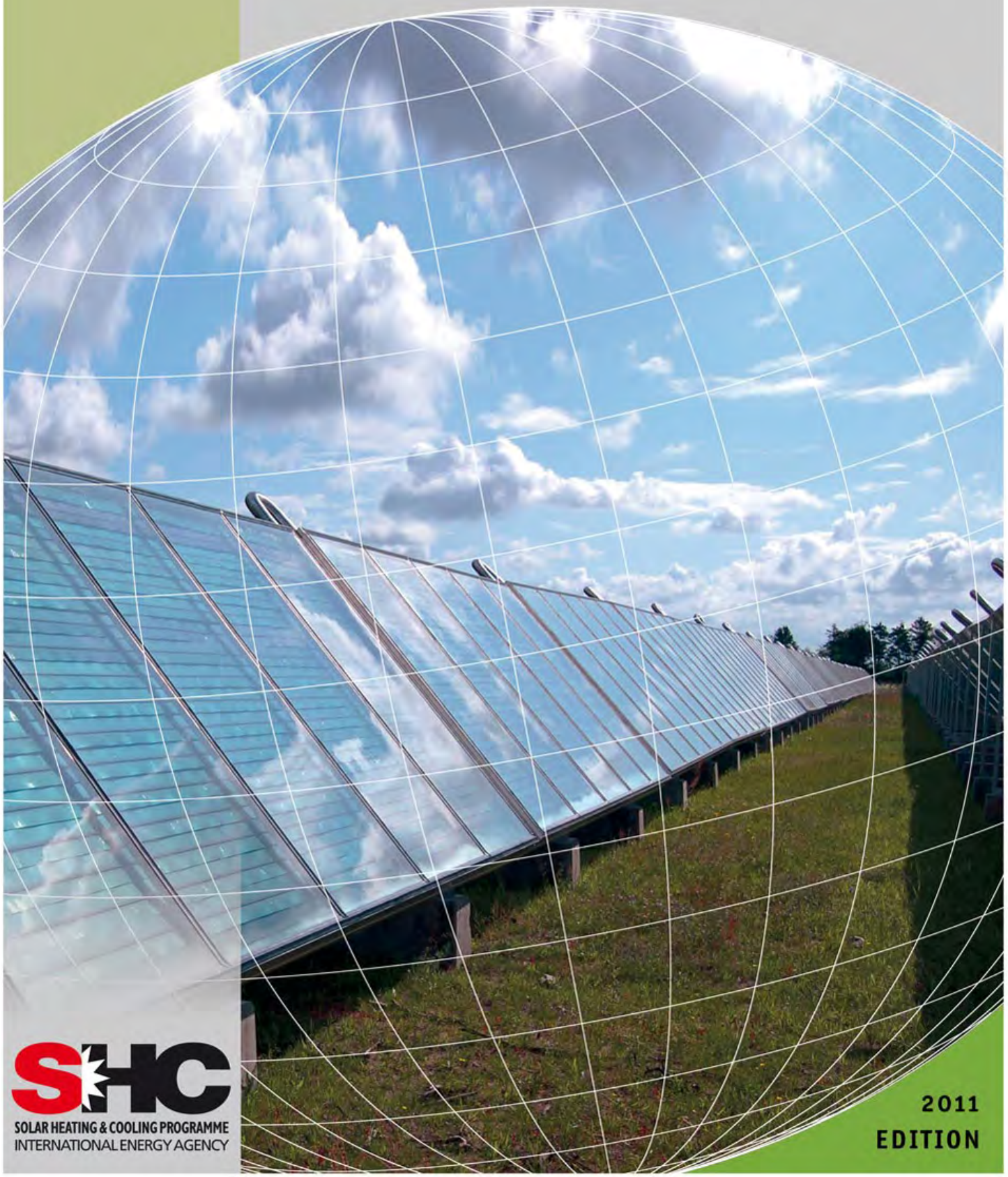
WERNER WEISS | FRANZ MAUTHNER

SOLAR HEAT WORLDWIDE

Markets and Contribution to the Energy Supply 2009



SHC
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

2011
EDITION

SOLAR HEAT WORLDWIDE

Markets and Contribution to the Energy Supply 2009

EDITION 2011

Werner Weiss | Franz Mauthner

AEE INTEC
AEE - Institute for Sustainable Technologies
A-8200 Gleisdorf, Austria

IEA Solar Heating & Cooling Programme, May 2011

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Supported by the Austrian Ministry for Transport, Innovation and Technology

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Design, Grafics, Typesetting & Imageprocessing: STEINHUBER INFODESIGN, Graz, Austria
Cover Photo: SUNMARK A/S

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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 this annual 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 and evacuated tube collectors with water as the energy carrier as well as glazed and unglazed air collectors.

The data were collected from a questionnaire 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 53 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 53 countries included in this report represent 4.1 billion people, which is about 61% of the world's population. The installed capacity in these countries is estimated to represent 85–90% of the solar thermal market worldwide.

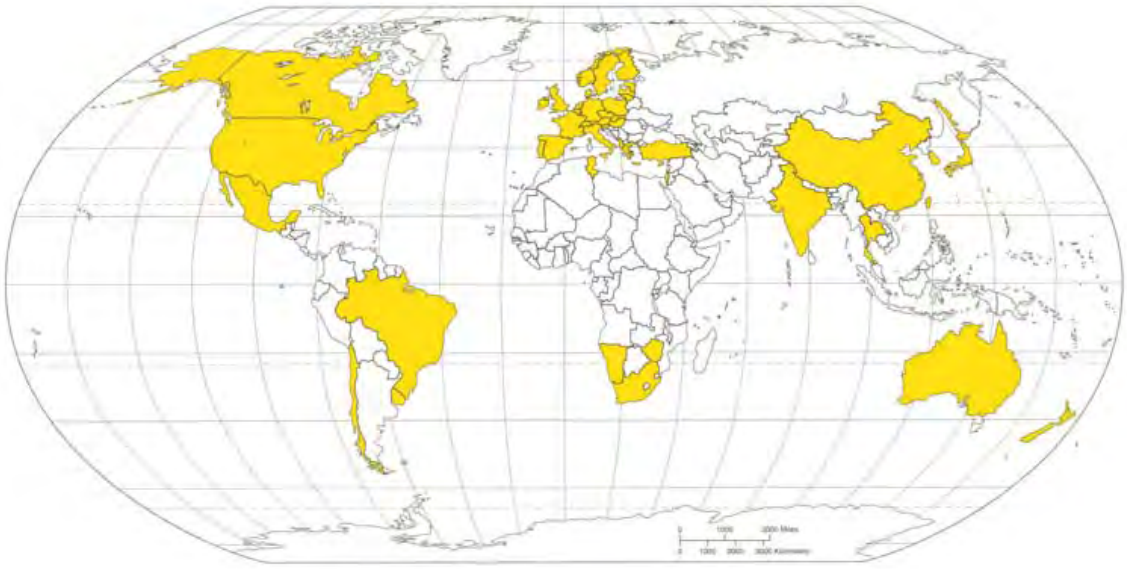


Figure 1: Countries represented in this report

2 Summary

Solar thermal capacity in operation worldwide by the end of 2009

The solar thermal collector capacity in operation worldwide equaled 172.4 GW_{th} corresponding to 246.2 million square meters[1] by the end of the year 2009. Of this, 151.5 GW_{th} were accounted for by flat-plate and evacuated tube collectors and 19.7 GW_{th} for unglazed water collectors. Air collector capacity was installed to an extent of 1.2 GW_{th}.

The vast majority of glazed and unglazed water and air collectors in operation are installed in China (101.5 GW_{th}), Europe (32.5 GW_{th}), and the United States and Canada (15.0 GW_{th}), which together account for 86.4% of total installed. The remaining installed capacity is shared between Australia and New Zealand (5.2 GW_{th}), Central and South America (4.7 GW_{th}), the Asian countries of India, South Korea, Taiwan and Thailand (4.6 GW_{th}), Japan (4.3 GW_{th}), the Middle East represented by Israel and Jordan (3.5 GW_{th}) and some African countries (1.1 GW_{th}), namely Namibia, South Africa, Tunisia and Zimbabwe.

Newly installed capacity in 2009

In the year 2009 a capacity of 36.5 GW_{th} corresponding to 52.1 million square meters of solar collectors were newly installed worldwide. This means an increase in collector installations of 25.3% compared to the year 2008.

The main driver for the above average market growth in 2009 was China whereas in key European markets as well as in the United States and other important economic regions, such as in Japan, the solar thermal sector suffered from the economic downturn, resulting in stagnating or decreasing local markets.

Glazed water collectors

The main markets for glazed water collectors (flat-plate and evacuated tube collectors) worldwide were in China (29.4 GW_{th}; +35.5%) and Europe (3.6 GW_{th}; –9.9%), which together accounted for 94.7% of the total newly installed glazed water collectors worldwide.

Compared to the year 2008, the worldwide market for glazed water collectors grew by 27.3% in 2009.

In addition to the high growth rate in China, it was also reported from Australia that due to a new financial incentive scheme the annual installations of glazed water collectors increased 78.5%. In Mexico, the total number of glazed water collector installations grew by 31.5% and in Europe, especially in many of the small and/or emerging markets with a volume of below 50,000 m²/a, growth rates were above 50% and up to 100%.

By contrast, some of the key markets worldwide were hit hard by the economic recession. The leading market in Europe, Germany, saw a downturn of 23.1% in the newly installed capacity of glazed water collectors compared to 2008. In Japan sales numbers dropped by 31.8% and in the United States installations of glazed water collectors decreased by 8.5%.

Unglazed water collectors

For unglazed water collectors (swimming pool collectors) the number of newly installed systems decreased significantly by 7.7% compared to 2008, accounting for 1.5 GW_{th} or 2.2 million of square meters in 2009, whereas there was an increase of 13.9% in the period 2007/2008.

1 Making the installed capacity of solar thermal collectors comparable with that of other energy sources, solar thermal experts from seven countries agreed upon a methodology to convert installed collector area into solar thermal capacity at a joint meeting of the IEA SHC Programme and major solar thermal trade associations held September 2004 in Gleisdorf, Austria. The represented associations from Austria, Canada, Germany, the Netherlands, Sweden and 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 the most important markets for unglazed water collectors, noteworthy growth rates were reported from Australia (+ 3.3%), Brazil (+ 45.9%), Mexico (+ 51.9%), Portugal (+ 87.0%) and Switzerland (+ 28.6%). Declining trends were seen in Austria (–45.2%), Canada (–18.5%), South Africa (–46.1%), Spain (-65.6%) and the United States (–23.9%).

Market development

Glazed water collectors

Between 2004 and 2009 the annually installed glazed water collector area worldwide almost tripled. The worldwide average annual growth rate between 2000 and 2009 was 20.8%.

Unglazed water collectors

The worldwide market of unglazed water collectors in 2008 recorded a significant growth in Brazil, Canada and South Africa while all other markets remained quite stable. In 2009, it was more or less only Brazil (+ 45.9%) and Mexico (+ 51.9%) that experienced a high growth rate while the general trend for unglazed water collectors was stagnating or falling.

Distribution of systems by system type and application

The thermal utilization of the energy from the sun greatly varies for different regions on Earth. In terms of collector types used, vacuum tube collectors are predominant in China while in other Asian countries, the Middle East and Europe most systems are equipped with flat plate collectors. By contrast, in North America (United States and Canada) and Australia unglazed water collectors for swimming pool heating is the dominant application.

The total installed collector area share of vacuum tube collectors of the total installed collector area in operation by the end of 2009 accounted for 56.0%. Followed by flat plate collectors accounting for 31.9%, unglazed water collectors for 11.4% and air collectors (glazed and unglazed) for 0.7%. In terms of newly installed collector area, there's a noticeable trend towards a higher share of vacuum tube collectors, which accounted for 78.3% in 2009.

The market for thermosiphon systems is more advanced in the Asian countries (especially China), Africa and the Middle East while in Europe, the United States as well as in Australia and New Zealand pumped systems are by far more common. In total, 70 – 80% of the total installed systems and more than 85% of the 2009 newly installed systems worldwide are thermosiphon systems.

Both trends, for thermosiphon systems and for vacuum tube collectors, are greatly affected by the Chinese market that influences the worldwide figures due to disproportionally high growth rates combined with an absolute market dominance of the latter mentioned technologies.

Spain, Germany and Austria have the most sophisticated markets for different solar thermal applications. They include systems for hot water preparation, systems for space heating of single- and multi-family houses and hotels, large-scale plants for district heating and a growing number of systems for air conditioning, cooling and industrial applications.
By the end of 2009, 115 solar supported district heating networks and 11 solar supported cooling systems with an installed capacity 350 kW_{th} (respectively 500 m²) were installed in Europe. The total capacity installed of these large-scale systems equals to 166 MW_{th}.

Besides Europe, Canada and Saudi Arabia have also installed quite large systems. The district heating system installed at Drake Landing in Canada has an installed capacity of 1.6 MW_{th} (2,293 m²). The world's largest system with a capacity of 25.4 MW_{th} (36.305 m²) was commissioned in April 2011 in Riyadh, Saudi Arabia.

Contribution of solar collectors to the supply of energy

The annual collector yield of all water-based solar thermal systems in operation by the end of 2009 in the 53 recorded countries is 141,775 GWh (510,338 TJ). This corresponds to an oil equivalent of 14.4 million tons and an annual CO_2 saving of 46.1 million tons.

The contribution of the total installed air collector capacity in operation in 2009 (1.2 GW_{th}) was not taken into consideration – with a share of about 0.7% of the total installed collector capacity, air collectors are excluded from the calculation.

Employment

Based on data collected from detailed country reports, the number of jobs in the fields of production, installation and maintenance of solar thermal systems is estimated to be 270,000 worldwide.

Preview 2010

The estimated total capacity of solar thermal collectors in operation worldwide by the end of 2010 is 196 GW_{th}, corresponding to 280 million square meters of collector area.

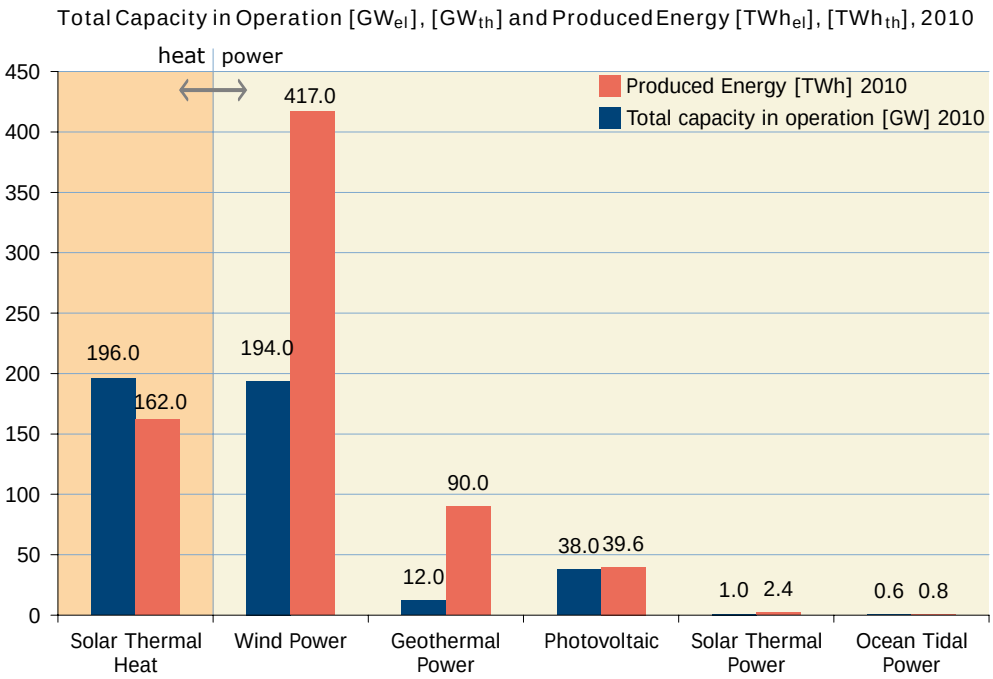


Figure 2: Total capacity in operation [GW_{el}], [GW_{th}] 2010 and annually energy generated [TWh_{el}], [TWh_{th}]. Sources: EWEA, EPIA, GWEC, IEA SHC 2011, Morse Associates Inc., REN 21

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

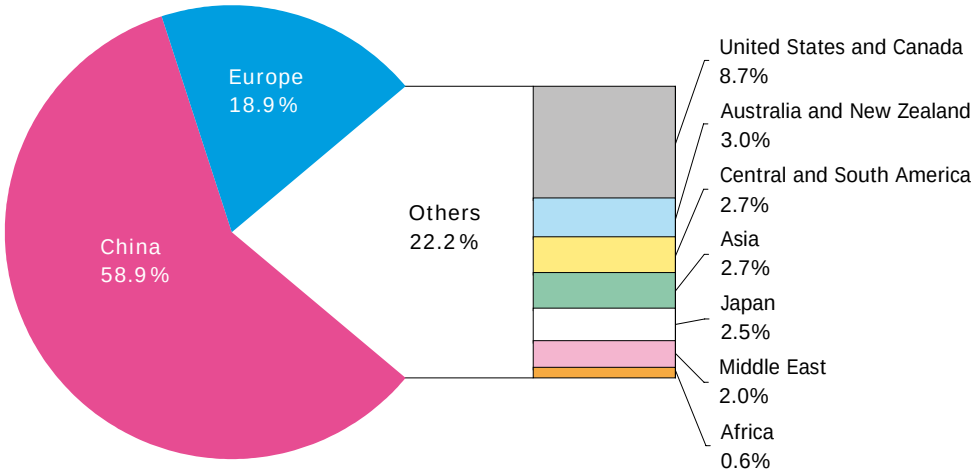
3 Total installed capacity in operation

This report aims to give the actual collector area that is 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 base 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.

3.1 General market overview of the total installed capacity in operation 2009

By the end of 2009, an installed capacity of 172.4 GW_{th} corresponding to a total of 246.2 million square meters of collector area was in operation in the 53 countries recorded in this report. These 53 countries represent 4.1 billion people, which is 61% of the world's population. The installed capacity in these countries represents more than 90% of the solar thermal market worldwide.

The vast majority of glazed and unglazed water and air collectors in operation are installed in China (101.5 GW_{th}), Europe (32.5 GW_{th}), and the United States and Canada (15.0 GW_{th}), which together account for 86.4% of the total. The remaining installed capacity is shared between Australia and New Zealand (5.2 GW_{th}), Central and South America (4.7 GW_{th}), the Asian countries of India, South Korea, Taiwan and Thailand (4.6 GW_{th}), Japan (4.3 GW_{th}), the Middle East represented by Israel and Jordan (3.5 GW_{th}) and some African countries (1.1 GW_{th}), namely Namibia, South Africa, Tunisia and Zimbabwe.



Africa:	Namibia, South Africa, Tunisia, Zimbabwe
Asia:	India, South Korea, Taiwan, Thailand
Central + South America:	Barbados, Brazil, Chile, Mexico, Uruguay
Europe:	EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East:	Israel, Jordan

Figure 3: Share of the total installed capacity in operation (glazed and unglazed water and air collectors) by economic regions at the end of 2009

As shown in Table 1 and Table 2, the total capacity is divided into 55.1 GW_{th} glazed flat-plate collectors (78.6 million square meters) and 96.4 GW_{th} evacuated tube collectors (137.7 million square meters), 19.7 GW_{th} unglazed water collectors (28.2 million square meters) and 1.2 GW_{th} glazed and unglazed air collectors (1.7 million square meters).

Country	Water Collectors*			Air Collectors*		TOTAL [MW_{th}]
	unglazed	glazed	evacuated tube	unglazed	glazed	
Albania		48.8	0.3			49.1
Australia	3,304.0	1,710.5	51.7			5,066.2
Austria	431.9	2,543.8	38.4	0.3		3,014.3
Barbados		92.2				92.2
Belgium	32.8	176.8	18.0			227.6
Brazil	890.3	2,799.7				3,690.0
Bulgaria		26.8				26.8
Canada	407.6	25.6	4.9	152.6	1.6	592.4
Chile	1.0	18.7				19.7
China		7,105.0	94,395.0			101,500.0
Cyprus		598.2	2.7			601.0
Czech Republic	10.2	104.1	23.1			137.4
Denmark	14.4	321.9	5.4	2.3	12.6	356.5
Estonia		1.4	0.3			1.6
Finland	8.2	18.3	1.6			28.2
France	74.0	1,279.1	23.4			1,376.4
FYRM		17.5	0.5		0.003	18.0
Germany	504.0	7,508.7	844.5		23.5	8,880.7
Greece		2,852.2	1.8			2,853.9
Hungary	4.0	73.5	16.7	0.4	0.1	94.6
India		1,987.3	169.6		11.4	2,168.3
Ireland		59.8	24.8			84.7
Israel	20.6	2,827.5		0.3		2,848.5
Italy	30.6	1,263.2	177.1			1,470.9
Japan		3,936.1	68.1		330.7	4,334.8
Jordan		482.6	144.1			626.7
Korea, South		1,047.6				1,047.6
Latvia		4.8	0.10			4.9
Lithuania		2.9	0.1			3.0
Luxembourg		17.1	1.3			18.4
Malta		23.2	8.2			31.4
Mexico	400.5	433.6	49.3		3.8	887.2
Namibia		10.7	0.3			11.0
Netherlands	264.1	264.6				528.7
New Zealand	4.9	100.1	6.8			111.8
Norway	1.3	9.1	0.4		0.8	11.6
Poland		275.9	81.0			356.9
Portugal	1.5	370.4	13.2			385.0
Romania		59.8	6.3			66.1
Slovakia		75.5	9.0			84.5
Slovenia		95.0	6.3			101.3
South Africa	527.6	202.1	14.7			744.4
Spain	77.7	1,319.5	81.2			1,478.4
Sweden	87.5	168.7	34.3			290.5
Switzerland	148.3	435.2	26.8	601.3		1,211.6
Taiwan	1.4	1,299.7	44.9			1,345.9
Thailand		64.0				64.0
Tunisia		268.8	14.7			283.5
Turkey		8,424.5				8,424.5
United Kingdom		254.9	66.8			321.7
United States	12,455.5	1,787.8	61.4		68.5	14,373.2
Uruguay		8.5				8.5
Zimbabwe		12.3	0.1			12.4
TOTAL	19,703.9	54,915.5	96,539.1	757.1	453.1	172,368.6

FYRM Former Yugoslav Republic of Macedonia
* If no data is given: no reliable database for this collector type is available
** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying

Table 1: Total capacity in operation by the end of 2009 [MW_{th}]

Country	Water Collectors*			Air Collectors*		TOTAL [m²]
	unglazed	glazed	evacuated tube	unglazed	glazed	
Albania		69,705	466			70,171
Australia	4,720,000	2,443,569	73,806			7,237,375
Austria	616,952	3,634,012	54,828	378		4,306,170
Barbados		131,690				131,690
Belgium	46,875	252,620	25,713			325,208
Brazil	1,271,849	3,999,547				5,271,396
Bulgaria		38,336				38,336
Canada	582,351	36,569	6,995	217,989	2,349	846,253
Chile	1,470	26,730				28,200
China		10,150,000	134,850,000			145,000,000
Cyprus		854,637	3,883			858,520
Czech Republic	14,621	148,646	33,030			196,298
Denmark	20,515	459,866	7,684	3,264	18,000	509,329
Estonia		1,951	390			2,341
Finland	11,779	26,118	2,342			40,240
France	105,699	1,827,223	33,379			1,966,300
FYRM		25,020	724		4	25,748
Germany	720,000	10,726,731	1,206,423		33,600	12,686,754
Greece		4,074,500	2,500			4,077,000
Hungary	5,688	105,011	23,803	500	200	135,202
India		2,838,948	242,247		16,320	3,097,515
Ireland		85,475	35,493			120,968
Israel	29,495	4,039,324		422		4,069,241
Italy	43,766	1,804,597	252,981			2,101,344
Japan		5,622,949	97,297		472,376	6,192,622
Jordan		689,371	205,916			895,287
Korea, South		1,496,514				1,496,514
Latvia		6,904	140			7,044
Lithuania		4,168	150			4,318
Luxembourg		24,482	1,818			26,300
Malta		33,144	11,723			44,867
Mexico	572,092	619,432	70,430		5,403	1,267,357
Namibia		15,259	447			15,706
Netherlands	377,287	378,051				755,338
New Zealand	7,025	142,975	9,644			159,645
Norway	1,920	13,010	540		1,110	16,580
Poland		394,188	115,648			509,836
Portugal	2,082	529,079	18,839			550,000
Romania		85,496	9,000			94,496
Slovakia		107,892	12,855			120,746
Slovenia		135,656	9,042			144,698
South Africa	753,678	288,710	20,972			1,063,360
Spain	111,000	1,885,000	116,000			2,112,000
Sweden	125,000	241,000	49,000			415,000
Switzerland	211,790	621,780	38,290	859,000		1,730,860
Taiwan	1,937	1,856,659	64,168			1,922,764
Thailand		91,392				91,392
Tunisia		384,000	21,000			405,000
Turkey		12,035,000				12,035,000
United Kingdom		364,138	95,445			459,583
United States	17,793,589	2,553,984	87,755		97,878	20,533,206
Uruguay		12,096				12,096
Zimbabwe		17,509	162			17,671
TOTAL	28,148,459	78,450,665	137,912,968	1,081,553	647,240	246,240,885

FYRM Former Yugoslav Republic of Macedonia
* If no data is given: no reliable database for this collector type is available
** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying

Table 2: Total installed collector area in operation by the end of 2009 [m²]

The distribution of the worldwide capacity in operation by the different types of solar collectors is shown in Figure 4 and Figure 5 depicts the distribution of unglazed and glazed water collectors for the 10 leading countries by the end of 2009.

