SOLARUPDATE

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Newsletter of the International Energy Agency Solar Heating and Cooling Programme

#SolarThermal
#SolarProcessHeat
#SolarCooling
#SolarDistrictHeating

In This Issue

IEA SHC Solar Award 2017

Austria's Climate and Energy Fund wins for large-scale solar thermal plant subsidy program

The Climate and Energy Fund challenged how subsidies are implemented. Its national support program for large-scale solar thermal plants in commercial applications is based on a 3-pronged approach – financial and technical support, quality assurance and communication. Mr. Ingmar Höbarth, Managing Director, received the award on behalf of the Climate and Energy Fund at SHC 2017, our International Conference on Solar Heating and Cooling for Buildings and Industry, held October 29 - November 2 in Abu Dhabi, UAE.

The **IEA SHC Solar Award** is given to an individual, company, or private/public institution that has shown outstanding leadership or achievements in the field of solar heating and cooling. With this year's award, the IEA SHC recognizes not only a government agency implementing a successful support scheme, but also a best practice for future policies in other countries. Accepting the award, Ingmar Höbarth remarked that "we are very proud that with this award IEA SHC is endorsing our support scheme. We are convinced that as a result even more companies will now opt for solar thermal technology and further countries will promote the thermal energy transition with similar support policies."

▲ **From left to right: Werner Weiss** (IEA SHC Austria rep.)**, Ken Guthrie** (IEA SHC Chairman)**, Ingmar Höbarth** (Climate and Energy Fund Managing Director)**, Gernot Wörther** (Climate and Energy Fund Project Manager)**, Doug McClenahan** (IEA SHC Award Chairman)

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> "This year's SHC Solar Award shines a light on a successful government solar thermal support scheme. The recipient, Climate and Energy Fund, understands the potential of large-scale solar plants for Austria's economy and has created an innovative subsidy program to support market expansion of large-scale solar thermal systems."
>
> KEN GUTHRIE
> *IEA SHC Chairman*

Impact of Support Program

Since the 2010 launch of the subsidy program on large-scale solar thermal plants in commercial applications, 161 large-scale solar thermal plants have been built for commercial applications. In total, these projects account for 60,061 m^2 of collectors (or about 42 MWth) and annually prevent the emission of 8,426 tons of CO2. The Climate and Energy Funds' subsidy budget is about 16.5 million Euros, resulting in an average subsidy of 39% per system. To better understand the operational behavior of the heat supply systems, 88 projects were selected for system monitoring for at least one year of operation, which includes data collection on the solar thermal system as well as on the integration of and interaction with the overall heat supply system. At this time, 37 projects have completed their monitoring, 13 projects are being monitored, and 38 projects are in the design and construction phase. The lessons learned thus far not only benefit the solar thermal industry as a whole, but also the individual system owners since the detailed system analysis helps them to identify, where possible, optimization potentials.

This subsidy program demonstrates that an innovative, multi-layered approach to support large-scale solar thermal plants for industry, district heating and cooling, and commercial buildings can support the market development of a technology with significant economic and energy potential. And as it is strongly linked to the key stakeholders, the widespread acceptance and success of the program will hopefully lead to its continued government support in the years to come.

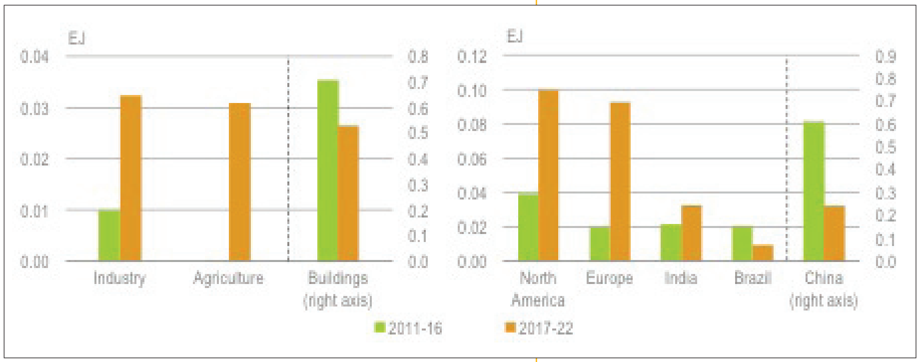
About the Austrian Climate and Energy Fund

The Austrian Climate and Energy Fund was established in 2007 by the federal government and is understood to be an impulse giver and innovation booster for sustainable energy and mobility technologies relevant to the climate. The Fund supports ideas, concepts and projects in the areas of research and development, market penetration and raising awareness.

Heat Decarbonization - What Role can Solar Thermal Play?

Heat accounts for more than half of global final energy consumption. However, heat production remains heavily fossil-fuel based and is a significant contributor to CO2 emissions, accounting for 39% of total annual energy-related emissions globally. To achieve the ambitious targets of the Paris climate change agreement, heat decarbonization is a must. But what role can solar thermal play?

The IEA's World Outlook 2016 (the 2017 edition was published in November) suggested that to help reach a 2 degrees climate target, solar thermal heat would have to see a massive increase of over 600% from 1.2 EJ today to 8.6 EJ in 2040. Most of the growth would have to be in buildings, with some increase also in industrial applications.



▲ **Figure 1: Net solar thermal consumption growth by sector (left) and by region (right), 2011-22**

Note: Data for buildings and China are plotted on the right axis due to their larger magnitudes. Source: IEA (2017), *Renewables 2017.*

Recent trends suggest that a rapid increase of solar thermal deployment in buildings is possible. Over the period 2008-15, solar thermal doubled from 0.5 EJ to 1.2 EJ, reaching 7% of renewable heat consumption in 2015. Most of the increase was driven by installations of solar water heaters in Chinese homes. Yet despite this increase, the pace of growth is actually slowing. In 2016, gross annual additions were down 9% compared to 2015, mostly due to a slow-down in China. However this trend overshadows those of other smaller market segments, which are experiencing stable growth such as larger systems for commercial hot water and heating, industrial process heat, and district heating.

The IEA's *2017 Renewable Market Report*, published on October 4, provides an outlook for solar thermal (and other renewable heat technologies) to 2022. We expect solar thermal energy consumption to increase by over a third globally, but the key Chinese market will grow at a slower pace than previously. This is due to the expectation of a continued decline in small domestic systems for hot water in China (see Figure 1). China has set an ambitious new solar thermal target in the 13th Fife Year Plan. However, the absence of robust support programmes, uncertainty over the pace of new housing development and questions over consumer preferences as living standards increase are likely to challenge the pace of deployment for small hot-water systems.

On the positive side, we expect accelerated growth in the industrial and agricultural sectors, driven by increasing cost-effectiveness of systems to supply process heat. Most of the growth is expected to be in applications where high heat demands that are currently met by fossil fuels coincide with good solar insulation, such as in India, which leads the growth in industrial solar thermal consumption over the next five years.

