

# SHC IEATask 45

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## Final Report Subtask C “Systems”

### Deliverables D1, D2,

Large solar heating/cooling systems,  
Seasonal storages, heat pumps



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Editor: Sabine Putz, SOLID

## **Final Report for “System Categorisation”, D1 and D2 in Subtask C**

Within the TASK45 Program, data from worldwide Large Scale Solar Thermal Plants were collected and summarized in Subtask C. This provides a market overview, reflects the market’s development within the last 30 years and shows opportunities for further growth and country specific potential for implementing Large Scale Solar Thermal Plants.

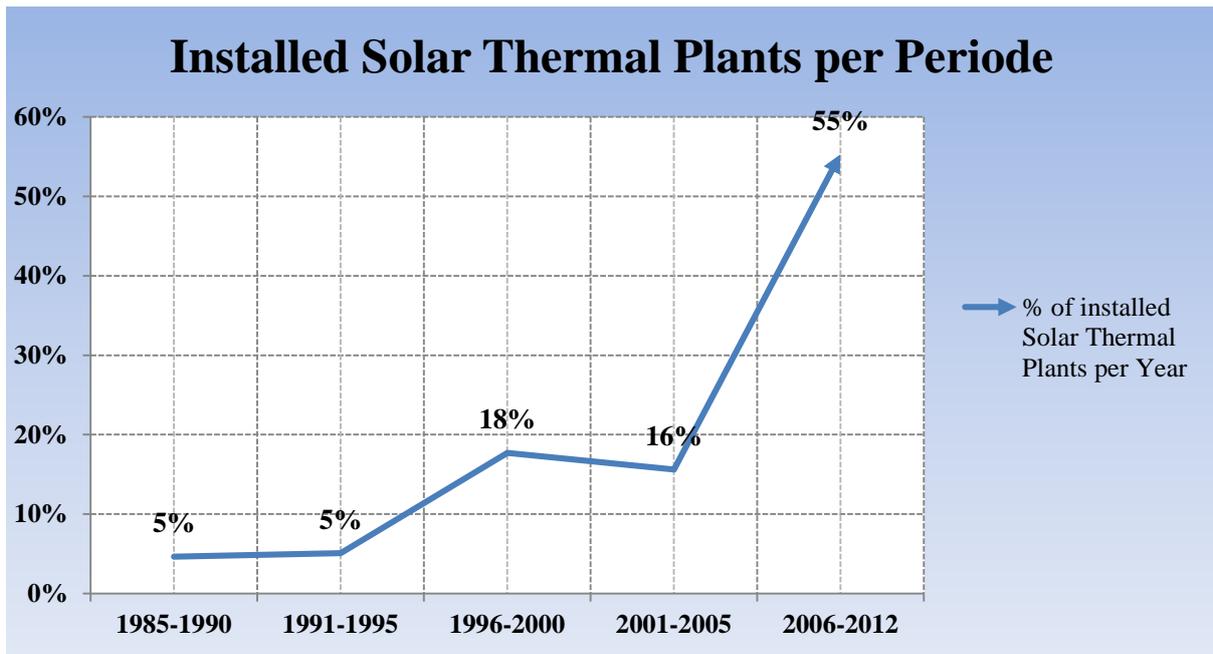
Main drivers for the growth of the solar-thermal industry are moves to limit carbon-dioxide emissions and requirements to increase the proportion of energy produced from renewable sources. Solar thermal collectors are classified by the data collection as Flat Plate High Temperature, Flat Plate Standard, CPC Evacuated Tube, Unglazed Collector, Heat pipe + Evacuated Solar Collector, Heat Pipe Collector, Parabolic Trough, All-glass Evacuated Solar Collector Tubes, Heat Pipe, Heat pipe/All-glass Evacuated Solar Collector Tubes and U Tube Solar Collectors.

The analysis includes following graphs, which reflect the results based on 237 plants and their specific data. 147 plants are focusing on General Heating technologies, 38 focus on General Cooling Technologies, 18 are installed to provide Warm Water, 11 plants are active for Swimming Pool Heating, 22 Solar Thermal Plants are specified on Process Heating and one focuses on Process Cooling.

General Heating includes plants for district heating, local district heating and heating of large building(s). General Cooling focuses on district cooling, local district cooling or cooling of large building(s). Industrial process heat could also include desalination, whereas Water Heating only focuses on hot water productions.

The registered plants are located in 32 countries, covering various kinds of solar thermal collector technologies and kinds of energy usage.