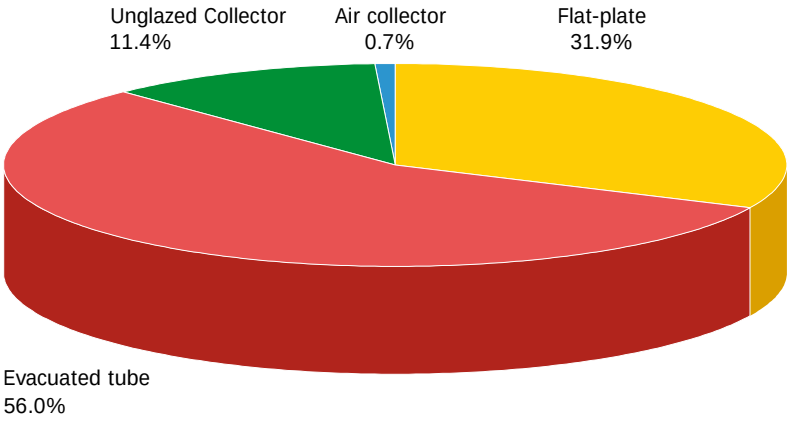


Figure 4: Distribution of the total installed capacity in operation by collector type in 2009

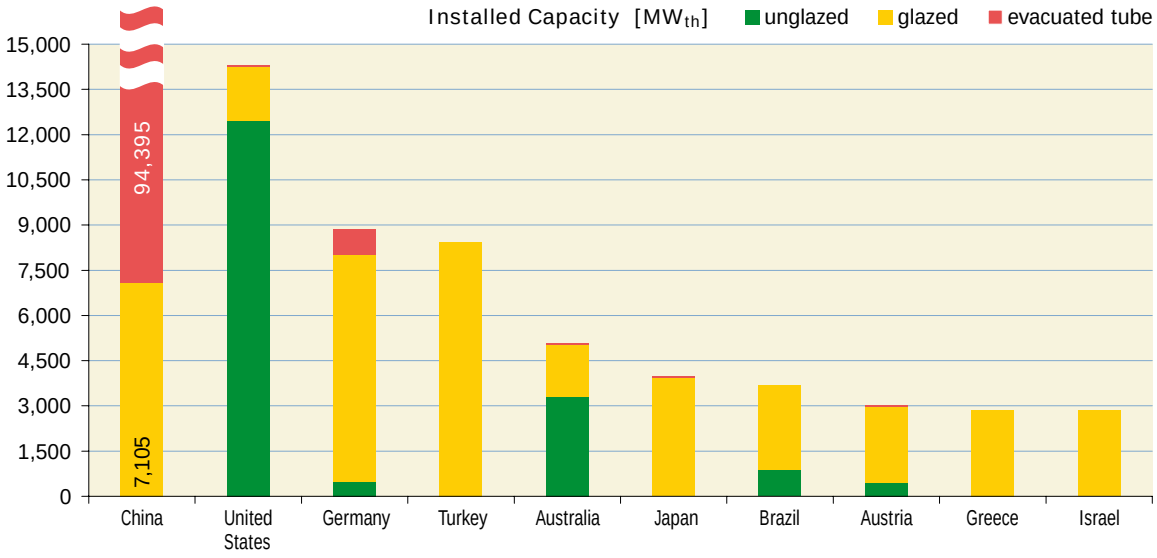


Figure 5: Total installed capacity of water collectors in operation in the 10 leading countries by the end of 2009

Figure 5 clearly shows how the different types of collectors are applied in the leading countries worldwide. China, as 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 extend in Brazil do unglazed collectors also play an important role. The rest of the "top 10 countries" are clearly focusing on flat-plate collector technology.

In comparison to 2008, the position of the top 10 nations remained the same.

3.2 Total capacity of glazed water collectors by the end of 2009

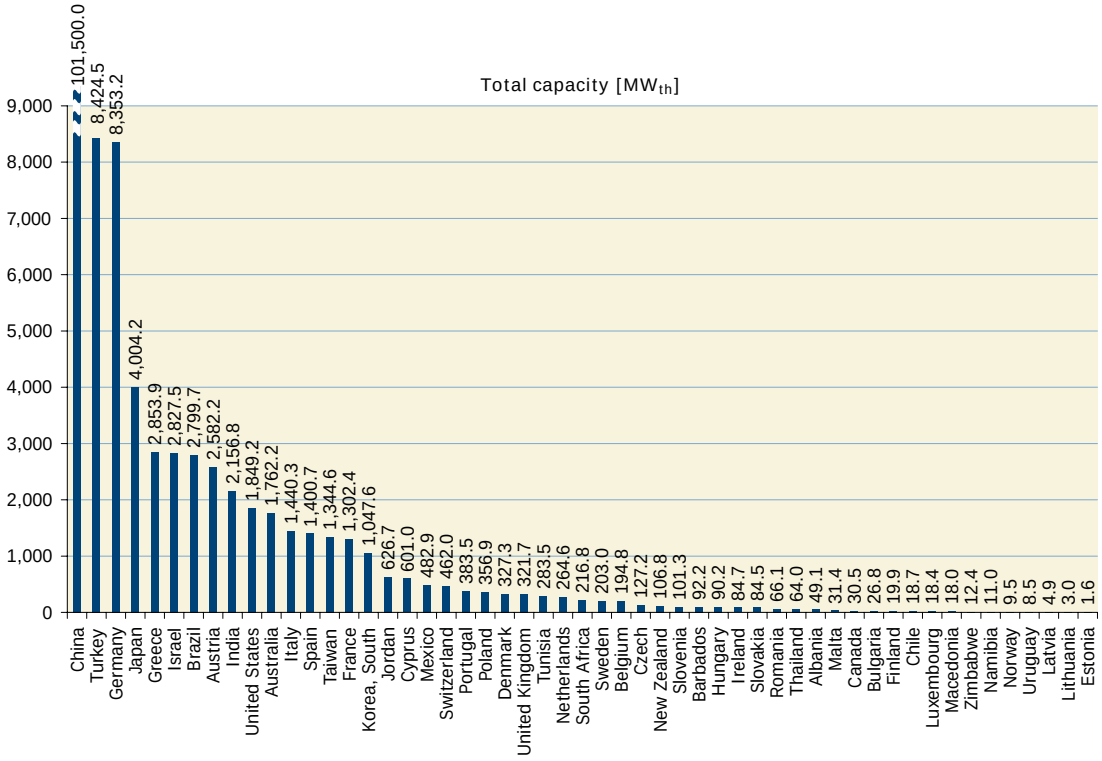


Figure 6: Total capacity of glazed flat-plate and evacuated tube collectors in operation by the end of 2009

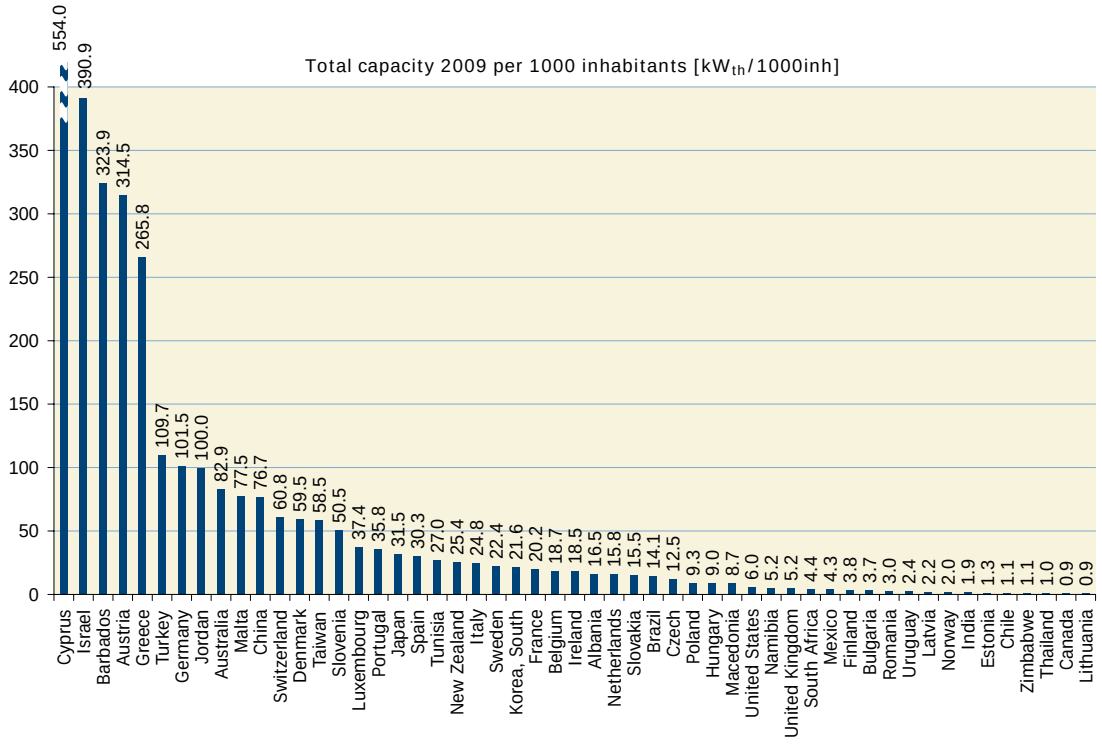
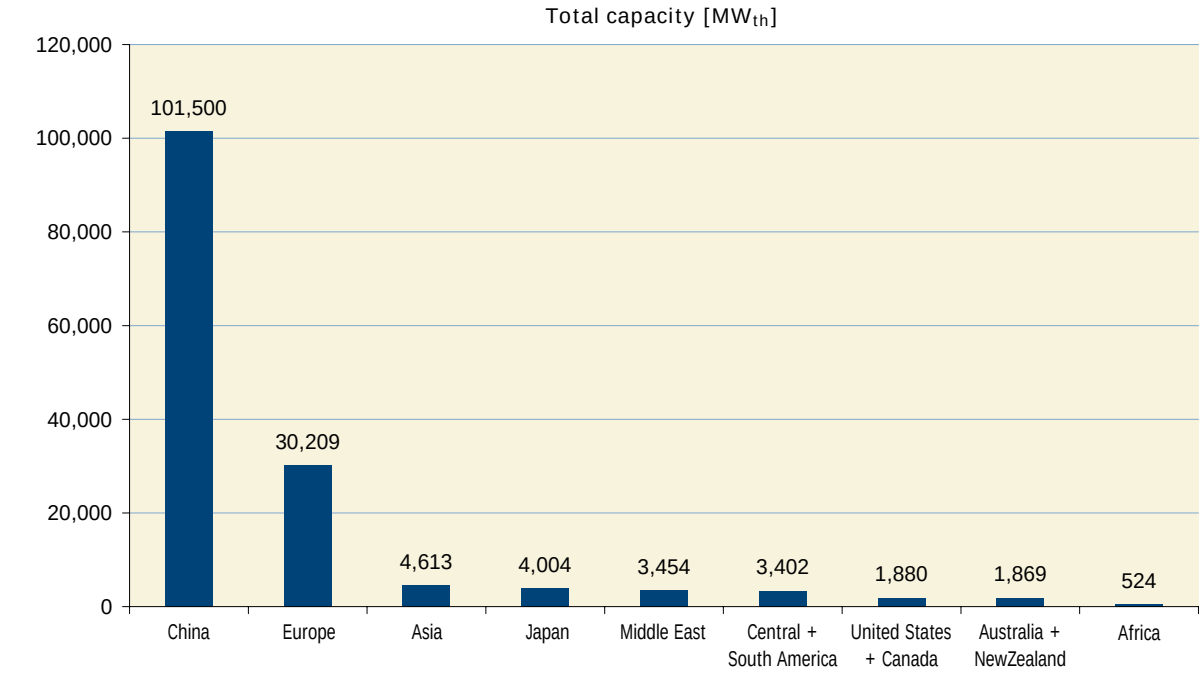


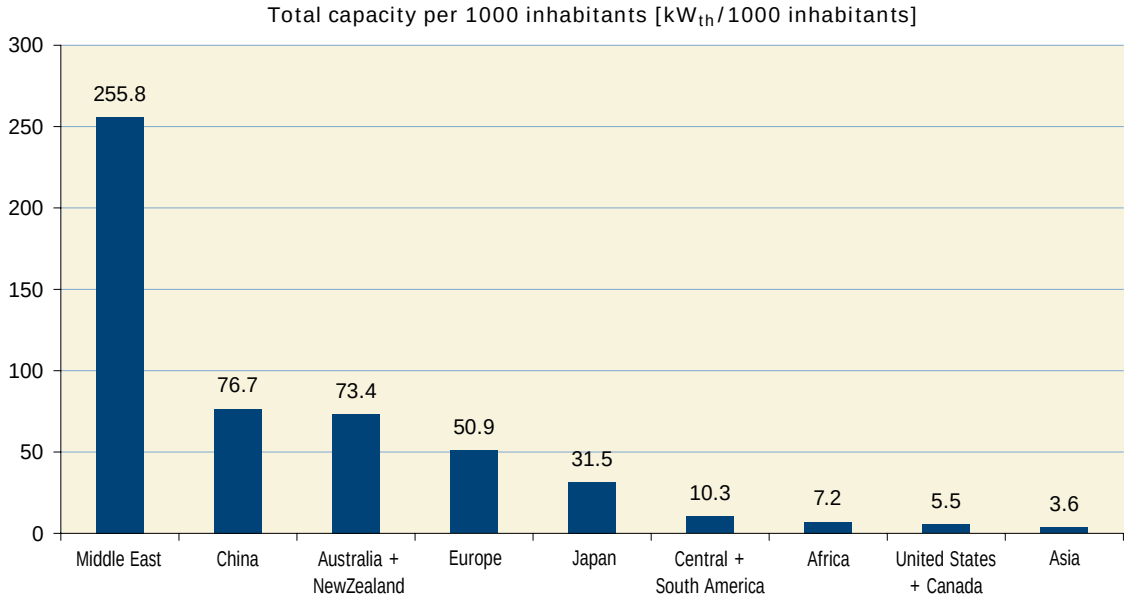
Figure 7: Total capacity of glazed flat-plate and evacuated tube collectors in operation in kW$_{th}$ per 1,000 inhabitants by the end of 2009

3.3 Total capacity of glazed water collectors by economic region at the end of 2009



Africa: Namibia, South Africa, Tunisia, Zimbabwe
Asia: India, South Korea, Taiwan, Thailand
Central + South America: Barbados, Brazil, Chile, Mexico, Uruguay
Europe: EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East: Israel, Jordan

Figure 8: Total capacity of glazed flat-plate and evacuated tube collectors in operation by economic region at the end of 2009



Africa: Namibia, South Africa, Tunisia, Zimbabwe
Asia: India, South Korea, Taiwan, Thailand
Central + South America: Barbados, Brazil, Chile, Mexico, Uruguay
Europe: EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East: Israel, Jordan

Figure 9: 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 2009

3.4 Total capacity of unglazed water collectors by the end of 2009

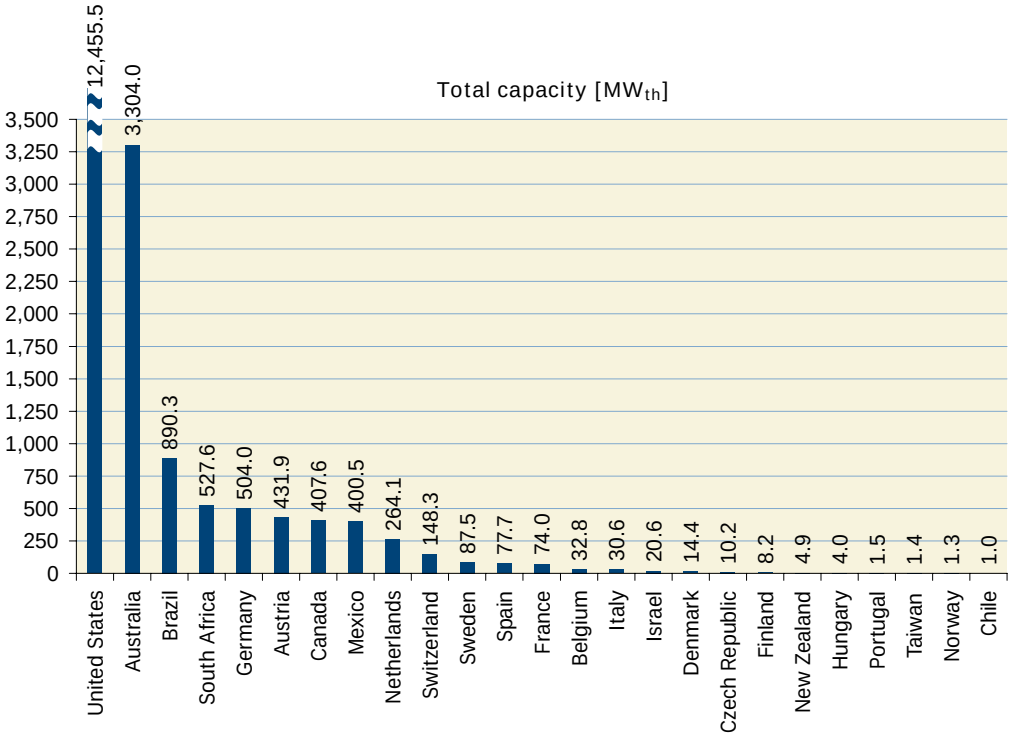


Figure 10: Total capacity of unglazed water collectors in operation by the end of 2009

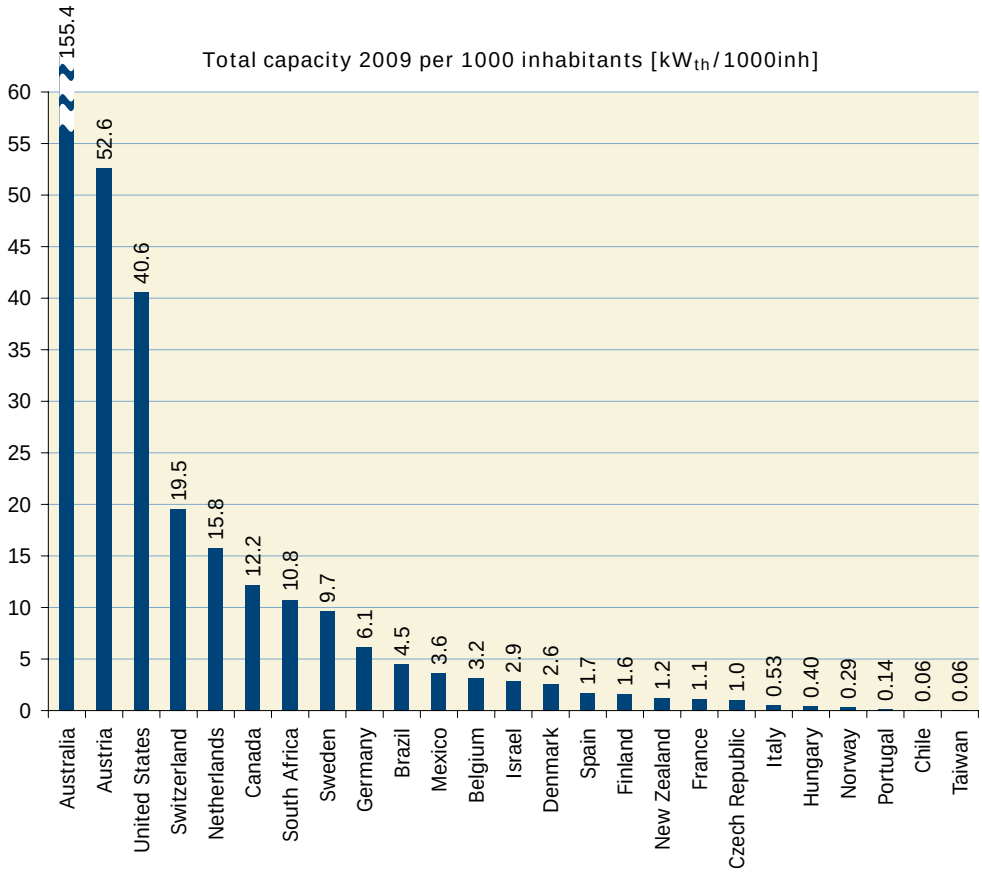
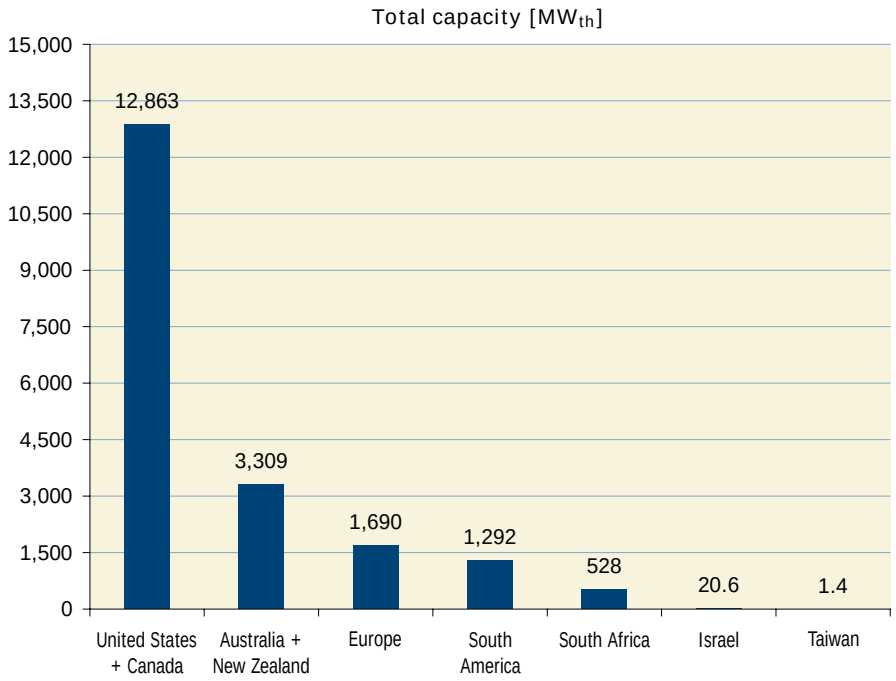


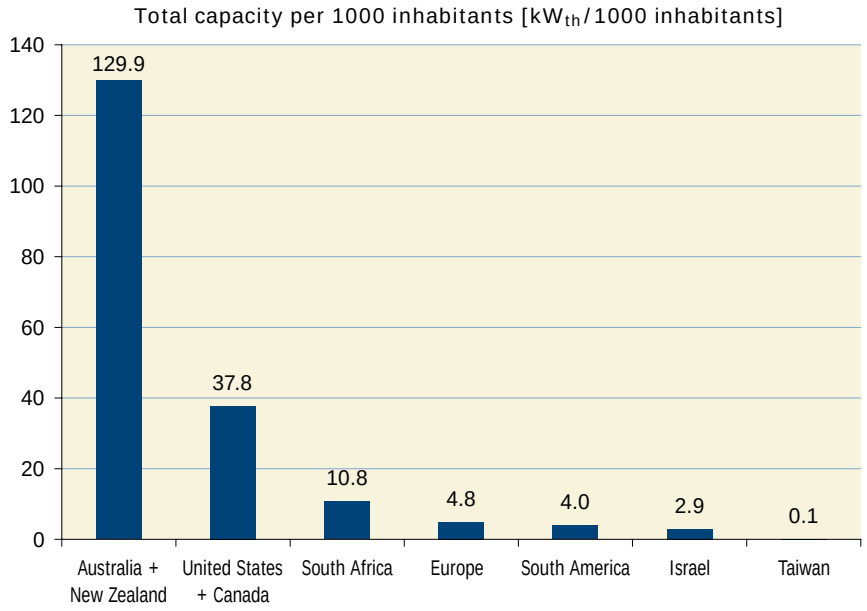
Figure 11: Total capacity of unglazed water collectors in operation in kW_{th} per 1,000 inhabitants by the end of 2009

3.5 Total capacity of unglazed water collectors by economic region at the end of 2009



Europe: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland
South America: Brazil, Chile, Mexico

Figure 12: Total capacity of unglazed collectors in operation by economic region by the end of 2009



Europe: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland
South America: Brazil, Chile, Mexico

Figure 13: Total capacity of unglazed collectors in operation by economic region and in kW_{th} per 1,000 inhabitants by the end of 2009

4 Market development of the newly installed capacity

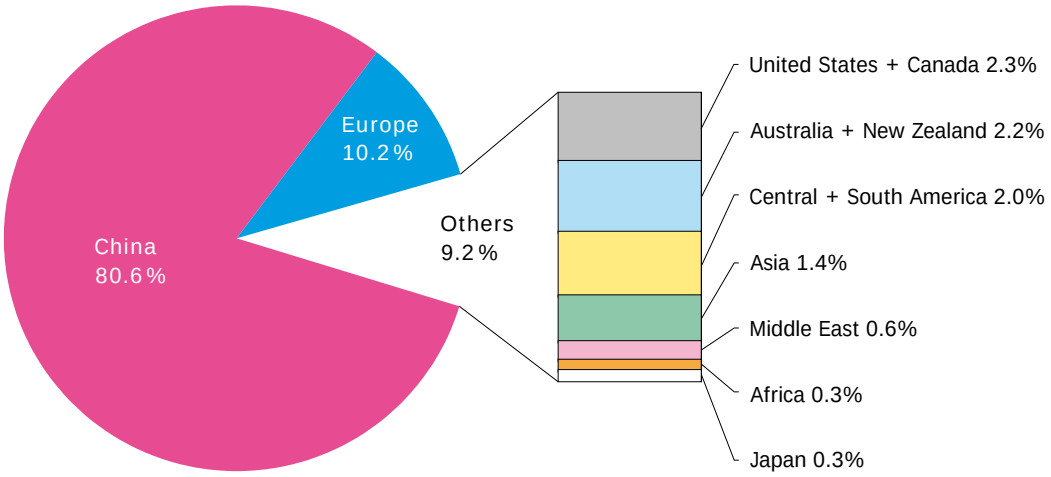
In the year 2009 a total capacity of 36.5 GW_{th} corresponding to 52.1 million square meters of solar collectors were installed worldwide. This means an increase in new collector installations of 25.3% compared to the year 2008.

