SOLARUPDATE

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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

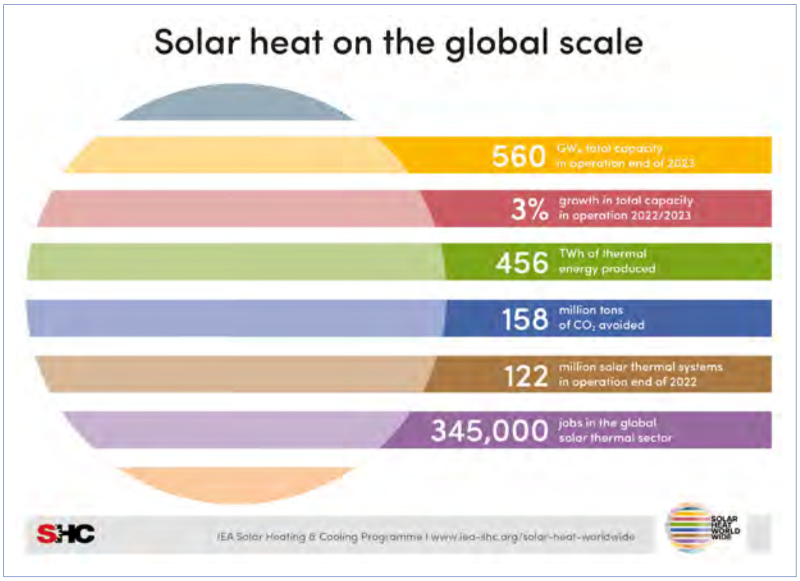
In This Issue

Solar Heat Worldwide

2024 EDITION

Our flagship report, Solar Heat Worldwide 2024 is the most comprehensive evaluation of solar heating and cooling markets, encompassing data from 72 countries. The 2024 edition is available for free on the IEA SHC website. Highlighted below are a few of the findings from this year's report.

In 2023, **18 GWth** or **26 million square meters** of collectors were installed, an increase in cumulative global installed capacity of 3% in 2023 compared to 2022. The annual solar thermal energy yield was **456 TWh**, saving **49.1 million tons of oil** and avoiding **158.4 million tons of CO_2**. With **122 million systems** in operation, the total operational solar thermal capacity reached **560 GWth**. What is behind these numbers can be found in detail in the report.



Market Trends and Developments in 2023

In 2023, there was a noticeable shift in solar markets from the traditionally strong European countries and China to emerging markets in Africa, Southeast Asia, and Latin America. This growth was counterbalanced by a decline in the largest

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solar heat market, China. Commanding over 70% of the global market share, China's 7.7% market decline, driven by challenges in the real estate sector, significantly impacted the global market landscape.

While the major solar thermal markets have faced declines, the resilience of the technology shines through as other markets steadily grow. As Lucio Mesquita, the Chair of the IEA SHC Programme, notes, *"This reaffirms the versatility and adaptability of the technology, signaling a promising future for solar heat applications worldwide. Market growth from 2022 to 2023, for the first time, was not dominated by European countries highlighting this shifting landscape."*

Taking a closer look at the market growth outside of China and Europe in Figure 1 reveals upward trends in Latin America and Sub-Sahara Africa, alongside rebounds in the MENA region.

