5.04	2,082.59

* France: incl. Oversea Departments

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

Table 5: Installed capacity in 1999, MW_{th}/a

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed	glazed	evacuated	unglazed	glazed	
Australia	266.00	49.70				315.70
Austria	10.32	105.38	1.68	2.10	0.39	119.86
Barbados		1.91				1.91
Belgium	0.88	0.98	0.14			2.00
Brazil		182.00				182.00
Canada	18.90	0.44	0.11	1.71		21.16
China		1,498.00	2,772.00			4,270.00
Cyprus		21.00				21.00
Denmark	0.05	9.01	0.04			9.09
Finland		1.40		0.35		1.75
France*	5.25	23.80				29.05
Germany	35.00	357.00	77.00		4.90	473.90
Greece		126.70				126.70
India		49.00				49.00
Ireland		0.24	0.03			0.27
Israel		273.00	0.30			273.30
Italy	2.10	31.50	2.10	0.35	0.35	36.40
Japan		211.13	4.12			215.26
Macedonia		1.05				1.05
Mexico	25.04	12.34				37.38
Netherlands	5.25	18.90	0.04	0.21		24.40
New Zealand	3.15	3.15				6.30
Norway	0.07	0.70			0.07	0.84
Portugal	0.35	5.25	0.35			5.95
South Africa	35.70	7.00				42.70
Spain		24.97				24.97
Sweden	2.09	12.63	0.61			15.33
Switzerland**	10.82	16.99	1.56	6.30		35.68
Taiwan		47.14	3.82			50.96
Turkey		525.00				525.00
United Kingdom	7.00	6.30	0.70			14.00
United States	516.75	24.97	0.98		0.39	543.08
Total	944.71	3,648.58	2,865.57	11.02	6.10	7,475.97

* France: incl. Oversea Departments

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

Table 6: Installed capacity in 2000, MW_{th}/a

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed	glazed	evacuated	unglazed	glazed	
Australia	266.00	52.50				318.50
Austria	6.35	110.50	1.55			118.40
Barbados		1.91				1.91
Belgium	0.52	2.92	0.21			3.65
Brazil		336.00				336.00
Canada	16.10	0.70	0.12	2.88		19.79
China		2,009.00	3,731.00			5,740.00
Cyprus		42.00				42.00
Denmark	0.42	18.20	0.11			18.73
Finland		1.05	0.04			1.09
France*	9.80	26.95				36.75
Germany	35.00	525.00	105.00			665.00
Greece		122.50				122.50
India		56.00				56.00
Ireland		0.11	0.08			0.19
Israel		294.00				294.00
Italy	2.10	32.00	2.63	0.35	0.35	37.43
Japan		217.00	2.80			219.80
Macedonien		1.05				1.05
Mexico	25.34	11.12				36.46
Netherlands	5.25	21.47				26.72
New Zealand	0.84	1.89	0.01			2.74
Norway	0.07	0.18				0.24
Portugal		4.20				4.20
South Africa	37.80	8.75				46.55
Spain	3.50	36.50	3.50			43.50
Sweden	2.37	15.08	0.30			17.75
Switzerland**	8.81	17.86	0.74	6.30		33.71
Taiwan		48.89	3.96			52.85
Turkey		441.00				441.00
United Kingdom	7.00	5.60	5.06			17.66
United States	710.09	17.04	0.26		0.26	727.64
TOTAL	1,137.35	4,478.98	3,857.35	9.53	0.61	9,483.82