The main driver for the above average market growth in 2009 was China, whereas in key European markets as well as in the United States and other important economic regions, such as in Japan, the solar thermal sector suffered from the economic downturn, resulting in stagnating or decreasing local markets.

4.1 General market overview of newly installed systems in 2009

The main markets for glazed and unglazed water and air collectors worldwide were in China (29.40 GW_{th}) and Europe (3.7 GW_{th}), which together account for 90.8% of the overall new collector installations in 2009.

The rest of the market is shared between the United States and Canada (0.82 GW_{th}), Australia and New Zealand (0.82 GW_{th}), Central and South America represented by Barbados, Brazil, Chile, Mexico and Uruguay (0.74 GW_{th}), the Asian countries of India, South Korea, Taiwan and Thailand (0.52 GW_{th}), the Middle East represented by Israel and Jordan (0.22 GW_{th}), Africa represented by Namibia, South Africa, Tunisia and Zimbabwe (0.12 GW_{th};) and Japan (0.11 GW_{th}).



Africa: Namibia, South Africa, Tunisia, Zimbabwe
Asia: India, South Korea, Taiwan, Thailand
Central + South America: Barbados, Brazil, Chile, Mexico, Uruguay
Europe: EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East: Israel, Jordan

Figure 14: Share of the newly installed capacity (glazed and unglazed water and air collectors) by economic regions in 2009

The total capacity is divided into 6.33 GW_{th} glazed flat-plate collectors (9.04 million square meters), 28.56 GW_{th} evacuated tube collectors (40.80 million square meters), 1.53 GW_{th} unglazed water collectors (2.19 million square meters) and 0.05 GW_{th} glazed and unglazed air collectors (0.08 million square meters) (Table 3 and Table 4).

In the Appendix, the tables containing data of the installed collector area for the years 2007 and 2008 (Table 15 and Table 16) can be found as well as the total installed collector area in 2008 (Table 17).

Country	Water Collectors*			Air Collectors*		TOTAL [MW_{th}/a]
	unglazed	glazed	evacuated tube	unglazed	glazed	
Albania		7.0	0.1			7.1
Australia	434.0	338.1	25.4			797.6
Austria	5.8	243.9	5.4	0.3		255.4
Barbados		4.9				4.9
Belgium		31.9	3.6			35.5
Brazil	284.9	273.8				558.7
Bulgaria		5.6				5.6
Canada	51.1	6.4	0.8	31.7	0.6	90.6
Chile		6.3				6.3
China		1,400.0	28,000.0			29,400.0
Cyprus		37.1	1.4			38.5
Czech Republic		21.0	7.0			28.0
Denmark		36.4	1.8			38.2
Estonia		0.04	0.3			0.3
Finland		2.0	0.8			2.8
France		185.5				185.5
FYRM		2.1			0.0	2.1
Germany		1,001.0	129.5			1,130.5
Greece		143.2	1.1			144.2
Hungary	2.1	9.8	5.6	0.4	0.14	18.0
India		263.6	121.4			385.0
Ireland		18.5	11.3			29.8
Israel*	2.0	186.5				188.5
Italy	4.9	283.8	47.3			336.0
Japan		97.9	1.2		8.5	107.5
Jordan		21.3	6.4			27.7
Korea, South*		48.1				48.1
Lativa		0.03	0.10			0.1
Lithuania		0.04	0.11			0.1
Luxembourg		2.6	0.7			3.3
Malta		3.1	2.9			6.0
Mexico	52.9	57.4	49.3		3.8	163.3
Namibia		2.8	0.2			3.0
Netherlands	20.2	31.7				51.9
New Zealand*	0.3	17.2				17.6
Norway	0.2	1.2	0.15			1.5
Poland		74.5	26.5			101.0
Portugal	1.1	91.0	9.5			101.5
Romania		7.7	6.3			14.0
Slovak Republic		8.1	1.3			9.5
Slovenia		11.9	3.5			15.4
South Africa	37.8	21.3	2.5			61.6
Spain	7.7	262.5	11.2			281.4
Sweden	17.5	9.2	5.7			32.4
Switzerland	8.4	94.7	7.2	7.7		118.1
Taiwan		72.9	8.6			81.6
Thailand*		10.3				10.3
Tunisia		49.1	10.4			59.5
Turkey		668.5				668.5
United Kingdom		36.4	26.0			62.4
United States	599.6	111.6	18.7		1.3	731.2
Uruguay*		5.1				5.1
Zimbabwe		0.2	0.1			0.2
TOTAL	1,530.5	6,326.5	28,561.3	40.0	14.2	36,472.5

FYRM Former Yugoslav Republic of Macedonia
* If no data is given: no reliable database for this collector type is available
** Estimated data (Israel, South Korea, New Zealand, Thailand, Uruguay. Based on data of previous years)
*** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying

Table 3: Newly installed capacity in 2009 [MW_{th}/a]

Country	Water Collectors*			Air Collectors*		TOTAL [m²]
	unglazed	glazed	evacuated tube	unglazed	glazed	
Albania		10,035	116			10,151
Australia	620,000	483,019	36,356			1,139,375
Austria	8,342	348,408	7,759	378		364,886
Barbados		7,051				7,051
Belgium		45,500	5,200			50,700
Brazil	407,051	391,089				798,140
Bulgaria		8,000				8,000
Canada	73,026	9,186	1,083	45,331	792	129,418
Chile		9,000				9,000
China		2,000,000	40,000,000			42,000,000
Cyprus		53,000	2,000			55,000
Czech Republic		30,000	10,000			40,000
Denmark		52,000	2,500			54,500
Estonia		60	390			450
Finland		2,800	1,200			4,000
France		265,000				265,000
FYRM		3,002			4	3,006
Germany		1,430,000	185,000			1,615,000
Greece		204,500	1,500			206,000
Hungary	3,000	14,000	8,000	500	200	25,700
India		376,505	173,495			550,000
Ireland		26,383	16,131			42,514
Israel*	2,795	266,446				269,241
Italy	7,046	405,389	67,565			480,000
Japan		139,821	1,682		12,110	153,613
Jordan		30,435	9,091			39,526
Korea, South*		68,680				68,680
Lativa		40	140			180
Lithuania		50	150			200
Luxembourg		3,650	1,050			4,700
Malta		4,386	4,122			8,508
Mexico	75,501	82,002	70,430		5,403	233,336
Namibia		3,979	244			4,224
Netherlands	28,814	45,260				74,074
New Zealand*	481	24,614				25,095
Norway	270	1,680	210			2,160
Poland		106,494	37,814			144,308
Portugal	1,500	130,000	13,500			145,000
Romania		11,000	9,000			20,000
Slovak Republic		11,600	1,900			13,500
Slovenia		17,000	5,000			22,000
South Africa	54,000	30,396	3,604			88,000
Spain	11,000	375,000	16,000			402,000
Sweden	24,993	13,126	8,183			46,302
Switzerland	12,057	135,355	10,285	11,000		168,697
Taiwan		104,214	12,305			116,519
Thailand*		14,650				14,650
Tunisia		70,188	14,812			85,000
Turkey		955,000				955,000
United Kingdom		51,975	37,125			89,100
United States	856,517	159,471	26,728		1,793	1,044,509
Uruguay*		7,235				7,235
Zimbabwe		217	138			355
TOTAL	2,186,393	9,037,891	40,801,807	57,209	20,302	52,103,602

FYRM Former Yugoslav Republic of Macedonia
* If no data is given: no reliable database for this collector type is available
** Estimated data (Israel, South Korea, New Zealand, Thailand, Uruguay. Based on data of previous years)
*** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying

Table 4: Newly Installed collector area in 2009 [m²/a]

Flat-plate and evacuated tube collectors accounted for 34.9 GW_{th} of the overall market in 2009, representing 95.7% of the total newly installed systems.

The distribution of the 2009 newly installed capacity by the different types of solar collectors worldwide is shown in Figure 15.

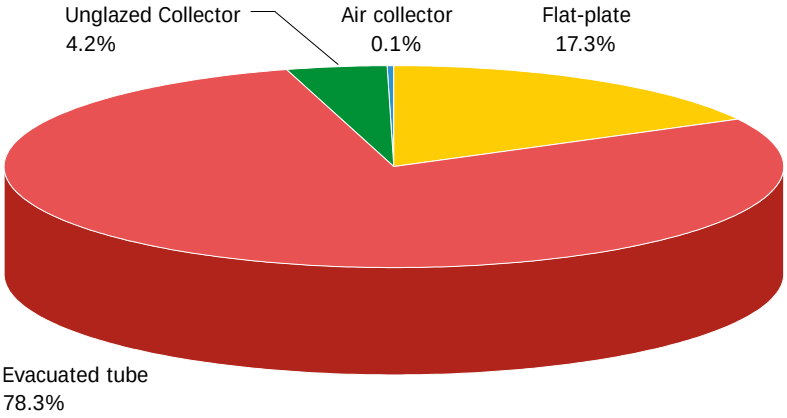


Figure 15: Distribution of the newly installed capacity by collector type in 2009

The strong Chinese market focuses on vacuum tube technology. It has been reported that more than 95% of the newly installed systems were equipped with this collector type. Consequently, the growth rates by type of glazed water collector in 2009 are high for vacuum tubes (+ 34.5%) and almost stagnating (+ 2.4%) for flat plate collectors. Many of the flat plate collector manufacturers in Europe therefore faced a challenging economic year in 2009, right after the tremendous growth rates in 2008.

In total numbers, the newly installed capacity of glazed and unglazed water collectors is shown in Figure 16 for the 10 leading markets in 2009.

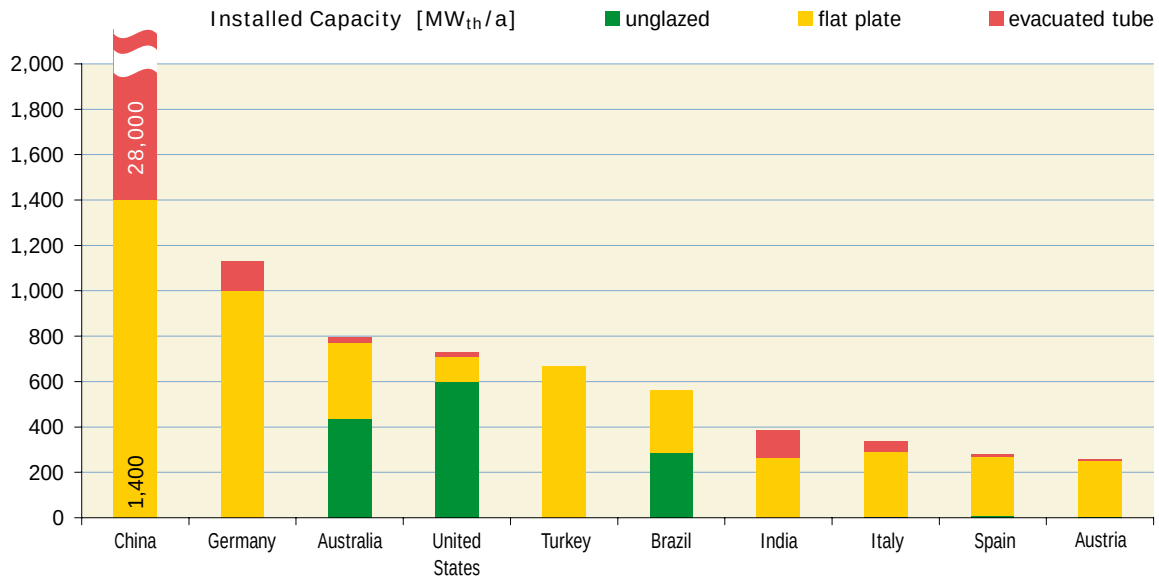


Figure 16: Total capacity of newly installed glazed and unglazed water collectors in the 10 leading countries in 2009

4.2 Newly installed capacity of glazed water collectors in 2009

In addition to the high growth rate in China (+ 35.5%), Australia reported a 78.5% growth in annual installations of glazed water collectors in response to a new financial incentive scheme. In Mexico, the total number of glazed water collector installation grew by 31.5% mainly due to a broad market campaign for solar water heaters as well as low-interest rates.

In Europe, especially many small and/or emerging markets with a volume of below 50,000 m²/a had growth rates above 50% and up to 100% (namely, Bulgaria, Denmark, Hungary, the Netherlands, Norway, Portugal and Romania).

By contrast, some of the key markets worldwide were hit hard by the economic crisis. The leading market in Europe, Germany, underwent a downturn of 23.1% in its newly installed capacity of glazed water collectors compared with 2008. Market development also has been affected by lower fossil fuel prices and declining end-user investments. In Japan, sales numbers dropped by 31.8% although some new subsidy schemes came into force and some local manufacturers introduced new products. In the United States, the installations of glazed water collectors dropped by 8.5% due to declines in U.S. home sales and prices and the economic recession.

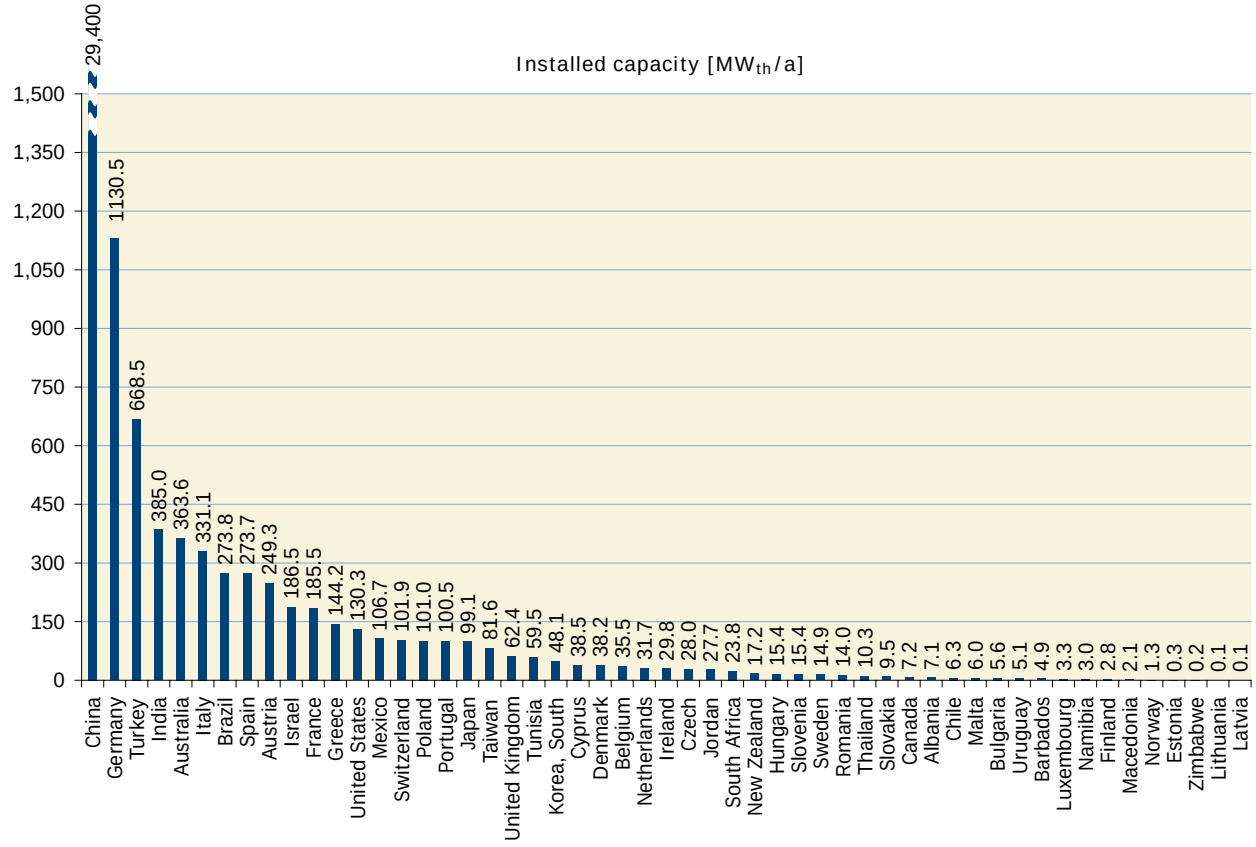


Figure 17: Newly installed capacity of glazed water collectors in 2009

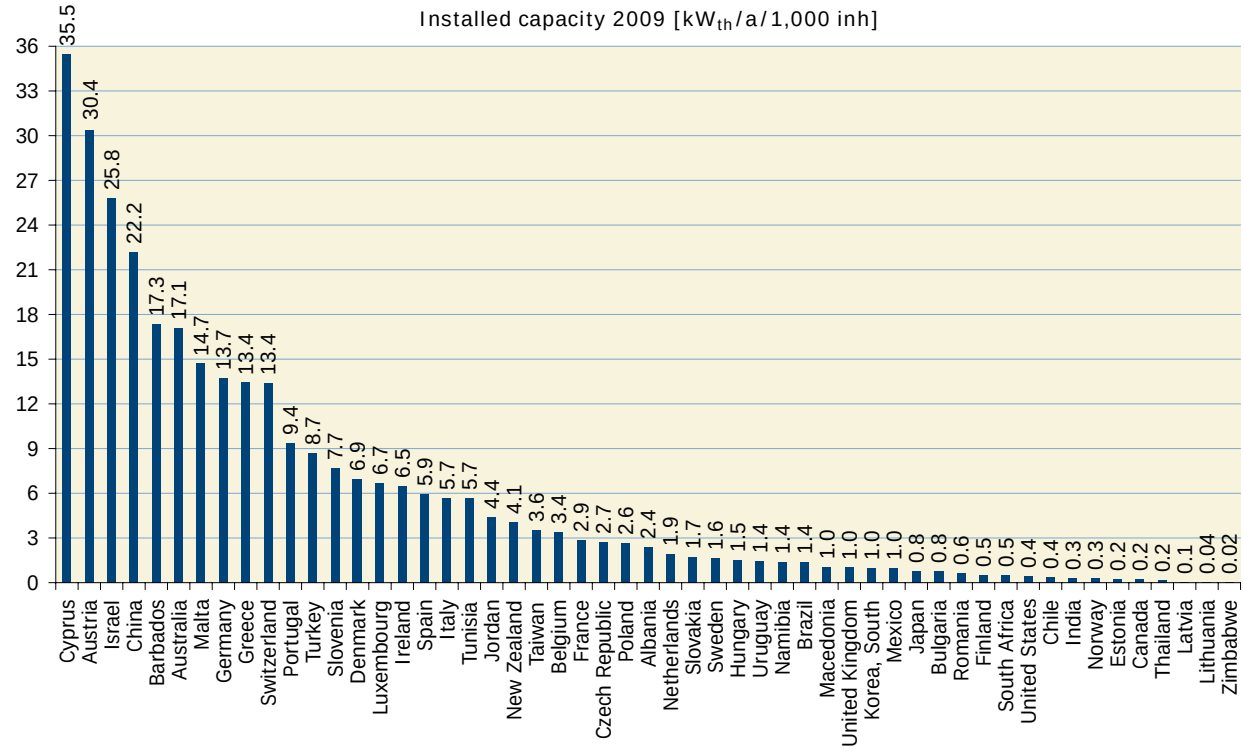
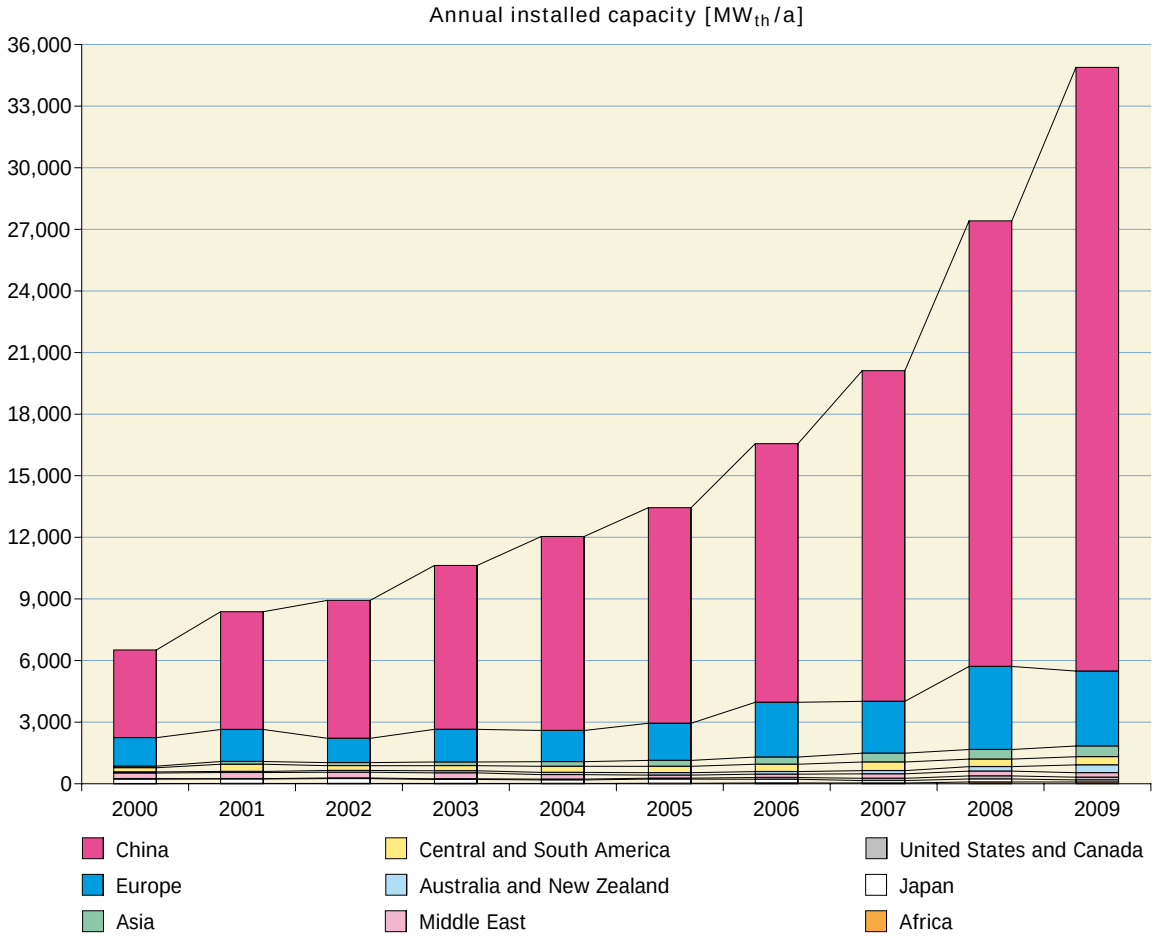


Figure 18: Newly installed capacity of glazed water collectors in 2009 in kW$_{th}$ per 1,000 inhabitants

4.3 Market development of glazed water collectors between 2000 and 2009

Analysis of the worldwide market of glazed water collectors shows in an impressive way that the market evolution is characterized by an over proportional growth (see Figure 19 for the period between 2000 and 2009).