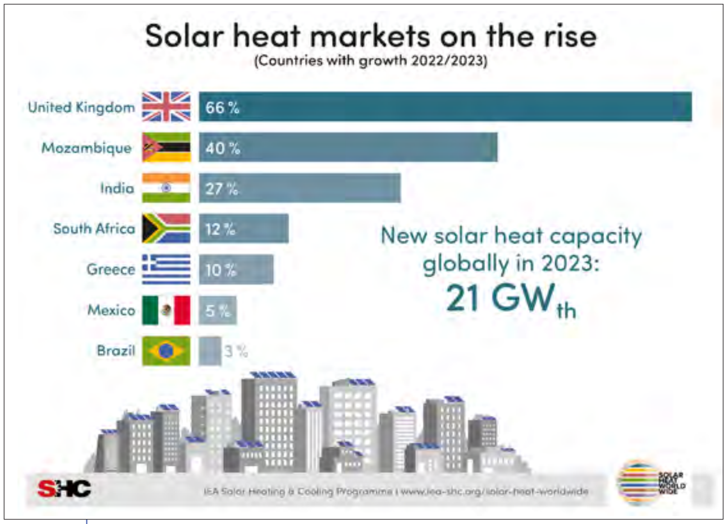
Sectors on the Move

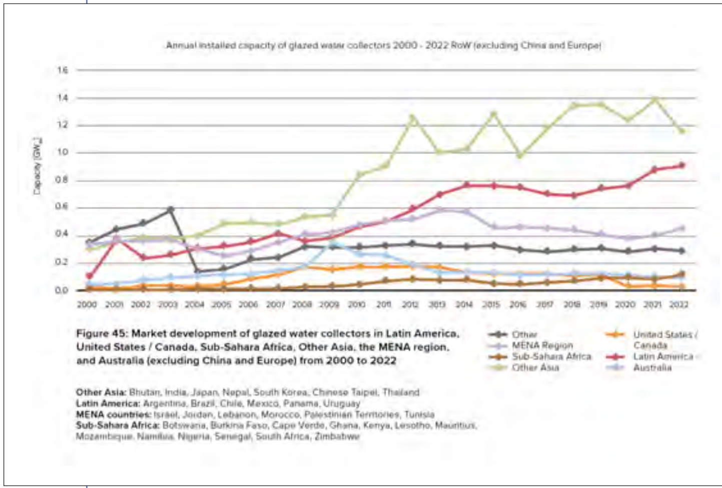
Large-scale Solar Heat Systems

At the end of 2023, there were **598 large-scale solar heat systems** operating, collectively totaling **2.3 GWth** of installed capacity and covering **3.3 million m²** of collectors. Historically dominated by Denmark, the Danish solar district heating market suffered a collapse in 2020 due to significant shifts in energy technology policy and funding conditions. This void has since been filled by other European countries, such as Germany and Austria, as well as China.

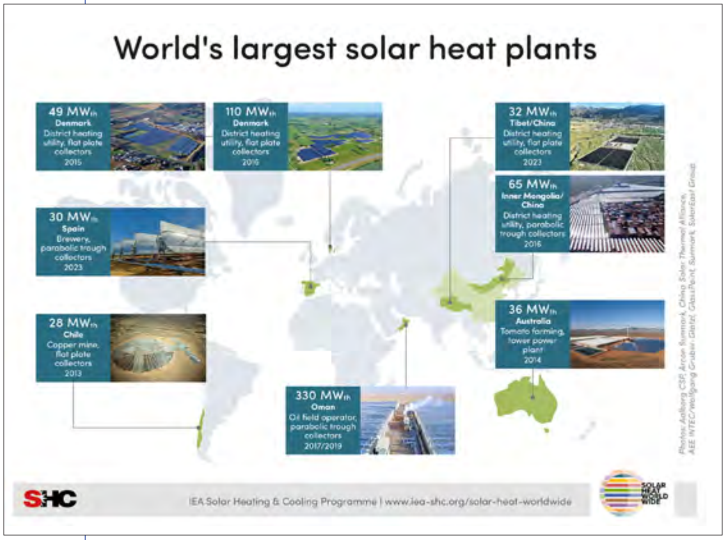
Solar district heating

Large-scale solar thermal heating systems meet a variety of heating needs, with solar district heating being the largest sub-sector. By the end of 2023, there were **336 large-scale solar district heating systems** (>350 kWth, 500 m^2) in operation, with a total installed capacity of **1,908 MWth (2.73 million m²)** were reported in operation. As shown in Figure 2, Denmark leads in this market segment, having the most systems and the largest installed area. Alongside Denmark (124 systems) and China (72 systems), several other countries have a growing interest in solar district heating for decarbonizing neighborhood and city heat sectors. Countries to note are Germany (56 systems, some with seasonal storage), Sweden (23 systems), Austria (20 systems), and Poland and France (with 8 systems each). Outside of Europe and China, solar district heating systems are installed in Saudi Arabia, Japan, Kyrgyzstan, Russia (Other Asia), the USA, Canada, and South Africa.





