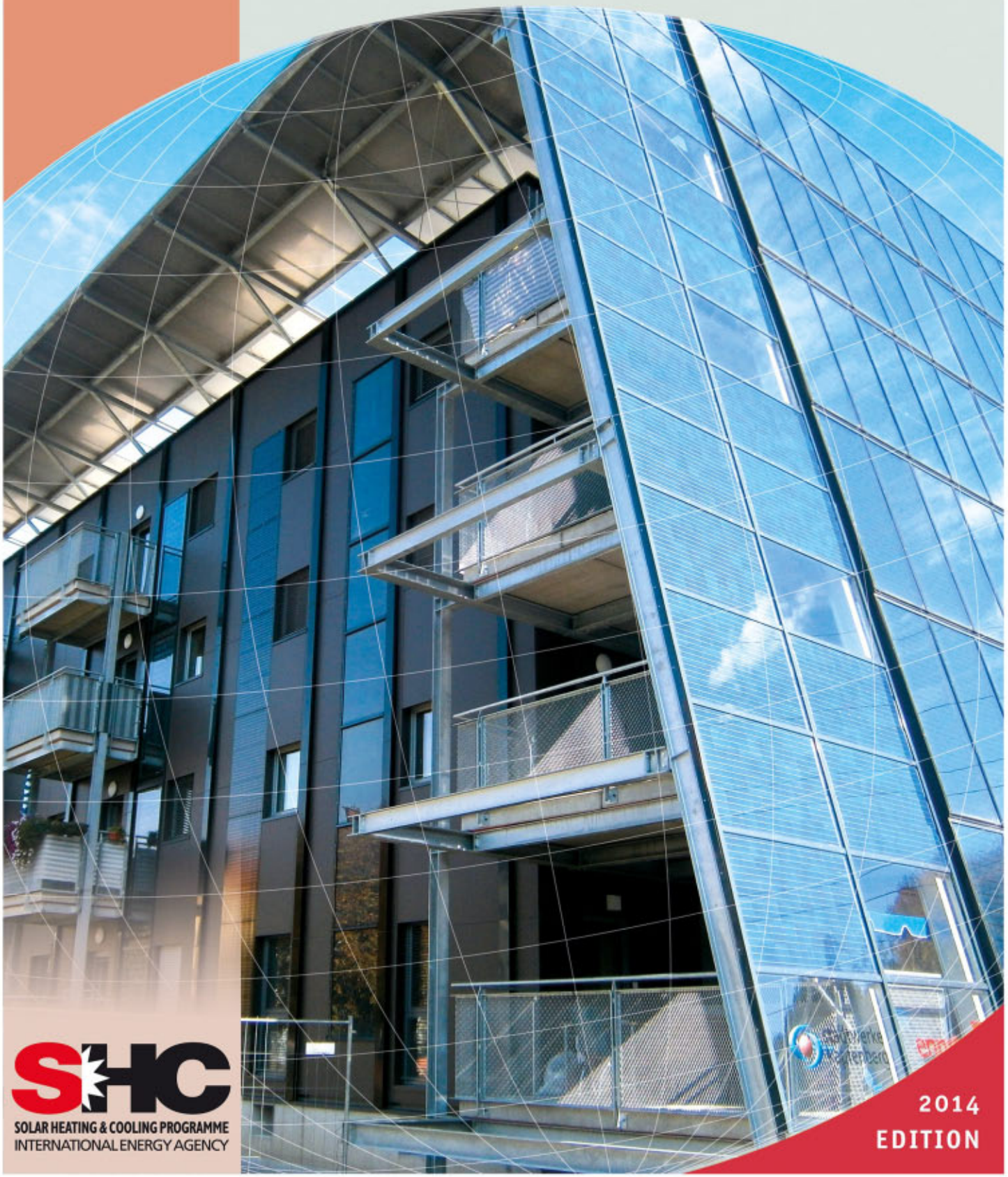
FRANZ MAUTHNER | WERNER WEISS

SOLAR HEAT WORLDWIDE

Markets and Contribution to the Energy Supply 2012



SHC
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

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EDITION

Solar Heat Worldwide

Markets and Contribution to the Energy Supply 2012

EDITION 2014

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Cover: AEE INTEC / Advanced building renovation of a residential building to a plus-energy building with prefabricated solar-active roof and façade elements

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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 installed in the important markets worldwide, and to ascertain the contribution of solar thermal systems to the supply of energy and the CO_2 emissions avoided as a result of operating these systems. The collectors documented are unglazed collectors, glazed flat-plate collectors (FPC) and evacuated tube collectors (ETC) with water as the energy carrier as well as glazed and unglazed air collectors.

The data were collected from a survey of the national delegates of the SHC Programme's Executive Committee and other national experts active in the field of solar thermal energy. As some of the 58 countries included in this report have very detailed statistics and others have only estimates from experts, the data was checked for its plausibility on the basis of various publications.

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

The 58 countries included in this report represent 4.4 billion people, or about 63% of the world's population. The installed capacity in these countries is estimated to represent 95% of the solar thermal market worldwide.

Figure 1: Countries represented in this report

2 Summary

This report comprises solar thermal market data from 58 countries covering an estimated 95% of the worldwide market.

Total installed capacity in operation worldwide by the end of 2012

By the end of 2012, an installed capacity of 269.3 GW_{th}, corresponding to a total of 384.7 million square meters[1] of collector area was in operation in the 58 countries recorded in this report.

The vast majority of the total capacity in operation was installed in China (180.4 GW_{th}) and Europe (42.8 GW_{th}), which together account for 83% of the total installed. The remaining installed capacity was shared between the United States and Canada (17.2 GW_{th}), Asia excluding China (10.3 GW_{th}), Latin America (7.4 GW_{th}), Australia and New Zealand (5.4 GW_{th}), the MENA[2] countries Israel, Jordan, Lebanon, Morocco and Tunisia (4.9 GW_{th}) and the Sub-Sahara African countries Mozambique, Namibia, South Africa and Zimbabwe (1.0 GW_{th}).

The breakdown of the cumulated capacity in operation in 2012 by collector type is 26.4% glazed flat-plate collectors, 64.6% evacuated tube collectors, 8.4% unglazed water collectors, and 0.6% glazed and unglazed air collectors.

The leading countries in cumulated unglazed and glazed water collector capacity in operation in 2012 per 1,000 inhabitants were Cyprus (548 kW_{th}/1,000 inhabitants), Austria (420 kW_{th}/1,000 inhabitants), Israel (385 kW_{th}/1,000 inhabitants), Barbados (320 kW_{th}/1,000 inhabitants), Greece (268 kW_{th}/1,000 inhabitants), Australia (233 kW_{th}/1,000 inhabitants), Germany (145 kW_{th}/1,000 inhabitants), Turkey (136 kW_{th}/1,000 inhabitants), China (134 kW_{th}/1,000 inhabitants) and Jordan (121 kW_{th}/1,000 inhabitants).

Newly installed capacity worldwide in 2012

In the year 2012, a capacity of 52.7 GW_{th}, corresponding to 75.3 million square meters of solar collectors, was installed worldwide. This means an increase in new collector installations of 9.4% compared to the year 2011.

The main markets were in China (44.7 GW_{th}) and Europe (3.7 GW_{th}), which together accounted for 92% of the new collector installations in 2012. The rest of the market was shared between Asia excluding China (1.3 GW_{th}), Latin America represented by Brazil, Chile and Mexico (1.0 GW_{th}), the United States and Canada (0.8 GW_{th}), Australia (0.7 GW_{th}), the MENA region represented by Israel, Jordan, Lebanon, Morocco and Tunisia (0.4 GW_{th}) and the Sub-Sahara African countries Mozambique, South Africa and Zimbabwe (0.1 GW_{th}).

The breakdown of the newly installed capacity in 2012 by collector type is 15.9% glazed flat-plate collectors, 81.0% evacuated tube collectors, 3.0% unglazed water collectors and 0.2% glazed and unglazed air collectors.

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1 To compare the installed capacity of solar thermal collectors with other energy sources, solar thermal experts 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 United States 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.

2 Middle East and North Africa

The leading countries in newly install unglazed and glazed water collector capacity in 2012 per 1,000 inhabitants were China (33 kW_{th}/1,000 inhabitants); Australia (29 kW_{th}/1,000 inhabitants); Israel (29 kW_{th}/1,000 inhabitants), Austria (18 kW_{th}/1,000 inhabitants); Greece (16 kW_{th}/1,000 inhabitants); Denmark (14 kW_{th}/1,000 inhabitants); Turkey (14 kW_{th}/1,000 inhabitants); Switzerland (14 kW_{th}/1,000 inhabitants); Cyprus (14 kW_{th}/1,000 inhabitants) and Lebanon (10 kW_{th}/1,000 inhabitants).

Contribution to the energy supply and CO_2 reduction

The annual collector yield of all water-based solar thermal systems in operation by the end of 2012 was 227.8 TWh (= 820 PJ) in the 58 recorded countries. This corresponds to an energy savings equivalent to 24.5 million tons of oil and 79.1 million tons of CO_2.

Distribution of systems by system type and application

The thermal use of the sun's energy varies greatly from region to region across the globe. It can be roughly distinguished by the type of solar thermal collector used (unglazed water collectors, evacuated tube collectors, flat plate collectors, glazed and unglazed air collectors, concentrating collectors), the type of system operation (pumped solar thermal systems, thermosiphon systems), and the main type of application (swimming pool heating, domestic hot water preparation, space heating, heating of industrial processes, solar district heating or solar thermal cooling).

For unglazed and glazed water collectors, the evacuated tube collector dominated with a 65% share of the cumulated capacity in operation and a 82% share of the newly installed capacity. In China, vacuum tube collectors played an important role, and since this was by far the largest market, the worldwide figures tend towards a higher share of this type of solar thermal collector.

Unglazed water collectors accounted for 8% of the cumulated water collectors installed worldwide and the share tended to decrease. In 2012 the share of unglazed water collectors was 3% of the newly installed capacity.

Worldwide, around 75% of all solar thermal systems installed are thermosiphon systems and 25% are pumped solar heating systems. Similar to the distribution by type of solar thermal collector in total numbers, the Chinese market influenced the overall figures most, and in 2012 89% of the newly installed systems were estimated to be thermosiphon systems while pumped systems only accounted for 11%.

In general, thermosiphon systems are more common in warm climates such as in Africa, South and East Asia (excluding China), Latin America, southern Europe and the MENA region. In these regions thermosiphon systems are more often equipped with flat plate collectors, while in China the typical thermosiphon system for domestic hot water preparation is equipped with evacuated tubes.

The calculated number of water-based solar thermal systems in operation was approximately 78 million by the end of 2012. The breakdown is 8% used for swimming pool heating, 78% used for domestic hot water preparation in single family houses, and 9% attached to larger domestic hot water consumers, such as multifamily houses, hotels, hospitals, schools, etc. Around 4% of the worldwide installed capacity supplied heat for both domestic hot water and space heating (solar combi-systems). The remaining systems accounted for about 1% or almost 4 million square meters of solar thermal collectors and delivered heat to district heating networks, industrial processes or thermally driven solar cooling applications.

Compared to the cumulated installed capacity, the share of swimming pool heating was much less for new installations (8% of total capacity and only 2% of newly installed capacity). To a lesser extent, this is also true for domestic

hot water systems in single-family houses. Here the share shows a declining trend, but with a share of 77% in 2012 this is still the most common application for solar thermal systems worldwide. The shares of large-scale domestic hot water applications tended to increase (9% of total capacity and already 17% of newly installed capacity) while the share of solar-combi systems remained at a low level of 3–4%.
The calculated number of different types of solar thermal systems in operation was approximately 78 million.

2.1 Preview 2013

The estimated total capacity of solar thermal collectors in operation worldwide by the end of 2013 is 330 GW_{th}, or 471 million square meters of collector area. This corresponds to an annual collector yield of 281 TWh, which is equivalent to savings of 30.1 million tons of oil and 97.4 million tons of CO_2[3].

The preview for 2013 is based on latest market data from Austria, Brazil, China, Germany, India, Japan, Mexico, Portugal and Spain, which represent more than 90% of the global solar thermal market. The other countries were estimated according to their trend over the past two years.

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 (**Figure 2**). And in installed capacity, solar thermal is the leader.

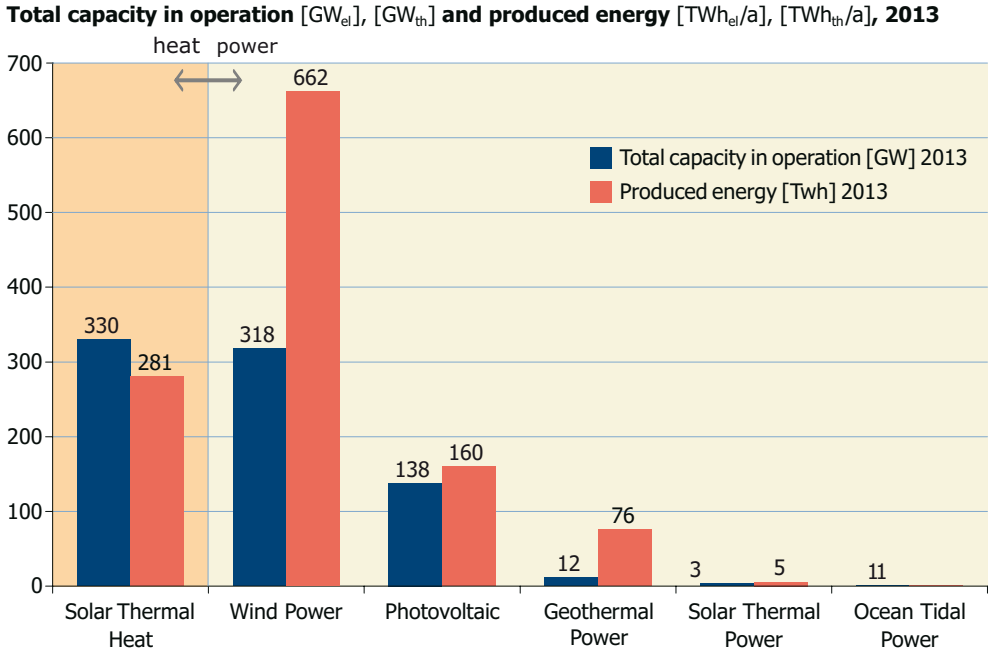


Figure 2: Total capacity in operation [GW_{el}], [GW_{th}] 2013 and annual energy generated [TWh_{el}], [TWh_{th}] *(Sources: AEE INTEC, GWEC, EPIA, IEA PVPS, Navigant Research, Ocean Energy Systems, REN21, U.S. Geothermal Energy Association)*

Employment

Based on data collected from the detailed country reports, the number of jobs in the fields of production, installation and maintenance of solar thermal systems is estimated to be 460,000 worldwide in 2013.

3 The preview 2013 represents a projection of 100% of the solar thermal market world-wide.

3 Total capacity in operation by end of 2012

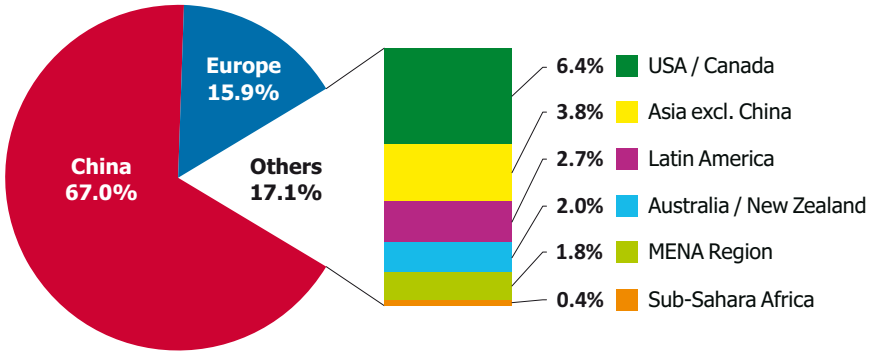
This report aims to give the actual collector area in operation and not the cumulated collector area that has ever been installed in a country. To determine the collector area (and respective capacity) in operation, either official country reports on the lifetime were used or, if such reports were not available, a 25-year lifetime for a system was calculated. The collector area in operation was then calculated using a linear equation. For China, the methodology of the Chinese Solar Thermal Industry Federation (CSTIF) was used. According to the CSTIF approach the operation lifetime is considered to be less than 10 years.

The analysis further aims to distinguish between different types of solar thermal collectors, such as unglazed water collectors, glazed water collectors including flat plate collectors (FPC) and evacuated tube collectors (ETC) as well as unglazed and glazed air collectors.

3.1 General market overview of the total installed capacity in operation

By the end of 2012, an installed capacity of 269.3 GW_{th} corresponding to a total of 384.7 million square meters of collector area was in operation in the 58 countries recorded in this report. These 58 countries represent 4.4 billion people, which is 63% of the world's population. The installed capacity in these countries represents more than 95% of the solar thermal market worldwide.

The vast majority of the total capacity in operation was installed in China (180.4 GW_{th}) and Europe (42.8 GW_{th}), which together accounted for 83% of the total installed. The remaining installed capacity was shared between the United States and Canada (17.2 GW_{th}), Asia excluding China (10.3 GW_{th}), Latin America (7.4 GW_{th}), Australia and New Zealand (5.4 GW_{th}), the MENA countries Israel, Jordan, Lebanon, Morocco and Tunisia (4.9 GW_{th}) and Sub-Sahara African countries Mozambique, Namibia, South Africa and Zimbabwe (1.0 GW_{th}).



Sub-Sahara Africa:	Mozambique, Namibia, South Africa, Zimbabwe
Asia excluding China:	India, Japan, Korea South, Taiwan, Thailand
Latin America:	Brazil, Chile, Mexico, Uruguay
Europe:	EU 28, Albania, Macedonia, Norway, Switzerland, Russia, Turkey
MENA Region:	Israel, Jordan, Lebanon, Morocco, Tunisia

Figure 3: Share of the total installed capacity in operation (glazed and unglazed water and air collectors) by economic region at the end of 2012

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed	FPC	ETC	unglazed	glazed	
Albania		77.8	0.6			78.3
Australia	3,045.0	2,035.6	47.6	196.0	5.0	5,329.2
Austria	391.0	3,002.7	55.7		1.3	3,450.8
Barbados*		92.2				92.2
Belgium	31.5	230.6	38.5			300.7
Brazil	1,620.3	4,163.1				5,783.4
Bulgaria		84.0	1.4			85.5
Canada	544.7	43.0	25.0	244.8	16.9	874.4
Chile***		56.0				56.0
China		12,177.7	168,212.3			180,390.0
Croatia#		84.0				84.0
Cyprus	1.5	605.7	16.2			623.4
Czech Republic	327.6	235.1	61.5			624.2
Denmark	14.4	444.0	6.0	2.3	12.6	479.3
Estonia		2.8	1.8			4.6
Finland	8.2	21.2	4.5			34.0
France (mainland) +	74.0	1,623.3	29.5	3.5	0.8	1,731.1
Germany	409.9	10,095.4	1,282.4		21.5	11,809.2
Greece		2,872.9	12.5			2,885.4
Hungary	9.5	118.1	35.8	1.3	1.0	165.6
India		3,521.7	994.0		14.1	4,529.8
Ireland		129.2	61.2			190.4
Israel	22.3	2,901.5		0.4		2,924.2
Italy	30.6	2,048.6	333.5			2,412.7
Japan		3,064.8	58.3		352.1	3,475.2
Jordan***	4.2	611.4	171.3			786.8
Korea. South		1,179.4				1,179.4
Latvia		2.0	0.8			2.8
Lebanon***		163.8	204.4			368.2
Lithuania		2.3	1.9			4.2
Luxembourg		24.5	3.3			27.9
Macedonia*		17.5	0.5			18.0
Malta		25.2	8.6			33.8
Mexico	582.1	610.6	228.2	0.2	5.6	1,426.7
Morocco***		343.9				343.9
Mozambique		0.2				0.2
Namibia**		14.5	0.9			15.4
Netherlands	293.1	300.2	11.9			605.2
New Zealand*	4.9	100.1	6.8			111.8
Norway	1.4	22.0	1.9		2.1	27.4
Poland		641.6	206.5			848.1
Portugal	1.5	661.9	15.5			678.9
Romania		56.5	21.0			77.5
Russia#		12.3	0.9			13.2
Slovakia		88.1	14.8			102.9
Slovenia		117.3	13.5			130.8
South Africa	606.8	266.7	80.9			954.5
Spain	93.9	1,862.9	117.2			2,074.0
Sweden	91.0	182.0	42.0			315.0
Switzerland	148.1	686.7	51.1	613.3		1,499.2
Taiwan	1.6	927.1	75.3			1,003.9
Thailand		84.3				84.3
Tunisia		415.1	32.3			447.5
Turkey		9,580.2	1,268.4			10,848.5
United Kingdom		376.6	120.2	13.3		510.1
United States	14,311.4	1,853.3	82.1	66.7	14.0	16,327.4
Uruguay**		8.8				8.8
Zimbabwe		13.1	0.6			13.7
TOTAL	22,670	70,983	174,061	1,142	447	269,303

Note: If no data is given: no reliable database for this collector type is available.
FPC: flat plate collector; ETC: evacuated tube collector

* Total capacity in operation refers to the year 2009

** Total capacity in operation refers to the year 2011

*** Total capacity in operation is based on estimations for new installations in 2012

\# New included countries compared to the 2013 edition of this report

\+ The figures for France relate to mainland France only, overseas territories of France (DOM) are not considered

Table 1: Total capacity in operation by the end of 2012 [MW_{th}]

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed	FPC	ETC	unglazed	glazed	
Albania		111,135	786			111,921
Australia	4,350,000	2,908,000	68,000	280,000	7,200	7,613,200
Austria	558,601	4,289,605	79,542		1,908	4,929,656
Barbados*		131,690				131,690
Belgium	45,000	329,469	55,064			429,533
Brazil	2,314,735	5,947,321				8,262,056
Bulgaria		120,050	2,050			122,100
Canada	778,102	61,475	35,695	349,750	24,140	1,249,162
Chile***		80,009				80,009
China		17,396,732	240,303,268			257,700,000
Croatia#		120,000				120,000
Cyprus	2,147	865,269	23,095			890,511
Czech Republic	468,000	335,813	87,925			891,738
Denmark	20,515	634,310	8,584	3,264	18,000	684,673
Estonia		3,930	2,590			6,520
Finland	11,779	30,251	6,472			48,502
France (mainland) +	105,699	2,318,973	42,129	5,053	1,117	2,472,971
Germany	585,600	14,422,000	1,832,000		30,720	16,870,320
Greece		4,104,200	17,800			4,122,000
Hungary	13,500	168,700	51,100	1,800	1,450	236,550
India		5,031,000	1,420,000		20,200	6,471,200
Ireland		184,524	87,444			271,968
Israel	31,817	4,145,000		550		4,177,367
Italy	43,766	2,926,580	476,420			3,446,766
Japan		4,378,220	83,340		502,949	4,964,509
Jordan***	5,940	873,420	244,674			1,124,034
Korea, South		1,684,824				1,684,824
Latvia		2,850	1,190			4,040
Lebanon***		234,000	292,000			526,000
Lithuania		3,300	2,700			6,000
Luxembourg		35,050	4,750			39,800
Macedonia*		25,020	724			25,744
Malta		36,000	12,293			48,293
Mexico	831,508	872,305	326,063	300	7,983	2,038,159
Morocco***		491,261				491,261
Mozambique		273				273
Namibia**		20,699	1,307			22,006
Netherlands	418,783	428,859	17,000			864,642
New Zealand*	7,025	142,975	9,644			159,645
Norway	2,007	31,445	2,674		2,961	39,088
Poland		916,500	295,000			1,211,500
Portugal	2,128	945,587	22,090			969,805
Romania		80,700	30,000			110,700
Russia#		17,601	1,297			18,898
Slovakia		125,920	21,080			147,000
Slovenia		167,550	19,250			186,800
South Africa	866,871	381,044	115,597			1,363,512
Spain	134,191	2,661,260	167,373			2,962,824
Sweden	130,000	260,000	60,000			450,000
Switzerland	211,540	980,970	72,980	876,154		2,141,644
Taiwan	2,254	1,324,383	107,546			1,434,183
Thailand		120,360				120,360
Tunisia		593,038	46,180			639,218
Turkey		13,685,943	1,811,970			15,497,913
United Kingdom		537,990	171,683	19,000		728,673
United States	20,444,848	2,647,521	117,232	95,239	20,000	23,324,841
Uruguay**		12,571				12,571
Zimbabwe		18,761	807			19,568
TOTAL	32,386,356	101,404,238	248,658,408	1,631,110	638,628	384,718,741

Note:
If no data is given: no reliable database for this collector type is available.
FPC: flat plate collector; ETC: evacuated tube collector
* Total capacity in operation refers to the year 2009
** Total capacity in operation refers to the year 2011
*** Total capacity in operation is based on estimations for new installations in 2012
# New included countries compared to the 2013 edition of this report
\+ The figures for France relate to mainland France only, overseas territories of France (DOM) are not considered

Table 2: Total installed collector area in operation by the end of 2012 [m²]

The total installed capacity in operation by end of 2012 is divided into flat plate collectors (FPC): 71 GW_{th} (101.4 million square meters), evacuated tube collectors (ETC): 174.1 GW_{th} (248.7 million square meters), unglazed water collectors 22.7 GW_{th} (32.4 million square meters), and glazed and unglazed air collectors: 1.6 GW_{th} (2.3 million square meters).