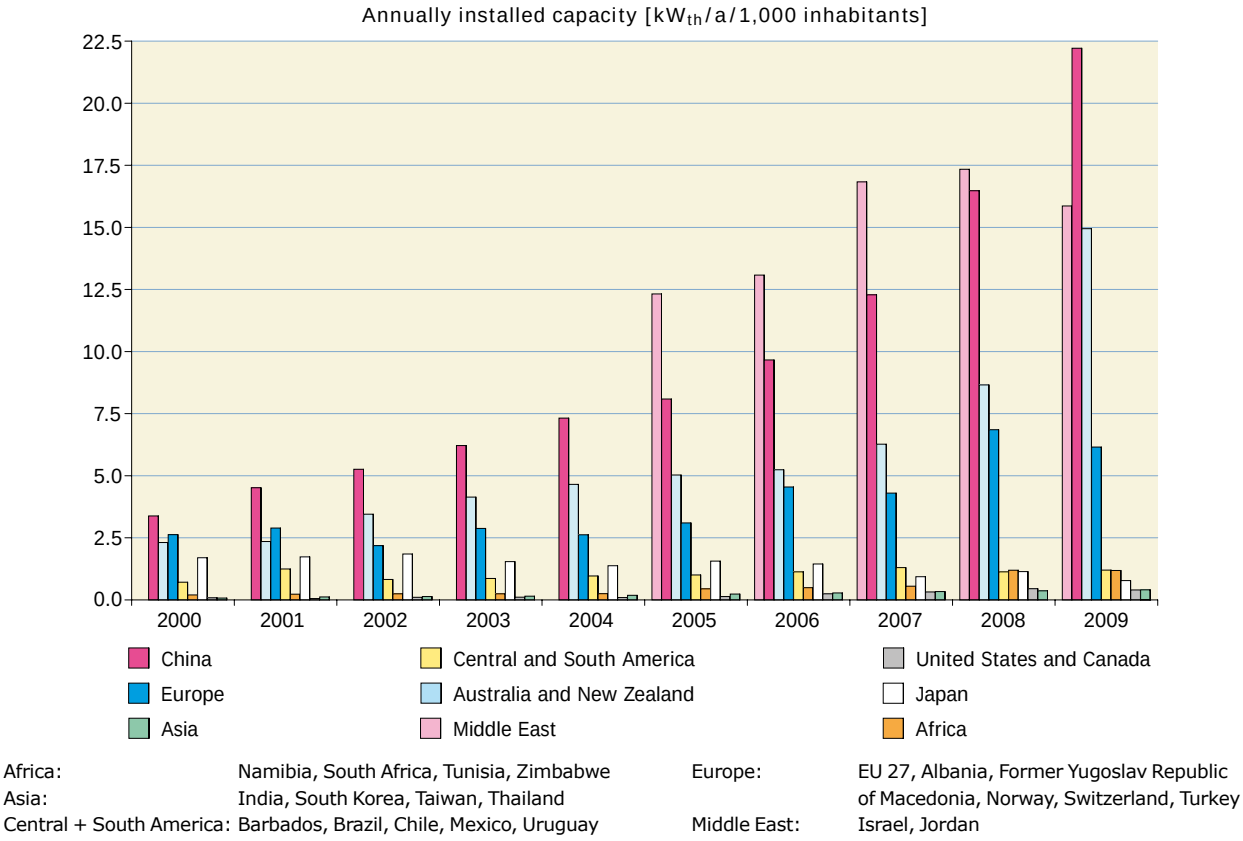
Africa:	Namibia, South Africa, Tunisia, Zimbabwe	Europe:	EU 27, Albania, Former Yugoslav Republic
Asia:	India, South Korea, Taiwan, Thailand		of Macedonia, Norway, Switzerland, Turkey
Central + South America:	Barbados, Brazil, Chile, Mexico, Uruguay	Middle East:	Israel, Jordan

Figure 19: Annually installed capacity of flat-plate and evacuated tube collectors from 2000 to 2009

Between 2004 and 2009 the annually installed glazed water collector area worldwide almost tripled. The worldwide average annual growth rate between 2000 and 2009 was 20.8%.

Compared to the year 2008, the worldwide market for glazed water collectors grew by 27.3% in 2009 (compared to 36.5% in the period 2007/2008).

Regardless of the downturns in the European (–9.9%), Middle Eastern (–6.7%) and North American (–9.8%) markets, the Chinese market (+ 35.5%) and to a certain extent the strong Australian market (+ 78.5%) is responsible for the above average growth in 2009.



Africa: Namibia, South Africa, Tunisia, Zimbabwe
Asia: India, South Korea, Taiwan, Thailand
Central + South America: Barbados, Brazil, Chile, Mexico, Uruguay
Europe: EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East: Israel, Jordan

Figure 20: Annually installed capacity of flat-plate and evacuated tube collectors in kW$_{th}$ per 1,000 inhabitants from 2000 to 2009

For 2009 the "Top 10" countries in terms of newly installed glazed water capacity per 1,000 inhabitants are shown in Figure 21.

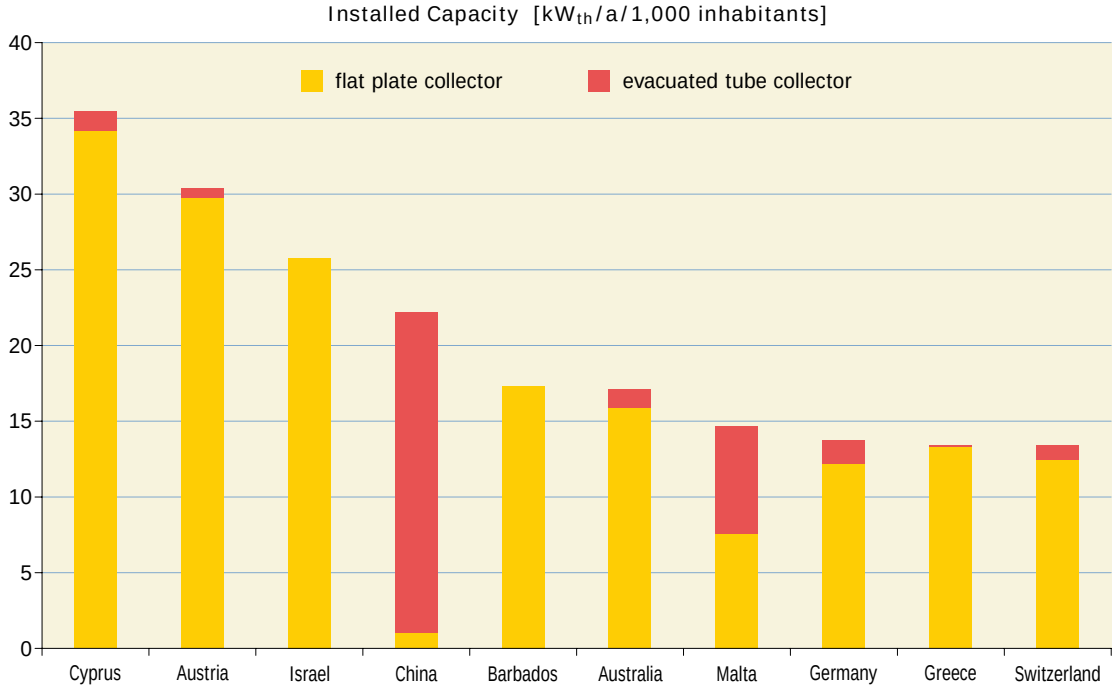
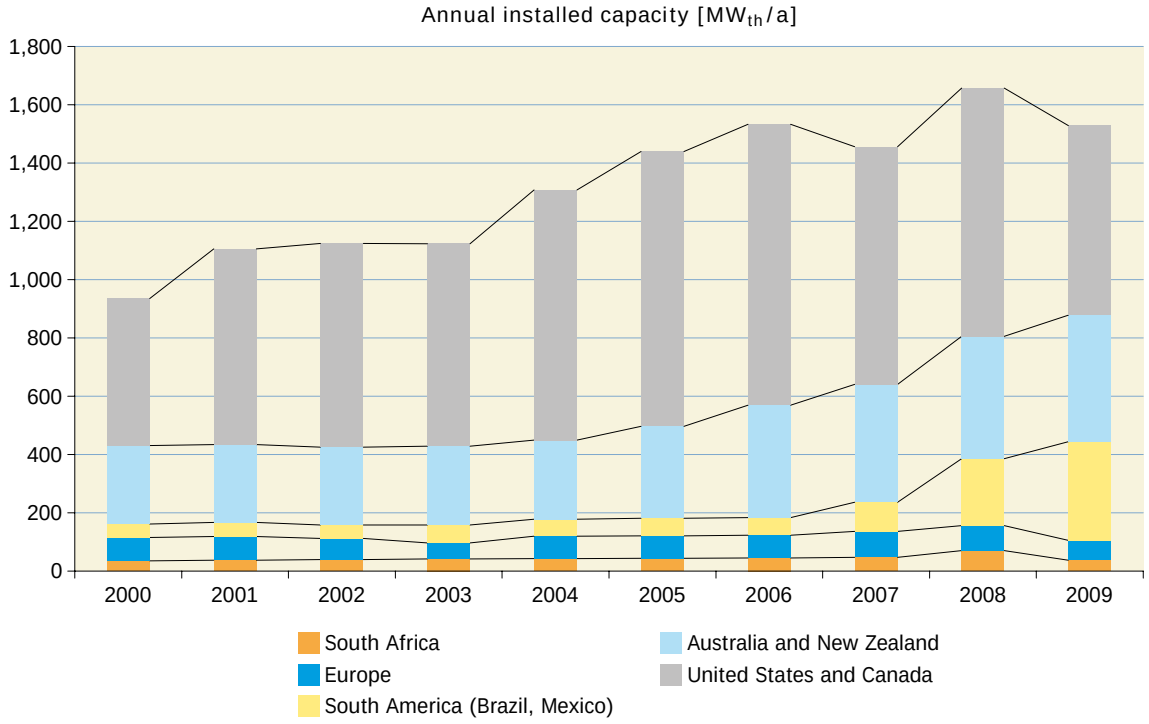


Figure 21: Newly installed capacity of glazed water collectors per 1,000 inhabitants in the 10 leading countries 2009

4.4 Market development of unglazed water collectors between 2000 and 2009

The worldwide market of unglazed collectors recorded a significant increase in 2001 and remained steady between 2001 and 2003. After a slight increase from 2004 to 2006, the installed capacity rate decreased again in 2007, mainly due to the major market decline in the United States and Canada.
In 2008, significant growth was recorded in Brazil, Canada and South Africa while all other markets remained quite stable. In 2009, it was more or less only Brazil (+ 45.9%) and Mexico (+ 51.9%) that gained from a high growth rate while the general trend for unglazed water collectors was stagnating or falling.
In total, new installations of unglazed water collectors decreased significantly by 7.7% in 2009 compared to 2008, accounting for 1.5 GW_{th} representing 2.2 million of square meters in 2009 compared to an increase of 13.9% in the period 2007/2008.



Europe (new installations 2009): Austria, Hungary, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland

Figure 22: Annually installed capacity of unglazed water collectors from 2000 to 2009

In the United States and Australia, unglazed collectors have a long history and still play an important role, but emerging players, especially countries from South America (namely Brazil and Mexico) and South Africa are benefitting from this low cost technology that fits perfectly to the moderate climate conditions. Nevertheless, in case of the United States (–23.9%), Canada (–18.5%) and South Africa (–46.1%) a vast decrease of unglazed water collector installations were reported in 2009.

In other large markets, such as China, Turkey, India and Japan, unglazed collectors almost do not exist. In Europe, the annual installations of unglazed collectors are far below 5% of the total newly installed collector area, and in the period 2008/2009 unglazed water collector installations further dropped by 20.5% to a total installed capacity of 68.0 MW_{th}.

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 corresponding annual energy yields, energy savings in terms of oil equivalents and CO_2 savings are calculated by means of the simulation tool T-Sol expert 4.5 [T-Sol, Version 4.5 Expert, Valentin Energiesoftware, www.valentin.de].

The annual collector yield of all water-based solar thermal systems in operation by the end of 2009 in the 53 recorded countries is 141,775 GWh (= 510,338 TJ). This corresponds to an oil equivalent of 14.4 million tons and an annual CO_2 savings of 46.1 million tons.

For glazed water collectors, the total installed capacity in operation in 2009 of 151.5 GW_{th} led to an annual solar thermal collector yield of 130,668 GWh (= 470,406 TJ/a). This corresponds to annual oil savings of 13.4 million tons respectively to annual CO_2 savings of 42.8 million tons.

For unglazed water collectors, the total installed capacity in operation in 2009 of 19.7 GW_{th} led to an annual solar thermal collector yield of 11,106 GWh (= 39,983 TJ/a). This corresponds to annual oil savings of 1.0 million tons respectively to annual CO_2 savings of 3.3 million tons.

The contribution of the total installed air collector capacity in operation in 2009 (1.2 GW_{th}) was not taken into consideration – with a share of about 0.7% of the total installed collector capacity air collectors were omitted from the calculation.

Within the standardization of definitions for renewable heat by EUROSTAT and IEA SHC, a new calculation method for the annual solar yield was used for this report:

"Solar thermal production (solar yield) is equal to the solar collector output".

This new definition led to higher annual solar yields than reported in previous publications.

Please find the issue of the methodology in the appendix (see Chapter 7.1).

Table 5 summarizes the calculated annual collector yields and the corresponding oil equivalents and CO_2 reductions of all solar thermal systems (systems for hot water, space heating and swimming pool heating) installed by the end of 2009.

Table 6 and Table 7 show the results for glazed and unglazed water collectors.

In Chapters 5.1 to 5.3, the annual collector yield, energy savings and CO_2 savings by economic regions for total numbers and per 1,000 inhabitants are graphed.

Country	Total glazed (flate plate and evacuated tube collectors) and unglazed Water Collectors						
	Total collector area [m²]	Total capacity [MW_{th}]	Calculated number of systems	Collector yield [GWh/a]	Collector yield [TJ/a]	Energy savings: Oil equivalent [toe/a]	CO_2 reduction [tCO_2/a]
Albania	70,171	49.1	8,870	54.0	194.5	6,206	19,675
Australia	7,237,375	5,066.2	551,002	4,107.3	14,786.5	425,165	1,345,547
Austria	4,305,792	3,014.1	400,314	1,723.1	6,203.0	184,071	690,594
Barbados	131,690	92.2	32,923	116.2	418.4	9,989	31,641
Belgium	325,208	227.6	69,818	130.1	468.5	13,925	44,107
Brazil	5,271,396	3,690.0	877,461	3,606.4	12,982.9	352,874	1,117,098
Bulgaria	38,336	26.8	7,050	20.0	71.9	2,280	7,208
Canada	625,915	438.1	7,617	250.3	901.2	23,626	74,482
Chile	28,200	19.7	6,690	21.5	77.3	2,479	7,854
China	145,000,000	101,500.0	33,052,750	83,509.2	300,633.0	8,296,529	26,356,225
Cyprus	858,520	601.0	179,087	758.3	2,729.7	73,682	232,995
Czech Republic	196,298	137.4	30,086	74.4	267.9	7,777	24,633
Denmark	488,065	341.6	102,231	217.7	783.6	23,224	73,731
Estonia	2,341	1.6	585	1.0	3.6	103	328
Finland	40,240	28.2	6,847	16.2	58.2	1,687	5,345
France	1,966,300	1,376.4	371,718	920.5	3,313.6	102,717	342,459
FYRM	25,744	18.0	3,298	15.5	55.8	1,807	5,730
Germany	12,653,154	8,857.2	1,615,570	5,137.8	18,496.0	560,211	1,963,450
Greece	4,077,000	2,853.9	1,599,815	3,138.7	11,299.4	474,159	1,502,161
Hungary	134,502	94.2	11,549	64.6	232.6	7,488	24,880
India	3,081,195	2,156.8	557,696	2,595.3	9,343.1	267,607	849,250
Ireland	120,968	84.7	27,996	50.6	182.3	4,999	16,096
Israel	4,068,819	2,848.2	991,397	4,136.4	14,890.9	379,084	1,200,936
Italy	2,101,344	1,470.9	514,613	1,369.4	4,929.8	155,003	490,980
Japan	5,720,246	4,004.2	1,384,681	3,328.5	11,982.5	351,322	1,118,800
Jordan	895,287	626.7	182,639	849.5	3,058.2	81,927	259,633
Korea	1,496,514	1,047.6	215,797	835.9	3,009.1	93,532	297,665
Lativa	7,044	4.9	1,761	3.3	11.7	333	1,054
Lithuania	4,318	3.0	1,080	1.9	7.0	212	671
Luxembourg	26,300	18.4	6,575	11.8	42.6	1,260	3,992
Malta	44,867	31.4	11,217	38.9	140.2	4,603	14,579
Mexico	1,261,954	883.4	61,085	656.1	2,362.1	78,424	249,306
Namibia	15,706	11.0	1,867	14.3	51.4	1,571	4,969
Netherlands	755,338	528.7	110,538	266.2	958.3	26,972	85,937
New Zealand	159,645	111.8	36,435	100.1	360.5	10,794	34,200
Norway	15,470	10.8	2,237	6.4	23.2	675	2,143
Poland	509,836	356.9	60,416	209.5	754.1	23,493	75,510
Portugal	550,000	385.0	55,076	406.7	1,463.9	49,479	157,769
Romania	94,496	66.1	23,624	56.1	202.0	6,356	20,131
Slovak Republic	120,746	84.5	20,124	58.0	208.9	6,598	20,901
Slovenia	144,698	101.3	21,883	60.2	216.7	6,713	22,583
South Africa	1,063,360	744.4	81,189	693.2	2,495.6	65,507	207,372
Spain	2,112,000	1,478.4	272,624	1,409.1	5,072.8	152,788	534,181
Sweden	415,000	290.5	24,453	151.2	544.2	15,721	55,949
Switzerland	871,860	610.3	89,574	335.6	1,208.2	35,355	119,470
Taiwan	1,922,764	1,345.9	458,922	1,174.8	4,229.4	115,587	365,961
Thailand	91,392	64.0	22,848	78.0	280.8	7,903	25,036
Tunisia	405,000	283.5	98,456	363.2	1,307.6	34,060	107,884
Turkey	12,035,000	8,424.5	2,814,987	9,808.4	35,310.4	992,602	3,143,252
United Kingdom	459,583	321.7	114,896	190.8	687.0	21,165	67,057
United States	20,435,328	14,304.7	529,258	8,608.9	30,992.0	842,623	2,669,767
Uruguay	12,096	8.5	3,024	8.2	29.7	973	3,083
Zimbabwe	17,671	12.4	4,418	15.1	54.3	1,868	5,939
TOTAL	244,512,092	171,158.5	47,738,665	141,774.5	510,388.4	14,407,109	46,102,199

FYRM: Former Yugoslav Republic of Macedonia

Table 5: Calculated annual collector yield and corresponding oil equivalent as well as CO_2 reduction of glazed and unglazed water collectors in operation by the end of 2009

Country	Glazed (flate plate and evacuated tube collectors) Water Collectors						
	Total collector area [m²]	Total capacity [MW_{th}]	Calculated number of systems	Collector yield [GWh/a]	Collector yield [TJ/a]	Energy savings: Oil equivalent [toe/a]	CO_2 reduction [tCO_2/a]
Albania	70,171	49.1	8,870	54.0	194.5	6,206	19,675
Australia	2,517,375	1,762.2	412,178	1,907.3	6,866.3	220,978	699,975
Austria	3,688,840	2,582.2	397,229	1,548.2	5,573.4	167,487	637,885
Barbados	131,690	92.2	32,923	116.2	418.4	9,989	31,641
Belgium	278,333	194.8	69,583	117.8	424.2	12,783	40,498
Brazil	3,999,547	2,799.7	871,101	3,130.0	11,268.1	312,277	988,752
Bulgaria	38,336	26.8	7,050	20.0	71.9	2,280	7,208
Canada	43,564	30.5	4,705	25.4	91.3	2,836	8,954
Chile	26,730	18.7	6,683	20.6	74.2	2,399	7,600
China	145,000,000	101,500.0	33,052,750	83,509.2	300,633.0	8,296,529	26,356,225
Cyprus	858,520	601.0	179,087	758.3	2,729.7	73,682	232,995
Czech Republic	181,677	127.2	30,013	70.0	251.9	7,366	23,330
Denmark	467,550	327.3	102,128	211.6	761.8	22,638	71,889
Estonia	2,341	1.6	585	1.0	3.6	103	328
Finland	28,461	19.9	6,788	12.5	45.2	1,336	4,232
France	1,860,601	1,302.4	371,190	885.8	3,188.8	99,387	331,960
FYRM	25,744	18.0	3,298	15.5	55.8	1,807	5,730
Germany	11,933,154	8,353.2	1,611,970	4,912.0	17,683.2	538,438	1,894,993
Greece	4,077,000	2,853.9	1,599,815	3,138.7	11,299.4	474,159	1,502,161
Hungary	128,814	90.2	11,520	62.7	225.6	7,309	24,314
India	3,081,195	2,156.8	557,696	2,595.3	9,343.1	267,607	849,250
Ireland	120,968	84.7	27,996	50.6	182.3	4,999	16,096
Israel	4,039,324	2,827.5	991,250	4,119.6	14,830.6	377,548	1,196,080
Italy	2,057,578	1,440.3	514,395	1,350.1	4,860.2	153,220	485,347
Japan	5,720,246	4,004.2	1,384,681	3,328.5	11,982.5	351,322	1,118,800
Jordan	895,287	626.7	182,639	849.5	3,058.2	81,927	259,633
Korea	1,496,514	1,047.6	215,797	835.9	3,009.1	93,532	297,665
Lativa	7,044	4.9	1,761	3.3	11.7	333	1,054
Lithuania	4,318	3.0	1,080	1.9	7.0	212	671
Luxembourg	26,300	18.4	6,575	11.8	42.6	1,260	3,992
Malta	44,867	31.4	11,217	38.9	140.2	4,603	14,579
Mexico	689,862	482.9	58,224	478.0	1,720.8	62,085	197,657
Namibia	15,706	11.0	1,867	14.3	51.4	1,571	4,969
Netherlands	378,051	264.6	108,652	163.5	588.6	17,147	54,815
New Zealand	152,620	106.8	36,400	97.2	350.0	10,517	33,322
Norway	13,550	9.5	2,227	5.8	21.0	618	1,964
Poland	509,836	356.9	60,416	209.5	754.1	23,493	75,510
Portugal	547,918	383.5	55,066	405.8	1,460.8	49,399	157,514
Romania	94,496	66.1	23,624	56.1	202.0	6,356	20,131
Slovak Republic	120,746	84.5	20,124	58.0	208.9	6,598	20,901
Slovenia	144,698	101.3	21,883	60.2	216.7	6,713	22,583
South Africa	309,682	216.8	77,420	312.5	1,125.0	30,370	96,208
Spain	2,001,000	1,400.7	272,069	1,356.8	4,884.4	147,986	519,041
Sweden	290,000	203.0	23,828	114.3	411.6	12,151	44,689
Switzerland	660,070	462.0	88,515	277.0	997.4	29,751	101,813
Taiwan	1,920,827	1,344.6	458,912	1,174.2	4,227.2	115,531	365,783
Thailand	91,392	64.0	22,848	78.0	280.8	7,903	25,036
Tunisia	405,000	283.5	98,456	363.2	1,307.6	34,060	107,884
Turkey	12,035,000	8,424.5	2,814,987	9,808.4	35,310.4	992,602	3,143,252
United Kingdom	459,583	321.7	114,896	190.8	687.0	21,165	67,057
United States	2,641,739	1,849.2	440,290	1,718.9	6,188.2	199,919	633,264
Uruguay	12,096	8.5	3,024	8.2	29.7	973	3,083
Zimbabwe	17,671	12.4	4,418	15.1	54.3	1,868	5,939
TOTAL	216,363,633	151,454.5	47,482,700	130,668.3	470,405.8	13,375,329	42,835,926