▲ **Figure 1. Market development of glazed water collectors from 2022 to 2022.**



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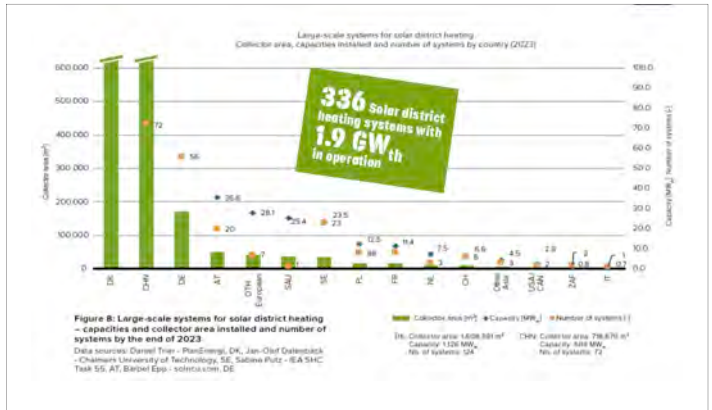
Solar heat in industrial processes (SHIP)

In 2023, at least **116 new SHIP systems** with a capacity of 94 MWth were installed. This is the same number of systems installed in 2022. So, what makes 2023 noteworthy? First, the **average system size more than tripled** compared to 2022. Second, concentrating collectors replaced flat-plate collectors as the predominant choice, especially in larger systems. From January 2023 to March 2024, 11 solar systems for industrial process heat with **concentrating collectors** were installed, totaling 120 MWth in capacity. Interestingly, most of these installations were at breweries. Additionally, in early 2024, an extraordinary plant was completed for the tourism industry in China using a parabolic trough collector system to supply snow for an indoor ski hall and heating and cooling for the Handan Bay Water World.

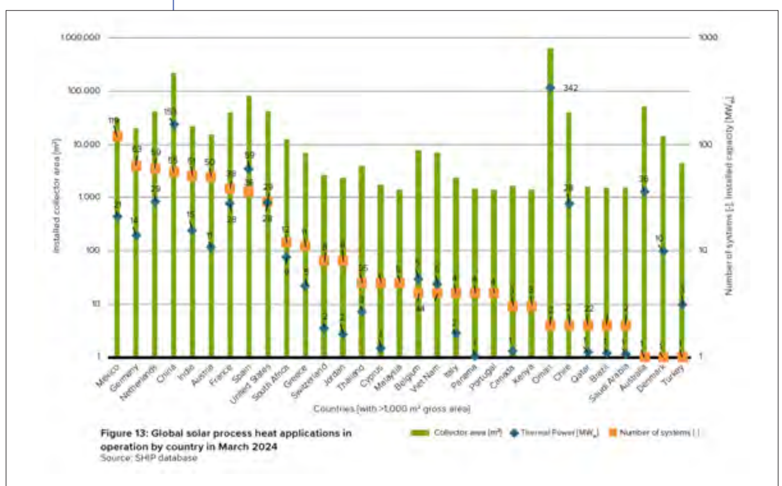
PV2Heat

PV2Heat systems connect the direct current (DC) from rooftop photovoltaic (PV) panels directly to a DC resistance heating element in the hot water tank, eliminating the need for inverters and minimizing intermediary electronics. These systems are well-suited for areas with unreliable grid service, high connection costs, or low initial capital. With the decreasing costs of PV technology, PV2Heat systems have become an attractive alternative for hot water generation. They also offer benefits such as eliminating the need for rooftop hot water storage tanks and avoiding issues with stagnation or frost. This technology has gained significant traction in recent years, especially in southern Africa. In **South Africa, 34,000 PV2Heat systems** have already been installed.

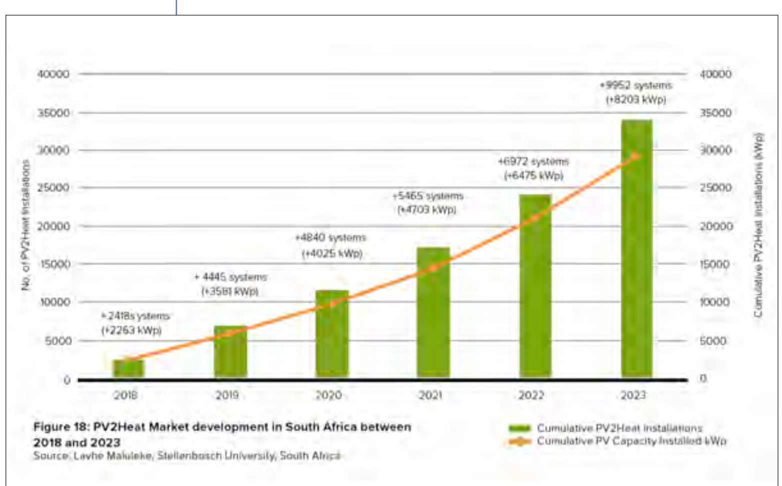
Explore the latest developments in all the solar heat technologies in our report, Solar Heat Worldwide*, and make use of our infographics showcasing key insights, available for free at* here.