* France: incl. Oversea Departments

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

Table 7: Installed capacity in 2001, MW_{th}/a

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed	glazed	evacuated	unglazed	glazed	
Australia	266.00	78.40				344.40
Austria	7.39	105.70	1.44			114.52
Barbados		1.91				1.91
Belgium	0.53	2.94	0.21			3.68
Brazil		217.00				217.00
Canada	16.66	0.75	0.11	6.76		24.28
China		1,050.00	5,670.00			6,720.00
Cypres		21.00				21.00
Denmark		11.20			3.50	14.70
Finland		1.05	0.04			1.09
France*	4.90	38.50				43.40
Germany	35.00	332.50	45.50			413.00
Greece		106.40				106.40
Hungary		0.81	0.04			0.84
India		70.00				70.00
Ireland		0.53	0.08			0.61
Israel		280.00				280.00
Italy	2.10	32.20	4.20			38.50
Japan		231.10	3.78			234.87
Macedonia		1.05				1.05
Mexico	21.38	14.25				35.64
Netherlands	5.25	23.35	0.51			29.11
New Zealand	0.84	2.47	0.07			3.38
Norway	0.14	0.49			0.07	0.70
Poland	0.22	8.63	0.83			9.68
Portugal		3.50				3.50
Slovenia		0.73	0.15			0.88
South Africa	39.20	9.73	0.01			48.94
Spain	0.21	38.87	3.26			42.35
Sweden	2.75	10.33	0.35			13.43
Switzerland**	7.39	17.39	1.11	2.10		27.99
Taiwan		50.70	4.11			54.81
Turkey		350.00				350.00
United Kingdom	7.00	5.60	5.25			17.85
United States	723.81	34.41	0.26		0.26	758.75
TOTAL	1,140.76	3,153.49	5,741.30	8.86	3.83	10,048.25

* France: incl. Oversea Departments

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

Table 8: Installed capacity in 2002, MW_{th}/a

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed	glazed	evacuated	unglazed	glazed	
Australia	270.90	93.80				364.70
Austria	6.93	115.64	1.20			123.77
Barbados		1.91				1.91
Belgium	1.31	6.00	0.34			7.64
Brazil		226.59				226.59
Canada	18.34	0.80	0.12	7.27		26.53
China		980.00	7,000.00			7,980.00
Cyprus		21.00				21.00
Czech Republic		4.47	0.43			4.90
Denmark		5.60			3.50	9.10
Estonia		0.11				0.11
Finland		1.05				1.05
France*	4.33	63.97	0.04			68.34
Germany	21.00	455.00	49.00			525.00
Greece		112.70				112.70
Hungary		1.01	0.04			1.05
India		70.00				70.00
Ireland		0.83	0.14		0.14	1.11
Israel		280.00				280.00
Italy	2.10	35.00	4.90			42.00
Japan		194.94	1.39			196.34
Lativa		0.28				0.28
Lithuania		0.28				0.28
Luxembourg		1.05				1.05
Macedonia		1.05				1.05
Malta		1.40	0.06			1.46
Mexico	34.26	18.45				52.71
Netherlands	9.80	19.38				29.18
New Zealand		4.17	0.25			4.41
Norway	0.35	1.05	0.07		0.07	1.54
Poland	0.21	16.74	1.61			18.56
Portugal		6.45				6.45
Slovak Republic		3.50				3.50
Slovenia		0.53	0.25			0.79
South Africa	41.30	9.79	0.01			51.10
Spain	0.57	43.05	5.38			49.00
Sweden	3.11	12.58	0.90			16.59
Switzerland**	6.05	18.36	0.42	1.40		26.22
Taiwan		57.63	4.67			62.30
Turkey		560.00				560.00
United Kingdom		8.40	7.00			15.40
United States	707.61	35.85	0.59		0.39	744.43
TOTAL	1,128.16	3,490.41	7,078.81	8.67	4.10	11,710.15