FYRM: Former Yugoslav Republic of Macedonia

Table 6: Calculated annual collector yield and corresponding oil equivalent as well as CO_2 reduction of glazed water collectors in operation by the end of 2009

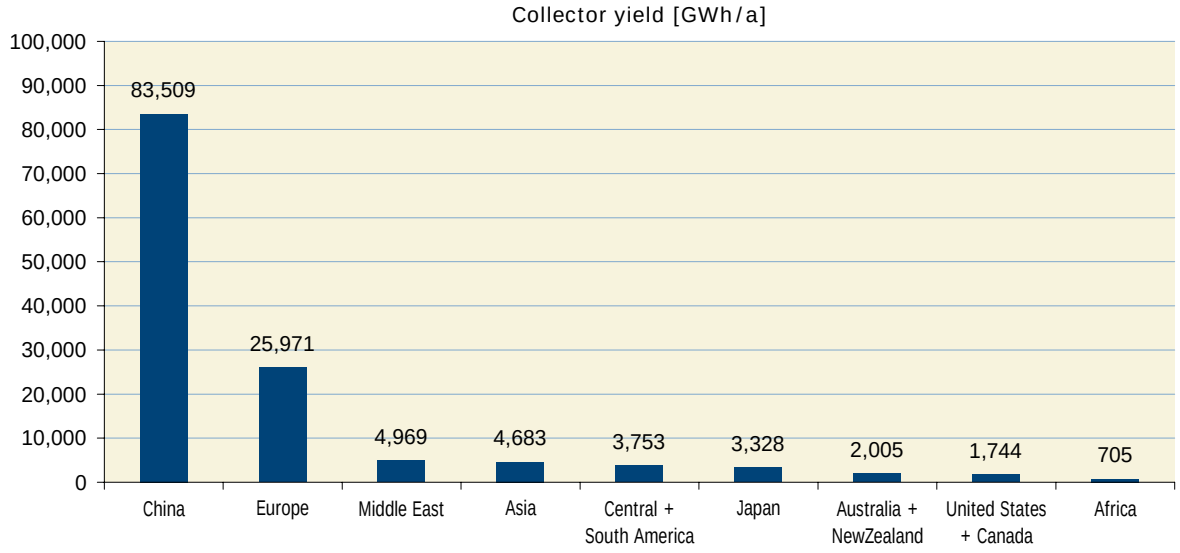
Country	Unglazed Water Collectors (swimming pool collectors)						
	Total collector area [m²]	Total capacity [MWth]	Calculated number of systems	Collector yield [GWh/a]	Collector yield [TJ/a]	Energy savings: Oil equivalent [toe/a]	CO_2 reduction [tCO_2/a]
Albania							
Australia	4,720,000	3,304.0	138,824	2,200	7,920	204,187	645,572
Austria	616,952	431.9	3,085	175	630	16,584	52,709
Barbados							
Belgium	46,875	32.8	234	12	44	1,142	3,609
Brazil	1,271,849	890.3	6,359	476	1,715	40,597	128,347
Bulgaria							
Canada	582,351	407.6	2,912	225	810	20,790	65,528
Chile	1,470	1.0	7	1	3	80	254
China							
Cyprus							
Czech Republic	14,621	10.2	73	4	16	411	1,303
Denmark	20,515	14.4	103	6	22	586	1,843
Estonia							
Finland	11,779	8.2	59	4	13	351	1,113
France	105,699	74.0	528	35	125	3,330	10,500
FYRM							
Germany	720,000	504.0	3,600	226	813	21,773	68,457
Greece							
Hungary	5,688	4.0	28	2	7	179	566
India							
Ireland							
Israel	29,495	20.6	147	17	60	1,536	4,855
Italy	43,766	30.6	219	19	70	1,783	5,633
Japan							
Jordan							
Korea							
Lativa							
Lithuania							
Luxembourg							
Malta							
Mexico	572,092	400.5	2,860	178	641	16,339	51,649
Namibia							
Netherlands	377,287	264.1	1,886	103	370	9,825	31,122
New Zealand	7,025	4.9	35	3	10	277	879
Norway	1,920	1.3	10	1	2	56	179
Poland							
Portugal	2,082	1.5	10	1	3	80	254
Romania							
Slovak Republic							
Slovenia							
South Africa	753,678	527.6	3,768	381	1,371	35,136	111,164
Spain	111,000	77.7	555	52	188	4,802	15,140
Sweden	125,000	87.5	625	37	133	3,570	11,260
Switzerland	211,790	148.3	1,059	59	211	5,604	17,657
Taiwan	1,937	1.4	10	1	2	56	177
Thailand							
Tunisia							
Turkey							
United Kingdom							
United States	17,793,589	12,455.5	88,968	6,890	24,804	642,704	2,036,502
Uruguay							
Zimbabwe							
TOTAL	28,148,459	19,703.9	255,966	11,106.3	39,982.6	1,031,780	3,266,273

FYRM: Former Yugoslav Republic of Macedonia

Table 7: Calculated annual collector yield and corresponding oil equivalent as well as CO_2 reduction of unglazed water collectors in operation by the end of 2009

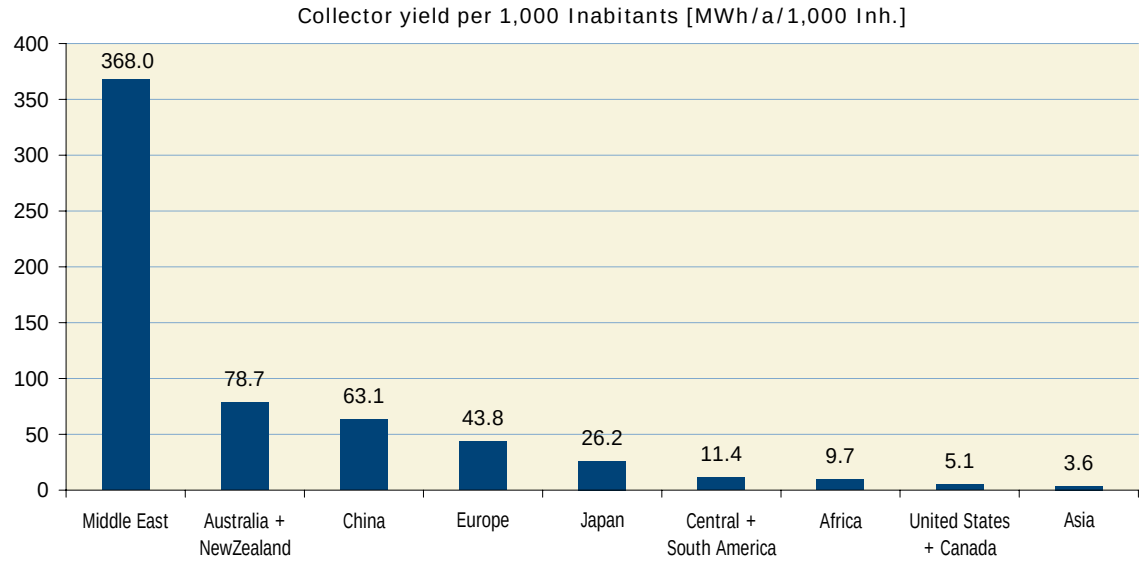
5.1 Annual collector yield by economic region

5.1.1 Collector yield of glazed flat-plate and evacuated tube collectors by economic region in 2009



Africa: Namibia, South Africa, Tunisia, Zimbabwe
Asia: India, South Korea, Taiwan, Thailand
Central + South America: Barbados, Brazil, Chile, Mexico, Uruguay
Europe: EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East: Israel, Jordan

Figure 23: Annual collector yield of glazed flat-plate and evacuated tube collectors in operation by economic region in 2009



Africa: Namibia, South Africa, Tunisia, Zimbabwe
Asia: India, South Korea, Taiwan, Thailand
Central + South America: Barbados, Brazil, Chile, Mexico, Uruguay
Europe: EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East: Israel, Jordan

Figure 24: Annual collector yield of glazed flat-plate and evacuated tube collectors in operation by economic region in MWh per 1,000 inhabitants in 2009

5.1.2 Collector yield of unglazed collectors by economic region in 2009

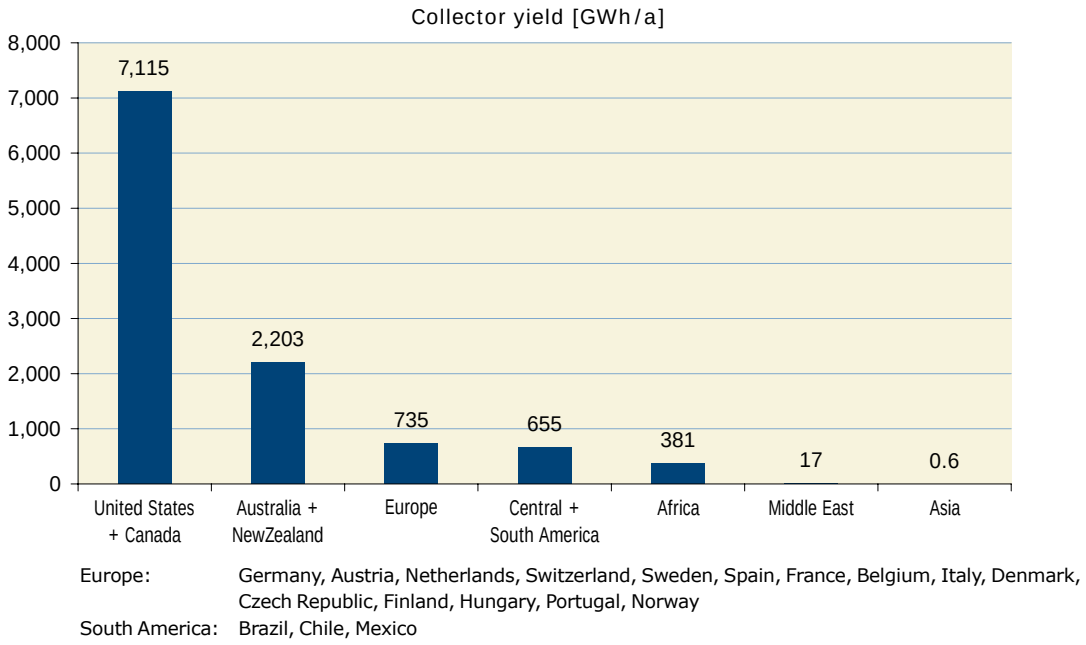


Figure 25: Annual collector yield of unglazed water collectors in operation by economic region in 2009

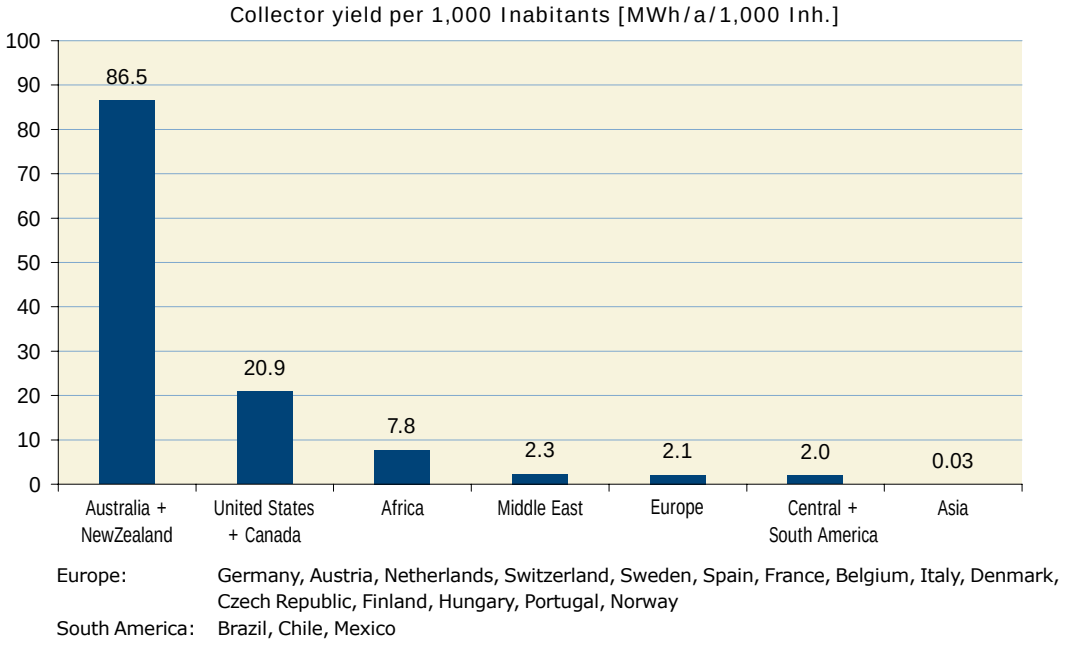
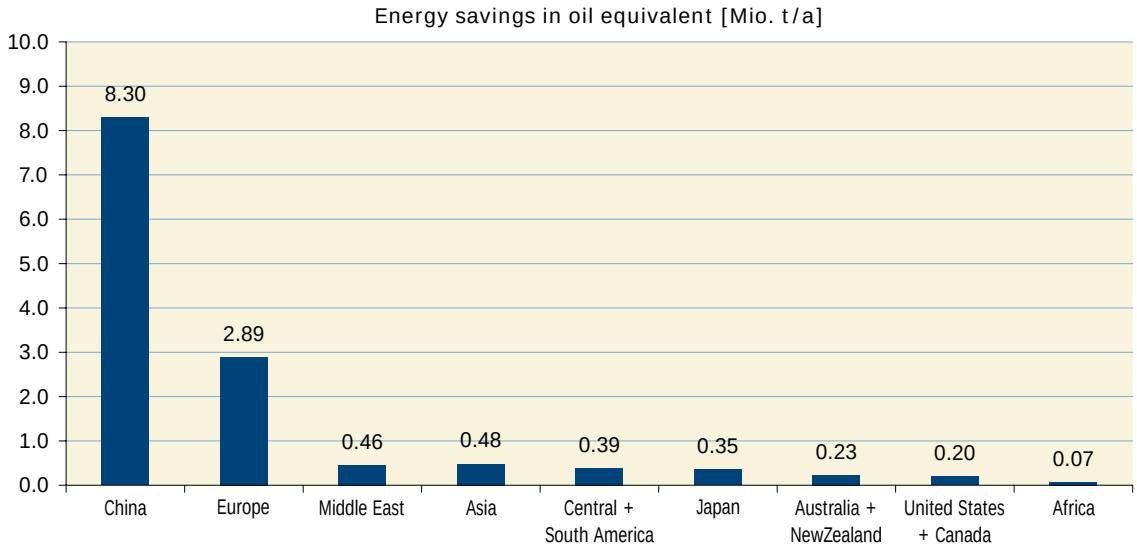


Figure 26: Annual collector yield of unglazed water collectors in operation by economic region in MWh per 1,000 inhabitants in 2009

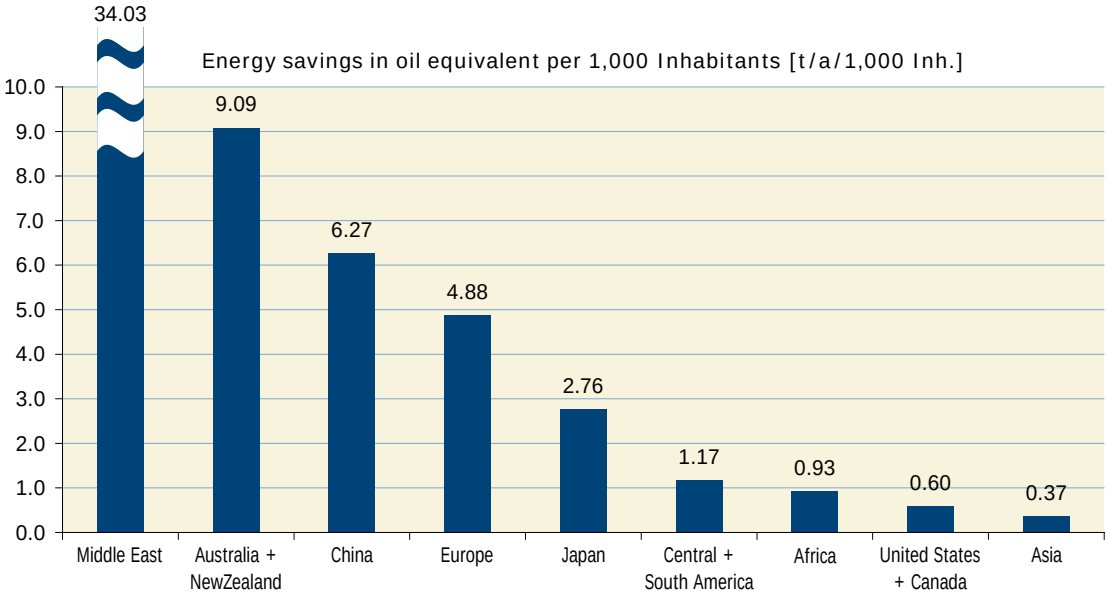
5.2 Annual energy savings by economic region

5.2.1 Energy savings in oil equivalents by glazed flat-plate and evacuated tube collectors by economic region in 2009



Africa:	Namibia, South Africa, Tunisia, Zimbabwe
Asia:	India, South Korea, Taiwan, Thailand
Central + South America:	Barbados, Brazil, Chile, Mexico, Uruguay
Europe:	EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East:	Israel, Jordan

Figure 27: Annual energy savings in oil equivalent by glazed flat-plate and evacuated tube collectors in operation by economic region in 2009



Africa:	Namibia, South Africa, Tunisia, Zimbabwe
Asia:	India, South Korea, Taiwan, Thailand
Central + South America:	Barbados, Brazil, Chile, Mexico, Uruguay
Europe:	EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East:	Israel, Jordan

Figure 28: Annual energy savings in oil equivalent by glazed flat-plate and evacuated tube collectors in operation by economic region per 1,000 inhabitants in 2009

5.2.2 Energy savings in oil equivalents by unglazed water collectors by economic region 2009

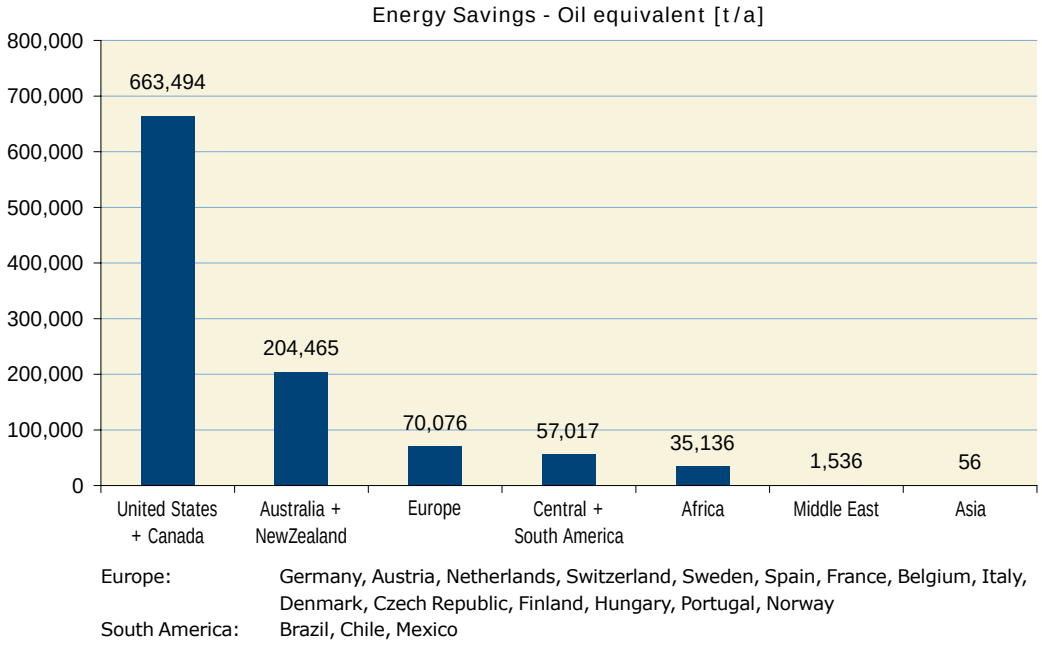


Figure 29: Annual energy savings in oil equivalents by unglazed water collectors in operation by economic region in 2009

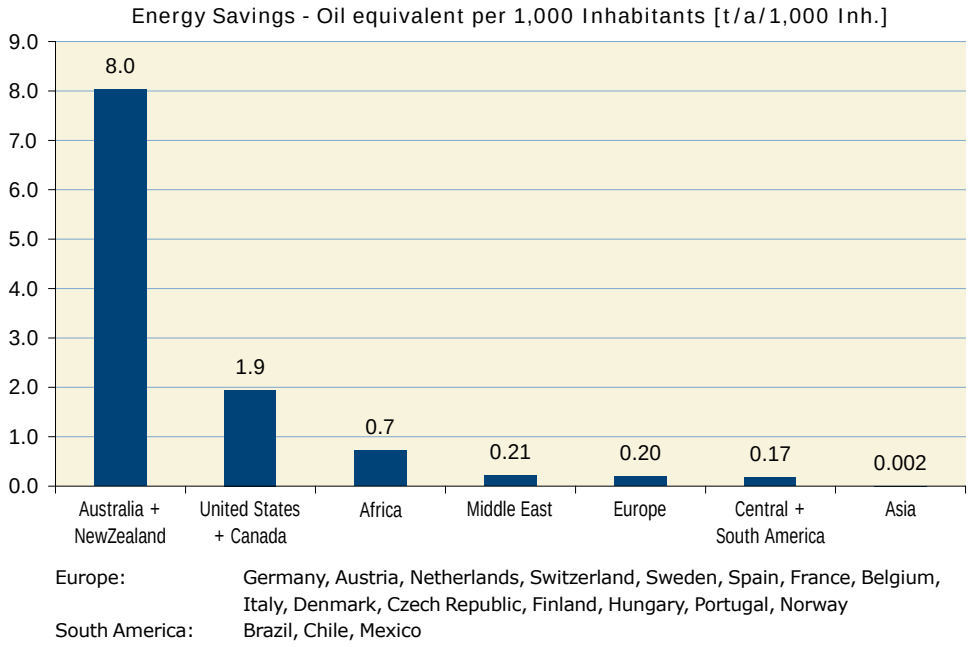
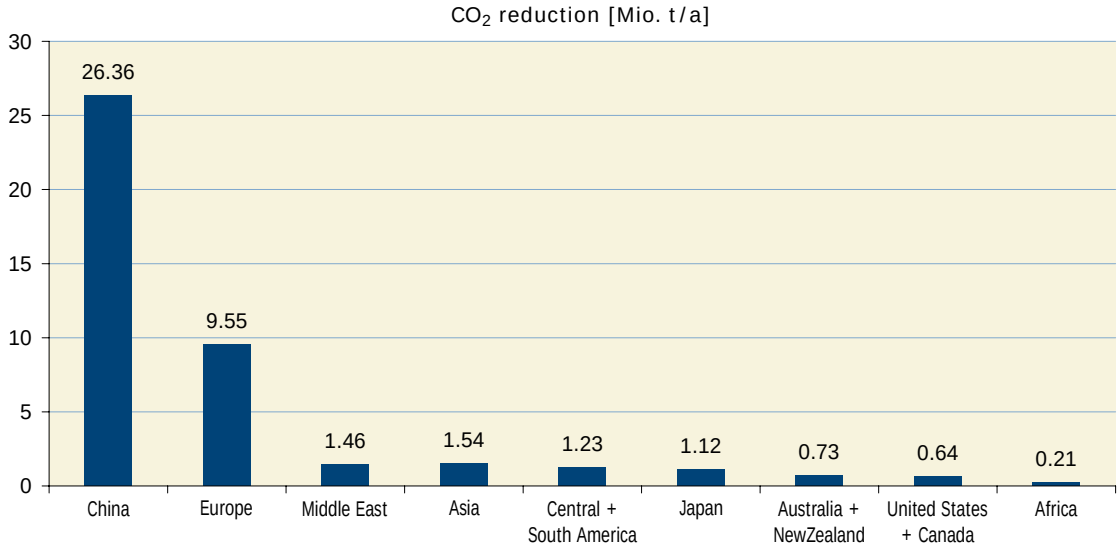