With a share of 65%, evacuated tube collectors are the predominant solar thermal collector technology worldwide, followed by flat plate collectors with 26% and unglazed water collectors with 8%. Air collectors only play a minor role in total numbers (**Figure 4**).

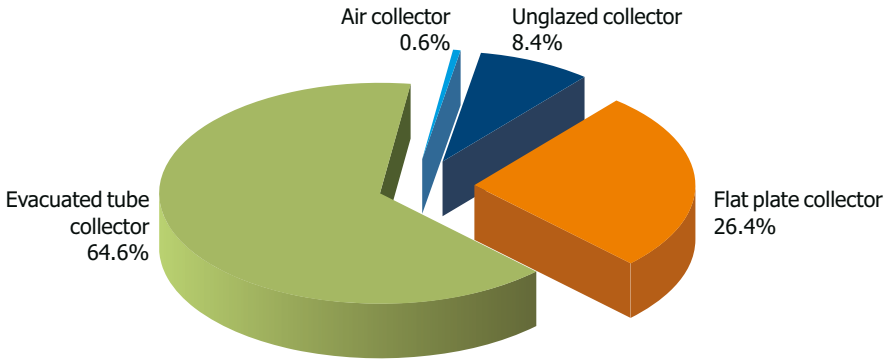


Figure 4: Distribution of the total installed capacity in operation by collector type in 2012 - WORLD

By contrast in Europe, the second largest marketplace for solar thermal collectors to China, flat plate collectors are much more widespread (**Figure 5**).

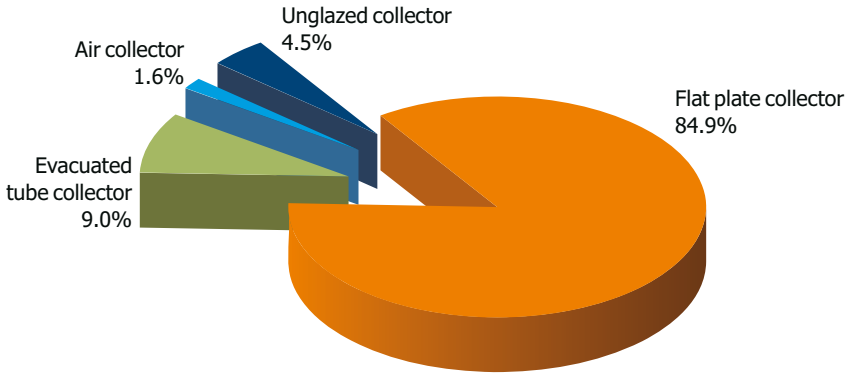


Figure 5: Distribution of the total installed capacity in operation by collector type in 2012 - EUROPE

Figure 6 shows the cumulated installed capacity of glazed and unglazed water collectors in operation for the 10 leading markets in 2012 in total numbers. Compared to the year 2011 the ranking has remained the same.

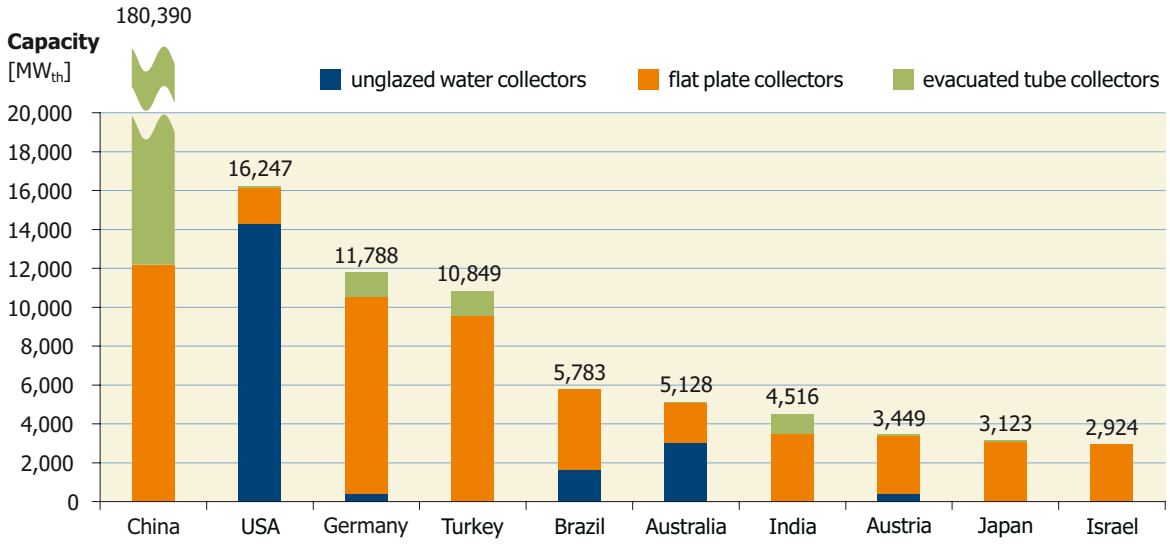


Figure 6: Top 10 countries of cumulated water collector installations (absolute figures in MW_{th})

China, as the world leader in total capacity, is focusing very much on evacuated tube collectors, whereas the United States is holding second position due to its high installation of unglazed water collectors. Only in Australia, and to some extent in Brazil, do unglazed water collectors also play an important role. The rest of the "Top 10 countries" are clearly focusing on flat plate collector technology.

The leading countries in cumulated unglazed and glazed water collector capacity in operation in 2012 per 1,000 inhabitants were Cyprus (548 kW_{th}/1,000 inhabitants), Austria (420 kW_{th}/1,000 inhabitants), Israel (385 kW_{th}/1,000 inhabitants), Barbados (320 kW_{th}/1,000 inhabitants), Greece (268 kW_{th}/1,000 inhabitants), Australia (233 kW_{th}/1,000 inhabitants), Germany (145 kW_{th}/1,000 inhabitants), Turkey (136 kW_{th}/1,000 inhabitants), China (134 kW_{th}/1,000 inhabitants), and Jordan (121 kW_{th}/1,000 inhabitants).

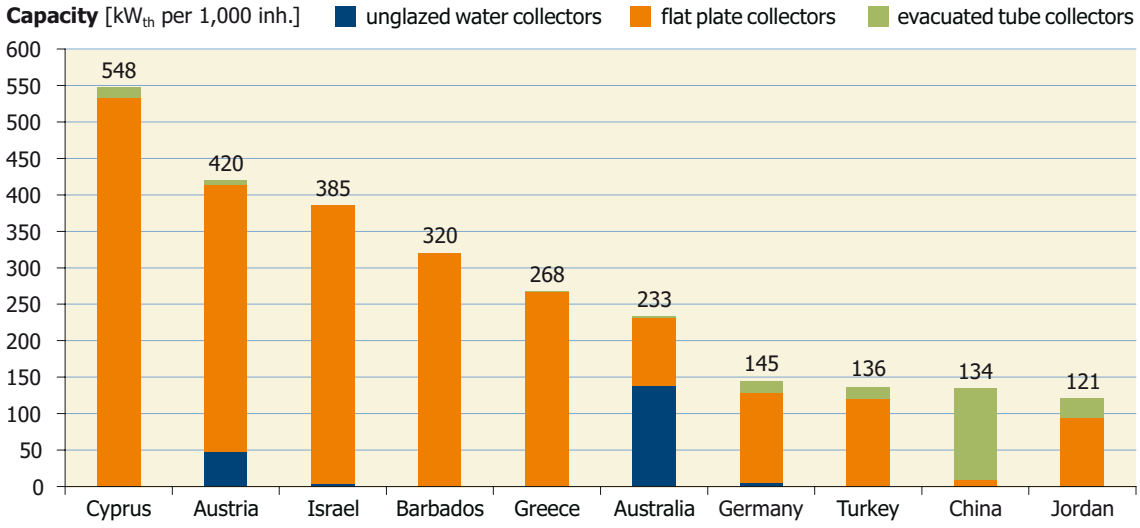


Figure 7: Top 10 countries of cumulated water collector installations (relative figures in kW_{th} per 1,000 inhabitants)

3.2 Total capacity of glazed water collectors in operation

With more than 180 GW_{th}, China is the leader by far in terms of total installed capacity of glazed water collectors. With more than 10 GW_{th} of installed capacity Germany and Turkey are next. Several countries, namely India, Brazil, Japan, Austria, Israel, Greece, Italy, Australia, Spain, the United States, France, South Korea, and Taiwan had more than 1 GW_{th} of water collectors installed by end of 2012 (**Figure 8**).

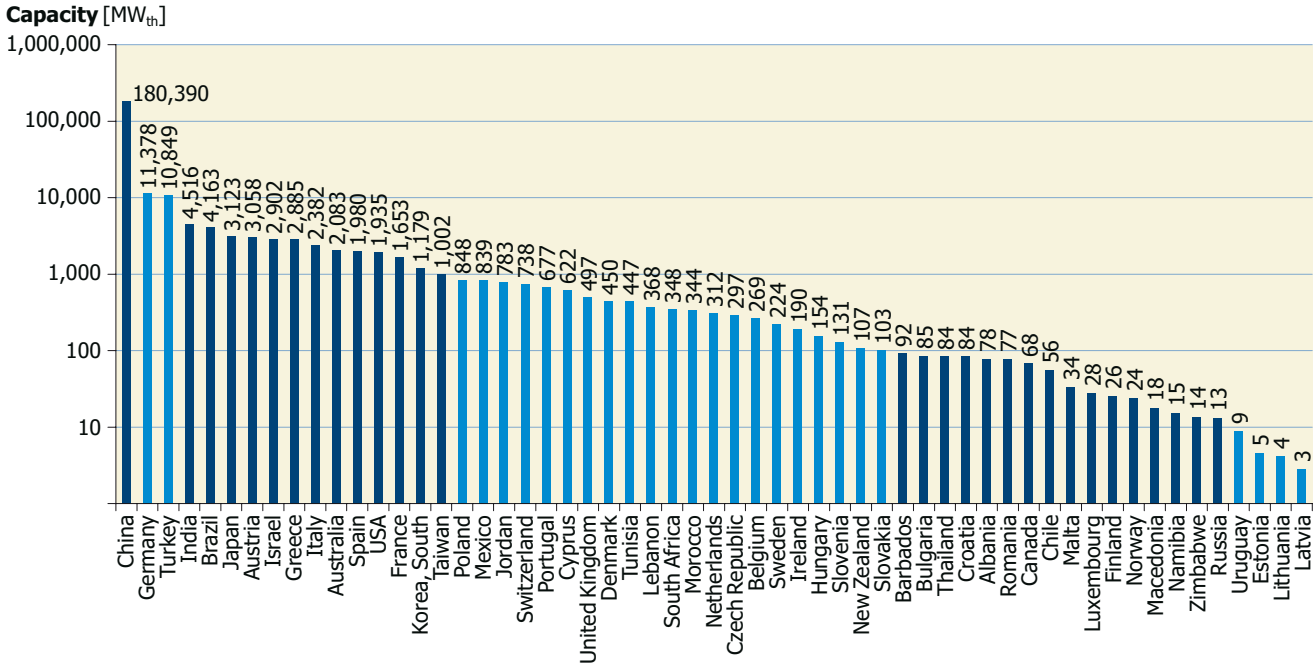


Figure 8: Total capacity of glazed water collectors in operation by the end of 2012

In terms of total installed capacity of glazed water collectors in operation per 1,000 inhabitants, there was a continued dominance by 5 countries: Cyprus ahead of Israel, Austria, Barbados and Greece. China is catching up with the Top 10 and almost reached the levels of Germany and Turkey (**Figure 9**).

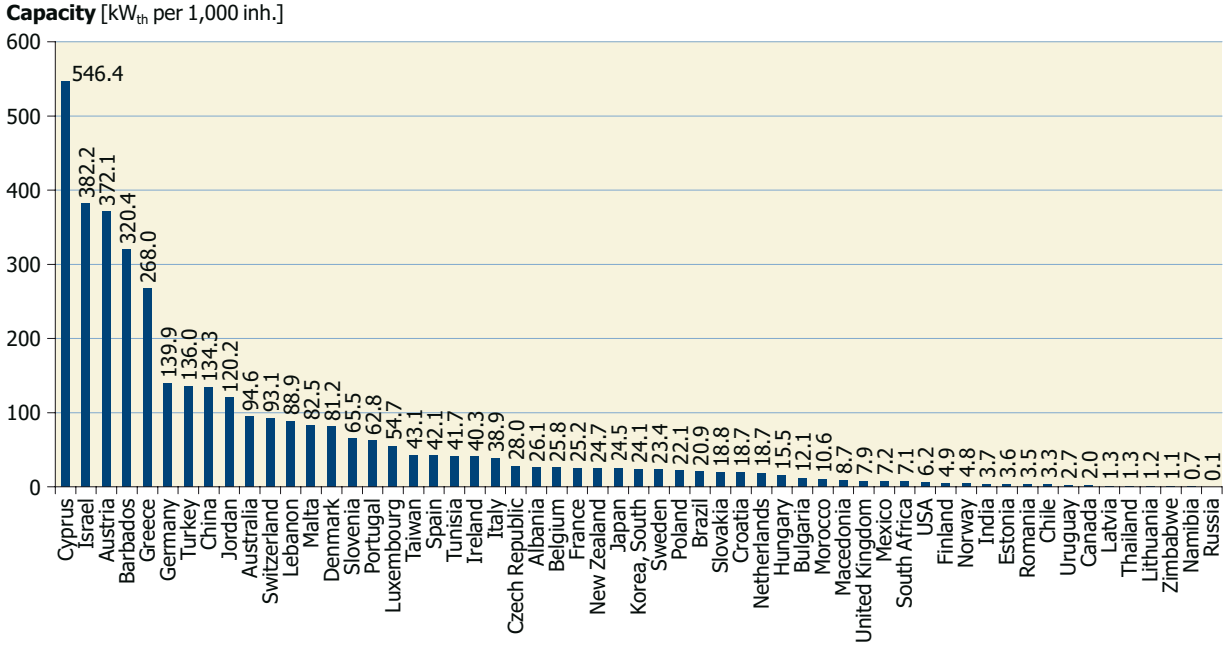


Figure 9: Total capacity of glazed water collectors in operation in kW_{th} per 1,000 inhabitants by the end of 2012

3.3 Total capacity of glazed water collectors in operation by economic region

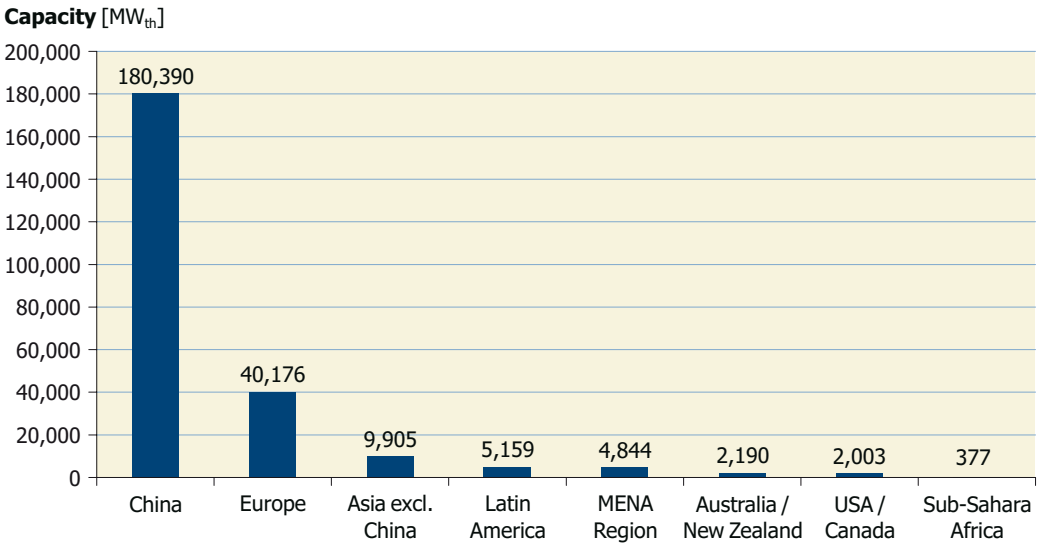
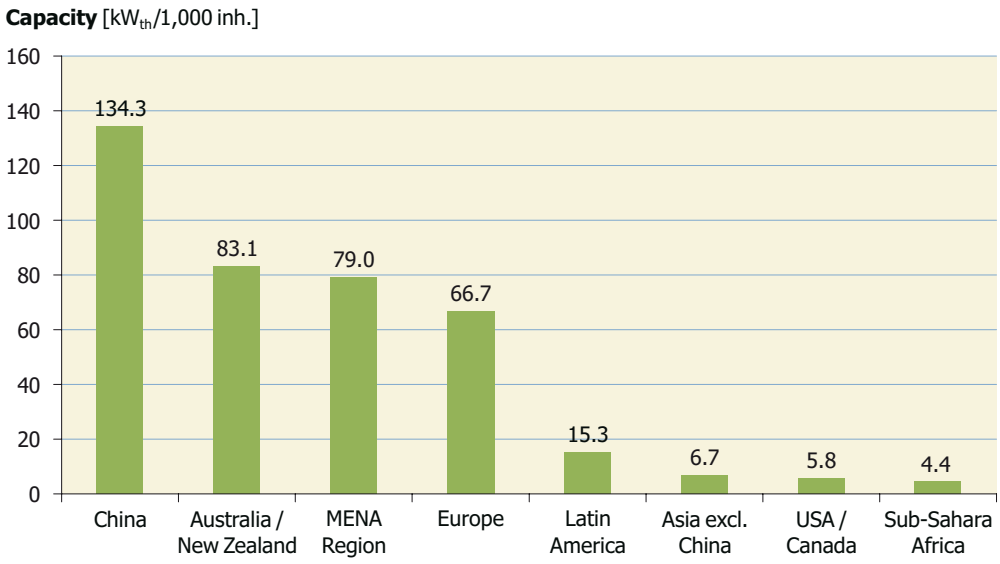


Figure 10: Total capacity of glazed flat plate and evacuated tube collectors in operation by economic region by the end of 2012



Sub-Sahara Africa:	Mozambique, Namibia, South Africa, Zimbabwe
Asia excluding China:	India, Japan, Korea South, Taiwan, Thailand
Latin America:	Brazil, Chile, Mexico, Uruguay
Europe:	EU 28, Albania, Macedonia, Norway, Switzerland, Russia, Turkey
MENA Region:	Israel, Jordan, Lebanon, Morocco, Tunisia

Figure 11: Total capacity of glazed flat plate and evacuated tube collectors in operation by economic region and in kW_{th} per 1,000 inhabitants by the end of 2012

3.4 Total capacity of unglazed water collectors in operation

84% of the total capacity of unglazed water collectors in operation is installed in three countries: the United States, Australia and Brazil (**Figure 12**).

Relative to the inhabitants of a country, the largest market penetration for unglazed collectors can be found in Australia (138.3 kW_{th}/1,000 inhabitants), followed by Austria (47.6 kW_{th}/1,000 inhabitants), the United States (45.6 kW_{th}/1,000 inhabitants), and the Czech Republic (30.9 kW_{th}/1,000 inhabitants).

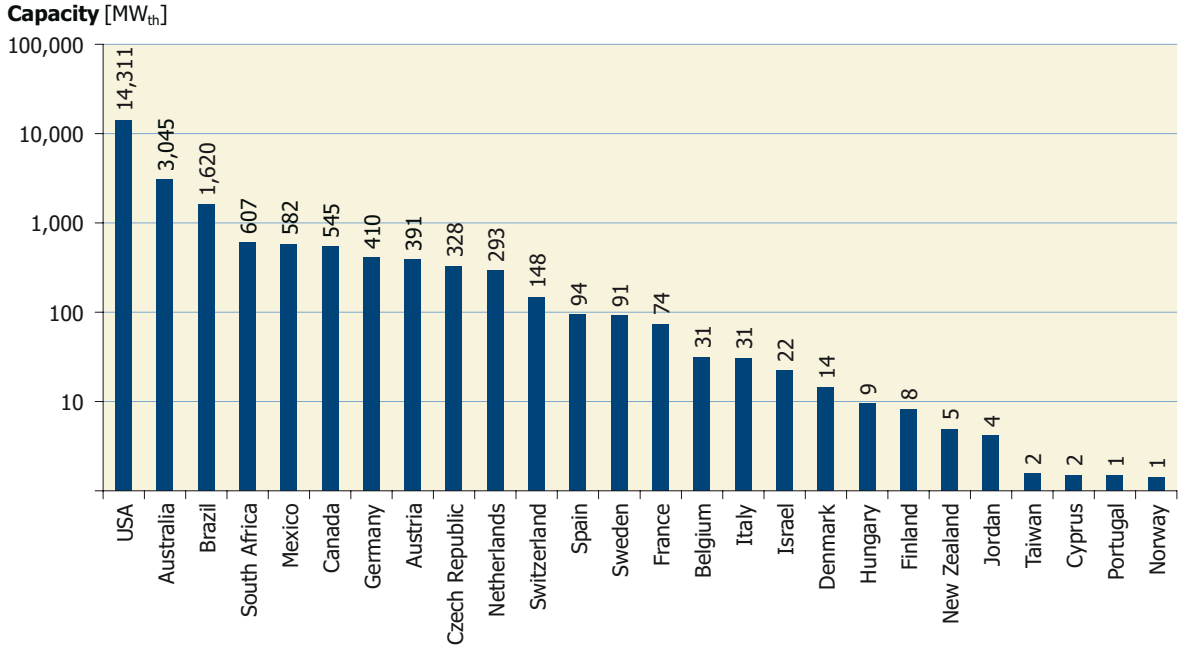


Figure 12: Total capacity of unglazed water collectors in operation by the end of 2012

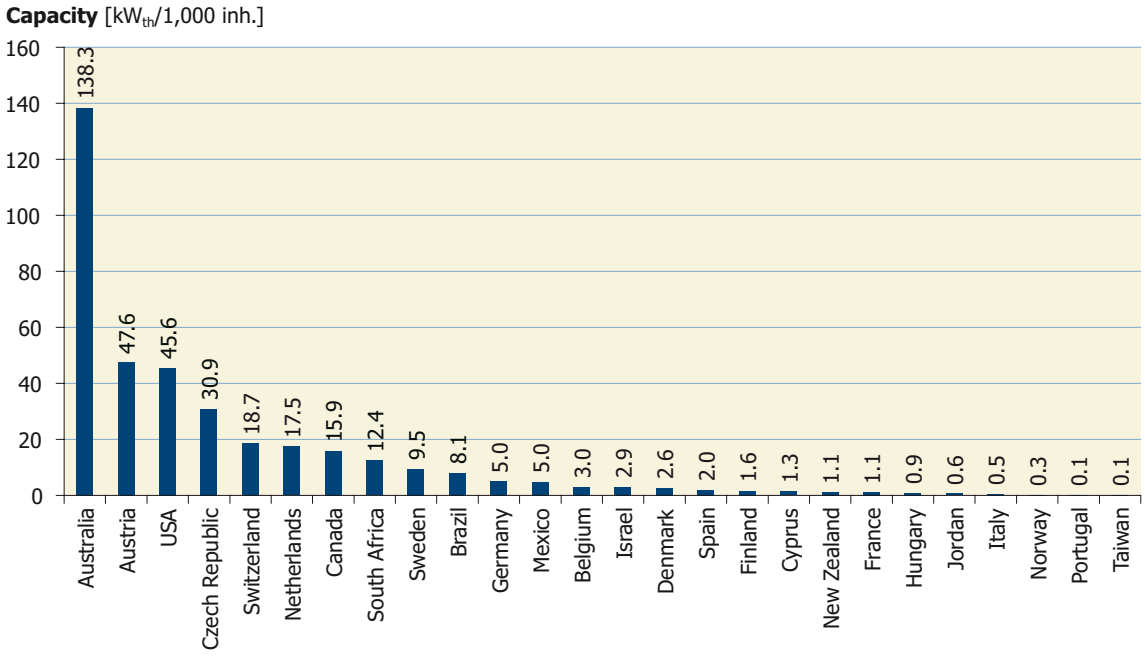


Figure 13: Total capacity of unglazed water collectors in operation in kW_{th} per 1,000 inhabitants by the end of 2012

4 Newly installed capacity in 2012 and market development

4.1 General market overview of newly installed capacity

In the year 2012, a total capacity of 52.7 GW_{th}, corresponding to 75.3 million square meters of solar collectors, was installed worldwide. This means an increase in new collector installations of 9.4% compared to the year 2011. In comparison, the market growth in the period 2010/2011 amounted to 14.3%.