Overall though, the deployment levels needed to meet long term decarbonization goals are ambitious given the current barriers the sector faces. Key challenges include cost-effectiveness, technological performance (especially for higher temperature heat demand) and competition from other sources, including solar PV coupled with heat pumps.

The work of the IEA Solar Heating and Cooling Programme can make an important contribution to addressing some of these challenges, with current Tasks (research projects) on issues such as cost reductions, thermal storage, and new generation solar heating and cooling systems.

This article was contributed by Ute Collier, Senior Programme Leader of the IEA's Renewable Energy Division.

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Building Integrated Solar Envelope Systems

Hurdles and opportunities offered by the exploitation of the solar source through multifunctional envelope technologies

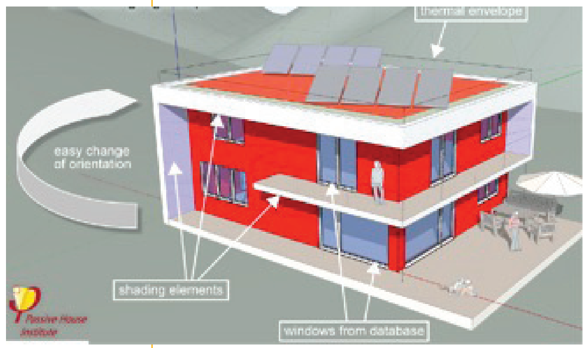
Making use of the solar source is key in highly energy efficient buildings both to limit thermal and lighting needs and to cover the residual demands by means of technologies exploiting a high share of renewable energy. However, this requires the careful design of the individual technologies and the planning of their integration into buildings as they may eventually result in complex systems to operate and maintain, and the thermal and visual comfort of the users may not be guaranteed. Moreover, different strategies can be competing against one another (e.g., glare control against minimization of space heating demand) and finding an optimal solution is not straightforward.

In the residential sector, solar thermal and PV systems are typically set up on building roofs with a limited attempt to incorporate them into the building envelope, creating aesthetic drawbacks and space availability problems. On the contrary, the use of facades is highly unexplored. Daylight control is delegated to the individuals' management of blinds and curtains, leading to high thermal loads both during mid-seasons and summer.

Dark Green SolarWall on the three walls of Bus garage in New York City
(Source: SolarWall)

In non-residential sectors (i.e., offices, schools, hospitals), the roof is again, most of the time, the only surface devoted to the installation of solar thermal and PV technologies. While daylight control nowadays is state of the art in terms of shading effect, the utilization of shading devices to also redirect natural light into the room, improving visual comfort at the same time, has still to be expanded. Moreover, when energy efficient technologies are installed together with traditional ones, frequently the first are just "added on top" of the main systems, thereby investment costs burst and performance is hardly optimized.

While taking advantage of the large areas of building façades with high solar irradiation is useful for electric and thermal conversion through PV and ST systems, the incoming irradiation could otherwise be exploited through extensive glazed surfaces, allowing for improved daylighting and passive solar heating. An interesting option to overcome these competing aspects is to combine multiple functions in integrated building envelope components, thus enabling these hybrid systems to use different aspects of solar energy simultaneously while guaranteeing envelope energy efficiency, users' comfort and architectural integration.



PHPP simulation environment
(Source: Passive House Institute)

IEA SHC Task 56 on Building Integrated Solar Envelope Systems for HVAC and Lighting focuses on the analysis of multifunctional envelopes that use or control incident solar energy in order to:

- deliver renewable thermal or/and electric energy to the systems providing heating, cooling and mechanical ventilation in buildings.
- reduce heating and cooling demands of buildings, while controlling daylighting.

The Task's scope is to prepare an overview of multifunctional solar envelope products and systems that are available or near to market, analyzing the conditions for their effective market penetration and discussing these factors with relevant stakeholders, such as technology

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Integrated Solar Envelope Systems *from page 4*

providers, consulting offices and architects. This is being accomplished through a number of different activities. On the one hand, by gathering relevant information on solar envelope systems in terms of energy performance, reliability and duration, architectural integration and costs. And on the other hand, assessing and categorizing tools available and opportunities offered by numerical simulation models and laboratory test methods for performance characterisation of solar envelope systems. Moreover, the barriers encountered by manufacturing companies, for example due to the large variability and inhomogeneity of construction standards among different countries, are evaluated and suggestions for improvement are being outlined.

The Task partners are also working to develop planning tools to use during the initial building design phase to easily predict technologies' performance when integrated in different building fabrics. To do this, partners simulate and monitor the interaction of the multifunctional solar envelopes with buildings heating, cooling and ventilation systems, and their impact on thermal and visual comfort. The lessons learned from this analysis will be used to elaborate simplified algorithms to be included in the planning tools.

Two partners are among others developers of DALEC (Day and Artificial Light with Energy Calculation) and PHPP (Passive House Planning Package). DALEC is a free online tool (www.dalec.net) supporting planners and architects to decide among different daylight and artificial lighting solutions in the early design phase. Based on the choices and climate data, daylighting and electric lighting are simulated in detail for a building while heating and cooling demands are calculated with a simplified approach based on standards. This allows an integrated evaluation of energy demands and visual and thermal comfort.

PHPP on the contrary, estimates the electricity demand for light and includes more thorough calculations in terms of space heating and cooling consumption by also taking into consideration the operation of heat pumps, solar thermal and PV panels.

Through the collaboration within SHC Task 56, it will be possible to add new simulation algorithms accounting for multifunctional components' performance.

Overall, SHC Task 56 work is devoted to supporting industry and consultancy with the market uptake and utilisation of multifunctional solar envelope systems. For this reason, the interaction with companies is of utmost importance. In addition to the cooperation within the Task activities, industry workshops are organised in conjunction with the Task's technical meetings. Here, invited companies present their technologies and projects in order to discuss in an open and collaborative environment the barriers and opportunities experienced when developing innovative building integrated solar envelope systems.

This article was contributed by Roberto Fedrizzi of EUREC and the SHC Task 56 Operating Agent, Ellika Cachat of Norwegian University of Science and Technology, Bärbel Epp of Solrico, Fabian Ochs of University Innsbruck, David Geisler-Moroder of Bartenbach, and Tomas Mikeska of Passiv Haus Institut. To learn more about SHC Task 56 visit http://task56.iea-shc.org/

1 **Webinar**
Advanced Lighting Solutions for Retrofitting Buildings
held on March 21, 2017

2 **Webinar**
Solar Heat for Industrial Processes
held on July 6, 2017

3 **Webinar**
Solar Energy in Urban Planning
held on September 13, 2017

4 **Webinar**
Energy Economy and Solar Heat –Perspectives and best practice
Held on December 14th, 2017. View here.

What role solar thermal will play in the energy sector in 2050 is one of the principal questions that the experts in IEA SHC Task 52 on Solar Heat and Energy Economics in Urban Environments intend to answer. This webinar will give information in two areas, one on energy scenarios about future development of energy systems and two on best practices, actual economy and planning tools for solar heat based urban energy concepts. Presenters: Sebastian Herkel of Fraunhofer Institute for Solar Energy Systems in Freiburg, Germany and IEA SHC Task 52 Operating Agent and Martin Joly of Sorane SA, a top Swiss company specializing in advanced building energy engineering.

