SOLARUPDATE VOL.55 | JANUARY 2012

Newsletter of the International Energy Agency Solar Heating and Cooling Programme

SHC 2012 CONFERENCE

JULY 9-11
SAN FRANCISCO

International Conference on Solar Heating and Cooling for Buildings and Industry

CONFERENCE ABSTRACTS
Due January 31

"SHC 2012 is the first of this new series of annual scientific conferences on solar thermal," explains IEA SHC chairman Werner Weiss." We invite all scientists and researchers as well as market and policy specialists to present and discuss their work. This will be a conference nobody in the solar heating and cooling industry can afford to miss!"

The worldwide capacity of solar collectors already stands at 200 GWth and installation numbers are growing in countries around the world. Solar heat is used to prepare domestic hot water, to heat buildings, and in industrial processes. It is also fed into district heating networks and used for air conditioning and other cooling applications.

While only 19% of the world's energy usage is electricity, this sector usually draws all the public attention. But 53% of all energy is used for heating and cooling purposes. The SHC 2012 conference puts the spotlight on the fastest growing technology in this sector – solar thermal energy.

SHC 2012 provides a platform to discuss the latest advancements in solar heating and cooling technologies. A Scientific Committee, headed by Professor Jane Davidson of the University of Minnesota, USA and Dr. Stephen Harrison of Queen's University will assure the quality of the papers presented at the conference.

The conference is supported by the International Solar Energy Society (ISES), the European Solar Thermal Industry Federation (ESTIF), the IEA Energy Conservation through Energy Storage (IEA ECES), and the California Solar Energy Industries Association (CALSEIA).

SHC 2012 will take place the same week as Intersolar North America thus creating a multidimensional experience for participants.

CONFERENCE TOPICS

- **Solar thermal collectors**
- **Thermal Storage**
- **Innovative components**
- **Solar heating and air-conditioning of buildings**
- **Solar heat for industrial processes**
- **District heating**
- **Solar cooling and refrigeration**
- **Building integration**
- **Solar building renovation**
- **Solar architecture**
- **Solar resource assessment**
- **Rating and certification**
- **Market strategies**
- **Policy issues**

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SHC Member Countries

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In This Issue

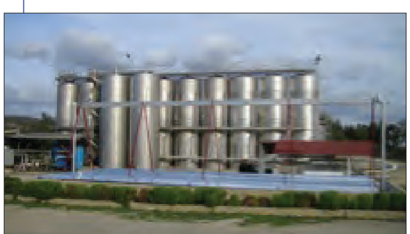
Solar Cooling – What's Next?

The first in a series of SHC Position Papers produced by the SHC Programme, this paper presents the status of solar cooling technology and outlines what is needed in the areas of R&D and market stimulation. The full Solar Cooling Position Paper is available on the SHC website.

The fast growing demand for cooling and air conditioning has led to a dramatic increase in peak electricity demand in many countries. Blackouts and brownouts in summer have frequently been attributed to the large number of conventional air conditioning systems running on electric energy. The increasing use of compressor cooling machines furthermore leads to increased emissions of greenhouse gas emissions, such as HFCs, which are used as cooling liquid inside the compressor machines.

An obvious possibility to counter this trend is to use the same energy that is responsible for the cooling demand—solar energy. The distinct advantage of cooling based on solar energy is the high coincidence of solar irradiation and cooling demand—the use of air conditioning is highest when solar irradiation [could you use sunlight since audience is policy makers?] is abundantly available. This coincidence leads to a low or even no need for energy storage, as the cooling produced from solar energy is immediately used.

While many people think of photovoltaic systems in combination with conventional compressor cooling machines as the most obvious solar option, the alternative option of using solar thermal systems in combination with thermally driven chillers is now a market ready technology.



▲ **Solar cooling installation at a winery in Tunisia.**

Technology

Thermally-driven chillers have been available for over 100 years. However, they were designed for rather large cooling capacities (>100kW) and high temperatures (>90 °C). Thus, their main use was in industrial applications, especially in using excess heat from other processes (including CHP plants). These large cooling machines were not suitable for use with low-temperature heat from typical solar thermal collectors, and they did not work well with the fluctuating temperatures provided by solar thermal systems. In recent years, numerous thermally-driven chillers have entered the market to work at lower temperatures and cooling capacities.

Markets

More than 1,000 cooling systems based on solar thermal collectors and thermally-driven chillers have been installed in recent years. And the interest in these products continues to increase. This is most evident where solar thermal collectors can be used for cooling in summer and for heating in winter. As high prices for (peak) electricity and frequent electricity outages become the norm the attractiveness of solar thermally driven cooling systems will continue to grow.