▲ **Figure 2. Solar District Heating systems at the end of 2023.**



▲ **Figure 3. Solar Heat in Industrial Processes (SHIP) systems in operation in March 2024.**



▲ **Figure 4. South Africa's PV2Heat market growth from 2018 to 2023.**

IEA SHC Solar Award 2024
Five Projects Shortlisted

Five projects shortlisted for the International Energy Agency Solar Heating Programme (IEA SHC) 2024 SHC SOLAR AWARD. The winner will be announced at the award ceremony on August 29th during the ISES and IEA SHC co-organized conference, EuroSun 2024, in Limassol, Cyprus.

The 14th IEA SHC Solar Award recognizes projects that reduce **costs and emissions by incorporating solar thermal technologies in an industrial process.** Eighteen projects were nominated, and five were shortlisted after careful evaluation by an international team of judges. The recipient of the 2024 Solar Award will be one of our five finalist projects from France, Kenya, Spain, Uganda, and the United States.

LACTOSOL – VERDUN, FRANCE

LACTOSOL demonstrates an industrial process that competitively reduces gas consumption using solar heat technology at the process level.

LACTOSOL uses solar heat to convert liquid whey, a by-product of cheesemaking, into whey powder for the food industry. A gas boiler powered the drying tower used to dry the liquid whey, so it turned to solar when the company Lactalis Ingredients wanted to meet its carbon footprint reduction commitment. Newheat took this opportunity to design, build, and finance the solar thermal plant using an onsite proprietary hot water loop. The results show that the solar thermal plant generates about 8,500 MWh, reducing the site's gas consumption by 6% (11% for the drying tower and 30% for preheating needs) and CO_2 emissions by 2,000 tons per year.

LACTOSOL is France's largest solar thermal plant and the second largest in Europe, serving an industrial site. The process level integration of this project is a unique showcase of the potential to decarbonize heat in industrial processes competitively and effectively. The project was developed under the "Heat as a Service Scheme," with Newheat as a majority shareholder and EPC contractor, thus taking on the technical and financial risk for the project. This model is particularly promising for developing industrial solar heat – it allows the industrial heat consumer to focus on their core business.

► **LACTOSOL plant in Verdun, France, collaborates with Newheat to manage the technical and financial aspects of the solar heat technology in its cheesemaking process.**
Project: NEWHEAT / photo credit: IMAGESinAIR Productions

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SOLCOOLDRY – MWAZARO, KENYA

SolCoolDry project demonstrates the advantages of a 100% solar-powered, off-grid food processing system for ice production and drying.

The SolCoolDry project combines the advantages of solar thermal and photovoltaics for two processes: ice production and food drying. Located in the southern coastal region of Kenya, the combination of solar applications – solar thermal and photovoltaics – means the local fishermen and other farmers have a 24-hour running solar drying system to dry produce and locally produced ice for cooling fish and other produce.