INTERVIEW

Solar Energy in Urban Planning

Interview with Maria Wall

The IEA SHC Programme is finishing its work on Solar Energy in Urban Planning (Task 51). To learn first hand about the impact Task 51 has had in this field, we asked Maria Wall, the Task Operating Agent, a few questions as a teaser before next year's wrap-up article on the Task's results.

Why was this work needed?

Maria Wall (Maria): Urban planning rarely includes solar energy planning today. Traditionally, only daylighting and the "right to light" have been considered when planning urban areas. However, since electric lighting came into use in the 20th century even simple rules for harvesting daylight were forgotten. Today, we have access to active solar systems and daylighting strategies, but how to ensure solar access for buildings and urban areas for the long term is not clear. Work is needed to build up knowledge, to develop methods, tools and guidelines, and to improve education and knowledge transfer.

What were the benefits of doing this work thru the SHC Programme?

Maria: What you invest in time you get back multiplied. Plus we could learn from each and avoid making the same mistakes and could be inspired by what other countries are doing to overcome specific barriers. Also, working with an international team meant that the approaches, methods and tools we developed could be used in different municipalities and countries.

What, if any, result surprised you?

Maria: Maybe how effective the action research was in our different countries and municipalities. The cooperation with local actors really created a win-win situation.

What is the most important deliverable of the Task and why?

Maria: It is hard to say since the different deliverables were so interlinked. All the results are very important and most of them benefited from the Task's action research strucutre that relied heavily on case studies, which was the core of the Task.

Are any Task deliverables being used by end-users yet?

Maria: Yes, the Swedish city of Malmö has invited one of the developers of the LESO-QSV method, which supports municipalities with the process of defining suitable areas for solar integration and their acceptability levels. Maria Cristina Munari Probst of LESO-EPFL in Switzerland will help the city through the process so that it can make informed decisions when future building permits are handled and be pro-active in supporting solar integrations. This is a great example of the benefits of international collaboration.

How has your Task work supported capacity building?

Maria: Perhaps the most important way is through knowledge transfer to municipalities and other key actors. Task experts were involved in real planning situations, which were a way for all involved to learn, but also a way to disseminate Task results.

What is the current status of solar energy in urban planning?

Maria: Urban planning still seldom includes solar energy issues. Although many good examples of planning processes, methods and tools exist, planning rules in general treat sunlight as an amenity and not a sustainability issue. We need to keep working on overcoming barriers and making further developments! And, not forget that more education is needed in this area.

We also worked on solar landscape planning, which is an even less developed research field. I am sure this will be developed further in the near future as the number of large scale solar fields is continuing to grow.

What is the future of this field?

Maria: The work with solar planning has just begun, especially within the framework of sustainable cities and as part of the renewable energy push for the "right to light" for daylight and solar energy production. We will also see many more initiatives from municipalities and developers, which will increase the need for knowledge and support methods and tools. And then there is legal reform, which many countries will need to ensure solar access protection.

Will we see more work in this area in the SHC Programme?

Maria: Yes, definitely needed. As a matter of fact several SHC Task 51 participants are discussing ideas for a new SHC Task. However, we are careful to first focus on finalizing our work in Task 51!

Did the Task work on/support any standards?

Maria: No, but it could maybe be part of future work. New standards are being discussed in Europe and globally.

Reports and other information on SHC Task 51 can be found at http://task51.iea-shc.org/

Large Scale Solar Installations – The Actors & Activities

Industry and researchers are collaborating to assess how best to integrate large scale solar thermal installations in combination with hybrid technologies into district heating and cooling networks. Besides the international scope of this work, what also makes it unique is that the IEA SHC Programme has teamed up with the IEA District Heating and Cooling Programme to ensure that the right stakeholders are involved.

Looking closely at the contributing projects and listening to outside market information is vital to the success of *IEA SHC Task 55 on Towards the Integration of Large SHC Systems into District Heating and Cooling (DHC) Network*. Without the right team in place, any Task and its objectives can be challenged. Because of this, the leader of Task 55, Sabine Putz has connected the Task's core expert participants, their projects and stakeholders in four dynamic subtask teams. All actors involved have a commitment to their group and share the Task 55 vision of large scale solar thermal installations globally. The Task 55 expert meetings, such as the 3rd meeting held in Abu Dhabi on 27-28 October 2017 allow for open communication within the expert group.

Examples of current projects contributing to SHC Task 55, are heat portfolio, BiNe2, UrbanDHExtended, optENgrid, giga-TES, BIG SOLAR, NEWsdhSOL, ISORC, and a solar heating project from Tibet. The project UrbanDHExtended focuses on the development of innovative urban district heating systems by integrating long-term thermal storage, large scale heat pumps, large-scale solar thermal installations, waste heat recovery, and analysis and evaluation through simulation. The results of this project will provide templates for new urban district heating areas. The project from Tibet will provide an interim report about the vacuum tube solar heating collectors installed onsite at Sunrain's large scale solar seasonal thermal storage heating plant, which is the world's first high altitude project of its kind.

Many more projects have registered their contributions in Task 55 and were presented at the 3rd Expert Meeting in Abu Dhabi. Participants discussed case studies, such as "Solar District Heating Inspiration and Experiences from Denmark" in greater technical and economic details.

To learn more about SHC Task 55 visit http://task55.iea-shc.org/.

TASK 55 AREAS OF WORK

Subtask A: Network Analyses and Integration

Leader: Ralf-Roman Schmidt (AIT, Austria)

Investigating DHC network supply strategies and assessing the technical characteristics of existing, newly integrated and planned SDH and SDC systems, focusing on > 0,5MWth up to GWth.

Subtask B: Components Testing, System Monitoring and Quality Assurance

Leader: Jiao Qingtai (SUNRAIN, China)

Elaborating methods for hybrid elements in in-situ collector tests and for simple thermal power and energy performance proofs. Providing data on automated monitoring and failure detection software for key components and developing/describing control strategies and self-learning controls.