Technical Barriers

The components for solar thermally driven cooling have reached a sufficient level of maturity and the main technical problems today lie at the system level—proper design and energy management of the systems. In many cases, earlier systems were designed too complex thus creating non-optimal control and high maintenance needs.

At the component level, further R&D could lead to higher efficiencies and lower costs. Of particular interest are:

- cooling machines that can be integrated in the solar collectors, thus reducing system complexity and energy losses,
- double-effect absorption chillers to achieve higher efficiencies at higher temperatures,
- single-axis tracking solar thermal collectors for temperatures between 150 – 250°C to drive double- and triple-effect chillers, and

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SHC 2012 CONFERENCE JULY 9-11 SAN FRANCISCO
International Conference on Solar Heating and Cooling for Buildings and Industry

Conference *from page 1*

CONFERENCE ABSTRACTS
Due January 31

Important Dates

- **Notification of Abstract Acceptance: March 15**
- **Early Bird Registration: June 15**
- **Full Paper Due: June 25**
- **Conference: July 9 - 11**

CONFERENCE NEWS

Conference proceedings to be published in ELSEVIER's *Energy Procedia*

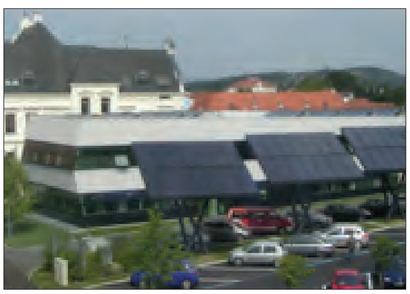
ELSEVIER will publish the SHC 2012 Conference proceedings in their renowned Energy Procedia. This collaboration will provide optimum visibility of the SHC 2012 proceedings and ensure that the authors' publications remain traceable and citable. Final online papers will contain linked references, XML versions and DOI numbers. All papers published in Energy Procedia will also be covered by Scopus and will be accessible on sciencedirect.com.

Select conference papers to be published in Solar Energy Journal

A selection of high quality papers from the SHC 2012 proceedings will be published in Elsevier's peer reviewed Solar Energy Journal, the most renowned peer reviewed journal devoted exclusively to the science and technology of solar energy applications and the official journal of the International Solar Energy Society.

To stay abreast of SHC 2012 developments go to **www.shc2012.org**

Solar Cooling *from page 2*



▲ **Solar heating and cooling installation at the Town Hall in Gleisdorf, Austria (304 m² flat plate collectors connected to 35 kW Yazaki chiller WFC 10 and a desiccant evaporative cooling system).**

- standard (non-tracking) solar thermal collectors to have higher efficiencies at temperatures between 80–150°C and reduced costs.

Non-Technical Barriers

As for most renewable energy options, the initial investment costs are significantly higher than those of conventional cooling solutions. Even where the investments pay off in just a few years, many consumers and decision makers chose the conventional option and its lower investment costs. Furthermore, the awareness and know-how of involved professionals (planners, installers) remains insufficient. Most of them have no experience and no training in solar thermally driven cooling systems thus creating a barrier for growth of this technology either by not actively marketing the technology or by poor quality planning or installations, thus reducing system efficiencies and increasing cost to the consumers.

Solutions & Recommendations

Both, public and private R&D efforts are needed to further improve solar thermally driven cooling at the system level. Research and development should focus on pre-engineered systems for the smaller capacity range, which minimize planning efforts and the possibility for installation errors. In solar heating systems, such pre-assembly has already led to better quality installations and is contributing to efforts leading to overall lower installation costs. Furthermore, a focus on quality procedures for design, commissioning, monitoring and maintaining solar cooling systems is needed to develop a sustainable market for solar thermally driven cooling technologies. Developing guidelines and planning tools as well as offering training courses to involved professionals are concrete examples of steps to be taken.

Solar cooling helps shave costly peak loads in the electricity grid, reduce conventional energy consumption, and avoid GHG emissions from compressor cooling machines. Therefore, governments should help solar cooling enter the market with financial support. Regardless of the concrete support scheme (e.g., direct grants, tax incentives), it is most important to avoid stop-and-go support, which usually hurts the market more than it helps. Stability of the support framework should have a high priority and it thus makes sense to seek funding sources outside of public budgets.

