SOLARUPDATE

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Newsletter of the International Energy Agency Solar Heating and Cooling Programme

INTERNATIONAL ENERGY AGENCY
Solar Heating & Cooling Programme

#SolarHeat
#SolarThermal
#SolarProcessHeat
#SolarCooling
#SolarDistrictHeating

In This Issue

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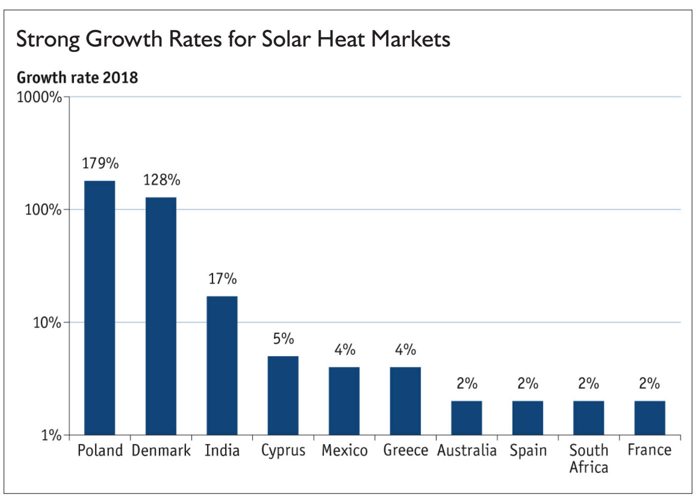
Solar Heat Worldwide 2019

Growth Reported in 10 of the Top 20 Markets

This 22,275 m² (15.6 MWth) solar collector field covers more than 90% of Langkazi's heating needs in Tibet. (Source: Arcon-Sunmark)

The most comprehensive publication on the global solar heating and cooling market. New to this year's report is the inclusion of hybrid Photovoltaic-Thermal (PVT) collectors. PVT collectors, which use a single device to convert solar radiation to heat and electricity, have gained market relevance in recent years and could play an important role in the future energy supply.

In 2018, positive growth was reported in 10 of the top 20 countries, pointing to a turnaround in the solar thermal sector. If this trend continues, global market growth can be expected again in 2019.



Solar thermal markets grow in 10 of the top 20 countries in 2018.

Large-Scale Solar Thermal Systems

A record 37 large-scale systems were commissioned in 2018. Of these new plants, the majority were outside of Europe. With the new 2018 data, there are now 339 large-scale solar thermal systems (>350 kWth; 500 m²) in operation. In terms of capacity, these systems combined total 1,747,200 m² of collector area and 1,2000 MWth of capacity.

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SOLAR WORLD CONGRESS
04 – 07 NOV, 2019
SANTIAGO, CHILE

International Conference on Solar Heating and Cooling for Buildings and Industry

SHC 2019 CONFERENCE 04 - 07 NOVEMBER SANTIAGO, CHILE

Registration is Open!

Early Bird Rate ends August 31st

SHC 2019 together with SWC 2019 will once again be the "must attend" solar event of the year.

Please join us and the conference host, SERC-Chile (Solar Energy Research Center) **in Santiago on November 4-7.**

Holding these two conferences together means that you will find in one place the most up-to-date information on solar technology trends and breakthroughs, global and regional policies, and market opportunities.

SHC 2019 - The International Conference on Solar Heating and Cooling for Buildings and Industry, will bring together the latest developments in solar heating and cooling and highlight market successes. SHC 2019 is sure to inspire as you participate in the conference sessions and discussions and learn firsthand about the developments in South America and across the globe. The aim of SHC 2019 is to have you leave ready to support the deployment of solar thermal technologies to become an increasingly significant contributor to a sustainable and renewable energy future.

SWC 2019 - Solar World Congress, will address the key ingredients of the renewable energy transformation: technology innovation, financial opportunities, policy developments, as well as community and grass-roots actions, case studies and best practices that already are leading towards achieving a 100% renewable energy system in cities and regions. Nevertheless, many challenges remain, and the ISES Solar World Congress 2019 will bring to the forefront a dialogue among diverse experts to discuss and formulate actions to meet these challenges.

This is the first conference to be held in South America. What better country than Chile to host this event, a country committed to renewable energy and with one of the fastest growing and strongest markets for solar energy technologies. And, home to the world's second largest solar process heat plant, the Gabriela Mistral copper mine in the Atacama Desert.

SAC2019 | 9th International Conference on **Solar Air Conditioning**

The 9th edition of the **International Conference on Solar Air Conditioning (SAC)** will take place once again with SHC 2019 and SWC 2019. We hope that you will join all or some of our sessions on November 5th.

SAC 2019 will give the floor to the new generation of solar cooling systems based on the coupling between PV and air conditioning systems as well as the diversification of usage of the solar heat beyond simply cooling: domestic hot water, space heating, process heat, heating for networks. The SAC conference is included when you register for SHC 2019 / SWC 2019. Day tickets are also available.

For more information visit, https://www.solaircon.com/home.html

Highlights of a few 2018 installations

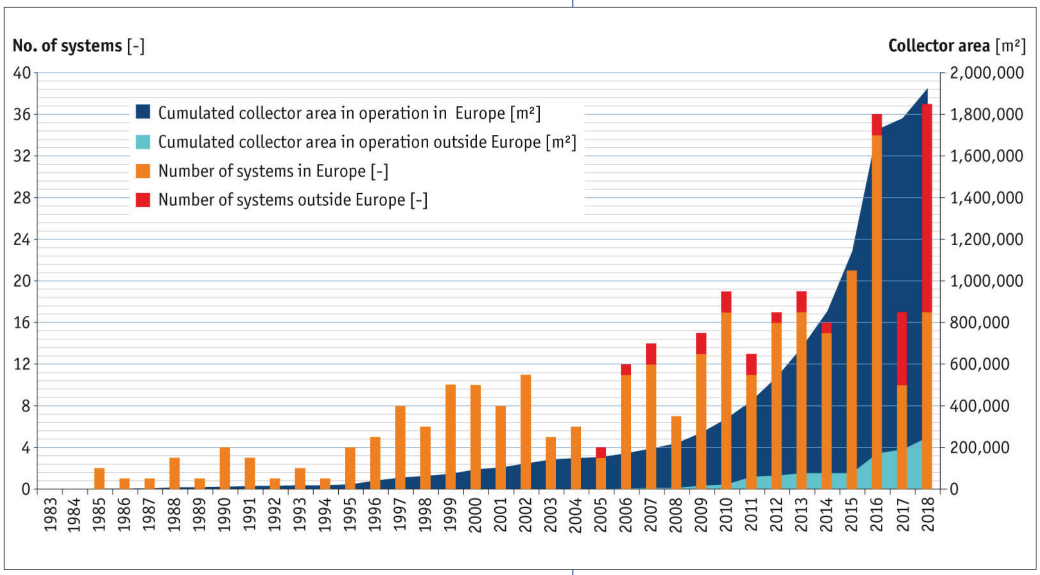
Denmark: The largest district heating plant built in 2018 was in Aabybro. The installed capacity is 18.3 MWth (26,195 m^2).

Tibet: In December 2018, the solar district heating plant in Langkazi began operation in Langkazi. The installed capacity is 15.6 MWth (22,275 m^2), includes a 15,000 m^3 seasonal storage system and covers more than 90% of Langkazi's heating needs.

Germany: Six new systems were installed in 2018, including Berlin's largest solar thermal system with a capacity of 0.7 MWth (983 m^2) at the Berlin-Köpenick heating plant for the district heating network.

South Africa: The first solar district heating system in Sub-Saharan Africa was built at Witwatersrand University in Johannesburg to provide hot water to 14 residence buildings. The installed capacity is 0.39 MWth (557 m^2) in combination with a 60 m^3 storage tank.

Large-scale solar thermal systems technology may be a niche market now, but as demand for hot water and heat put pressure on electricity production, this will undoubtedly change.



▲ **Large-scale systems for solar district heating and large residential, commercial and public buildings worldwide.** (Data source: Daniel Trier - PlanEnergi, DK, Jan-Olof Dalenbäck - Chalmers University of Technology, SE, Sabine Putz - IEA SHC Task 45, AT, Bärbel Epp - solarthermalworld.org, DE)

Solar Heat in Industry (SHIP)

2018 was another big year for solar heat for industrial processes (SHIP) installations. With economic competitiveness, a reliable supply chain and policies to reduce air pollution driving the market - 108 plants started operation. Mexico (51 plants), China (15 plants) and India (10 plants) lead the way with the highest number of new installations.

SHIP is a growing global business – the largest plants in operation are the Mirah solar plant in Oman to extract heavy oil at the Amal oilfield and the Gabriela Mistral copper mine in Chile's Atacama Desert.

Photovoltaic-Thermal Systems (PVT)

New in this year's report is data on Photovoltaic-Thermal (PVT) systems. PVT is a hybrid system that integrates solar electric (PV) and solar thermal (T) energy conversion in a single device to reach higher yields per area. As data is not readily available 26 PVT manufacturers from 11 countries were surveyed confirming that over 1 million systems have been sold. The countries with the most systems installed are France, South Korea, China and Germany.