The main markets were in China (44.7 GW_{th}) and Europe (3.7 GW_{th}), which together accounted for 92% of the overall new collector installations in 2012. The rest of the market was shared between Asia excluding China (1.3 GW_{th}), Latin America represented by Brazil, Chile and Mexico (1.0 GW_{th}), the United States and Canada (0.8 GW_{th}), Australia (0.7 GW_{th}), the MENA region represented by Israel, Jordan, Lebanon, Morocco and Tunisia (0.4 GW_{th}) and the Sub-Sahara African countries Mozambique, South Africa and Zimbabwe (0.1 GW_{th}).

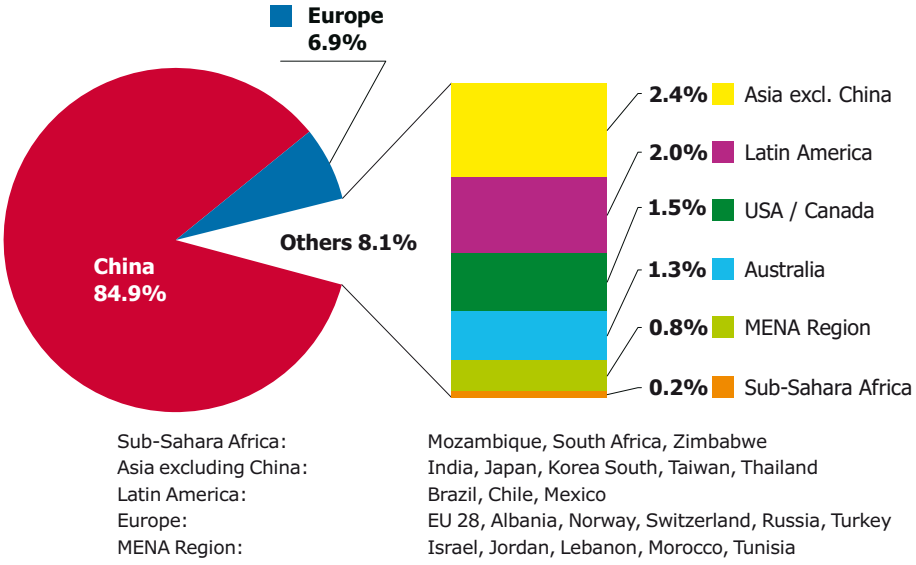


Figure 14: Share of the newly installed capacity (glazed and unglazed water and air collectors) by economic regions in 2012

The global market growth rate of 9.4% in the period 2011/2012 was mainly driven by the large markets in China (+10.9%), Brazil (+11.8%), India (+44.4%) and the United States (+2.7%). In other major solar thermal markets such as in Australia (–4.7%), Germany (–9.5%), Israel (–16.5%), Italy (–15.4%), and Turkey (–10.1%) declines were recorded.

In terms of economic regions, there was positive market growth in the period 2011/2012 in Asia, Latin America and the United States whereas in Sub-Sahara Africa, Australia, Europe and the MENA region solar thermal system installations dropped.

In China, the growth rates between 2000 and 2011 were on average around 23% and since then have been leveling off (+17.6% in 2010/2011, +10.6% in 2011/2012, +3.3% in 2012/2013).

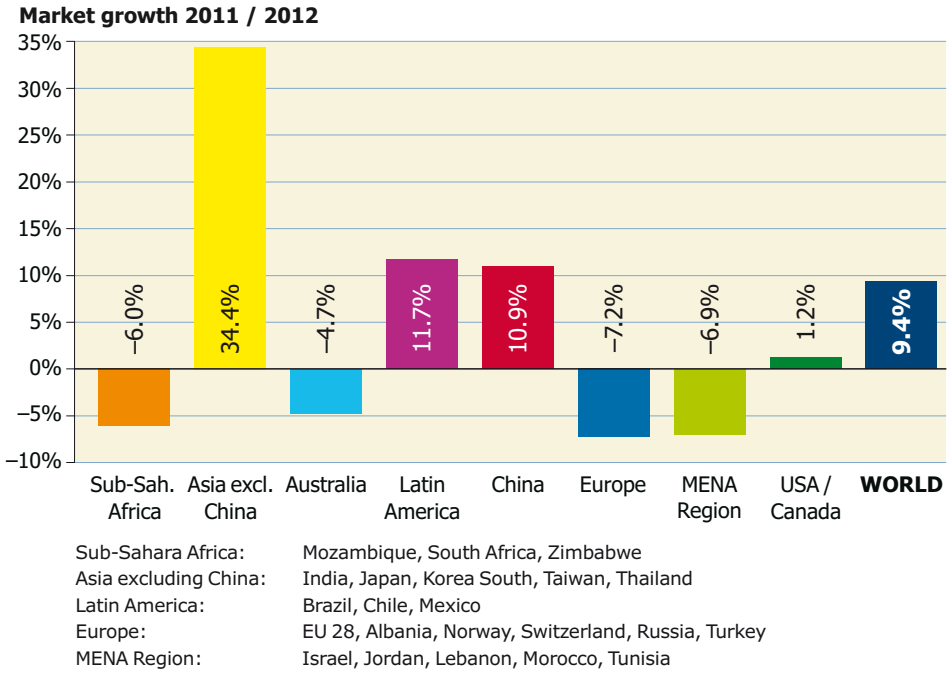


Figure 15: Market growth of newly installed capacity between 2011 and 2012 by economic region

Of all the Asian countries covered in this report, positive market figures were reported for China (+10.9%), India (+44.4%), Japan (+1.2%), South Korea (+16.5%), Taiwan (+ 5.5%), and Thailand (+ 19.9%).

In Latin American, countries with positive market growth were Brazil (+11.8%), Chile (+15%) and Mexico (+11.0%).

The market decline in Sub-Sahara Africa is mainly caused by the 6.7% reduction of new installations in South Africa.

Israel, the largest and most mature market in the MENA region, reported a negative growth rate of –16.5% for 2012.

Of the top 10 European countries only four countries—Poland, France, Greece and Denmark—reported a positive growth rate. A significant decrease of –7.2% was reported for all of Europe with the larger markets Turkey, Germany, Italy, Spain, Austria and Switzerland experiencing significant market declines.

The United States and Canada experienced a market growth of 16.1% in 2009/2010 followed by a significant decrease of –21.7% in 2010/2011, and recovered again in 2011/2012 (+1.2%)

In Australia, the market for water collectors declined for a third year in a row, –5.4% in the period 2009/2010, –10.4% in the period 2010/2011, and –4.7% in the period 2011/2012.

Country	Water Collectors			Air Collectors		TOTAL [MW_{th}]
	unglazed	FPC	ETC	unglazed	glazed	
Albania		14.7	0.1			14.8
Australia	455.0	167.6	21.3	24.5	0.7	669.1
Austria	1.7	140.6	3.9		0.6	146.7
Belgium		35.4	8.1			43.4
Brazil	367.9	438.1				806.0
Bulgaria		5.2	0.4			5.6
Canada	50.1	4.6	5.5	11.1	8.7	79.8
Chile*		15.3				15.3
China		3,500.0	41,230.0			44,730.0
Croatia #		9.6				9.6
Cyprus	0.0	14.5	1.0			15.5
Czech Republic	35.0	25.9	9.1			70.0
Denmark		78.8	0.4			79.1
Estonia		0.6	0.6			1.3
Finland		2.1	0.7			2.8
France (mainland) +		168.5	6.1	3.2	0.7	178.5
Germany		725.2	79.8			805.0
Greece		169.1	1.1			170.1
Hungary	1.1	24.5	10.5	0.2	0.2	36.4
India		374.5	640.5		5.6	1,020.6
Ireland		13.0	5.7			18.7
Israel	0.8	217.4				218.2
Italy		198.7	32.3			231.0
Japan		111.1	2.2		5.6	118.9
Jordan*		38.2	9.6			47.8
Korea, South		44.6				44.6
Latvia		0.1	0.1			0.2
Lebanon*		30.8	15.4			46.2
Lithuania		0.4	0.8			1.3
Luxembourg		2.3	0.6			2.9
Malta		1.0	0.4			1.4
Mexico	76.7	66.7	66.7			210.0
Morocco*		55.0				55.0
Mozambique			0.1			0.1
Netherlands	19.2	19.6	5.6			44.4
Norway		10.7	0.6		1.4	12.6
Poland		151.2	60.2			211.4
Portugal	0.1	58.5	5.0			63.6
Romania		6.0	4.9			10.9
Russia #		4.3	0.2			4.5
Slovakia		4.6	0.7			5.3
Slovenia		9.5	2.1			11.6
South Africa	34.3	15.5	35.2			85.1
Spain	2.5	147.7	8.8			159.1
Sweden	0.6	5.8	2.1			8.5
Switzerland	8.3	87.9	12.1			108.3
Taiwan	0.0	74.0	8.3			82.3
Thailand		15.9				15.9
Tunisia		52.0	1.5			53.5
Turkey		802.4	334.6			1,137.0
United Kingdom		33.5	8.0	3.5		45.0
United States	530.2	160.8	8.4	10.5	9.8	719.7
Zimbabwe		0.6	0.4			1.0
TOTAL	1,583.4	8,354.1	42,651.7	52.9	33.2	52,675.3

Note: If no data is given: no reliable database for this collector type is available.
FPC: flat plate collector; ETC: evacuated tube collector
No data from Barbados, Macedonia, Namibia, New Zealand and Uruguay

* Country market data for new installations in 2012 estimated by AEE INTEC

\# New included countries compared to the 2012 edition of this report

\+ The figures for France relate to mainland France only, overseas territories of France (DOM) are not considered

Table 3: newly installed capacity in 2012 [MW_{th}/a]

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed	FPC	ETC	unglazed	glazed	
Albania		21,060	140			21,200
Australia	650,000	239,400	30,450	35,000	1,000	955,850
Austria	2,410	200,800	5,590		830	209,630
Belgium		50,500	11,500			62,000
Brazil	525,508	625,855				1,151,363
Bulgaria		7,400	600			8,000
Canada	71,510	6,513	7,812	15,824	12,359	114,018
Chile*		21,893				21,893
China		5,000,000	58,900,000			63,900,000
Croatia #		13,750				13,750
Cyprus	24	20,646	1,439			22,109
Czech Republic	50,000	37,000	13,000			100,000
Denmark		112,500	500			113,000
Estonia		900	900			1,800
Finland		3,000	1,000			4,000
France (mainland)		240,750	8,750	4,500	1,000	255,000
Germany		1,036,000	114,000			1,150,000
Greece		241,500	1,500			243,000
Hungary	1,500	35,000	15,000	300	250	52,050
India		535,000	915,000		8,000	1,458,000
Ireland		18,516	8,148			26,664
Israel	1,200	310,500				311,700
Italy		283,800	46,200			330,000
Japan		158,741	3,208		7,950	169,899
Jordan*		54,531	13,705			68,236
Korea, South		63,774				63,774
Latvia		150	150			300
Lebanon*		44,000	22,000			66,000
Lithuania		600	1,200			1,800
Luxembourg		3,250	900			4,150
Malta		1,499	510			2,009
Mexico	109,500	95,250	95,250			300,000
Morocco*		78,572				78,572
Mozambique			143			143
Netherlands	27,396	27,972	8,000			63,368
Norway		15,236	795		1,983	18,014
Poland		216,000	86,000			302,000
Portugal	182	83,624	7,090			90,896
Romania		8,500	7,000			15,500
Russia #		6,097	287			6,384
Slovakia		6,500	1,000			7,500
Slovenia		13,500	3,000			16,500
South Africa	49,068	22,176	50,344			121,588
Spain	3,591	211,060	12,623			227,274
Sweden	910	8,251	3,006			12,167
Switzerland	11,815	125,609	17,287			154,711
Taiwan	5	105,698	11,848			117,551
Thailand		22,660				22,660
Tunisia		74,238	2,180			76,418
Turkey		1,146,298	478,000			1,624,298
United Kingdom		47,893	11,382	5,000		64,275
United States	757,400	229,700	12,000	15,000	14,000	1,028,100
Zimbabwe		802	570			1,372
TOTAL	2,262,019	11,934,463	60,931,007	75,624	47,372	75,250,486

Note: If no data is given: no reliable database for this collector type is available.
FPC: flat plate collector; ETC: evacuated tube collector
No data from Barbados, Macedonia, Namibia, New Zealand and Uruguay

* Country market data for new installations in 2012 estimated by AEE INTEC

\# New included countries compared to the 2012 edition of this report

\+ The figures for France relate to mainland France only, overseas territories of France (DOM) are not considered

Table 4: New Installed collector area in 2012 [m²/a]

New installations in 2012 are divided into flat plate collectors: 8.4 GW_{th} (12.0 million square meters), evacuated tube collectors: 42.7 GW_{th} (60.9 million square meters), unglazed water collectors: 1.6 GW_{th} (2.3 million square meters,) and glazed and unglazed air collectors: 0.09 GW_{th} (0.12 million square meters).

With a share of 81%, evacuated tube collectors are by far the most important solar thermal collector technology worldwide (**Figure 16**). In a global context this breakdown is mainly driven by the dominance of the Chinese market where more than 86% of all newly installed collectors in 2012 were evacuated tube collectors.

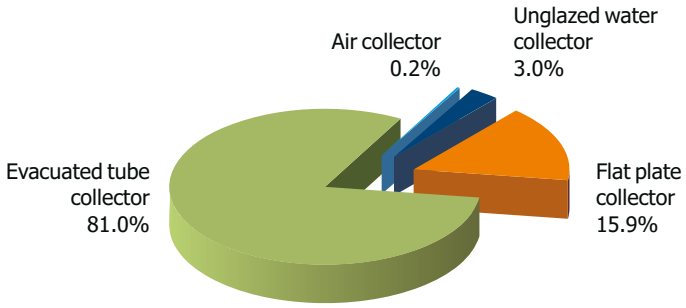


Figure 16: Distribution of the newly installed capacity by collector type in 2012 - WORLD

By contrast, in Europe the situation is almost the opposite with more than 86% of all solar thermal systems installed in 2012 being flat plate collectors (**Figure 17**).

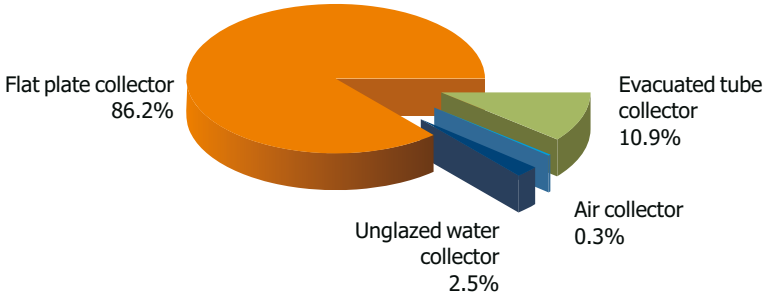


Figure 17: Distribution of the newly installed capacity by collector type in 2012 – EUROPE

Figure 18 shows the newly installed capacity of glazed and unglazed water collectors for the 10 leading markets in 2012 in total numbers. Compared to the newly installed capacity in 2011, China remained the market leader in absolute terms followed by Turkey.

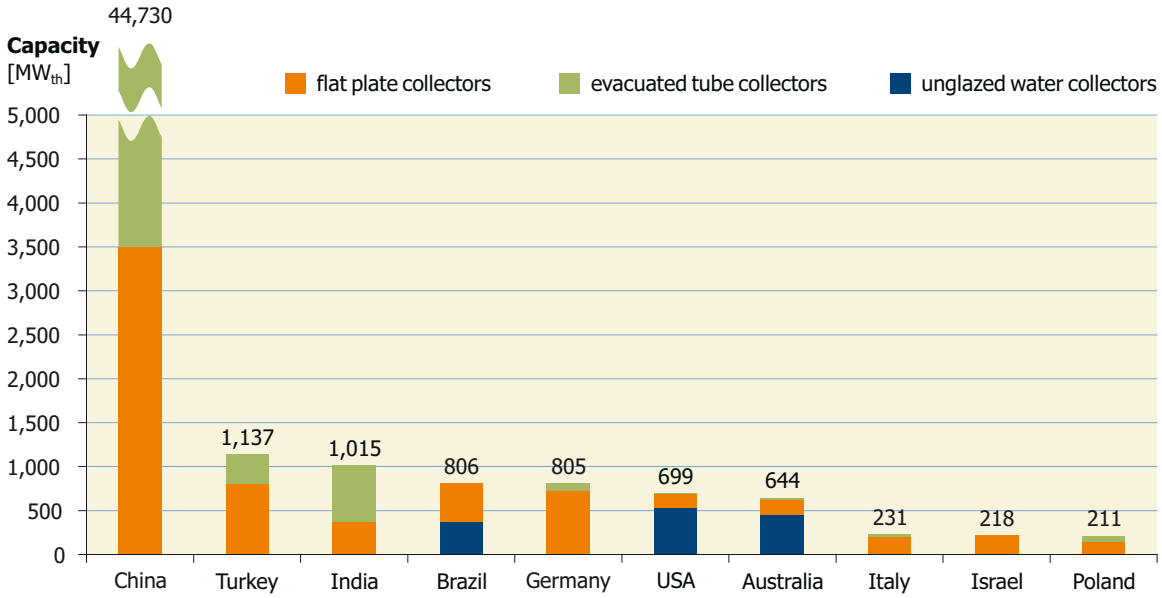


Figure 18: Top 10 markets for glazed and unglazed water collectors in 2012 (absolute figures in MW_{th})

Germany faced a significant market decline in 2012 and hence fell behind India and Brazil within the top 10 ranking. Poland entered the top 10 in 2012 as one of the most dynamic markets in Europe in recent years replacing Spain where the market has halved over the last four years.

As illustrated in **Figure 19** China is leading as well with a remarkable 33.3 kW_{th} of newly installed solar thermal capacity per 1,000 inhabitants in 2012 ahead of Australia, Israel, Austria and Greece.

Denmark is ranked in sixth position, but it is worth mentioning that the majority of the Danish systems are large scale (>5,000 m²) and hydraulically connected to district heating systems (see **Chapter 7.2**).

By contrast, Australia is ranked second, which is mainly due to the country's large market share of unglazed water collectors that are used primarily for swimming pool heating.

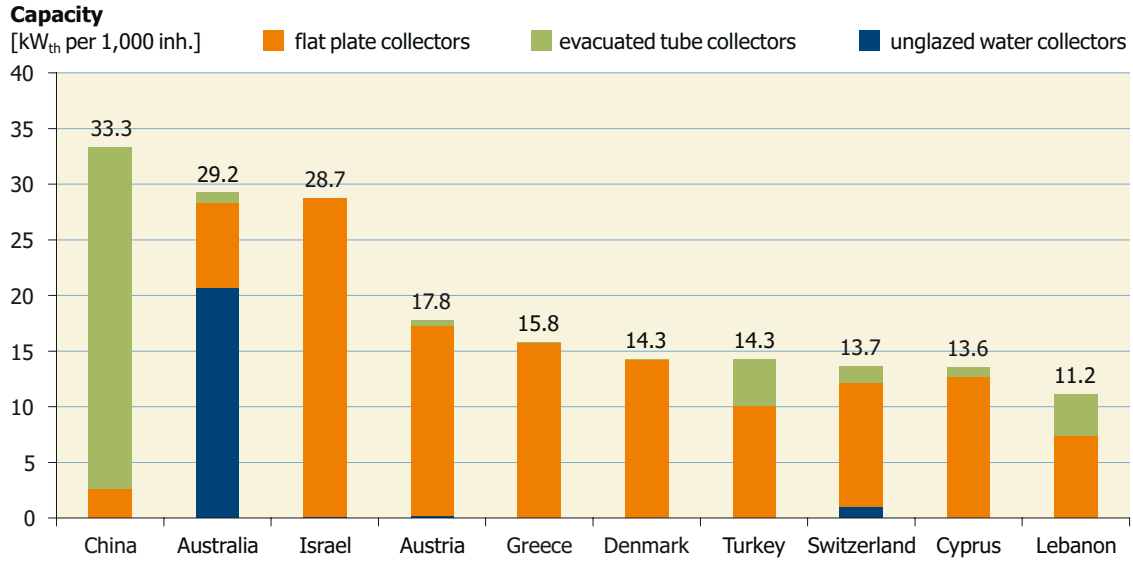


Figure 19: Top 10 markets for glazed and unglazed water collectors in 2012 (relative figures in kW_{th} per 1,000 inhabitants)

4.2 Newly installed capacity of glazed water collectors

In 2012 glazed water collectors (evacuated tube and flat plate collectors) accounted for 96.8% of the total installed capacity (**Figure 16**).

For glazed water collectors, the solar thermal market in 2012 grew by 9.6% with China once again as the strong driver of this positive development. Within the top 10 glazed water heater markets Germany fell behind India in 2012 and Poland passed Australia and Spain (**Figure 20**).

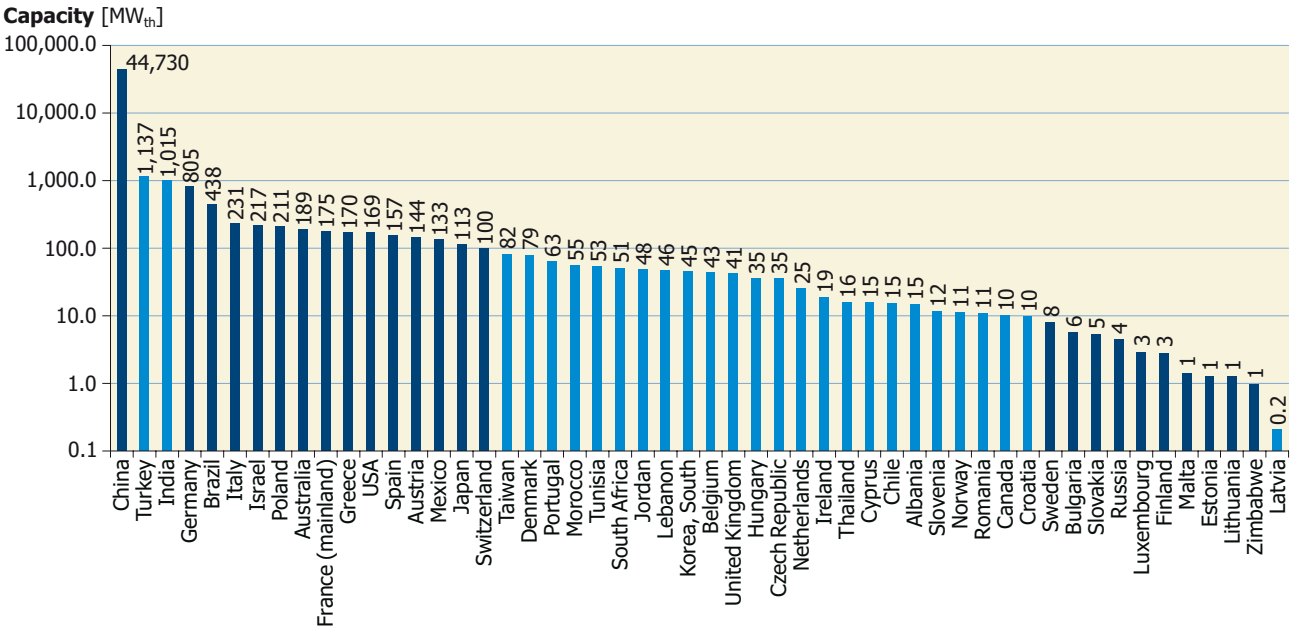


Figure 20: Newly installed capacity of glazed water collectors in 2012

In terms of newly installed glazed water collector capacity per 1,000 inhabitants, China is the leader ahead of Israel and Austria. Compared to the year 2011, Cyprus fell behind Greece, Denmark and Turkey (**Figure 21**).

