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Newsletter of the International Energy Agency Solar Heating and Cooling Programme

SHC INTERNATIONAL ENERGY AGENCY Solar Heating & Cooling Programme

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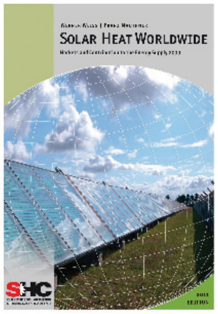
Solar Thermal Generates 196 GWth

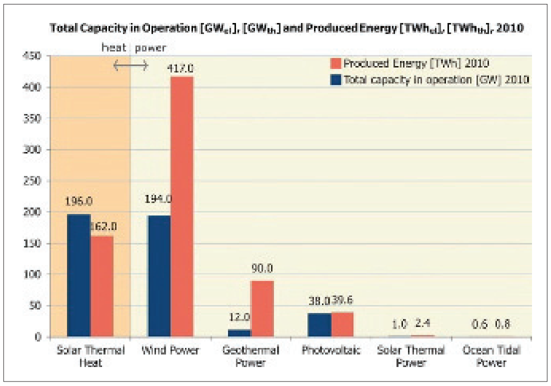


Data collected from 53 countries, representing 90-95% of the solar thermal market, shows solar thermal is second only to wind among nontraditional renewables in its contribution to meeting global energy demand.

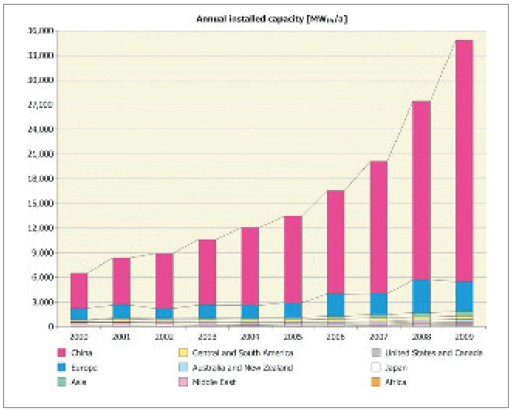
The IEA SHC Programme tracks the installation of solar thermal systems and produces an annual report, Solar Heat Worldwide: Markets and Contributions to the Energy Supply. This year's edition reports that 196 GWth or 280 million square meters of collector area are installed worldwide.

In terms of country specific data, China leads in new installations of glazed collectors followed by Germany, Turkey, India, and Australia. However, on a per capita basis smaller countries top the list – Cyprus, Austria and Israel followed by China and Barbados.

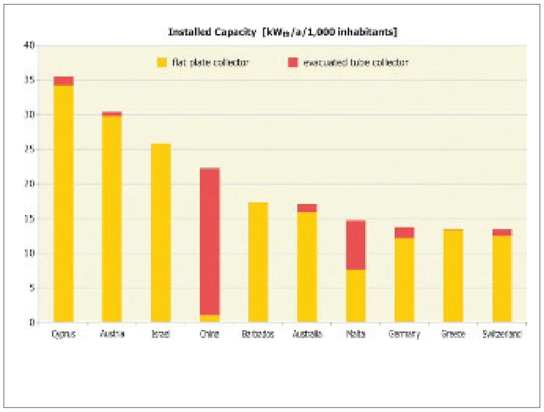
To read the full report go to www.iea-shc.org.



▲ **Figure 1: Solar Heat-total capacity** Sources: EWEA, EPIA, GWEC, IEA SHC 2011, Morse Associates Inc., REN 21



▲ **Figure 2: Solar Heat-annual installed capacity**



▲ **Figure 3: Solar Heat-per capita**

IEA Initiates Solar Heating & Cooling Roadmap

Building on the energy technology scenarios and strategies to halve today's energy sector CO_2 emission by 2050 as outlined in the International Energy Agency's Energy Technology Perspectives 2008 report, the G8 has asked the IEA to develop energy technology roadmaps for the key energy technologies needed to achieve long-term global energy and climate change goals.

It is clear that one of the most important greenhouse gas mitigation opportunities lies in the increasing use of renewable energy. The IEA Secretariat envisions solar thermal energy making a significant contribution to the growth of the renewables portfolio. This technology has experienced significant market growth over the past years and has tremendous potential worldwide. However, a significant number of technology development and demonstration, legal and regulatory, and public policy issues must be addressed. At the same time, a long-term perspective in the worldwide development of solar thermal energy supported by all key stakeholders will be beneficial in unlocking the potential of solar energy for heating and cooling.

The potential for solar thermal energy has been estimated for specific regions and specific applications, but a long-term perspective for global development is lacking thus far. A commonly supported global roadmap accompanied by an action plan is an essential step for the international community to move forward on solar heating and cooling technologies.

Roadmap Objectives

The overall aim of the project is to develop a *Solar Heating and Cooling Roadmap* that creates a growth path for solar thermal energy technology from today to 2050 and identifies technology, financing, policy and public engagement milestones needed to realize the technology's full potential. The *Solar Heating and Cooling Roadmap* will provide guidance to government and industry decision makers as they set priorities and will accelerate efforts to develop and deploy technologies to enlarge the contribution of solar heating and cooling technologies in the energy mix.

Roadmap Process

In close liaison with the Solar Heating and Cooling Programme, the IEA Secretariat organized the first workshop at the IEA headquarters in Paris. In total, 31 governmental officials, researchers, and industry representatives from Australia, China, Europe, India, Japan, Singapore, and the USA participated.

The aim of this first workshop was to create consensus on a general vision for the deployment of solar thermal energy and to start setting milestones for the draft roadmap. A specific focus was chosen for in-depth discussions on technology development and markets in different regions as well as on cost development and economics of solar heating and cooling technologies.

The next step in this process will be for the IEA Secretariat's Renewable Energy Division to prepare a first draft based on the results of the Paris workshop discussions. This first draft will then be discussed and consensus reached on the roadmap's details and discussion points at the second workshop on 28 August 2011 in conjunction with the ISES Solar World Congress in Kassel, Germany.

A final workshop will be organized in Asia in September/October 2011, and the roadmap published in early 2012.

