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Newsletter of the International Energy Agency Solar Heating and Cooling Programme

INTERNATIONAL ENERGY AGENCY
Solar Heating & Cooling Programme

#SolarHeat
#SolarThermal
#SolarProcessHeat
#SolarCooling
#SolarDistrictHeating

In This Issue

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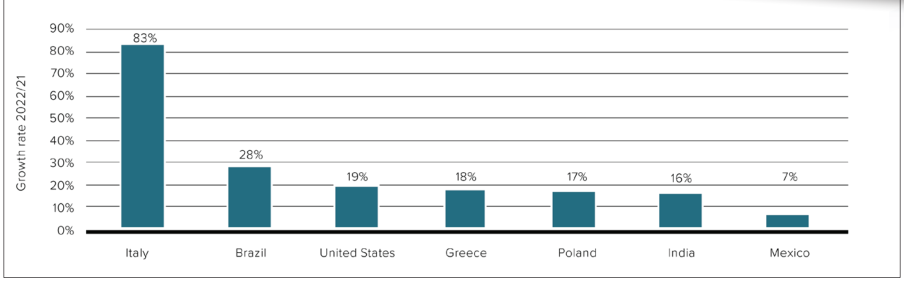
Solar Thermal Market Records Year of Growth

Our flagship report, Solar Heat Worldwide 2022 is the most comprehensive evaluation of solar heating and cooling markets with data from 70 countries. The 2022 report has a new design to better highlight all the data but covers the same categories – 2021 market development and trends, 2020 global markets, country statistics, distribution by system types and applications, and contributions to the energy supply and CO_2 reductions. The full report and key findings are available for free on the IEA SHC website.

Top Solar Thermal Markets in 2021



▲ **Solar heat markets with the highest growth rates in 2021.**

2021 was a bright year for solar thermal – the market grew by 3% after seven years of a downward market. Generating 425 TWh_{th} of green heat saves 45.7 million tons of oil and avoids 147.5 million tons of CO_2. And with 109 million systems in operation, the cumulated solar thermal capacity was 522 GW_{th} or 746 million square meters of collector area.

Below are a few highlights from the 2022 report.

National Policies and Rising Fossil Fuel Prices Drive Demand

Positive trends were observed in several solar heat markets. Italy, for example, experienced a phenomenal 83% growth last year, driven by increased construction activities combined with a new tax reduction scheme, the "Superbonus" for energy-efficient buildings. Likewise, demand in Brazil (+29%) and the United States (+19%) rose as people spent more time at home during the pandemic and invested in solar pool heating solutions. Sales for commercial clients in Brazil also increased due to growth in the construction sector and rising electricity prices caused by power shortages.

Below are the top three countries for different market segments.

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SHC Members

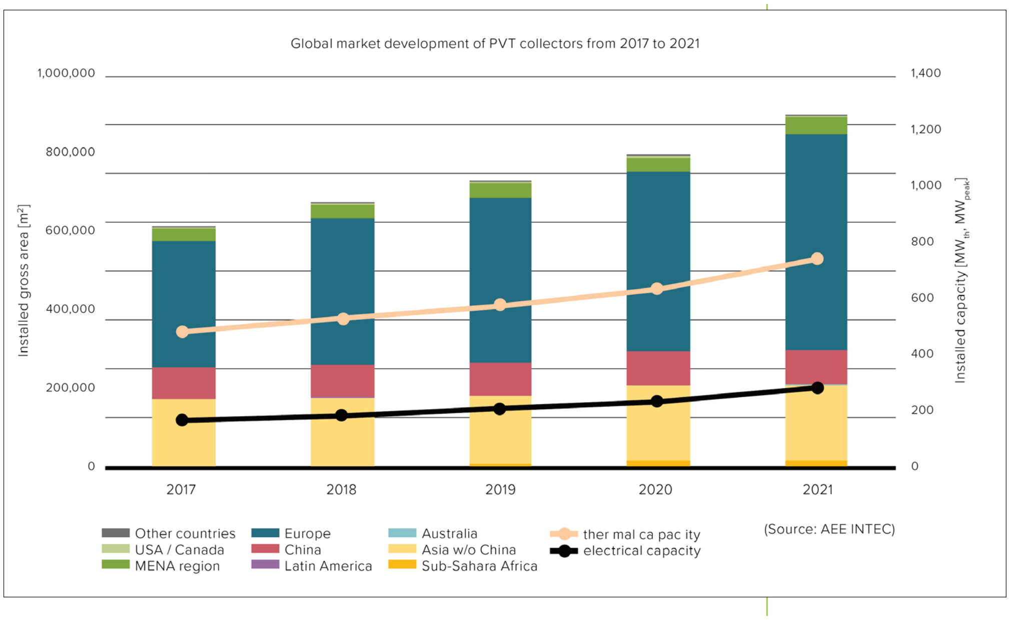
AUSTRALIA
AUSTRIA
BELGIUM
CANADA
CCREEE
CHINA
DENMARK
EACREEE
ECI
ECREEE
EUROPEAN COMMISSION
FRANCE
GERMANY
ISES
ITALY
NETHERLANDS
NORWAY
PORTUGAL
RCREEE
SACREEE
SICREEE
SLOVAKIA
SOUTH AFRICA
SPAIN
SWEDEN
SWITZERLAND
TURKEY
UNITED KINGDOM

Leading Markets for Solar Thermal Solutions

Three top markets		1	2	3
Solar district heating New additions **2021** [MW_{th}]		China	France	Denmark
Solar industrial heat New additions **2021** [MW_{th}]		China	France	Mexico
PVT systems Total in operation **2021** [MW_{th} / MW_{peak}]		France	South Korea	China
Solar air heating systems Total in operation at the end of **2020** [MW_{th}]		Canada	Australia	Japan
Swimming pool heating Total in operation **2020** [MW_{th}]		USA	Brazil	Australia

Photos: GRENoneTEC, TVP Solar; AST Eis- und Solartechnik GmbH, DualSun, SolarWall Conserval Engineering Inc.

PV-Thermal Market on the Rise



Cumulated PVT capacity for the years 2017 to 2021.

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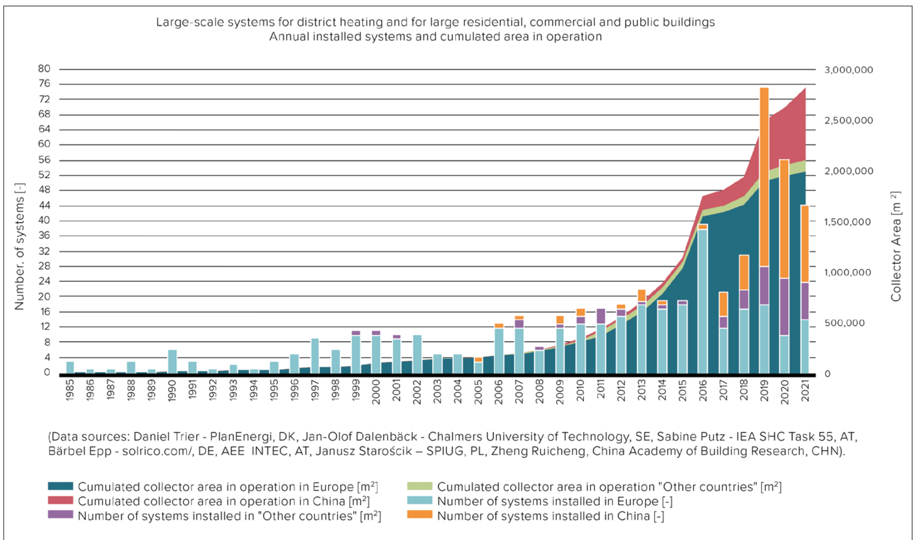
A highlight of this year's report is the section on PV-Thermal systems (PVT) – generating both solar heat and solar electricity. Thirty-eight manufacturers worldwide provided detailed sales data giving a country-specific view of PVT deployment. France is the leading market with air-based PVT collectors used for heating. However, unglazed PVT collectors gained popularity as a heat source for brine heat pumps in residential and commercial buildings in the other leading countries, South Korea and China.

Today, 1.4 million m² of PVT collector area is in operation. In 2021, the global PVT capacity in operation grew 13% after steady 9% growth between 2017 and 2020.

Large-Scale Solar Heating Market Shifts To China



▲ **Large-scale systems worldwide – annual achievements and cumulated collector area in operation in 2021.**

Europe has dominated the market for large-scale solar thermal plants connected to a local or district heating grid or installed on large residential, commercial, or public buildings since the early 1980s, but there has been an enormous shift. In 2021, China accounted for 75% of the market, with 20 systems installed, totaling a collector area of about 151,000 m². France followed with 3 systems, totaling 10,600 m² collector area, and Denmark 1 system with 8,013 m² collector area.

Solar district heating (SDH) systems are the largest subsector of the large-scale solar heating market. By the end of 2021, 299 SDH systems (> 350 kW_{th}, 500 m²) were operating with a 1.6 GW_{th} capacity. Denmark dominates this sector with 125 installed systems and 1.1 GW_{th} capacity due to its past favorable policies and funding that lasted until 2020. Seeing the technology's potential for decarbonizing the heat sector in neighborhoods and cities, other countries are taking the lead. In 2021, China and France overtook Denmark and reached the top ranked positions in new solar district heating capacity.

"With 21 GW of new capacity installed in 2021, the solar thermal sector has again proven that it is a significant player in the move towards climate neutrality. Our flagship publication Solar Heat Worldwide shows the wide range of customers that can profit from zero-carbon heat produced onsite."

TOMAS OLEJNICZAK
Chair of the IEA SHC Programme

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Solar Heat Worldwide 2022 *from page 3*

QUICK STATS

Capacity

- 522 GW_{th} (746 million m^2 collectors) global solar thermal capacity in 2021
- 425 TWh solar thermal heat supplied in 2021
- Top countries
  - Installed capacity in 2020 – China, Turkey, US, Germany, Brazil in 2020
  - Installed capacity per 1,000 inhabitants in 2020 – Barbados, Cyprus, Israel, Austria, Greece

Market Growth

- 3% growth in 2021
- Market leaders in 2021 – Italy 83%, Brazil 28%, US 19%, Greece 18%, Poland 17%, India 16%, and Mexico 7%

New Installations

- 21 GW_{th} / 31 million m^2 collector area in 2021
  Once again, led by China with 18 GW_{th} or 83% of new market growth.
- By application in 2020 – 51% large DHW systems (multi-family housing, tourism, and public sector), 35% DHW (single-family housing), 6% solar combisystems (single- and multi-family housing), 6% swimming pool heating, and 2% other (solar district heating, solar process heat, solar cooling)

Environment

- 45.7 million tons of oil savings in 2021
- 147.5 million tons of CO_2 avoided in 2021
  CO_2 savings are 4 times the annual CO_2 emissions of Switzerland.