* France: incl. Oversea Departments

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

Table 9: Installed capacity in 2003, MW_{th}/a

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed	glazed	evacuated	unglazed	glazed	
Albania		6.18				6.18
Australia	270.90	105.00	0.70			376.60
Austria	6.23	126.00	1.82			134.05
Barbados		1.91				1.91
Belgium		10.29				10.29
Brazil		272.37				272.37
Canada	25.24	0.82	0.14	11.34		37.53
China		1,050.00	8,400.00			9,450.00
Cyprus		21.00				21.00
Czech Republic		5.67	0.28			5.95
Denmark		8.40			3.50	11.90
Estonia		0.18				0.18
Finland		0.98	0.16			1.14
France*	4.34	77.50				81.84
Germany	21.00	472.50	52.50			546.00
Greece		150.50				150.50
Hungary	0.21	1.75	0.14			2.10
India		140.00				140.00
Ireland		0.84	0.56		0.07	1.47
Israel	1.12	49.00				50.12
Italy	1.75	42.00	8.40			52.15
Japan		172.40	3.24			175.64
Lativa		0.35				0.35
Lithuania		0.35				0.35
Luxembourg		1.19				1.19
Macedonia		1.05				1.05
Malta		2.86	0.09			2.95
Mexico	28.86	19.24				48.11
Namibia		0.03				0.03
Netherlands	24.99	18.41				43.40
New Zealand		5.57	0.43			6.00
Norway	0.14	1.05			0.18	1.37
Poland	0.46	15.79	1.89			18.13
Portugal		11.26				11.26
Slovak Republic		3.85				3.85
Slovenia		1.26	0.21			1.47
South Africa	42.70	9.80	0.01			52.51
Spain	3.15	55.44	4.41			63.00
Sweden	6.07	12.26	1.88			20.21
Switzerland**	7.82	20.93	0.88	1.40		31.03
Taiwan		72.26	5.86			78.12
Tunisia		4.90				4.90
Turkey		336.00				336.00
United Kingdom	0.70	8.40	7.00			16.10
United States	884.96	32.58	0.13		0.26	917.93
TOTAL	1,330.64	3,350.11	8,490.73	12.74	4.01	13,188.22

* France: incl. Oversea Departments

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

Table 10: Installed capacity in 2004, MW_{th}/a

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed	glazed	evacuated	unglazed	glazed	
Albania		5.89				5.89
Australia	270.90	112.70	1.40			385.00
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
Canada	28.32	1.82	0.32	12.63	0.02	43.09
China		1,365.00	8,785.00			10,150.00
Cyprus		35.00				35.00
Czech Republic		9.24	1.65			10.89
Denmark		14.70	0.18			14.88
Estonia		0.18				0.18
Finland	0.35	0.84	0.21			1.40
France*	4.20	107.42	3.45			115.07
Germany		595.00	70.00			665.00
Greece		154.35				154.35
Hungary		0.70				0.70
India		350.00				350.00
Ireland		3.01	0.18			3.19
Israel	0.73	49.70				50.43
Italy	2.10	50.40	11.20			63.70
Japan		200.57	2.98			203.56
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	20.09	14.14				34.23
New Zealand		7.14	0.84			7.98
Norway		0.70				0.70
Poland	0.08	16.44	2.83			19.36
Portugal		15.05	0.35			15.40
Slovak Republic		4.62	0.63			5.25
Slovenia		3.15	0.21			3.36
South Africa	44.10	9.80				53.90
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	7.67	0.07	0.20	1,043.18
TOTAL	1,416.61	4,212.25	8,911.44	14.79	0.21	14,555.31

* France: incl. Oversea Departments

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

Table 11: Installed capacity in 2005, MW_{th}/a

7.2 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 combi systems[6]) and weather data, the energy output of the systems and the resulting energy savings in oil equivalent were calculated.

Four major applications and reference systems (see table below) were chosen for the simulations. For these reference systems, the daily hot water demand, the space heating demand (only for solar combi systems) 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[7] in use for the respective application. Furthermore, a hydraulic scheme is shown for each reference system.