The *Solar Heating and Cooling Roadmap* is one of a series of technology roadmaps that the IEA will deliver to future G8 meetings and use in the IEA's report, Energy Technology Perspectives. The development of this roadmap will create comprehensive guidance to government and industry decision makers to accelerate the overall RD&D process in order to deliver an earlier uptake of solar thermal energy into the marketplace.

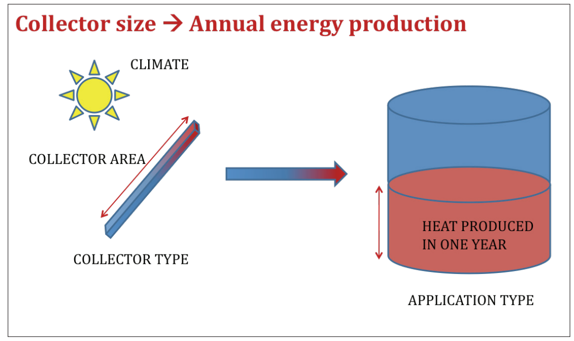
Article contributed by Werner Weiss, Chairman of the IEA SHC Programme, w.weiss @aee.at

The ISES Solar World Congress 2011 will take place in Kassel, Germany from **28 August** to **2 September**. The ISES Solar World Congress is the world's largest scientific congress in the field of renewable energy and buildings, bringing together the leading scientists from the most important research institutes and universities worldwide. It offers the renewable energy community the exchange platform on the latest developments in the fields of solar and renewable energy. About 1,000 researchers, engineers, architects, climatologists and students are expected to participate.

http://www.swc2011.org/cms/

New Method to Calculate Solar Thermal Output

Energy statistics should include the estimated solar thermal energy produced and now this is possible. The SHC Programme and major solar thermal industry associations agreed on a common calculation method to estimate the annual solar collector energy output in kWh. By calculating the amount of energy produced by solar thermal systems, worldwide solar thermal energy can now be easily compared with other (renewable) energy sources.



The newly developed methodology introduces very simple formulas, using easily accessible information, such as solar radiation on a horizontal plane at a given location and installed collector area in a country or region to estimate the respective annual solar collector output.

"A real breakthrough has been achieved with this new conversion factor," states Werner Weiss, Chair of the IEA SHC Programme. *"The SHC Programme and major solar trade associations, covering a vast part of the world's solar thermal market, are paving the way with their agreement for a better global evaluation of the energy provided by the solar thermal technology."*

Dr. Harald Drück, ESTIF board member notes, *"In connection with the implementation of the European directive on renewable energy sources (2009/28/EC), the data on solar thermal energy produced will help the European Solar Thermal Industry Federation (ESTIF) and the European Commission monitor the execution of the National Renewable Energy Action Plans, and in particular assess whether the specific targets, as set by each of the 27 EU countries for the renewable heating and cooling sector, are actually met.* Drück remarks, *"This is also an effective vehicle for solar thermal to demonstrate its performance. Solar thermal holds a strong position in the market today – our solutions help citizens reduce carbon footprint and reliance on scarce, imported fossil fuels."*

It is the hope of the SHC Programme and ESTIF that organizations publishing data on solar thermal energy production will use these conversion factors.

For more information contact Jan Erik Neilsen of PlanEnergie, Denmark and Operating Agent for Tasks 43 and 45, jen@planenergi.dk.

Un-glazed Collectors for pool heating:

$$Q_{\text{un-glazed collector}} = 0.29 * H_0 * A_a$$

kWh, kWh/m², m²

Q: Annual collector output
Ho: Annual global horizontal solar irradiation
Aa: Collector aperture area

Glazed Collectors in DHW :

$$Q_{\text{glazed collector,DHW}} = 0.44 * H_0 * A_a$$

kWh, kWh/m², m²

Q: Annual collector output
Ho: Annual global horizontal solar irradiation
Aa: Collector aperture area

Glazed collectors: Glazed flat plate and evacuated tubular collectors
DHW: Domestic hot water systems

Glazed Collectors in Combi-systems :

$$Q_{\text{glazed collector,Combi}} = 0.33 * H_0 * A_a$$

kWh, kWh/m², m²

Q: Annual collector output
Ho: Annual global horizontal solar irradiation
Aa: Collector aperture area

Glazed collectors: Glazed flat plate and evacuated tubular collectors
Combi-systems: Systems for combined space heating and domestic hot water system

Assessing the Life Cycle of a Solar Heating and Cooling System

task 38

Life Cycle Assessment (LCA) takes into account resource use (raw materials and energy) and environmental burdens related to the full life cycle of a technology. LCA investigations of a technology helps decision makers evaluate energy and environmental advantages of a given technology in a specific climate.

In SHC Task 38: Solar Air Conditioning and Refrigeration, a LCA methodology was applied to a solar heating and cooling (SHC) plant equipped with a water-ammonia absorption chiller to estimate the energy and environmental performances of the plant during its life-cycle. To estimate the energy and environmental benefits related to the use of this SHC plant, its eco-profile was compared to that of a conventional system (a vapor compression chiller used during the cold season and a gas boiler used in winter).

The main components of the investigated SHC plants were:

- absorption chiller, SolarNext/Pink chilli®PSC12 (12 kW), filled with ammonia/water solution;
- evacuated tube solar collector field (35 m2 absorber area);
- hot water insulated storage tank (2000 l);
- wet cooling tower (32 kW);
- heating system for winter operation (gas boiler 20 kW);
- back-up system in summer operations (the same gas boiler used in the winter operation or a cooling unit 10 kW) and;
- two-pipe fan coil units for cooling and heating distribution; and three pumps.

Two different configurations of the plant were investigated (hot back-up[1] and cold back-up[2]) in two locations: Palermo (southern Italy) and Zurich (Switzerland).

The eco-profiles of the evacuated solar thermal collectors (gas boiler, heat storage, vapour compression chiller, pumps and piping, electricity and natural gas) were inferred from the Ecoinvent database while the eco-profiles of the absorption chiller and the cooling tower were assessed from primary data provided by companies. The eco-profile for this investigation was determined at three different levels (Functional Units):

- whole SHC plant with absorption chiller (FU_1);
- 1 kW of power of the main component of the plant that is the absorption chiller (FU_2);
- 1 kWh of energy produced by plant (FU_3).