Figure 30: Annual energy savings in oil equivalent by unglazed water collectors in operation by economic region per 1,000 inhabitants in 2009

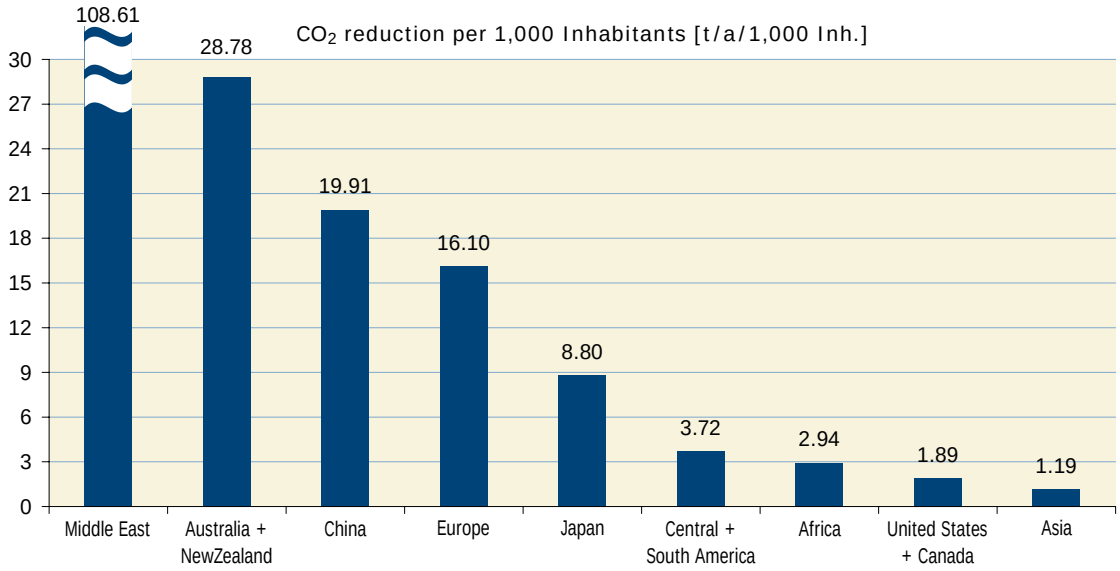
5.3 Annual contribution to CO_2 reduction by economic region

5.3.1 Contribution to CO_2 reduction by flat-plate and evacuated tube collectors and economic region in 2009



Africa:	Namibia, South Africa, Tunisia, Zimbabwe
Asia:	India, South Korea, Taiwan, Thailand
Central + South America:	Barbados, Brazil, Chile, Mexico, Uruguay
Europe:	EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East:	Israel, Jordan

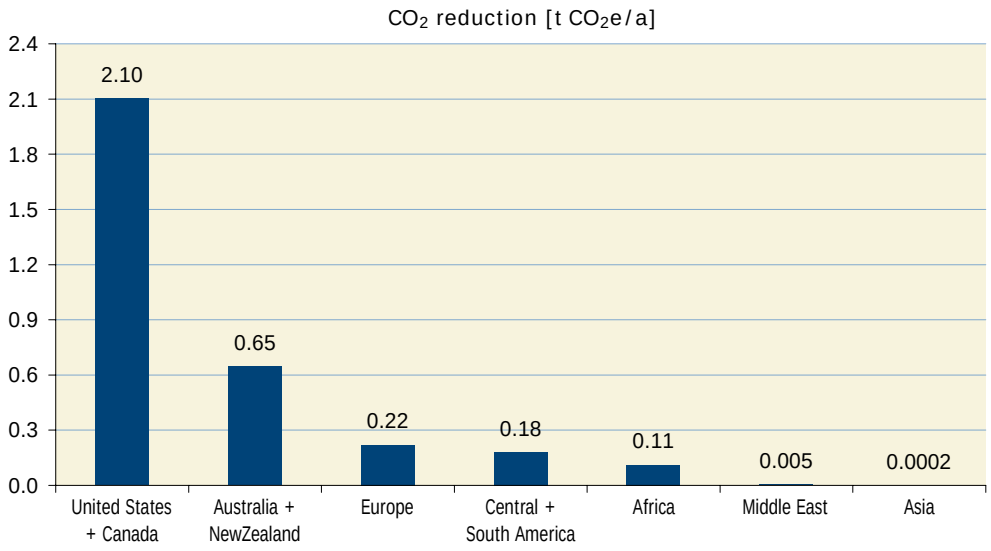
Figure 31: Contribution to CO_2 reduction by flat-plate and evacuated tube collectors in operation by economic region in 2009



Africa:	Namibia, South Africa, Tunisia, Zimbabwe
Asia:	India, South Korea, Taiwan, Thailand
Central + South America:	Barbados, Brazil, Chile, Mexico, Uruguay
Europe:	EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East:	Israel, Jordan

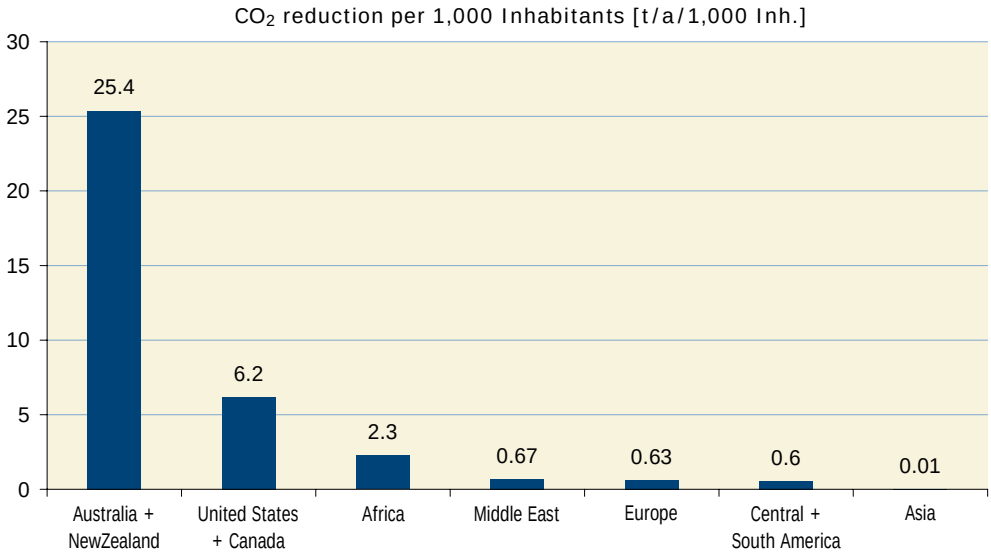
Figure 32: Contribution to CO_2 reduction by flat-plate and evacuated tube collectors in operation by economic region per 1,000 inhabitants in 2009

5.3.2 Contribution to CO_2 reduction by unglazed water collectors and economic region in 2009



Europe: Germany, Austria, Netherlands, Switzerland, Sweden, Spain, France, Belgium, Italy, Denmark, Czech Republic, Finland, Hungary, Portugal, Norway
South America: Brazil, Chile, Mexico

Figure 33: Contribution to CO_2 reduction by unglazed collectors in operation by economic region in 2009



Europe: Germany, Austria, Netherlands, Switzerland, Sweden, Spain, France, Belgium, Italy, Denmark, Czech Republic, Finland, Hungary, Portugal, Norway
South America: Brazil, Chile, Mexico

Figure 34: Contribution to CO_2 reduction by unglazed water collectors in operation by economic region per 1,000 inhabitants in 2009

6 Distribution of systems by system type and application

If one observes the thermal utilization of the energy from the sun, it becomes clear that it greatly varies in different regions on Earth. In terms of the type of collectors used, in China vacuum tube collectors predominate while in other Asian countries, the Middle East and Europe most systems are equipped with flat plate collectors. By contrast, in North America (United States and Canada) and Australia unglazed water collectors for swimming pool heating is the dominant application.

Another distinction can be made between pumped systems and thermosiphon systems. The market for thermosiphon systems is more advanced in the Asian countries (especially China), Africa and the Middle East while in Europe, the United States, and Australia and New Zealand pumped systems are by far more common.

For glazed water collectors, the market has become more sophisticated in the past years. In several well-established markets in Europe as well as in some South American (Brazil, Mexico) and Asian (China, India, Japan) countries, the market penetration of solar combi-systems, solar supported district heating networks, industrial applications and solar cooling systems is increasing.

6.1 Distribution by application of the total installed capacity in operation

While in a worldwide context domestic hot water systems for single-family houses are predominant, especially in some European markets and in India, a remarkable share of the total installed capacity in operation is large domestic hot water applications and solar combi- systems.

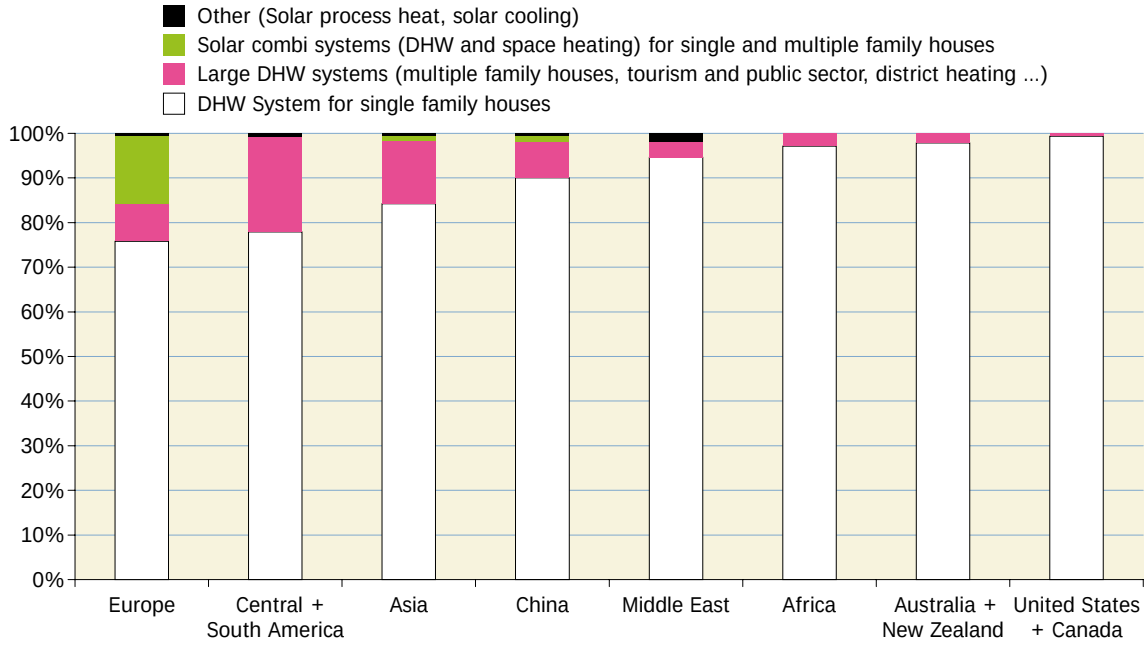
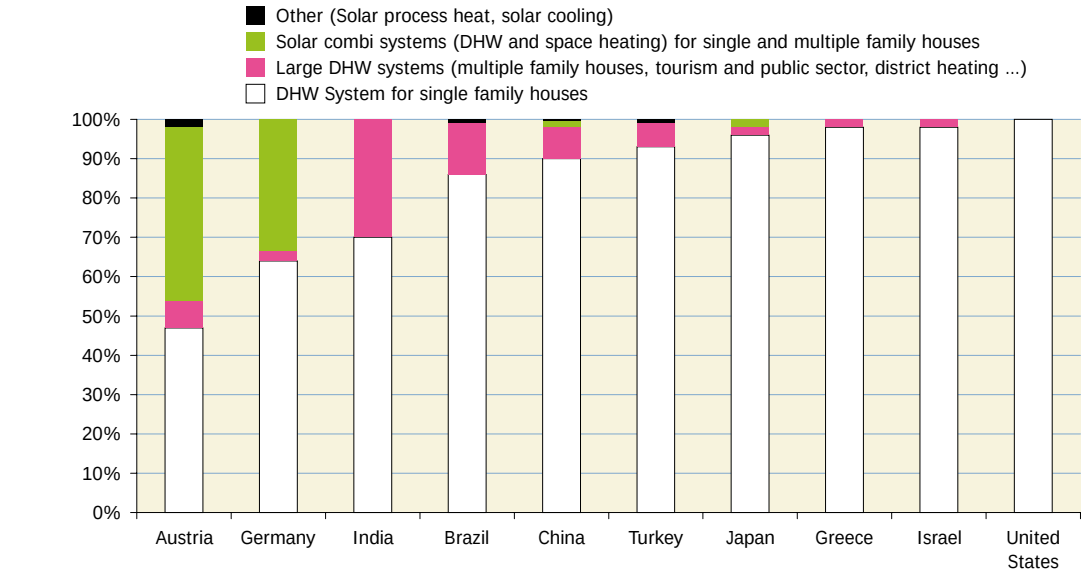


Figure 35: Weighted distribution of solar thermal systems by application for the total installed glazed water collector capacity in operation by the end of 2009



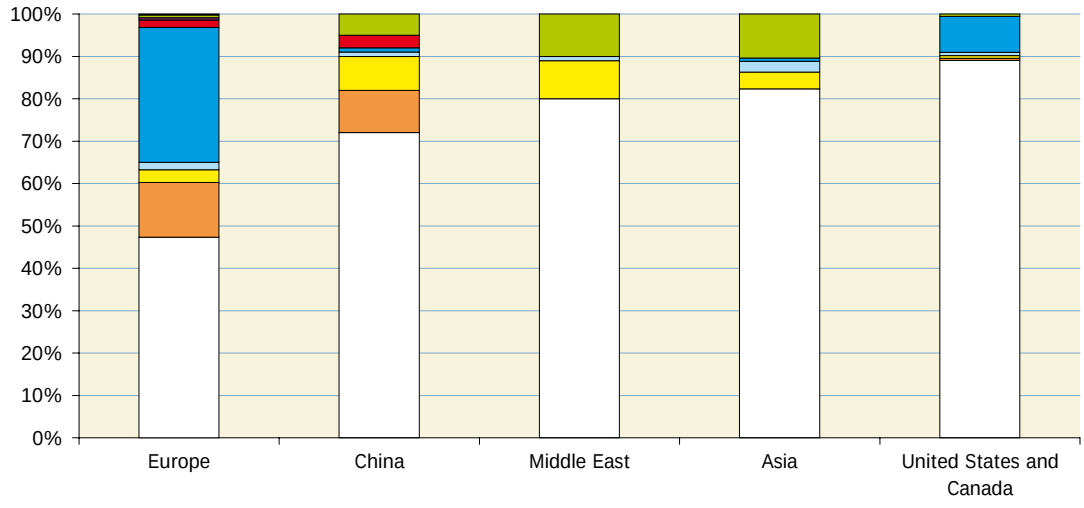
DHW: Domestic Hot Water

Figure 36: Distribution of solar thermal systems by application for the 10 leading markets of the total installed glazed water collector capacity in operation by the end of 2009

In Austria and Germany already about 30% of the total installed glazed water collector capacity is operated as solar combi-systems.

6.2 Distribution by application of the newly installed capacity in 2009

When analyzing the markets of newly installed systems in 2009, a trend towards more sophisticated fields of application is obvious (see Figure 37, Figure 38 and Figure 39).



Europe: Albania, Austria, Cyprus, Denmark, France, Germany, Hungary, Ireland, Former Yugoslav Republic of Macedonia, Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland, Turkey
Asia India, Japan, Taiwan
DHW: Domestic Hot Water

Figure 37: Weighted distribution of different applications of the newly installed capacity of glazed water collectors by economic region in 2009

In general, the large markets in Europe tend to become more sophisticated as a result of their continuous R&D activities while other strong markets, such as in Brazil, China, India and Turkey, conquer the market with a broader variety of applications.

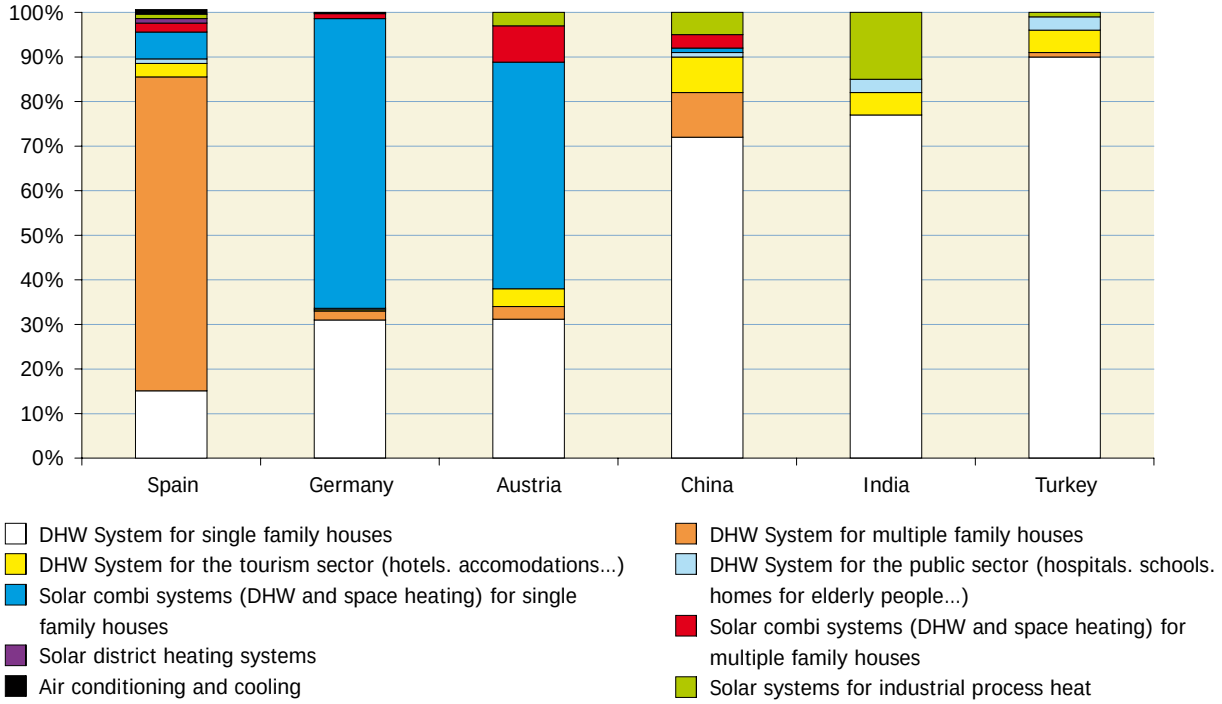


Figure 38: Distribution of different applications of the newly installed capacity of glazed water collectors for the 6 leading countries worldwide in 2009

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

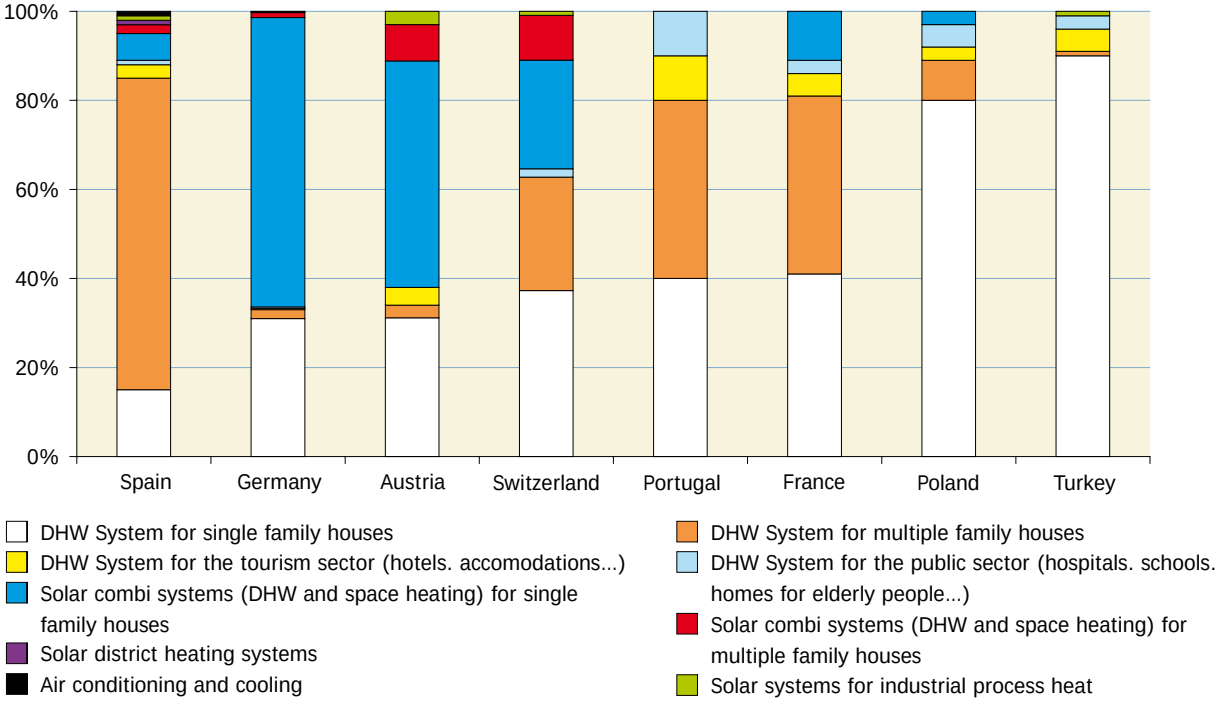
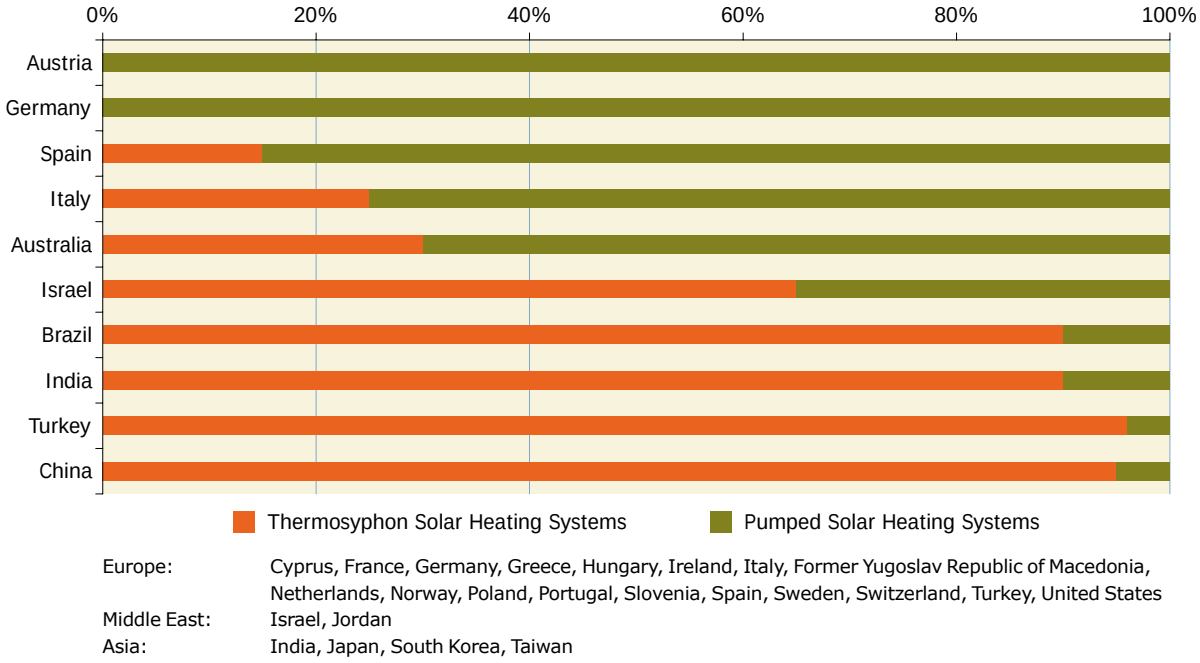


Figure 39: Distribution of different applications of the newly installed capacity of glazed water collectors for the 8 leading European countries in 2009

6.3 Distribution by type of system of the newly installed capacity in 2009

Figure 40 and Figure 41 show the market share of the newly installed thermosiphon and pumped systems for both, the most important economic regions as well as for the 10 leading countries for glazed water collectors in the year 2009.