To learn more, download the free report here.

In terms of plant size, Denmark is home to 3 of the 5 largest systems, leading with a 156,694 m^2 system with 110 MW_{th} installed capacity, followed by China's 93,000 m^2 system with 65 MW_{th} installed capacity.

In terms of the number of systems, after Denmark's 125 systems, China follows with 41 systems with 279.3 MW_{th} installed capacity, followed by Germany (45 systems with 81.5 MW_{th} installed capacity), Sweden (24 systems, 23.9 MW_{th} installed capacity), and Austria (22 systems, 34 MW_{th} installed capacity).

Large-scale solar systems for the residential, public and commercial sectors can be found on many types of buildings, including hospitals, hotels, and sports centers. The number of systems is increasing in Latin America (Mexico and Brazil), the MENA region (Jordan, Kuwait, UAE), and Asia outside of China (Cambodia, India, Thailand). By the end of 2021, 230 systems with a capacity of 324 MW_{th} were supplying green heat. China is the market leader with 84 systems with 223 MW_{th} capacity, followed by Turkey (18 systems, 14.2 MW_{th}) and Latin America (16 systems, 12 MW_{th}). In Europe, the three market leaders are Greece (44 systems, 10.7 MW_{th}), France (14 systems, 10.4 MW_{th}), and Austria (410 systems, 7 MW_{th}).

Multi-MW solar industrial heat plants (SHIP) demand is increasing worldwide as industrial companies search for a CO_2-free heat supply. The largest plants for solar heat for industrial processes (SHIP) are a 300 MW plant in an oil field in Oman, followed by a 37 MW system in Australia for a tomato producer, and a 28 MW system for a copper mine in Chile.

The number of SHIP plants increased to at least 975 documented plants with an overall installed collector area of 1.23 million m^2. Mexico leads in the number of SHIP systems installed due to their cost-competitiveness with fossil fuels, particularly liquefied petroleum gas.

Solar thermal technologies are suitable for supplying heat to many processes, such as drying, boiling, sterilizing, or bleaching with temperature needs up to 400 °C. This is important, considering that industry is among the most challenging economic sectors to decarbonize, given the long investment cycles for new energy infrastructure.

Market Trends

In 2022 the market trends to keep an eye on are the continued dominance of the Chinese market, particularly domestic hot water systems and MW solar systems, solar heat for industrial processes (SHIP), PV-Thermal applications, solar cooling applications with capacities over 350 kW, and building integrated solar air heating systems.

Four Nominations Shortlisted!

The SHC Solar Award is given to an individual, company, or private/public institution that shows outstanding leadership or achievements in the field of solar heating and cooling and supports the work of the IEA SHC.

This year's SHC Solar Award will recognize a Solar Heating or Cooling project to reduce energy use and costs in social housing. The winner will be announced during EuroSun 2022 in Kassel, Germany.

The recipient of the 2022 Solar Award will be one of four finalists from Australia, France, Namibia, and South Africa. The finalists' projects may be very different, but all are effective examples of saving costs and energy for vulnerable occupants through solar heating and cooling technologies.

"My Home" – Perth, Australia

"My Home" houses demonstrate that high-quality construction, thermal comfort, and energy efficiency are achievable in compact, low-cost housing.

"My Home" is a philanthropic developer that brings together Government, Church, Private Sector, and Community Housing Providers to deliver the project using a Public Private Partnership model. One of their five projects is in North Fremantle. This project is building 18 affordable, long-term occupancy homes for older women who are experiencing homelessness. Fundamental to the house designs are comfortable, joyful, and refreshing living spaces. If someone is walking past the houses, they are seen as an attractive home and NOT as a place where homeless people live.

The houses complement the appearance of surrounding homes, albeit with a smaller footprint, so they fit into the neighborhood. The 32 m^2 house footprint includes bed, living, bathroom, and kitchen spaces plus a veranda, all of which support independent living. In addition, each site includes shared facilities – outdoor gathering spaces, storage, vegetable gardens, and car parking.

The houses are demountable and cost-efficient. By using lightweight prefabricated domestic construction and a 'flat pack' panel system, the houses can easily be moved to another site as needed. Thoughtful design of the homes, based on a contemporary aesthetic and rigorous design principles, and low maintenance with easy to clean and robust materials and fittings reduce long-term costs. A sense of "My Home" is essential as this will be the 'forever home' for some residents.

Each house is energy efficient – solar PV panels and passive solar (Passivhaus) design principles provide comfort to residents in a hot climate. Houses are also water efficient and include a rainwater tank supply. Plus, the base housing unit can be adapted to suit the needs of specific occupant groups, such as single parents with a child/children.

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GrandLyon Habitat – Lyon, Auvergne Rhône Alpes area, France

GrandLyon Habitat project shows the benefits of solar thermal installations and serves as an example for other social landlords.

GrandLyon Habitat (GLH) has a long history of social housing since its creation in 1920. Today, this organization is the leading social landlord in Lyon and manages more than 27,000 housing units. GrandLyon Habitat is a pioneer in sustainable development and provides economically disadvantaged people affordable housing.

GLH has equipped three residential sites, totaling 1,062 apartments, with large-scale solar thermal installations. The commissioning of the installations in the three residences was staggered between September 2018 and October 2019. The solar installations on these three residences total 895 m^2 of collectors and produced an average of 440 MWh in 2021, according to detailed monitoring.

GrandLyon Habitat's project to equip several of their residences with solar thermal energy, with the financial support of the "Fond Chaleur" of the ADEME, is reducing the gas consumption of 1,062 dwellings. In 2021, gas reductions were nearly 450 MWh. This replacement of fossil fuel with renewable energy reduces the energy bills of the inhabitants, which is significant given the sharp rise in energy costs projected for the future. In addition, the use of a remote monitoring system makes it possible to precisely quantify the gas savings achieved, check that the installations are working properly, and troubleshoot quickly, for example, to reduce the risk of damage to the installation due to freezing or overheating of the collectors.

Aussenkehr Social Housing Development – Aussenkehr, Namibia

Aussenkehr Social Housing Development project provides a simple, affordable, and sustainable housing option with homes built locally and equipped with solar technologies.

Aussenkehr is a settlement in southern Namibia on the north bank of the Orange River. It is one of the hottest and driest places in the country. A large-scale irrigation project, where water is taken from the Orange River, made it possible for people to settle here, and table grapes are now grown on more than 3,000 hectares of irrigated land. Up to 15,000 permanent and seasonal workers live in the vicinity of the settlement, of which most work at the grape farms. Most people stay in traditional reed huts, which do not have water, sanitary facilities, and electricity connections. To

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provide farmworkers with affordable yet sustainable and energy-efficient homes, ORVI, one of the Orange River Vineyards, developed a housing project to accommodate its employees. It comprises 58 houses made of precast concrete bricks, with pitched roofs and ceilings, all built during 2020. The houses all have potable water and an electricity connection.

To keep running costs as low as possible, the houses are equipped with solar thermosyphon systems for hot water preparation supplied and installed by Solsquare Energy (Pty) Ltd., a Namibian solar company. The hot water is used not only for showers but also for washing clothes and cooking.

This project not only significantly improved the living standards and hygiene conditions of the farm workers and their families but also demonstrated how simple and affordable houses can be built locally and equipped with sustainable solar technologies.

In addition to the enormous reduction in monthly electricity costs due to the use of solar energy, the majority of electricity in southern Africa is produced in old coal-fired power plants. These solar thermal systems will save approximately 120,000 kWh of electricity and avoid releasing 36 tons of CO_2 annually.

Melville Place Residential Development – Cape Town, South Africa

Melville Place Residential Development is an excellent example of how solar thermal can maximize the benefits of affordable, sustainable housing without compromising residents' quality of living.

Melville Place is a new residential development located in Ottery in the Southern Suburbs of Cape Town. The estate was developed with a strong focus on social and environmental sustainability. It was designed to provide low- and middle-income working residents with affordable yet modern housing.

The complex consists of three-story blocks with a total of 346 apartments. The system is distributed over the separate blocks and consists of evacuated tube collectors with a total area of 343 m^2 and 46,000 liters of hot water storage with backup from heat pumps.

The development was designed to incorporate water and energy-saving features. Melville is equipped with several features, such as a rainwater catchment and purification system as well as black water treatment, which allows the complex to operate without the need for municipal water. In addition, the complex plans to generate most of the electricity required on the premises, and a solar thermal system is fitted to provide hot water. The solar hot water system is estimated to produce 244.90 MWh of solar energy while preventing the production of 84,700 kg of CO_2 emissions annually.

Learn more about the SHC Solar Award at https://www.iea-shc.org/solar-award.

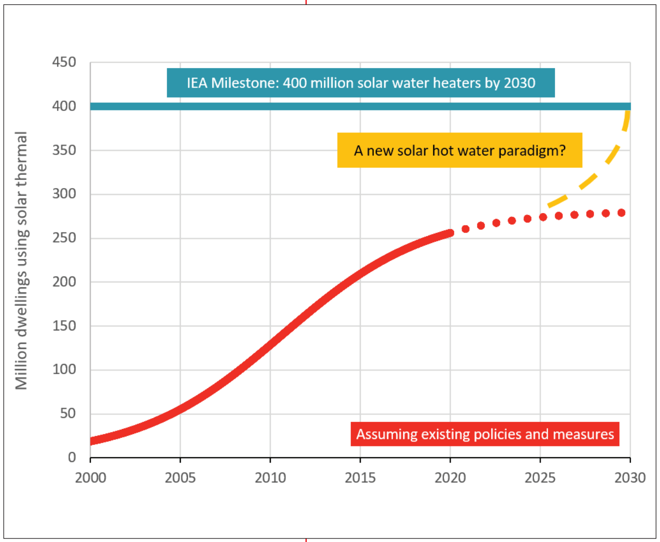
400 Million Residential Solar Water Heaters by 2030

The International Energy Agency (IEA) has provided the solar hot water sector with a clear mission to deploy at least 400 million residential solar systems by 2030. Dr. Richard Hall, a Vice Chair of the Solar Heating and Cooling Programme (SHC), discusses the implications of this new global mission on the structure of the solar thermal sector.