Highlights From This Year's Report

New Capacity

The vast majority of the 34.6 GWth of new installed capacity in 2017 was led once again by China (26.1 GWth) and then Europe (2.8 GWth), which together accounted for 83% of the overall new collector installations.

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Solar Heat Worldwide 2019 *from page 3*

▲ **Flat-plate collectors are used in the food and beverage industry in Mexico.**

▲ **PVT collectors installed on four of seven apartments in the Swiss village of Blatten.** (Photo: Swiss Travel Fund Cooperative (Reka))

Applications

Domestic hot water systems continue to be the most common application representing 63% of the total capacity in operation and 44% of new installations in 2017. Despite this hold on the market, there have been signs of a downward trend. By contrast, large-scale domestic hot water applications are trending upward – representing 28% of total capacity and 51% of new installed capacity. The reason for this uptick is attributed to it taking over some of the market shares for swimming pool heating and domestic hot water heating in single-family houses.

Two other applications to note are solar district heating and solar process heat, both of which continue to steadily increase although still representing only 3% of the global market.

Jobs & the Environment

In 2017 the estimated number of jobs (production, installation and maintenance) was 672,000.

The worldwide turnover of the solar thermal industry in 2017 is estimated at €15.2 billion (US$ 16.9 billion).

Solar thermal systems in operation at the end of 2018 produced 480 TWh, which corresponds to a final energy saving equivalent to 43 million tons of oil and 138 million tons of CO_2.

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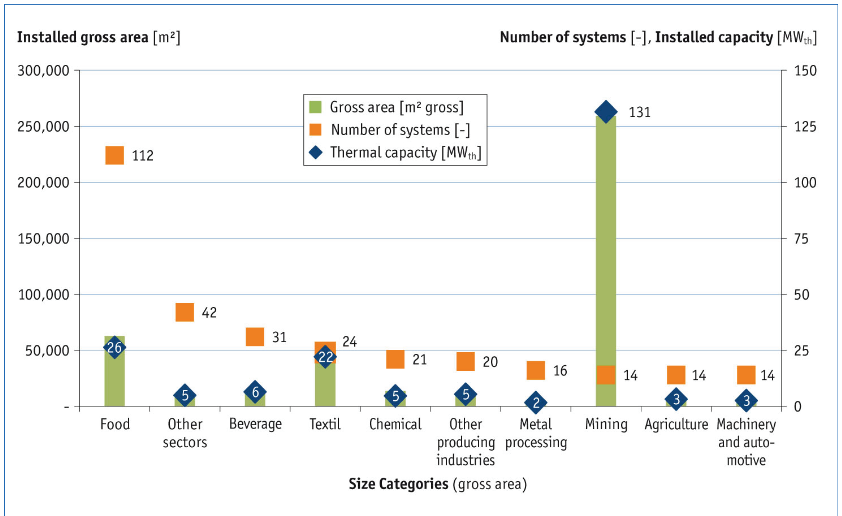
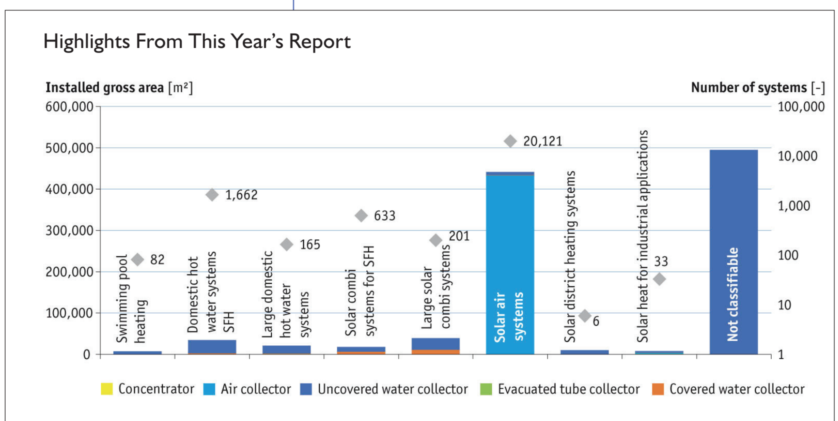
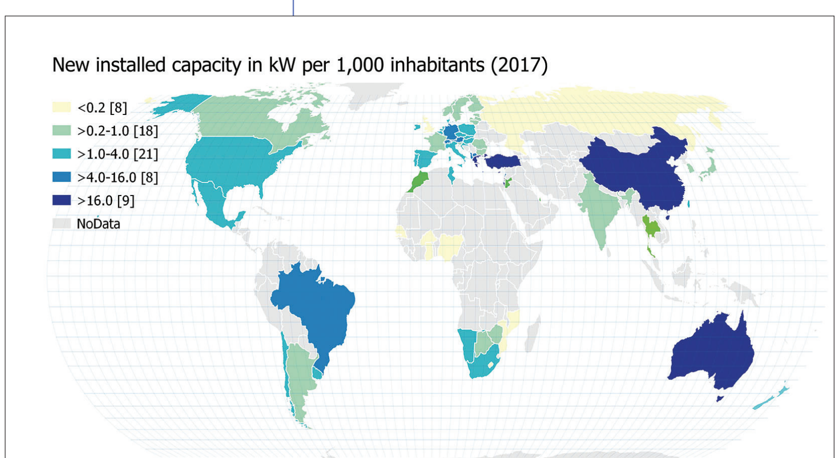


▲ **Global solar process heat systems in operation by the end of March 2019 – industry sector.** (Source: IEA SHC Task49 / IV SHIP database)



▲ **PVT systems in operation worldwide by type of application, collector types and collector area at the end of 2018.** (Source: IEA SHC Task 60 survey, AEE INTEC)



▲ **New installed capacity in 2017 in kWth per 1,000 inhabitants.**

"In a world where CO_2 emissions were unfortunately still rising in 2018, reaching more than 37 gigatons, despite the growing deployment of green power means now more than ever we need to turn our focus to the heat sector. Renewables still are significantly lagging behind in this sector, providing only 10% of the heat produced. The heat sector accounts for 47% of the world's energy demand -- this is higher than the combined demand for electricity (17%) and transport (27%) — a statistic that highlights the huge potential for solar heat, the most efficient and easiest way to produce green heat from 50°C to several hundred °C."

DANIEL MUGNIER, *IEA SHC Chairman*

Top 10

Top 10 Markets in 2017 (in MWth)	**Top 10 Markets per 1,000 inhabitants in 2017** (in kWth)
China 26,082	Israel 36 ^
Turkey 1,348 ^	Cyprus 31
India 1,063 ^	Barbados 27
Brazil 884	Greece 21 ^
United States 658	China 19
Germany 452	Australia 18 ^
Australia 418 ^	Turkey 17 ^
Israel 299 ^	Austria 8
Mexico 274 ^	Palestinian Territories 7
Greece 222 ^	Switzerland 6 ^

^ denotes increase from 2016

Top 10

Total Collector Installations in 2017 (in MWth)	**Total Collector Installation per 1,000 inhabitants in 2017** (in kWth)
China 334,516 ^	Barbados 540 ^
United States 17,763 ^	Cyprus 440 ^
Turkey 16,280 ^	Austria 413
Germany 13,738 ^	Israel 397 ^
Brazil 10,411 ^	Greece 300 ^
India 7,736 ^	Australia 276 ^
Australia 6,320 ^	Palestinian Territories 269
Austria 3,618	China 242 ^
Israel 3,298 ^	Turkey 201 ^
Greece 3,233 ^	Denmark 199

^ denotes increase from 2016

You can read the full report on the IEA SHC website, http://www.iea-shc.org/solar-heat-worldwide.

Task 60

PVT Systems Taking Hold in Europe

PVT projects are blossoming all over Europe, demonstrating that this technology, which combines PV with Solar Thermal in one collector, has many advantages over the classical "side-by-side" installations. In IEA SHC Task 60: PVT Systems, industry participants are reporting interesting, innovative solar hybrid installations. At the last Task meeting in May 2019, participants were happy to be able to discuss best practices from many different projects.

Below are examples of recent PVT installations from Task 60's industry participant from Austria, 3F Solar.

Hotel Donabaum in Spitz

Three different system types – PV, Solar Thermal, and PVT – were installed on the hotel's roof. The reason for this three-systems approach is because of local conditions and load profiles.

On the main roof, the PVT collectors are located in the three front rows of the bird's-eye view. In the next five rows, a large surface of thermal collectors is visible. On the spa roof next to the main hotel building, the PV collectors are installed. Not only do the solar collectors, but also the vineyards make for beautiful views as can be seen here.

Smart Block II in Vienna

A PVT project that is on the way is the restoration of existing urban building stock where the different houses have a common energy production system. The project is called Smart Block II and more information can be found here.