Following 1<sup>st</sup> graph shows installed Solar Thermal Plants Worldwide per Period from 1985 - 2012:

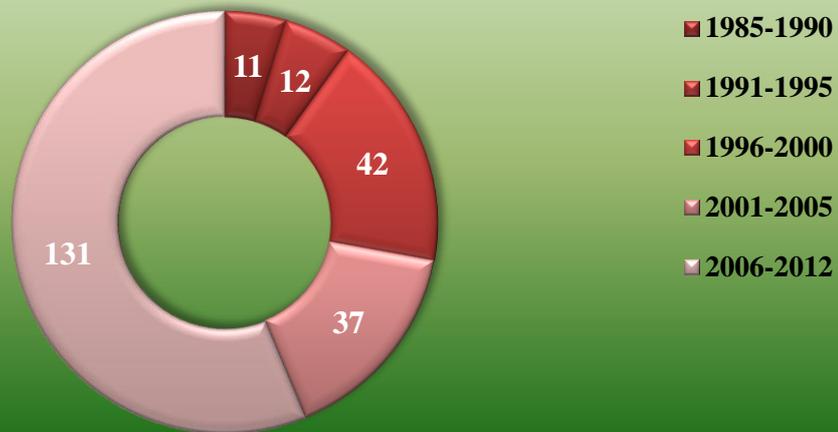


**Graph 1: Installed Solar Thermal Plants Worldwide per Period from 1985 – 2012.**

Between the year 2001 and 2012, 55% of all covered Large Scale Solar Thermal Plants worldwide were installed. This development reflects the growing turn to renewable energies and supports further research in this field as well as increasing economic opportunities for Large Scale Solar Thermal Plants.

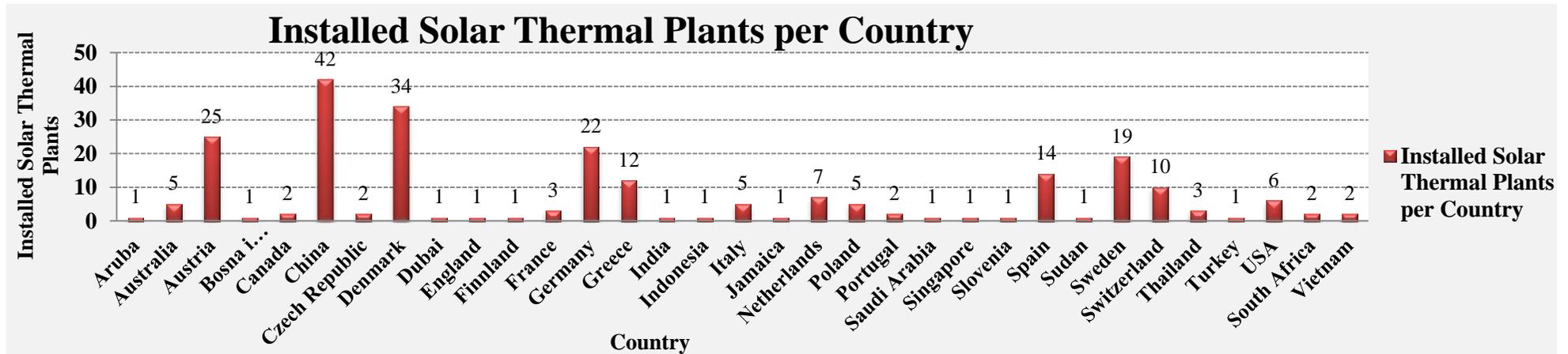
In absolute numbers, 131 registered plants were installed between 2006 and 2012. Starting in 1985, 11 plants were installed between 1985 and 1990. In the next period, from 1991 – 1995, numbers didn't really increase with only 12 plants constructed worldwide. However between 1996 and 2000, the number of plants obviously increased, counting 42 Large Scale Solar Thermal Plants as constructed. Within a short decrease from 2001 – 2005 (only 37 plants in newly operation), the number of installed plants almost tripled in 2006 – 2012, compared to 1996 – 2000. This reflects the current trend in fostering Large Scale Solar Thermal Plants, as following illustration 2 manifests:

## Worldwide Installed Solar Thermal Plants from 1985 - 2012



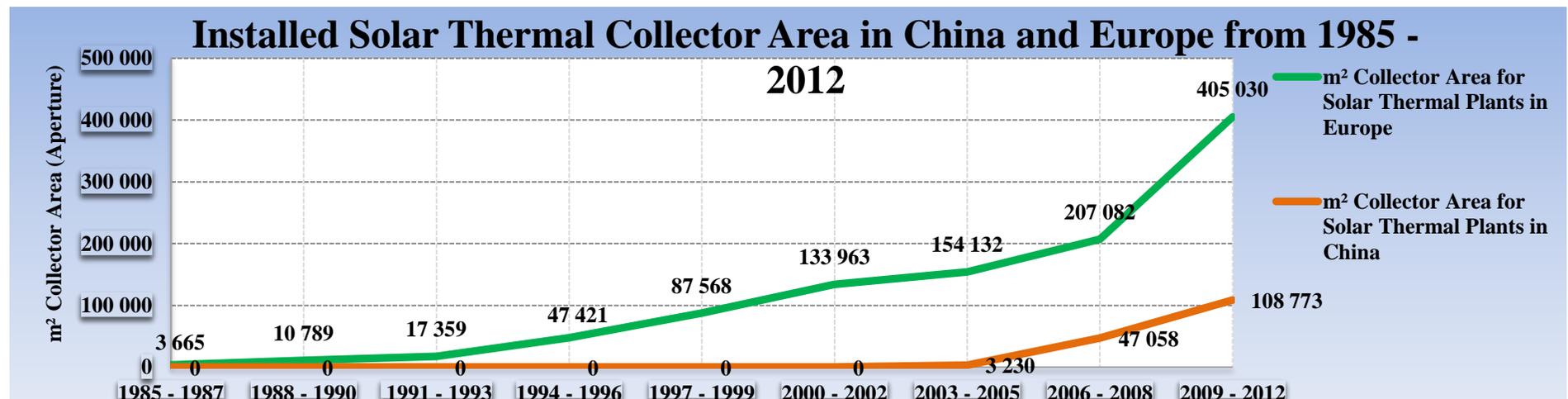
**Graph 2: Installed Solar Thermal Plants Worldwide per Period from 1985 – 2012.**

Data are also focusing on country specific activities. China constructed most plants with around 42 Large Scale Solar Thermal Plants registered as installed until 2012, followed by Denmark, Austria and Germany. Although not all data for plants in different countries were available, a trend showing various plants in Europe and a growing number in China can be identified. Most plants are still located in Europe. Following graph reflects country specific activities:



**Graph 2: Solar Thermal Plants per Country.**

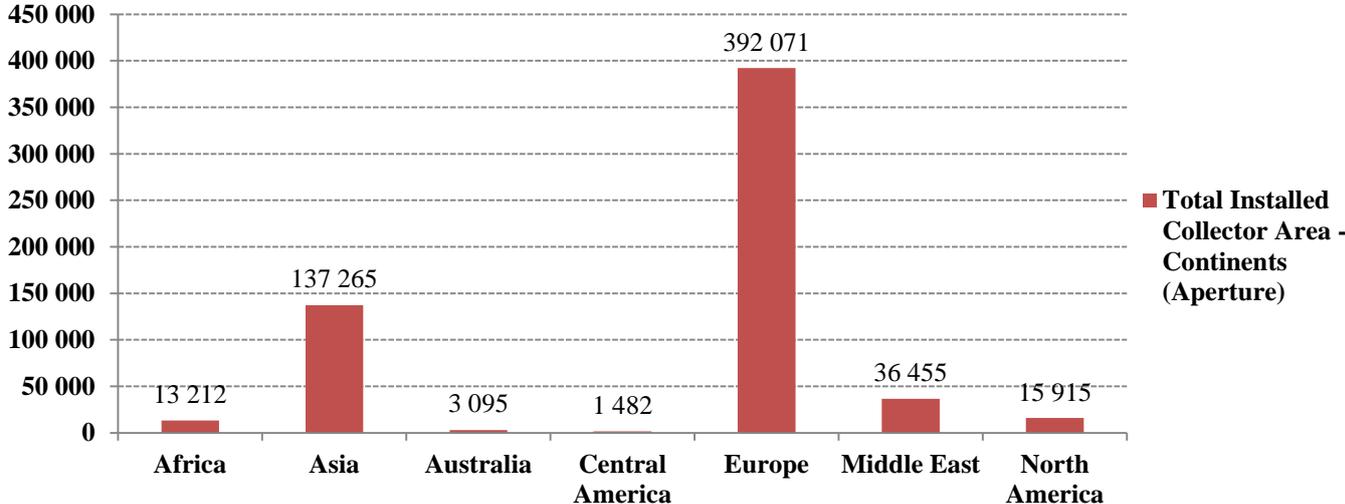
Based on the increasing number of solar thermal plants in China, following graph compares European and Chinese trend for Large Scale Solar Thermal Plants from 1985 - 2012. Although most plants are still constructed in Europe, following graph illustrates the Chinese's markets 'development for Large Scale Solar Thermal Plants. A trend can be identified:



**Graph 3: Installed Solar Thermal Plants in Europe and China.**

In regard to installed collector area (m<sup>2</sup>) as well as installed Large Scale Solar Thermal Plants Europe is leading worldwide. Most solar thermal collectors located in Europe use Flat Plate Standard Collectors for energy capture. This technology is followed by Flat Plate High Temperature Collectors, most installed area in Europe as well. The number of CPC Evacuated Tube Collectors increases in Asia, followed by Africa. The total installed collector area (Aperture) in Europe covers 392.071m<sup>2</sup>. Asia currently generates energy by Large Scale Solar Thermal Plants with 137.265m<sup>2</sup> followed by the Middle East with 36.455m<sup>2</sup> of collector area. Summarized, graph 5 reflects Total Installed Collector Area (Aperture) per Continent:

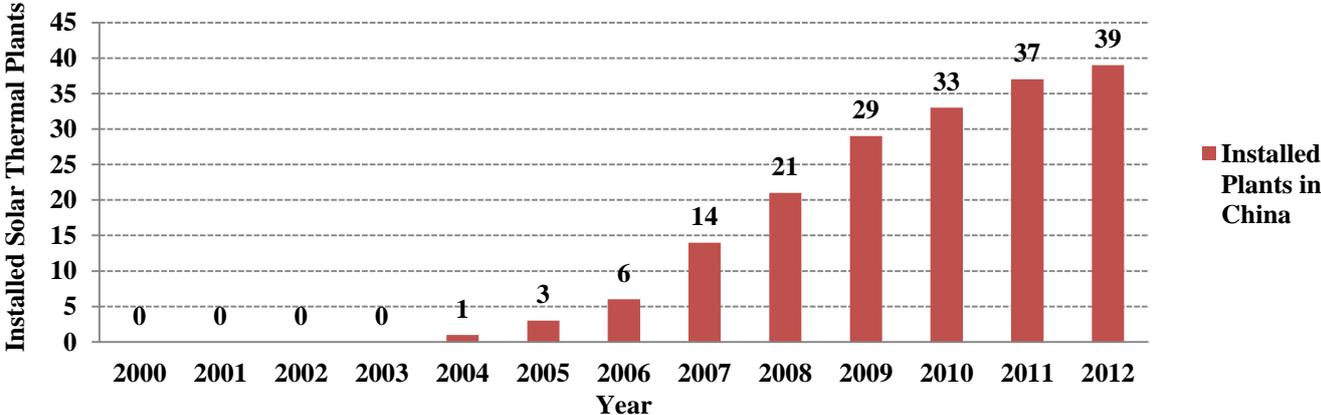
### Total Installed Collector Area - Continents (Aperture)



Graph 4: Total Installed Collector Area in m<sup>2</sup> (Aperture) per Continent.

Asia and especially China show increasing interest in Renewable Energies. Based on increasing development, the number of installed Large Scale Solar Thermal Plants grew in China every year. Collected data start in 2004 and provide an obvious trend within the Large Scale Solar Thermal Energy Sector, as following illustration reflects:

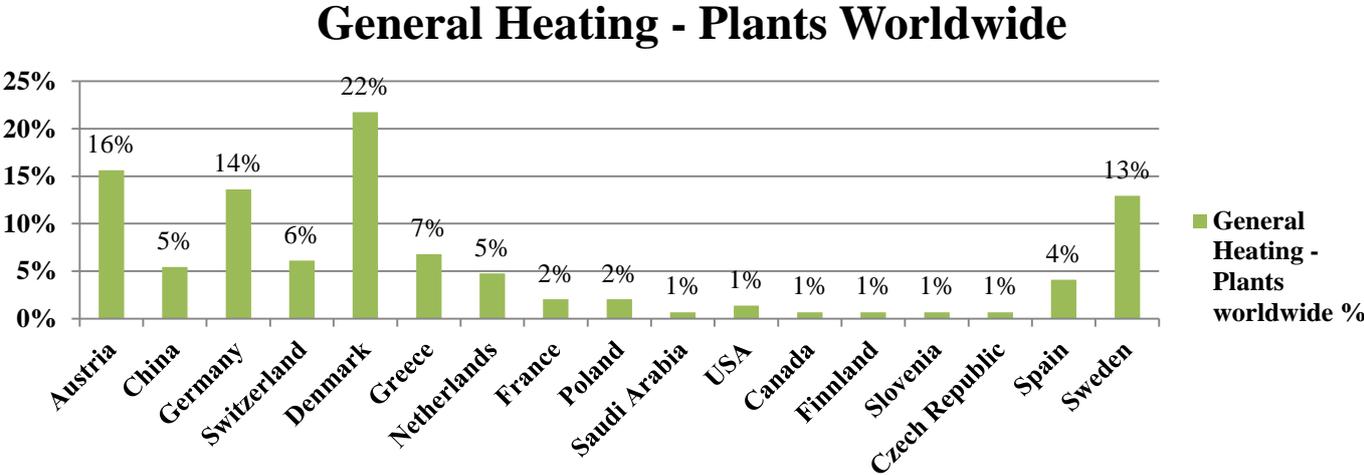
### Installed Solar Thermal Plants in China 2000 - 2012



Graph 5: Installed Solar Thermal Plants in China from 2000 – 2012.