In their flagship Net Zero by 2050: A Roadmap for the Global Energy Sector, the IEA states that to limit the rise in global temperature to 1.5 ºC, we need a “massive deployment of all available clean … energy technologies” and “drastic and immediate technology and policy shifts” to decarbonize buildings. For the solar heating and cooling sector, this means having at least 400 million solar hot water systems in operation by 2030 and 1.2 billion in operation by 2050.

Revival, Stagnation, or the Birth of Rival?

To achieve this milestone, we need to deploy around 300 million solar hot water systems in the 2020s (see graph), although I acknowledge that the exact number is arguable. The reason this number is so high is that many of the rural low-cost thermosyphon systems installed over the past 20 years, which have an assumed operational lifetime of between 10 and 15 years, will be decommissioned by 2030.



Source: *IEA Net Zero by 2050 and SHC Solar Heat Worldwide 2022*

With such an increase in deployment, I find myself wondering how the sector will respond and whether it will be able to meet such high levels of demand. I see three possibilities ahead of us: 1) a revival of solar thermal, with it entering a new growth phase; 2) a stagnation of the sector, with it being unable to meet the demands placed upon it; or 3) the birth of a rival form of solar thermal, based on photovoltaics.

A revival of solar thermal (evacuated tube and flat plate) is certainly a possibility given the demand, but I would argue that we must seriously consider the possibility that solar thermal has already reached technological maturity. The consequence of this would be solar thermal reaching a market share in 2030 that is well below what is required to limit the rise in global temperature to 1.5 °C (the second law of energy-technology deployment) (Kramer and Haigh, 2009). This is not only a problem for the solar sector, but also for the global effort to decarbonize heat. But if a technological breakthrough occurs and a new rival form of solar thermal develops, then there would still be a way to meet these targets.

Urban Solar Hot Water Systems

To date, the rapid growth of solar thermal worldwide can largely be explained by the technological breakthroughs in all-glass evacuated tubes achieved by Tsinghua University, along with the economic, political, and cultural landscape of China in the era following the economic reforms instigated by Deng Xiaoping. Yu and Gibbs (2018) argue that the rural Chinese market between the 1990s and early 2000s provided an ‘empty space’ for solar thermal diffusion to take hold. But the challenge for the future growth of the market lies in the fact that the urban market is now an ‘occupied space.’ This

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means that for solar to increase its market share in hot water heating, we now need a technological breakthrough that addresses the "high-end demands of urban markets."

I think we are seeing the emergence of such new urban solar thermal systems in OECD countries like the United Kingdom, the United States, and Australia. In the broadest sense, these systems use photovoltaic power to heat devices, which can come in several forms, such as smart power diverters and smart hot water tanks. For people living in urban areas, these smart consumer devices offer benefits such as being very compact, smartphone-connected, having low capital costs, and being highly reliable. A perceived downside of these devices is that they do not necessarily promote self-sufficiency, often connecting consumers with large-scale renewable power plants. However, as was the case for the rural solar thermosyphon systems, the economic savings and convenience of these new urban solar thermal systems may outweigh concerns for the environment or personal desire to become independent from the grid. And their perceived acceptability may be an important tool in promoting their installation in situations where solar thermal is considered too difficult or disruptive. In this sense, I see the two technologies as being complementary rather than true rivals, with each appealing to slightly different markets, but with their combined efforts achieving our ultimate goal of decarbonization.

Whist these new urban solar thermal systems are seemingly only being deployed in the 10,000s, I believe that this new paradigm of solar thermal could make a significant contribution to meeting the IEA's 400 million residential solar water heaters by 2030 millstone. It must be made clear to Governments that just as the technological breakthroughs by Tsinghua University led to the growth of the evacuated tube collector market, we need strong and well-funded innovation programs to ensure that these 'urban' solar thermal systems enter their growth phases as soon as possible. Challenges such as the current structural shortage of semiconductors, device interoperability, and cyber security will become pressing issues sooner than many people expect.

A Pivotal Task: Solar Hot Water for 2030

There is little doubt that solar will play a major role in the complete decarbonization of heating, cooling, and hot water (Mercure et al., 2021). What is coming into question is which types of solar technologies will dominate the solar heat sector in the 2030 to 2050 period. Figuring out the answer to this question, which will not only be technical, but will have broader economic, political, and cultural dimensions, must be at the core of our work within the IEA Solar Heating and Cooling Programme.

This is why I think the new SHC Programme's Task 69 on Solar Hot Water for 2030 is potentially one of the most important Tasks the SHC has ever undertaken. Encompassing both solar thermosyphon systems and photovoltaic power to heat devices, the work being undertaken within the guiding framework of SHC Task 69 will provide the sector with the knowledge and skills to effortlessly pivot between the two solar worlds. If SHC Task 69 is not successful, then I fear the real possibility of the sector missing, by a significant margin, the IEA's 2030 millstone. Not meeting the milestone will not only diminish the relevance of the SHC Programme in the eyes of the IEA but will contribute to the world being on a disaster course of 3˚C of global heating.

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IEA SHC & ISES

Solar Decathlon Europe

IEA SHC & ISES Recognize Outstanding Solar Building Concepts

IEA SHC and ISES (International Solar Energy Society) teamed up to present an Out-of-Contest Award during the Solar Decathlon Europe this June in Wuppertal, Germany. The driver behind this collaboration was to shine a light on the team that successfully integrated solar thermal concepts in their building.

Solar Decathlon Europe is the world's largest construction competition for universities, with 18 teams from 10 countries participating this year. To the surprise of the IEA SHC/ISES jury, not one team but two teams stood out, and both received the Solar Award. The first team was VIRTUe from the Eindhoven University of Technology in the Netherlands and the second team was LOCAL+ from the Aachen University of Applied Sciences in Germany.

The Solar Award recognizes the Solar Decathlon teams with the most convincing and transferable technical integration and significant CO_2 reduction achieved by onsite solar energy use covering the building's space heating and hot water demand.

The Solar Award jury of ISES President Prof. Klaus Vajen from the University of Kassel, Germany, Kerstin Krüger, Vice-Chair of the IEA SHC Programme and German Executive Committee member, and Prof. Andreas Häberle, head of the SPF Institute for Solar Technology in Rapperswil, Switzerland and leader of IEA SHC Task 64 visited all 16 full-scale (1:1) flagship buildings for sustainable urban living. "What we saw during our tour was that many teams used colored PV and PVT elements in the façade or on the roof combined with heat pumps. But some teams developed special solutions for distributing heat in the building, increasing the solar share, and meeting heating demand in winter," noted Häberle.

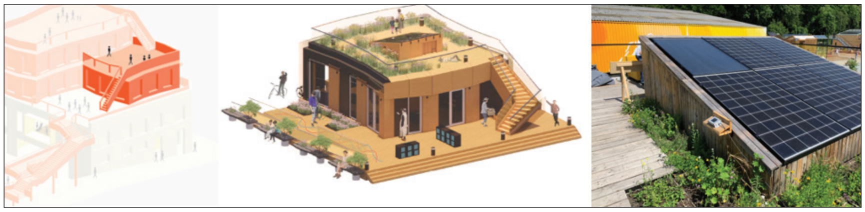
> "We were impressed by the well-thought-out technology concepts and the team spirit we saw. In both teams, we were welcomed by professional guides showing us around their projects,"
>
> ANDREAS HÄBERLE
> IEA SHC

Team VIRTUe
of the Eindhoven University of Technology

VIRTU/e

The jury lauded the overall energy concept of the winning team VIRTUe, which followed three objectives:

- Reducing energy demand with a highly insulated and air-tight building envelope and a heat-recovery ventilation & showering system.
- Decarbonizing the energy supply using onsite solar electricity and heat production combined with a brine heat pump.



The wood-based building of the VIRTUe team from the Netherlands can be used to add additional floor space to existing buildings. The roof is walkable and includes a PVT field plus a solar collector linked to the house's underfloor heating and cooling system.

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- Matching demand and supply with the help of thermal and electric storage and managed by a smart home and energy management system.

A unique feature of the VIRTUe building was the distribution of heat and cold via the floor, where phase-change material elements were integrated to achieve a higher thermal mass. Other aspects the SHC/ISES jury noticed were that the team included only students, even for the project management, and they brought their own power container with PV modules and 120 kWh battery for the two-week construction period so that they would not need a power connection on site.

▲ **Team VIRTUe of the Eindhoven University of Technology in the Netherlands.**

Team LOCAL+

from the Aachen University of Applied Sciences

The LOCAL+ team from Aachen also convinced the jury with its overall energy supply concept – a PVT field on the roof to provide heat and electricity for a brine heat pump. The unique features were ice storage that could be regenerated by thermal energy from the PVT elements and heat and cooling distribution using ceiling elements made from clay, a 100% recyclable material. The jury was also impressed by the team spirit of LOCAL+ as they banded together to finish their house after suffering severe storm damage during the construction period.

To learn more about Solar Decathlon Europe 21/22, visit https://sde21.eu/.

▲ **Team LOCAL+ from the Aachen University of Applied Sciences with the SHC/ ISES jury.**

◀ **The energy concept of the LOCAL+ team from the University of Applied Sciences in Aachen, Germany, uses façade-integrated PV elements (blue on the photo). These are color-coordinated with the other building materials to increase the acceptance of onsite energy production.**

SPOTLIGHT

Collaborative Solar Initiatives Shine Bright in Southern Africa

The combination of abundant solar energy resources and heavy reliance on fossil fuels has led many African nations to look to the sun for solutions. And not surprisingly, they are finding solar solutions for all different applications and community needs. Here are highlights from four of our Southern Africa member countries.

Botswana

Public Private Partnerships Tackle Sustainable Development Goals

Botswana, a landlocked country, relies heavily on coal and other fossil fuels for energy production, which it primarily imports from neighboring countries, in particular South Africa. The small share of renewables is dominated by bioenergy, but the potential for solar is immense. Botswana has abundant solar energy resources. Receiving over 3,200 hours of sunshine per year with an average insolation on a horizontal surface of 21MJ/m², it has one of the highest rates of insolation in the world.