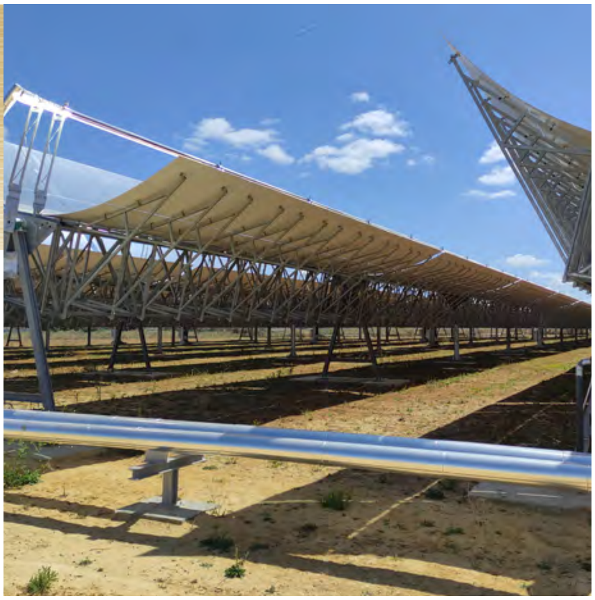
The first part of the SolCoolDry system consists of a 15-kilowatt peak rooftop photovoltaic system with three inverters and a 19.2 kilowatt-hour Lithium NMC battery storage. This powers the flake ice machine and the ice storage room. The second part of the system is two solar tunnel food dryers using heated air during the day. One of the dryers is equipped with a heat exchanger supplied with heat from a 2000-liter hot water storage tank, which is heated by 12 m^2 of flat-plate collectors during the day so that it can run for 24 hours. To make the system totally independent, a water treatment system is being built to use the groundwater on-site instead of an outside water supply.

▲ **SolCoolDry facility in Kenya uses a combination of solar thermal and solar PV for food drying.**
Photo credits: Fraunhofer Institute for Solar Energy Systems ISE

The success of this self-sufficient, off-grid food preservation and processing system has significantly reduced post-harvest losses and caught the attention of others. The Kenyan solar enterprise WeTu at Lake Victoria is replicating this system, and there is no doubt that this is only the beginning of similar Kenyan implemented projects.

HEINEKEN SEVILLE – SEVILLE, SPAIN

The Heineken Seville brewery holds the title of largest solar thermal plant for industrial use in Europe and marks the first use of Concentrated Solar Power (CSP) technology in a factory, reducing gas consumption by 60%.



Heineken Seville combines thermodynamic principles and CSP technology into a factory setting for the first time. This pioneering technological advancement significantly enhances energy reliability and availability by doubling the production capacity of superheated water for industrial use. Plus, using water as a heat transfer fluid eliminates the need for synthetic oils that could potentially harm the environment. The 7-hectare solar field with 43,414 m^2 of mirrors and CSP (Concentrated Solar Power) solar thermal technology has an installed thermal power of 30.38 MW and thermal storage of 68 MWh. What this means for the environment is an emissions reduction of 8,924

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tons of CO_2 annually and a 60% reduction in fossil fuel consumption.

With an investment of 20.47 million euros in a public-private collaboration involving ENGIE Spain, Heineken Spain, and national, regional, and local public administrations, the project is co-financed by the European Regional Development Fund (FEDER) and managed by the Institute for Energy Diversification and Saving (IDAE). Heineken Spain and ENGIE Spain have formed an alliance through a Thermal Purchase Agreement (TPA), where Heineken pays for the energy consumed and provides the land, while ENGIE commits to supplying fully renewable energy at a predetermined price. After 20 years, the solar thermal plant will transfer ownership to Heineken.

► **Heineken Seville's Thermal Purchase Agreement with ENGIE Spain leads to the first of its kind, a factory using Concentrated Solar Power (CSP) and Europe's largest SHIP (solar heat for industrial processes) plant.**
Photo credits: AZTEQ/Solarlite - Engie

SOLAR FOOD PROCESSING – KANGULUMIRA, UGANDA

Fruit, especially pineapples, have been sundried for decades in Uganda. However, the production process was hampered by production losses of up to 40%. This project demonstrates an integrated farm2fork system solution for a self-sufficient solar pineapple drying facility.

This holistic agriculture approach takes pineapples from the field to a 100% solar-processed product for international markets. 100% solar with a 5-year payback is achieved by combining solar heat (covering 80% of energy needs with photovoltaic (covering the remaining 20%). What makes this project, TWIGA Sun Fruits, unique is its focus on sustainability – Economic impact: local production and shortened value chain from producers to consumers; Social impact: high-quality jobs for women in rural regions; and Ecological impact: 100% solar-powered operations.

