Three days for solar thermal
and 30 minutes against it

SHC 2012 provided an opportunity for an international exchange of ideas.

Photos(3): IEA SHC

At the beginning of July, experts from all over the world met in San Francisco at the inaugural International Conference on Solar Heating and Cooling, SHC 2012. There they were able to discuss their latest research findings and the state of technology. Only one refused to tow the line.

What is the output achieved by solar collectors in Lebanon? What sort of operating results are provided by China's largest solar thermal cooling system in Hainan? What are the prospects for new materials used for long-term storage systems in central Europe? Throughout the world, engineers and scientists in research institutes and companies are working on improving the efficiency of solar thermal systems and, using innovative processes, making solar thermal fit for new applications. From 9 to 11 July, they were able to discuss their experiences and findings at the 1st International Conference on Solar Heating and Cooling, SHC 2012, which was held in San Francisco as part of the International Energy Agency's IEA SHC Programme.

Although in terms of numbers the event offered a relatively modest programme across the three days with 230 presentations, it was nevertheless notable in terms of its diversity. For example, the delegates not only presented collectors for medium temperature applications and developments for seasonally storing solar thermal energy but also dealt with the planning process for process heating systems, discussed the monitoring results for district heating plants and investigated energy efficient building concepts. The IEA SHC chair, Werner Weiss, is convinced that solar thermal technologies have a bright future and will significantly contribute to a future energy system based on renewable energies. He believes the conference will provide an important step in making this change happen.

Case for cheap photovoltaics

However, one person did not share this optimism. On the second day of the conference, Professor Norbert Fisch from Braunschweig University used the 30 minutes of his lecture on solar advanced buildings to explain to the listeners why the word solar in his lecture title refers to photovoltaics. He said that it is now so cheap that in Germany you can even afford to install it on the north-facing roofs of buildings. "In the past the focus was on lowering the energy consumption in buildings and using renewable energies for the rest. However, the low costs of photovoltaics means that this no longer applies." Instead, the question is now how much insulation is required to be competitive with solar electricity. He then showed the astonished delegates his own home, which completely eliminates the need for solar thermal energy. Instead solar modules supply the energy for a heat pump. "My home is supplied with one hundred percent electricity," confirmed Fisch.

Conference Chair Stephen Harrison from Queen's University in Kingston, Canada, was left speechless and also told the delegates so after the presentation. Fisch, who from the end of the 1970s was mostly involved during the next twenty years in developing

solar thermal projects at the University of Stuttgart's Institute for Thermodynamics and Thermal Engineering (ITW), had already caused a sensation on the first day. Following a presentation on solar thermal cooling systems, he advised the young researchers to think about using photovoltaics instead. He said that solar thermal did not have any future for this application. He apologised for his comments, however, at the beginning of his 30-minute lecture. The organisers were fortunate that, following his presentation, the next person on the lecture list was Jan Erik Nielsen from the Danish consultancy company, Plan Energi. By using examples from his homeland he was able to demonstrate that solar thermal does not have to be expensive, whereby he believes that it is better to have collector arrays that are too large than too small.

Examples of cheap solar thermal energy

For example, the heat produced from the several-thousand-square-metre solar thermal plants that 29 Danish local communities have installed in meadows to feed their district heating networks costs between 0.03 and 0.06 €/kWh. It is therefore no surprise that several of them are planning to extend their collector arrays and others are planning to start supplying heat with solar thermal energy. A total of 27 construction projects are currently being planned, which cover plant sizes of up to 37.8 MW (54,000 m²). Nielsen, who manages IEA-SHC Task 45 as its Operating Agent, says the low thermal prices can be put down to the low interest rate, cheap collector arrays and the low cost of land in the countryside. In addition, the plants used have simple system designs. "No hocus-pocus," he said.

Nielsen advocates the use of larger plants: "It also seems cost effective to go for higher solar fractions and long-term storage. Therefore make it big." The use of water pits with improved geometry as

Professor Norbert Fisch (left) had a lot to discuss following his lecture on heating with solar power.

The "master.system" from Sun Master includes all necessary heating components and can be very simply mounted on almost any roof

seasonal storage tanks, which would be cheap and simple to use because they are only sealed above, would only cost 20 €/m³. In addition, large-scale plants can also be used for "intelligent solar heating networks" that enable the daily electricity price fluctuations to be used economically.

They work as follows: during the summer months the solar collectors provide sufficient energy to supply the district heating network and charge the thermal storage system. From September they can support a wood-fired boiler that simultaneously generates electricity via an ORC turbine. When the electricity prices in the liberalised Danish energy market increase in winter, an intelligent aspect of the system is its ability to earn additional money through the cogeneration while providing cheap heat. If the electricity prices are low, cheap heat can be produced using a heat pump. In February the solar thermal systems can start heating the thermal storage system again.