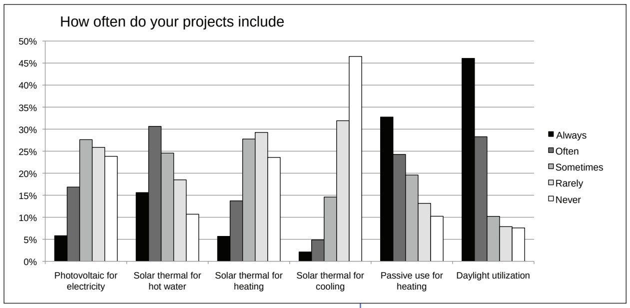
Building regulations prescribing minimum energy efficiencies should cover not only heating, but also cooling. Cooling solutions based on renewable energies, such as solar cooling, is then an option to achieve the required efficiencies.

Architects Need Solar Design Tools

The SHC Programme's work on Solar Energy and Architecture is a three-year project that involves more than 45 researchers, academics, professionals and graduate students from 14 countries (Australia, Austria, Belgium, Canada, Denmark, Germany, Italy, Norway, Portugal, South Korea, Singapore, Spain, Sweden and Switzerland). The ultimate goals of the project are to make architecture a driving force for the use of solar energy in buildings, to instigate high-quality, inspiring architecture that utilizes active and passive solar strategies, to identify obstacles that architects are facing in the implementation of these strategies, and to improve their qualifications and interactions with engineers, manufacturers and clients.

Methods and Tools

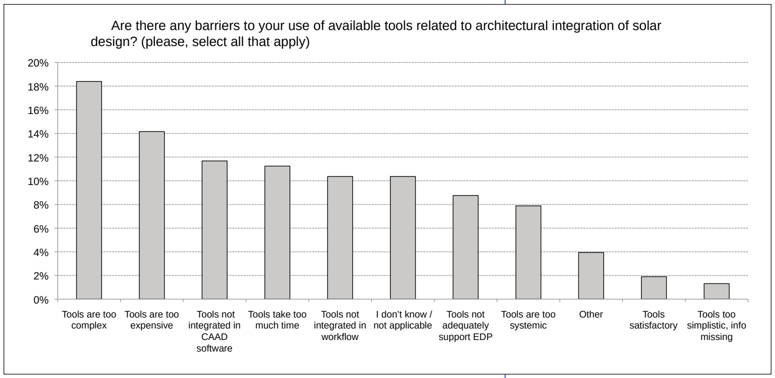
Of the 49 current and completed Tasks under the umbrella of the IEA SHC Programme, this is the first one to address the issues of solar energy use in buildings purely from the architects' point of view. This is important research because up to 80% of all design decisions that influence a building's energy performance, such as form (shape), orientation, façade design, materials, glazing, etc. are made during the early design stage, by architects. True integration of both passive strategies and active solar technologies can successfully be achieved only if they are dealt with from the earliest stages of the design process—a conceptual design stage done by architects. The question is, however, whether architects have the right tools to do it.



▲ **Figure 1. Distribution of answers for question on the occurrence of solar energy systems used, for all countries (n=325 to 342).**

The first step in this journey was to investigate and present a landscape of digital tools predominantly used by architects around the world for various stages of their design process. The review, presented in the Task's report State of the Art of Digital Tools Used by Architects for Solar Design, describes 56 software tools, grouped in three categories—CAAD tools (23), Visualization tools (13) and Simulation tools (20). In general, the review shows that most tools are better suited for the detailed design stage rather than for the early design phase, and that the vast majority of them have limited ability to deal with various aspects of solar design.

The next stage of the project was to identify the obstacles that architects are facing when implementing solar strategies in their designs. In order to do so, two international surveys were conducted concurrently in 2010; one related to architectural integration of solar energy systems and the other to methods and tools for solar design. Both surveys were developed jointly by experts from all the Task's participating countries and then translated into 10 languages. The response rates were lower than hoped for due to a variety of reasons, such as uneven funding from country to country and the ability to actively distribute the surveys to broader audiences. Nevertheless, the responses still provide good indications of the general needs and obstacles that architects interested in actively utilizing solar strategies in their design are facing in different countries. These findings were affirmed by a literature review of similar studies done in the past.



▲ **Figure 2. Distribution of answers about barriers related to the use of the tools for the architectural integration of solar design. (n=685).**

The survey on methods and tools intended to find out if and how existing design methods and design tools are suitable for the successful utilization of both active and passive solar strategies during the early design phase. The respondents were predominantly architects (89%), with more than 10 years of practice (72%), working in firms of various sizes and on variety of projects, predominantly within their own country (70%). Although 82% of the respondents declared the use of solar energy important, the breakdown shows that for

continued on page 5

Architects *from page 4*

many this meant primarily daylighting and passive heating while active strategies were less predominant (see Figure 1).