Subtask C: Design of the Solar Thermal System and of Hybrid Components

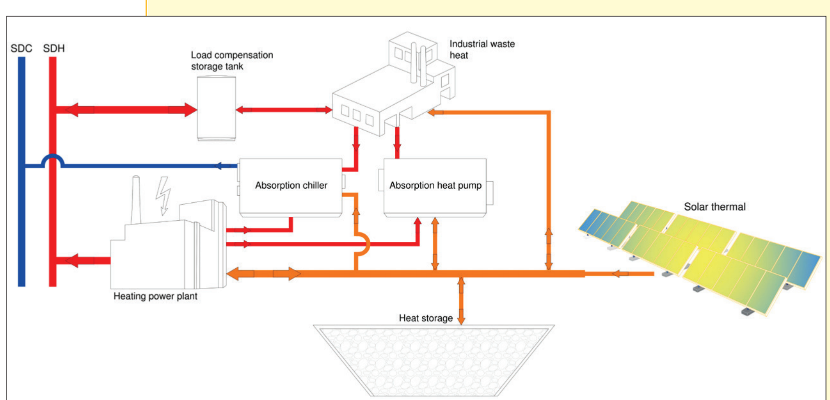
Leader: Jan-Erik Nielsen (PlanEnergi, Denmark)

Focusing on design of solar thermal systems and integration of hybrid technologies. Simulating and comparing large scale collector fields to the measurements of Subtask B. Calculating parameters of seasonal storages and working on guidelines for the design and construction of different storage types.

Subtask D: Economic Aspects and Promotion

Leader: Patricio Aguirre (TECNALIA, Spain)

Elaborating economic aspects to assist practitioners, architects, system designers and district heating providers in their efforts for the integration of DHC applications. Creating a database to collect information on different system and disseminating project results.



IEA SHC & ISES Hold "The" Solar Conference of 2017

The IEA SHC's International Conference on Solar Heating and Cooling for Buildings and the International Solar Energy Society's Solar World Congress were held jointly for the first time last month. This new partnership resulted in 2017's largest experts event on integrated solar solutions for buildings, industry, cities, regions and utilities with 500 participants from 50 countries and over 300 presentations.

His Excellency Thani bin Ahmed Al Zeyoudi, the UAE's Minister of Climate Change and Environment, provided a warm welcome to the international solar research experts, many who may play an important role in advancing the adaption of solar technologies to the dusty, often waterless Gulf region. The conference was hosted by Masdar Institute of Science and Technology.

Ken Guthrie, Chair of the IEA SHC Programme, and David Renné, President of ISES, emphasized that solar thermal's future lies in comprehensive system solutions and the need for all renewable technologies to work together to speed up the transition to 100% clean energy. This theme was carried throughout the technology sessions covering topics such as as seasonal storage, building integration, PV-Thermal systems, solar cooling, district heating, industry innovations, renewable cities and urban planning, and daylighting to name just a few.

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▲ **Opening ceremony of the joint SHC 2017 and SWC 2017 conference with welcome speeches from Ken Guthrie, Chair of IEA SHC, H.E. Thani bin Ahmed Al Zeyoudi, UAE's Minister of Climate Change and Environment, Steve Griffith, VP of Research at Masdar Institute of Science and Technology, and David Renné, President of ISES (from left to right).**
(Photo credit: Masdar Institute at Khalifa University of Science and Technology)

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2017 Conference *from page 8*

A Few Conference Highlights

Utility-scale solar heat plants push prices to record lows

Professor Klaus Vajen from the German University of Kassel had encouraging words for the research community, "We have reached the commercial stage in Denmark. This country in northern Europe has seen the installation of 110 solar district heating systems most of them without any direct subsidies." Denmark's large solar fields are delivering energy at or below 30 EUR/MWh, beating the 54 EUR/MWh price of gas-sourced heat – good news to spark renewed interest throughout Europe and China. And a feasibility study of a 350 MWth solar heat plant in the Austrian city of Graz found the average heat price, including seasonal storage, to be 35 EUR/MWh all year round, which is in line with the cost of energy from gas-fired boilers in the country.

Massive increase in solar heating and cooling support needed

The electrification of the heat sector prompted controversial discussions during several plenary sessions. Cédric Philibert, Senior Analyst in the IEA's Renewable Energy Division, warned that the 100% target was often misunderstood to mean a complete decarbonization of the power market. He emphasized that the most difficult sector to decarbonize will be the industrial one considering its 80% heat share is in energy consumption.

Meanwhile, residential PV-driven heat pump systems for hot water have become cost competitive because of low electricity prices in several countries. But electric heating would not have that much of an impact on the market, said Werner Weiss, Managing Director of the Austrian research institute AEE INTEC. He pointed out that heat consumption shows 6 times as much seasonal fluctuation when compared to electricity demand. An increase in power loads for space heating in winter would require expensive additional capacities.

The conference ended with an inspiring speech by Hans-Josef Fell, President of the Energy Watch Group. He emphasized that "Policymakers need to contemplate a massive increase in solar heating and cooling support to be able to meet renewable targets."

Mission Innovation Workshop

In parallel to the SHC 2017 conference, around 100 government representatives and solar experts met to identify key research fields in the five priority areas within Mission Innovation's Affordable Heating and Cooling of Buildings Innovation Challenge. The five priority areas are thermal energy storage, heat pumps, non-atmospheric heat >> sinks and sources, predictive maintenance and optimization, and physiological studies. The group then identified and discussed five further cross-cutting areas: heating and cooling data platforms, dynamic controls, non-air conditioned buildings, heat system integration, and non-technological issues.

Mission Innovation is a global initiative of 22 countries and the European Union that aims to double the investment in clean energy R&D in five years.

http://mission-innovation.net/

CONFERENCE ORGANIZERS

IEA Solar Heating and Cooling Programme
www.iea-shc.org
www.shc2017.org

International Solar Energy Society
www.ises.org
www.swc2017.org

Masdar Institute
https://www.masdar.ac.ae/

Solar Heat for Industry: Great Potential Ahead

Researchers in IEA SHC Task 49 on Solar Heat Integration in Industrial Processes have worked intensively across national borders to increase deployment of Solar Heat for Industrial Processes (SHIP), which is regarded as one of the most promising solar thermal applications. When SHC Task 49 was launched in 2012, there were reportedly around 120 SHIP systems adding up to 88 MWth. Over the last years, total installation figures have tripled to more than 500 systems and approximately 291 MWth globally.

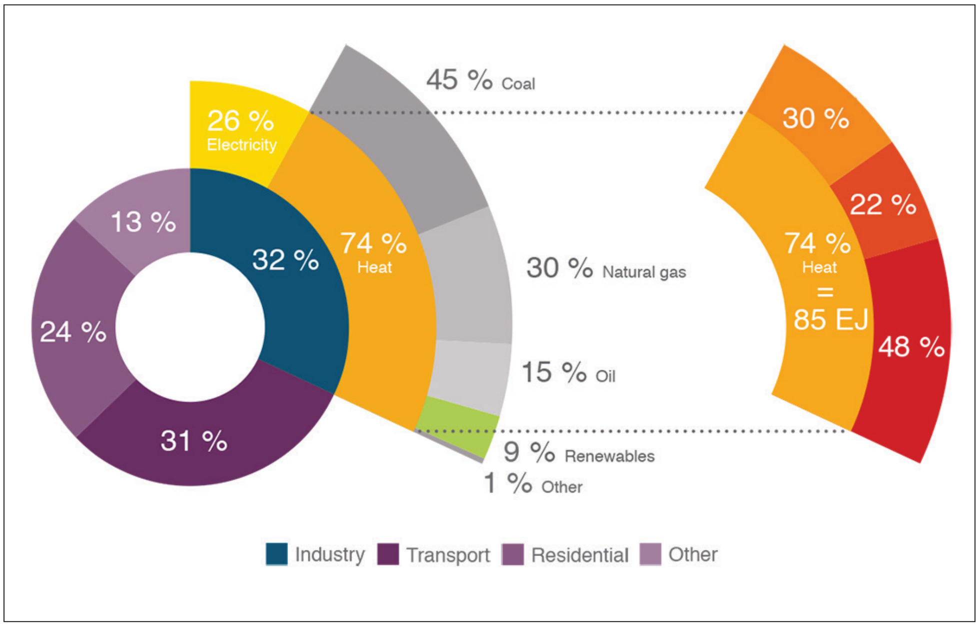

Figure 1. Total Final Energy Consumption 2014: 360 EJ (Exajoule). (Source: IEA/IRENA)