Data were collected –as already mentioned- in the fields of General Heating, General Cooling, Water Heating, Swimming Pool Heating, Process Heating and Process Cooling. Depending on data available, specific graphs for each purpose are provided within an excel sheet. Following illustrations are application specific.

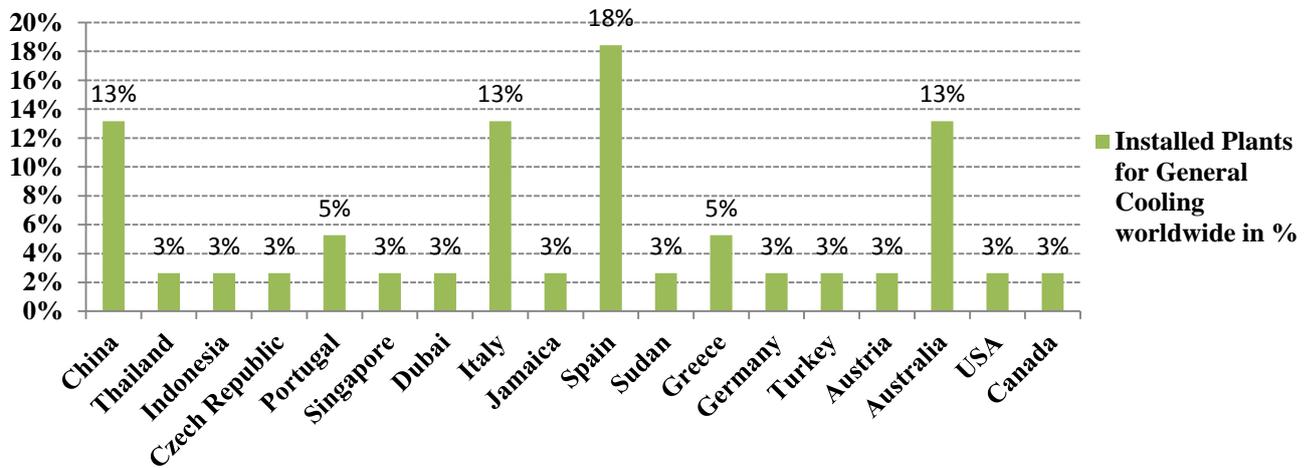
Providing energy for General Heating is Large Scale Solar Thermal Plant’s primary purpose worldwide. Most plants are constructed to provide energy in this field and numbers are increasing. 22% of all installed plants are located in Denmark, 16% in Austria and 14% in Germany. This implies Europe as world leader for General Heating based on Large Scale Solar Thermal Plants. However, China uses it by 5%, with expected growth trends. Illustration 6 presents countries and their share of Large Scale Solar Thermal Plants for General Heating purposes:



**Graph 6: Installed Solar Thermal Plants for General Heating Worldwide.**

General Cooling based on Solar Thermal Energy receives increasing attention. A growing number of companies’ works in this field and more and more countries support the technology’s energy market implementation. Most data were provided by Spain with 18% of all covered plants installed, followed by Australia, China and Italy with 13% of the worldwide applications. Although Europe is also leading within this technology, China increases the number of installations rapidly. Following Graph 7 provides information about specific countries and their Large Scale Solar Thermal General Cooling Installations:

## Installed Solar Thermal Plants for General Cooling Worldwide



**Graph 7: Installed Solar Thermal Plants for General Cooling Worldwide.**

### Summary

Data collected within the Task45 project reflect a worldwide trend in the field of Large Scale Solar Thermal Plants with different primary purposes. Varieties of collector technologies capture solar energy and convert it into an important energy source for different usages.

Based on a source of 237 plants from 32 countries, a first impression and possible trends as well as areas including chances for development and growth can be identified. Collected data provide also value for companies to compare technological aspects and possible partners for countries or research and target markets. From a scientific perspective, data sources open ways for innovation and further research as well as cooperation and development.

It can be recommended to increase the number of plants, covered by the data collection to support growth in the field of Large Scale Solar Thermal Plants and contribute to an increase of renewable energy usage.