The system life-phase included production, use, and end-of-life. And, the energy and environmental indexes selected to show the performances of the investigated system included:

- Global Energy Requirement (GER), which represents the entire demand, valued as PE, that arises in connection with every life-cycle step (MJ/FU of PE).
- Global Warming Potential (GWP), which is a measure of the relative, globally averaged, warming effect arising from the emissions of particular greenhouse gases. The index is expressed as kg of CO_2 equivalent/FU and is referred to a period of 100 year.

1 Hot back-up: in summer operations an auxiliary gas boiler supports the solar system providing an additional heat input for the absorption chiller.

2 Cold back-up: in summer operations an auxiliary conventional chiller supports the absorption chiller.

Checklist Method For Integration of Solar Cooling Systems

If a solar cooling project is to be successful then technical, economical and organizational requirements must be met. This checklist offers a first step in the design phase to help determine if the project is feasible or not. If the project is feasible then the method will present requirements for some of the project's parameters, such as materials, planner, building owner, installer, exploitation staff and monitoring of the installation.

To use this checklist go to SHC Task 38 publications

	E_{PT} (years)	EM_{PT}, (years)	E_{RR}
Palermo hot back-up	5.1	4.0	4.3
Palermo cold back-up	5.8	6.0	3.8
Zurich hot back-up 4.4	3.9	5.0	
Zurich cold back-up 4.8	5.6	4.6	

▲ **Table 1: Payback indexes**

- Energy Payback Time (E_{PT}), which is defined as the use time (years) necessary for a plant to save as much energy (valued as primary) as that consumed during all the life-cycle phases of the system itself (except for the use phase)
- Emission Payback Time (EM_{PT}), which is defined as the time (year) during which the cumulative avoided emissions (in terms of equivalent CO_2, due to the application of the innovative plant, are equal to those released during the life cycle of the plant itself.
- Energy Return Ratio (E_{RR}), which represents how many times the PE savings overcome the GER due to the innovative plant.

A detailed analysis of the production phase for the different configurations showed that the main contribution to GER and GWP was the production of solar collectors (45-50% for GER and 37-50% for GWP) and absorption chiller (21-24% for GER and 19-25% for GWP).

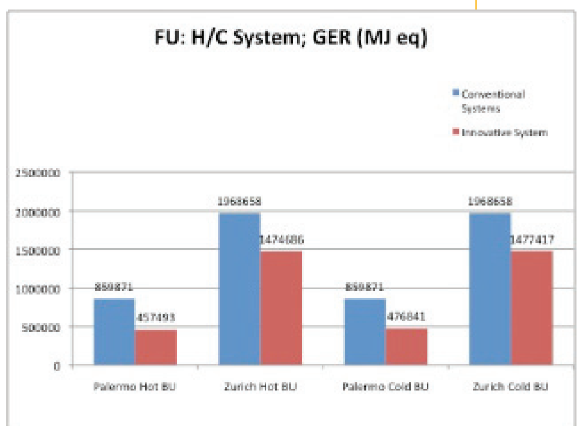
The analysis of the use phase allowed the calculation of the energy consumed by the plant for the two localities (Palermo and Zurich), and hourly simulations were carried out using TRNSYS.

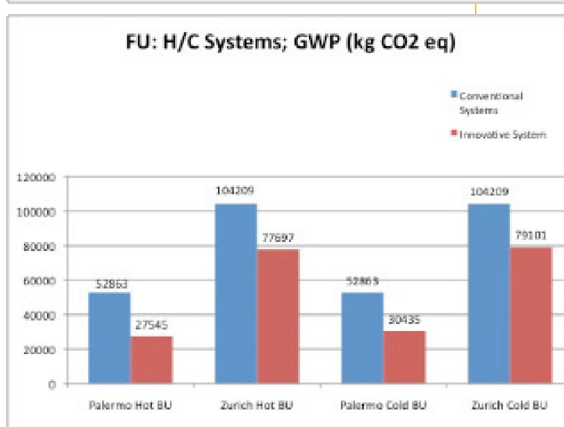
The assessment of the contribution of the plant's different life-cycle phases showed that the main contributions to GER and GWP were due to the use phase (GER: 68-74% in Palermo and 90-91% in Zurich; GWP: 72-73% in Palermo and 88-90% in Zurich). While the contribution of the end-of-life phase was negligible, the rest of the share was mainly due to the production phase.

The energetic and environmental performances of the SHC plant were compared with those of a conventional plant (Figure 1 shows the results for FU_I), which consisted of a water vapour compression chiller (10 kW; COP 2.5) for cooling and a gas boiler (20 kW) for heating during winter.

As shown in Table 1, the range of the payback indexes were relatively close—E_{PT} ranged from 4.4 to 5.8 years, EM_{PT},CO_2 ranged from 3.9 to 6.0 years, and E_{RR} ranged from 3.8 to 5.0.

In summary, the colder the climate, the lower the E_{PT} and EM_{PT},CO_2eq indexes and the higher the E_{RR} index given the impact of the heating loads. For all the payback indexes, the hot back-up was slightly better than the cold back-up. Nevertheless, from the energy and environmental point of view the results of all the payback indexes show good performances for each configuration. These results quantify the net energy and environmental benefits related to SHC systems, despite the larger amount of energy and emissions related to their construction and end-of-life.





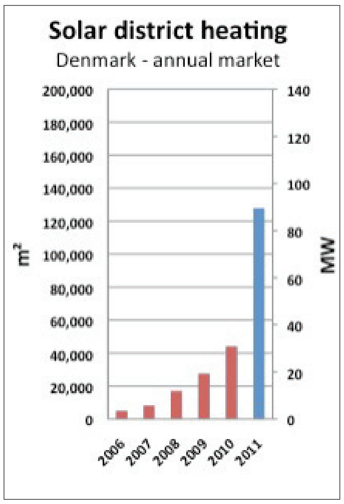
▲ **Figure 1: Comparison of a SHC plant and a conventional plant for the entire life: GER (left) and GWP (right) of FU_I**

The results also indicated that the LCA of a SHC plant should include a detailed analysis of the use phase. This will allow for the proper assessment of the real benefits from the energy produced by the system during its useful life, despite the larger amount of energy and emissions related to its construction. The advantages of using a SHC plant will also depend on the climatic conditions of the installation site.