"There is more final energy consumption of heat in the industrial sector (85 exajoule (EJ) in 2014) than there is electricity consumed worldwide (71 EJ). Electricity, however, is talked about more," says Christoph Brunner, Operating Agent of SHC Task 49 and head of the Industrial Processes and Energy Systems department at AEE INTEC in Austria.

More than 50% of the industrial heat demand requires temperatures below 400°C and can therefore be supplied by solar thermal technologies. The most promising industrial sectors are listed in Figure 2 with their heat demand related to the year 2014.

The most visible outcome of SHC Task 49 is the online database of solar heat for industrial process (SHIP) plants (www.SHIP-Plants.info) with 253 projects from 37 countries. All installations include details on the systems engineering and economics. To quantify the technology's global opportunities, the SHC Task 49 experts analyzed the results of several national studies that had tried to determine the potential of solar process heat while considering restrictions, such as temperature range and the space available for the systems. "For Europe, where mainly non-concentrating collectors had been investigated, the percentage of technical potential for solar process heat related to the total industrial heat demand is around 3 to 4 %," concludes Brunner.

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Solar Heat for Industry *from page 10*

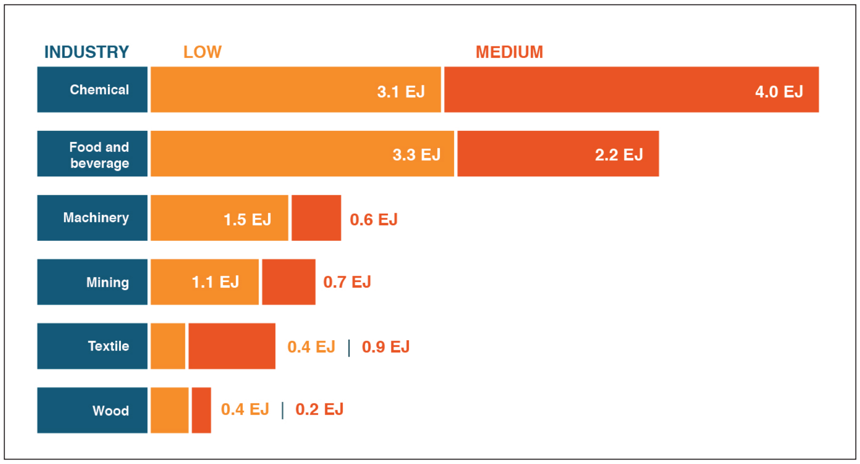


Figure 2. Total heat demand in 2014 for low and medium temperature SHIP applications. (Source: IRENA/IEA)

The International Renewable Energy Agency (IRENA) investigated an economically realisable SHIP potential of 1.3 to 2.2 EJ up to 200°C worldwide by 2030 covering up to 3.4% of the total process heat demand. A total collector area between 800 and 1,600 million m2 would be necessary to achieve this goal.

The IEA Technology Roadmap published in 2012 predicts a solar share of 20% in the temperature range below 120°C by 2050. An installed solar thermal capacity of 3,200 GWth or 4,500 million m2 of collector area could make this share a reality.

Despite the high potential for SHIP plants, the SHC Task 49 researchers agree that several technical and market challenges need to be tackled to combat low deployment rates:

- Design hybrid models with energy efficiency measures and other renewable energy sources (biomass, biogas, heat pumps) in mind;
- Up competitiveness by reducing the cost of technologies and devising new solar heat supply models;
- Develop industrial solutions as 'prosumers': connect with district heating networks and integrate waste heat recovery;
- Greatly step up communication efforts to raise awareness of SHIP among potential customers in industry;
- Implement measures for raising energy prices (e.g., carbon tax) or stipulating a renewable quota in certain industries.

This article was contributed by Bärbel Epp and www.solarthermlaworld.org. All graphics are from www.solarpayback.com. For more information visit the SHC Task 49 webpage at http://task49.iea-shc.org/.

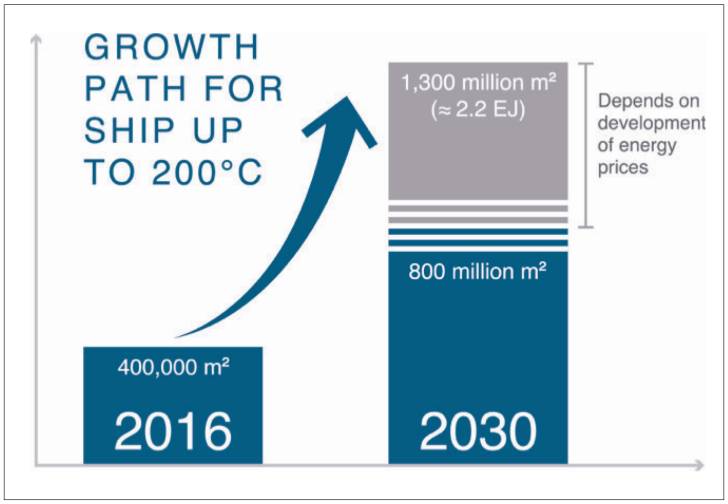


Figure 3. Growth path for SHIP up to 200°C. (Source: IRENA)

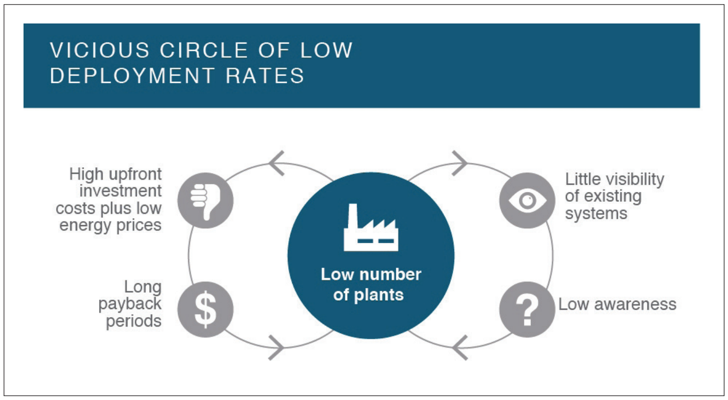


Figure 4. Challenges for SHIP deployment. (Source: Solar Payback)