7.2.1 Solar thermal systems for swimming pool heating with unglazed plastic absorbers

Country	Reference system	Total collector area [m²]	Number of systems	Reference climate
Australia	C: 200 m² unglazed plastic absorber	3,447,000	17,235	Sydney
Austria	C: 200 m² unglazed plastic absorber	593,294	2,966	Graz
Belgium	C: 200 m² unglazed plastic absorber	33,300	167	Brussels
Canada	C: 200 m² unglazed plastic absorber	642,493	3,212	Montreal
Denmark	C: 200 m² unglazed plastic absorber	21,870	109	Copenhagen
Finland	C: 200 m² unglazed plastic absorber	500	3	Copenhagen
France*	C: 200 m² unglazed plastic absorber	90,888	454	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	20,000	100	Jerusalem
Italy	C: 200 m² unglazed plastic absorber	16,000	80	Bologna
Mexico	C: 200 m² unglazed plastic absorber	428,586	2,143	Mexico City
Netherlands	C: 200 m² unglazed plastic absorber	312,800	1,564	De Bilt
New Zealand	C: 200 m² unglazed plastic absorber	2,350	12	Wellington
Norway	C: 200 m² unglazed plastic absorber	1,500	8	Oslo
Poland	C: 200 m² unglazed plastic absorber	1,550	8	Warsaw
South Africa	C: 200 m² unglazed plastic absorber	541,500	2,708	Johannisburg
Sweden	C: 200 m² unglazed plastic absorber	51,146	256	Gothenburg
Switzerland	C: 200 m² unglazed plastic absorber	212,670	1,063	Zurich
United States	C: 200 m² unglazed plastic absorber	26,920,993	134,605	Denver, Los Angeles
Total		34,091,241	170,457	

C: collector area

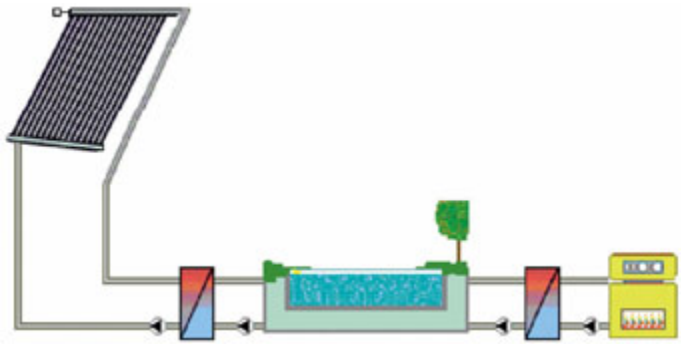


Figure A1: Hydraulic scheme of the swimming pool reference system

6 Solar combi systems 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.

7 Glazed flat plate and evacuated tube collector

7.2.2 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 vacuum tube collectors at the end of 2005 for each country.
It must be pointed out, that the market share of the new installed capacity in the year 2005 can differ a lot from the total market share.

Country	reference system	reference climate	% of total market[8]
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
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
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
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
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
oTaiwan	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

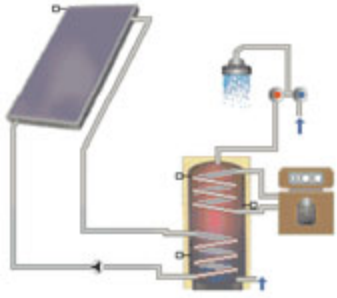


Figure A2: Hydraulic scheme of the DHW reference system

8 percentage of total collector area (flat plate and vacuum tube) at the end of 2005 for DHW systems for single family houses

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

The market share in the following table is referring to the total capacity in operation of flat plate and vacuum tube collectors at the end of 2005 for each country.
It must be pointed out, that the market share of the new installed capacity in the year 2005 can differ a lot from the total market share.

Country	reference system	reference climate	% of total market[9]
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
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

Figure A3: Hydraulic scheme of the DHW system for muli family houses

9 percentage of total collector area (flat plate and vacuum tube) until 2005 for DHW systems for multi-family houses and district heating systems

7.2.4 Solar combi systems 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 vacuum tube collectors at the end of 2005 for each country.
It must be pointed out, that the market share of the new installed capacity in the year 2005 can differ a lot from the total market share.
The reference system is designed for a one family house with 140 m² gross area.