Europe: Cyprus, France, Germany, Greece, Hungary, Ireland, Italy, Former Yugoslav Republic of Macedonia, Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland, Turkey, United States
Middle East: Israel, Jordan
Asia: India, Japan, South Korea, Taiwan

Figure 40: Weighted share between thermosiphon and pumped systems by economic region for newly installed glazed water collectors in 2009

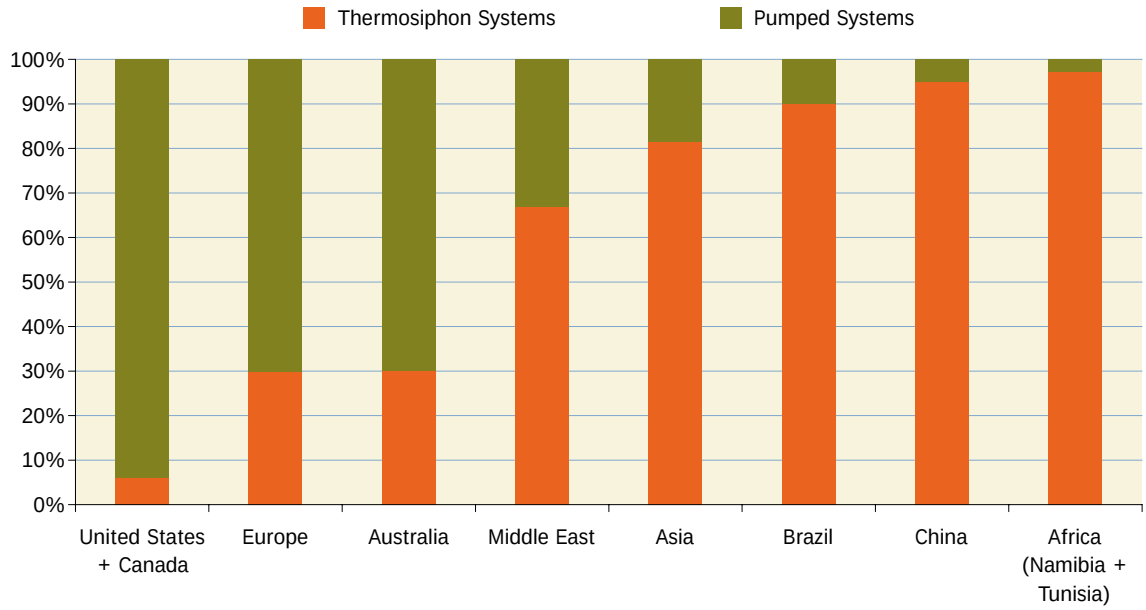


Figure 41: Share between thermosiphon and pumped systems for newly installed glazed water collectors for the 10 leading countries worldwide in 2009

6.4 European large scale solar thermal applications

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

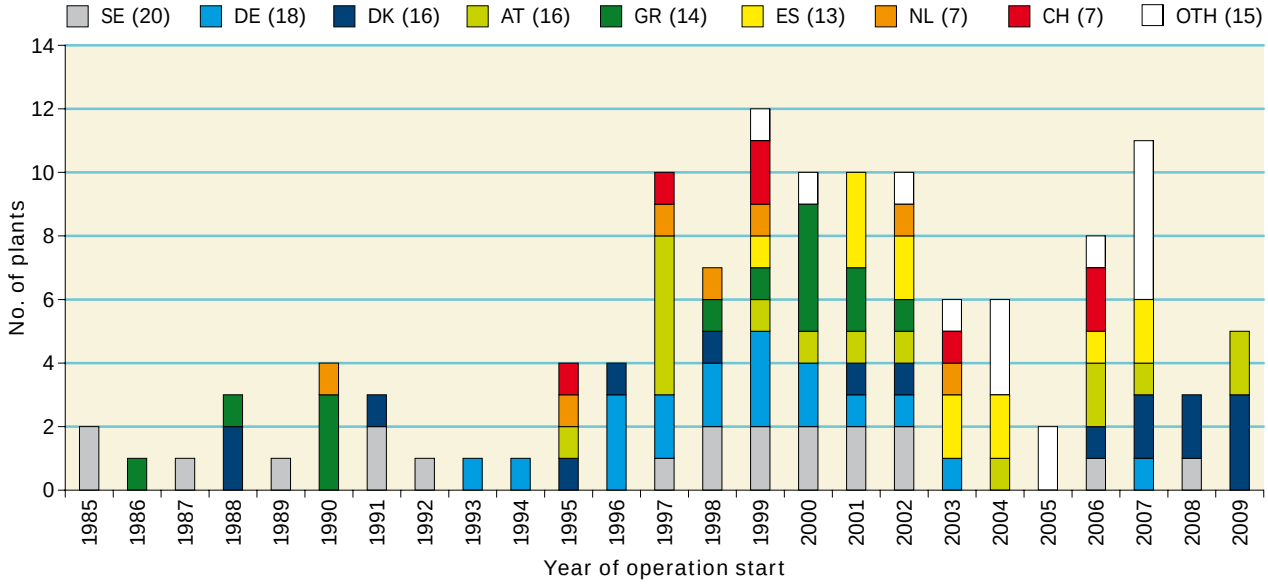


Figure 42: Large-scale solar heating and cooling systems in operation in Europe by the end of 2009
(Source: Jan-Olof Dalenbäck - Chalmers University of Technology)

By the end of 2009, 115 solar supported district heating networks and 11 solar supported cooling systems with an installed capacity > 350 kW_{th} (respectively > 500 m²) were installed in Europe. The total capacity installed of these systems equals 166 MW_{th}.

The largest plants reported to be installed in Europe are located in Marstal, Denmark (18,300 m²) and Broager, Denmark (10.700 m²). In Denmark there is a veritable boom in connecting large solar thermal systems to district heating and combined heating and power grids.

6.5 Worldwide large scale solar thermal applications

The largest solar thermal system is being built in Riyadh, Saudi Arabia for the Princess Nora University. The solar plant comprises 36,305 m² of collector area and was commissioned in April 2011.

Probably the world's largest solar cooling plant is currently under construction for the United World College in Singapore. A 1.575 MW absorption cooling device combined with a 3.900 m² solar thermal collector field aims to supply 2,500 people at the university campus with air-conditioningand domestic hot water.

The largest solar process heat application is installed in Hangzhou, China. The 13,000 m² of solar collectors on the roof of a textile factory provide hot water for a dyeing process run at a favorably low supply temperature of 55°C.

7 Appendix

7.1 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, flat-plate and evacuated tube collectors). Air collectors were not included.
- For each country, the overall collector area installed (water collectors) was allocated to the four types of systems:
  - Solar thermal systems for swimming pool heating with unglazed collectors,
  - Solar domestic hot water systems for single-family houses,
  - Solar domestic hot water systems for multi-family houses, hotels and district heating, and
  - Solar combi-systems[2] for domestic hot water and space heating for single- and multi-family houses.
- Reference systems were defined for each country and for each type of system.
- The number of systems for each country was determined from the share of collector area for each system type and the collector area per reference system.

Reference collectors and a reference climate were determined for each country apart from the reference systems. On the basis of these reference conditions, simulations were performed with the simulation program T-Sol [T-Sol, Version 4.5 Expert, Valentin Energiesoftware, www.valentin.de] to obtain the solar yields, energy savings and CO_2 emissions.

The annual collector yield per square meter of collector area, depending on the application (swimming pool heating, domestic hot water preparation, space heating, etc.), the local climatic conditions and the plant dimensions (high or low solar fraction) were calculated for each country and each system. The energy savings were obtained from the energy equivalent of the fuel used and the rate of efficiency of the auxiliary heating system.

For the auxiliary heating system, oil was taken as the fuel for all plants and the energy equivalent per liter of fuel oil 38,052 kJ (higher heating value) respectively 10.57 kWh was used in all countries in order to achieve comparable results.

To obtain an exact statement about the CO_2 emissions avoided, the substituted energy source would have to be ascertained for each country. Since this could only be done in a very detailed survey, which goes beyond the scope of this report, the energy savings and the CO_2 emissions avoided relate to 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 CO_2 emissions avoided by solar systems were ascertained from the energy savings (oil equivalent). As the emission factor 0.0733 g CO_2/kJ respectively 2.79 kg CO_2 / l was used.

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.

2 Solar combi-systems are solar heating installations that provide both space heating and domestic hot water

7.1.1 Solar thermal systems for swimming pool heating with unglazed collectors

Country*	Reference climate	Collector area (gross area) for single system [m²]	Total collector area unglazed 2009 [m²]	Total number of systems unglazed 2009
Australia	Sydney	34	4,720,000	138,824
Austria	Graz	200	616,952	3,085
Belgium	Brussels	200	46,875	234
Brazil	Brasília	200	1,271,849	6,359
Canada	Montreal	200	582,351	2,912
Chile	Santiago de Chile	200	1,470	7
Czech Republic	Praha	200	14,621	73
Denmark	Copenhagen	200	20,515	103
Finland	Helsinki	200	11,779	59
France	Paris	200	105,699	528
Germany	Würzburg	200	720,000	3,600
Hungary	Budapest	200	5,688	28
Israel	Jerusalem	200	29,495	147
Italy	Bologna	200	43,766	219
Mexico	Mexico City	200	572,092	2,860
Netherlands	Amsterdam	200	377,287	1,886
New Zealand	Wellington	200	7,025	35
Norway	Oslo	200	1,920	10
Portugal	Lisbon	200	2,082	10
South Africa	Johannesburg	200	753,678	3,768
Spain	Madrid	200	111,000	555
Sweden	Gothenburg	200	125,000	625
Switzerland	Zürich	200	211,790	1,059
Taiwan	Taipei	200	1,937	10
United States	Indianapolis, Los Angeles	200	17,793,589	88,968
TOTAL			28,148,459	255,966

* Countries not listed in this table means that there was no reliable database for unglazed collectors available

Table 8: Solar thermal swimming pool heating reference systems with unglazed water collectors and the total collector area in operation by the end of 2009

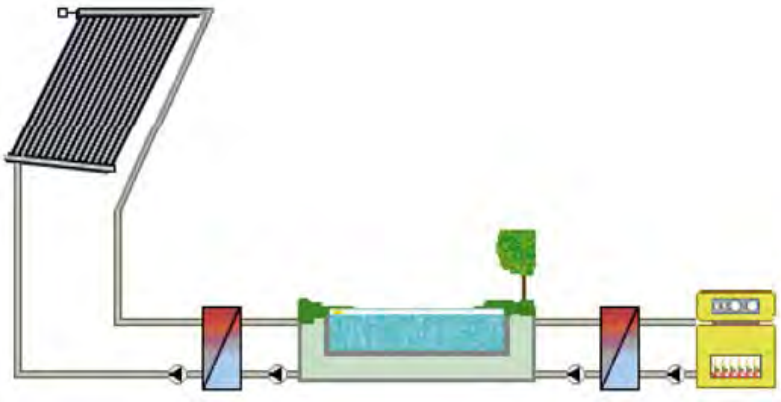


Figure 43: Hydraulic scheme of the swimming pool reference system

7.1.2 Solar domestic hot water systems for single-family houses

The market share in the following table refers to the total capacity in operation of flat-plate and evacuated tube collectors by the end of 2009 for each country. It must be pointed out that the market share of the new installed capacity in the year 2009 can differ significantly from the total market share.

Country	Reference climate	Collector area [m²]		Share of DHW-SFH [%]	Number of systems DHW-SFH	Hot water		Storage capacity [l]	System
		for single system*	total of DHW-SFH 2009			demand [l/d]	temp. [°C]		
Albania	Tirana	2.5	19,648	28	7,859	150	60	150	TS
Australia	Sydney	4.0	2,467,028	98	616,757	170	60	300	PS
Austria	Graz	6.0	1,731,993	47	288,665	150	60	300	PS
Barbados	Grantley Adams	4.0	131,690	100	32,923	150	60	200	TS
Belgium	Brussels	4.0	278,333	100	69,583	150	60	200	PDS
Brazil	Brasília	4.0	3,439,610	86	859,903	150	60	200	TS
Bulgaria	Sofia	4.0	27,320	71	6,830	150	60	200	PS
Canada	Montreal	6.0	26,138	60	4,356	150	60	200	PS
Chile	Santiago de Chile	4.0	26,730	100	6,683	150	60	200	PS
China	Shanghai	4.0	130,500,000	90	32,625,000	150	60	200	TS
Cyprus	Nicosia	4.0	703,986	82	175,997	150	60	200	TS
Czech Republic	Praha	6.0	179,860	99	29,977	150	60	300	PS
Denmark	Copenhagen	4.0	402,093	86	100,523	150	60	200	PS
Estonia	Tallin	4.0	2,341	100	585	150	60	200	PS
Finland	Helsinki	4.0	27,038	95	6,759	150	60	200	PS
France	Paris	4.0	1,395,451	75	348,863	150	60	200	PS
FYRM	Skopje	4.0	12,100	47	3,025	150	60	200	PS
Germany	Würzburg	6.0	7,637,218	64	1,272,870	150	60	300	PS
Greece	Athens	4.0	3,995,460	98	998,865	150	60	200	TS
Hungary	Budapest	6.0	51,526	40	8,588	150	60	300	PS
India	Neu-Delhi	4.0	2,156,837	70	539,209	150	60	200	TS
Ireland	Dublin	4.0	108,871	90	27,218	150	60	200	PS
Israel	Jerusalem	4.0	3,958,537	98	989,634	150	60	200	TS
Italy	Bologna	4.0	2,057,578	100	514,395	150	60	200	PS
Japan	Tokyo	4.0	5,491,436	96	1,372,859	150	60	200	TS
Jordan	Amman	4.0	716,230	80	179,057	150	60	200	TS
South Korea	Seoul	4.0	808,118	54	202,029	150	60	200	PS
Lativa	Riga	4.0	7,044	100	1,761	150	60	200	PS
Lithuania	Vilnius	4.0	4,318	100	1,080	150	60	200	PS
Luxembourg	Luxembourg	4.0	26,300	100	6,575	150	60	200	PS
Malta	Luqa	4.0	44,867	100	11,217	150	60	200	PS
Mexico	Mexico City	4.0	193,161	28	48,290	150	60	200	PS
Namibia	Windhoek	4.0	6,754	43	1,688	150	60	200	TS
Netherlands	Amsterdam	3.0	313,782	83	104,594	110	60	100	PDS
New Zealand	Wellington	4.0	144,989	95	36,247	170	60	300	PS
Norway	Oslo	6.0	13,279	98	2,213	150	60	300	PS
Poland	Warsaw	6.0	331,393	65	55,232	150	60	300	PS
Portugal	Lisbon	4.0	191,771	35	47,943	150	60	200	PS
Romania	Bucharest	4.0	94,496	100	23,624	150	60	200	PS
Slovak Republic	Bratislava	6.0	120,746	100	20,124	150	60	300	PS
Slovenia	Ljubjana	6.0	120,099	83	20,017	150	60	300	PS
South Africa	Johannesburg	4.0	309,682	100	77,420	150	60	200	TS
Spain	Madrid	4.0	700,350	35	175,088	150	60	200	PS
Sweden	Gothenburg	6.0	29,000	10	4,833	150	60	300	PS
Switzerland	Zürich	6.0	442,247	67	73,708	150	60	300	PS
Taiwan	Taipei	4.0	1,828,243	95	457,061	150	60	200	TS
Thailand	Bangkok	4.0	91,392	100	22,848	150	60	200	TS
Tunisia	Tunis	4.0	392,850	97	98,213	150	60	200	TS
Turkey	Ankara	4.0	11,192,550	93	2,798,138	150	60	200	TS
United Kingdom	London	4.0	459,583	100	114,896	150	60	200	PS
United States	Indianapolis, Los Angeles	6.0	2,641,739	100	440,290	150	60	200	PS
Uruguay	Montevideo	4.0	12,096	100	3,024	150	60	200	PS
Zimbabwe	Harare	4.0	17,671	100	4,418	150	60	200	PS
TOTAL			188,083,573		45,939,552				

*) gross area

FYRM: Former Yugoslav Republic of Macedonia
DHW-SFH: domestic hot water systems for single family houses
PS: pumped system
TS: thermo siphon system
PDS: pumped drain back system
Auxiliary heating device: oil boiler

Table 9: Domestic hot water reference systems for single family houses and the total collector area in operation by the end of 2009

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.

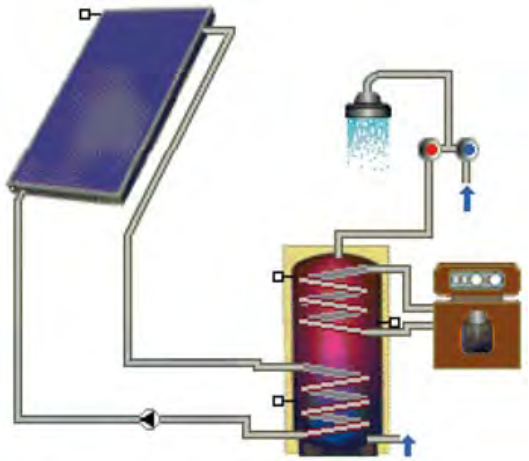


Figure 44: Hydraulic scheme of the DHW pumped reference system

Figure 45: Hydraulic scheme of the DHW thermosiphon reference system

For the Chinese thermosiphon systems, the above reference system 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.

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

The market share shown in Table 10 refers to the total capacity in operation of flat-plate and evacuated tube collectors by the end of 2009 for each country. It must be pointed out that the market share of the new installed capacity in the year 2008 can differ greatly from the total market share.

Country	Reference climate	Collector area [m²]		Share of DHW-MFH [%]	Number of systems DHW-MFH	Hot water		Storage capacity [l]	System
		for single system	total of DHW-MFH 2009			demand [l/d]	temp. [°C]		
Albania	Tirana	50.0	50,523	72	1,010	2000	60	2500	PS
Australia	Sydney	50.0	50,348	2	1,007	2000	60	2500	PS
Austria	Graz	50.0	322,531	9	6,451	2000	60	2500	PS
Brazil	Brasília	50.0	559,937	14	11,199	2000	60	2500	PS
Bulgaria	Sofia	50.0	11,016	29	220	2000	60	2500	PS
Canada	Montreal	50.0	17,426	40	349	2000	60	2500	PS
China	Shanghai	50.0	12,325,000	9	246,500	2000	60	2500	PS
Cyprus	Nicosia	50.0	154,534	18	3,091	2000	60	2500	PS
Czech Republic	Praha	50.0	1,817	1	36	2000	60	2500	PS
Denmark	Copenhagen	50.0	60,781	13	1,216	2000	60	2500	PS
Finland	Helsinki	50.0	1,423	5	28	2000	60	2500	PS
France	Paris	50.0	186,060	10	3,721	2000	60	2500	PS
FYRM	Skopje	50.0	13,644	53	273	2000	60	2500	PS
Germany	Würzburg	50.0	298,329	3	5,967	2000	60	2500	PS
Greece	Athens	50.0	81,540	2	1,631	2000	60	2500	PS
Hungary	Budapest	50.0	55,390	43	1,108	2000	60	2500	PS
India	Neu-Delhi	50.0	924,359	30	18,487	2000	60	2500	PS
Ireland	Dublin	50.0	3,629	3	73	2000	60	2500	PS
Israel	Jerusalem	50.0	80,786	2	1,616	2000	60	2500	PS
Japan	Tokyo	50.0	114,405	2	2,288	2000	60	2500	PS
Jordan	Amman	50.0	179,057	20	3,581	2000	60	2500	PS
Korea, South	Seoul	50.0	688,396	46	13,768	2000	60	2500	PS
Mexico	Mexico City	50.0	496,701	72	9,934	2000	60	2500	PS
Namibia	Windhoek	50.0	8,952	57	179	2000	60	2500	PS
Netherlands	Amsterdam	50.0	45,366	12	907	2000	60	2500	PS
New Zealand	Wellington	50.0	7,631	5	153	2000	60	2500	PS
Norway	Oslo	50.0	136	1	3	2000	60	2500	PS
Poland	Warsaw	50.0	152,951	30	3,059	2000	60	2500	PS
Portugal	Lisbon	50.0	356,147	65	7,123	2000	60	2500	PS
Slovenia	Ljubjana	50.0	2,894	2	58	2000	60	2500	PS
Spain	Madrid	50.0	180,090	9	3,602	2000	60	2500	PS
Sweden	Gothenburg	50.0	43,500	15	870	2000	60	2500	PS
Switzerland	Zürich	50.0	52,806	8	1,056	2000	60	2500	PS
Taiwan	Taipei	50.0	92,584	5	1,852	2000	60	2500	PS
Tunisia	Tunis	50.0	12,150	3	243	2000	60	2500	PS
Turkey	Ankara	50.0	842,450	7	16,849	2000	60	2500	PS
TOTAL			18,475,288		369,506				

FYRM: Former Yugoslav Republic of Macedonia
DHW-MFH: domestic hot water systems for multi family houses
PS: pumped system
Auxiliary heating device: oil boiler

Table 10: Domestic hot water reference systems for multi-family houses, hotels and district heating and the total collector area in operation in 2009 (flat-plate and evacuated tube collectors)

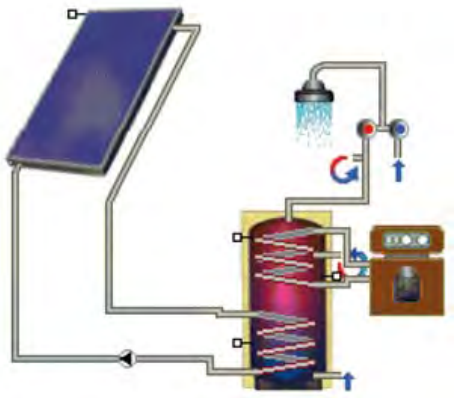


Figure 46: Hydraulic scheme of the DHW system for multi-family houses

7.1.4 Solar combi-systems for domestic hot water and space heating for single- family houses

The market share of combi-systems in the following table refers to the total capacity in operation of flat-plate and evacuated tube collectors at the end of 2009 for each country. It must be pointed out that the market share of the new installed capacity in the year 2009 can differ significantly from the total market share. The reference system is designed for a single-family house with a 140 m² heated floor area.