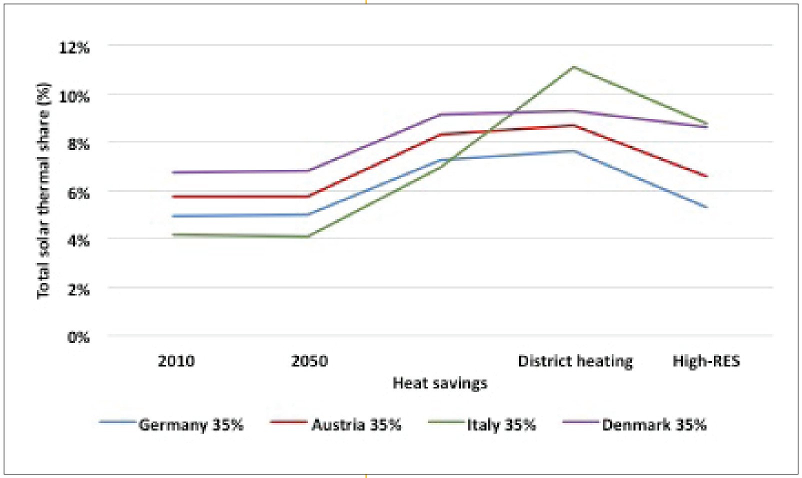
Is Solar Thermal a Viable Solution for a Future Renewable Energy System?

Solar thermal integration might in some situations be counter-beneficial for a renewable transition, especially when considering an energy system supplied by high shares of renewable energy. This is one of the conclusions from a study performed by Aalborg University as part of SHC Task 52 on Solar Heat and Energy Economics in Urban Environments. This conclusion was reached by performing a series of energy system analyses under various conditions of four national energy systems in Germany, Austria, Italy and Denmark. The solar thermal potentials were identified for each country today and in a future energy system converted to 100% renewable sources in the heating and electricity sectors. However, mixed results were found regarding the impacts on economy, environment and energy consumption when installing these solar thermal potentials.

A significant benefit of installing solar thermal is the reduction in fuel consumption for fuels such as biomass, which will be in high demand in future energy systems.

The Aalborg University study conducted for SHC Task 52: Solar Heat and Energy Economics in Urban Environments concluded that solar thermal has a role to play in a future energy system by 1) easing the pressure on scarce resources, 2) supplying heat where no alternative heating sources are available, and 3) contributing to enhancing energy security through local energy production.

These conclusions were formed based on the results of an analysis of the solar thermal potentials in each national energy system under various conditions. These systems include a current energy system (2010), a future business-as-usual energy system as projected by the European Commission (2050), a system with reduced heat demands due to building retrofits (Heat savings), and a scenario with significant expansions of the district heating systems in each country (District heating). Furthermore, a final scenario was developed supplied by 100% renewable sources in the heating and electricity sectors (High-RES). Secondly, the societal impacts of installing the solar thermal potentials were quantified for the same scenarios. Because of the societal focus no taxes, subsidies or similar incentives were included in the study and the costs included are investments, operation and maintenance, fuels, CO2, and energy exchange while applying an interest rate of 3%. These scenarios were developed using the hour-by-hour EnergyPLAN energy system analysis tool, which has been used in more than 100 research articles. The solar thermal projects analyzed were plants for single-family houses supplying both hot water and space heating and solar thermal plants for district heating systems with short-term storages.



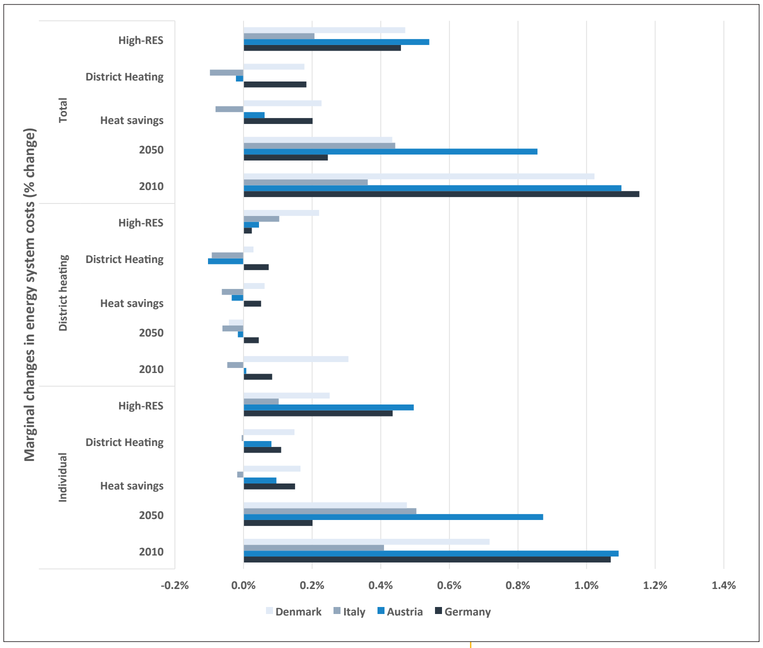
▲ **Figure 1. The technical solar thermal potentials for each national energy system under the assumption that 35% of all heat consumers are supplied by a solar thermal plant in the building or in a district heating network. The solar thermal share is a measure of the solar thermal supply out of the total heat supply.** (Source: Aalborg University)

The results showed that the maximum solar thermal potential in a national system is in the range of 3-12% of the total heat supply. This potential is influenced by the energy system configurations and the number of buildings connected to the solar thermal supply, either directly in the building or via a district heating network. These findings are depicted in Figure 1, which shows the variations in solar thermal potential depending on the energy system configurations. The solar thermal share increases after implementing heat savings and expansions of district heating networks, although the annual solar generation decreases due to a lower heat demand. The solar thermal potentials could increase to 6-12% when half the consumers are connected to a

continued on page 13

Solar Thermal *from page 12*

solar thermal plant while a 20% connection rate results in a solar thermal potential of 3-6%. These shares correspond to collector areas of 37-175 million m2 in Germany, 6-16 million m2 in Austria, 23-69 million m2 in Italy, and 4-14 million m2 in Denmark.



▲ **Figure 2. The change in energy system costs for each national energy system when installing the maximum solar thermal potentials. The change in energy system costs is a comparison to a system with no solar thermal plants installed.** (Source: Aalborg University)

The economic impact of installing these solar thermal potentials is illustrated in Figure 2, which shows that the costs increase when installing the solar thermal potentials directly in individual buildings whereas the costs in some cases either reduce or increase in district heating networks. When installing both of these types an overall additional cost is expected of up to 1% compared to installing no solar thermal (for Germany this equals an extra cost of almost 5 billion /year). This highlights the importance of the type of solar thermal plant and in which part of the energy system solar thermal is installed. In the high renewable scenario, the costs increase for all solar thermal types and energy systems because of the competition with other renewable sources that might provide the same heating for lower costs (e.g., geothermal, excess industrial heating, heat pumps). Installing solar thermal could therefore increase the total energy system costs, but this is highly impacted by the energy system configuration. Extreme cost reductions of up to 65% compared to current costs are necessary for solar thermal potentials in the individual buildings to become cost-neutral within the energy system.