Concerning design methods, results indicate that in the majority of cases, architects handle solar integration by themselves. In some cases in the early design phase, they may consult a colleague architect with specific experience, a building science specialist or a solar energy consultant. Results also show that respondents use mostly an Integrated Design Process, which means that respondents are involved in multidisciplinary teams with other professionals, such as engineers and experts. They also use an intuitive design process which refers to their own experiences. Lastly, an energy-oriented design method is used, which indicates that the interest in solar energy utilization is real. Described design methods were used more often than the use of several propositions to evaluate possibilities, interactions with future users of the building, rules of thumb, and expert systems architecture. Identified barriers include claims that current methods are unsystematic, do not support decision-making processes in a satisfactory manner, and do not much improve one's knowledge of solar technologies.

"Architects recognize the importance of solar energy in buildings, but often find it difficult to include solar strategies in their designs due to a lack of standardized software to use during the early design stage of a project."

MARIA WALL
Task 41 Operating Agent

Challenges and Insights

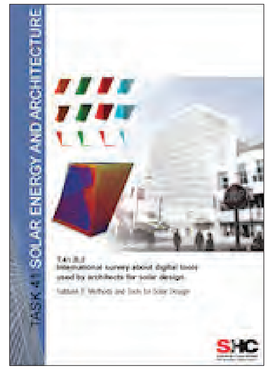
Challenges regarding digital tools identified by the survey include insufficient skills in solar or energy simulation tools, commonly held perceptions that these tools are too complex, expensive and time-consuming, poor integration into CAAD software, or simply not suitable for the early design stage (see Figure 2). Additionally, the results show that tools need to be simpler, that the interoperability between software needs to be improved, that tools should provide key data about solar energy aspects as well as explicit feedback to the architect. Finally, tools need better visualisation especially for active solar energy systems, as visualisation is one of the key components in convincing clients and client's advisors to utilize active solar systems in a project.

This Task has yielded important insights about how to improve the digital tools architects use to make it easier to integrate solar installations into building designs. To help architects identify and choose suitable tools and methods for solar design (active, passive and daylighting), Task experts are preparing an Architects' Guide on Tools for Solar Design. This resource will help architects evaluate design options, improve communications with clients and clients' advisors, and improve collaboration with engineers and solar consultants during the detailed design phase of the project. Task researchers also are initiating a dialogue with tool developers to share with them the needs for digital tools as this was strongly expressed by architects in the surveys.

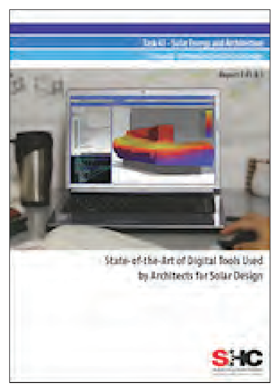
Next Steps

The final stage of this work will be the dissemination of findings through seminars in collaboration with local and national professional associations and with universities. These public events, using the results of this Task, will help to increase the awareness and accessibility of solar strategies and to instigate better and innovative architectural designs. Seminars in Austria, Norway, Sweden and Switzerland have already started, while in other countries they will begin in the coming months.

This article was contributed by Maria Wall of Lund University, Sweden and SHC Task 41 Operating Agent, maria.wall@ebd.lth.se, Miljana Horvat of Ryerson University, Canada, mhorvat@ryerson.ca, and Marie-Claude Dubois of Université Laval, Canada, marie-claude.dubois@arc.ulaval.ca. For more information and upcoming seminars visit the SHC Task 41 webpage.



▲ **International Survey about Digital Tools used by Architects for Solar Design**
A summary of the survey conducted by professionals in 14 countries. The report points out that there is a high awareness of the importance of solar energy use in buildings, but that a number of barriers exist that are preventing the widespread application of digital tools during the design process. The results of the survey will be used to develop guidelines for both professionals and software tool developers.



▲ **State-of-the-Art of Digital Tools Used by Architects for Solar Design**
Fifty-six widely used digital tools are reviewed and classified into three categories 1) CAAD (computer-aided architectural design), 2) visualization, and 3) simulation tools. With a focus on the early design phase, readers are able to analyze the current software landscape for building projects.

Solar Cooling

new work

The demand for air-conditioning is rapidly increasing, especially in developing countries. And the potential for solar cooling to meet this demand is immense. The results of past IEA SHC work in this field (most recently, SHC Task 38: Solar Air-Conditioning and Refrigeration) have demonstrated the technology's potential for building air-conditioning, particularly in sunny regions, and identified work needed to achieve economically competitive systems that provide solid long-term energy performance and reliability.