▲ Water heater to be replaced at Camphill Community Trust.

An alternative care home, SOS Children's Village, and a boarding school for children with learning disabilities, Camphill Community Trust, are set to receive and benefit from the installation of 50 thermosyphon solar geysers. The solar geysers will directly improve the lives of 240 people, thanks to grants from the SOLTRAIN IV project, funded by the Austrian Development Agency (ADA), and a locally based mining company, Debswana Diamond Company, the world's biggest diamond producer by value.

These two organizations have teamed up with SOLTRAIN trainers and member companies of the Solar Industries Association Botswana (SIAB) to install a total of 120 m² of collectors, which will create a long list of benefits – job creation, long-term financial savings, energy savings, contributions towards national carbon emission targets, training of artisans and maintenance teams, and public awareness for the technologies. The long-term benefits of the partnership are expected to extend beyond the project into collaboration on other initiatives to promote the use of renewable energy in more communities.

▲ Solar Collectors to be replaced at SOS Village Tlokweng.

SIAB, registered under the societies act in 2005, is a group of locally based companies working in solar thermal and photovoltaics fields. Using a unified voice, they advocate for a wider uptake of solar technologies in the country by disseminating information, fostering high standards of practice, and cultivating good ethics and ideals. The association became a partner coordinator to the SOLTRAIN IV project in 2019 to support the lead coordinating partner, the Clean Energy Research Centre (CERC) based at the University of Botswana, in their work and to build close working relationships with the private sector. The project is regionally coordinated by the Austrian Research Centre AEE INTEC.

The SOLTRAIN project has been operating in Botswana for two phases (six years) and focuses on solar thermal technologies in six SADC region countries. The need for this project in the

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2030 Targets for Solar Thermal Collector Area

Country	Estimated average collector area per inhabitant by 2030	Estimated installed collector area by 2030	Installed collector area at the end of 2020*	Roadmap launch
Botswana	0.3 m^2 per person	910,000 m^2	17,275 m^2	February 2018
Lesotho	0.5 m^2 per person	~1.1 M m^2	4,257 m^2	June 2019
Namibia	0.5 m^2 per person	1.5 M m^2	54,372 m^2	February 2019
South Africa	0.5 m^2 per person	~30 M m^2	2,493,082 m^2	September 2015

region came from the deficit in power supply and the ability of thermal technologies to reduce reliance on the grid by up to 50%. The initiative has successfully restored trust in solar technologies tarnished by poor design, selection, and installation.

The project's focus is capacity building, knowledge transfer, financial incentives, supporting regulatory framework, research and development, and public awareness. The benefits for the association members have been numerous. They include training in solar thermal design, technical support in developing initiatives, public awareness, business meetings with local organizations, networking with regional institutions, supply chain, and accessing grants for demonstration projects, including this collaborative project with Debswana.

Debswana is a diamond mining company based in Botswana that contributes about 30% of the GDP to the country annually. The company's sustainability and carbon neutral goals and strategic plan for 2030 align closely with the SOLTRAIN project and SIAB, which led to the company supporting the collaborative solar project through its Corporate Social Investment program. Debswana's six company values drive the company to meet its objectives passionately and pride itself on upholding the qualities. Three of the six values stand out for this project," pull together," show we care," and "shape the future," all of which are significant in shaping the key performance indicators. This project, which is set to be completed by September 2022, would not have reached inception without the company "showing they care" by "pulling together" with ADA/SOLTRAIN and SIAB to "shape the future" of these social institutions and the extension in supporting local SMEs.

▲ **Inception meeting with Debswana at SOS Village Tlokweng.**

The Solar Industries Association Botswana, Camphill Community Trust, and SOS Children's Village would like to extend their gratitude to the Austrian Development Agency, AEE INTEC, the Clean Energy Research Centre, and Debswana for contributing to the development of this project. We look forward to a collaborative future in working toward Sustainable Development Goals (SDGs).

Contributed by Karen Gibson, the Solar Industries Association Botswana, Botswana SOLTRAIN partner Coordinator.

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Lesotho

Teaching and Training a New Solar Generation

Lesotho produces electricity from hydro sources, but not enough to meet the country's demand, so it relies on energy imports from neighboring countries to meet its growing demand. But, bolstered by the National Policy 2015-2025, the energy sector guideline, the promotion and development of renewable energy are growing. And one of the key players has been the Bethel Business and Community Development Centre, where technical and commercial education and training combine.

▲ **Nthabiseng Masiloane at Solarsoft in Mohales Hoek with evacuated tube solar cookers. She graduated from BBCDC and works as a technician and SOLTRAIN coordinator.**

BBCDC is a technical and commercial school with 250 full-time students and 17 full-time staff located 250 km south of the capital Maseru. It began operations in 1993. Lesotho is a landlocked country at a high altitude in Southern Africa with a population of 2 million and 35,000 square km in area. Solar energy utilization is a core curriculum component at BBCDC and central to all operations. This community is not connected to the national electricity grid and relies entirely on solar energy systems.

Today, five heavy-duty solar power systems are operating on the campus, providing electricity for all applications, including welding, refrigeration, kitchen appliances, computer labs, lighting, shop equipment, and irrigation pumps. An average 150kWh/day of electricity is being produced. In addition, over 6,000 liters of hot water are produced by direct thermal technology each day, which translates into 330 kWh energy equivalent. The annual value of energy produced by solar electrical and thermal power based on M2.00/kWh is about M350,000.00 (M1.00 = R1.00 = USD0.063, June 2022). Solar thermal systems are used extensively for water heating, cooking, space heating (passive design), cooling (solar chimneys and radiation), greenhouses (3), and daylighting. Solar water heaters include a 500-liter pumped system and numerous low- and high-pressure water heaters employing evacuated glass tubes. Several different types of solar cookers operate daily on the BBCDC campus and most recently include promising large evacuated tube designs. And nine guest rooms for visitors are served entirely with solar water heating.

▲ **SOLTRAIN technical tour for local decision-makers of high-pressure solar water heaters on May 6, 2022, at St. Elizabeth Training Institute.**

In 2000, experience gained from the practical application of solar technology on the campus was used to start a solar business. A trademark: "Solarsoft" was registered, inspired by the work of Amory Lovins, who used the term "soft energy paths" for decarbonization and transition to renewables. Solarsoft is headquartered in Mohales Hoek and operates throughout Lesotho with four full-time technicians. From 2014 to 2022, BBCDC is the lead regional Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN) partner for Lesotho, which is a joint program of AEE INTEC and the Austrian Development Agency. SOLTRAIN is advancing technical, commercial, and engineering capacity for solar thermal adoption and adaptation. BBCDC imported five containers of solar water

► **Earthship at BBCDC: a lecture theatre using passive solar design. The south and west walls are entirely earth sheltered.**

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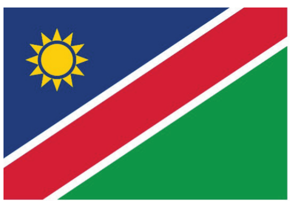
heaters for commercial installation and constructed three large wastewater treatment systems in Lesotho that incorporate living machines and greenhouses to enhance bio-reaction.

BBCDC is in the final stages of commissioning and opening a 200 m^2 lecture theatre, an Earthship. Eight hundred used automobile tires were used to construct an 80 m^2 back-filled wall that acts as an enormous heat sink and temperature moderator. The windows and daylight features are designed for excellent solar gain, and the roof is well insulated. As Ivan Yaholnitsky of the Ministry of Education notes, “The operation of the Earthship biosphere is sheer grandeur, with the sun, water, and life in an elaborate symphony. Human technology should correspond.” The structure will primarily be used in conjunction with an adjacent solar lab for education. Solar energy application, technology, and engineering provide exceptional strategic advantage and performance for the school. If you are well prepared, there are no emergencies.

Contributed by Ivan Yaholnitsky: Principal and Managing Director of the Ministry of Education, Lesotho.



Namibia

Committed to Reaching 2030 Solar Thermal Target

Namibia is located in the Southern Sunbelt region of Africa, where access to clean energy remains a challenge. The semi-arid country is dominated by warm weather, however, the occurrence of cold weather necessitates the need for heat for various applications. On the other hand, the country imports about 60% of its annual energy requirements from neighboring countries through the Southern Africa Power Pool, mainly South Africa, whose energy generation mix is dominated by coal. Thus Namibia is a net importer of energy. Moreover, heating and cooling in businesses and households account for between 40% and 50% respectively, which is attributed to higher electricity bills.

▲ **Solar collectors for pumped water heating on the Katutura State Hospital Maternity Ward in Windhoek.**

The government of Namibia has, through the National Energy Policy and the National Renewable Energy Policy, recognized the 2030 Solar Thermal Technology Roadmap of Namibia (STTR-Nam). The 2030 STTR-Nam aims to guide the country’s transformation from a fossil fuel-based energy economy to a low-carbon economy while improving energy access for many people in Namibia. The target of the 2030 STTR Nam is to have 1,500,000 m^2 collector area installed at domestic and commercial institutions, mines, hotels, hospitals, etc. by 2030. The government has further shown commitment in supporting and advocating for solar thermal. In 2007, a cabinet directive was enacted for all new public institutions’ water heating requirements to be met with Solar Water Heaters (SWH).

▲ **Lady Pohamba’s 210 m^2 pumped solar water heating system.**

Solar Installation Highlights

Major installations in the country have been made by the private sector in the housing, health, hospitality, education, and housing sectors. The most recent installation is a solar water heating system at the Katutura State Hospital Maternity Ward. Installed in May 2022, the pumped solar water heating is a hybrid system that relies on a 120 m^2 collector area as the first heating priority and a heat pump as a second priority.

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Other solar water heating systems include the largest pumped system in the country at the Lady Pohamba Private Hospital and the thermosiphon systems installed at the Orange River vineyards' low-cost housing development in Aussenkehr. All these systems were installed with co-financing under the regional Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN) project funded by the Austrian Development Agency (ADA) through AEE INTEC. Solar water heating has also been adopted in the country by other institutions and individuals.