Country	reference system	reference climate	% of total market[10]
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]

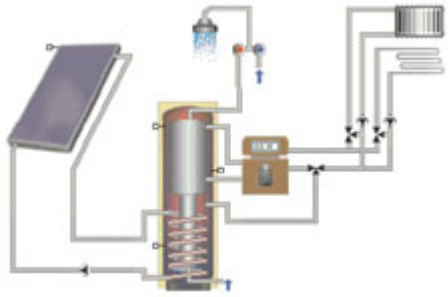


Figure A4: Hydraulic scheme of the solar combi reference system

10 percentage of total collector area (flat plate and vacuum tube) until 2005 for solar combi systems

7.3 Reference collector

Data of the reference absorber for swimming pool heating:

η = 0.85

a1 = 20 [W/m²K]

a2 = 0.1 [W/m² K²]

Data of the reference collector for all other applications:

η = 0.8

a1 = 3.69 [W/m²K]

a2 = 0.007 [W/m² K²]

7.4 Reference climates

Country	reference climate
Albania	Tirana
Australia	Sydney
Austria	Graz
Barbados	Raizet
Belgium	Brussels
Brazil	Rio de Janeiro
Canada	Montreal
China	Shanghai
Cyprus	Cyprus
Czech Republic	Praha
Denmark	Copenhagen
Estonia	Tallin
Finland	Helsinki
France	Paris
Germany	Würzburg
Greece	Athens
Hungary	Budapest
Indien	Bombay
Irland	Dublin
Israel	Jerusalem
Italy	Bologna
Japan	Tokyo
Lativa	Riga
Lithuania	Vilnius
Luxembourg	Luxembourg
Macedonia	Skopje
Malta	Valletta
Mexico	Mexico City
Namibia	Windhoek
IparNetherlands	De Bilt
New Zealand	Wellington
Norway	Oslo
Poland	Warsaw
Portugal	Lisbon
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, Los Angeles

7.5 Population data

Raised countries in alphabetic order:

	Country	Inhabitants 2005		Country	Inhabitants 2005
1	Albania	3,130,000	24	Lithuania	3,431,000
2	Australia	20,155,000	25	Luxembourg	465,000
3	Austria	8,233,000	26	Macedonia	2,034,000
4	Barbados	270,000	27	Malta	402,000
5	Belgium	10,419,000	28	Mexico	107,029,000
6	Brazil	186,405,000	29	Namibia	2,031,000
7	Canada	32,268,000	30	Netherlands	16,299,000
8	China	1,315,844,000	31	New Zealand	4,028,000
9	Cyprus	835,000	32	Norway	4,620,000
10	Czech Republic	10,220,000	33	Poland	38,530,000
11	Denmark	5,431,000	34	Portugal	10,495,000
12	Estonia	1,330,000	35	Slovak Republic	5,401,000
13	Finland	5,249,000	36	Slovenia	1,967,000
14	France*	62,329,000	37	South Africa	47,432,000
15	Germany	82,689,000	38	Spain	43,064,000
16	Greece	11,120,000	39	Sweden	9,041,000
17	Hungary	10,098,000	40	Switzerland	7,252,000
18	India	1,103,371,000	41	Taiwan	24,000,000
19	Ireland	4,148,000	42	Tunisia	10,102,000
20	Israel	6,725,000	43	Turkey	73,193,000
21	Italy	58,093,000	44	United Kingdom	59,668,000
22	Japan	128,085,000	45	United States	298,213,000
23	Lativa	2,307,000		TOTAL	3,837,451,000

	* France	62,329,000
	Guadeloupe	440,000
	Martinique	393,000
	Réunion	756,000
	Polynésie	244,000
	France métropole	60,496,000

Economic Region	Inhabitants in 2005
United States + Canada	330,481,000
Japan	128,085,000
China + Taiwan	1,339,844,000
Europe**	478,300,000
Australia + New Zealand	24,183,000
Others***	1,536,558,000
Total	3,837,451,000

** Europe: EU 27, Switzerland, Norway, Albania, Macedonia, Oversea Departments of France.

*** Others: Barbados, Brazil, India, Israel, Mexico, Namibia, South Africa, Tunisia, Turkey

Source for population data:

Statistisches Jahrbuch 2007, http://www.statistik.at

David Ince, Fair Trading Commission Barbados

www.visitcyprus.org.cy/

www.cia.gov/cia/publications/factbook/geos/gp.html#People

martiniquetourism.com/article/view/4

7.6 2004 and 2005 Data in m²

The presented data in chapter 3 to 5 has been originally collected in square meters. Through an agreement of international experts collector areas of solar thermal applications 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 at a joint meeting of the IEA SHC Programme and major solar thermal trade associations, that was held in 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.
Nevertheless solar thermal collectors are traditionally quoted in square meters. Therefore Table 12 to Table 15 give the 2004 and the 2005 data in m².