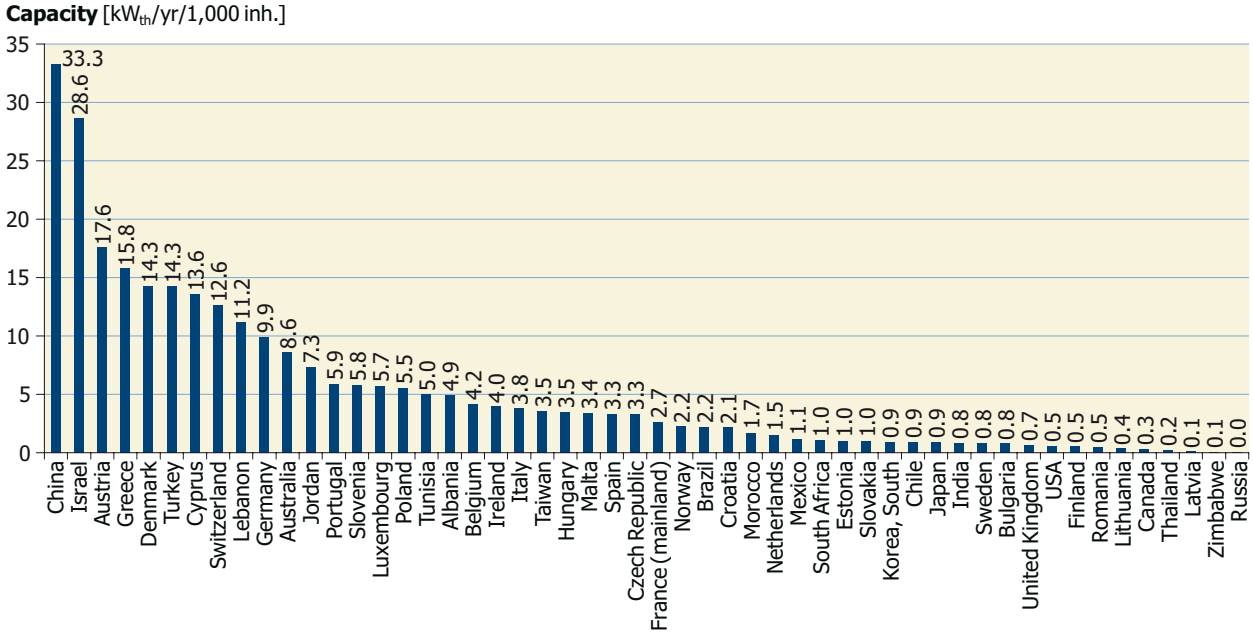
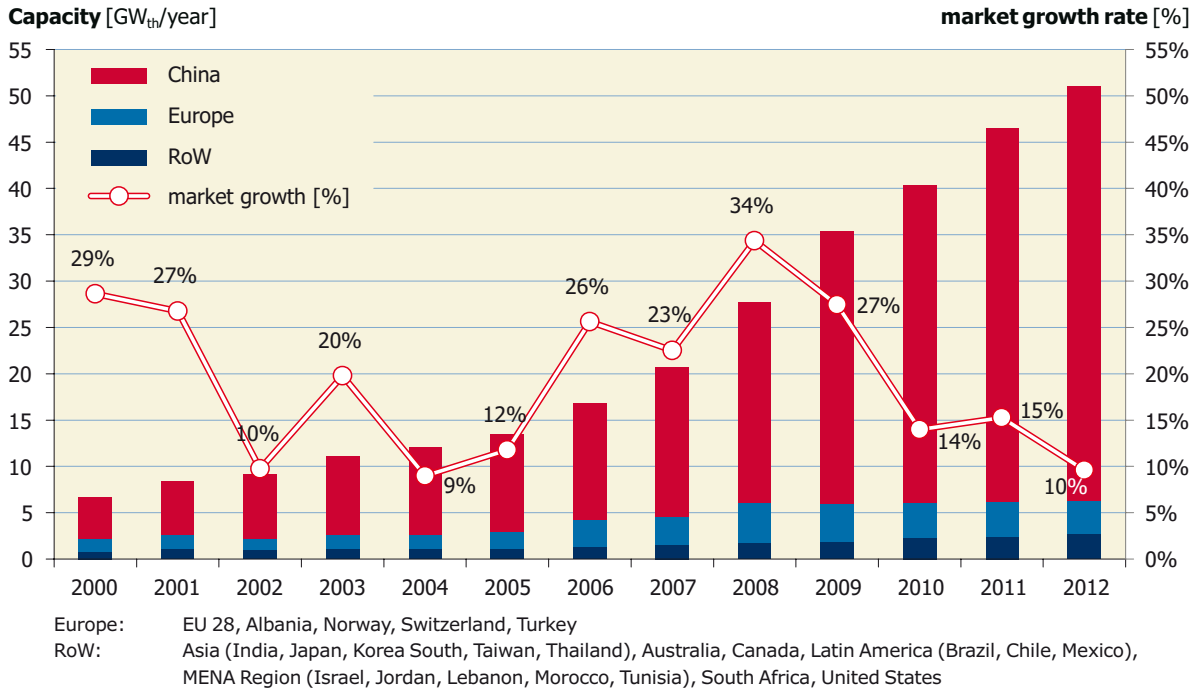


Figure 21: Newly installed capacity of glazed water collectors in 2012 in kW_{th} per 1,000 inhabitants

4.3 Market development of glazed water collectors between 2000 and 2012

The worldwide market of glazed water collectors is characterized by a steady growth over the past 12 years with China as the main driver for this positive development. Between 2000 and 2012, the average growth rate worldwide was around 20% and between 2006 and 2012 the annual installed glazed water collector area worldwide tripled. Compared to the year 2011, the growth rate has dropped from 15.3% to 9.6% in 2012 (**Figure 22**).



Europe: EU 28, Albania, Norway, Switzerland, Turkey
RoW: Asia (India, Japan, Korea South, Taiwan, Thailand), Australia, Canada, Latin America (Brazil, Chile, Mexico), MENA Region (Israel, Jordan, Lebanon, Morocco, Tunisia), South Africa, United States

Figure 22: Global market development of glazed water collectors from 2000 to 2012

In 2000 the Chinese market was about three times as large as the European market while in 2012 the Chinese market volume exceeded it 13-fold (**Figure 23**).

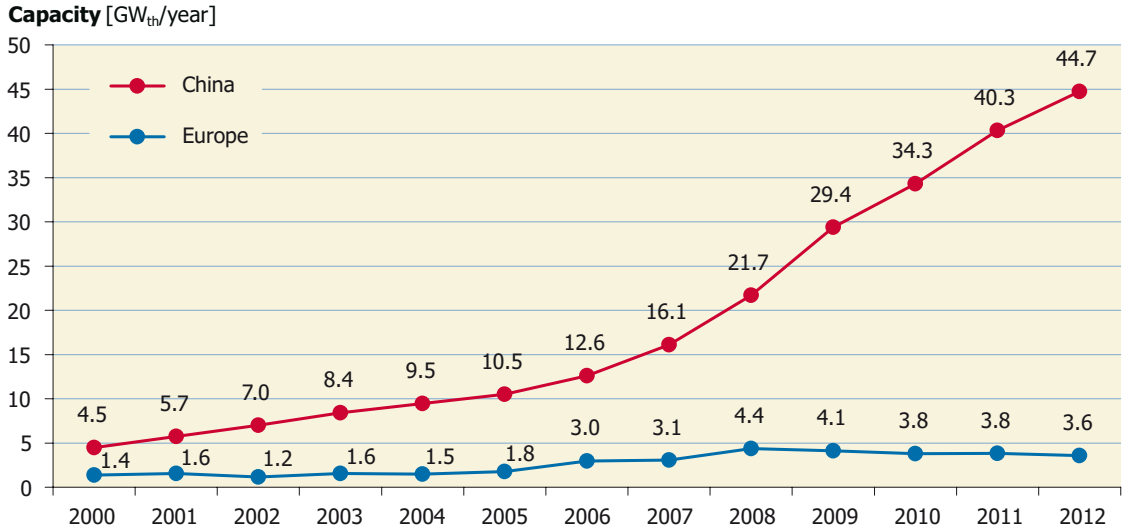


Figure 23: Market development of glazed water collectors in China and Europe

In 2008 the European market peaked and since then the market has been declining. By contrast, in the remaining markets worldwide an upwards trend can be observed (indicated as RoW (Rest of World) in **Figure 24**).

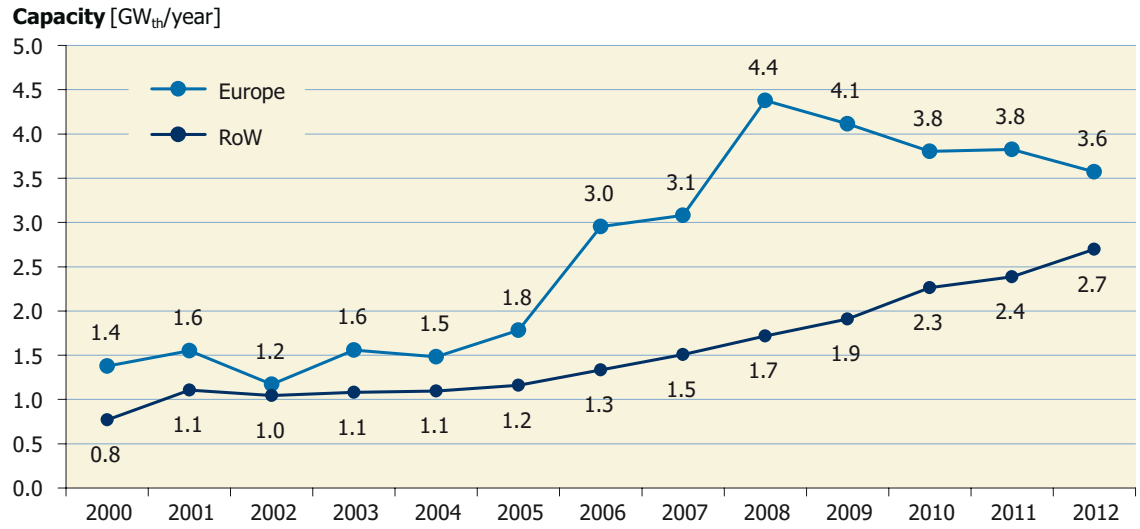


Figure 24: Market development of glazed water collectors in Europe and the Rest of World (excluding China)

RoW includes all economic regions other than China and Europe (**Figure 25**). Of these countries, Asia (excluding China) and Latin America hold the largest market shares and both regions show a steady upwards trend mainly due to the developments in India and Brazil.

In 2012 the MENA region saw a 16.5% decrease in its largest market, Israel, which holds more than 50% of the solar thermal capacity installed. Also South Africa, the only country with a considerable solar thermal market in Sub-Sahara Africa, reported a market decline of 6.7% in 2012.

The Australian market has seen a significant market decline since 2009. The annual installed capacity almost halved from 364 MW_{th} in 2009 to 189 MW_{th} in 2012. In the United States and Canada, the market for glazed water collectors has more or less stagnated, since 2008.

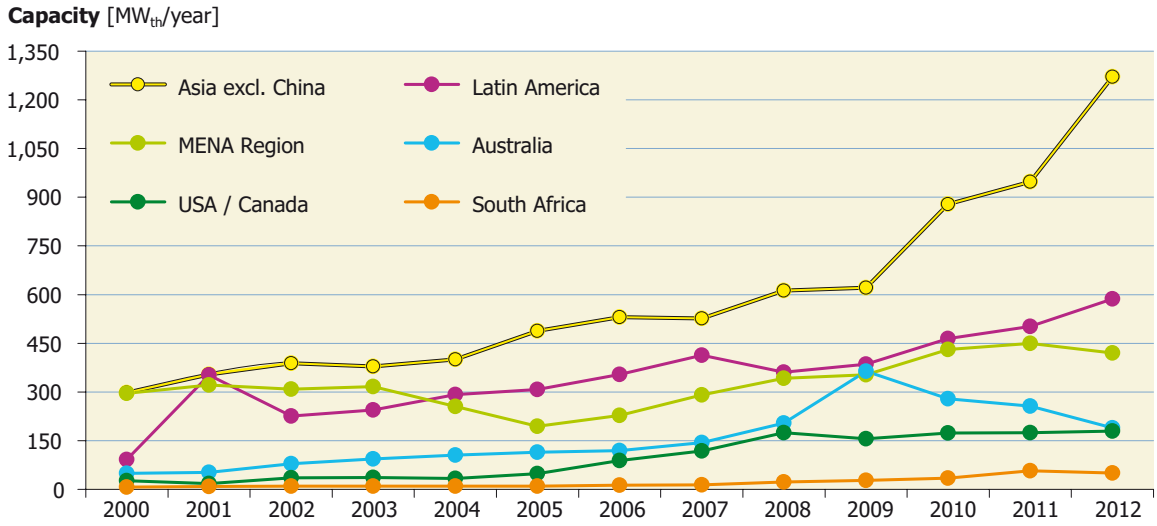


Figure 25: Market development of glazed water collectors in Rest of World (excluding China and Europe)

In relative figures, the annual global market volume for glazed water collectors grew from 1.8 kW_{th} per 1,000 inhabitants in 2000 to 12.0 kW_{th} per 1,000 inhabitants in 2012 (**Figure 26**).

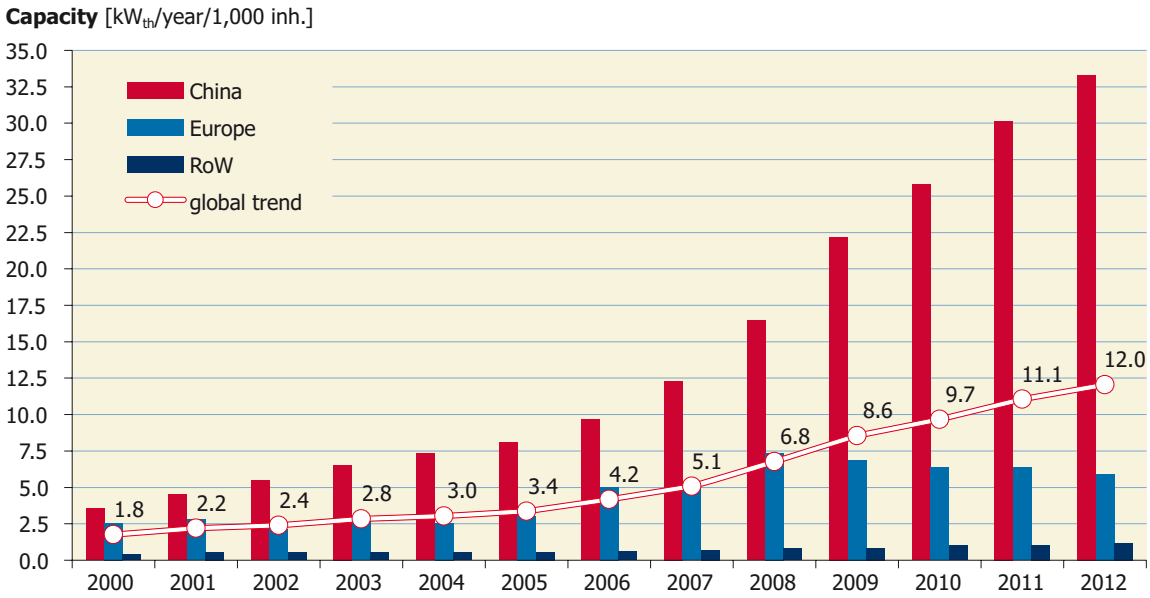


Figure 26: Annual installed capacity of glazed water collectors in kW_{th} per 1,000 inhabitants from 2000 to 2012

It can be noted that in 2012 China has the highest market penetration in terms of glazed water collector installations per capita not only compared to other economic regions, but also compared to all other countries covered in this report. The annual installed capacity rose from 3.5 kW_{th} per 1,000 inhabitants in 2000 to 33.3 kW_{th} per 1,000 inhabitants in 2012. Worldwide, only Israel shows a comparable market penetration of 28.6 kW_{th} per 1,000 inhabitants in 2012 as can be seen in **Figure 21**.

In Europe, the market penetration peaked in 2008 with 7.4 kW_{th} per 1,000 inhabitants and since then a constant downwards trend in per capita installations can be observed leading to a value of 5.9 kW_{th} per 1,000 inhabitants in 2012.

The other economic regions showed a slow, but steady upwards trend at a low market penetration level. Here, the annual installed capacity rose from 0.4 kW_{th} per 1,000 inhabitants in 2000 to 1.2 kW_{th} per 1,000 inhabitants in 2012.

4.4 Market development of unglazed water collectors between 2000 and 2012

In 2012 unglazed water collectors accounted for 3.0% of the total installed capacity (**Figure 16**) and compared to the year 2011 the market grew moderately by 2.1%.

The most important markets for unglazed collectors in 2012 were the United States (530 MW_{th}), Australia (455 MW_{th}), and Brazil (368 MW_{th}). The three countries accounted for 85% of the recorded unglazed water collector installations. Another 14% were installed in Mexico, Canada, the Czech Republic, South Africa, and the Netherlands. Only 1% was installed in other countries (**Figure 27**).

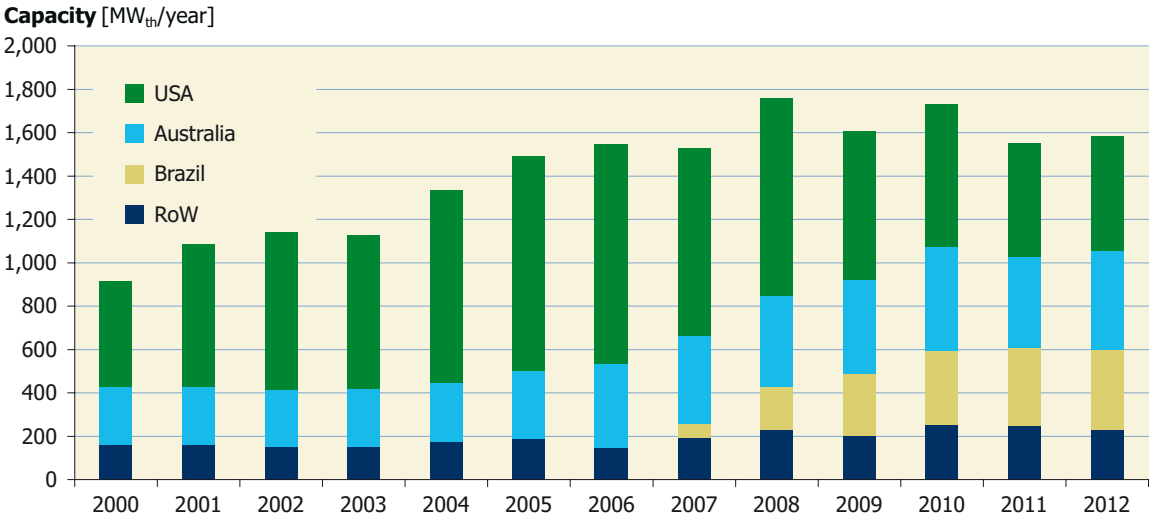


Figure 27: Global market development of unglazed water collectors from 2000 to 2012

Although the unglazed water collector market in the United States faced a heavy market downturn between 2006 and 2011, the global annual market volume for unglazed water collectors remained at a constant level between 1.5 GW_{th} and 1.75 GW_{th} (**Figure 27**). The reason for this development is the Brazilian market, which entered in 2007 and has grown steeply since then (**Figure 28**).

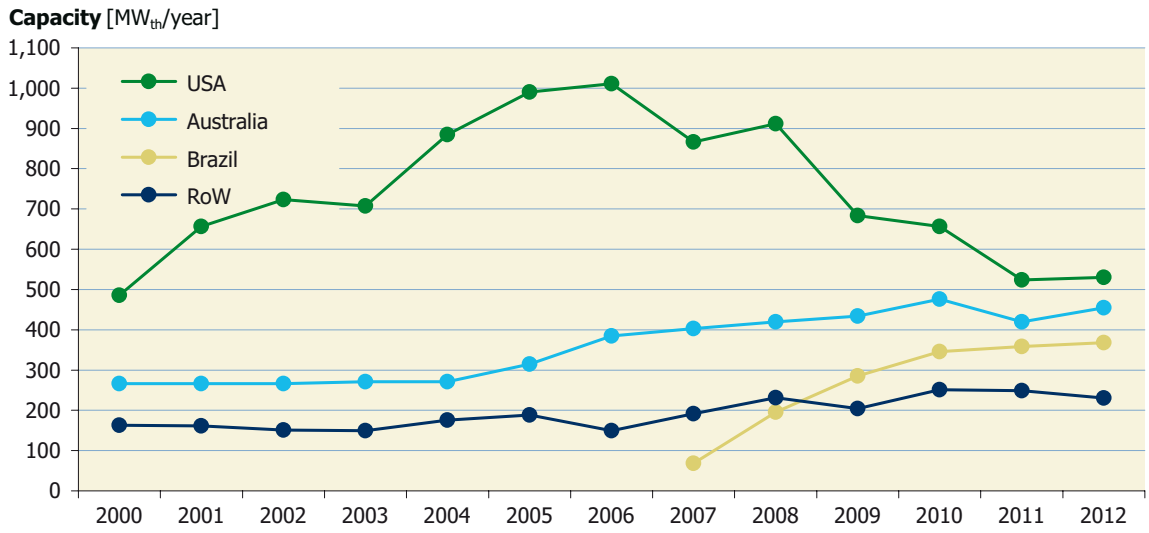


Figure 28: Global market development of unglazed water collectors from 2000 to 2012

5 Contribution to the energy supply and CO_2 reduction

In this section, the contribution of the total installed glazed and unglazed water collectors in operation to the thermal energy supply and CO_2 reduction is shown.

The basis for these calculations is the total glazed and unglazed water collector area in operation in each country as shown in **Table 1**. The contribution of the total installed air collector capacity in operation in 2012 of 1.6 GW_{th} was not taken into consideration—with a share of around 0.6% of the total installed collector capacity these collectors were omitted from the calculation.

The results are based on calculations using the simulation tool T-SOL expert 4.5 (www.valentin.de) for each country. For the simulations, different types of collectors and applications as well as the characteristic climatic conditions were considered for each country. A more detailed description of the methodology can be found in the appendix (see **Chapter 8.1**).

The annual collector yield of all water-based solar thermal systems in operation by the end of 2012 in the 58 recorded countries was 227.8 TWh (= 820 PJ). This corresponds to an energy savings equivalent of 24.5 million tons of oil and 79.1 million tons of CO_2. The calculated number of different types of solar thermal systems in operation was around 78 million (**Table 5**).

The most important field of application for solar thermal systems is heating domestic hot water (see **section 6.3**), and therefore, this type of application also accounted for the highest savings in terms of oil equivalent and CO_2. In 2012, 92% of the energy provided by solar thermal systems worldwide was used for heating domestic hot water, mainly by small-scale systems in single family houses and larger applications attached to multi-family houses, hotels, schools, etc. Swimming pool heating held a share of 10% in the contribution to the energy supply and CO_2 reduction and the remaining 2% was met by solar combi systems.

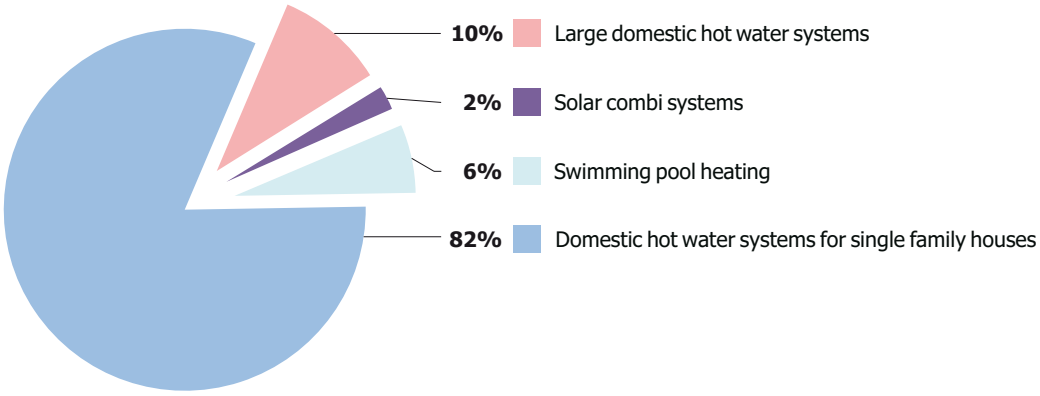


Figure 29: Share of energy savings and CO_2 reduction by type of application of glazed and unglazed water collectors in operation by the end of 2012

Table 5 summarizes the calculated annual collector yields and the corresponding oil equivalents and CO_2 reductions of all water-based solar thermal systems (systems for hot water, space heating and swimming pool heating) in operation by the end of 2012.