▲ **Thermosiphon systems installed on 58 low-cost housing development in Aussenkehr.**

Current Trend

The uptake of solar heating technology in the country has started to gain momentum as many institutions and individuals are taking on the role of ensuring contribution to climate change mitigation as stipulated in Namibia's updated Nationally Determined Contribution (NDC). This comes with the added benefit of long-term energy cost savings associated with the competitive renewable energy technologies. The main drivers of this uptake are the awareness-raising programs and funding opportunities, such as those provided by the SOLTRAIN program and the Solar Revolving Fund (SRF) of the Ministry of Mines and Energy.

Contributed by Joseph T. K. Shigwedha and co-authors Helvi Ileka and Fenni Shidhika of Namibia University of Science and Technology.

South Africa

Turning to the Sun to Relieve Overstrained Electrical Grid

A Day of the year has been allocated to the power of the sun thanks to the UN Environment Programme (UNEP). International Day of the Sun on May 3rd recognizes and promotes the expansion of this abundant renewable energy resource.

International Day of the Sun also coincides with a major research collaboration to identify the optimal thermal technologies that companies and households can use as alternative energy sources. The first collaboration will focus on solar water heating potential using different solar technology solutions.

The move by the South African National Energy Development Institute (SANEDI) and the Council for Scientific and Industrial Research (CSIR) could take huge pressure off the overstrained national electricity grid and ease load shedding if companies switch to solar and related thermal heating and cooling technologies. Companies switching to low-carbon technologies would also shield themselves against high electricity tariff increases, save money, give themselves greater energy security, and contribute to reducing carbon emissions.

SANEDI and the CSIR have established a Thermal Laboratory that will test and compare a range of low carbon technologies and develop business cases to implement the most effective solutions at different scales, explains SANEDI Manager for Renewable Energy and South Africa's IEA SHC representative, Dr. Karen Surridge. "We want to identify the most savvy, energy efficient thermal technologies to use for heating and cooling tailored

"Using solar thermal technology to reduce pressure on the national grid is not new, but we need to revive it and realize how powerful it is as a means to save electricity, ease load shedding, alleviate pressure on the national grid, save money, and reduce carbon emissions," says Karen Surridge. "Solar thermal systems can be used at scale, from small household installations to large-scale industrial, commercial, and agricultural installations. No matter how big or small your solar thermal system is, it will help and ensure you have hot water when you need it."

Contributed by SANEDI, May 2022 press release.

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Spotlight on Southern Africa *from page 16*

towards specific types of businesses and present these to companies for evidence-based consideration."

Heating and cooling are intensive users of energy. They often account for between 40% and 50% of electricity costs in companies and households and draw large amounts of electricity from the overstretched national grid if coal-based electricity is used.

Technologies such as solar water heating are highly energy efficient. Recent examples of this have been shown by the Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN), funded by the Austrian Development Agency and in which SANEDI is a South African partner.

SANEDI, often under the banner of SOLTRAIN, is creating awareness of Renewable Energy (RE), Energy Efficiency (EE), more specifically on solar water heating technology at military units in Limpopo province of South Africa. After only two and half years of operation, the system is already making significant savings in electricity and water.

The project paved the way for other government entities to look into installing large-scale renewable energy technologies at their facilities and hold 'Decision Makers' seminars to be trained on renewable heating and cooling technologies and their benefits.

Some of the many solar projects undertaken by SOLTRAIN include:

- Wits Junction student residence complex in Johannesburg estimates it will save R40 million in electricity and other costs over the 20-year lifespan of a combined solar water heating, co-generation, and gas heating system it has installed. The complex comprises 14 buildings and provides accommodation for 1,103 students who use 94,000 liters of hot water daily.
- The SA National Defence Force has saved 490,500 kWh of energy and R1,079,100 in electricity costs after installing a relatively small (3000L) solar water heating system at Air Force Base Hoedspruit in Limpopo. (Read more about this in the Solar Update, July 2021 issue
- Centurion Building retirement residence in Sea Point, Cape Town, has saved at least 470MWh of electricity and R220,000 in electricity costs since it replaced its electric boilers with a hybrid solar thermal and heat pump hot water system in 2018.
- Klein Karoo International (KKI), a major ostrich leather, feathers, and meat producer based in Oudtshoorn, Western Cape, replaced its oil fueled water heating system with a solar thermal plant and saved just over R413, 000 in its first year of operation.
- Melomed Gatesville Hospital in Cape Town has saved R130,000 a year after switching to a hybrid solar water heating and heat pump system.

In addition to being involved in the SOLTRAIN initiative, SANEDI has also managed solar thermal projects on behalf of the Gauteng provincial government. These include the installation of three 300-liter high-pressure solar water heaters, which have reduced electricity costs at Frida Hartley Shelter for Women in Johannesburg from about R40,000 to R1,000 a month and the fitting of solar water heaters that could save Sibonile Primary School an estimated R10,000 a month.

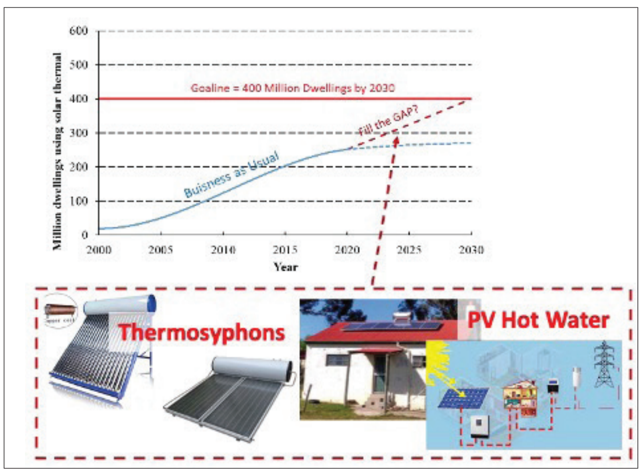
▲ **University of the Witwatersrand Junction Student Residences uses a pumped solar thermal system with a hot water storage tank and external heat exchanger. In one year, this installation gives a solar yield of 397.70 MWh and is responsible for avoiding 137,600 kilograms of CO_2 emissions.** Source: SOLTRAIN

▲ **Klein Karoo International (Pty) Ltd Tannery (KKI) installed a solar thermal plant. In one year, this solar installation generates 397 MWh and is responsible for avoiding 137,000 kilograms of CO_2 emissions.** Source: SOLTRAIN

NEW WORK

Solar Hot Water for 2030 Project Kicks Off in July

Worldwide, 250 million dwellings used solar thermal technologies for water heating in 2020. However, to reach carbon neutrality by 2050, as proposed by the IEA in their Net Zero by 2050: A Roadmap for the Global Energy Sector, we estimate that 170 million new conventional solar thermal technologies (e.g., thermosyphons and pumped circulation systems) and 120 million emerging solar systems (e.g., PV-driven systems) are needed.



▲ **Millions of dwellings use solar thermal. The horizontal red line represents the IEA target for 2030, the blue curve represents an S-curve of business as usual, and the dashed lines show future trends. SHC Task 69 aims to help 'fill the gap' through solar hot water systems, both existing thermosyphon and emerging PV solar-derived systems.** Source: Solar Heat Worldwide 2022 and Net Zero by 2050.

In our new SHC Task 69 on Solar Hot Water for 2030, we aim to shape an affordable, reliable path forward for the solar hot water market. The Task starts this July and will run through June 2025.

A team of experts from around the world will collaborate to identify opportunities to improve solar water heaters' performance, cost, and reliability, aiming to accelerate the rollout of best practices for these technologies to help meet national and international 2030 targets. The two technologies expected to play the biggest role in the solar hot water market are solar thermal thermosyphon and solar photovoltaic (PV) derived hot water heating systems. What is unique about these two different technologies is that they do not

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Solar Hot Water for 2030 — Questions to Answer in New Task

The international team of Task experts will work to answer these questions.

- What is the current distribution of hot water technologies installed by region? What are the existing barriers and opportunities?
- Which technologies are expected to be installed in these regions, considering the spectrum of economic development and climatic factors?
- What is the commercial best practice for thermosyphon systems and photovoltaic self-consumption water heaters?
- What are the potential advantages/disadvantages of deploying systems to integrate solar thermal thermosyphon systems and PV self-consumption systems with other energy systems?
- What are the 'most economic' and 'most efficient' options—and potential developments—for thermosyphon systems and photovoltaic self-consumption water heaters (i.e., including PV-powered heat pumps)?
- How much contribution can the 'lowest carbon' options make to emissions reductions (for thermosyphon systems and photovoltaic self-consumption water heaters)? (This is a function of location in terms of solar resource level, seasonal variation, and GHG intensity of backup fuels.)
- What regulatory/policy frameworks exist now/are needed in the future to ensure and/or encourage these two technologies (solar thermal thermosyphon systems and solar photovoltaic self-consumption) to be reliable, affordable, and clean sources of hot water?
- What minimum performance and reliability standards are in place for these technologies? What minimum performance and reliability standards should be recommended?
- What activities (e.g., training, R&D) are needed to facilitate rapid commercial manufacture/supply and deployment of water heaters in different regions across the world?

New Work *from page 18*

rely on pumped circulation, require little maintenance, have relatively low up-front costs, and have the potential for innovative "smart" control systems.

The project's work will be divided into four work streams.

- State-of-the-art and operating environments in different regions (Subtask A leader: Christoph Rohringer, Austria)
- Thermosyphon hot water systems (Subtask B leader: Bojia Li, China)
- Solar Photovoltaic Hot Water (Subtask C joint leaders: Richard Hall (UK) & Dean Clift (AU))
- Training and standards (Subtask D leader: Jianhua Fan (DK), Denmark)

Solar hot water collectors have long been the front-runners for providing clean energy to residential and commercial markets. In the coming decades, they will be relied on to meet the ever-growing heating demand. On average, water heating accounts for ~16% of primary energy use in residential buildings, and buildings consume ~35% of total primary energy. And solar thermal is the preferred renewable technology for water heating, especially where heat demand is low. In the IEA's Net Zero Emissions Scenario, solar thermal meets 35% of demand by 2050, up from 7% today. So stay tuned on how this Task's work and training opportunities for SHW installers and designers will support this target.

To learn more about SHC Task 69 or how to join, contact Robert Taylor of the University of New South Wales – Sydney, robert.taylor@unsw.edu.au, and He Tao of the China Academy of Building Research, iac@vip.sina.com. To follow the activities of this Task, visit the IEA SHC website, https://task69.iea-shc.org/.