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed	glazed	evacuated	unglazed	glazed	
Albania		8,830				8,830
Australia	387,000	150,000	1,000			538,000
Austria	8,900	180,000	2,594			191,494
Barbados		2,731				2,731
Belgium		14,700				14,700
Brazil		389,100				389,100
Canada	36,050	1,168	200	16,196		53,614
China		1,500,000	12,000,000			13,500,000
Cyprus		30,000				30,000
Czech Republic		8,100	400			8,500
Denmark		12,000			5,000	17,000
Estonia		250				250
Finland		1,400	230			1,630
France*	6,200	110,715				116,915
Germany	30,000	675,000	75,000			780,000
Greece		215,000				215,000
Hungary	300	2,500	200			3,000
India		200,000				200,000
Ireland		1,194	800		100	2,094
Israel	1,600	70,000				71,600
Italy	2,500	60,000	12,000			74,500
Japan		246,286	4,629			250,914
Lativa		500				500
Lithuania		500				500
Luxembourg		1,700				1,700
Macedonia		1,500				1,500
Malta		4,083	132			4,215
Mexico	41,235	27,490				68,725
Namibia		48				48
Netherlands	35,700	26,300				62,000
New Zealand		7,950	620			8,570
Norway	200	1,500			250	1,950
Poland	650	22,550	2,700			25,900
Portugal		16,088				16,088
Slovak Republic		5,500				5,500
Slovenia		1,800	300			2,100
South Africa	61,000	14,000	10			75,010
Spain	4,500	79,200	6,300			90,000
Sweden	8,677	17,512	2,685			28,874
Switzerland**	11,171	29,903	1,257	2,000		44,331
Taiwan		103,230	8,370			111,600
Tunisia		7,000				7,000
Turkey		480,000				480,000
United Kingdom	1,000	12,000	10,000			23,000
United States	1,264,225	46,544	186		372	1,311,327
TOTAL	1,900,908	4,785,872	12,129,613	18,196	5,722	18,840,310

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

Table 12: Collector Area installed in 2004, m²/a

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed	glazed	evacuated	unglazed	glazed	
Albania		8,420				8,420
Australia	387,000	161,000	2,000			550,000
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
Canada	40,455	2,593	450	18,036	25	61,559
China		1,950,000	12,550,000			14,500,000
Cyprus		50,000				50,000
Czech Republic		13,200	2,350			15,550
Denmark		21,000	250			21,250
Estonia		250				250
Finland	500	1,200	300			2,000
France*	6,000	153,459	4,930			164,389
Germany		850,000	100,000			950,000
Greece		220,500				220,500
Hungary		1,000				1,000
India		500,000				500,000
Ireland		4,300	250			4,550
Israel	1,045	71,000				72,045
Italy	3,000	72,000	16,000			91,000
Japan		286,531	4,262			290,793
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	28,700	20,200				48,900
New Zealand		10,200	1,200			11,400
Norway		1,000				1,000
Poland	120	23,485	4,048			27,653
Portugal		21,500	500			22,000
Slovak Republic		6,600	900			7,500
Slovenia		4,500	300			4,800
South Africa	63,000	14,000				77,000
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		23,000				23,000
Turkey		480,000				480,000
United Kingdom		18,000	10,000			28,000
United States	1,414,356	64,568	10,963	93	279	1,490,259
TOTAL	2,023,730	6,017,501	12,730,633	21,129	304	20,793,297