The town of Marstal on the island of Ærø is realising such a system at the moment, whereby the town intends to almost double the existing solar thermal output of its heating network, which amounts to 12.9 MW (18,365 m²). From 2014 it is planned that the solar collectors will provide 55 % of the required heat. The operating company, Marstal District Heating, expects a heating price of 0.078 €/kWh. The project, which is called Sunstore 4, will also produce electricity at a cost of 0.10 €/kWh.

Trend towards large-scale systems

The fact that solar thermal does not have to be limited to residential buildings is shown not just by the examples from Denmark. Weiss already pointed out during his introductory lecture that "solar thermal systems have reached the megawatt scale." He referred, for example, to the world's largest solar thermal plant in Saudi Arabia with a capacity of 25 MW (36,000 m²). In Singapore, a huge solar cooling plant with a cooling capacity of 1.6 MW and powered by 3,900 m² of flat plate collectors has also been installed in 2011. The largest solar process heat applications to be connected to dyeing and weaving mills are installed in China: an initial plant producing 9.1 MW (13,000 m²) was constructed in the province of Zhejiang at Shaoxing Dyeing and Weaving Mill in Hangzhou. Meanwhile another two projects, each comprising 10.5 MW (15,000 m²), have been commissioned in the neighbouring province of Jiangsu.

However, the projects in China should not obscure the fact that solar heat for industrial processes is currently still at an early stage of development. Less than 100 operating solar thermal systems for process heat were reported worldwide in 2009, with a total capacity of about 24 MW (34,000 m²). "So far, most of these systems are experimental in nature and relatively small in scale," explained Christoph Brunner from the Austrian Institute for Sustainable Technologies (AEE INTEC). He pointed out, however, that there is considerable potential for market and technological developments, since 28 % of the overall energy demand in the EU27 countries originates in the industrial sector and the majority of this consists of heat below 250 °C. This has been established by IEA-SHC Task 49 and Christoph Brunner, its Operating Agent. In several specific industry sectors, such as beverages and food, pulp and paper, machinery and textiles, the share of heat demand at low and medium temperatures below 250 °C is around 60 %.

"Tapping into this potential would provide a significant solar contribution to industrial energy requirements," said Brunner. He believes, however, that this requires a three-stage approach. Firstly, the processes need to be technologically optimised to lower the process temperature with increased heat

The delegates had sufficient time between the presentations to explain the results from their research projects on posters.

and mass transfer, whereby the solar thermal systems need to be optimised in regards to integration schemes and safety issues. Secondly, systems need to be optimised to enhance the energy efficiency and, thirdly, the solar thermal energy needs to be integrated.

The lack of marketable collectors should no longer be an obstacle for solar process heat. "Many advanced collectors are available that are optimised for specific temperature ranges for process heat applications," said Werner Platzer from the Fraunhofer Institute for Solar Energy Systems in Germany. He was originally planning to just present products in his lecture. However, he said that there are now too many. Instead he presented different types of solar collectors such as advanced flat plate collectors, CPCs, vacuum tube collectors, troughs and Fresnel collectors along with their characteristic features. Nevertheless, there is still a lot that needs to be done in this area by IEA-SHC Task 49, since until now it has not been really possible to compare the performance of the different types. "Barriers on the collector side include a lack of certified products, comparable performance data and models for evaluating the performance," explained Platzer.

Further storage research required

Referring to the importance of thermal storage systems, German scientist Barbara Mette from ITW said that "the challenge is not only the energy production but the energy storage." In her lecture she provided an overview of the worldwide research work being conducted on long-term thermochemical storage systems. Teams from the AEE in Austria, the Energy Research Centre of the Netherlands, the INSA de Lyon in France, the ITW in Germany, the Swiss Federal Laboratories for Materials Testing and Research, and the University of Minnesota in the US have developed and tested system designs using different storage materials.

According to Mette, the work shows that long-term heat storage is a realistic and sustainable technology for the future. "Energy storage densities more than four times greater than those for water storage systems have already been demonstrated in pilot plants," she said, describing the current state of the technology. However, in order to transform the developments into marketable products, further research is required in the field of material development and system integration. In particular, there is still scope for improvement in terms of the energy storage density and the thermal and mechanical stability of the storage materials. "In addition, pilot plants operating under realistic boundary conditions need to be set up and monitored with the aim of answering questions regarding the installation, maintenance and operating reliability."

Therefore despite the technological progress made in recent years, research institutes and companies still have enough work to do in creating new applications for solar thermal energy. This means that the working groups in the IEA SHC programme should also be able to present interesting findings from their joint work next year. The conference will then be held in conjunction with the European Solar Thermal Industry Federation (ESTIF) in Freiburg, which will be home ground for the organisers of PSE AG. Without them the conference in San Francisco would not have occurred, since the financial risk for the event rested solely on their shoulders. It is to be hoped that they will focus entirely on solar thermal during the three days of the next SHC conference.

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Further information:
www.shc2012.org, www.iea-shc.org