Some of the heating sources in a future high-renewable energy system, as the one designed in the study, provide constant base-load generation thereby allowing less room for fluctuating renewables such as solar thermal. Similarly, the advantages of solar thermal reduce in terms of reductions of fossil fuels and CO2-emissions when transitioning towards a high-renewable energy system as the technologies replaced will also be renewable sources. Solar thermal might therefore end up competing with other renewable resources in the energy system.

A significant benefit of installing solar thermal is the reduction in fuel consumption for fuels such as biomass, which will be in high demand in future energy systems. The study proved that the entire energy system biomass consumption can be reduced by 0-2% when installing the solar thermal potentials, and this share increases if only the reductions within the electricity and heating sectors are considered. Solar thermal should therefore contribute to replacing combustion technologies such as biomass boilers, especially when no other renewable technologies are available.

The overall conclusions are rather similar across the various national energy systems, despite the significant differences in terms of energy system configurations, climate, and energy resources and demands. This verifies that the findings might be applied to diverse countries, and also countries not directly investigated in the study.

Factors such as lower temperatures in district heating networks, seasonal district heating storages in combination with solar thermal, solar thermal for cooling, and industrial purposes could improve the solar thermal potential and feasibility.

The implications of the study are that long-term planning is required for installing solar thermal. Solar thermal will be part of the future energy systems, but should be carefully investigated for its impact on the entire energy system and the technologies that are replaced. Solar thermal has a role to play by reducing local demands for biomass, which can instead be used in the transport or industrial sectors. The transition towards a 100% renewable energy system is challenging and a variety of energy sources are necessary, including solar thermal technologies.

This article was contributed by SHC Task 52 experts, Prof. Brian Vad Mathiesen and PhD Fellow Kenneth of Aalborg University, Denmark. Additional information can be found here on Task 52, University of Aalborg, Sustainable Energy Planning Group: or www.EnergyPLAN.eu

SHC Publications

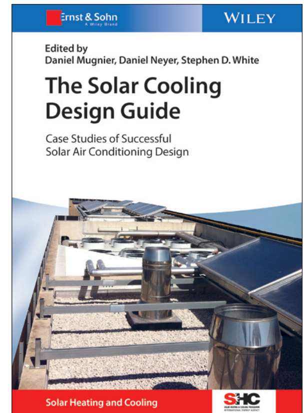
Highlights from 2017

In case you missed reading, using and referencing our reports, here are a few published this year. All our publications can be found on the IEA SHC website under the tab "Publications and Online Tools" or under a specific Task.

New Generation Solar Heating and Cooling

The Solar Cooling Design Guide

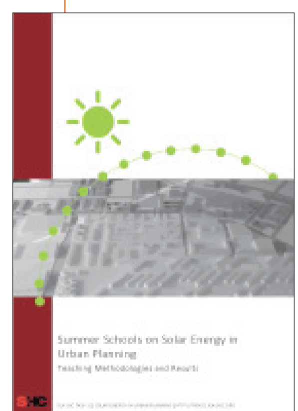
Published in November 2017, this is the newest addition to the SHC Book Series. This book is a compendium of case studies of successful solar air conditioning designs with over 100 illustrations in its 132 pages. It is intended to be a companion book to the "Solar Cooling Handbook: A Guide to Solar Assisted Cooling and Dehumidification Processes" published by IEA SHC Task 48: Quality Assurance & Support Measures for Solar Cooling Systems (see http://task48.iea-shc.org/publications for more information). You can order a print or e-book from http://www.wiley.com/WileyCDA/ or Amazon.



Solar Energy in Urban Planning

Summer Schools on Solar Energy in Urban Planning Teaching Methodologies and Results

Describes an interdisciplinary summer school on solar energy in urban planning. Teaching methodologies and results are from the September 2016 summer school "City in Transformation" in Berlin-Adlershof, Germany and are an example of successful collaboration between teaching, research and practice, to serve as inspiration and encouragement for educators.

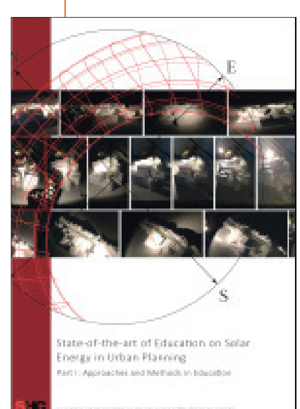


Illustrative Prospective of Solar Energy in Urban Planning: Collection of International Case Studies

Presents 34 case studies from 10 countries on solar energy in urban planning addressing how the planning process has been developed, how the stakeholders have been involved, which instruments have been applied, which energy technology and environmental impacts have been addressed, and what the role was of the researchers during the entire process. The case studies examples of new urban areas, existing urban areas and landscapes.

State-of-the-Art of Education on Solar Energy in Urban Planning: Part I: Approaches and Methods in Education

Focuses on education in order to strengthen the knowledge and competence of relevant stakeholders in solar energy in urban planning. The core of this study is to create substantial links between research and education as well as between research and practice. Knowledge gaps in current education were investigated, reasons for these gaps were identified and solutions and strategies are proposed to overcome these shortcomings.



Net Zero Energy Buildings

Solution Sets for Net Zero Energy Buildings

The first book to evaluate building strategies in houses, educational buildings and offices that have been demonstrated to work in practice. It examines how the design challenges of climate and building type have been addressed, and to what extent the various design approaches have been successful in hot and cold climates. You can order a print or e-book from http://www.wiley.com/WileyCDA/ or Amazon.

Solar Heat Worldwide 2017

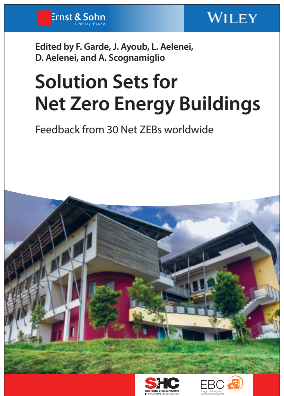
Global Market Development and Trends in 2016 / Detailed Market Figures 2015

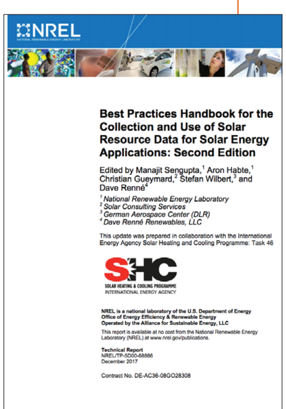
Annual report on the solar thermal capacity installed and trends in the important markets worldwide. Collectors covered are unglazed collectors, glazed flat-plate collectors (FPC) and evacuated tube collectors (ETC) with water as the energy carrier as well as glazed and unglazed air collectors.