* France: incl. Oversea Departments

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

Table 13: Collector Area installed in 2005, m²/a

Country	Water collectors			Air Collectors		TOTAL [m²]
	unglazed	glazed	evacuated tube	unglazed	glazed	
Albania		24,260				24,260
Australia	3,154,000	1,594,000	1,000			4,749,000
Austria	587,224	2,147,045	34,803			2,769,072
Barbados		74,601				74,601
Belgium	26,000	45,249	3,000			74,249
Brazil		2,314,110				2,314,110
Canada	602,038	76,388	1,200	81,352		760,978
China		6,200,000	55,800,000			62,000,000
Cyprus		734,000				734,000
Czech Republic		46,500	3,500			50,000
Denmark	21,870	306,570	550		15,000	343,990
Estonia		570				570
Finland		8,000	380			8,380
France*	100,000	692,000	62			792,062
Germany	775,000	4,949,000	752,000			6,476,000
Greece		2,994,200				2,994,200
Hungary	2,800	33,340	560			36,700
India		1,000,000				1,000,000
Ireland		3,094	1,800		2,800	7,694
Israel	18,955	4,771,045				4,790,000
Italy	14,000	412,000	34,000			460,000
Japan		7,571,480	154,520			7,726,000
Lativa		1,650				1,650
Lithuania		1,650				1,650
Luxembourg		11,500				11,500
Macedonia		13,000				13,000
Malta		15,000	360			15,360
Mexico	385,586	257,058				642,644
Namibia		455				455
Netherlands	292,200	289,400				581,600
New Zealand	2,400	83,520	1,070			86,990
Norway	1,500	11,000			1,450	13,950
Poland	1,430	89,887	3,270	3,000	2,500	100,087
Portugal		274,300				274,300
Slovak Republic		56,750				56,750
Slovenia		100,876	875			101,751
South Africa	510,000	246,000	30			756,030
Spain	10,612	666,178	23,643			700,433
Sweden	38,677	193,512	11,685			243,874
Switzerland**	210,850	316,090	23,680	832,000		1,382,620
Taiwan		1,318,773	106,927			1,425,700
Tunisia		120,000				120,000
Turkey		8,520,000				8,520,000
United Kingdom	7,240	114,950	53,970			176,160
United States	26,253,522	1,592,256	552,766		227,674	28,626,218
TOTAL	33,015,904	50,291,256	57,565,651	916,352	249,424	142,038,587

* France: incl. Oversea Departments

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

Table 14: Total Collector Area in operation at the end of 2004, m²

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed	glazed	evacuated tube	unglazed	glazed	
Albania		32,680				32,680
Australia	3,447,000	1,700,000	3,000			5,150,000
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
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		59,700	5,850			65,550
Denmark	21,870	327,570	800		15,000	365,240
Estonia		820				820
Finland	500	9,200	680			10,380
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		1,250,000				1,250,000
Ireland		7,394	2,050		2,800	12,244
Israel	20,000	4,780,000				4,800,000
Italy	16,000	468,000	49,000			533,000
Japan		6,864,596	134,853			6,999,449
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	312,800	307,600				620,400
New Zealand	2,350	89,440	2,160			93,950
Norway	1,500	12,000			1,450	14,950
Poland	1,550	113,372	7,318	3,000	2,500	127,740
Portugal		285,800				285,800
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	51,146	210,618	17,061			278,825
Switzerland**	212,670	344,780	24,060	835,000		1,416,510
Taiwan		1,325,733	99,967			1,425,700
Tunisia		143,000				143,000
Turkey		9,000,000				9,000,000
United Kingdom		201,160				201,160
United States	26,920,993	1,656,824	563,729	93	227,953	29,369,592
TOTAL	34,091,241	54,006,527	69,338,077	937,481	249,728	158,623,054