Multi-family house in Vienna

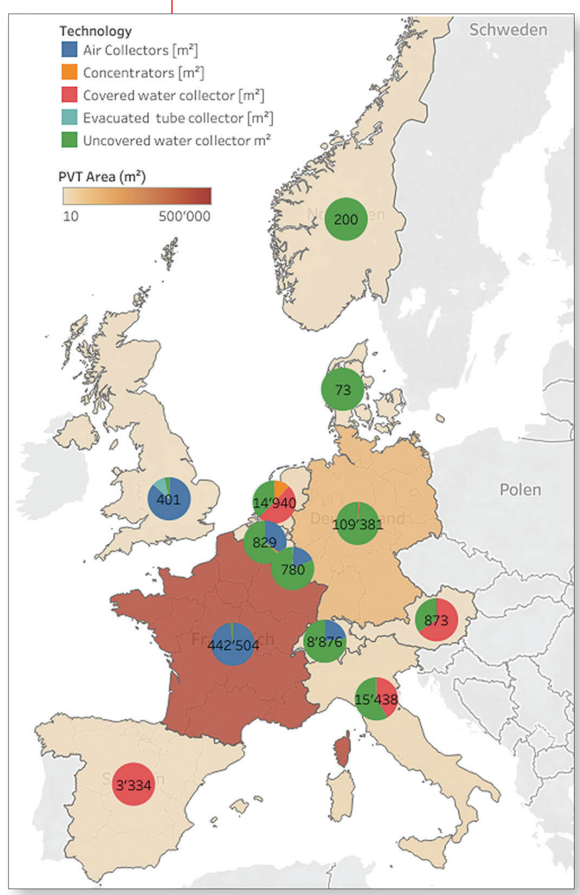
A rather large PVT project on top of several residential buildings (40 collectors) was commissioned in 2018. In this particular case, the planner and contractor tendered for hybrid PVT collectors! A show of interest from the beginning if builders are aware of the advantages of PVT solutions. In this case, the PVT advantage is the ability to generate electricity and heat on the roof as a way to maximize the use of all available space.

These are three vibrant testimonies that PVT hybrid collectors are making their way on the energy scene in Austria thanks to young companies like 3F Solar Technologies GmbH. Find them at: www.3f-solar.at

For more information on SHC Task 60: PVT Systems visit the Task webpage, http://task60.iea-shc.org/ or contact the Operating Agent, Jean-Christophe Hadorn, jchadorn@gmail.com.

"The aim of SHC Task 60 is to assess existing PVT solutions and develop new system solutions principles in which the PVT technology offers advantages over the classic "side by side installations" of solar thermal collectors and PV modules. Best practices are not yet widespread for these systems, and so this international collaborative project will help to accelerate the market acceptance of PVT technologies."

JEAN-CHRISTOPHE HADORN
SHC Task 60 Operating Agent



How We Can Reduce the Price of Solar Thermal Systems

IEA SHC Task 54: Price Reduction of Solar Thermal Systems wrapped up after three years of investigating how to reduce by up to 40% the purchase price of solar thermal systems. Experts from 10 countries analyzed the current cost-structures and socio-economic framework conditions for solar thermal in selected countries. They focused on the complete value chain from production to post-production processes and costs with a particular emphasis on the identification and reduction of post-production cost drivers, for example, channels of distribution. This article highlights the most promising measures for reducing the levelized cost of heat (LCoHsol) of solar thermal systems and outlines recommendations for accompanying, non-technical measures to strengthen solar thermal's position in the future renewable energy mix.

The energy transition towards renewable energy sources, especially in regard to solar thermal applications, leaves room for improvement. Heating accounts for about 40% of the total primary energy use, and the demand for domestic hot water continues to grow worldwide. This raises the question, "Why then has the global market for solar thermal systems been shrinking over the past decade?"[1]

One answer is that photovoltaic (PV) installations and the direct conversion of the solar-based electricity into thermal energy by resistive heaters or the indirect conversion by using heat-pumps became more competitive because of decreasing costs for PV systems and less effort to install. Add to this the fact that in most countries, energy policies predominantly are aimed at electrical rather than thermal solutions. Therefore, a drastic increase in the competitiveness of solar thermal systems is mandatory if a stable or even increasing market is to be reached in the future.

From October 2015 to September 2018, a multi-disciplinary, international team of solar thermal researchers and industry representatives joined SHC Task 54 (http://task54.iea-shc.org/) to investigate ways to make solar thermal applications more competitive. Based on the results, technical suggestions for cost-optimized systems and recommendations for non-technical improvements in the solar thermal sector were documented. The following are a few of the results from this work.

"An overall cost reduction of more than 40% can be achieved by combining various technical measures or by changing the systems and production completely."

MICHAEL KÖHL
SHC Task 54 Operating Agent

Calculating Solar Heat Costs Using the Levelized Cost of Heat (LCoH)

The LCoH calculation method was developed to determine the economic impact of evaluated improvements by comparisons between reference and optimized systems. Improvements all along the entire value chain were investigated.

Figure 1. SHC Task 54 participants investigated improvements all along the entire value chain.

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On the component and material level, Task experts addressed the introduction of cost-efficient materials and simplified, easy-to-install system solutions as well as the possibilities of standardization and plug-and-play systems. They also examined technological measures, such as overheating prevention, as a means to reduce maintenance costs and non-technical recommendations to strengthen solar thermal's position in the energy transition.

To compare different designs and technological solutions with one another, SHC Task 54 started with an assessment of the costs of the heat produced by solar thermal systems over their lifetime. As a calculation method, the levelized cost of heat (LCoH), a measure based on the concept of levelized cost of energy, widespread in the electrical power sector, was chosen. In working with the LCoH concept, the Task continued the work of the FRoNT[2] project, which laid the foundation for the application of the method to any heating technology. Task experts took the work a step further by extending the methodology to calculate the levelized cost of the heat substituted by solar thermal energy. They also extended the concept to estimate the cost of the heat generated by the entire solar assisted heating system or the conventional sources of heat supply.

Under simplifying assumptions described in the Task 54 Info-sheet A01[3] the LCoH becomes:

$$LCoH_{sol,fin} = \frac{I_0 + \sum_{t=1}^{T} C_t}{\sum_{t=1}^{T} E_t}$$

Where:

LCoH: levelized cost of heat in €/kWh

I_0: initial investment in € **€**

C_t: operation and maintenance costs (year t) in € **€**

Σ_t: final energy (in year t) in kWh

T is the period of analysis or the service life in years

There are different system assumptions related to different costs:

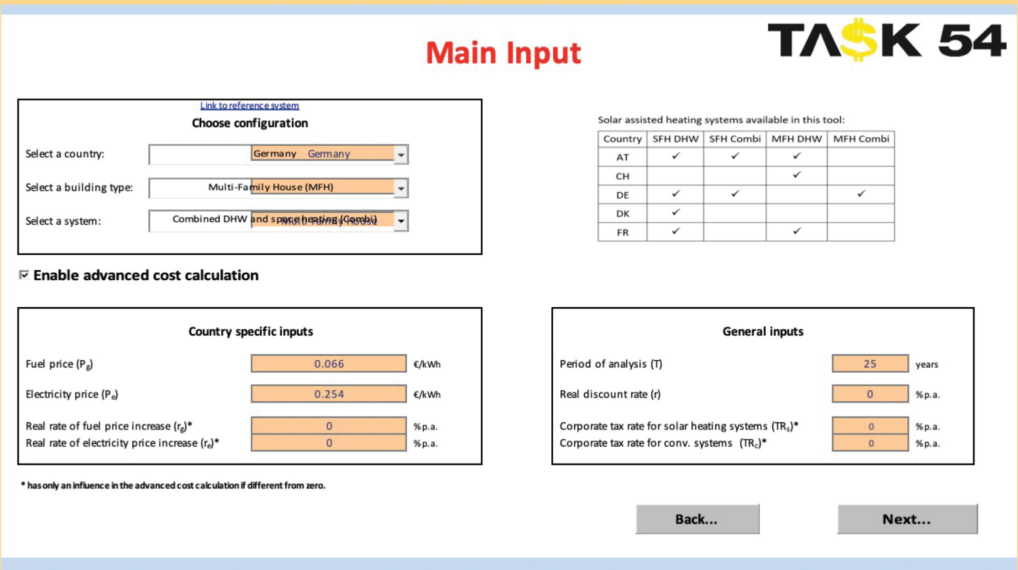
- **LCoH**$_{sol,fin}$: Levelized cost of the heat substituted (saved) by the solar part of the heating system. It is the main indicator of IEA SHC Task 54. It allows the comparison of different solar thermal system designs and technologies as part of the complete heating system.
- **LCoH**$_{ov,fin}$: Overall levelized cost of the heat generated by the solar assisted heating system. The complete heating system is considered here. This enables a comparison of the solar assisted heating system with other heating technologies.
- **LCoH**$_{conv,fin}$: Levelized cost of the heat supplied by the conventional part of the solar assisted heating system or by a conventional system alone (in this case $LCoH_{conv}$ and $LCoH_{ov}$ are equal). It is the twin of the $LCoH_{sol}$ and can be easily derived from the data used to calculate the $LCoH_{sol}$ and the $LCoH_{ov}$.

The index "fin" corresponds to the final energy, considered at the denominator of the LCoH equation, in order to differentiate with other studies, using the solar collector yield or the useful solar heat, for instance.

Free Online LCoH Tool

This easy to use Excel tool provides a method to calculate the Levelized Cost of Heat of solar thermal systems. Users can compare 1) the effects of different solar thermal technological solutions and designs and 2) a solar thermal system with other heating systems over their service lifetime.