▲ **Farming cooperative turns to solar heat to improve drying process and increase production. Strong partnerships have led to a project that goes beyond fruit drying to economic, ecological, and social benefits for surrounding communities.**
Photo credit: Russel Pictures, Uganda

Based on Appropriate Technology, the system is easily adaptable to different countries and agricultural products. Its innovative use of solar thermal energy for process heat distinguishes it in sub-Saharan Africa, which hosts only 0.4% of global solar thermal applications. Additionally, integrating an ERP software solution ensures complete product traceability to the agricultural producer, enhancing transparency, including farmer payments. Partnerships are central to this project, involving cooperation with smallholder farmers, the solar company All in Trade Ltd (AiT), Makerere University (MAK), the Management Center Innsbruck (MCI), and the University of Innsbruck for expertise in food processing, energy efficiency, and renewable energies.

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BALL CORPORATION
FAIRFIELD, CALIFORNIA, UNITED STATES

The Ball Corporation, one of the world's largest producers of aluminum packaging specializing in beverage cans, turns to solar heat to produce up to 8 million aluminum cans daily at its Fairfield, California plant.

Using solar thermal at its Fairfield facility demonstrates why solar is a sound financial and environmental decision. This manufacturing site requires substantial heat, around 60°C (140°F), for its operational processes and product cleaning. With sustainability as a core focus, Ball Corporation embarked on a groundbreaking initiative that culminated in a collaboration with SOLID.

In partnership with TIGI, SOLID designed and constructed a 3,956 m^2 solar heat plant boasting a thermal capacity of 2.8 MW. This project is California's largest solar thermal facility and the second largest in the United States, projected to save over 200,000 therms (5,860 MWh) of natural gas annually.

At the heart of this project is the innovative integration of a new hot water loop, significantly minimizing losses compared to conventional steam networks. Distributing hot water at 80°C through optimally sized pipes reduces distribution losses from approximately 30% in the previous steam system to about 5%. By 2025, the plan is complete decarbonization by decommissioning boilers, retiring the steam system, and installing a heat pump to complement the solar setup. The project was made possible through a Heat Purchase Agreement facilitated by SOLID America Energy Services LLC, jointly owned by TIGI Solar and SOLID Solar Energy Systems, which financed the project, secured grants, and now manages operations and maintenance.

To learn more about this year's SHC Solar Award and past awards, visit https://www.iea-shc.org/solar-award.

► **Ball Corporation's Fairfield plant uses a Heat Purchase Agreement with SOLID Solar Energy Systems and TIGI Solar to build California's largest solar thermal facility and second largest in the US. The projected savings are over 5,860 MWh of natural gas annually.** Photo credit: SOLID Solar Energy Systems

Empowering Women in Renewable Heating and Cooling: Boosting Participation and Impact

The SOLTRAIN+ project is actively encouraging women to participate in the Renewable Heating and Cooling (RHC) sector by first understanding the needs in the five Southern African partner countries, Botswana, Lesotho, Namibia, South Africa, and Zimbabwe.

On November 22, 2023, Gender Managers (GMs) from SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), Namibia Energy Institute (NEI), Solar Industries Association Botswana (SIAB) and AEE - Institute for Sustainable Technologies (AEE INTEC), Selma Festus, Fenni Shidhika, Karen Gibson and Monica Spork-Dur, respectively, co-hosted the first Gender & Diversity (G&D) hybrid event at the Safari Mercure Hotel in Windhoek, Namibia. The workshop was on the margins of the 7th SOLTRAIN Regional Conference hosted by SACREEE and NEI on November 22-23, 2023 at the same venue. The workshop presented the gender and diversity work package in the SOLTRAIN+ initiative as well as the value chains and opportunities in the RHC sector. The event was opened by Kudakwashe Ndhlukula, the Executive Director of SACREEE. Karen Gibson gave an overview of the G&D work package highlighting opportunities for SOLTRAIN+ with a call to increase strategic partnerships with other organizations through the gender multiplier implementation structure.

The Honorable Kornelia K. Shilunga, the Deputy Minister of Mines and Energy in Namibia, inspired the workshop participants by reminiscing on the importance of women in energy, the struggles for female participation in politics, and finally, the recent joys of an inclusive 50/50 gender balance in the political space in Namibia. Her message was clear that to affect deep structural and sustainable change in male-dominated sectors such as energy, women should not shy away from politics since this is the platform where influencing decision-making processes are made.
To better understand the barriers faced by women entering the RHC industry in the SOLTRAIN+ partner countries, a team comprising Selma Festus, Karen Gibson, and

The Gender & Diversity workshop participants with Hon. Kornelia Shilunga, Deputy Minister of Mines and Energy, Namibia.