Article contributed by SHC Task 38 participant, Prof. Marco Beccali of the Dipartimento dell'Energia, Università degli Studi di Palermo, Italy, marco.beccali@dream.unipa.it.

denmark

country of large solar district heating systems



▲ **Figure 1. Annually installed collector capacity for district heating systems in Denmark since 2006.**

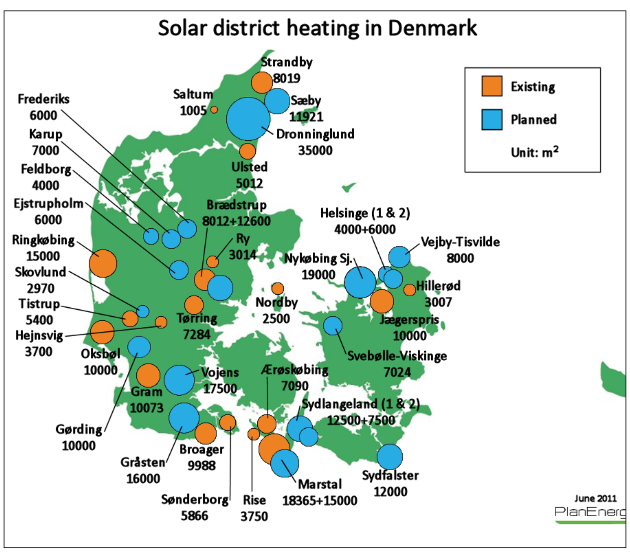
Solar District Heating Booming

We see at the moment in Denmark an interesting development in solar heating systems for district heating. Since 2006, the installed capacity has increased from 30 MW to 150 MW – a factor of 5 in five years. And this development seems to be continuing in 2011. According to information from the Danish District Heating Association's "Solar Group" more than 100,000 m² will be installed in 2011.

Another illustration of this boom is shown in Figure 2. Here it is seen that the number of systems planned equals more or less the total number of existing systems.

The history of the Danish district solar heating systems dates back to 1988 with the 1,000 m² system in Saltum.

Between 1988 and 2006 a few solar district heating systems were installed - including the well known Marstal system on the island of Aeroe.



▲ **Figure 2. Existing solar district heating systems and systems planned.**

But then around 2006, a virtual boom started due to increasing fossil fuel prices and decreasing prices on solar collector fields. Many systems were installed on a purely commercial basis (no subsidies for solar thermal are available in Denmark). The use of solar in district heating systems is now generally accepted and acknowledged by the district heating sector, which delivers 50% of the Danish heat demand. The website, www.solvarmedata.dk, shows the historical and actual performance of the solar district heating systems. Although all the systems have yet to be reported, the number is steadily growing.

The concept of solar district heating is now so well established in Denmark that Legoland even displays a system.

Some interesting projects underway are:

- Dronninglund: 35,000 m² with 60,000 m³ seasonal water pit storage.
- Marstal: Enlarging collector field to 34,000 m² and establishing a 75,000 m³ water pit storage.
- Braedstrup: Enlarging collector field to 18,000 m² and establishing a borehole seasonal storage. Followed by a potential enlargement to 50,000 m².

The main reason for this dramatic development is simple – It is good business. Even without subsidies the price of solar heat is competitive with the price of heat from other fuels. This is due to decreased prices and increased efficiency of collector fields, and increased prices of other fuels.

The SHC Programme's *Task 45: Large Systems: Large Solar Heating/Cooling Systems, Seasonal Storage and Heat Pumps*, which focuses primarily on large solar systems for district heating and cooling, has just started. The first meeting was held in Barcelona in April 2011 and the next meeting will be in Canada in October 2011. Denmark is leading this work and more information on the Task can be found at www.iea-shc.org/task45.

Solar Air Heating

Another positive solar development in Denmark is the use of solar air heaters for summerhouses. A small air collector with a PV powered ventilator supplies warm dry air to the summerhouse keeping it dry during the quite humid Danish winter as well as supplying some heat in the spring and autumn.

Individual Solar Systems for Domestic Hot Water and Space Heating

When the subsidy scheme for individual solar heating systems stopped in 2001, the Danish market for individual solar systems collapsed. Since then the market has somewhat recovered, but remains at a low level—20,000 m² installed per year. Systems being installed are primarily used to provide

▲ **Figure 3. First solar district heating system in Denmark: SALTUM 1988, 0.7 MW, 1,000 m².** **The system remains in operation in 2011.**

hot water, but an increasing number of systems are also supplying space heating.

Danish Building Regulation

The energy requirements in the Danish building regulation were tightened in 2006 and again in 2010. Now the maximum primary energy use for heating, hot water and ventilation (including pumps and controls) is around 65 kWh per m^2 heated area. This is quite a tough limit, and it is expected that individual solar systems will become common in new buildings. So when the construction sector becomes active again at some point in the future, the market for individual solar systems is expected to grow along with the growing market for new buildings. In 2015, the requirement is expected to be tightened to around 37 kWh per m^2 heated area.

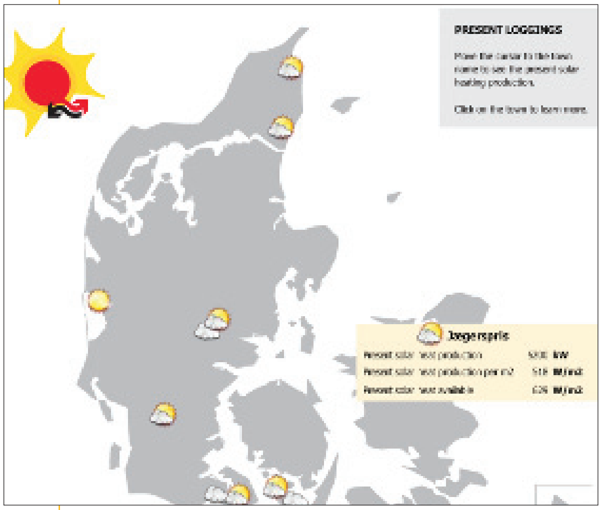
Danish Solar Thermal Strategy

In 2007, the Danish Energy Authority published its "Solar Thermal Strategy," which included the potential of solar thermal to provide 40% of the energy for heating buildings by 2050. The estimated 12.5 TWh solar energy would be supplied from 15 million m^2 solar district heating systems and 5 million m^2 individual solar systems.