To meet these challenges, a new SHC Task entitled "Quality Assurance and Support Measures for Solar Cooling" started in October 2011.

"Solar cooling sector is now facing a decisive challenge: technically mature, this technology must become cost competitive and standardized so as to keep on developing. Thanks to Task 48 and its ambitious work plan, the IEA framework provides a unique opportunity to assist the industry sector in this way."

DANIEL MUGNIER
Task 48 Operating Agent

SHC Work

Finding solutions to make solar thermally driven heating and cooling systems at the same time efficient, reliable and cost competitive is the goal of the new SHC Task 48: Quality Assurance and Support Measures for Solar Cooling. These three major targets should be reached thanks to four levels of activities:

1) Development of tools and procedures to characterize the main components of Solar Air-Conditioning systems.

2) Creation of a practical and unified procedure, adapted to specific best technical configurations.

3) Development of three quality requirements targets—prescriptive and performance based.

4) Production of tools to promote Solar Thermally Driven Cooling and Heating systems.

The scope of the work covers technologies for the production of cold water or conditioned air by means of solar heat, that is, starting with the solar radiation reaching the collector and ending with the chilled water and/or conditioned air transferred to the application. Although the distribution system, the building, and the interaction of both with the technical equipment are not the main topic of the Task this interaction will be considered where necessary.

The Task is divided into four subtasks:

Quality Procedure on Component Level. This subtask concentrates on developing tools to show the level of quality of the most critical components of the solar cooling and heating system. These components are mainly the chiller, the heat rejection device, the pumps, and the solar collectors.

Quality Procedure on System Level. This subtask concentrates on developing tools to show the level of quality of the solar cooling and heating systems. To achieve this goal, a procedure will be developed to extend the quality characteristics from a component level to a system level. In a second step, an extension of the procedure from a single stationnary state to a performance prediction over a year will be developed. Thus Subtask B is closely linked to subtask A and its results.

Market Support Measures. The work within this subtask will create a panel of measures to support the market. These measures will use the results of Subtasks A and B, and above all, explore the possibilities to identify, rate, and verify the quality and performance of solar cooling solutions. The resulting tools are intended to provide a framework that will enable policy makers

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New Generation of Solar Cooling Systems

The largest solar cooling installation is in Singapore at the United World College. This installation, commissoned the end of 2011, includes:

- $3{,}900 m^2$ of solar collectors (Gluatmugl HT double glazing) on three roofs,
- a 420-ton (1.5 MW cooling capacity) BROAD absorption chiller,
- and a $60 m^3$ storage tank.

The customer pays an equivalent rate as that of the Singapore District Cooling system (capacity, energy). Also, the customer made no initial payment & customer payments cover the loan for this solar cooling + domestic hot water system.

For more information contact S.O.L.I.D. Solarinstallation und Design GmbH, Graz, Austria, Tel: +43 316 292840-0, e-mail: office@solid.at

MarketPlace

New Work *from page 6*

to craft suitable interventions (for example, certificates, label and contracting, etc.) that will support solar cooling on a level playing field with other renewable energy technologies. Even if the completion of these tools is not quickly achieved, the subtask should be able to initiate all and maybe complete some of them.

Dissemination and Policy Advice. The work in this subtask covers horizontal activities related to Subtasks A, B, and C. The objectives of this subtask are the implementation of targeted promotion activities based on the collective work results, the production of dissemination material for external communication, the implementation of knowledge transfer measures towards the technical stakeholders, the development of instruments and their provision for policy makers, and the creation and promotion of certification and standardization schemes.

The first reports from this work will be available the end of 2012.

Countries currently collaborating in the Task are Australia, Austria, Canada, Belgium, France, Germany, Italy, Singapore, South Africa, Spain, and the USA.

For more information contact the Operating Agent, Daniel Mugnier of TECSOL (www.tecsol.fr), daniel.mugnier@tecsol.fr or visit the SHC Task 48 webpage.

Canadian Community Stores Summer's Solar Heat for the Winter

This year's prestigious Energy Globe Award was awarded to a solar heating and cooling project in Alberta, Canada. The Drake Landing Solar Community achieves to cover 80% of the heat demand with solar thermal energy. Former IEA SHC chairman Doug McClenahan was personally involved in the project development and proudly accepted the award at a gala ceremony in Wels, Austria.