Country	Total collector area [m²]	Total capacity [MW_{th}]	Calculated number of systems	Collector yield [GWh/a]	Energy savings [t_{oe}/a]	CO_2 reduction [t_{CO2}/a]
Albania	111,921	78	14,347	78	8,412	27,193
Australia	7,326,000	5,128	1,010,588	4,598	494,147	1,597,429
Austria	4,927,748	3,449	490,570	2,094	225,104	727,693
Barbados	131,690	92	32,923	116	12,491	40,379
Belgium	429,533	301	107,383	182	19,544	63,180
Brazil	8,262,056	5,783	1,329,864	5,785	621,816	2,010,145
Bulgaria	122,100	85	22,455	64	6,841	22,116
Canada	875,272	613	14,333	457	49,120	158,790
Chile	80,009	56	10,065	60	6,451	20,854
China	257,700,000	180,390	58,742,715	149,837	16,104,526	52,061,101
Croatia	120,000	84	30,000	65	6,949	22,465
Cyprus	890,511	623	196,236	791	85,064	274,987
Czech Republic	891,738	624	60,205	382	41,074	132,780
Denmark	663,409	464	77,712	286	30,766	99,457
Estonia	6,520	5	1,630	3	303	978
Finland	48,502	34	12,126	21	2,298	7,430
France (mainland)	2,466,801	1,727	387,400	1,194	128,321	414,824
Germany	16,839,600	11,788	1,841,364	6,939	745,807	2,410,971
Greece	4,122,000	2,885	1,591,106	3,164	340,057	1,099,302
Hungary	233,300	163	27,008	109	11,671	37,730
India	6,451,000	4,516	1,224,561	5,423	582,826	1,884,103
Ireland	271,968	190	62,943	114	12,239	39,564
Israel	4,176,817	2,924	1,381,826	3,910	420,271	1,358,610
Italy	3,446,766	2,413	590,603	2,119	227,796	736,395
Japan	4,461,560	3,123	1,094,867	2,610	280,508	906,799
Jordan	1,124,034	787	198,953	1,064	114,325	369,580
Korea, South	1,684,824	1,179	242,952	854	91,753	296,611
Latvia	4,040	3	1,010	2	200	648
Lebanon	526,000	368	113,353	448	48,185	155,766
Lithuania	6,000	4	1,500	3	290	939
Luxembourg	39,800	28	9,950	18	1,923	6,218
Macedonia	25,744	18	3,298	15	1,661	5,370
Malta	48,293	34	12,073	42	4,505	14,563
Mexico	2,029,876	1,421	105,300	1,244	133,710	432,246
Morocco	491,261	344	122,815	439	47,209	152,611
Mozambique	273	0.2	68	0.2	25	81
Namibia	22,006	15	2,718	20	2,158	6,975
Netherlands	864,642	605	130,026	385	41,402	133,839
New Zealand	159,645	112	39,911	103	11,101	35,886
Norway	36,126	25	1,308	14	1,479	4,780
Poland	1,211,500	848	152,447	495	53,173	171,893
Portugal	969,805	679	188,330	753	80,932	261,629
Romania	110,700	77	27,675	66	7,063	22,834
Russia	18,898	13	743	8	847	2,737
Slovakia	147,000	103	24,500	71	7,595	24,551
Slovenia	186,800	131	28,250	78	8,353	27,003
South Africa	1,363,512	954	125,969	904	97,113	313,937
Spain	2,962,824	2,074	341,762	2,063	221,693	716,666
Sweden	450,000	315	34,103	187	20,061	64,851
Switzerland	1,265,490	886	153,112	540	58,026	187,580
Taiwan	1,434,183	1,004	293,158	880	94,586	305,769
Thailand	120,360	84	30,090	103	11,043	35,697
Tunisia	639,218	447	223,551	575	61,751	199,622
Turkey	15,497,913	10,849	3,589,317	13,904	1,494,448	4,831,103
United Kingdom	709,673	497	177,418	295	31,674	102,391
United States	23,209,601	16,247	976,949	11,793	1,267,572	4,097,679
Uruguay	12,571	9	3,143	9	921	2,977
Zimbabwe	19,568	14	4,892	17	1,796	5,808
TOTAL	382,449,002	267,714	77,715,472	227,790	24,482,975	79,146,115

Table 5: Calculated annual collector yield and corresponding oil equivalent and CO_2 reduction of glazed and unglazed water collectors in operation by the end of 2012

In **Chapters 5.1 to 5.3**, the annual collector yield, energy savings and CO_2 savings by economic regions and worldwide are graphed.

5.1 Annual collector yield by economic region

In 2012 gross solar thermal collector yields amounted to 227.8 TWh worldwide (**Table 5**) and the major share, 82%, was contributed by domestic hot water applications for single family houses (**Figure 29**).
Of the thermal energy gains, China accounted for 66% (150 TWh), Europe 16% (37 TWh) and Rest of the World 18% (42 TWh) (**Figure 30**).

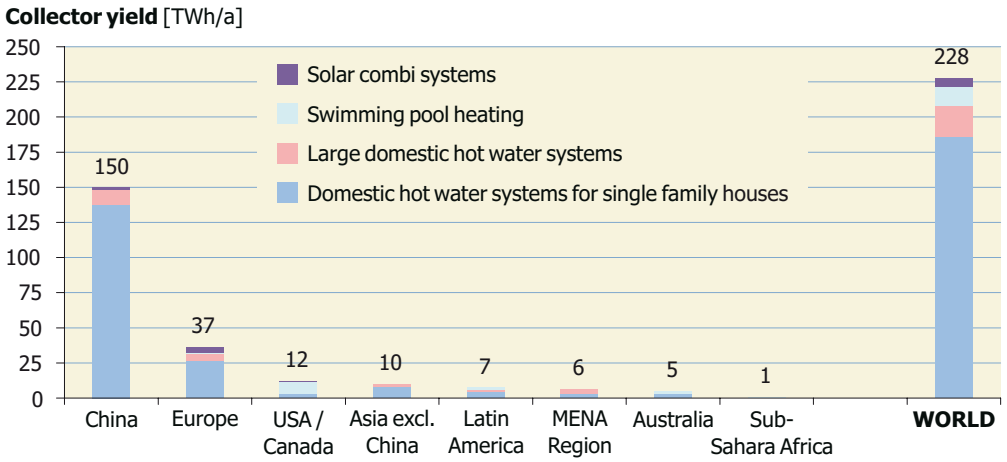
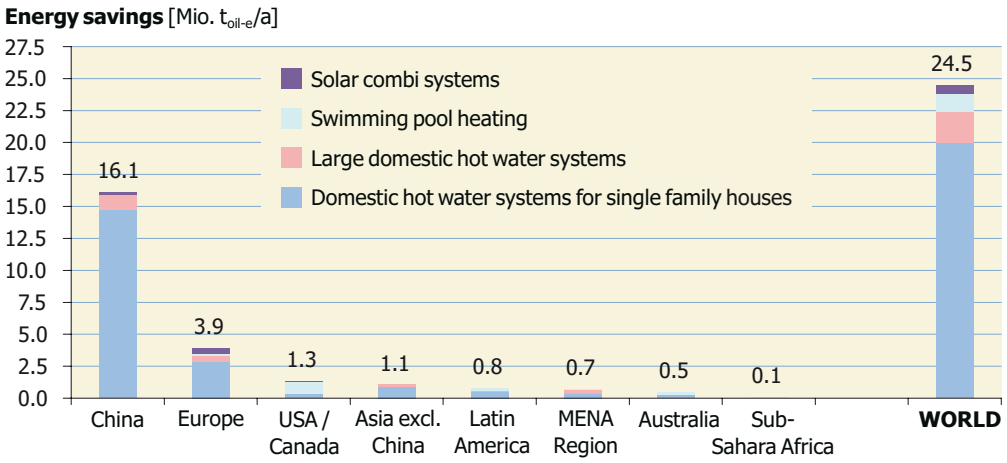


Figure 30: Annual collector yield of unglazed and glazed water collectors in operation by end of 2012

5.2 Annual energy savings by economic region

Considering a utilization ratio of 0.8 for the reference oil boiler, which is assumed to be partly replaced by the solar thermal system (see methodology **Chapter 8.1**), the annual final energy savings amounted to 284.7 TWh or 24.5 million tons of oil equivalent in 2012[4].
The breakdown was China 16.1 million tons oil equivalent; Europe 16.1 million tons oil equivalent, Rest of World 4.5 million tons oil equivalent (**Figure 31**).



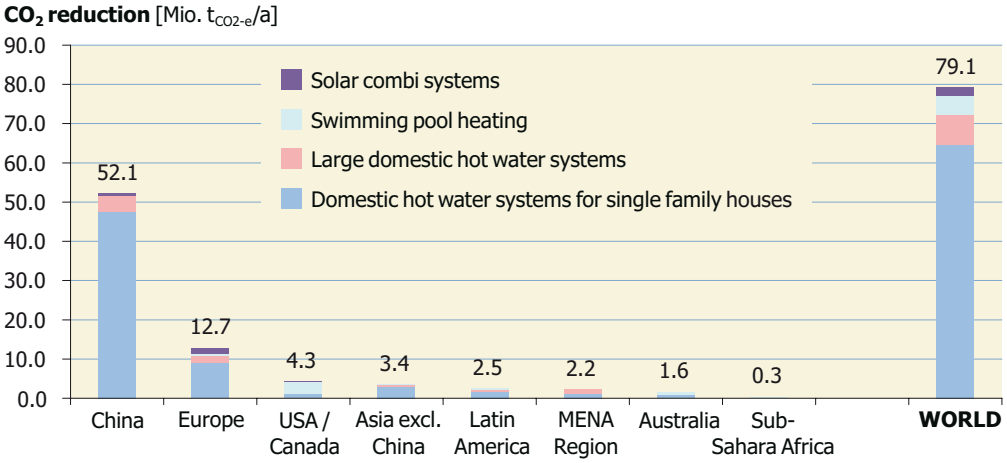
Sub-Sahara Africa:	Mozambique, Namibia, South Africa, Zimbabwe	Europe:	EU 28, Albania, Macedonia, Norway,
Asia excluding China:	India, Japan, Korea South, Taiwan, Thailand		Switzerland, Russia, Turkey
Latin America:	Brazil, Chile, Mexico, Uruguay	MENA Region:	Israel, Jordan, Lebanon, Morocco, Tunisia

Figure 31: Annual energy savings in oil equivalent
by unglazed and glazed water collectors in operation by end of 2012

4 1 toe = 1.163 x 104 kWh (Defra/DECC 2013)

5.3 Annual contribution to CO_2 reduction by economic region

24.5 million tons of oil equivalents correspond to an annual CO_2 emission reduction of 79.1 million tons[5]. Here, the breakdown was China 52.1 million tons of CO_2e; Europe 12.7 million tons of CO_2e, Rest of World 14.4 million tons of CO_2e (see **Figure 32**).



Sub-Sahara Africa:	Mozambique, Namibia, South Africa, Zimbabwe	Europe:	EU 28, Albania, Macedonia, Norway,
Asia excluding China:	India, Japan, Korea South, Taiwan, Thailand		Switzerland, Russia, Turkey
Latin America:	Brazil, Chile, Mexico, Uruguay	MENA Region:	Israel, Jordan, Lebanon, Morocco, Tunisia

Figure 32: Contribution to CO_2 reduction by unglazed and glazed water collectors in operation by end of 2012

5 1 toe (fuel oil) = 3,232.7 kg CO_2e (Defra/DECC 2013)

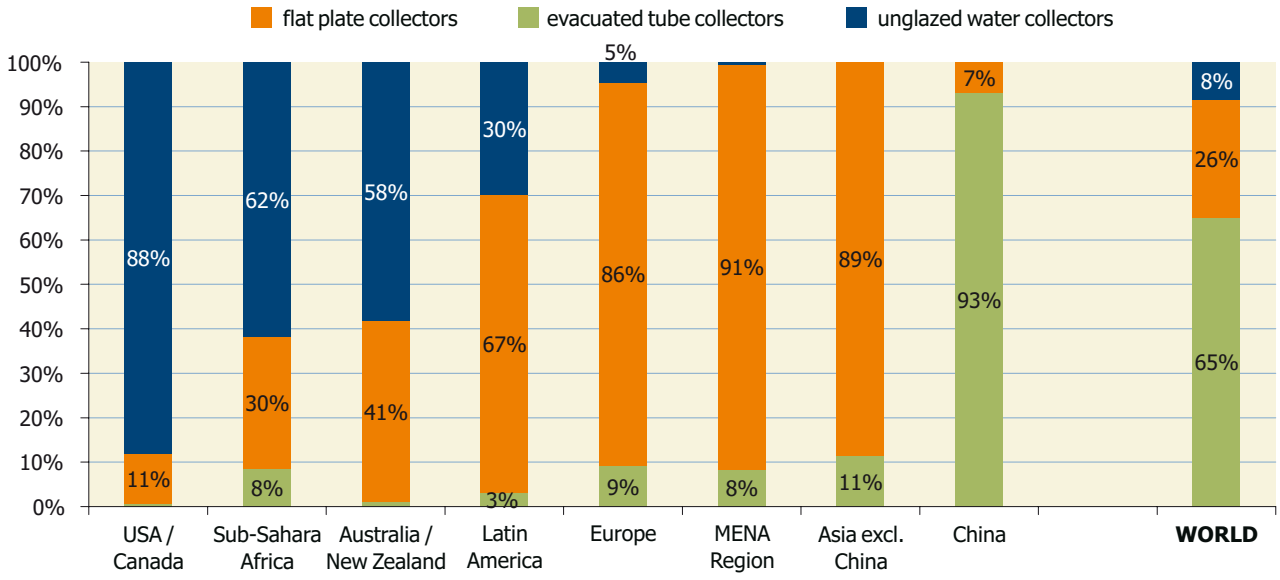
6 Distribution of systems by system type and application

The use of solar thermal energy varies greatly from region to region and can be roughly distinguished by the type of solar thermal collector used (unglazed water collectors, evacuated tube collectors, flat plate collectors, glazed and unglazed air collectors, concentrating collectors), the type of system operation (pumped solar thermal systems, thermosiphon systems), and the main type of application (swimming pool heating, domestic hot water preparation, space heating, others such as heating of industrial processes, solar district heating or solar thermal cooling).

In **Chapters 6.1 to 6.3**, the share of these system types and applications are shown by different economic regions for both the cumulated capacity in operation by the end of 2012 and the newly installed capacity in 2012[6].

6.1 Distribution by type of solar thermal collector

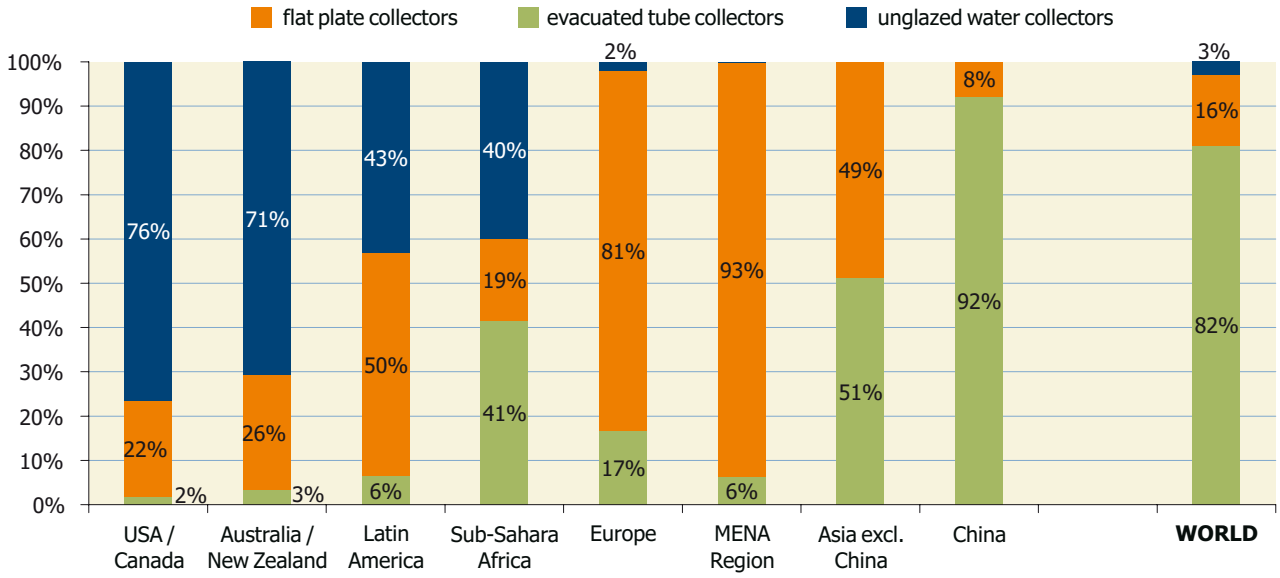
In terms of the total water collector area, evacuated tube collectors dominated with a share of 65% of the cumulated capacity in operation (**Figure 33**) and a share of 82% of the newly installed capacity (**Figure 34**). Especially in China, vacuum tube collectors played an important role and since this was by far the largest market supported by high growth rates, the worldwide figures tend towards a higher share of this type of solar thermal collector. Unglazed water collectors accounted for 8% of the cumulated water collectors installed worldwide and for 3% of the newly installed capacity.



Sub-Sahara Africa:	Mozambique, Namibia, South Africa, Zimbabwe
Asia excluding China:	India, Japan, Korea South, Taiwan, Thailand
Latin America:	Brazil, Chile, Mexico, Uruguay
Europe:	EU 28, Albania, Macedonia, Norway, Switzerland, Russia, Turkey
MENA Region:	Israel, Jordan, Lebanon, Morocco, Tunisia

Figure 33: Distribution by type of solar thermal collector
for the total installed water collector capacity in operation by the end of 2012

6 It has to be considered that statistical information summarized in **Chapters 6.1 to 6.4** is sometimes based on rough expert estimations by country representatives only and hence especially the share by type of system and application of the cumulated installed capacity in operation can deviate significantly from figures published in previous editions of this report.

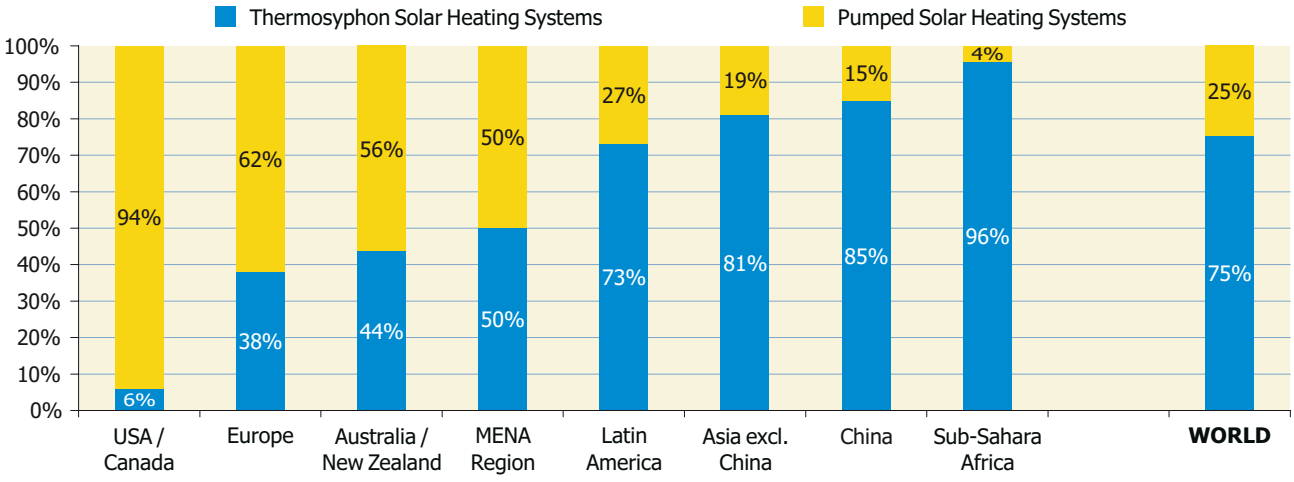


Sub-Sahara Africa: Mozambique, South Africa, Zimbabwe
Asia excluding China: India, Japan, Korea South, Taiwan, Thailand
Latin America: Brazil, Chile, Mexico
Europe: EU 28, Albania, Norway, Switzerland, Russia, Turkey
MENA Region: Israel, Jordan, Lebanon, Morocco, Tunisia

Figure 34: Distribution by type of solar thermal collector for the newly installed water collector capacity in 2012

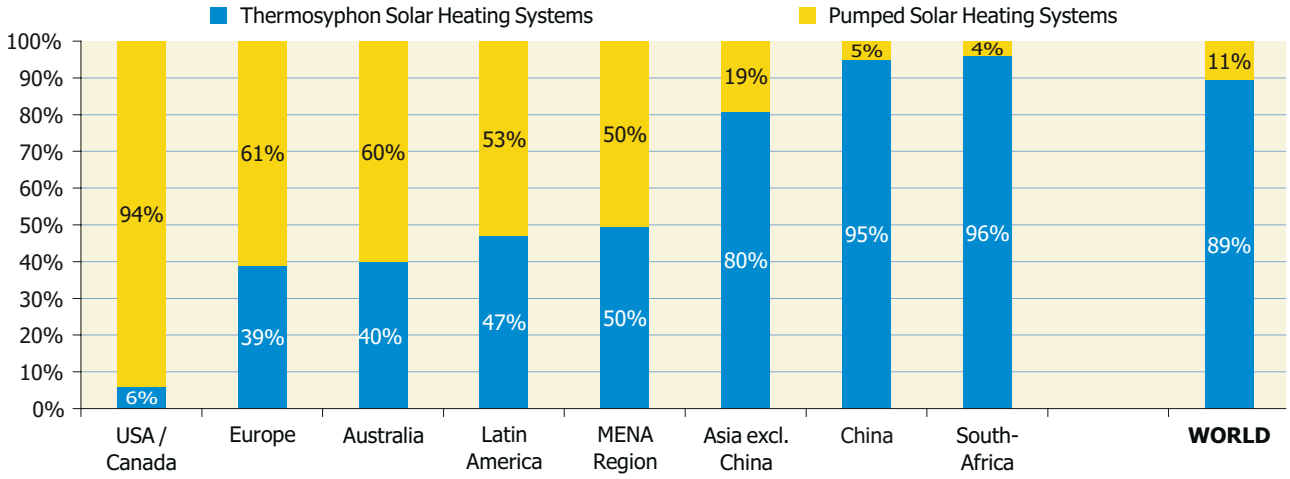
6.2 Distribution by type of system

Worldwide, about three quarters of all solar thermal systems installed are thermosiphon systems and the rest are pumped solar heating systems (**Figure 35**). Similar to the distribution by type of solar thermal collector in total numbers the Chinese market influenced the overall figures most, and in 2012 89% of the newly installed systems were estimated to be thermosiphon systems while pumped systems only accounted for 11% (**Figure 36**).