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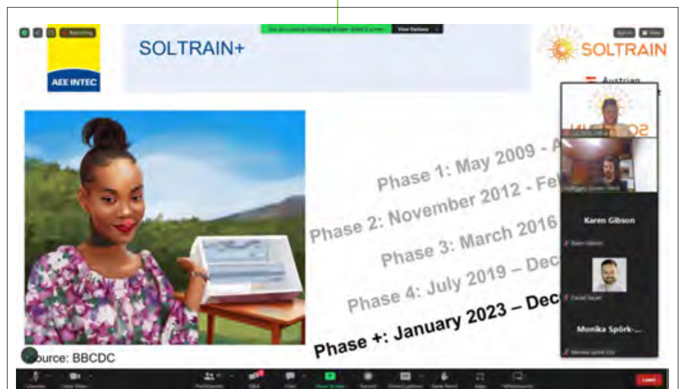
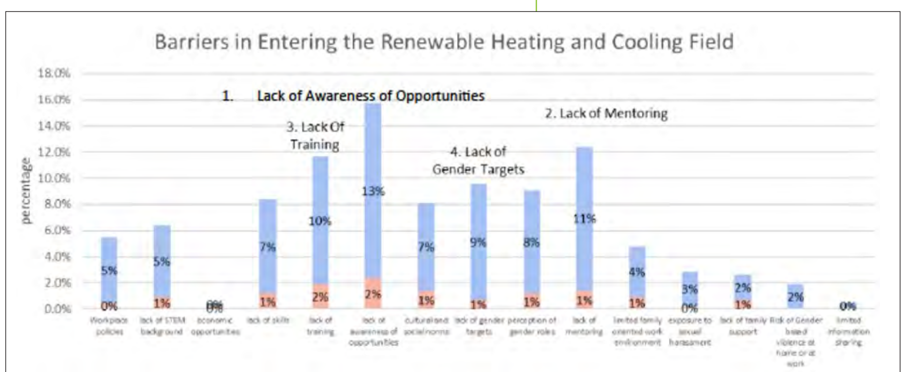


Monica Spork-Dur with the assistance of seven gender managers and multipliers has undertaken some ground truthing in these partner countries.

Due to limited literature directly relating to women in the sector, a survey was conducted in the countries with 103 responses, 80% of which were women in the RHC sector. Results show that almost 40% of the workforce are women in small, medium, and large organizations from the hundred and three responses, however, less than 20% are in technical positions.

The feedback from the survey identifies the key barriers and includes the need for capacity building, providing equal opportunities, gender training, and the need for cultural and social norms to change.



▲ **Overall barriers to entering the renewable heating and cooling sector.**

Some of the recommendations from the study include that workplace practices should incorporate training for the office staff and the community at large. In addition, there is a need to encourage women to participate in capacity building, installing demonstration systems, participating in research tasks, applying for bursary funding, and designing additional activities to raise awareness and create dialogue.

To continue the work of this first meeting, The first Gender Webinar was held on June 5, 2024, the webinar drew a strong turnout and marked an important step in tackling climate change. This virtual event delved into the crucial topic of climate change awareness and mitigation through SOLTRAIN+ activities. The webinar focused on understanding climate change dynamics, showcasing renewable heating and cooling technologies, highlighting SOLTRAIN+ mitigation measures, sharing regional opportunities, and identifying actions to enhance women's participation. Also, the webinar highlights renewable heating and cooling technology options and mitigation measures being implemented by the project. Presenting the need for the technology and the applications, the opportunities brought in by the project to the region and areas of inclusive actions to increase the participation of women in the sector.

You can follow the SOLTRAIN+ Gender & Diversity initiative's work to support the participation of women and young talent in the renewable heating and cooling sector on the SOLTRAIN website, https://www.soltrain.org/.