The tool includes – User Guide, Methodology used, and Main Input and Advanced Cost Calculation worksheets. You can download the tool here plus the supporting Info Sheet, LCoH for Solar Thermal Applications A01.



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Investigating New Materials and Production Processes

The work on new materials and production processes was focused on polymeric materials and compounds, continuous and discontinuous processes, and all-polymeric collector systems. The investigations revealed that dramatic cost reductions by more than 50% are possible if solar thermal systems are entirely re-engineered. The highest potential of novel all-polymeric systems is for small-scale hot water preparation in warm or tropical climate zones. While various all-polymeric products (e.g., Sunlumo One World Solar System) have been developed, only a few have been introduced into the market, for example by Magen EcoEnergy (left) or Aventa Solar (right). A tailor-made absorber material was successfully developed and commercialized by Borealis AG based on a polypropylene block copolymer. For this specific grade, a factor of two lifetime values was deduced compared to black-pigmented absorber grades currently used for unglazed swimming pool collectors (Wallner et al., 2016). To fully exploit the high-cost reduction potentials of all-polymeric, extruded collector systems for solar thermal hot water preparation, high production numbers of more than 500,000 units per year would be necessary.

▲ **"Heat Kit"collector of Magen EcoEnergy (top) and thermosiphon collector of Aventa Solar (bottom).** (Sources: Magen EcoEnergy and Aventa Solar)

Part of SHC Task 54 was to study the cost-reduction potential for the end-user when introducing new materials for the solar collector. Examples from this work are high-temperature performance polymers used as absorber material and engineered plastics used as collector glazing. These new lighter materials reduced the collector weight by approximately 8 kg/m^2 and the cost reduction along the whole value chain due to easy handling during production, transport and installation. The application of polymers requires a re-design of the complete solar circuit, which goes hand-in-hand with system simplification and cost reductions. The number of production steps is significantly reduced compared to conventional solar collector production because highly industrialized polymeric processing (extrusion and injection molding) allows integrated functional design for the absorber components. The levelized cost of heat "$LCoH_{sol,fin}$" was estimated for three projects in Norway (see Table 1). It is not straight forward to compare the figures, but for each of them the $LCoH_{sol,fin}$ is below the Norwegian electricity costs of 0.115 €/kWh.

Table 1. $LCoH_{sol}$ calculation of three buildings in Norway with all-polymeric solar collectors and adapted system designs.

		
Ilseng State Prison Retrofit, DHW preparation 237 m^2 Collector area 8.4 m^3 Heat store 1100 kWh/(m^2 a) solar irradiance*	**Bjørkelangen Elementary School** New-built, DHW preparation 105 m^2 Collector area 5.6 m^3 Heat store 889 kWh/(m^2 a) solar irradiance*	**Housing Estate Oslo, 34 passive houses** New-built, Solar combisystems with each 14 m^2 Collector area 0.8 m^3 Heat store 1210 kWh/(m^2 a) solar irradiance*
$LCoH_{sol,fin}$ = 0.099€/kWh For retrofit $LCoH_{sol,fin}$ = 0.073€/kWh New built	$LCoH_{sol,fin}$ = 0.035€/kWh	$LCoH_{sol,fin}$ = 0.082€/kWh
* Solar irradiance on tilted collector surface.		

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Innovative Technical Improvements of Components

Another area of work in SHC Task 54 was the analysis of the different technical improvements for cost reduction. Measures to reach cost reductions were analyzed, and their effects on investment and operating and maintenance costs were quantified for a reference domestic hot water system for multi-family houses. The results were discussed and assessed together with companies from the Swiss solar thermal market. The reference system has a flat plate collector field of 17 m^2 and a cluster of two heat storages of 750 liters each, used for warm water storage and solar pre-heating. The following are a few of the cost reduction measures.

Use of Pre-Insulated Plastic Pipes

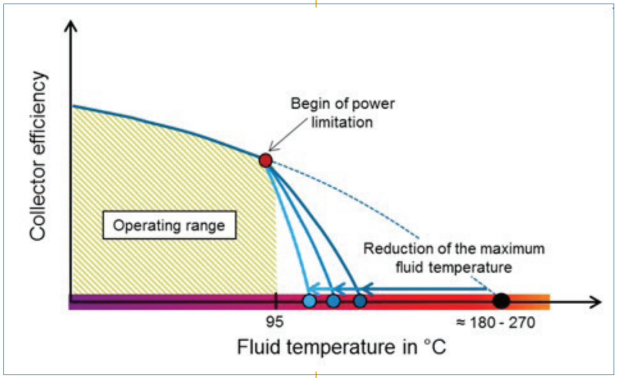
With some of the measures analyzed, a temperature limitation in the solar pipes can be achieved that allows for the use of inexpensive plastic pipes for heating installations. The estimations apply both to plastic-metal composite pipes and pure plastic pipes. Besides lower material costs, the installation time can be reduced for the use of pre-insulated heating pipes and press-fittings as well. In the study, an overall cost reduction was assessed to be 9% of the total investment costs.

Over-Heating Protection: Collectors

Overheating-safe collectors can include mechanisms that once a certain collector temperature is reached the absorbed irradiation is reduced or the heat loss increased. Ideally, the collector should have very high efficiency at temperatures up to around 70 °C and at temperatures above the power is switched off. Depending on the maximum achievable temperature, the temperature limitation can enable the use of inexpensive materials for the collector and the hydraulics. In addition, safety components such as pressure compensation vessels can be scaled down or omitted. In the study, it was estimated that with the use of collectors with over-heating protection together with plastic piping the investment cost of the system could be reduced by 9% and the maintenance costs by 65%. A restriction is that no extra costs for the mechanism itself were taken into account, as the mechanism of the protection was not specified.

Over-Heating Protection: Drain-Back Systems

Overheating protection in a drain-back system is achieved by draining the fluid from the collectors before reaching excessive temperatures. The collectors themselves thus reach normal stagnation temperatures of around 200 °C and the remaining hydraulic components reach significantly lower temperatures depending on the drain temperature, which enables the use of plastics, e.g., for piping. The savings in components and maintenance that can be achieved with drain-back compared to conventional systems were analyzed for both glycol- and water-drain-back systems. The highest savings were estimated for the water-drain-back system with plastic piping. They sum up to 12% less investment cost and 65% less maintenance costs.



▲ **Figure 3. Example of an efficiency curve of a solar collector with overheating prevention.**

Combination of Technical Improvements

It is difficult to reach our goal of 40% reduction in the purchase price with only one measure. Even the polymeric examples shown above required changes in the systems. An optimal combination of standardizing components, limiting the stagnation temperature, and improving the system performance make it possible to meet the goals. Table 2 shows the results for a single-family domestic hot water system in Germany.

Non-Technical Improvements and Learning Curve Issues

Technical optimization is a necessary means for cost reduction but is not a universal remedy for solar thermal. As the learning curves for PV and solar thermal in 2017 illustrate, production costs for solar thermal systems in Germany have been declining for the past years, and yet, the technology is still

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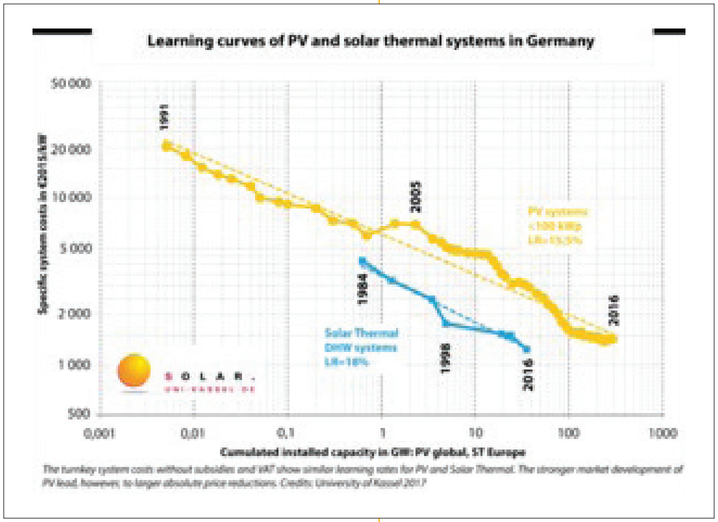
Table 2. The Levelized Cost of Heat for a Solar Domestic Hot Water System in Germany	
$LCoH_{sol,fin}$ Reference System (without VAT)	0.124 €/kWh
$LCoH_{sol,fin}$ Heat pipe system (without VAT)	0.069 €/kWh
Cost reduction potential for solar heat	**44%**

lacking behind PV with a far stronger market development in recent years (Figure 4).

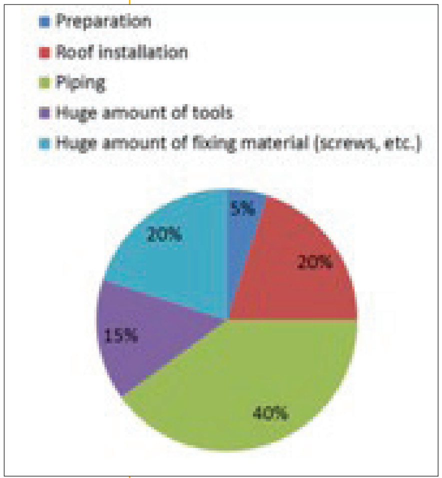


▲ **Figure 4. Learning curves of PV and solar thermal systems in Germany** (Source: University of Kassel).