"We tend to forget about hot water as a critical part of the energy mix…until we are forced to take a cold shower! We are now in the early stages of a seismic shift in how we make and use energy – so, for me, this new IEA SHC Task 69 on Solar Hot Water for 2030 is all about making sure hot water is not forgotten during our society's transition to a sustainable energy system. I believe that through international collaboration and coordination (within the Task), we can really impact the trajectory and the speed of the rollout of reliable and affordable solar hot water technologies."

ROBERT TAYLOR
Co-Task Manager

PROJECTS IN THE PIPELINE

Life Cycle and Cost Assessment for Heating and Cooling Technologies

To prepare for upcoming regulations and initiatives, the solar heating and cooling industry will need to be well aware of the overall life-cycle-energy and environmental performance of their products, not just in terms of production and use but also end-of-life treatment. This proposed project would build upon the earlier work of IEA SHC Tasks 38, 48, 53 and IEA PVPS Task 12 to produce methodology guidelines and compile reliable data for the economic and environmental evaluation of solar heating and cooling technologies.

For more information, contact the Task Organizer, Karl-Anders Weiss at karl-anders.weiss@ise.fraunhofer.de.

Low Carbon, High Comfort Integrated Lighting

The Task's proposed goal is to identify and support lighting – electric and façade (daylighting and passive solar) while aligning people's lighting needs with digitized lighting on the building and building-related urban scale. The proposed structure for this Task is illustrated to the right.

For more information, contact the Task Organizer, Jan de Boer at jan.deboer@ibp.fraunhofer.de.

Fall School 2022 – Solar Neighborhood Strategies & Concepts

Preparations for the second Fall School of SHC Task 63 on Solar Neighborhood Planning are underway. The main objective of the course is to introduce and discuss various strategies and methods to assess and evaluate solar neighborhood strategies and concepts from different perspectives and standpoints

Presentations and discussions will serve as the groundwork to better understand the various perspectives that should be considered when selecting a neighborhood's passive and active solar strategies. These perspectives can encompass life cycle analysis, solar technologies integration, techno-economic aspects, simulations and multi-criteria solutions, impact on energy goals and sustainable developments, and other practical, social, and technical aspects. The preliminary list of potential topics includes,

1. Status of solar technologies deployment and 100% renewables
2. Life cycle of solar technologies and impact
3. Socio/economic aspects
4. PV and solar thermal collector integration in buildings
5. Neighborhood simulations to analyze different solar strategies
6. Overview of various strategies and applications
7. Technologies and sustainable developments – case study from an industry perspective

What makes this "school" unique is that it draws from the expertise of the participants in SHC Task 63 and other prominent people in various fields of solar energy applications (including simulations). Students will learn from those working in industry, academia, and research institutions.

The Fall School will be a 5-day course with student presentations on the last day during the SHC Task 63 meeting in Calgary, Canada. The first four days (September 6, 8, 13, and 15) will be online and the last in-person day will be a showcase of the students' work and a networking opportunity with the SHC Task participants. Students will work in groups on a project that explores the integration of various solar technologies and strategies while analyzing differing perspectives of those who would be involved in the decision-making process.

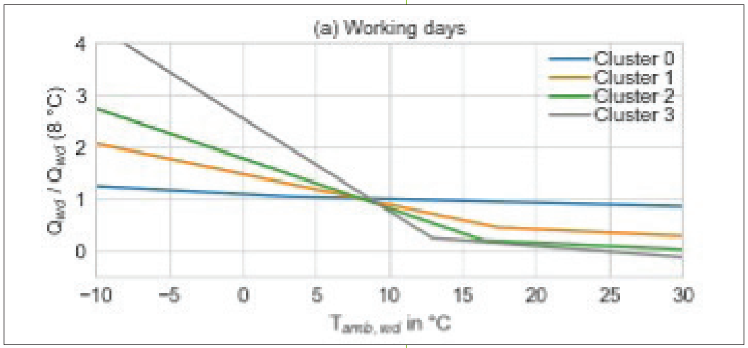
Ph.D. students and Advanced Master's students are welcome.

For more information, contact Dr. Caroline Hachem-Vermette at the University of Calgary, caroline.hachem@ucalgary.ca.

How Load Profile and Roof Area Limit Solar Fractions of SHIP Plants

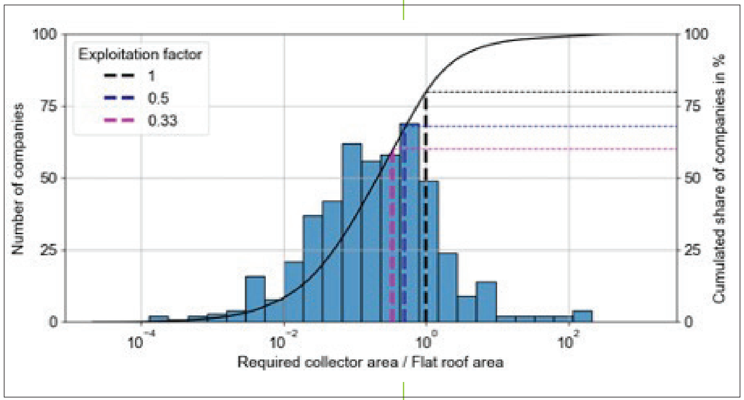
Solar heat for industrial processes (SHIP) is a pivotal technology to decarbonize the industrial heat demand worldwide. And participants in SHC Task 64 on Solar Process Heat are working on the system level to identify, verify, and promote the role of solar heating plants in combination with other heat supply technologies.

One area SHC Task 64 experts are focusing on is the heat load, and they have produced reference heat load profiles for industrial applications with different shares of space heating demand have been developed (SHC Solar Update, December 2020). Figure 1 shows these load profiles as a function of the ambient temperature: Cluster 0 represents classical industries such as chemicals, food, etc., in which the heat load is constant throughout the year. In contrast, Cluster 3 represents industries whose load profiles are strongly correlated with the ambient temperature as space heating of halls plays a significant role, which is typical for the manufacturing industries, for example.



▲ **Figure 1. Reference load profiles showing the ambient temperature dependency.**

In a recent study, Felix Pag, head of SHC Task 64 Subtask A on Integrated Energy Systems, analyzes the influence of the heat load profiles over a year on the possible solar fractions in Northern Europe. In this study, a collector field is pre-designed according to the summer heat demand following the methodology of the VDI guideline 3988 for 489 industrial companies whose load profiles were available. The resulting collector area is compared to the available roof area, which is analyzed from OpenStreetMap data.



▲ **Figure 2. The absolute number of companies and cumulated share of companies as a function of the relation of the required collector area and the flat roof area (area availability factor) in logarithmic scale. The exploitation factor represents the relation of the collector area to the roof area.**

The results show that the majority of companies have enough roof area available to cover their summer heat demand with solar collectors. Assuming a realistic utilization of the roof area (exploitation factor 0.33, meaning the roof area is three times bigger than the collector area), only 40 % of the companies do not have sufficient roof area, as shown in Figure 2.

But the load profile often limits the potential solar fractions even more. Figure 3(a) shows the potential solar fractions of every company, neglecting the collector area's potential limitation by the roof size. Obviously, companies from Cluster 0 with a constant heat load profile over the year have a high summer heat load compared to winter load and consequently can achieve high solar fractions of up to more than 40%. On the other hand, the more space heating is included in the heat load, the more the solar fraction is reduced. So, companies from Cluster 2 rarely achieve more than 10%. Figure 3(b) shows the potential solar fractions of the roof area availability considering an exploitation factor of 0.33. The solar fractions of the companies with limited roof area compared to the potential collector area are significantly reduced (right of the dashed line), partly from more than 40% to below 5%.

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SHIP Plants *from page 21*

The results of this study imply two main consequences for the design of future solar process heat systems:

1. If the heat load profile is seasonal, the solar collector area should be oversized compared to the VDI 3988 to reach higher solar fractions.
2. Solar solutions must focus on combining with other technologies, such as heat pumps, and highlighting synergies.

Both these consequences are part of the upcoming work in Task 64 Subtask A. And the results will be shared with the public on the SHC website.

This article was contributed by Felix Pag of the University of Kassel, Institute of Thermal Engineering, and leader of Task 64: Solar Process Heat, Subtask A: Integrated Energy Systems. For more information on this work and other Task news, visit the SHC Task 64 webpage, https://task64.iea-shc.org/.

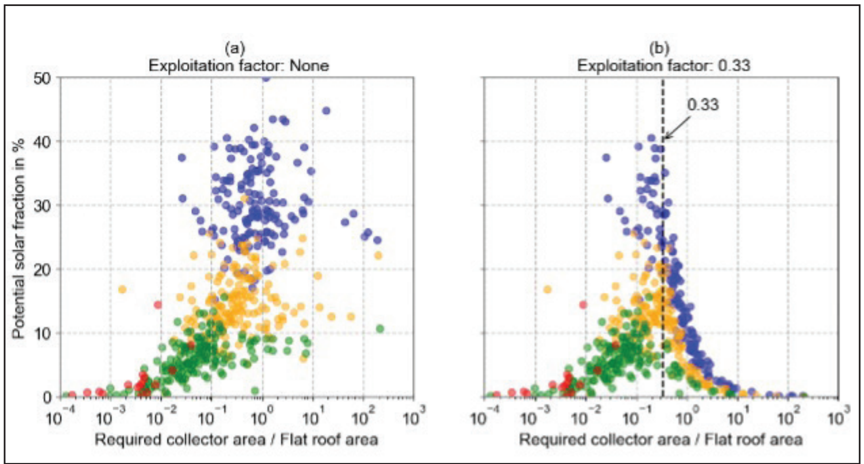

Figure 3. The potential solar fraction is shown as a function of the relation of the required collector area and the flat roof area (area availability factor). In (a), the collector area is as large as needed according to the VDI 3988 and is not limited to the roof area. In (b), only one-third of the total roof area is utilized as collector area at a maximum representing a realistic exploitation factor of 0.33. The dashed line shows the insufficient threshold above which the roof area is insufficient.

Registration is Open!

This September, the University of Kassel will host EuroSun 2022!

What makes this EuroSun unique? It will be the first time ISES and IEA SHC are co-organizers.

Why is this worth noting? It means that the conference is drawing speakers and participants from two leading international solar organizations.