At the moment an action plan is under development to suggest actions needed to reach this ambitious vision in the "Strategy."

Article contributed by Jan Erik Nielsen of PlanEnergi, Denmark and Operating Agent of Task 45 and co-Operating Agent of Task 43, jen@solarkey.dk and Jens Windeleff, Danish Energy Authority and Danish SHC Executive Committee representative, jew@ens.dk

▲ **Figure 4. Largest Danish system (to date): MARSTAL 196-2001, 13 MW, 18 000 m².**



▲ **Figure 5. The website www.solvarmedata.dk shows the measured performance of the Danish solar district heating systems.**

▲ **Figure 6. Smallest solar district heating system in Denmark: Lego model of BRAEDSTRUP 2008, 0.2 m²! (real scale: BRAEDSTRUP 2007, 5.6 MW, 8 000 m²)**

solar + heat pumps

task 44

Participating Countries

Austria
Belgium
Canada
Denmark
Finland
France
Germany
Italy
Spain
Sweden
Switzerland
UK
USA

Heat pumps, actively promoted by electric utilities, have become a popular heating system and when combined with solar the energy savings only increase. Manufacturers see a bright future for this technology and are focused on optimizing their systems. And, this is where the IEA Solar Heating and Cooling Programme comes in. Working with the IEA Heat Pump Programme, the goal is to optimize the combination of solar thermal energy and heat pumps, primarily for single-family houses.

Project participants are working on several types of systems:

- Small-scale residential heating and hot water systems that use heat pumps and any type of solar thermal collectors as the main components.
- Systems offered as one product from a system supplier/ manufacturer.
- Electrically driven heat pumps and to a lesser degree thermally driven heat pumps.
- Market available solutions and advanced solutions (produced during the course of the Task).

To better focus on the current market demand for single family solutions, large-scale systems (systems using any type of district network or systems for large buildings) are not included in this work nor is the comfort cooling of buildings. However, a heat pump can be used for cooling and so the performance assessment methodology of the Task will not forget this "optional" feature.

Companion Technologies?

Solar and heat pump technologies share some common traits:

- Solar collectors and heat pumps use electricity to make "free" energy available for hot water and space heat.
- In both cases, the "free" resource varies with the seasons in terms of exergy (quality).
- Both have decreasing efficiency with increasing supply temperature.
- Both have relatively high capital costs and lower running costs compared to conventional heating systems.
- Both use thermal storage in the systems.

The optimization of one technology will often help the other one, and it makes sense to look at both with a consistent and global view. The main "complementary disadvantages" of the two technologies are:

- Collectors cannot easily supply 100% of the load – solar systems need an auxiliary heater unless large storage tanks are possible.
- Heat pumps use a significant amount of primary energy – improving the COP (Coefficient of Performance), SCOP (Seasonal COP) or SPF (Seasonal Performance Factor) by using solar can provide an environmental advantage for heat pumps.

To combine these two "mature" technologies is not easy however so solar companies and research institutes are busy working on:

- Increasing the solar fraction for heating and hot water by using less material and simplifying the systems when possible to increase the system or components MTBF (mean time before failure).
- Finding alternatives to using very large heat storages to reach high renewable fraction.
- Reaching for an overall solar fraction greater than 50%.
- Trying to limit investment costs so that the cost of heat is 1 to 2 to that of the more traditional heating solutions (fossil, direct heating).
- Trying to provide affordable solutions for thermal solar cooling.

Heat pump companies and research institutes are focusing on:

- Increasing the annual COP or SPF (above 5 is the target).
- Possibly making direct use of solar energy for hot water or heating if the produced temperature is sufficient.
- Avoiding any or significant temperature decrease of the ground over many heating seasons when using a ground coupled heat pump.
- Making reversible machines for additional summer cooling at marginal cost.

Moving From Non-Integrated to Fully Integrated Systems

There are basically two kinds of systems that can be designed when working with two heat producers:

- *A non-integrated solution:* the heat pump system provides the heating and serves as the back up for the domestic hot water. The solar system provides 60-70% of the hot water needs. The two systems interact only at the level of

> The IEA framework provides a unique opportunity for experts from universities and industries working on thermal solar and heat pumps to exchange new ideas and test them.
>
> JEAN-CHRISTOPHE HADORN, Task Operating Agent

the DHW tank; the heat pump works for solar just as a gas or fuel boiler back up would.

- *A fully integrated system:* the heart of the system is the heat pump, but solar provides energy to the evaporator side of the heat pump either through a storage tank or directly, and when possible to the DHW tank and/or to the heating distribution system.

In this project, *Task 44: Solar & Heat Pump Systems*, more than 20 monitored systems are under investigation. Eight basic configurations have been classified as "generic" that is, as representative of all others. Below is an illustration of one of the Task's generic systems.