Sub-Sahara Africa: Namibia, South Africa
Asia excluding China: India, Japan, Korea South, Taiwan, Thailand
Latin America: Brazil, Chile
Europe: EU 27, Albania, Norway, Switzerland, Turkey
MENA Region: Israel, Jordan, Lebanon, Tunisia

Figure 35: Distribution by type of system for the total installed glazed water collector capacity in operation by the end of 2012



Sub-Sahara Africa:	Mozambique, South Africa
Asia excluding China:	India, Japan, Korea South, Taiwan, Thailand
Latin America:	Brazil, Chile
Europe:	EU 28, Albania, Norway, Switzerland, Russia, Turkey
MENA Region:	Israel, Jordan, Lebanon, Tunisia

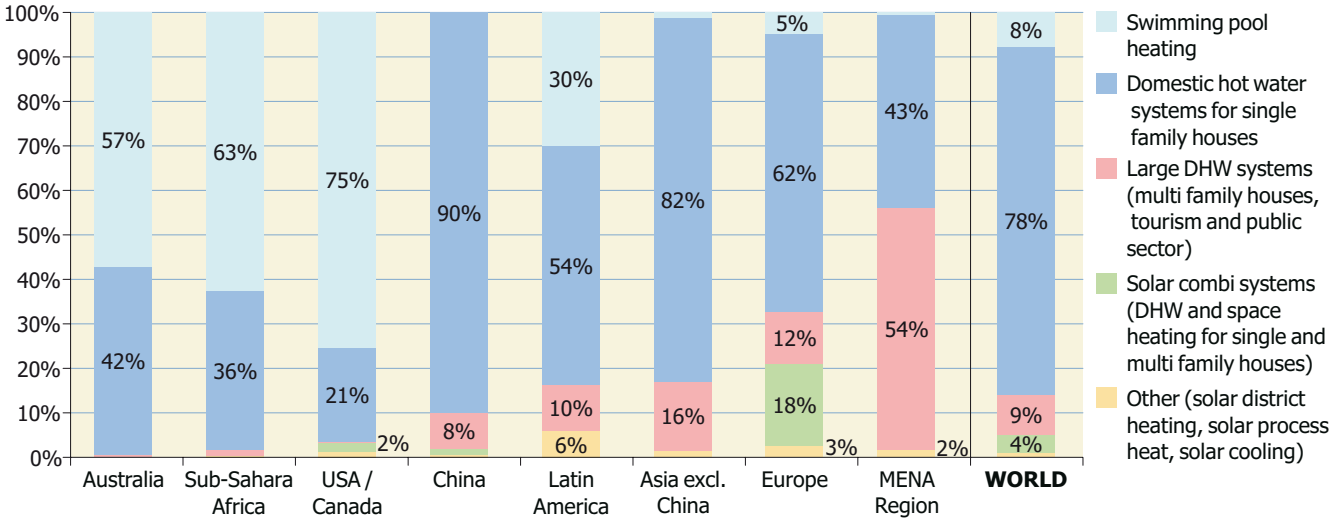
Figure 36: Distribution by type of system for the newly installed glazed water collector capacity in 2012

In general, thermosiphon systems are more common in warm climates such as in Africa, Latin America, southern Europe and the MENA region. In these regions thermosiphon systems are more often equipped with flat plate collectors, while in China, the typical thermosiphon system for domestic hot water preparation is equipped with evacuated tubes.

6.3 Distribution by kind of application

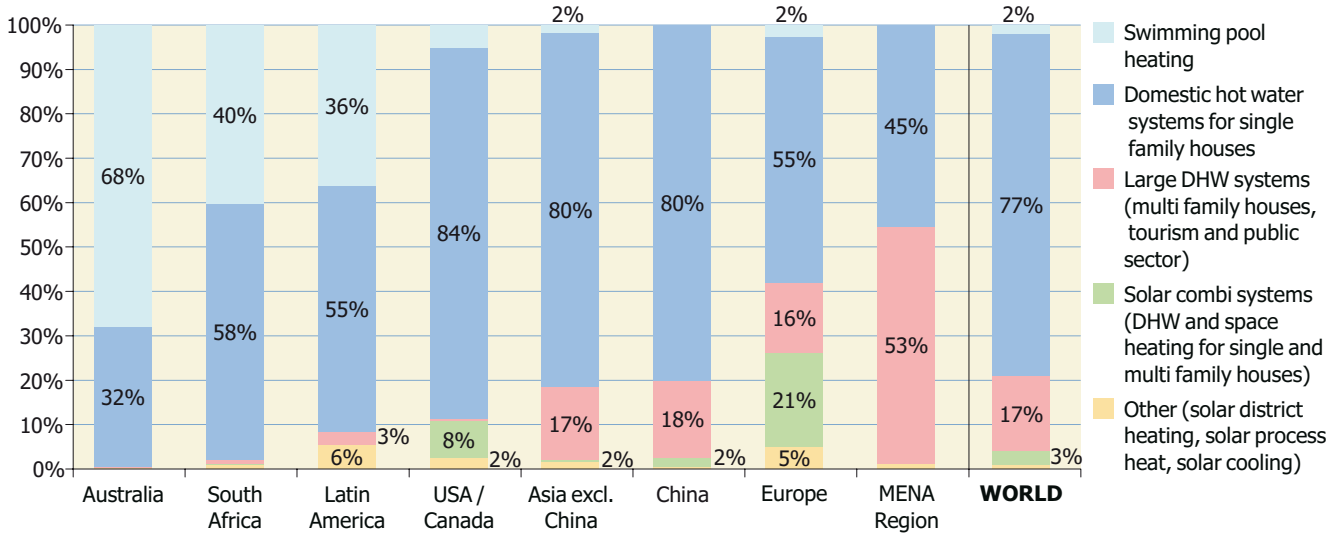
The calculated number of water-based solar thermal systems in operation by the end of 2012 was round 78 million (**Table 5**). Of these, 8% were used for swimming pool heating, 78% were used for domestic hot water preparation in single family houses and 9% were attached to larger domestic hot water systems for multifamily houses, hotels, hospitals, schools, etc. Around 4% of the worldwide installed capacity supplied heat for both domestic hot water and space heating (solar combi-systems). The remaining systems accounted for around 1% or almost 4 million square meters of solar thermal collectors and delivered heat to district heating networks, industrial processes or thermally driven solar cooling applications (**Figure 37**).

Compared to the cumulated installed capacity, the share of swimming pool heating was much less for new installations (8% of total capacity and only 2% of newly installed capacity). And to a lower extent this was also true for domestic hot water systems in single family houses. Here the share shows a declining trend, but with a share of 77% in 2012 this is still the most common application for solar thermal systems worldwide. The share of large-scale domestic hot water applications tended to increase (9% of total capacity and 17% of newly installed capacity) while the share of solar-combi systems remained at a low level of 3–4% worldwide (**Figure 38**).



DHW Domestic hot water
Sub-Sahara Africa: Namibia, South Africa
Asia excluding China: India, Japan, Korea South, Taiwan,
Latin America: Brazil, Chile, Mexico
Europe: EU 18, Albania, Norway, Switzerland, Russia, Turkey
MENA Region: Israel, Jordan, Lebanon, Tunisia

Figure 37: Distribution of solar thermal systems by application for the total installed water collector capacity by economic region in operation by the end of 2012

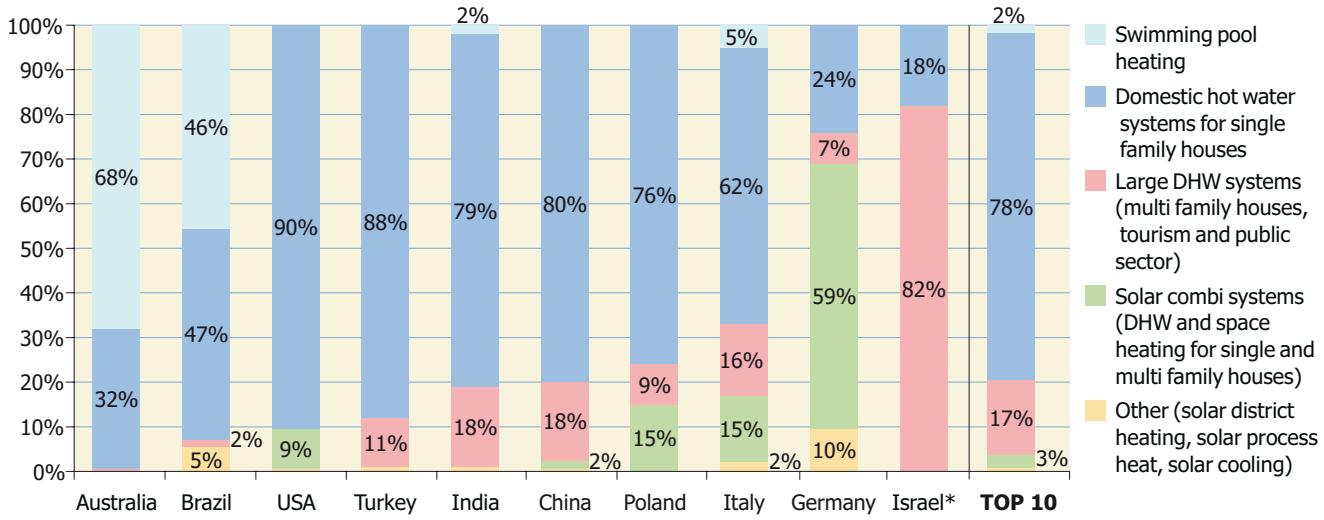


DHW Domestic hot water
Asia excluding China: India, Japan, Korea South, Taiwan, Thailand
Latin America: Brazil, Chile, Mexico
Europe: EU 18, Albania, Norway, Switzerland, Russia, Turkey
MENA Region: Israel, Jordan, Lebanon, Tunisia

Figure 38: Distribution of solar thermal systems by application for the newly installed water collector capacity by economic region in 2012

Of the top 10 markets in terms of newly installed glazed water collector capacity, Germany, Italy, Poland, India, and Brazil have the most sophisticated markets for different solar thermal applications (**Figure 39**). The applications include domestic hot water preparation, space heating of single and multi-family houses, and hotels. In addition a noteworthy share of other applications include those for solar district heating, solar process heating and solar cooling.

It should be noted that some countries appear to "specialize" in certain applications. In Denmark, for example, more than two thirds of the 2012 newly installed capacity was large-scale solar thermal systems attached to district heating networks. The data shows that 40,000 m² of solar assisted solar thermal systems were installed in Denmark in 2011, 76,000 m² in 2012, and another 96,000 m² in 2013. By end of 2013 fifty large-scale solar district heating plants with an average system size of around 7,800 m² were installed in Denmark (see **Chapter 7.2**). In India a notable share of concentrating solar thermal collectors are in use and the most commonly used are Scheffler dishes. They are used for community cooking in temples, prisons, student hostels, community places of stay, etc. Moreover, solar process heat installations with both concentrating and conventional non-concentrating collectors are increasing due to rising oil prices.



* In the MENA region (especially in Israel), but also in China, it is very common to equip multifamily houses with thermosiphon systems for domestic hot water preparation. A typical system is connected to one apartment. By contrast, in many European countries large pumped DHW systems in multifamily houses supply DHW or both DHW and space heating to the entire building. When interpreting the figures in **Chapter 6.3** this has to be considered.

Figure 39: Distribution of solar thermal systems by application for the 10 leading markets of the newly installed glazed water collector capacity in 2011

7 Exceptional markets and applications for solar thermal systems

7.1 Overview of global megawatt-scale solar thermal applications

Megawatt-scale solar supported district heating systems and solar heating and cooling applications in the commercial and industrial sector have gained increasing interest all over the world in recent years, and several ambitious projects have been successfully implemented.

In June 2013 the world's largest collector field was commissioned in Chile. The installation with a maximum thermal peak capacity of 32 MW covers a total of 39,300 m² of flat plate collector area connected to 4,000 m³ thermal energy storage. The projected thermal energy output is 51.8 GWh per year. The solar thermal system is designed to cover 85% of the process heat demand needed to refine copper at the world´s largest copper mine[7].

The world's largest solar district heating plant started its operation in February 2014 in Dronninglund, Denmark. The collector field, with a collector area of 37,275 m² (26 MW_{th}) together with a seasonal storage, is designed to cover around 50% of the total annual heat demand of 1,400 connected customers. The collector field works together with a 60,000 m³ pit heat storage, gas motors for combined heat and power production (CHP), an absorption heat pump, a biomass boiler and a back-up oil boiler. Due to the large storage the gas motors will always be able to produce electricity when the electricity price is high—even when there is no heat load (as the storage then can absorb the heat production)[8]. A system similar to the one in Dronninglund is installed in the Danish city of Marstal[9] and more so-called smart district heating plants with large-scale solar thermal systems and seasonal storages are scheduled to be built in Denmark.

In Riyadh, Saudi Arabia another large-scale solar district heating plant was commissioned in July 2011. The solar thermal plant with a total capacity of 25 MW_{th} (36.305 m²) is connected to a heating network for the supply of space heating and domestic hot water at a university campus[10]. Another successful solar supported heating network was implemented in Alberta, Canada. The Drake Landing community uses a 1.6 MW_{th} (2.293 m²) centralized solar thermal plant connected to a seasonal storage to supply more than 90% of the energy needed for space heating of 52 detached energy efficient homes[11].

In Singapore, a large-scale solar thermal heating and cooling installation with a total capacity of 2.73 MW_{th} (3,900 m²) started operation in 2011. The roof mounted solar thermal plant is connected to a 1.76 MW_{th} absorption chiller and supplies hot water and cooling to about 2,500 students, who live and study at a newly created 76,000 m² campus[12].

Probably the largest solar thermal system in the United States is a solar process heat application that was dedicated in April 2012 in North Carolina. The 5.5 MW_{th} (7,800 m²) solar thermal system equipped with flat plate collectors supplies hot water to a turkey processing plant, lessening the use of propane gas[13].

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7 http://www.sunmark.com/

8 For further information go to http://task45.iea-shc.org/

9 http://sunstore4.eu/

10 http://solarthermalworld.org/content/saudi-arabia-worlds-biggest-solar-thermal-plant-operation

11 http://www.dlsc.ca/

12 http://www.solid.at/

13 http://solarthermalworld.org/content/usa-contractor-runs-7804-m2-collector-system-prestage-foods-factory

The largest solar process heat applications installed in China are connected to dyeing and weaving mill factories. A system with a thermal peak capacity of 9.1 MW_{th} (13,000 m²) was constructed in the province of Zhejiang and two other projects of 10.5 MW_{th} (15,000 m²) have been commissioned in the neighboring province of Jiangsu.

More examples of solar process heat applications can be found at **http://ship-plants.info/**.

7.2 Large-scale solar district heating and cooling applications in Europe

In the Scandinavian countries of Denmark and Sweden, but also in Austria, Germany, Spain and Greece large-scale solar thermal applications connected to local or district heating grids have been in use since the early 1980s.

By the end of 2013, 192 large-scale solar thermal systems >350 kW_{th} (500 m²) connected to heating networks and 17 systems connected to cooling networks were in operation in Europe. The total installed capacity of these systems equaled 423 MW_{th} (about 600,000 m²). The average system size was 2.0 MW_{th} or 2,900 m².

In summary, 37 systems larger than 3.5 MW_{th} or 5,000 m² were reported with most installations in Denmark (30) followed by Germany (2), Sweden (1), Austria (1), the Netherlands (1), France (1) and Norway (1).

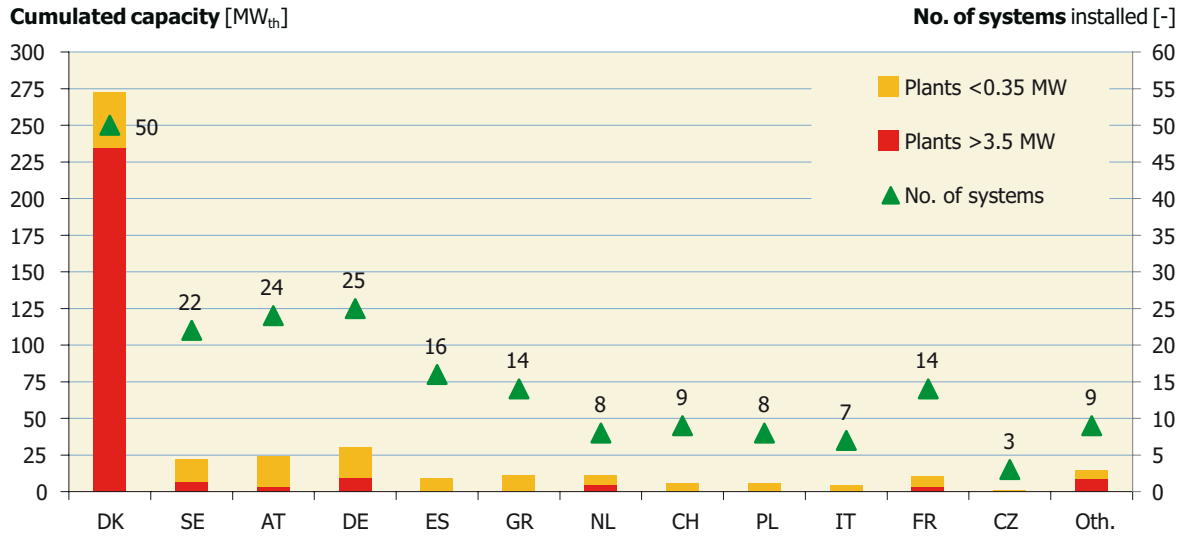

Figure 40: European large-scale solar heating systems by end of 2013
(Source: Jan-Olof Dalenbäck—Chalmers University of Technology)

By end of 2013, 9 of the 10 largest European solar thermal systems were installed in Denmark: Dronninglund (37,275 m²), Marstal (33,300 m²), Gråsten (19,017 m²), Braedstrup (18,612 m²), Tarm (18,585 m²), Vojens (17,500 m²), Ringkøbing (15,000 m²), Oksbøl (14,745 m²) and Jægerspris (13,300 m²). The only system within the top 10 ranking outside of Denmark was commissioned in 2013 in Akershus, Norway (12,581 m²).

The market for solar supported district heating networks in Denmark has been booming for several years and is driven by high taxes for fossil fuels and an energy supply system that is characterized by decentralization on the one hand and a high share of wind energy for electricity production on the other hand. This together with the liberalized market mechanisms for electricity in Europe and low solar thermal system prices for large-scale systems make solar thermal heat in Denmark even competitive against natural gas driven combined heat and power systems in many cases[14].

14 More information about the (Danish) Solar District Heating success story in Europe can be found here: http://www.solar-district-heating.eu/ and here http://www.solvarmedata.dk/side5696.html

7.3 Market for solar air conditioning and cooling applications

Solar cooling applications convert the energy from the sun into cold by means of driving a thermal cooling machine with thermal energy generated with solar thermal collectors.

By the end of 2013, an estimated 1,050 solar cooling systems were installed worldwide. The marked showed a positive trend between 2004 and 2013, but the growth rates tended to decrease from 32% in 2007/2008 to 11% in 2012/2013.

Approximately 80% of the solar cooling installations worldwide are installed in Europe, most notably in Spain, Germany and Italy. The majority of these systems is equipped with flat plate or evacuated tube collectors. By contrast some examples for thermal cooling machines driven by concentrated solar thermal energy (with concentrating solar thermal collectors such as parabolic troughs or Fresnel collectors) were reported from India, Australia and Turkey[15].

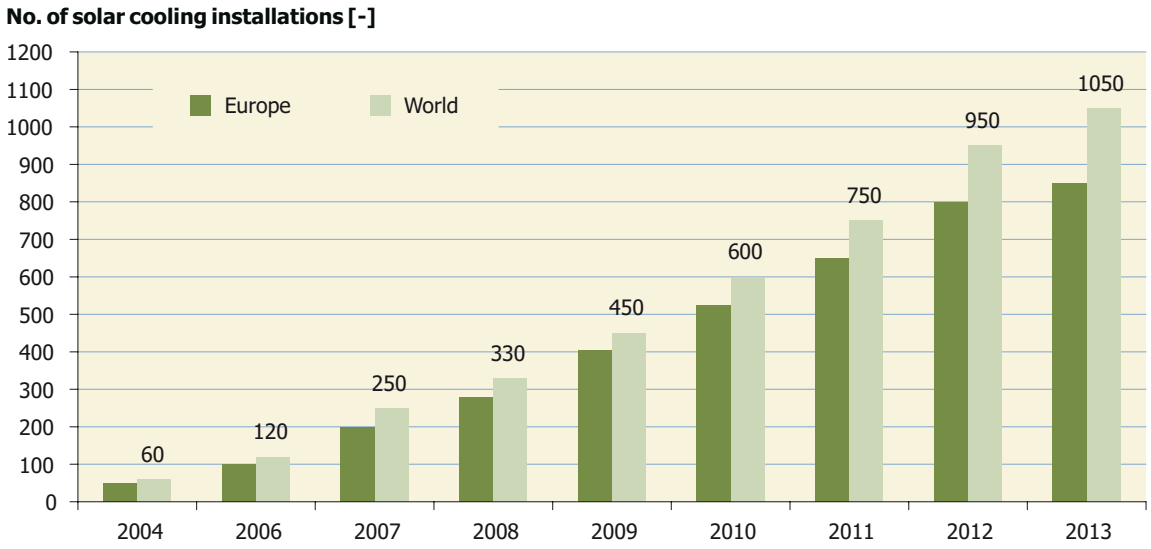

Figure 41: Market development 2004–2013 of small to large-scale solar air conditioning and cooling systems *(Source: Climasol, EURAC, Fraunhofer ISE, Green Chiller, Rococo, Solem Consulting, Tecsol)*

The overall number of systems installed to date indicates that solar cooling is still a niche market, but one which is developing. Since 2007, a cost reduction of about 50% has been realized as a result of the further standardization of the solar cooling kits.

15 Jakob U. (2013): Status and Perspective of Solar Cooling outside of Australia; Australian Solar Cooling 2013 Conference, Sydney 2013

7.4 Good practice examples of world-wide installed solar process heat applications

A variety of industrial processes demand vast amounts of thermal energy, which makes the industrial sector a promising market for solar thermal applications. Depending on the temperature level of the needed heat, different types of solar thermal collectors are used—air collectors, flat plate and evacuated tube collectors for temperatures at or below 100°C to concentrating solar thermal collectors such as parabolic troughs, Fresnel collectors or Scheffler dishes for temperatures up to 400°C.

Currently Solar Heat for Industrial Processes (SHIP) is still a niche market, but a number of promising projects have been realized in the last couple of years ranging from small-scale demonstration plants to very large systems, such as the world's largest solar thermal plant in Chile, which delivers heat for the electro-winning of copper (see **section 7**).

Currently, 124 SHIP applications are reported to be in operation all over the world with a cumulated installed capacity of over 93 MW_{th} (133,200 m²). Of that, 18 systems are larger than 1,000 m² and another 25 systems are between 500–1,000 m² (**Figure 42**).

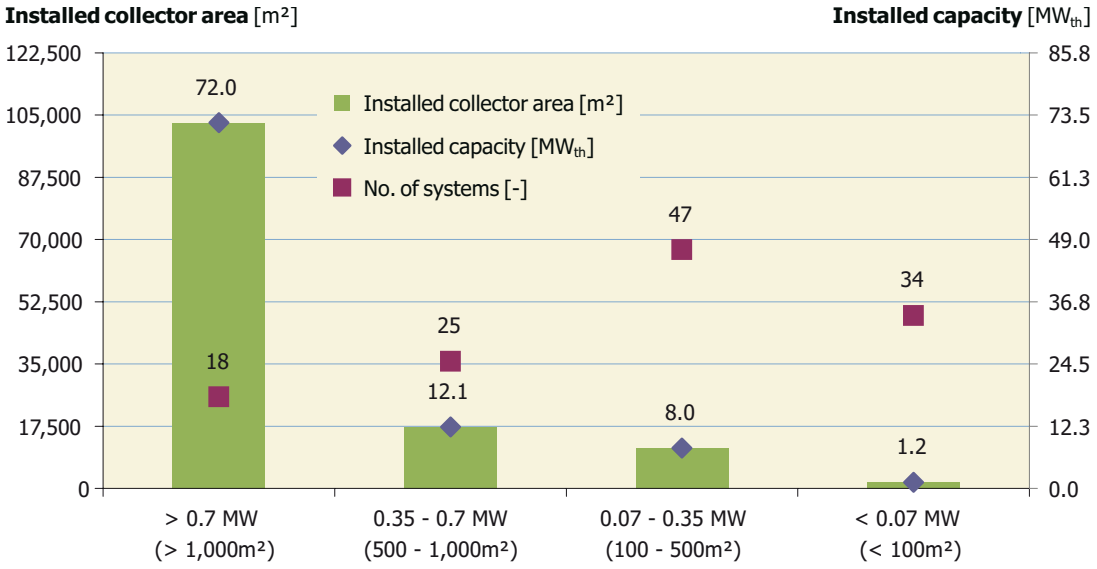

Figure 42: Global solar process heat applications in operation
(Source: IEA SHC Task49/IV SHIP database, accessed on 2014-05-16)

The SHIP database was created within the framework of IEA SHC Task 49/IV. This online database contains an overview of existing solar thermal plants worldwide. Each plant description contains detailed information, for example, location, size of the collector field, collector technology used, integration point in the production process and costs.