"A park that is used for heat storage!" rejoiced the jury of the Energy Globe Award. Fifty-two homes of the Drake Landing Solar Community in Okotoks, Alberta (Canada) are profiting from an ingenious system where heat from the summer sun is stored below the surface of the earth. In winter it is used to meet 80% of the community's entire energy needs.

This solar heating system is part of a larger research project of SHC Task 45: Large Solar Heating/Cooling Systems, Seasonal Storage, Heat Pumps that is working to support the fast growing market for solar district heating systems with research. Already today, large solar thermal systems can be competitive with conventional energy solutions. The world leader in such systems, Denmark, experienced a doubling of this market in 2011 – without any subsidies.

"We are thrilled to receive the Energy Globe Award. We knew we had built a great renewable heating system, able to save most of the energy our community would otherwise have to buy from non-renewable sources. We hope that the Energy Globe Award for this project will help make it a showcase for others to see what is possible already today."

DOUG McCLENAHAN
Former IEA SHC Chairman

The Drake Landing Solar Community (DLSC) shows the extent to which solar heat can be used even at higher latitudes. But before the system could be completed, there was a lot of drilling to be done: 144 boreholes were drilled up to 37 metres deep into the ground. During the summer, 800 solar collectors heat up a glycol-and-water mixture kept in this system of underground heating tubes – to store heat for the winter. The area is now overgrown by a beautiful park. DLSC is en route to achieving its target of 90 percent in the year 2012 and a reduction of five tons of greenhouse gas emissions per home per year.

Solar and Heat Pump Systems

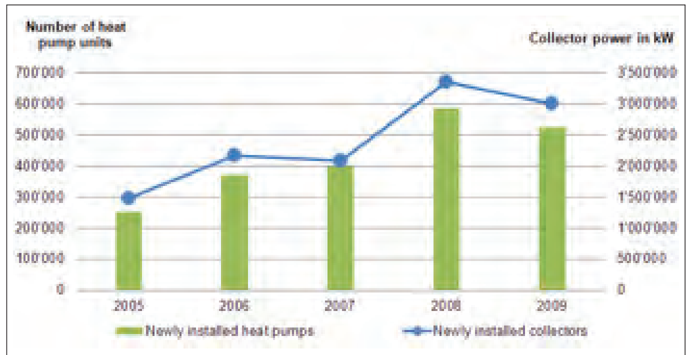
The IEA SHC Programme and the IEA Heat Pump Programme are jointly assessing the performance of combined systems using solar thermal and heat pumps. To begin the work, a survey of systems sold in the participating countries was conducted–90 different systems were identified! Since European countries are dominant in this new market segment, it is anticipated that about 120 combinations are on the market worldwide.

Survey results show that most systems are used for the combined production of domestic hot water and space heating. Approximately 25% of the systems use air as the only source for the heat pump, 25% use the ground, and nearly 50% of the systems are multi source. Almost 75% of the systems are feeding hot water storage in parallel while the other have more integrated hydraulic schemes.

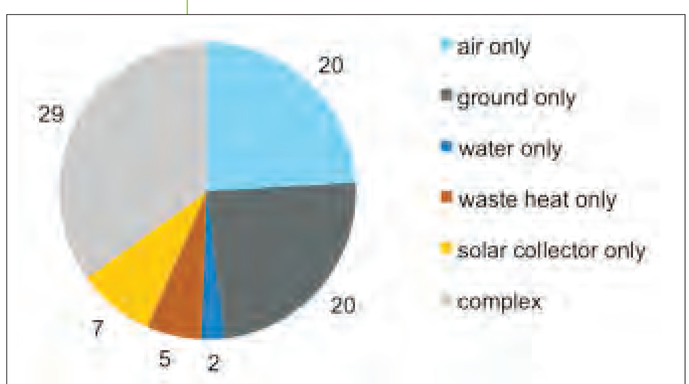
As far as the heat source for the heat pump is concerned, Figure 2 shows that air and ground heat sources dominate the market together with so called "complex" sources where more than one source is used (often air and solar on the evaporator side or ground coupled heat pump with some injection of solar heat in the borehole).

For more information on this survey and SHC Task 44 visit the SHC Task 44 webpage.