The features of this system are:

- Active use of the solar energy for support of the ground heat source regeneration. It is not yet clear if this regeneration brings a definite advantage. Task participants are working on the theoretical principle.
- Active regeneration can cause drying-off of the ground around the borehole in certain types of soil and without ground water flow. In the presence of water flow regeneration is of no use.
- The problem can be the outflow of the accumulated energy with the ground water. This process depends on local conditions and can significantly reduce the advantage of the active regeneration of the borehole.
- The system provides some increase of the solar gains from the solar collector and prevents stagnation in the summer (but this should not be a priority criteria)

Comparisons

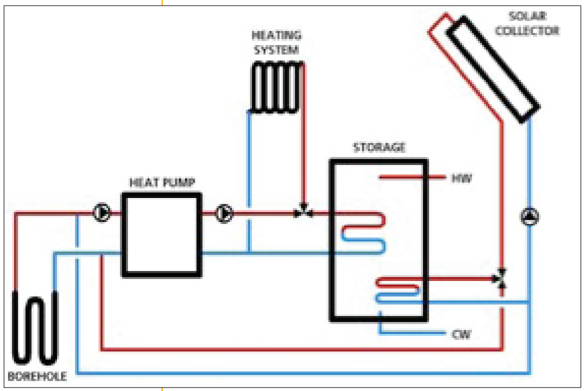
This is main the goal of this project – careful descriptions of each system that can be compared and a common framework for system simulations. To facillitate this process, Task participants have created the "square view" as a fast way to understand any configuration.

What the Future Holds

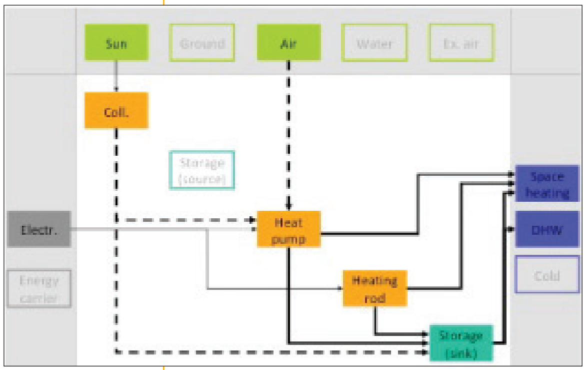
Market penetration for these combined systems over the next 10 years will be dominated by the heating market, but applications for cooling will also see growth. To more readily move into the market there a some specific steps to take:

- field testing of projects is commonly discussed,
- laboratory testing method is elaborated on and tested,
- common performance indicators are agreed upon (seasonal performance factor, primary energy ratio, eonomical limits, etc.),
- systems are compared using both monitored results and extended performances in other climates through simlations (benchmarking),
- system rankings and recommendations are given,
- simulation tools for planners are developed,
- best practices are collected internationally,
- standards are defined,
- technology is deployed, and
- a continous improvement process follows with innovation and knowledge consolidation to lead to reliable, cost effective and high solar or renewable energy fraction and IEA Tasks lead or follow the developments.

Article contributed by Jean-Christophe Hadorn of BASE Consultants SA, Switzerland and Operating Agent of SHC Task 44/HPP Annex 38, jchadorn@baseconsultants.com, www.iea-shc.org/Task44



▲ **Figure 1: System Type 2: Active Regeneration**



▲ **Figure 2: The "square view" is a new way to describe any solar and heat pump combination.**

Working to Define NetZEBs

task 40

Why Net-Zero Energy Solar Buildings?
Energy consumption in commercial and residential buildings worldwide accounts for about one-third of the world's energy and one-quarter of greenhouse gas emissions. If current trends continue, by 2025 buildings worldwide will be the largest consumers of global energy, using as much power as the transportation and industrial sectors combined.

Recent studies show that improving energy efficiency in buildings is the least costly way to reduce a large quantity of carbon emissions. By changing energy management practices and instituting technologies that enhance energy efficiency, building owners and managers can reduce energy consumption by up to 35%. However, energy efficiency efforts in buildings alone can not address future demand for more energy in this sector. To achieve breakthrough solutions to this problem, a coordinated effort in a whole-building systems approach emphasizing the integration of renewables on-site or distributed generation and energy efficiency is required to design the buildings of the future.

Several International Energy Agency (IEA) countries have adopted a vision of so-called 'net zero energy buildings' (NetZEBs) as a long-term goal of their energy policies. However, what is missing is a clear definition and international agreement on the measures of building performance that could inform 'zero energy' building policies, research, development and deployment programmes, and industry adoption around the world.

What is the IEA Doing?
The Solar Heating and Cooling (SHC) and the Energy Conservation in Buildings and Community Systems (ECBCS) Programmes are collaborating on a five-year project "Towards Net-Zero Energy Solar Buildings". The principle objective of this work is to study current net-zero, near net-zero and very low energy buildings and to develop a common understanding, a harmonized international definitions framework, tools, innovative solutions, and industry guidelines.

A primary means for achieving this objective is to document existing NetZEB or near NetZEB examples in the participating countries and to propose practical projects with convincing architectural quality for future demonstration. These projects aim to equalize their small annual energy needs, cost-effectively, through building integrated heating/cooling systems, distributed/on-site power generation and interactions with utilities. These examples and the supporting research results presented in conference papers, international journals, Task reports, sourcebooks, guidelines and tools are key to industry adoption.

This project is building upon industry experiences with net-zero and low energy solar buildings and developments in whole building integrated design and operation. By addressing concerns of comparability of performance calculations between building types and communities for different climates, solution options will be developed that are attractive for broad market adoption and incorporation into national demonstration buildings.

The Task is structured around four areas of work:

Subtask A. Establishment of an internationally agreed understanding on NZEBs based on a common methodology. To accomplish this, experts are:

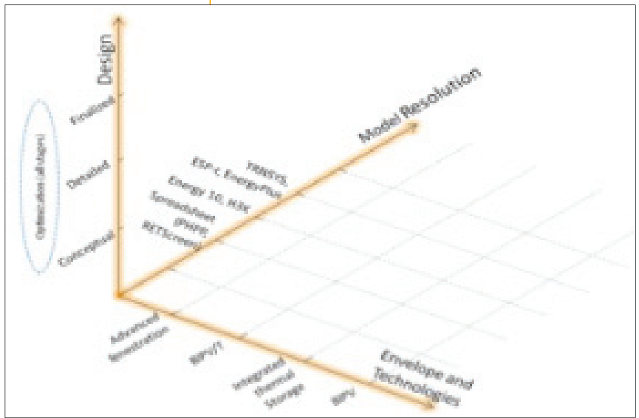
- reviewing and analyzing existing NetZEB definitions and data with respect to the demand and the supply side;
- studying grid interaction (power/heating/cooling) and time dependent energy mismatch analysis;
- developing harmonized international definition framework for the NetZEB concepts considering large-scale implications, exergy and credits for grid interaction (power/heating/cooling);
- developing a monitoring, verification and compliance guide for checking the annual balance in practice (energy, emissions and costs) harmonized with the definition; and
- continuing to further an international consensus on a definitions framework and monitoring procedures of NetZEB as well as adapting the US Department of Energy's High Performance Buildings Database to capture information on NetZEB in participating countries.