The comparatively weak position of solar thermal derives from a range of non-technical obstacles the sector is facing. Studies by SHC Task 54 and partners [4,5,6,7] confirm that there are also soft factors with significant influence on the final purchase price of solar thermal systems and their perception by house owners and potential customers.

Distribution models, for instance, are still dominated by two or even three step distribution channels with high margins and pricing power for each trade intermediary. This leads to retail prices that are in the range of 2-3 times higher than production prices, making cost structures non-transparent and unpredictable for the customers. Through the avoidance of direct sales, cost reductions in the production process do not arrive at the end-customer, which makes them obsolete for reasons of competitiveness. Therefore, any technical cost-optimization must be accompanied by a radical transformation of the established distribution models. Solutions may lie in the establishment of new business models with direct marketing, for example, via online shops and tools. Also, leasing or contracting models with a fixed price for solar thermal heating would lower the entrance barrier for private costumers.

In this context, installation becomes the focus of attention as a key element in the solar thermal value chain. SHC Task 54 experts investigated installation prices and routines in seven countries to gain insights into the bottlenecks and cost drivers. A survey of 23 installation companies revealed that there are significant time losses in installation due to complex piping construction and roof installation. Other time-consuming factors and price drivers in the installation process are connected to the comparatively huge amount of tools and fixing materials needed for each system, which are also quite heterogeneous for different systems and manufacturers.



▲ **Figure 5. Results of IEA SHC Task 54 installation survey of 23 installation companies in 7 countries. The diagram displays the most time-consuming parts of the installation process.**

The results of the study give reason to assume that heating and sanitary installation companies prefer installing solar thermal only when they are familiar with the system type and when the effort and risk of installation failures are moderate. These prerequisites can be achieved by the following factors which are also explicitly recommended by the survey respondents:

- Standardized mounting for all kinds of systems
- Provision of useful collector fixing kits or detailed mounting videos by manufacturers
- Increased and open communication among all stakeholders, better cooperation and sharing of "lessons learned"
- Specialized solar thermal installation companies and subcontracting models
- Wireless sensors

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Reducing the Price *from page 11*

The recommendations provided by installers coincide in a large part with those of the 138 energy consultants interviewed by SHC Task 54[8]. As a target group with the closest contact to potential users of solar thermal, they play a decisive role, not only in the selection process but more importantly as barometers for today's status and perception of solar thermal. The investigation shows that solar thermal is still among those technologies that are primarily recommended in combination with conventional heating systems in new buildings (up to 60% ticked 'frequently' when asked about their frequency of recommending solar thermal next to PV, heat pump and pellet) and refurbishment projects (about 45%). Yet, the actual installation figures remain far below these indicators.

Reasons for the downward trend are numerous. On the one hand, customers are looking for the most (investment) cost-efficient solutions, and solar thermal is not competitive enough. On the other hand, energy consultants see a need for new financing models apart from mechanisms such as the KfW funding in Germany, for instance, which is perceived as being too complex and difficult to obtain. The need for easy-to-understand and easy-to-get financing could be one lever for reviving solar thermal from an economic point of view. From a technological point of view, systems should be robust –keywords being stagnation prevention, higher efficiency and low maintenance.

Chances of reviving solar thermal are also seen in innovative, but with focused marketing and PR measures. More lobbying work in ministries, image campaigns and best practice studies are mentioned as crucial instruments in highlighting the advantages of solar thermal applications to the public. Stronger involvement of media and solar thermal associations should help in promoting the technology. SHC Task 54 has taken up these recommendations by developing a catalog of marketing best practices[9] and by highlighting promising marketing campaigns for solar thermal[10].

Conclusion

SHC Task 54's investigative work of the solar thermal value chain shows that there is room for cost reductions on the material, component and system levels by limiting the temperature and pressure loads. In particular, combinations of different measures, for example, increased performance by using more efficient stores and collectors with overheating prevention and standardization can reduce the $LCoH_{sol,fin}$ by more than 40%.

However, the Task's studies also revealed that cost reduction is not the only way to strengthen solar thermal's position. Economic considerations must be made alongside any technical innovations, and a call for a radical transformation of the solar thermal market is needed. Distribution models must be in favor of the market, which means a stronger orientation towards customer needs as opposed to profit maximization from retailer to retailer. Transparency of costs, financing and reliability in operation must be highlighted from the beginning and communicated in a way that every customer can understand. These measures need to be accompanied by consumer-oriented promotion and marketing measures pushed by politicians, solar thermal associations and the media.

This article was contributed by Michael Köhl, the Task 54 Operating Agent.

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8 Survey from Fraunhofer ISE with German Association of energy Consultants in 2018, results based on 138 replies out of 500, see also Info Sheets D.

9 Deliverable report on http://task54.iea-shc.org.

10 See Heat Changers Case Study, Info Sheet A 14 (http://task54.iea-shc.org/info-sheets)

UK TRAINING WORKSHOP ON DISTRICT HEATING

This past March, UK Government Department for Business, Energy and Industrial Strategy (BEIS) hosted a Solar Academy training workshop on Solar Heat Networks: Solar Heat Networks: Policy, Planning, Design and Performance. The motivation for this training is the new initiative, Heat Networks Investment Project (HNIP). Over the next three years, (BEIS will invest £320m of capital funding into heat networks through the HNIP.

In the UK, heat networks have the potential to substantially contribute to the country's goal to decarbonize heat, however only if the source of heat for the network is low carbon. One of the most effective ways of decarbonizing a heat network is to use solar heat. To share what is happening outside of the UK in this field, BEIS invited two national experts from IEA SHC Task 55: Towards the Integration of Large SHC Systems into District Heating and Cooling Networks to speak on Solar Heat Networks – Jan Erik Nielsen from the renewable energy planning company PlanEnergi in Denmark and Christian Holter from the solar engineering company SOLID in Austria. They were joined by three UK experts – Grant Feasey from the solar collector manufacturing company AES Solar, Renaldi Renaldi from Newcastle University and Edmund Papworth from the small-scale heat network company, Minus 7.

The workshop created the perfect platform to bring together around 50 stakeholders involved in the implementation of heat networks to discuss how solar heat can be used to affordably reduce carbon emissions of both existing and new heat networks.

You can find the full workshop report here.

Solar Academy WEBINARS

Most Recent **Solar Heating and Cooling Market and Industry Trends 2018** July 2019

1 **Building Integrated Solar Envelope Systems for HVAC and Lighting** September 2019

2 **Material and Component Development for Thermal Energy Storage** November 2019

3 **Renovating Historic Buildings Towards Zero Energy** December 2019

You can watch past webinars on the SHC YouTube channel click here

Combining Short and Long-Term Heat Storage for Solar Heating Systems

By the end of 2020, near-zero energy consumption is required by all new buildings in the EU, as stated in the Energy Performance of Buildings Directive. Solar heating is a promising technology to achieve this aim. However, due to the mismatch of solar energy resources and the demand patterns of single-family houses in central and northern Europe, long-term heat storage is essential for solar combi-systems that cover hot water supply and heating with a solar fraction higher than 50%. Water tanks can be used for this purpose, but large storage volumes are necessary to compensate for sensible heat losses.

The idea is to combine short and long-term heat storage utilizing stable supercooling of sodium acetate trihydrate (SAT) composites, which permit the use of the sensible heat capacity of the melted composite while preserving its heat of fusion at room temperature. The result: loss-free heat storage that can be used for on-demand supply in periods without solar irradiation.

From Laboratory to Application

The principle of supercooling is as follows. The heat from solar collectors is used to melt the material (at 58 °C). After the complete module is melted, it is cooled down by taking out the heat for immediate use, for instance for hot tap water. Supercooling now takes place, meaning that the material does not solidify when cooling down. It will only crystallize/solidify when below a certain temperature or when crystals are brought into contact with the supercooled liquid. The moment the material solidifies, the heat of solidification (heat of fusion) becomes available for use. Some materials have a very strong degree of supercooling. Material tests show that SAT composites crystallized in the range of -9 °C to -15 °C in contact with steel[1]. This means that the material can be stored for very long periods without solidification taking place, and thus, the heat of solidification also is stored very long.

IEA SHC Storage Project

SHC Task 58: Material and Component Development for Thermal Energy Storage is a joint project with the IEA Energy Conservation through Energy Storage Technology Collaboration Programme (ECES). It is focused on furthering the understanding and development of thermochemical materials (TCM) and phase-change materials (PCM), the development of measuring procedures for characterization and test methods for validating the performance of PCMs and TCMs as well as the development of effective design approaches for specific components. Task experts from both materials research and storage applications are working on storage systems, components, materials and testing, and characterization.