The SHIP database can be accessed by private users and it is the intention to continuously add new and existing SHIP applications in order to spread knowledge about the possibilities offered by this technology.

The database can be found at **http://ship-plants.info/**

7.5 Market for Solar Air Heating Systems

Solar air heating is a solar thermal technology in which the energy from the sun heats air. In colder climates, space heating is usually the largest use of building energy and it is the air in the buildings that is heated. Space heating consumes much more energy than hot water in most buildings. Solar air heating systems can be building integrated and typically reduce between 20–30% of conventional energy used for heating buildings.

The air is generally taken off the top of the wall (since hot air rises) and the heated or pre-heated fresh air is then connected to existing or new fans and ducted into the building via the ventilation system.

Solar air heaters are also common in agricultural applications primarily for drying.

Solar air heating systems have been used globally for the past 30 years by schools, municipalities, military, agricultural and commercial and industrial entities as well as in residential buildings. Wall mounted systems are common and take advantage of the lower winter sun angles and eliminate any snow accumulation typical of roof mounted systems. Storage of the heat is possible, but most solar air systems do not include storage to minimize costs.

Solar space heating with air collectors has not been common in Europe, likely due to the lack of an European test standard for air collectors, but in North America, building integrated solar air collectors are the most popular form of solar thermal systems in the commercial, industrial and institutional markets due to their low cost and architectural integration into buildings.

8 Appendix

8.1 Methodological approach for the energy calculation

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

- Only water collectors were used in the calculations (unglazed water collectors, flat-plate collectors and evacuated tube collectors). Air collectors were not included.
- For each country, the cumulated water collector area was allocated to the following applications (based on available country market data):
  - Solar thermal systems for swimming pool heating
  - Solar domestic hot water systems for single-family houses,
  - Solar domestic hot water systems for multifamily houses including the tourism sector as well as the public sector (to simplify the analysis solar district heating systems, solar process heat and solar cooling applications were also allocated here), and
  - Solar combi systems for domestic hot water and space heating for single- and multifamily houses.
- Reference systems were defined for each country and for each type of application (pumped or thermosiphon solar thermal system).
- The number of systems per country was determined from the share of collector area for each application and the collector area defined for the reference system.

Apart from the reference applications and systems mentioned above, reference collectors and reference climates were determined. On the basis of these boundary conditions, simulations were performed with the simulation program T-Sol [T-Sol, Version 4.5 Expert, Valentin Energiesoftware, www.valentin.de] and gross solar yields for each country and each system were obtained. The gross solar yields refer to the solar collector heat output and do not include heat losses through transmission piping or storage heat losses[16].

The amount of final energy saved is calculated from the gross solar yields considering a utilization rate of the auxiliary heating system of 0.8. Final energy savings are expressed in tons of oil equivalent (toe): 1 toe = 11,630 kWh.

Finally, the CO_2 emissions avoided by the different solar thermal applications are quoted as kilograms carbon dioxide equivalent ($kgCO_2e$) per tons of oil equivalent: 1 toe = 3.233 t CO_2e[17]

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 therefore relate to fuel oil. It is obvious that not all solar thermal systems 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 following tables describe the key data of the reference systems in the different countries, the location of the reference climate used and the share of the total collector area in use for the respective application. Furthermore, a hydraulic scheme is shown for each reference system.

16 Using gross solar yields for the energy calculations is based on a definition for Renewable Heat by EUROSTAT and IEA SHC. In editions of this report prior to 2011 solar yields calculated included heat losses through transmission piping and hence energy savings considered were about 5 to 15% less depending on the system, the application and the climate.

17 Source: Defra/DECC 2013

8.1.1 Reference systems for swimming pool heating

The information in **Table 6** refers to the total capacity of water collectors in operation used for swimming pool heating as reported from each country by the end of 2012.

Country*	Reference climate	Total collector area [m²]	Collector area per system [m²]	Total number of systems	Specific solar yield [kWh/m²a]
Australia	Sydney	4,185,763	34	123,111	466
Austria	Graz	558,601	200	2,793	283
Brazil	Brasília	2,271,569	200	11,358	375
Canada	Montreal	545,294	200	2,726	386
Cyprus	Nicosia	2,147	200	11	508
Czech Republic	Prague	526,194	200	2,631	303
Denmark	Copenhagen	20,515	200	103	295
France	Paris	23,583	200	118	328
Germany	Wurzburg	585,600	200	2,928	314
Hungary	Budapest	27,996	200	140	344
India	New-Delhi	161,275	200	806	529
Israel	Jerusalem	31,817	200	159	568
Italy	Bologna	172,338	200	862	442
Jordan	Amman	5,940	200	30	578
Mexico	Mexico City	831,508	200	4,158	311
Netherlands	Amsterdam	418,783	200	2,094	272
Norway	Oslo	1,873	200	9	316
Portugal	Lisbon	1,940	200	10	421
Russia	Moscow	16	200	0	269
South Africa	Johannesburg	867,194	200	4,336	505
Spain	Madrid	148,141	200	741	472
Sweden	Gothenburg	130,050	200	650	295
Switzerland	Zürich	211,540	200	1,058	277
Taiwan	Taipei	10,039	200	50	319
United States	LA, Indianapolis	17,594,787	200	87,974	387
	TOTAL	29,334,505		248,854	
	AVERAGE		193		382

* Countries not listed in this table did not report any share of collectors used for swimming pool heating.

Table 6: Solar thermal systems for swimming pool heating by end of 2012

Figure 43 shows the hydraulic scheme of the swimming pool reference system as used for the simulations of the solar energy yields.

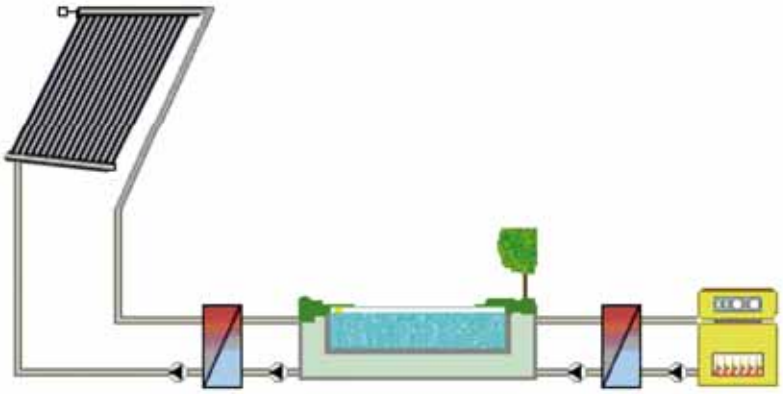

Figure 43: Hydraulic scheme of the swimming pool reference system

8.1.2 Reference systems for domestic hot water preparation in single-family houses

The information in **Table 7** refers to the total capacity of water collectors in operation used for domestic hot water heating in single family houses at the end of 2012 as reported by each country.

Country	Reference climate	Total collector area [m²]	Collector area per system [m²]	Total number of systems	Specific solar yield [kWh/m² a]	Type of system
Albania	Tirana	31,864	2.5	12,746	713	TS
Australia	Sydney	3,103,607	3.5	886,745	844	PS
Austria	Graz	2,051,412	6.0	341,902	451	PS
Barbados	Grantley Adams	131,690	4.0	32,923	882	TS
Belgium	Brussels	429,533	4.0	107,383	423	PDS / PS
Brazil	Brasília	5,211,723	4.0	1,302,931	809	TS
Bulgaria	Sofia	87,014	4.0	21,753	524	PS
Canada	Montreal	34,136	6.0	5,689	556	PS
Chile	Santiago de Chile	36,804	4.0	9,201	771	PS
China	Shanghai	231,930,000	4.0	57,982,500	592	TS
Croatia	Zagreb	120,000	4.0	30,000	539	PS
Cyprus	Nicosia	771,988	4.0	192,997	912	TS
Czech Republic	Prague	179,752	4.7	38,245	385	PS
Denmark	Copenhagen	279,756	4.0	69,939	454	PS
Estonia	Tallinn	6,520	4.0	1,630	432	PS
Finland	Helsinki	48,502	4.0	12,126	441	PS
France	Paris	943,337	3.2	294,793	496	PS
Germany	Wurzburg	7,314,300	6.0	1,219,050	424	PS
Greece	Athens	3,969,486	2.5	1,587,794	772	TS
Hungary	Budapest	139,980	6.0	23,330	473	PS
India	New-Delhi	4,773,740	4.0	1,193,435	882	TS
Ireland	Dublin	244,772	4.0	61,193	423	PS
Israel	Jerusalem	829,000	3.0	276,333	1,024	TS
Italy	Bologna	2,136,995	4.0	534,249	661	PS
Japan	Tokyo	4,372,329	4.0	1,093,082	586	TS
Jordan	Amman	894,475	4.6	194,451	986	TS
Korea, South	Seoul	909,805	4.0	227,451	525	PS
Latvia	Riga	4,040	4.0	1,010	462	PS
Lebanon	Beirut	447,100	4.0	111,775	860	TS
Lithuania	Vilnius	6,000	4.0	1,500	450	PS
Luxembourg	Luxembourg	39,800	4.0	9,950	450	PS
Macedonia	Skopje	12,100	4.0	3,025	627	PS
Malta	Luqa	48,293	4.0	12,073	868	PS
Mexico	Mexico City	335,543	4.0	83,886	718	PS
Morocco	Rabat	491,261	4.0	122,815	894	TS
Namibia	Windhoek	9,903	4.0	2,476	1,032	TS
Netherlands	Amsterdam	343,311	2.8	122,611	433	PDS / PS
New Zealand	Wellington	159,645	4.0	39,911	647	PS
Norway	Oslo	1,181	8.0	148	430	PS
Poland	Warsaw	848,050	6.0	141,342	397	PS
Portugal	Lisbon	725,414	4.0	181,354	804	PS
Romania	Bucharest	110,700	4.0	27,675	594	PS
Russia	Moscow	1,497	4.0	374	443	PS
Slovakia	Bratislava	147,000	6.0	24,500	481	PS
Slovenia	Ljubljana	155,044	6.0	25,841	424	PS
South Africa	Johannesburg	485,683	4.0	121,421	1,009	TS
Spain	Madrid	1,155,501	4.0	288,875	766	PS
Sweden	Gothenburg	34,200	4.0	8,550	383	PS
Switzerland	Zürich	706,147	5.7	123,885	426	PS
Taiwan	Taipei	1,404,065	4.8	292,514	616	TS
Thailand	Bangkok	120,360	4.0	30,090	854	TS
Tunisia	Tunis	625,155	2.8	223,270	902	TS
Turkey	Antalya	14,258,080	4.0	3,564,520	910	TS
United Kingdom	London	709,673	4.0	177,418	415	PS
United States	LA, Indianapolis	5,077,571	6.0	846,262	646	PS
Uruguay	Montevideo	12,571	4.0	3,143	682	TS
Zimbabwe	Harare	19,568	4.0	4,892	854	TS
	TOTAL	299,476,976		74,350,976		
	AVERAGE		4,3		640	

PS: pumped system
TS: thermosiphon system
PDS: pumped drain back system

Table 7: Solar thermal systems for domestic hot water heating in single family houses by end of 2012

Figure 44 shows the hydraulic scheme used for the energy calculation for all pumped solar thermal systems and **Figure 45** refers to the thermosiphon systems.

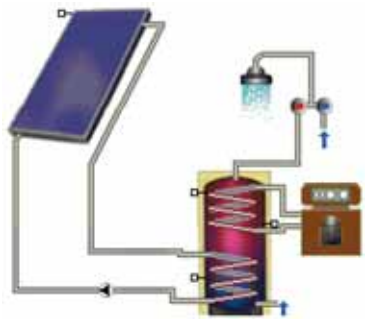

Figure 44: Hydraulic scheme of the domestic hot water pumped reference system for single family houses

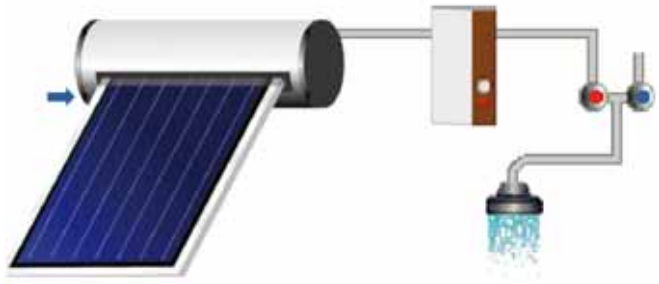

Figure 45: Hydraulic scheme of the domestic hot water thermosiphon reference system for single family houses

For the Chinese thermosiphon systems the reference system above was used, but instead of a flat plate collector as shown in **Figure 45** a representative Chinese vacuum tube collector was used for the simulation.

8.1.3 Reference systems for domestic hot water preparation in multifamily houses

The information in **Table 8** refers to the total capacity of water collectors in operation used for domestic hot water heating in multifamily houses at the end of 2012 as reported by each country.

Country	Reference climate	Total collector area [m²]	Collector area per system [m²]	Total number of systems	Specific solar yield [kWh/m² a]	Type of System
Albania	Tirana	80,057	50.0	1,601	694	PS
Australia	Sydney	36,630	50.0	733	725	PS
Austria	Graz	382,614	50.0	7,652	505	PS
Brazil	Brasília	778,763	50.0	15,575	658	PS
Bulgaria	Sofia	35,086	50.0	702	515	PS
Canada	Montreal	295,842	50.0	5,917	621	PS
Chile	Santiago de Chile	43,205	50.0	864	733	PS
China	Shanghai	21,904,500	50.0	438,090	502	PS
Cyprus	Nicosia	102,162	50.0	2,043	750	PS
Czech Republic	Prague	29,218	42.4	689	436	PS
Denmark	Copenhagen	356,709	50.0	7,134	414	PS
France	Paris	1,247,563	20.0	62,378	489	PS
Germany	Wurzburg	1,982,988	50.0	39,660	472	PS
Greece	Athens	148,392	50.0	2,968	642	PS
Hungary	Budapest	17,498	50.0	350	522	PS
India	New-Delhi	1,515,985	50.0	30,320	749	PS
Ireland	Dublin	8,159	50.0	163	425	PS
Israel	Jerusalem	3,316,000	3.0	1,105,333	919	PS
Italy	Bologna	620,418	50.0	12,408	593	PS
Japan	Tokyo	89,231	50.0	1,785	516	PS
Jordan	Amman	223,619	50.0	4,472	801	PS
Korea, South	Seoul	775,019	50.0	15,500	485	PS
Lebanon	Beirut	78,900	50.0	1,578	809	PS
Macedonia	Skopje	13,644	50.0	273	577	PS
Mexico	Mexico City	862,825	50.0	17,256	713	PS
Namibia	Windhoek	12,103	50.0	242	814	PS
Netherlands	Amsterdam	80,255	50.0	1,605	418	PS
Norway	Oslo	16,749	50.0	335	406	PS
Poland	Warsaw	302,875	50.0	6,058	447	PS
Portugal	Lisbon	226,934	40.0	5,673	705	PS
Russia	Moscow	16,926	50.0	339	416	PS
Slovenia	Ljubljana	3,736	50.0	75	477	PS
South Africa	Johannesburg	10,635	50.0	213	867	PS
Spain	Madrid	1,422,156	50.0	28,443	676	PS
Sweden	Gothenburg	45,900	50.0	918	430	PS
Switzerland	Zürich	84,316	20.0	4,216	457	PS
Taiwan	Taipei	20,079	33.8	594	518	PS
Tunisia	Tunis	14,063	50.0	281	756	PS
Turkey	Antalya	1,239,833	50.0	24,797	750	PS
United States	LA, Indianapolis	32,484	50.0	650	688	PS
	TOTAL	38,474,071		1,849,883		
	AVERAGE		46.5		602	

PS: pumped system

Table 8: Solar thermal systems for domestic hot water heating in multifamily houses by end of 2012

Figure 46 shows the hydraulic scheme of domestic hot water reference system for multifamily houses as used for the simulations of the solar energy yields. As opposed to small-scale domestic hot water systems, all large-scale systems are assumed to be pumped solar thermal systems.

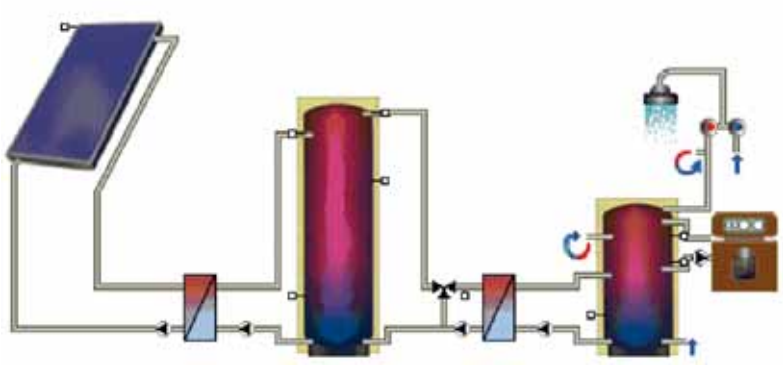

Figure 46: Hydraulic scheme of the domestic hot water pumped reference system for multifamily houses

8.1.4 Reference systems for domestic hot water preparation and space heating in single and multifamily houses (solar combi-systems)

The information in **Table 9** refers to the total capacity of water collectors in operation used for domestic hot water heating in multifamily houses at the end of 2012 as reported by each country.

Country	Reference climate	Total collector area [m²]	Collector area per system [m²]	Total number of systems	Specific solar yield [kWh/m² a]	Type of System
Austria	Graz	1,935,121	14.0	138,223	369	PS
China	Shanghai	3,865,500	12.0	322,125	388	PS
Cyprus	Nicosia	14,214	12.0	1,184	663	PS
Czech Republic	Prague	156,574	8.4	18,640	351	PS
Denmark	Copenhagen	6,429	12.0	536	348	PS
France	Paris	143,859	11.0	13,078	370	PS
Germany	Wurzburg	6,956,712	12.0	579,726	378	PS
Greece	Athens	4,122	12.0	344	558	PS
Hungary	Budapest	47,827	15.0	3,188	422	PS
Ireland	Dublin	19,038	12.0	1,586	364	PS
Italy	Bologna	517,015	12.0	43,085	499	PS
Netherlands	Amsterdam	22,293	6.0	3,715	352	PS
Norway	Oslo	16,323	20.0	816	342	PS
Poland	Warsaw	60,575	12.0	5,048	365	PS
Portugal	Lisbon	15,517	12.0	1,293	593	PS
Russia	Moscow	459	15.0	31	350	PS
Slovenia	Ljubljana	28,020	12.0	2,335	362	PS
Spain	Madrid	237,026	10.0	23,703	619	PS
Sweden	Gothenburg	239,850	10.0	23,985	389	PS
Switzerland	Zürich	263,488	11.0	23,953	385	PS
United States	LA, Indianapolis	504,759	12.0	42,063	579	PS
	TOTAL	15,054,718		1,248,657		
	AVERAGE		12.5		431	

combi-system system for the supply of domestic hot water and space heating
PS: pumped system

Table 9: Solar combi system reference for single and multifamily houses and the total collector area in operation in 2011

Figure 47 shows the hydraulic scheme of domestic hot water reference system for multifamily houses as used for the simulations of the solar energy yields.

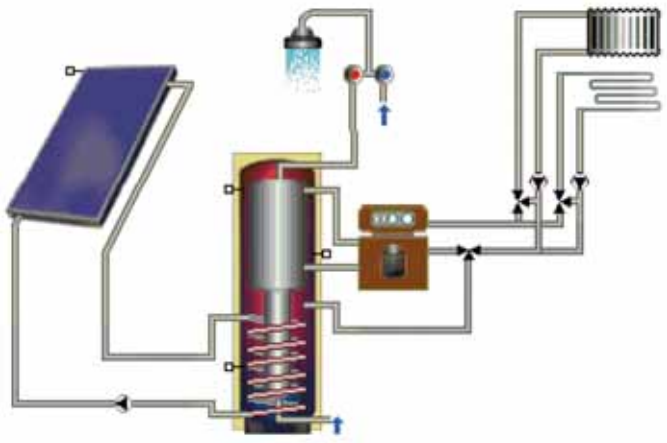

Figure 47: Hydraulic scheme of the solar-combi reference system for single and multifamily houses

8.2 Reference collectors

8.2.1 Data of the reference unglazed water collector for swimming pool heating

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

8.2.2 Data of the reference collector for all other applications except for China

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

8.2.3 Data of the Chinese reference vacuum tube collector

$\eta = 0.74$ $a_1 = 2.5$ [W/m²K] $a_2 = 0.013$ [W/m² K²]

8.3 Reference climates

No.	Country	Reference climate	Horizontal irradiation [kWh/m²·a]	Inclined irradiation [kWh/m²·a]	Avg. Outside air temp. [°C]
1	Albania	Tirana	1,604	1,835	13.5
2	Australia	Sydney	1,674	1,841	18.1
3	Austria	Graz	1,126	1,280	9.2
4	Barbados	Grantley Adams	2,016	2,048	27.4
5	Belgium	Brussels	971	1,095	10.0
6	Brazil	Brasília	1,793	1,838	22.0
7	Bulgaria	Sofia	1,188	1,304	10.1
8	Canada	Montreal	1,351	1,568	6.9
9	Chile	Santiago d. C.	1,753	1,850	14.5
10	China	Shanghai	1,282	1,343	17.1
11	Croatia	Zagreb	1,212	1,352	11.3
12	Cyprus	Nicosia	1,886	2,098	19.9
13	Czech Rep.	Prague	998	1,111	7.9
14	Denmark	Copenhagen	989	1,164	8.1
15	Estonia	Tallinn	960	1,126	5.3
16	Finland	Helsinki	948	1,134	4.6
17	France	Paris	1,112	1,246	11.0
18	Germany	Wurzburg	1,091	1,225	9.5
19	Greece	Athens	1,585	1,744	18.5
20	Hungary	Budapest	1,199	1,346	11.0
21	India	New-Delhi	1,961	2,275	24.7
22	Ireland	Dublin	949	1,091	9.5
23	Israel	Jerusalem	2,198	2,400	17.3
24	Italy	Bologna	1,419	1,592	14.3
25	Japan	Tokyo	1,175	1,287	16.7
26	Jordan	Amman	2,145	2,341	17.9
27	Korea, South	Seoul	1,161	1,280	12.7
28	Latvia	Riga	991	1,187	6.3
29	Lebanon	Beirut	1,935	2,132	19.9
30	Lithuania	Vilnius	1,001	1,161	6.2
31	Luxembourg	Luxembourg	1,037	1,158	8.4
32	Macedonia	Skopje	1,381	1,521	12.5
33	Malta	Luqa	1,902	2,115	18.7
34	Mexico	Mexico City	1,706	1,759	16.6
35	Morocco	Rabat	2,011	2,281	17.2
36	Mozambique	Maputo	1,927	2,135	22.8
37	Namibia	Windhoek	2,363	2,499	21.0
38	Netherlands	Amsterdam	999	1,131	10.0
39	New Zealand	Wellington	1,401	1,542	13.6
40	Norway	Oslo	971	1,208	5.8
41	Poland	Warsaw	1,024	1,156	8.1
42	Portugal	Lisbon	1,686	1,875	17.4
43	Romania	Bucharest	1,324	1,473	10.6
44	Russia	Moscow	996	1,181	5.9
45	Slovakia	Bratislava	1,214	1,374	10.3
46	Slovenia	Ljubljana	1,115	1,231	9.8
47	South Africa	Johannesburg	2,075	2,232	15.6
48	Spain	Madrid	1,644	1,844	15.5
49	Sweden	Gothenburg	934	1,105	7.2
50	Switzerland	Zürich	1,094	1,218	9.6
51	Taiwan	Taipei	1,372	1,398	20.8
52	Thailand	Bangkok	1,765	1,898	29.1
53	Tunisia	Tunis	1,808	2,038	19.3
54	Turkey	Antalya	1,795	1,958	18.4
55	UK	London	943	1,062	12.0
56	USA	LA, Indianapolis	1,646	1,816	14.3
57	Uruguay	Montevideo	1,534	1,647	15.9
58	Zimbabwe	Harare	2,017	2,087	18.9

Source: T-Sol expert version 4.5 and Meteonorm version 6.1.