Results are encapsulated in four-technical papers 1) *Load Matching and Grid Interaction of Net Zero Energy Buildings*, 2) *Net Zero Energy Buildings: Calculation Methods and input Variables - An international View,* 3) *Criteria for Definition of Net Zero Energy Buildings,* and 4) *Comfort and Energy Performance Recommendations for Net Zero Energy Buildings.*

Subtask B. Identification and refinement of design approaches and tools to support industry adoption (see Figure 1). This is being done by:

- conducting work along four major R&D stream: in documenting and analyzing processes and tools currently being used to design NetZEBs and under development by participating countries;
- assessing gaps, needs and problems to inform simulation engine and detailed design tools developers of priorities for NetZEBs;
- qualitative and quantitative benchmarking of selected tools; and
- selecting six case studies buildings (detailed analysis of simulated/ designed vs. actual performance), and proposing the redesign/optimization of these buildings.

Results of the work are detailed in four technical papers, 1) *Design, Optimisation and Modelling Issues of Net-Zero Energy Solar Buildings*, 2) *Applying A Design Methodology for a Net Zero Energy House to Evaluate Design Processes and Tools,* 3) *Solar 2002: A Belgian Pilot Project for Zero Energy Buildings,* and 4) *Design Optimisation Methodologies for a Near Net Zero Energy Demonstration Home.*

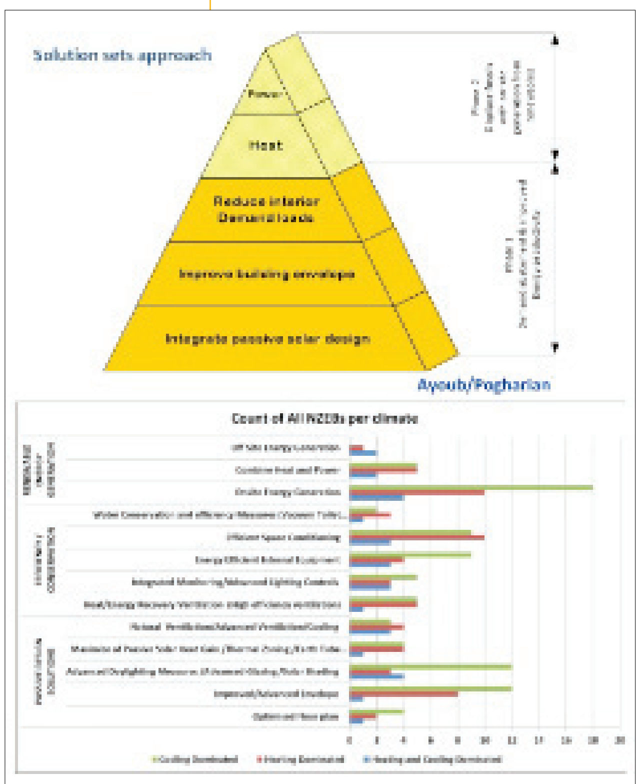


▲ **Figure 1. The 3D matrix represents model resolution, technologies and design stage. Access data on technologies and design methodology to give better models.** (Source: Compiled by A. Athienitis, Subtask B Co-Leader, ANNEX 52 (SHC Task 40).

Subtask C. This activity focuses on developing and testing innovative, whole building net-zero solution sets (see Figure 2) for cold, moderate and hot climates with exemplary architecture and technologies that would be the basis for demonstration projects and international collaboration. Experts are:

- documenting and analyzing current NetZEBs designs and technologies, benchmarking with near NetZEBs and other very low energy buildings (new and existing) for cold, moderate and hot climates considering sustainability, economy and future prospects using a projects database, literature review and practitioner input (workshops);
- developing and assessing case studies and demonstration projects in close cooperation with practitioners;
- investigating advanced integrated design concepts and technologies in support of the case studies, demonstration projects and solution sets; and
- developing NZEB solution sets and guidelines with respect to building types and climate and documenting design options in terms of market application.

Results of the work thus far are covered in five technical papers 1) *The Road Towards "Zero Energy" in Buildings: Lessons Learned from The Solar XXI Building in Portugal*, 2) *Net Zero Energy Solar Buildings: An Overview and Analysis on Worldwide Building Projects,* 3) *Net Zero Energy Buildings in France: From Design Studies to Energy Monitoring - A State of the Art review,* 4) *BOLIG+ - an Energy Neutral Multifamily Building,* and 5) *Impact of the Zero Energy Mass Custom Home Mission to Japan on Industry Education Toward Commercialisation*



▲ **Figure 2. The whole-system approach to developing the solution sets for NetZEBs in various climates and an example of the Solution Set output.**

Subtask D. The final activity is crosscutting work that focuses on dissemination to support knowledge transfer and market adoption of NetZEBs on a national and international level. This is being accomplished by:

- establishing an NetZEB web page within the IEA SHC/ECBCS Programmes' framework, and a database that can be expanded and updated with the latest projects and experiences;

continued on page 12

MarketPlace

Net-zero Workshop

Net-zero Energy Building (NZEB) PhD Summer Workshop June 20-25, 2011 in Montreal, Canada

SHC Task 40/ECBCS Annex 52: Net Zero Energy Solar Buildings welcomed PhD students from across the globe to a 6-day workshop. Thirteen professors/instructors led 32 engineering and architecture PhD students through a series of classes to train and educate then in the broad topics of NZEB buildings, and more importantly, to perform high-quality research and design on four NZEB case studies. The case studies are internationally significant buildings being researched in detail as part of SHC Task 40/ECBCS Annex 52. Targeted studies were conducted on the following topics:

- Assessment of appropriate model resolution and different simulation and design tools in performing building or system re-design,
- Assessment of design processes of NZEB design using process maps,
- Assessment of occupant comfort (thermal, visual) and its relationship with NZEB strategies (e.g., high levels of glazing, natural ventilation, daylighting),
- Assessment of advanced control strategies to reduce energy use, reduce peak loads, and improve thermal comfort, and;
- Assessment of potential for optimization of design and control to improve building performance.