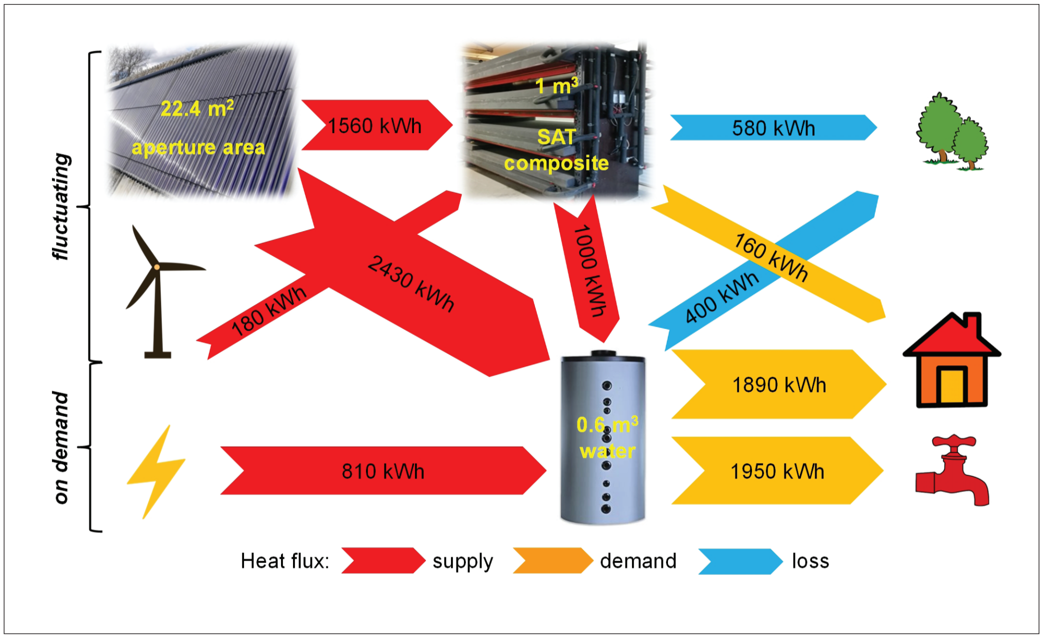

Figure 1. Simulated annual heat flux for a house with 3 occupants in the Danish climate. About 80% of heat demand could be covered by using solar collectors and a recharge of the SAT composite with wind power in January. [3]

continued on page 15

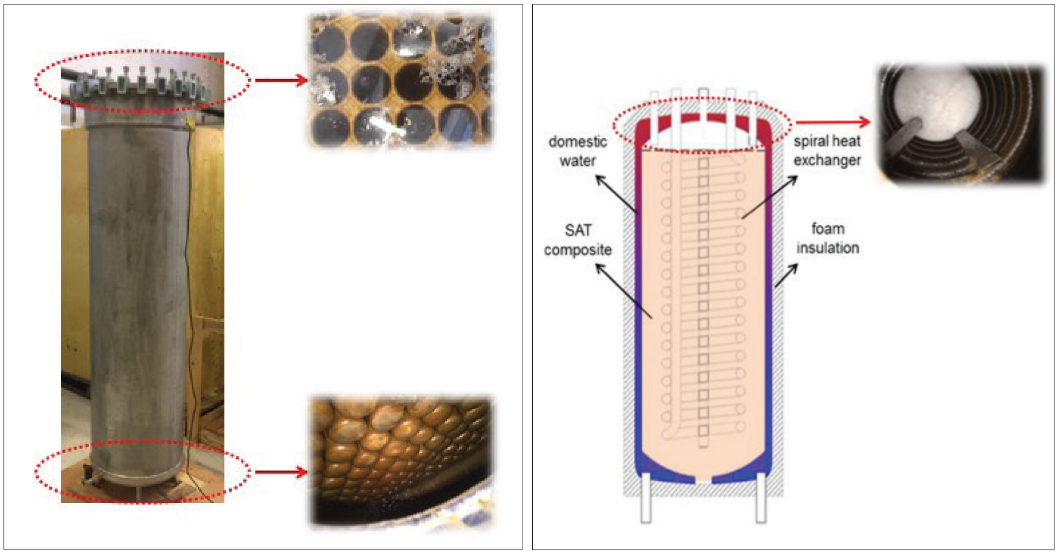

Figure 2. Cylindrical heat storage units:

a) with shell-and-tube heat exchangers and
b) tank-in-tank design with internal spiral heat exchanger.

The heat of fusion, available in a supercooled state at 20°C, was determined to be in the range of 205 - 216 kJ/kg [2]. For demonstration, stable supercooling of SAT composites were applied to a solar heating system utilizing four flat heat storage units, each containing about 200 kg of composite and 22.4 m^2 evacuated tubular solar collectors. Parallel operation of the units was found to be feasible to overcome heat transfer limitations of SAT. The experimental findings were then used to simulate a system with 1 m^3 of composite and a 0.6 m^3 water tank for heat storage in an energy-efficient house located in Denmark [3]. Results showed that hot water and space heating, with a yearly heat demand of 4,000 kWh, could be covered with a solar fraction of approximately 70%. Further, a power-to-heat conversion could be possible with wind energy in winter. In this way, almost all heat demand could be covered by solar and wind energy – even with a relatively small storage volume, see Figure 1.

Heat Storage Unit Development

The next step is to develop less expensive cylindrical units with SAT. Units with different heat exchanger designs from HM Heizkörper GmbH in Germany are currently tested at the Technical University of Denmark [4]. Prototypes showed potential for reduced heat losses and applicability in solar heating systems. Figure 2a presents a unit with a shell-and-tube heat exchanger that was developed for optimized heat transfer. A prototype using standard water tank components was manufactured by NILAN A/S in Denmark. This design is a tank-in-tank unit (schematic drawing in Figure 2b) that utilizes thermal stratification in the outer tank for domestic water use. It stores 27 kWh of heat between 25 °C and 90 °C, of which 11.5 kWh can be preserved at room temperature. The addition of thickening agents proved to be suitable to stabilize SAT in flat prototype units, whereas in cylindrical units SAT composites with polymeric solutions were identified to have better heat transfer properties.

What's Next

Different climates, solar collector types, and improved heat storage units will be included in future investigations to study the application and suitability of the system concept. Among other things, material and heat storage test methods, as well as a definition of operation conditions, are part of activities of the joint IEA SHC/ECES Task 58/Annex 33: Material and Component Development for Thermal Energy Storage

This article was contributed by Gerald Englmair, Simon Furbo, and Mark Dannemand of the Technical University of Denmark, Department of Civil Engineering-gereng@byg.dtu.dk; sf@byg.dtu.dk; markd@byg.dtu.dk

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Task 61

Working to Meet the Needs of the Lighting Industry

China hosted the 3rd industry workshop of IEA SHC Task 61 / IEA EBC Annex 77: Integrated Solutions for Daylighting and Electric Lighting. The workshop was held as part of the 2019 International Daylighting and Electric Lighting Innovation Technology Conference organized by the China Academy of Building Research (CABR) in Beijing in March. Over 150 researchers, engineers, designers, other technical staff attended, and over 2,500 people watched the presentations live online.

The objective of the Task's industry workshops are to continuously mirror the Task's work with the needs of the industry. At this workshop, 11 speakers gave interesting insights into a wide range of topics regarding daylighting and electric lighting:

- Xu Wei, Director of Institute of Building Environment and Energy (IBEE) of CABR, shared his vast knowledge on Near Zero Energy Building (NZEB) and experiences with these applications in China.
- Jan de Boer, the Operating Agent of IEA SHC Task 61/EBC Annex 77, gave an overview for the cooperative project.
- Zhao Jianping, Vice President of IBEE, introduced the promotion and demonstration of the lighting environment in green buildings in China.
- Yan Da, the Operating Agent of IEA EBC Annex 66, discussed how occupant behavior influences the building lighting energy simulation.
- Hao Luoxi, Vice President of CIE, reported on the light environment of the human settlements based on active health intervention.
- Barbara Matusiak, from the Norwegian University of Science and Technology, presented tentative conclusions from a profound literature review of users' lighting needs and requirements (presentation given by Jan de Boer for Barbara Matusiak).
- Anne Sophie Louise Stoffer, from the Danish Building Research Institute, explained how to use visualization and operational cost calculation to obtain a better lighting environment.
- David Geisler, from Bartenbach GmbH in Austria, introduced the BSDF model and rating method for advanced facade systems.
- Daniel Cheng, from the NVC lighting company in China, presented the applications of dynamic colorful lighting.
- Niko Gentile, from Lund University, discussed how to save energy using integrated lighting design.
- Shao-Yu Wu, from the DIAL company in Germany, introduced the new features of the lighting design software DIALux Evo.

For more information on SHC Task 61 / EBC Annex 77: Integrated Solutions for Daylighting and Electric Lighting visit, http://task61.iea-shc.org

"The conference was a success in bringing together European and Chinese experts to discuss a wide rangeof lighting topics. There is no doubt that there will be more cooperation between China and Europe in the field of lighting."