Table 10: Reference climates for the 58 countries surveyed

8.4 Population data

No	Country	2012	Region code
1	Albania	3,002,859	6
2	Australia	22,015,580	3
3	Austria	8,219,743	6
4	Barbados	287,733	4
5	Belgium	10,438,350	6
6	Brazil	199,321,400	4
7	Bulgaria	7,037,935	6
8	Canada	34,300,080	8
9	Chile	17,067,370	4
10	China	1,343,240,000	5
11	Croatia	4,480,043	6
12	Cyprus	1,138,071	6
13	Czech Republic	10,591,710	6
14	Denmark	5,543,453	6
15	Estonia	1,274,709	6
16	Finland	5,262,930	6
17	France (mainland)	65,630,690	6
18	Germany	81,305,860	6
19	Greece	10,767,830	6
20	Hungary	9,958,453	6
21	India	1,205,074,000	2
22	Ireland	4,722,028	6
23	Israel	7,590,758	7
24	Italy	61,261,250	6
25	Japan	127,368,100	2
26	Jordan	6,508,887	7
27	Korea, South	48,860,500	2
28	Latvia	2,191,580	6
29	Lebanon	4,140,289	7
30	Lithuania	3,525,761	6
31	Luxembourg	509,074	6
32	Macedonia	2,082,370	6
33	Malta	409,836	6
34	Mexico	117,299,200	4
35	Morocco	32,309,240	7
36	Mozambique	23,515,930	1
37	Namibia	2,165,828	1
38	Netherlands	16,730,630	6
39	New Zealand	4,327,944	3
40	Norway	5,021,106	6
41	Poland	38,415,280	6
42	Portugal	10,781,460	6
43	Romania	21,848,500	6
44	Russia	142,517,670	6
45	Slovakia	5,483,088	6
46	Slovenia	1,996,617	6
47	South Africa	48,810,430	1
48	Spain	47,042,980	6
49	Sweden	9,573,256	6
50	Switzerland	7,925,517	6
51	Taiwan	23,234,940	2
52	Thailand	67,245,400	2
53	Tunisia	10,732,900	7
54	Turkey	79,749,460	6
55	United Kingdom	63,047,160	6
56	United States	313,914,000	8
57	Uruguay	3,316,328	4
58	Zimbabwe	12,619,600	1
Σ Solar Thermal World Statistics		4,424,753,696	63.0%
Σ Inhabitants world		7,020,760,225	100.0%

Data source: International Data Base of the U.S. Census Bureau http://www.census.gov/ipc/www/idb/country.php

Table 11: Inhabitants by the end of 2012 of the 58 surveyed countries in alphabetical order

Region Code / Region		Σ Inhabitants	Share
1	Sub-Sahara Africa	86,184,778	2.0%
2	Asia excl. China	1,455,189,038	34.3%
3	Australia / New Zealand	26,057,058	0.6%
4	Latin America	337,637,999	8.0%
5	China	1,336,718,015	31.5%
6	Europe	598,744,151	14.1%
7	MENA Region	60,721,971	1.4%
8	United States / Canada	345,081,566	8.1%
TOTAL		4,246,334,576	100.0%

Data source: International Data Base of the U.S. Census Bureau
http://www.census.gov/ipc/www/idb/country.php

Sub-Saharan Africa: Mozambique, Namibia, South Africa, Zimbabwe
Asia excluding China: India, Japan, Korea South, Taiwan, Thailand
Latin America: Brazil, Chile, Mexico, Uruguay
Europe: EU 28, Albania, Macedonia, Norway, Switzerland, Russia, Turkey
MENA Region: Israel, Jordan, Lebanon, Morocco, Tunisia

Table 12: Inhabitants per economic region by the end of 2011

8.5 Market data of the previous years

The data presented in **Chapters 3 – 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 as well.

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 officials and major solar thermal trade associations in Gleisdorf, Austria in September 2004. The represented associations from Austria, Canada, Germany, the Netherlands, Sweden and the United States 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.

In order to ensure consistency of the calculations within this report the following tables provide data from the previous years. If necessary the numbers have been revised in 2013 compared to the data originally published in earlier editions of this report due to changes in methodology or the origin of the data for each country.

In the following **Table 13**, **Table 14** and **Table 15** these countries are highlighted accordingly and in **Chapter 8.6** (References) the respective data source is cited.

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed	FPC	ETC	unglazed	glazed	
Albania		7,480	82			7,562
Australia	680,000	362,351	35,837			1,078,188
Austria	5,539	268,093	11,805	350		285,787
Barbados**						
Belgium		31,306	6,995			38,301
Brazil	493,725	472,956				966,681
Bulgaria		7,750	650			8,400
Canada	84,690	11,481	11,493	89,560	2,267	199,491
Chile*		10,920				10,920
China		3,000,000	46,000,000			49,000,000
Croatia #		11,250				11,250
Cyprus	109	32,931	1,782			34,822
Czech Republic	53,000	73,898	17,719			144,617
Denmark		61,944	400			62,344
Estonia		100	400			500
Finland		4,000	2,000			6,000
France (mainland)		247,000	9,000			256,000
Germany		1,038,000	112,000			1,150,000
Greece		212,500	1,500			214,000
Hungary	2,400	14,700	6,300	300	150	23,850
India		608,436	280,369			888,805
Ireland		17,472	13,109			30,581
Israel		316,000				316,000
Italy		427,500	62,500			490,000
Japan		146,866	4,794		11,850	163,511
Jordan	5,940	79,621	12,654			98,215
Korea, South		69,803				69,803
Latvia		100	100			200
Lebanon**						
Lithuania		50	150			200
Luxembourg		3,500	1,000			4,500
Macedonia**						
Malta		1,759	1,101			2,860
Mexico	90,000	95,000	85,000		2,580	272,580
Morocco		69,260				69,260
Mozambique**						
Namibia		5,440	860			6,300
Netherlands	26,507	45,862	4,000			76,369
New Zealand**						
Norway	170	2,123	813			3,106
Poland		111,000	35,000			146,000
Portugal	353	186,990	302			187,645
Romania		8,500	7,000			15,500
Russia**						
Slovakia		12,800	2,200			15,000
Slovenia		15,000	4,000			19,000
South Africa	50,000	42,300	7,700			100,000
Spain	11,000	315,500	21,500			348,000
Sweden	17,191	13,567	7,132			37,890
Switzerland	11,944	129,026	15,746	8,000		164,716
Taiwan	2	115,938	11,811			127,751
Thailand*		18,200				18,200
Tunisia		72,200	12,500			84,700
Turkey*		1,333,970	348,000			1,681,970
United Kingdom		75,600	29,600			105,200
United States	937,856	225,383				1,163,239
Uruguay**						
Zimbabwe		450	75			525
TOTAL	2,470,426	10,433,875	47,186,980	98,210	16,847	60,106,338

* revised due to new / adapted database in 2014
\# added in 2014
** no available data for the year 2010

Table 13: Newly installed collector area in 2010 (revised 2014) [m²/a]

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed	glazed	evacuated tube	unglazed	glazed	
Albania		12,890	98			12,988
Australia	600,000	343,980	22,230	36,000	900	1,003,110
Austria	5,700	221,500	8,690		350	236,240
Barbados**						
Belgium		35,500	10,000			45,500
Brazil	512,099	517,517				1,029,616
Bulgaria		10,000	800			10,800
Canada	74,490	7,880	9,500	28,377	7,165	127,412
Chile*		19,037				19,037
China		2,880,000	54,720,000			57,600,000
Croatia #		14,500				14,500
Cyprus	142	26,794	1,643			28,579
Czech Republic	65,000	49,150	16,650			130,800
Denmark		61,897	504			62,401
Estonia		900	900			1,800
Finland		3,000	1,000			4,000
France (mainland)		242,200	8,800	553	117	251,670
Germany		1,152,000	118,000	428		1,270,428
Greece		230,000				230,000
Hungary	1,500	14,000	6,000	300	250	22,050
India		606,000	404,000			1,010,000
Ireland		12,538	8,232			20,770
Israel	2,500	370,984				373,484
Italy		339,300	50,700			390,000
Japan		155,264	1,802		10,773	167,839
Jordan		54,531	13,705			68,236
Korea, South		54,733				54,733
Latvia		1,000	800			1,800
Lebanon*		40,000	20,000			60,000
Lithuania		600	1,200			1,800
Luxembourg		3,500	1,000			4,500
Macedonia**						
Malta		2,335	480			2,815
Mexico	90,000	95,000	85,000	300		270,300
Morocco		71,429				71,429
Mozambique			130			130
Namibia**						
Netherlands	27,396	31,445	5,000			63,841
New Zealand**						
Norway	160	2,863	946			3,969
Poland		187,400	66,300			253,700
Portugal	235	126,227	736	204		127,402
Romania		8,500	7,000			15,500
Russia**						
Slovakia		19,320	3,680			23,000
Slovenia		9,000	3,000			12,000
South Africa	48,200	42,811	39,300			130,311
Spain	8,600	249,700	17,250	1,500		277,050
Sweden	22,601	15,654	5,153			43,408
Switzerland	9,040	129,142	8,721	9,000		155,903
Taiwan		100,386	11,061			111,447
Thailand*		18,900				18,900
Tunisia		64,300	8,000			72,300
Turkey*		1,301,075	504,600	1,570		1,807,245
United Kingdom		72,953	18,826	5,597		97,376
United States	747,900	220,000	11,400	15,500	6,000	1,000,800
Uruguay*						
Zimbabwe		230	320			550
TOTAL	2,215,563	10,249,865	56,223,156	99,329	25,555	68,813,468

* revised due to new / adapted database in 2013
\# added in 2014
** no available data for the year 2011

Table 14: Newly installed collector area in 2011 (revised 2014) [m²/a]

Country	Water Collectors			Air Collectors		TOTAL [m²]
	unglazed	glazed	evacuated tube	unglazed	glazed	
Albania		90,075	646			90,721
Australia	3,900,000	2,642,000	46,000	264,000	6,600	6,858,600
Austria	586,191	4,101,100	74,926		1,078	4,763,295
Barbados		131,690				131,690
Belgium	45,000	289,888	33,395			368,283
Brazil	1,789,227	5,351,866				7,141,093
Bulgaria*		112,650	1,450			114,100
Canada	719,364	55,316	27,921	334,426	11,781	1,148,808
Chile*		58,116				58,116
China		14,787,370	202,612,630			217,400,000
Croatia #		105,500				105,500
Cyprus	2,123	845,449	21,656			869,228
Czech Republic	418,000	299,743	74,925			792,668
Denmark	20,515	583,707	8,588	3,264	18,000	634,074
Estonia		3,030	1,690			4,720
Finland	11,779	27,251	5,472			44,502
France (mainland)	90,000	1,995,094	33,379			2,118,473
Germany	610,000	13,386,000	1,718,000		32,000	15,746,000
Greece		4,105,700	16,300			4,122,000
Hungary	12,000	133,700	36,100	1,500	1,200	184,500
India		4,457,384	522,616		16,320	4,996,320
Ireland		116,539	57,319			173,858
Israel	30,617	4,234,498		550		4,265,665
Italy	43,766	2,673,510	399,490			3,116,766
Japan		4,594,313	83,753		475,199	5,153,265
Jordan	5,940	818,889	230,969			1,055,798
Korea, South		1,621,050				1,621,050
Latvia		2,700	1,040			3,740
Lebanon		190,000	270,000			460,000
Lithuania		2,700	1,500			4,200
Luxembourg		31,800	3,850			35,650
Macedonia		25,020	724			25,744
Malta		34,502	11,782			46,284
Mexico	722,008	777,055	230,813		7,983	1,737,859
Morocco*		412,689				412,689
Mozambique #		130				130
Namibia		20,699	1,307			22,006
Netherlands	410,239	418,478	14,000			842,717
New Zealand	7,025	142,975	9,644			159,645
Norway	2,090	16,885	1,958		1,019	21,952
Poland		694,000	215,500			909,500
Portugal	1,946	861,963	15,000			878,909
Romania*		72,200	23,000			95,200
Russia #		11,504	1,010			12,514
Slovakia		119,420	20,080			139,500
Slovenia		154,050	16,250			170,300
South Africa	851,878	373,821	67,972			1,293,671
Spain	130,600	2,450,200	154,750			2,735,550
Sweden	130,000	256,000	60,000			446,000
Switzerland	212,260	864,440	61,160	876,000		2,013,860
Taiwan	85	2,070,686	86,522			2,157,294
Thailand*		97,700				97,700
Tunisia		518,800	44,000			562,800
Turkey		13,185,391	1,333,970			14,519,361
United Kingdom		490,097	160,301	14,000		664,398
United States	19,980,762	2,502,284	105,232	84,685	6,000	22,678,963
Uruguay		12,571				12,571
Zimbabwe		17,959	237			18,196
TOTAL 2010	30,733,415	94,450,147	208,918,828	1,578,425	577,180	336,257,996

* revised due to new / adapted database in 2013
\# added in 2014
** no available data for the year 2012

Table 15: Total collector area in operation by the end of 2011 (revised 2014) [m²]

8.6 References to reports and persons that have supplied the data

The production of the report, *Solar Heat Worldwide 2012 –2014 edition* was kindly supported by national representatives of the recorded countries or other official sources of information as cited below.

COUNTRY	CONTACT	SOURCE REMARKS
AlbaniaAlbania	**Edmond M. HIDO** EEC - Albania-EU Energy Efficiency Centre (EEC)	EEC - Albania-EU Energy Efficiency Centre
Australia	**David Ferrari** Sustainability Victoria	Sustainability Victoria Out of operation systems calculated by Sustainability Victoria
Austria	**Werner Weiss** AEE - Institute for Sustainable Technologies	Biermayr et al., 2013 http://www.nachhaltigwirtschaften.at/iea/results.html/id7253 Out of operation systems calculated by AEE INTEC
Belgium	**ESTIF – European Solar Thermal Industry Federation** **AEE INTEC**	Glazed water collectors: ESTIF, 2013 http://www.estif.org/statistics/st_markets_in_europe_2012/ Unglazed water collectors: AEE INTEC recordings Unglazed water collectors: AEE INTEC recordings
Brazil	**Marcelo Mesquita** Depto. Nac. de Aquecimento Solar da ABRAVA	DASOL ABRAVA Out of operation systems calculated based on DASOL ABRAVA long time recordings
Bulgaria	**ESTIF – European Solar Thermal Industry Federation** **AEE INTEC**	Glazed water collectors: ESTIF, 2013 (estimation) http://www.estif.org/statistics/st_markets_in_europe_2012/ Unglazed water collectors: AEE INTEC recordings http://www.estif.org/statistics/st_markets_in_europe_2012/
Canada	**Reda Djebbar** Natural Resources Canada	ClearSky Advisors Inc. Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2012) http://www.cansia.ca/sites/default/files/survey_of_active_solar_thermal_collectors_-_2012_-_july_17.pdf Out of operation systems considered
Chile		AEE INTEC, 2014 (estimation) Projected by AEE INTEC (0% growth rate 2011 / 2012)
China	**Hu Runqing** Center for Renewable Energy Development - Energy Research Institute (NDRC)	CSTIF - Chinese Solar Thermal Industry Federation Out of operation systems calculated by CSTIF
Croatia	**ESTIF – European Solar Thermal Industry Federation**	Glazed water collectors: ESTIF, 2013 http://www.estif.org/statistics/st_markets_in_europe_2012/
Cyprus	**Soteris Kalogirou** Cyprus University of Technology	Cyprus University of Technology; Energy Service, Ministry of Commerce, Industry & Tourism, Cyprus Out of operation systems considered for flat plate collectors only by AEE INTEC
Czech Republic	**Ales Bufka** Ministry of Industry and Trade	Ministry of Industry and Trade; Bufka, A.: Solar collectors in 2012 - statistical review

Denmark	**ESTIF – European Solar Thermal Industry Federation**	Glazed water collectors: ESTIF, 2013 http://www.estif.org/statistics/st_markets_in_europe_2012/
	AEE INTEC	Unglazed water collectors: AEE INTEC recordings
Estonia	**ESTIF – European Solar Thermal Industry Federation**	Glazed water collectors: ESTIF, 2013 (estimation) http://www.estif.org/statistics/st_markets_in_europe_2012/
Finland	**ESTIF – European Solar Thermal Industry Federation**	Glazed water collectors: ESTIF, 2013 (estimation) http://www.estif.org/statistics/st_markets_in_europe_2012/
	AEE INTEC	Unglazed water collectors: AEE INTEC recordings
France (mainland)	**Céline Coulaud** ADEME - Centre de Sophia Antipolis	Glazed water collectors: ADEME; Enerplan Unglazed water collectors: AEE INTEC recordings
	John Hollick SAHWIA - Solar Air Heating World Industry Association	Air collectors: SAHWIA
Germany	**Jan Knaack** BSW - Bundesverband Solarwirtschaft e.V.	Glazed water collectors: BSW Unglazed water collectors: AEE INTEC recordings http://www.solarwirtschaft.de/unsere-themen/zahlen-und-fakten.html Out of operation systems considered for unglazed water collectors only by AEE INTEC
	John Hollick SAHWIA - Solar Air Heating World Industry Association	Air collectors: SAHWIA
Greece	**Vassiliki Drosou** CRES - Centre for Renewable Energy Sources	Vassiliki Drosou (CRES), Costas Travasoras (EBHE)
Hungary	**Pál Varga** MÉGNAP- Hungarian Solar Thermal Industry Federation	MÉGNAP- Hungarian Solar Thermal Industry Federation
India	**Jaideep N. Malaviya** Malaviya Solar Energy Consultancy	Malaviya Solar Energy Consultancy (based on market survey)
Ireland	**Mary Holland** Sustainable Energy Authority of Ireland	Energy policy statistical support unit of Sustainable Energy Authority of Ireland Based on Grant scheme data; BER database
Israel	**Asher Vaturi** ICTAF - Israel Bureau of Statistics	Israel Bureau of Statistics, Israel Ministry of water and energy & The Max Stern Yezreel Valley College Out of operation systems (replacements) considered by ICTAF
Italy	**Valeria Verga** Assolterm - Associazione Italiana Solare Termico	Glazed water collectors: Assolterm processing of data by Price Waterhouse Coopers Unglazed water collectors: AEE INTEC recordings
Japan	**Yamashita Noriaki** ISEP - Institute for Sustainable Energy Policies	ISEP; Solar System Development Association (SSDA) Out of operation systems calculated by ISEP
Jordan		AEE INTEC, 2014 (estimation) Projected by AEE INTEC (0% growth rate 2011 / 2012)
Korea, South		2012 New & Renewable Energy Statistics by the Korea New & Renewable Energy Center, 2013 http://solarthermalworld.org/content/south-korea-renewable-building-obligation-increases-market-size

Latvia	**ESTIF – European Solar Thermal Industry Federation**	Glazed water collectors: ESTIF, 2013 (estimation) http://www.estif.org/statistics/st_markets_in_europe_2012/
Lebanon		AEE INTEC, 2014 (estimation) Projected by AEE INTEC (10% growth rate 2011 / 2012)
Lithuania	**ESTIF – European Solar Thermal Industry Federation**	Glazed water collectors: ESTIF, 2013 (estimation) http://www.estif.org/statistics/st_markets_in_europe_2012/
Luxembourg	**ESTIF – European Solar Thermal Industry Federation**	Glazed water collectors: ESTIF, 2013 (estimation) http://www.estif.org/statistics/st_markets_in_europe_2012/
Malta	**Godwin Sant** Malta Resources Authority	Malta Resources Authority
Mexico		ANES – Asociación Nacional de Energía Solar http://solarthermalworld.org/print/62486
Morocco		AEE INTEC, 2014 (estimation) Projected by AEE INTEC (10% growth rate 2011 / 2012)
Mozambique	**Unpublished sources, provided by Geraldo Nhumaio**	SOLTRAIN survey
Netherlands	**Reinoud Segers** Statistics Netherlands (CBS)	Statistics Netherlands (CBS) Cumulated areas: Statistics Netherlands based on survey of sales. Market Shares: Expert Estimates NL Agency.
Norway	**Peter Bernhard** Asplan Viak AS – KanEnergi	Asplan Viak AS – KanEnergi
Poland	**Aneta Wiecka** EC BREC Institute for Renewable Energy (EC BREC IEO)	EC BREC IEO
Portugal	**João Farinha Mendes** APISOLAR - Associação Portuguesa da Indústria Solar	APISOLAR (www.apisolar.pt); „Oservatório Solar : Estatisticas Solar Termico 2012" http://www.aguaquentesolar.com/_fich/18/ST-Pt2012_fntApisolar.pdf
Romania	**ESTIF – European Solar Thermal Industry Federation**	Glazed water collectors: ESTIF, 2013 (estimation) http://www.estif.org/statistics/st_markets_in_europe_2012/
Russia	**Semen Frid, Sophia Kiseleva** Moscow State University **Vitaly Butuzov** Yuzhgeoteplo corporation, Krasnodar	Moscow State University
Slovakia	**ESTIF – European Solar Thermal Industry Federation**	Glazed water collectors: ESTIF, 2013 http://www.estif.org/statistics/st_markets_in_europe_2012/
Slovenia	**ESTIF – European Solar Thermal Industry Federation**	Glazed water collectors: ESTIF, 2013 http://www.estif.org/statistics/st_markets_in_europe_2012/
South Africa	**Dieter Holm** SOLTRAIN coordinator Southern Africa and SESSA organiser for Gauteng	Eskom's"Dashboard"(2008-2011); Raj Pandaram (2013); SOLTRAIN2 survey in Gauteng (2013)
Spain	**Pascual Polo** ASIT - Asociación Solar de la Industria Térmica	ASIT - Asociación Solar de la Industria Térmica Out of operation systems calculated by ASIT
Sweden	**Jan-Olof Dalenbäck** Svensk Solenergi / CHALMERS	Svensk solenergi; CHALMERS University of Technology

Switzerland	**SWISSOLAR**	SWISSOLAR – Schweizerischer Fachverband für Sonnenenergie: Markterhebung Sonnenergie, 2012 http://www.swissolar.ch/fileadmin/files/swissolar_neu/1._Unsere_Themen/1.07_Schweizer_Solarindustrie/Marktumfrage_2012.pdf Out of operation systems calculated by SWISSOLAR
Taiwan	**K.M. Chung** Energy Research Center - National Cheng Kung University	Bureau of Energy, Ministry of Economic Affairs, R.O.C. Out of operation systems calculated by Bureau of Energy, Ministry of Economic Affairs, R.O.C.
Tunisia	**Moncef Njaimi** ANME - National Agency of Energy Conservation	ANME - National Agency of Energy Conservation
Turkey	**A. Kutay Ulke** EZINC Metal San. Tic. A.S.	EZINC Metal San. Tic. A.S. Out of operation systems calculated by AEE INTEC
United Kingdom	**ESTIF – European Solar Thermal Industry Federation**	Glazed water collectors: ESTIF, 2013
	SAHWIA - Solar Air Heating World Industry Association	Air collectors: SAHWIA http://www.estif.org/statistics/st_markets_in_europe_2012/
United States	**Les Nelson** IAPMO Solar Heating & Cooling Programs	Water Collectors: IAPMO Solar Heating & Cooling Programs; provided by Les Nelson (Director); Out of operation systems considered based on historical data (1975 – 2009) from U.S. Department of Energy (DoE) - Energy Information Administration (EIA)
	John Hollick SAHWIA - Solar Air Heating World Industry Association	Air collectors: SAHWIA

8.6.1 Additional literature and web sources used

The following reports and statistics were used in this report.

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- Bundesministerium für Verkehr, Innovation und Technologie (BMVIT): Innovative Energietechnologien in Österreich – Marktentwicklung 2012; prepared by Peter Biermayr et al., Vienna, Austria May 2013
- Bundesverband Solarwirtschaft e.V. (BSW-Solar): Statistische Zahlen der deutschen Solarwärmebranche (Solarthermie) 2012; accessed on November 2013
- ClearSky Advisors Inc.: Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2012); Prepared by ClearSky Advisors Inc., Dr. Reda Djebbar, Natural Resources Canada, July 2013
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- European Solar Thermal Industry Federation (ESTIF): Solar Thermal Markets in Europe, Trends and Market Statistics 2012; Belgium - Brussels; June 2013
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- REN 21: MENA 2013 - MENA renewables status report; June 2013
- REN 21: Renewables 2013 Global Status Report, June 2013

The following online sources were used in this report:

- http://www.anes.org/
- http://www.aderee.ma/
- http://www.apisolar.pt/
- http://www.asit-solar.com/
- http://www.dasolabrava.org.br/
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- http://www.ome.org/
- http://www.olade.org/
- http://www.ren21.net/
- http://sahwia.org/
- http://www.solar-district-heating.eu/
- http://www.solarwirtschaft.de/
- http://www.solrico.com/
- http://www.solarthermalworld.org/

8.7 List of Figures

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