* France: incl. Oversea Departments

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

Table 15: Total Collector Area in operation at the end of 2005, 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	John Ballinger Solar Efficient Architecture, Kangaroo Valley
	Ken Guthrie Sustainability Victoria, Melbourne
Austria	Gerhard Faninger IFF- Klagenfurt 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 ABRAVA-DASOL - National Depto of Solar Industries
	Samuel Abreu Universidade Federal de Santa Catarina
Canada	Doug McClenahan CANMET - Natural Resources Canada, Ottawa
China	Chinese Solar Thermal Industry Federation(CSTIF)
	Jiang Xinian Guangzhou Institute of Energy Conservation Chinese Academy of Sciences, Beijing
	Luguang Yan, Prof. Li Zhongming China Solar Energy Society (CSES) Huo Zhichen
Cyprus	Christodoulos Pharconides Renewable Energy Systems Engineer, Cyprus Institute of Energy
	Soteris Kalogirou Higher Technical Institute, Nicosia
Czech Republic	Eva Kudrnová Technology Centre AS CR, Prague
Denmark	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 Stryi-Hipp Bundesverband Solarindustrie e.V. – Bsi, Berlin
Greece	Vassiliki Drosou Mechanical Energy Engineer, 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 OPET India, Energy Environment Technology Division, TERI
	C. Palaniappan Planters Energy Network – PEN
Ireland	Amanda Barriscale, Joe Jolley 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
Italy	Paolo Zampetti ENEA, Rome
	Riccardo Battisti Department of Mechanical and Aeronautical Engineering, University of Rome „La Sapienza"
	Giacobbe Braccio, ENEA, C.R. Trisaia, Rotondella, Matera
Japan	Noriaki Yamashita, Takuo Yamaguchi Institute for Sustainable Energy Policies (ISEP) Solar System Development Association(SSDA)
	Kazuki Yoshimura National Institute of Advanced Industrial Science and Technology, Nagoya
Macedonia	Dejan Zrmanovski Ministry of Economy, Department of Energy, Energy Efficiency and Renewable Energy Sources Unit
Malta	Arthur Tua TUA ENGINEERING Ltd.

Mexico	Wilfrido Rivera Gomez-Franco Centro de Investigacion en Energia, Universidad Nacional Autonoma de Mexico
	Isaac Pilatowsky and Claudio Estrada Centro de Investigacion en Energia, Temixco, Morelos
	Asociación Nacional de Energía Solar, A.C.
Namibia	Brita Emmermacher The Desert Research Foundation of Namibia, Energy Desk
	Robert W Schultz Energy Researcher, Windhoek, Namibia
Netherlands	Lex Bosselaar SenterNovem, Utrecht
	Reinoud Segers Statistics Netherlands
New Zealand	Michael Donn School of Architecture, Wellington
	Brian Cox Solar Industries Association New Zealand
Norway	Fritjof Salvesen KanEnergi AS, 1351 Rud
Poland	Grzegorz Wiśniewski EC BREC Institute for Renewable Energy Ltd., Poland
	Stanislaw Golebiowski, Krystian Kurowski EC BREC / IBMER, Warzawa
Portugal	João Farinha Mendes INETI - Edificio G, Lisbon
	ADENE, Agência para a Energia (www.adene.pt)
Slovenia	Gradbeni Institut ZRMK, Ljubliana
South Africa	Nadia Hamid, Mark Tanton Energy Development Corporation (EDC) of the Central Energy Fund (CEF)
	Dieter Holm Sustainable Energy Society of Southern Africa, Pretoria
Spain	Manuel Romero Director, Renewable Energy Division, CIEMAT, Madrid
Sweden	Jan-Olof Dalenbäck Chalmers University of Technology, Göteborg Solar Energy Association – SEAS

Switzerland	Urs Wolfer Bundesamt für Energie, Bern
Taiwan	Shyi-min Lu EEL,ITRI
Tunisia	Sami Marrouki Directeur ANME, Directeur Exécutif MEDREC (Centre Méditerranéen des Energies Renouvelables)
Turkey	Gulsun Erkul First Secretary (Energy Adviser), Permanent Delegation of Turkey to the OECD
	Mehmet ÇAĞLAR Ministery of Energy and Natural Resources of TURKEY
	A. Kutay ULKE Mechanical Engineer, Export Department, EZINC Metal San. ve Tic. A.S.
	Sebahattin Öz Manager of Solar Energy Division, Electrical Power Survey and Development Administration in Turkey
United States	Drury Crawley U.S. Department of Energy, Washington D.C.

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CBS: Statistics Netherlands, Rijswijk, www.cbs.nl