Solar Resource Assessment and Forecasting

Best Practices Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications: Second Edition

Drawing from 10 years of international collaboration, this publication covers all pertinent aspects of solar radiation, which are relevant for the planning and operation of solar thermal heating and cooling systems, as well as for concentrating solar thermal and PV plants. Project developers, engineering procurement construction firms, utility companies, system operators, energy suppliers, financial investors, organizations involved in planning and managing solar research programs, and others involved in solar energy systems planning and development will find this handbook to be a valuable resource.





INFO SHEETS
Price Reduction of Solar Thermal Systems

New Info Sheets are added often. Click here to see the complete list.

Reference System, Austria Conventional heating system for single-family house

INFO Sheet A02 • Describes the reference conventional system for domestic hot water preparation and space heating in a single-family house in Austria. The system is modeled with TSol to calculate the fuel consumption and electric energy needed to provide the required domestic hot water and space heating.

Reference System, Austria Solar domestic hot water system for single-family house

INFO Sheet A04 • Describes the reference solar domestic hot water (SDHW) system for domestic hot water preparation in a single-family house in Austria. The system is modeled with TSol to calculate the fuel consumption and electric energy, as well as the substituted fuel provided by the SDHW system, which are needed to provide the required domestic hot water and space heating.

Reference System, Germany Solar domestic hot water system for single-family house

INFO Sheet A08 • Describes the reference solar domestic hot water (SDHW) system in Germany. The system is modeled with TRNSYS to calculate the fuel consumption and electric energy needed to provide the required domestic hot water as well as the substituted fuel provided by the SDHW system

Reference System, Austria Conventional heating system for multi-family house

INFO Sheet A03 • Describes the reference conventional system for domestic hot water preparation and space heating in a multi--family house in Austria. The system is modeled with TSol to calculate the fuel consumption and electric energy needed to provide the required domestic hot water and space heating.

Reference System, Austria Solar domestic hot water system for multi-family house

INFO Sheet A06 • Describes the reference solar domestic hot water (SDHW) system for domestic hot water preparation in a multi-family house (MFH) in Austria. The system is modeled with TSol to calculate the fuel consumption and electric energy, as well as the substituted fuel provided by the SDHW system, which are needed to provide the required domestic hot water and space heating.

Reference System, Germany Conventional heating system for single-family house

INFO Sheet A07 • Describes the conventional reference system for domestic hot water preparation and space heating in single-family houses in Germany. The system is modeled with TRNSYS to calculate the fuel consumption and electric energy needed to provide the required domestic hot water and space heating.

Reference System, Germany Solar Combisystem for single-family house

INFO Sheet A09 • Describes the reference solar combisystem for domestic hot water preparation and space heating in single-family houses in Germany. The system is modeled with TRNSYS to calculate the fuel consumption and electric energy needed to provide the required domestic hot water and space heating as well as the substituted fuel provided by the combisystem.

Reference System, Switzerland Solar domestic hot water system for multi-family house

INFO Sheet A11 • Describes a Swiss reference solar domestic hot water (SDHW) system for multi-family houses that uses a gas burner as auxiliary. The system is modeled in the simulation software Polysun with template No. 8a that was adapted for a larger heat demand of a multi-family house.

Reference System, Denmark Solar domestic hot water system for single-family house

INFO Sheet A12 • This info sheet gives information on a reference solar domestic hot water system for Denmark.

LCOH for Solar Thermal Applications - Guideline for levelized cost of heat (LCOH) calculations for solar thermal applications

INFO Sheet A01 • Details the methodology used to calculate the levelized cost of the heat substituted by solar thermal energy and the concept to estimate the cost of the heat generated by the entire solar assisted heating system, or the conventional sources of heat supply.

Two New Tasks to Start in 2018!

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PVT Systems: Application of PVT collectors and new solutions in HVAC systems

This Task will focus on the application of PVT collectors with the aim to assess existing solutions and to develop new system solution principles in which the PVT technology really offers advantages over the classical "side by side installations" of solar thermal collectors and PV modules. Energy production, competitive cost, safety and reliability of systems are therefore in the scope of the Task. The objectives of the Task are to:

1. Provide an overview on the present (2018-2020) state-of-the-art of the PVT technology worldwide.
2. Gather the results and the operating experience made with the systems in which PVT collectors are integrated.
3. Improve the testing, modeling and adequate technical characterization of PVT collectors in order to enhance (and simplify) the correct inclusion of the PVT technology in simulation programs and planning tools.
4. Address all types of PVT collectors since the current markets have made no clear choices.
5. Find more typical PVT solutions beside the two applications which are well known, i. e. regeneration of bore-hole storages and pre-heating of DHW for multi-family houses.
6. Explore potential cost reductions in the balance of systems, i.e. piping technology and materials, hydraulics, controls etc.
7. Increase awareness of PVT.
8. Support the re-start of the PVT industry.

For more information contact Jean-Christophe Hadorn of Solar energy & strategies, jchadorn@gmail.com

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Integrated Solutions for Daylighting and Electric Lighting: From component to user centered system efficiency

This Task will foster the integration of daylight and electric lighting solutions to the benefits of higher user satisfaction and at the same time energy savings. The objectives of the Task are to:

1. Review the relation between user perspective (needs/acceptance) and energy in the emerging age of "smart and connected lighting" for a relevant repertory of buildings.
2. Consolidate findings in use cases and "personas" reflecting the behaviour of typical users.
3. Provide recommendations for energy regulations and building performance certificates based on a review of specifications concerning lighting quality, non-visual effects as well as ease of design, installation and use.
4. Assess and increase robustness of integrated daylight and electric lighting approaches technically, ecologically and economically.
5. Demonstrate and verify or reject concepts in lab studies and real use cases based on performance validation protocols.
6. Develop integral photometric, user comfort and energy rating models (spectral, hourly) as pre-normative work linked to relevant bodies: CIE, CEN, ISO. Initialize standardization.
7. Provide decision and design guidelines incorporating virtual reality sessions. Integrate approaches into wide spread lighting design software.
8. Combine competencies: Bring companies from electric lighting and façade together in workshops and specific projects. Support allocation of added value of integrated solutions in the market.

For more information contact Jan de Boer of Fraunhofer Institute for Building Physics, jan.deboer@ibp.fraunhofer.de

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 61 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.

Follow IEA SHC on

SOLARUPDATE

The Newsletter of the IEA Solar Heating and Cooling Programme

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Prepared for the IEA Solar Heating and Cooling Executive Committee

by

KMGroup, USA

Editor:
Pamela Murphy

This newsletter is intended to provide information to its readers on the activities of the IEA Solar Heating and Cooling Programme. Its contents do not necessarily reflect the viewpoints or policies of the International Energy Agency or its member countries, the IEA Solar Heating and Cooling Programme members or the participating researchers.

www.iea-shc.org

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