How will this impact the conference? The technical presentations will cover an array of solar applications from solar buildings to water purification, solar components from PVT to storage, and cross-cutting themes from grid stabilization to renewable energy education. Plus, speakers are coming from around the world – a total of 63 countries. And presentations will cover new research, practices, and policies leading no doubt to robust discussions from the plenaries, keynotes, and technical sessions to the coffee breaks and social events.

Registration News

Conference registration fees are structured to save you money. How many 10% discounts do you qualify for?

There will be many oppportunities for the next solar generation. As conference co-chair, Klaus Vajen notes, "for the very the first time, we invite 100 students to participate in the conference free of charge, plus there will be a Young ISES party, dedicated networking opportunities with senior experts from research and industry, and a special Masters Course in Solar Energy."

See you in Kassel!

Registration link and information – www.eurosun2022.org/registration-0

Compact Thermal Energy Storage Materials

IEA SHC is again partnering with the IEA Energy Storage (ES) Programme to tackle storage issues. Building on earlier projects, IEA SHC and IEA ES are collaborating to push compact thermal energy storage technology developments and accelerate the market introduction of these technologies. To achieve these goals requires a diverse international team of experts from materials research, components development and system integration, and industry and research organizations.

The objectives of SHC Task 67/ES Task 40 on Compact Thermal Energy Storage Materials are fourfold: 1) better understand the factors that influence the storage density and the performance degradation of Compact Thermal Energy Storage (CTES) materials, 2) characterize these materials in a reliable and reproducible manner, 3) develop methods to determine the State of Charge of a CTES effectively, and 4) increase the knowledge base on how to design optimized heat exchangers and reactors for CTES technologies.

To meet these objectives, the project participants will work in five focused areas:

- Subtask A: Material Characterization and Database
- Subtask B: CTES (Compact Thermal Energy Storage) Material Improvement
- Subtask C: State of Charge – SoC Determination
- Subtask D: Stability of PCM (Phase Change Material) and TCM (Thermochemical Material)
- Subtask E: Effective Component Performance with Innovative Materials

As Wim van Helden, the SHC Task Manager, notes, "A number of improved CTES materials were developed in the first joint SHC and ES Task, SHC Task 58/ES Task 33. In this new collaborative Task, we will take the developments a step further by gaining more knowledge on the mechanisms behind materials performance to increase our possibilities to enhance CTES materials in a targeted and more efficient manner."

Since the start of the Task in October 2021, the experts have been working hard. Below are some of the activities and findings of the first two Subtasks.

Material Characterization and Database

The joint Task's work on material characterization and a database fall under the work of Subtask A. This Subtask is dedicated to standardized measurement procedures for thermal energy storage materials and further expanding and maintaining the existing material and knowledge database available here, https://thermalmaterials.org/.

In the prior joint SHC Task 58/ES Task 33 on Material & Components for Thermal Energy Storage, new materials were found and developed in research projects by the participating partners. And measurement procedures were advanced to identify these materials' main physical or chemical parameters. Some applied measurement procedures have since been validated, while others are just at the beginning of the process. More details on

"In this new collaborative Task, we will take the developments a step further by gaining more knowledge on the mechanisms behind materials performance to increase our possibilities to enhance CTES materials in a targeted and more efficient manner."

WIM VAN HELDEN
SHC TASK 67 TASK MANAGER

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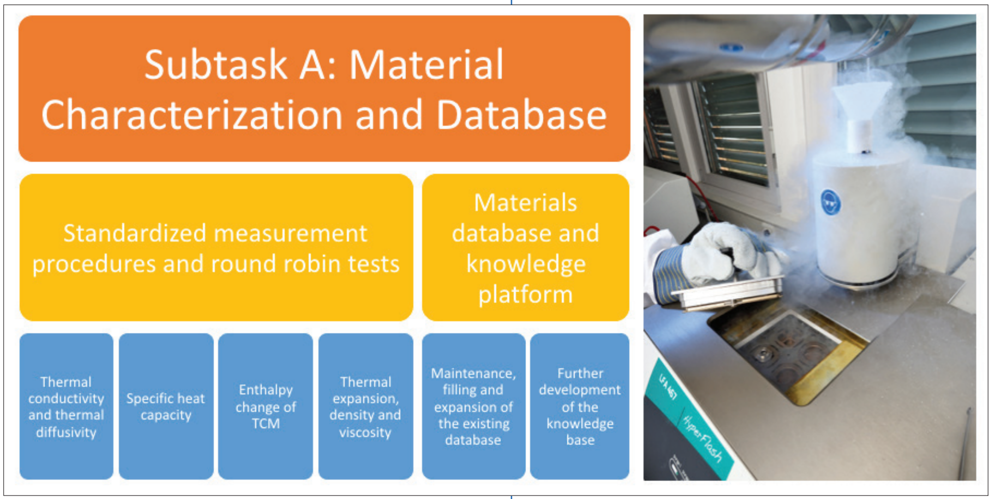
these procedures can be found in the SHC Task 58 report, Material and Component Development for Thermal Energy Storage: TCM measuring procedures and testing under application conditions.

In this current Task, participants will carry on the previous work to expand the database with other classes of materials, especially thermochemical storage materials, and to encourage its use by experts working in the field.

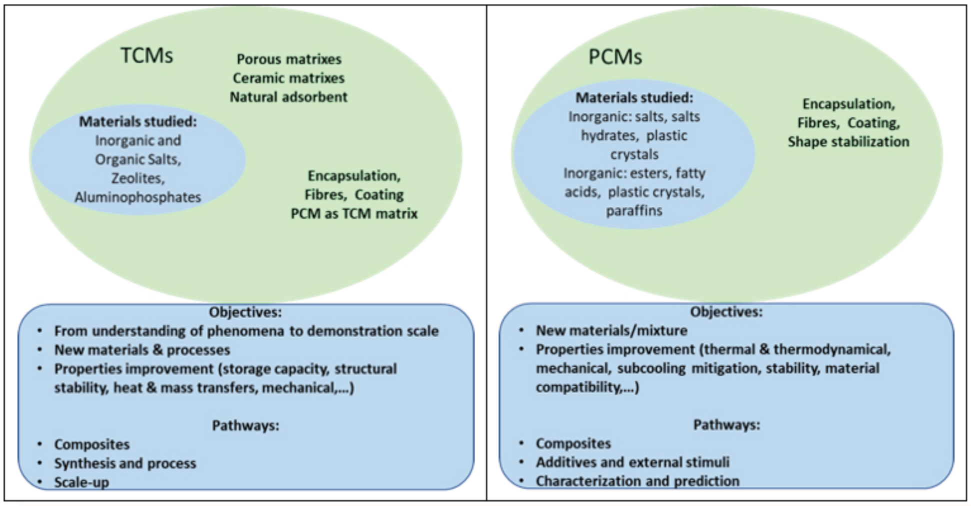
And measurement activities will continue with standardized measurement procedures further developed based on round robin tests on thermal conductivity and specific heat capacity, enthalpy change due to sorption/chemical reactions, thermal expansion, and viscosity. Thirty-seven organizations from 14 countries have recently started their round-robin measuring campaigns (see Figure 1).



▲ **Figure 1. Work structure of Subtask A.**

CTES Material Improvement

The work in Subtask B focuses on improving compact thermal energy storage materials (tailored materials and composites) with the primary objective of identifying proper strategies to tune the reactivity of CTES materials, thus improving their properties and final performances. It is generally known that TES materials must fulfill several requirements to be considered good candidates for the targeted applications. For this reason, key parameters need to be improved, including energy storage density, kinetics, thermal conductivity, mechanical properties, cycling behavior, compatibility, and ability to be engineered into a practical system. This implies identifying ad-hoc strategies to design advanced functional materials to substantially impact (simplify) the TES system design and cost.



▲ **Figure 2. Example of the materials covered in Subtask B.**

The materials targeted in Subtask B are PCMs, focusing both on solid-liquid and solid-solid transitions and composites or shape-stabilized derived materials, and TCMs, focusing both on sorption processes (ad- and absorption) and chemical reactions (mainly gas-solid systems). Figure 2 shows an example of the materials to be studied and the paths for improvement.

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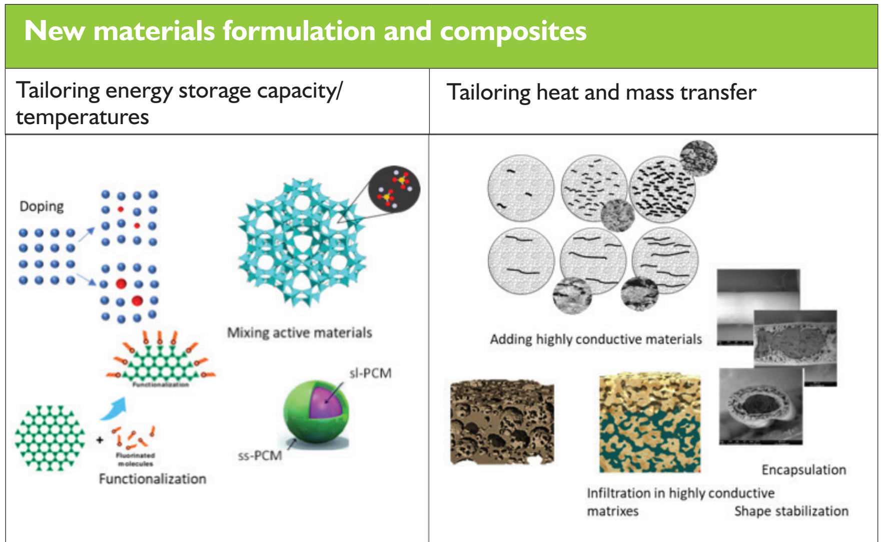
Compact Thermal Energy Storage Materials *from page 24*

Figure 3 shows how the research includes tailoring energy storage capacity/working temperature through crystal structure modification, functionalization, and nanostructured materials. New Composites are designed by mixing active and porous inorganic and organic materials. Enhancing heat and mass transport properties by 1) adding highly conductive materials, 2) infiltration in highly conductive matrixes, and 3) material with high thermal conductivity (foam/fibers). Improving integration into the application using 1) shape-stabilization, 2) granulation with active and inactive binders, 3) coatings, and 4) monoliths.



▲ **Figure 3. Materials modification strategies studied in Subtask B.**

In the Subtask, the expertise and research work of more than 20 institutions and experts in the thermal energy storage field is being shared to define common guidelines (including strategies for material improvement and definition of KPIs) in close collaboration with the other Subtasks of SHC Task 67/ES Task 40.