SOLAR + HEAT PUMP



▲ **Figure 1. Market development of solar collectors** *(EU27+CH, data from ESTIF)* **and heat pumps** *(AT, CH, DE, FI, FR, IT, NO, SE, and UK, data from EHPA www.ehpa.org).*



▲ **Figure 2. Solar and heat pump systems reviewed by Task 44 by source of energy for the heat pump.**

Solar Heat for Industrial Processes

new work

Approximately 30% of the world's industrial heat demand requires temperatures below 100°C, and 57% requires temperatures below 400°C. The importance of this breakdown is that the heat demand below 100°C could theoretically be met with solar thermal systems using current technologies once systems are suitably integrated, and the heat demand up to 400°C could be met as technologies continue to develop In various industrial sectors—food, wine and beverages, transport equipment, machinery, textiles, pulp and paper. In this higher temperature range, 60% of the heat demand requires low and medium temperatures (below 250°C) so tapping this potential would provide a significant solar contribution to industrial energy requirements.

Despite this potential, the use of solar thermal energy in the industrial sector is insignificant compared to other applications. Approximately 200 solar thermal plants are installed worldwide at industrial sites, equalling a total installed capacity of 42 MWth (60,000 m2) or an average installation of 210 kWth (300 m2). Moving this technology into the market is critical so in 2012 the SHC Programme will begin new work in this area.

SHC Work

Over the last two years, the awareness of solar process heat for industry has grown and new systems installed. This positive development now needs to be supported with further research and development in the key research areas of solar process heat. For this reason, the SHC Programme, in collaboration with SolarPACES, initiated Task 49/IV Solar Process Heat for Production and Advanced Application. Over the next four years, participants will work in three areas:

Process Heat Collectors. This subtask will focus on:

- Improving solar process heat collectors and collector loop components.
- Providing a basis for the comparison of collectors with respect to technical and economical conditions.
- Giving comprehensive recommendations for standardized testing procedures.

Process Integration and Process Intensification Combined with Solar Process Heat. This subtask is tasked with:

- Improving solar thermal system integration for production processes using advanced heat integration and storage management, advanced methodology for decisions on integration place and integration types.
- Working to increase the potential of solar process heat by combining process intensification and solar thermal systems and fostering new applications for solar (thermal/UV) technologies.

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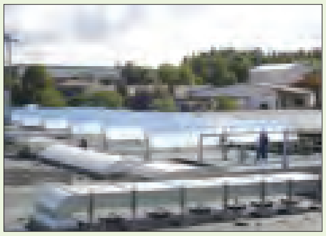
P3 - Pilot Plant for Solar Process Steam Generation in parabolic trough collectors for indirect steam supply via existing steam distribution



▲ **P3 Pilot Plant at Alanod in Ennepetal, Germany**
Source: DLR

This first of its kind pilot project at Alanod Aluminium-Veredelung GmbH & CO. KG in Germany demonstrates the use of parabolic trough collectors for process heat generation. In most industries, steam networks are used for the heat supply to the industrial processes. At P3 a solar steam generator was integrated into the production facility so that process steam could be generated directly by the absorbers of the parabolic trough collectors and then fed into the existing steam line. The main benefits of this direct feed are time and cost savings during the installation phase. This project has shown that the addition of a solar energy system is comparatively easy and does not require a complex control system. Key attributes of the system are:

- Utilisation of existing infrastructure
  - Steam Distribution
  - Condensate return
  - Feedwater treatment
- Simple back-up control
- High security of supply
- Increase of potential solar share
- Improved solar capacity factor
- Reduced storage requirement
- Collector Field: 108 m^2
- Saturated Steam at 4 bar, 143°C

▲ **Flat plate collectors used to produce solar heat for soft drink production in Arizona, USA.**

Saudi Arabia Builds World's Largest Solar Thermal System

In July 2011, the largest solar thermal system (25 MWth) was commissioned in Riyadh, Saudi Arabia by Millennium Energy Industries. This milestone provides a boost to large-scale solar supported district heating systems and solar heating and cooling applications in the commercial and industry sectors worldwide. Now the Middle East joins Europe and China on the growing list of large-scale solar thermal success stories.

Project Details

North of Riyadh, the Princess Noura Bint Abdulrahman University for Women campus covers a total area of 8 km^2 and has the capacity for 40,000 female students, lecturers and university personnel. The campus includes 15 different colleges, a hospital, a hotel, and all other necessary infrastructure for living, working and studying.

To supply hot water and space heating, a solar supported district heating network was installed. Oil-fired boilers with a peak load capacity of 70 MWth together with a 25 MWth (36,305 m^2) solar thermal system cover the heat demand. During the summer, the thermal load of the district heating network is calculated to be 30 MWth.

Solar Thermal System Details

The entire solar thermal collector area of 36,305 m^2 is installed on the flat roof of a large warehouse. The prevailing share of the solar thermal generated heat is directly fed into the district heating grid, however, during times of high solar radiation and low demand for hot water the excess heat can also be stored in tanks with a total capacity of 900 m^3.