For more information contact Josef Ayoub Operating Agent of SHC Task 40/ECBCS Annex 52 Operating Agent, Josef.Ayoub@rncan-nrcan.gc.ca

New Marketing Tool – Database of Architecturally Appealing Solar Thermal Systems

Online database showcases solar thermal energy systems appealingly integrated into buildings. The examples include single and multi-family residences as well as institutional and commercial buildings.

The appearance of a product not only makes a first impression on a customer, but also plays a decisive role in their final decision to buy or not buy the product. The effective use of design and strong visual quality adds value to the product. When it comes to solar thermal systems, the collector design is only one part of the final product. Placement of the collector field and attractive architectural integration are critical to the purchase decision.

This marking tool shows in pictures that solar thermal can be high-tech, good looking and sustainable and provides technical information for each building. Click on the database and begin your tour of well-designed solar thermal systems. New examples will continue to be added so check back often.

If you have any questions, please contact Michael Köhl, michael.koehl@ise.fraunhofer.de.

Task 40 *from page 11*

- transferring Task outputs (reports, sourcebooks, guidelines, other) to national policy groups, industry associations, utilities, academia and funding programs;
- participating in national and international workshop, seminars, and industry exhibitions highlighting the results and activities of the Task;
- contributing high quality technical articles and features in journals to stimulate market adoption; and
- establishing an education network of highly qualified people that will continue the work in the filed in their future endeavours.

To-date, plans have been put in action to hold the first six-day training workshop in Montreal, Canada, in conjunction with the ASHRAE 2010 summer conference, that will provide current PhD students and advanced Master's students a thorough understanding on NetZEBs and their fundamental principles.

To learn more contact Josef Ayoub of CanmetENERGY and Operating Agent of SHC Task 40/ECBCS Annex 52, Josef.Ayoub@RNCan-NRCan.gc.ca

IEA programme SHC

Current Tasks and Operating Agents

Solar Resource Knowledge Management
Dr. David Renné
National Renewable Energy Lab
1617 Cole Blvd., Golden, CO 80401
UNITED STATES
david_renne@nrel.gov

Solar Air-Conditioning and Refrigeration
Dr. Hans-Martin Henning
Fraunhofer Institute for Solar Energy Systems
Heidenhofstr. 2
D-79 110 Frieburg
GERMANY
hans-martin.henning@ise.fraunhofer.de

Polymeric Materials for Solar Thermal Applications
Mr. Michael Köhl
Fraunhofer Institute for Solar Energy Sytems
Heidenhofstr. 2
D-79 110 Freiburg
GERMANY
michael.koehl@ise.fraunhofer.de

Net Zero Energy Solar Buildings
Mr. Josef Ayoub
CanmetENERGY
Natural Resources Canada
1615, boul. Lionel-Boulet
Varennes, Quebec J3X 1S6
CANADA
Josef.Ayoub@rncan-nrcan.gc.ca

Compact Thermal Energy Storage
Mr. Wim van Helden
ECN Energy Research Centre of the Netherlands
P.O. Box 1
NL 1755 ZG Petten
NETHERLANDS
vanhelden@ecn.nl

Solar Energy and Architecture
Ms. Maria Wall
Lund University
P.O. Box 118
SE-221 00 Lund
SWEDEN
maria.wall@ebd.lth.se

Solar Rating and Certification Procedures
Mr. Les Nelson
Western Renewables Group
30012 Aventura, Ste. A
Rancho Santa Margarita, CA 92688
UNITED STATES
lnelson@westernrenewables.com

Mr. Jan Erik Nielsen
PlanEnergi
Aggerupvej 1
DK-4330 Hvalsö
DENMARK
jen@solarkey.dk

Solar and Heat Pumps
Mr. Jean-Christophe Hadorn
BASE Consultants
8 rue du Nant - CP 6268
CH - 1211 Genève 6
SWITZERLAND
jchadorn@baseconsultants.com

Large Systems: Large Solar Heating/Cooling Systems, Seasonal Storage, Heat Pumps
Mr. Jan Erik Nielsen
PlanEnergi
Aggerupvej 1
DK-4330 Hvalsö
DENMARK
jen@solarkey.dk

Solar Resource Assessment and Forecasting
Dr. David Renné
National Renewable Energy Lab
1617 Cole Blvd., Golden, CO 80401
UNITED STATES
david_renne@nrel.gov

Solar Renovation of Non-Residential Buildings
Mr. Fritjof Salvesen
Asplan Viak AS
P.O.Box 24, 1300 Sandvika,
NORWAY
fritjof.salvesen@asplanviak.no

Solar Heat Integration in Industrial Processes
Mr. Christoph Brunner
AEE INTEC
Feldgasse 19, A-8200 Gleisdorf
AUSTRIA
c.brunner@aee.at

Quality Assurance and Support Measures for Solar Cooling
Mr. Daniel Mugnier
TECSOL SA
105 av Alfred Kastler - BP 90434
66 004 Perpigan Cedex
FRANCE
daniel.mugnier@tecsol.fr

Member Countries and Executive Committee Members

AUSTRALIA	Mr. M. Maffucci	MEXICO	Dr. W. R. Gomez-Franco
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CHAIRMAN
Mr. Werner Weiss
AEE - Institute for Sustainable Technologies
Feldgasse 19
A-8200 Gleisdorf
AUSTRIA
Tel: +43/3112 5886 17
e-mail: w.weiss@aee.at

SHC SECRETARIAT
Ms. Pamela Murphy
KMGroup
9131 S. Lake Shore Dr.
Cedar, MI 49621
USA
Tel: +1/231/620-0634
e-mail: secretariat@iea-shc.org

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.

S●LARUPDATE
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by

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Pamela Murphy

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