JAN DE BOER
SHC Task 61/EBC Annex 77 Operating Agent

▲ **Jan de Boer, the leader of SHC Task 61 / EBC Annex 77: Integrated Solutions for Daylighting and Electric Lighting in Beijing.**

COUNTRY HIGHLIGHT

Austria's Solar Thermal Market Goes Hand in Hand with Strong IEA SHC Collaboration

Austria and the IEA Solar Heating and Cooling Programme look back on over 40 years of successful collaboration. In 1977 Austria was one of the founding members of this Technology Collaboration Programme. Since that time, Austria continues to be one of the most active countries in the Programme, and Austrian experts have actively participated in almost all of the 62 Tasks. The thematic priorities of the IEA SHC work also are reflected in the development of the Austrian solar market.

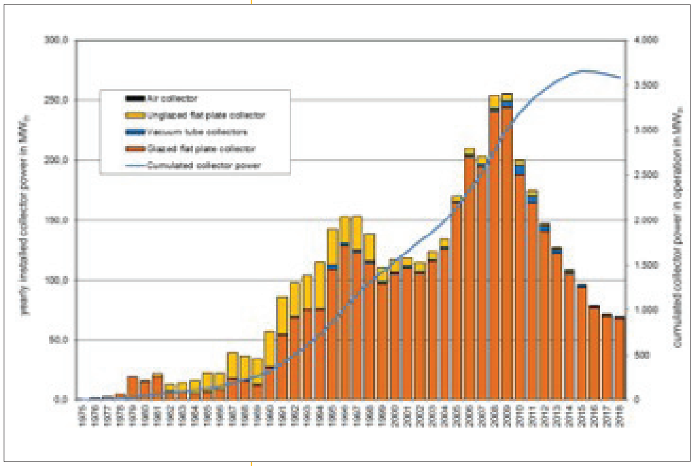
Austria ranks 3rd in the world in total solar water collector capacity per 1,000 inhabitants.

In Austria, solar thermal systems for hot water preparation and swimming pool heating experienced its first boom in the late 1970s. The use of solar collectors for domestic hot water dominated the market for 20 years and demonstrated that solar heating systems are founded on reliable and mature technology. It was not until the beginning of the 1990s that another solar technology, the first solar combi-systems (combined domestic hot water preparation and space heating), appeared on the market.

▲ **Figure 1. The first detached house using a solar combi system that covers 100% of the hot water and space heating needs was built in 1997.**

Being one of the leading countries in the development of this new application, Austria initiated a collaborative IEA SHC project on solar combi-systems in 1998. The combination of thermally well-insulated buildings and low-temperature heat supply systems offered a wealth of new possibilities for solar space heating systems with short term storage. Also, the growing environmental awareness and subsidies in several countries supported the development of this type of system. Triggered and supported by national research and development projects, but also by IEA SHC Task 26: Solar Combisystems, it was possible in the 1990s to tap into the area of solar thermal energy for space heating applications.

This development is also visible in the Austrian market statistics. Numerous solar combi-systems for water heating and space heating subsequently triggered strong growth figures. This was followed by a period of falling oil prices, and as a result the number of new collector installations also fell.



▲ **Figure 2. Market development of solar thermal collectors in Austria until 2018.** (Source: AEE INTEC)

The significant increase in sales between 2002 and 2009 reached its peak in 2009. This development was due to the rise in energy prices as well as the expansion of thermal solar energy applications to multi-family housing, the tourism sector, the integration of solar energy into local and district heating networks as well as commercial and industrial applications.

At the IEA SHC level, this was reflected in several Tasks on topics like "Solar Energy in Architecture," "Solar Heat for Industrial Processes" or "Large-scale Solar Heating and Cooling Systems" and numerous Tasks on thermal storage. The results of these international projects significantly influenced the research sector and industrial innovations.

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Austria *from page 17*

By the end of the year 2018, approximately 5.1 million m² of solar thermal collectors were in operation, corresponding to an installed thermal capacity of 3.5 GWth and a solar yield of 2,104 GWhth. The environmental benefit is 425,434 tons per year of avoided CO_2-emissions.

This data positions Austria in third place worldwide among the top 10 countries with the highest cumulated glazed and unglazed water collector capacity in operation per 1,000 inhabitants. The leading country is Barbados with an installed capacity of 540 kWth/1,000 inhabitants, followed by Cyprus with 440 kWth/1,000 inhabitants and with 413 kWth/1,000 inhabitants.

Export – A Success Story

Despite the declining development of the national and global solar thermal markets in recent years, Austrian solar technology companies remain very successful in international markets. For almost 20 years, the export share of solar collectors produced in Austria has exceeded 80%.

Exports and the domestic market propelled the Austrian solar thermal industry to reach a turnover of about 164 million Euros in 2018 and approximately 1,400 full-time jobs in Austrian solar thermal businesses.

Export highlights are the installation of the solar plant at Princess Noura University in Riyadh, Saudi Arabia with a collector area of 36,200 m² and the solar cooling system for IKEA in Singapore with a cooling capacity of 800kW installed in 2017.

Another project that needs mentioning is the first solar district heating plant in South Africa launched in May 2019 at WITS Junction. This plant in Johannesburg is the largest solar plant in Sub-Saharan Africa. The large-area collectors used in these systems were developed in research projects together with the industry. The international cooperation within the framework of the IEA SHC played a significant role.

Austria may be a small country with just under 9 million people, but it is big on solar. The combination of an environmentally aware population, a diverse solar portfolio from single-family housing to district heating and industrial processes, and comprehensive subsidy schemes that include all of Austria's provinces are creating one of the world's most robust solar thermal markets.

This article was contributed by Werner Weiss, Austria's IEA SHC Executive Committee member.

▲ **Figure 3. Solar system for a multi-family building in Graz, Austria.**

▲ **Figure 4. The WITS Junction solar system is the largest solar thermal installation in Sub-Saharan Africa. The district heating project combines solar, co-generation and gas heating technologies, servicing 14 student residence buildings with hot water from one centralized hot water plant. Installation includes a 600 m² solar heating plant with 10 m² of collectors.** (Source: Black Dot Energy/SOLTRAIN)

New Project Starting in September

Solar Neighborhood Planning

Building on past IEA SHC work, this new project, Task 63: Solar Neighborhood Planning, will target the building sector between individual buildings and cities. Neighborhoods, for this project, are defined as a group of buildings or a small district/precinct and may be part of an urban area, rural development of a separate community.

The Task's main objective is to support developers, property owners/associations, architects, urban planners, municipalities, institutions, and other key players to develop solar neighborhoods with long-term solar access for energy production, daylighting buildings, and outdoor environments – resulting in sustainable and healthy environments.

For four years, an international team of experts will work together to:

- Identify, develop and test planning strategies and concepts for increased solar energy capture and utilization in neighborhoods, in view of achieving Net Zero Energy and /Net Zero Carbon status
- Examine strategies, business models and stakeholder engagement for increasing the use of passive and active solar energy.
- Identify the current workflow of solar planning tools and then further develop this "tool chain" to support decisions in all planning stages – the coupling of tools
- Carry out Case Studies in each of the participating countries to create close ties between practice and implementation

Interested in learning more about this new project? Contact Maria Wall of Lund University, Sweden, maria.wall@ebd.lth.se

Why focus on neighborhoods?

"Solar neighborhoods are needed if Net Zero Energy districts and low carbon cities are to be achieved. Plus, increasing the number of solar neighborhoods would create energy (resource) self-sufficient and energy price resilient (price fluctuations and energy imports) zones – helping to 'future-proof" towns and cities."

MARIA WALL
Task Operating Agent,
SHC Task 51: Solar Neighborhood Planning

Regional Sustainable Energy Centres to Join IEA SHC

Over the next months, the IEA SHC Executive Committee will be welcoming five more UNIDO-coordinated Regional Sustainable Energy Centres (GN-SEC) as members. These new Centres will join ECREEE and RCREEE, who have been members since 2012 and 2014, respectively.

"The centres cover most of the non-OECD countries. These are the new emerging markets were investment and capital have to go to in the coming year", explained Martin Lugmayr, the Manager of the GN-SEC, the Global Network of Regional Sustainable Energy Centres. Daniel Mugnier, IEA SHC chairman said that the knowhow of the IEA SHC programme has to be spread to these new emerging markets. Daniel Mugnier, IEA SHC Chairman said that the know-how of the IEA SHC Programme has to be spread to these new emerging markets and a strategic cooperation between IEA SHC and UNIDO's Centres could support this outreach.