Country	Reference climate	Collector area [m²]		Share of CS (2010) [%]	Number of CS 2009	Storage capacity [l]	Space heat demand [kWh/m²·a]	System
		for single system	total of CS 2009					
Austria	Graz	16.0	1,633,809	44	102,113	1,000	80	PS
China	Shanghai	12.0	2,175,000	2	181,250	800	80	PS
Denmark	Copenhagen	12.0	4,675	1	390	1,000	100	PS
France	Paris	15.0	279,090	15	18,606	1,000	80	PS
Germany	Würzburg	12.0	3,997,607	34	333,134	800	80	PS
Hungary	Budapest	12.0	21,898	17	1,825	800	90	PS
Ireland	Dublin	12.0	8,468	7	706	1,000	100	PS
Japan	Tokyo	12.0	114,405	2	9,534	800	50	PS
Netherlands	Amsterdam	6.0	18,903	5	3,150	500	80	PS
Norway	Oslo	12.0	136	1	11	1,000	100	PS
Poland	Warsaw	12.0	25,492	5	2,124	1,000	100	PS
Slovenia	Ljubjana	12.0	21,705	15	1,809	800	80	PS
Spain	Madrid	12.0	1,120,560	56	93,380	1,000	60	PS
Sweden	Gothenburg	12.0	217,500	75	18,125	1,000	100	PS
Switzerland	Zürich	12.0	165,018	25	13,751	800	80	PS
TOTAL			9,804,264		779,908			

Combi-system systems for the supply of hot water and space heating
PS: pumped system
Auxiliary heating device: oil boiler

Table 11: Reference systems for combi-systems (CS) for single-family houses and the percentage of the total collector area in operation

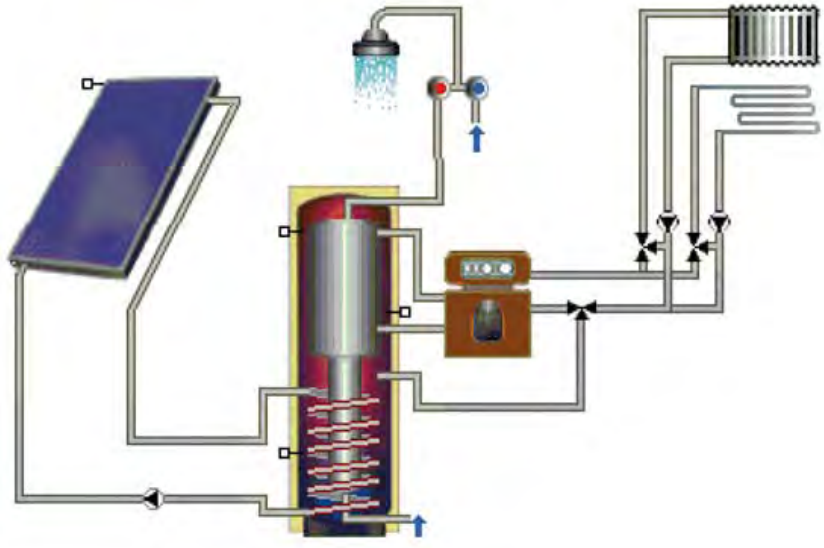


Figure 47: Hydraulic scheme of the solar combi reference system

7.2 Reference collectors

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

$\eta = 0.85$ $a_1 = 20$ [W/m²K] $a_2 = 0.1$ [W/m²K²]

7.2.2 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/m²K²]

7.2.3 Data of the Chinese reference vacuum tube collector

$\eta = 0.74$ $a_1 = 2.5$ [W/m²K] $a_2 = 0.013$ [W/m²K²]

7.3 Reference climates

Country	Reference climate	Horizontal irradiation G0 [kWh/m²*a]	Avg. Outside air temperature [°C]
Albania	Tirana	1604.3	13.5
Australia	Sydney	1674.0	18.1
Austria	Graz	1126.0	9.2
Barbados	Grantley Adams	2016.3	27.4
Belgium	Brussels	971.1	10.0
Brazil	Brasília	1792.5	22.0
Bulgaria	Sofia	1187.5	10.1
Canada	Montreal	1351.4	6.9
Chile	Santiago de Chile	1752.7	14.5
China	Shanghai	1281.9	17.1
Cyprus	Nicosia	1885.5	19.9
Czech Republic	Praha	998.4	7.9
Denmark	Copenhagen	989.4	8.1
Estonia	Tallin	960.2	5.3
Finland	Helsinki	948.0	4.6
France	Paris	1112.4	11.0
FYRM	Skopje	1380.8	12.5
Germany	Würzburg	1091.3	9.5
Greece	Athens	1584.6	18.5
Hungary	Budapest	1198.7	11.0
India	Neu-Delhi	1960.5	24.7
Ireland	Dublin	948.7	9.5
Israel	Jerusalem	2198.0	17.3
Italy	Bologna	1419.0	14.3
Japan	Tokyo	1175.2	16.7
Jordan	Amman	2145.4	17.9
Korea, South	Seoul	1161.1	12.7
Latvia	Riga	991.2	6.3
Lithuania	Vilnius	1001.2	6.2
Luxembourg	Luxembourg	1037.4	8.4
Malta	Luqa	1901.9	18.7
Mexico	Mexico City	1706.3	16.6
Namibia	Windhoek	2363.0	21.0
Netherlands	Amsterdam	999.0	10.0
New Zealand	Wellington	1401.2	13.6
Norway	Oslo	971.1	5.8
Poland	Warsaw	1024.2	8.1
Portugal	Lisbon	1686.4	17.4
Romania	Bucharest	1324.3	10.6
Slovakia	Bratislava	1213.8	10.3
Slovenia	Ljubjana	1114.6	9.8
South Africa	Johannesburg	2075.1	15.6
Spain	Madrid	1643.5	15.5
Sweden	Gothenburg	933.9	7.2
Switzerland	Zürich	1093.8	9.6
Taiwan	Taipei	1372.2	20.8
Thailand	Bangkok	1764.8	29.1
Tunisia	Tunis	1808.2	19.3
Turkey	Ankara	1700.9	12.0
United Kingdom	London	942.6	12.0
United States	Indianapolis	1,492.3	11.3
	Los Angeles	1,799.8	17.2
Uruguay	Montevideo	1,534.2	15.9
Zimbabwe	Harare	2,017.1	18.9

FYRM: Former Yugoslav Republic of Macedonia

Table 12: Reference climates for the 53 countries surveyed

7.4 Population data

Country	2009
Albania	2,982,540
Australia	21,262,641
Austria	8,210,281
Barbados	284,589
Belgium	10,414,336
Brazil	198,739,269
Bulgaria	7,204,687
Canada	33,487,208
Chile	16,601,707
China	1,323,591,583
Cyprus	1,084,748
Czech Republic	10,211,904
Denmark	5,500,510
Estonia	1,299,371
Finland	5,250,275
France	64,420,073
Macedonia	2,066,718
Germany	82,329,758
Greece	10,737,428

Country	2009
Hungary	10,007,168
India	1,156,897,766
Ireland	4,579,996
Israel	7,233,701
Italy	58,126,212
Japan	127,078,679
Jordan	6,269,285
Korea, South	48,508,972
Latvia	2,231,503
Lithuania	3,555,179
Luxembourg	491,775
Malta	405,165
Mexico	111,211,789
Namibia	2,108,665
Netherlands	16,715,999
New Zealand	4,213,418
Norway	4,660,539
Poland	38,482,919
Portugal	10,707,924

Country	2009
Romania	22,011,818
Slovakia	5,463,046
Slovenia	2,005,692
South Africa	49,052,489
Spain	46,295,240
Sweden	9,059,651
Switzerland	7,604,467
Taiwan	22,974,347
Thailand	66,644,811
Tunisia	10,486,339
Turkey	76,805,524
United Kingdom	61,996,848
United States	307,006,550
Uruguay	3,494,382
Zimbabwe	11,392,629

Σ Solar Thermal World Statistic	4,121,460,113
Σ Inhabitants world	6,776,917,465

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

Table 13: Inhabitants by the end of 2009 of the 53 surveyed countries in alphabetical order

	Inhabitants	Share
United States and Canada	337,272,420	8.3%
Japan	127,288,419	3.1%
China	1,317,065,677	32.3%
Europe	584,993,796	14.3%
Australia and New Zealand	25,180,770	0.6%
Asia	1,277,445,083	31.3%
Central and South America	326,513,406	8.0%
Africa	72,605,112	1.8%
Middle East	13,244,984	0.3%
TOTAL	4,081,609,667	100%

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

Middle East:	Israel, Jordan
Africa:	Namibia, South Africa, Tunisia, Zimbabwe
Central + South America:	Barbados, Brazil, Chile, Mexico, Uruguay
Asia:	India, South Korea, Taiwan, Thailand
Europe:	EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey

Table 14: Inhabitants per economic region by the end of 2009

7.5 Market data of the previous years

The data presented in Chapters 3 through 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 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.

Nevertheless, solar thermal collectors are traditionally quoted in square meters and therefore Table 15 and Table 16 provide the 2007 and 2008 data in m² as well as the total installed collector area in 2008 (Table 17).

Country	Water Collectors*			Air Collectors*		TOTAL [m²]
	Unglazed	Glazed	evacuated tube	Unglazed	Glazed	
Albania		9,290	88			9,378
Australia	576,000	203,000	3,000			782,000
Austria	8,662	277,620	3,399			289,681
Barbados		6,438				6,438
Belgium	8,828	37,000	5,000			50,828
Brazil	97,442	475,394	350			573,186
Bulgaria		2,500				2,500
Canada	39,879	1,462	2,385	17,056	128	60,910
Chile		6,200				6,200
China		1,150,000	21,850,000			23,000,000
Cyprus		15,000	1,000			16,000
Czech Republic	6,000	18,900	6,100			31,000
Denmark	600	23,000	400	3,400	3,500	30,900
Estonia		350				350
Finland		2,100	622			2,722
France	5,300	305,000	12,700			323,000
FYRM		1,952	200			2,152
Germany	30,000	840,000	100,000		5,000	975,000
Greece		279,000	4,000			283,000
Hungary		6,000	2,000			8,000
India		424,150			7,000	431,150
Ireland		14,872	4,799			19,671
Israel	700	301,000				301,700
Italy	5,138	295,596	49,266			350,000
Japan		166,223	4,051		12,509	182,783
Jordan		7,666	3,600			11,266
Korea, South		38,700				38,700
Latvia		1,500				1,500
Lithuania		700				700
Luxembourg		3,000				3,000
Malta		5,500				5,500
Mexico	46,281	107,989				154,270
Namibia		2,810	190			3,001
Netherlands	27,722	19,920				47,642
New Zealand	600	11,800	5,150			17,550
Norway	200	720	50			970
Poland		47,032	21,115			68,147
Portugal	618	44,483	5,696			50,797
Romania		6,500				6,500
Slovakia		15,554	9,911			25,465
Slovenia		6,515	1,150			7,665
South Africa	67,300	14,000				81,300
Spain	3,000	251,000	11,000			265,000
Sweden	20,435	15,554	9,911			45,900
Switzerland	10,320	63,022	2,554	2,000		77,896
Taiwan		125,000	9,900			134,900
Thailand		8,000				8,000
Tunisia		39,000	1,000			40,000
Turkey		700,000				700,000
United Kingdom		27,000	27,000			54,000
United States	1,125,441	130,089	20,527		1,267	1,277,324
Uruguay		2,857				2,857
Zimbabwe		171				171
TOTAL	2,080,465	6,558,131	22,178,114	22,456	29,404	30,868,570

FYRM: Former Yugoslav Republic of Macedonia
* Countries not listed in this table means that there was no reliable database for unglazed collectors available
** Unglazed air collectors in Switzerland: this is a very simple site-built system for hay drying

Table 15: Newly installed collector area in 2007 [m²/a]

Country	Water Collectors*			Air Collectors*		TOTAL [m²]
	Unglazed	Glazed	evacuated tube	Unglazed	Glazed	
Albania		9,740	104			9,844
Australia	600,000	277,000	14,000			891,000
Austria	15,220	343,617	4,086			362,923
Barbados		7,051				7,051
Belgium		82,000	9,000			91,000
Brazil	278,910	392,246				671,156
Bulgaria		4,000				4,000
Canada	89,577	13,173	1,083	34,135	1,191	139,159
Chile		7,000				7,000
China		1,240,000	29,760,000			31,000,000
Cyprus		40,290	1,000			41,290
Czech Republic		26,500	8,500			35,000
Denmark		31,000	2,000			33,000
Estonia		500				500
Finland	270	3,905	650			4,825
France		390,000				390,000
FYRM		3,866	554			4,420
Germany		1,900,000	200,000		6,900	2,106,900
Greece		298,000				298,000
Hungary		8,500	2,500			11,000
India		463,487	23,174			486,662
Ireland		31,727	11,883			43,610
Israel	2,500	278,000				280,500
Italy	7,340	422,280	70,380			500,000
Japan		205,622	1,946		13,386	220,954
Jordan		20,041	30,062			50,103
Korea, South		51,552				51,552
Latvia		1,800				1,800
Lithuania		840				840
Luxembourg		2,800	800			3,600
Malta		6,000				6,000
Mexico	49,690	115,943				165,633
Namibia		3,952	203			4,154
Netherlands	28,216	23,414				51,630
New Zealand	600	20,379				20,979
Norway	180	1,030	210			1,420
Poland		89,820	39,812			129,632
Portugal	802	78,858	7,160			86,820
Romania		8,000				8,000
Slovakia		12,000	1,500			13,500
Slovenia		14,000	2,500			16,500
South Africa	100,222	21,397	18,092			139,710
Spain	32,000	409,000	25,000			466,000
Sweden	28,648	14,530	12,283			55,461
Switzerland**	9,374	104,040	8,793	7,000		129,207
Taiwan	330	105,683	11,751			117,764
Thailand		9,939				9,939
Tunisia		75,000	5,000			80,000
Turkey		930,000				930,000
United Kingdom		47,250	33,750			81,000
United States	1,125,771	175,272	28,194		2,249	1,331,486
Uruguay		4,213				4,213
Zimbabwe		336	24			360
TOTAL	2,369,649	8,826,593	30,335,994	41,135	23,727	41,597,098

FYRM: Former Yugoslav Republic of Macedonia

* Countries not listed in this table means that there was no reliable database for unglazed collectors available

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

Table 16: Newly installed collector area in 2008 [m²/a]

Country	Water Collectors*			Air Collectors*		TOTAL [m²]
	Unglazed	Glazed	evacuated tube	Unglazed	Glazed	
Albania		57,283	336			57,619
Australia	4,100,000	1,960,550	37,450			6,098,000
Austria	624,110	3,293,175	47,069			3,964,354
Barbados		129,516				129,516
Belgium	46,875	207,120	20,513			274,508
Brazil	864,798	3,608,458				4,473,256
Bulgaria		30,336				30,336
Canada	509,325	27,383	5,912	172,658	1,557	716,835
Chile	1,470	17,730				19,200
China		10,243,297	114,756,703			125,000,000
Cyprus		801,637	1,883			803,520
Czech Republic	14,621	118,646	23,030			156,298
Denmark	20,515	407,866	5,184	3,264	18,000	454,829
Estonia		1,891				1,891
Finland	11,779	23,318	1,142			36,240
France	100,320	1,734,240	31,680			1,866,240
FYRM		22,018	724			22,742
Germany	720,000	9,296,731	1,021,423		33,600	11,071,754
Greece		3,870,000				3,870,000
Hungary	2,688	47,846	4,858			55,392
India		2,508,948	22,247		16,320	2,547,515
Ireland		57,009	19,001			76,010
Israel	26,700	3,772,878		422		3,800,000
Italy	36,719	1,399,208	185,417			1,621,344
Japan		5,772,026	101,618		441,856	6,315,500
Jordan		642,477	250,588			893,065
Korea, South		1,427,834				1,427,834
Latvia		6,864				6,864
Lithuania		4,118				4,118
Luxembourg		20,832	768			21,600
Malta		33,946				33,946
Mexico	496,591	537,430				1,034,021
Namibia		6,365	377			6,742
Netherlands	360,815	342,926				703,741
New Zealand	6,544	118,361	9,644			134,550
Norway	1,709	11,760	346		1,152	14,966
Poland	1,248	276,186	73,474	2,880	2,400	356,188
Portugal	1,340	340,700	12,131			354,172
Romania		74,496				74,496
Slovakia		96,292	10,955			107,246
Slovenia		118,656	4,042			122,698
South Africa	699,678	258,314	17,368			975,360
Spain	86,400	1,459,200	96,000			1,641,600
Sweden	105,000	235,000	41,000			381,000
Switzerland**	211,800	509,980	29,930	845,000		1,596,710
Taiwan	1,860	1,648,836	46,991			1,697,686
Thailand		76,742				76,742
Tunisia		279,862	6,218			286,080
Turkey		10,636,800				10,636,800
United Kingdom		312,163	58,320			370,483
United States	17,382,099	3,391,405	59,643		148,798	20,981,945
Uruguay		4,861				4,861
Zimbabwe		17,292	24			17,316
TOTAL	26,435,004	72,298,810	117,004,008	1,024,224	663,682	217,425,729

FYRM: Former Yugoslav Republic of Macedonia

* Countries not listed in this table means that there was no reliable database for unglazed collectors available

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

Table 17: Total collector area in operation by the end of 2008 [m²]

7.6 References to reports and persons that have supplied the data

The production of the solar heat worldwide report 2009 was kindly supported by national representatives of the recorded countries.

COUNTRY	CONTACT	SOURCE *Remarks*
Albania	Edmond M. Hido	Albania-EU Energy Efficiency Centre (EEC)
Australia	Sonja Ott	Renewable Energy Team- Sustainability Victoria *new installed capacity in 2009 from Sonja Ott - totals projected by AEE INTEC*
Austria	Werner Weiss; Manuela Eberl	AEE INTEC
Barbados	James Husbands	Solar Dynamics Ltd
Belgium	ESTIF 2010	*new installed according to ESTIF 2010 -* *total installed projected from AEE INTEC database*
Brazil	Marcelo Mesquita; Ronaldo Yano Toraiwa	Gestor do DASOL Depto. Nac. Aquecimento Solar da ABRAVA
Bulgaria	Ivanka Pandelieva	Sofia energy center (SEC) *new installed from SEC; Ivanka Pandelieva - totals projected by AEE INTEC*
Canada	Doug McClenahan; Reda Djebbar	Natural Resources Canada; SAIC Canada
Chile	Cristian Yanez	CDT Chile
China	Hu Runqing	Center for Renewable Energy Development - Energy Research Institute (NDRC) *Share between types of collectors estimated by Hu Runqing*
Cyprus	ESTIF 2010	*new installed according to ESTIF 2010 -* *total installed projected from AEE INTEC database*
Czech Republic	ESTIF 2010	*new installed according to ESTIF 2010 -* *total installed projected from AEE INTEC database*
Denmark	Jens Windeleff	ESTIF 2009 / Danish Energy Authority *new installed according to ESTIF 2010 -* *total installed projected from AEE INTEC database*
Estonia	ESTIF 2010 (estimation)	*new installed according to ESTIF 2010 -* *total installed projected from AEE INTEC database*
Finland	ESTIF 2010 (estimation)	*new installed according to ESTIF 2010 -* *total installed projected from AEE INTEC database*
France	Céline Coulaud	ADEME - Centre de Sophia Antipolis *Share between types of collectors /* *applications according to AEE INTEC database*
Germany	ESTIF 2010	*new installed according to ESTIF 2010 -* *total installed projected from AEE INTEC database*

Greece	Costas Travasaros; Vassiliki Drosou	Centre for Renewable Energy Sources (CRES)
Hungary	Pal Varga	Association of Hungarian Building Engineers (MÉGSZ) *personal estimation Pal VARGA*
India	Jaideep Malaviya; Prashant Bhanware	Greentech Knowledge Solutions Pvt. Ltd. and Ministry of New and Renewable energies (MNRE) *http://mnes.nic.in/pdf/greentech-SWH-MarketAssessment-report.pdf*
Ireland	Amanda Barriscale	Sustainable Energy Ireland (Grant scheme data; GHS and REHEAT programmes)
Israel	ESTIMATION AEE INTEC 2010	
Italy	Valeria Verga	Associazione Italiana Solare Termico (Assolterm) *Assolterm-Assotermica market study;* *Share between types of collectors edited by AEE INTEC*
Japan	Yamashita Noriaki	ISEP - Institute for Sustainable Energy Policies (ISEP, SSDA, METI)
Jordan	Nidal Abdalla	National Energy Research Center (NERC)
Korea, South	ESTIMATION AEE INTEC 2010	
Latvia	ESTIF 2010 (estimation)	*new installed according to ESTIF 2010 - total installed projected from AEE INTEC database*
Lithuania	ESTIF 2010	*new installed according to ESTIF 2010 - total installed projected from AEE INTEC database*
Luxembourg	ESTIF 2010	*new installed according to ESTIF 2010 - total installed projected from AEE INTEC database*
Former Yugoslav Republic of Macedonia	Sanja Popovska-Vasilevska	Solar Macedonia, Company Information and Ministry of Economy of Republic of FYRM *new installed from Solar Former Yugoslav Republic of Macedonia; Sanja Popovska-Vasilevska - totals projected by AEE INTEC*
Malta	Godwin Sant	Malta Resources Authority
Mexico	ANES	Asociación Nacional de Energía Solar, A.C. (ANES), Solarthermalworld *new installed systems from ANES, Solarthermalworld - totals projected by AEE INTEC*
Namibia	Kudakwashe Ndhlukula	Renewable Energy & Energy Efficiency Institute (REEEI) *REEEI Annual Market Survey*
Netherlands	Reinoud Segers	Statistics Netherlands (CBS)
New Zealand	ESTIMATION AEE INTEC 2010	
Norway	Fritjof Salvesen Peter Bernhard	KanEnergi AS

Poland	Grzegorz Wiśniewski; Aneta Wiecka	Institute for Renewable Energy Ltd. (EC BREC) *glazed water collectors from EC BREC*
Portugal	João Farinha Mendes	Unidadede Energia Solar (sources: APISOLAR [Associação Portuguesa da Indústria Solar] and ADENE [Agência para a Energia])
Romania	ESTIF 2009 (estimation)	*new installed according to ESTIF 2010 -* *total installed projected from AEE INTEC database*
Slovakia	ESTIF 2009	*new installed according to ESTIF 2010 -* *total installed projected from AEE INTEC database*
Slovenia	ESTIF 2009	*new installed according to ESTIF 2010 -* *total installed projected from AEE INTEC database*
South Africa	Dieter Holm	SESSA
Spain	Pascual Polo; Esther Rojas	Asociación Solar de la Industria Térmica (ASIT)
Sweden	Jan-Olof Dalenbäck	Svensk solenergi; CHALMERS University of Technology
Switzerland	Urs Wolfer	SWISSOLAR
Taiwan	K.M. Chung	Energy Research Center - National Cheng Kung University
Thailand	ESTIMATION AEE INTEC 2010	
Tunisia	Moncef Njaimi	National Agency of Energy Conservation (ANME)
Turkey	A. Kutay Ulke	EZINC Metal San. Tic. A.S.
United Kingdom	ESTIF 2009	*new installed according to ESTIF 2010 -* *total installed projected from AEE INTEC database*
United States	Peter Wong	U.S. Department of Energy (DoE) - Energy Information Administration (EIA)
Uruguay	ESTIMATION AEE INTEC 2010	
Zimbabwe	Anton Schwarzlmüller	DSH, Soltrain Market Report 2010

7.6.1 Additional literature and web sources used

The following reports and statistics were used in this report.

- European Solar Thermal Industry Federation (ESTIF): Solar Thermal Markets in Europe, Trends and Market Statistics 2009; Belgium - Brussels; June 2010
- Bundesamt für Energie (BFE): Markterhebung Sonnenenergie 2009 - Teilstatistik der Schweizerischen Statistik der erneuerbaren Energien, Switzerland - Bern; July 2010
- Bundesministerium für Verkehr, Innovation und Technologie (BMVIT): Innovative Energietechnologien in Österreich – Marktentwicklung 2009; Wien; May 2010
- U.S. Department of energy (DoE) - Energy Information Administration (EIA): Solar Thermal Collector Manufacturing Activities 2009, U.S. Energy Information Administration DOE/EIA, Washington: December 2010
- Bank Sarasin & Cie AG: Solarwirtschaft – Uterwegs in neue Dimensionen (Technologien, Märkte und Industrien im Vergleich); Bank Sarasin & Co. Ltd ("BSC"), Switzerland – Basel: November 2010
- REN 21: Renewables 2010 Global Status Report; Revised edition as of September 2010
- Eskom: The South African Solar Water Heater Industry, August 2009
- Global Solar Thermal Energy Council: http://www.solarthermalworld.org/
- SOLRICO: http://www.solrico.com/
- TECH4CDM - Renewable technologies and energy efficiency in Latin America; http://www.tech4cdm.com/

7.7 List of Figures

7.8 List of Tables