Following this strategy, the preliminary work has included building a map of all the materials studied by the experts involved, including 1) the types of materials, 2) the improving strategies, 3) the main goals of the research, and 4) the application addressed. Experts have also identified synergies between the different research entities. Working groups will take the next steps, which include defining KPIs and preparing (by the end of 2022) a joint document on guidelines for materials improvement summarizing the most relevant findings of the experts participating in Subtask B in connection with the scientific community work.

To learn more about SHC Task 67, visit the Task webpage https://task67.iea-shc.org. If you have questions, contact the SHC Task Manager, Wim van Helden at w.vanhelden@aee.at.

MarketPlace

The Solar Heating and Cooling Programme is not only making strides in R&D but also supporting the growth of the solar thermal sector. This section of the newsletter highlights the link between our R&D work and its practical impact on the world.

Solar Thermal Collector Testing Standard

ISO 9806 is the international standard for the testing of solar thermal collectors. As all solar thermal applications use collectors, this standard is the core standard for the whole solar heating and cooling community. ISO 9806 is not only relevant for testing, certification, and subsidies, it is highly relevant for R&D and designing and dimensioning solar thermal systems.

This standard covers a vast range of products – standard flat plate collectors, evacuated tube collectors, swimming pool heaters, process heat collectors, and hybrid PVT collectors.

Every device that converts solar radiation directly into heat, whether liquid heating collectors or air heating collectors, is covered by this single standard.

It is now time to revise and update the 2017-issued ISO 9806 standard. By definition, standards undergo a critical review and revision about every five years. The technical committee registered this revision in May 2022. The revision is managed by the ISO/TC 180/WG4 under the project lead of Andreas Bohren, head of the Swiss SPF Institute for Solar Technology (www.spf.ch). The working group is comprised of experts from testing laboratories and industry. All of whom are driven by their conviction that solar thermal technologies are core technologies for decarbonization.

Strong standards are relevant to developing the industry, demonstrating solar thermal advantages, and reducing trade barriers.

Standardization work is usually not considered the most exciting way to spend one's time. But making standards is a great opportunity to support the industry and guide the technology in a good direction. The process is open to all experts and stakeholders of ISO member countries. If you want to become part of this process, please contact your national standardization body (address under www.iso.org/members.html) and ask to become a member of the ISO/TC 180/WG4.

If you have questions about the procedures and working plan, please contact the project leader Andreas Bohren at andreas.bohren@ost.ch. But don't wait too long; the revision was launched in June 2022, and the relevant technical work will be completed by the end of this year.

Simulation Tools To Reduce Financial Risk of SHIP Plants

Low uncertainty simulation tools can reduce the financial risk of solar projects and foster the transition to a sustainable energy system. This is why participants in IEA SHC Task 64/IEA SolarPACES Task IV on Solar Heat Processes are working to address the lack of standard simulation tools for Solar Heating of Industrial Processes (SHIP) plants. Several simulation tools are readily available to developers that can provide a variety of technical and financial results and sensitivity analysis but often produce significant differences in yield assessment and uncertainty levels. How SHC/SolarPACES researchers are working with simulation tools to address these differences is described in the Energies journal article, "Assessing the Uncertainties of Simulation Approaches for Solar Thermal Systems Coupled to Industrial Processes."

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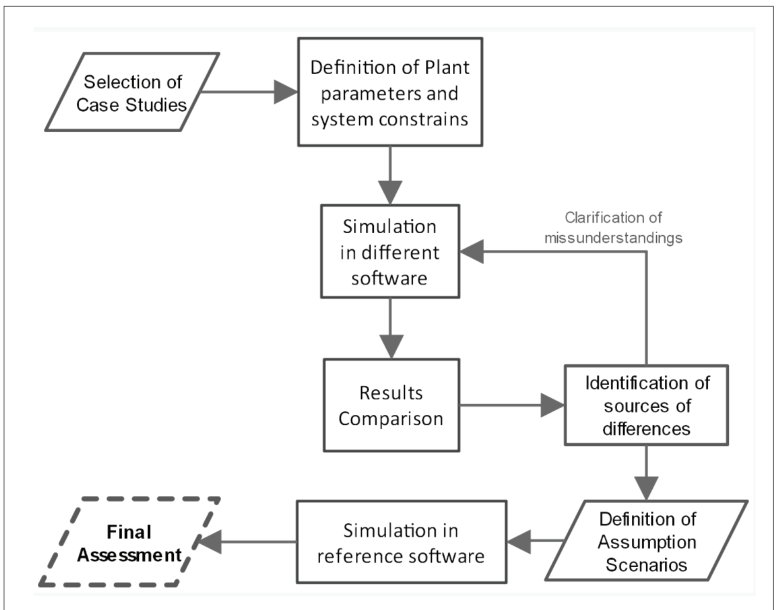
MarketPlace *from page 26*

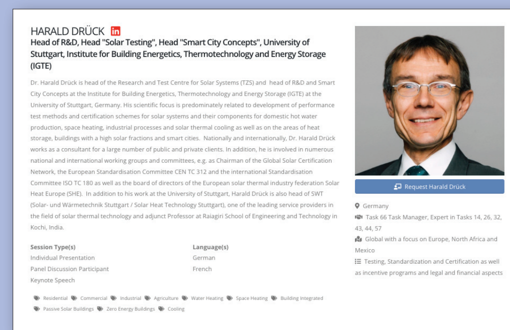
In brief, the identification and classification of several available simulation tools are performed based on their capabilities and simulation approaches. And a case study of solar heat supply to a copper mining operation provides a basis for comparing the results of equivalent simulation tools. This methodology allowed the researchers to identify the main differences among the simulation tools used for yield assessment in SHIP systems. In addition, the effects of physical characteristics of SHIP plants and different simulation approaches also were quantified. The results have supported the development of a basic guideline for a standardized yield assessment procedure with known uncertainties. Creating this common framework could partially reduce the risk perceived by the finance industry regarding SHIP systems.



▲ **Methodology implemented to identify the sources of differences in the results of energy yield assessments employing different simulation tools (software).** Source: *Energies 2022,15(9), 3333; https://doi.org/10.3390/en15093333*

New SHC Resource

Solar Speakers Directory



The IEA SHC Programme has a new resource – the "Solar Heating and Cooling Superstars" speaker directory. This one-of-a-kind resource is a list of qualified solar heating and cooling experts available to share their expertise at your next event.

The user-friendly online format lets you search by topic area, event session type, and language. Plus, each speaker has provided a short bio and other background information to help you decide the best match for your event.

If you find a potential speaker you would like to invite to your event, then you simply click "Request (name)" below their photo to submit your request.

If you would like to be considered for the directory, email SHC Secretariat, secretariat@iea-shc.org, for more information.

SHC Publications

New Publications Online!

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

Solar Heat Worldwide 2022

This is the most comprehensive report on the solar thermal market and trends. Data from 70 countries, representing 95% of the solar market, provides the basis for this comprehensive annual report on solar heat. It is divided into two parts: Part 1(Chapters 3-4) covers global market developments in 2021 and highlights trends for different applications and Part 2 (Chapters 5-7) presents detailed market figures for 2020.

SHC Annual Report 2021

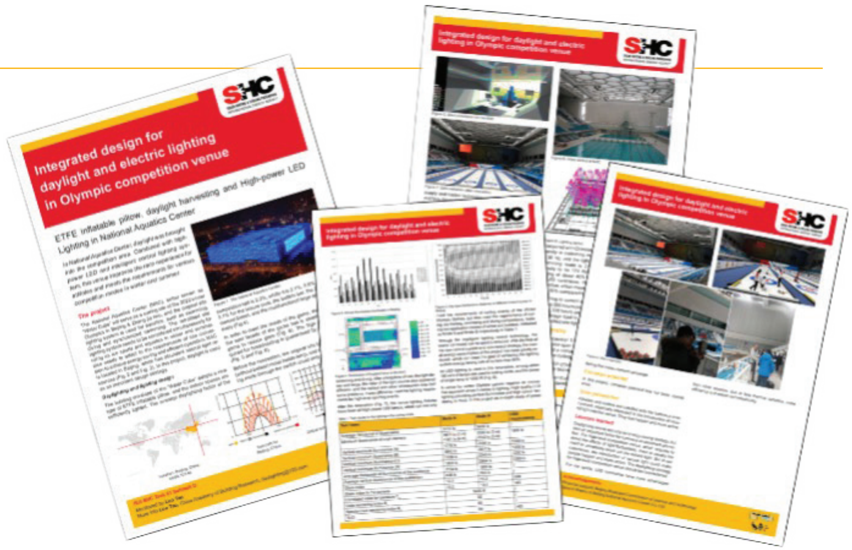
The 2021 report features a special article on solar district heating and cooling.

Solar Neighborhood Planning
Identification of existing tools and workflows for solar neighborhood planning

Many different tools are available today that can perform (advanced) solar analyses for solar neighborhoods. This SHC Task 63 report focuses on the state-of-art tools for solar neighborhood planning and the Key Performance Indicators (KPIs) commonly used in countries participating in the Task. The report is divided into the following sections: Overview of existing tools for solar neighborhood planning (Chapter 2), National Common Indicators (NCI) (Chapter 3), Work flow stories (Chapter 4), Comparative study (Chapter 5), and Discussion (Chapter 6).

Daylighting & Electric Lighting
Case Studies

Twenty-five case study fact sheets on daylighting and electric lighting in office, retail, sport/recreation, health, and residential buildings in 12 countries are now online. Each SHC Task 61/EBC Annex 77 fact sheet analyzes the lighting application and concisely summarizes the findings – The project, Monitoring (energy, photometry, circadian potential, user perspective), and Lessons learned.



IEA SHC programme

The International Energy Agency was formed in 1974 within the framework of the Organization for Economic Cooperation and Development (OECD) to implement a program of international energy cooperation among its member countries, including collaborative research, development and demonstration projects in new energy technologies. The members of the IEA Solar Heating and Cooling Agreement have initiated a total of 67 R&D projects (known as Tasks) to advance solar technologies for buildings and industry. The overall Programme is managed by an Executive Committee while the individual Tasks are led by Operating Agents.

Follow IEA SHC on

SOLARUPDATE

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