GN-SEC Global Network Regional Sustainable Energy Centres

OVERVIEW OF OPERATING SUSTAINABLE ENERGY CENTRES

Centre	Year established	Office location	In partnership with	Website
ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE)	2008	Praia, Cape Verde	Economic Community Of West African State (ECOWAS)	http://www.ecreee.org
Regional Centre for Renewable Energy and Energy Efficiency (RCREEE)	2008	Cairo, Egypt	Arab League	http://www.rcreee.org
SADC Centre for Renewable Energy and Energy Efficiency (SACREEE)	2015	Windhoek, Namibia	Southern African Development Community (SADC)	https://www.sacreee.org
East African Centre for Renewable Energy and Energy Efficiency (EACREEE)	2016	Kampala, Uganda	East African Community (EAC)	https://www.eacreee.org
Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE)	2016	Nuku'alofa, Kingdom of Tonga	Pacific Community (SPC) and SIDS DOCK*	https://www.pcreee.org
Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE)	2018	Brigdetown, Barbados	with CARICOM and SIDS DOCK*	https://www.ccreee.org

*SIDS DOCK is an institutional mechanism established to facilitate the development of a sustainable energy economy within the small island developing states jointly coordinated by the Caribbean Community Climate Change Center (CCCCC) and the Secretariat of the Pacific Regional Environment Programme (SPREP). Source: GN-SEC

Germany's Growing Solar District Heating Market

Today, 34 large-scale solar thermal plants with a total capacity of 44 MWth are feeding heat into the country's district heating networks. A significant share of these plants originated in the long-term R&D programs of the federal government starting in the 1990s. More than 20 years later, the program "Solarthermie2000" continues to fund R&D demonstration projects and support further research in this field. The largest system with seasonal storage is still the plant in Crailsheim, which started operation in 2004.

Solar district heating is a key topic in German solar energy research. Currently, 10 R&D projects are running within the framework of the 7th Energy Research Programme of the federal government. The last decade has also seen a rising interest in the commercial use, supported by various market introduction actions. Mainly heat suppliers, utilities, energy cooperatives and municipalities invest in solar district heating, simply because solar thermal energy is a convincing solution for decarbonizing the district heating systems today. Economic feasibility was reached thanks to a long-term renewable heat incentive scheme of the German Ministry for Economics and Energy.

The graph below shows the long-term market development up to 2018 and offers market estimates for the next five years (based on known projects in the preparation and planning phases). At present, basically two sectors are developing:

- "Energy Villages" are smaller communities in rural areas that typically switch from de-central heating oil boilers in every single-family house to small district heating networks that use renewable energy sources. In these energy villages, solar thermal plants supply 100% of the heating demand in summer and are often combined with large biomass boilers for the winter periods. In 2013, the first solar district heating plant of this type began operation in the village of Büsingen in the southwestern part of Germany. Another eight plants followed, five of them in the year 2018 alone. In various regions in Germany, the regional governments support the model of "solar energy villages" for a faster energy transition in rural areas.

▲ **Figure 1. Solar thermal plant Senftenberg** (Source: Stadtwerke Senftenberg)

continued on page 20

Germany *from page 21*

In the sector of large urban district heating systems, the number of concrete projects is significantly increasing. Germany´s largest solar district heating plant to date is in Senftenberg in the state of Brandenburg, which started operation in 2016. The plant has a capacity of 5.8 MWth. Senftenberg marks an important milestone in this sector in Germany. Several smaller plants followed in its footsteps and more projects are in the planning and tendering phase. An even larger SDH system will be developed shortly in Ludwigsburg (collector field with a gross area of 14,800 m^2).

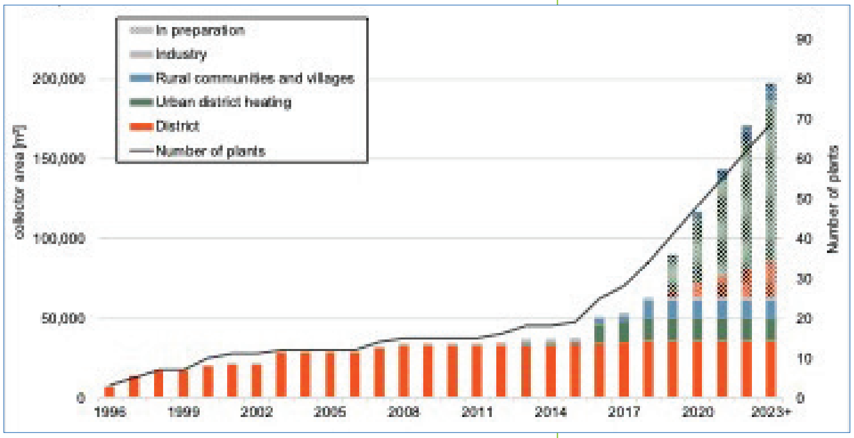


Figure 2. SDH market development in Germany (Source: Steinbeis Research Institute Solites)

Figure 2 shows that the integration of solar thermal into urban district heating represents about 75% of the newly installed capacity expected for the coming years.

District heating and solar thermal energy play an important role in the energy transition of the heat sector and not only in Germany. These positive developments should not hide the fact that this can only be the start. Compared to the objectives of the "Energieeffizienzstrategie Gebäude," the building sector strategy of the German Ministry for Economics and Energy, the present installation rates for solar district heating need to increase by a factor of 50! Without a doubt, this goal only can be reached if we convince more representatives of municipalities, heat supply enterprises and citizens of the benefits of solar district heating and if the policy framework requirements for renewable heat become more attractive.

To support this market, experts in IEA SHC Task 55: Towards the Integration of Large SHC Systems in DHC Networks are working to identify technical and economic requirements for the commercial introduction of solar district heating and cooling (DHC) in a broad range of countries. To learn what is happening in this project, visit http://task55.iea-shc.org.

SHC Publications

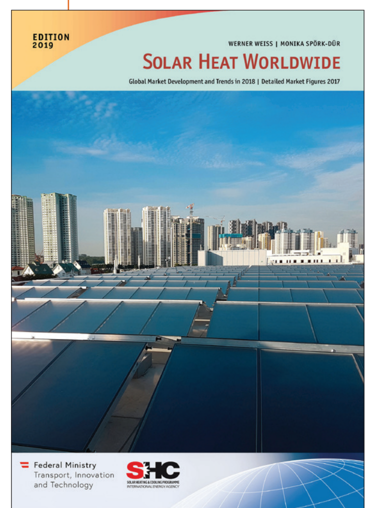
New Publications Online!

You won't want to miss the new reports highlighted below. You can read them online or download them for free. Our complete library of publications – online tools, databases and more – dating back to the start of the SHC Programme, can be found on the IEA SHC website under the tab "Publications and Databases" or under a specific Task.

SOLAR HEAT WORLDWIDE 2019

Global Market Development and Trends in 2018 / Detailed Market Figures 2017

This is the foremost report on the solar thermal market and trends. Data from 68 countries, or 95% of the solar market, provide the basis for this comprehensive annual report on solar heat. The report is divided into two parts: Part 1(Chapters 3-4) covers the global market development in 2018 and highlights trends for different applications – solar assisted district heating, solar heat for industrial processes, PV-Thermal systems, solar cooling and solar air heating and Part 2 (Chapters 5-8) presents detailed market figures for 2017, solar thermal system costs and the levelized cost of solar heat for different applications and regions worldwide.



NEW GENERATION SOLAR COOLING SYSTEMS

New reports from IEA SHC Task 53, our most recent Task on solar cooling are available for free download. Each report complements the Task's overall objective - to support the development of a strong and sustainable market for solar driven systems for both cooling (ambient and food conservation) and heating (ambient and domestic hot water).

- Technical report on simulations results and systems intercomparison
- Monitoring data analysis on technical issues & on performances
- Adapted Monitoring Procedure for the thermal side of New Generation Solar Heating & Cooling Systems
- Monitoring Procedure for Field Test & Demo Systems with Compression Heat Pumps Driven by Photovoltaic Solar Energy
- Technical report on system sizing and optimised control strategies
- LCA and techno-eco comparison between reference and new systems
- Technical report on components and system models validation
- Technical report on the reference conditions for modelling
- Report on a new and universal classification method "new generation solar cooling square view" for generic systems
- Technical report on best practices for energy storage including both efficiency and adaptability in solar cooling systems
- Catalogue of Selected Systems
- Definition of the existing cooling reference systems

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TASK HIGHLIGHTS

Looking for an overview of what IEA SHC has been working on? Look no further, every year the ongoing SHC Tasks highlight their main accomplishments for that year in short, informative reports.

TECHNOLOGY POSITION PAPERS

Solar Standards and Certification

This white paper outlines the relevance and importance of standardization and certification in the field of solar thermal products and the benefits of harmonizing standardization and certification at the international level.

Solar Heating and Cooling & Solar Air-Conditioning

This white paper provides relevant information to energy policymakers so that they can understand why and how solar cooling and air-conditioning (SAC) systems should be supported and promoted. It presents state of the art solar thermal and photovoltaic supported solar heating and cooling systems. In addition, it provides a comprehensive summary of the main findings as provided by the IEA SHC Task 53 work. This is the summary report, the full report can be downloaded from the Task webpage.

Daylighting of Non–Residential Buildings

This white paper provides an inside view for energy policy makers and decision makers in the private sector to understand why and how the targeted use of daylight in the built environment (non-residential buildings) should be supported and promoted.

IEA SHC programme

The International Energy Agency was formed in 1974 within the framework of the Organization for Economic Cooperation and Development (OECD) to implement a program of international energy cooperation among its member countries, including collaborative research, development and demonstration projects in new energy technologies. The members of the IEA Solar Heating and Cooling Agreement have initiated a total of 63 R&D projects (known as Tasks) to advance solar technologies for buildings and industry. The overall Programme is managed by an Executive Committee while the individual Tasks are led by Operating Agents.

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SOLARUPDATE

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by

KMGroup, USA

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