This system was engineered to withstand the arid environment and provide high performance, including overheat and safety management provisions. A critical task before construction began was to find a supplier of solar thermal collectors that could cope with the special technical and climatic requirements of this unique project. On the one hand, the economic performance was critical, but also of importance were the technical requirements of the system. In addition to high thermal efficiency of the solar thermal collectors, it had to be possible to hydraulically connect a large number of solar thermal collectors with minimum piping effort and for both the solar thermal collectors and the steel support construction on the roof to withstand sandstorms reaching speeds up to 100 miles per hour.

A large-scale flat plate collector was specially adapted for the use in such large-scale solar thermal applications by the Austrian manufacturer GREENoneTEC together with AEE-Institute for Sustainable Technologies (AEE INTEC) also from Austria

The special hydraulic design of the flat plate collector, specifically the meander type absorber, enables simple parallel connections of long collector rows. Up to 110 m^2 of serial connected collectors (11 pieces) can be put together in parallel connections if the supply and return line are Tichelmann connected to the field (same hydraulic length for both the supply and the return line). If they are not connected in this way then only up to 80 m^2 (8 pieces) are possible.

The flow distribution within parallel absorber pipes was defined as a critical indicator during the design phase. Within the above-mentioned defined limits, the maximum ratio between the highest and the lowest possible velocity in the absorber pipes is 1.5.

▲ **Figure 1. Overview of the university's 36,305 m^2 roof mounted solar thermal collector field on a huge warehouse.** (Source: Millennium Energy Industries)

▲ **Figure 2. Sectional view of the roof mounted solar thermal collector field showing the solar thermal collectors including the steel support construction and the piping for the solar primary loop. In the background is the skyline of the university campus.** (Source: AEE INTEC)

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Due to this optimization, the piping effort and heat losses were minimized and the partial stagnation effectively excluded.

Link to IEA SHC Work

To validate the function of the hydraulic concept in detail as well as to proof the overall energetic performance, the solar thermal system will undergo comprehensive monitoring, and SHC Task 45, Large-scale Solar Heating and Cooling Systems will analyse these monitoring results in order to further develop and improve large-scale solar thermal systems.

This article was contributed by Werner Weiss of AEE INTEC and IEA SHC Chairman, w.weiss@aee.at. The project team was Millennium Energy Industries, www.millenniumenergy.co.uk, info@millenniumenergy.co.uk, AEE - Institute for Sustainable Technologies (AEE INTEC), www.aee-intec.at, and GREENoneTEC Solarindustrie, www.greenonetec.com

◀ **Figure 3. Six storage tanks of 150 m³ for load compensation purposes are attached to the solar supported district heating network.** (Source: AEE INTEC)

▲ **Figure 4. Collector loop to the district heating network plate heat exchanger.** (Source: AEE INTEC)

◀ **Figure 5. Supply and return line of the district heating network.** (Source: AEE INTEC)

Solar Heat *from page 9*

Design Guidelines, Case Studies and Dissemination.

This subtask will work on:

- Providing a worldwide overview of results and experiences from solar heat for industrial process systems (including completed and ongoing demonstration system installations using monitoring data, as well as carrying out economic analyses) in order to lower the barriers for market deployment and to disseminate the knowledge to the main target groups.
- Developing a performance assessment methodology for the comparison and analysis of different applications, collector systems, and regional and climatic conditions.
- Developing design guidelines and simplified fast and easy to handle calculation tools for solar yields and performance assessment.

The Kick-off meeting for this Task is February 29, 2012 – March 1, 2012 at Fraunhofer ISE in Freiburg, Germany.

Countries that have expressed interest in participating are Austria, Germany, France, Italy, Mexico, Portugal, Spain, Switzerland, Australia, Belgium, Denmark, Netherlands, USA, Great Britain, China, Hungary, South Africa, South Korea, and Sweden.

For more information contact the Operating Agent, Christoph Brunner of AEE INTEC, Christoph Brunner c.brunner@aee.at or visit the SHC Task 49 webpage.

The two most challenging issues facing solar process heat are improving solar process collectors so that they can reach higher efficiency at higher temperatures and lowering the process temperatures using advanced heat and mass transport. It is expected that within the work of Task 49/IV suitable solutions will be found to these challenges.

CHRISTOPH BRUNNER
Task 49 Operating Agent

IEA programme SHC

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 44 R&D projects (known as Tasks) to advance solar technologies for buildings. The overall Programme is managed by an Executive Committee while the individual Tasks are led by Operating Agents.

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