This article was contributed by Selma Fetus, of SACREEE (SADC Centre for Renewable Energy and Energy Efficiency)

Task 63

Planning for Enhanced Solar Access and Utilization in Neighborhoods

***IEA SHC Task 63: Solar Neighborhood Planning* completes the work after more than four years, working on solar strategies, planning aspects, business models, stakeholder and citizen engagement, solar planning tools, including examples of real case studies from the 10 participating countries. This article highlights the main topics and some of the results.**

The ongoing climate and energy crisis is pushing cities to develop strategies for achieving zero/plus-energy or carbon-neutral neighborhoods. In the pursuit of sustainable urban development, integrating solar energy emerges as a key activity, offering both challenges and opportunities for cities. Some cities are front-runners, establishing exemplary showcases of sustainable urban areas by deploying passive and active solar strategies and integrating solar systems.

The urban fabric needs to utilize passive solar gains and daylight to reduce energy consumption in buildings and improve indoor and outdoor comfort for inhabitants. In addition, active solar energy systems integrated in the urban context contribute to the production of renewable energy in the form of heat and electricity. All these solar strategies support cities and citizens in achieving sustainable and healthy developments. Since the built environment has a long lifetime, we must ensure long-term solar access for buildings and outdoor environments when developing neighborhoods and cities.

From September 2019 to April 2024, a multi-disciplinary and international team worked together in SHC Task 63 with the main objective of supporting key players to achieve solar neighborhoods that facilitate long-term solar access for energy production and for daylighting buildings and outdoor environments – resulting in sustainable and healthy environments. Based on this work, processes, methods, and good examples were highlighted and developed to facilitate the successful implementation of solar strategies in neighborhoods. Below are examples of results from the Task.

Strategies for the Design of New and Existing Solar Neighborhoods

It is important to address the potential energy performance and solar availability already in the urban planning and urban design phases. Several analysis methods, including modeling and simulation, can be employed to understand a neighborhood's energy performance and assess the feasibility of implementing solar strategies and concepts. These methods may vary according to the type

Solar neighborhoods have the potential to create environments that are,

- Energy (resource) self-sufficient
- Using a high share of renewables
- Resilient to energy prices
- Achieving high levels of thermal and visual comfort and improving air quality
- Supporting the creation of climate-proof cities

MARIA WALL
SHC Task 63 Manager

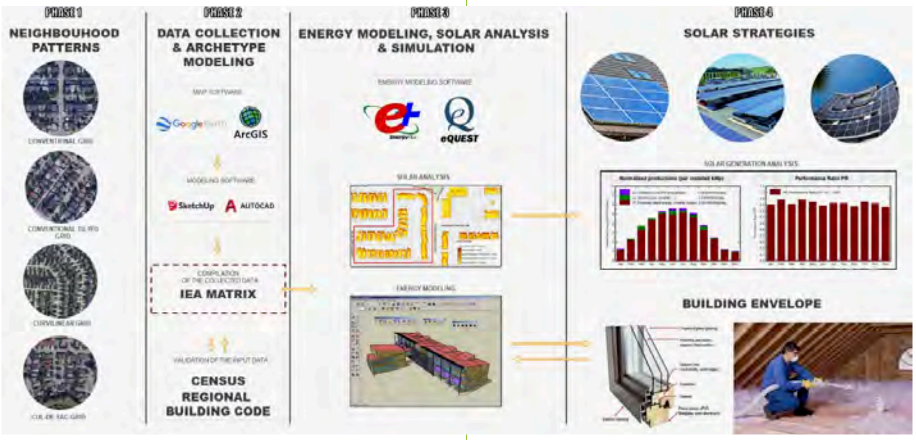


Figure 1. Overall modeling and simulation process of archetype analysis. (Report A1, Strategies for the Design of New and Existing High Energy Performance Solar Neighborhoods)

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of neighborhoods and their phase of development, whether existing or in the planning phase. Figure 1 illustrates an example of phases employed in a specific method to analyze archetypes of neighborhoods as used in SHC Task 63. An archetype is a representative type of neighborhood. The process starts with identifying distinct neighborhood patterns, followed by data collection employing various GIS tools. Then, assuming specific construction materials, energy simulations are conducted to determine energy consumption and the potential of various solar strategies. Results show examples of analysis of the energy performance and solar strategies of existing and theoretical neighborhoods.

Read more in report A1, Strategies for the Design of New and Existing High Energy Performance Solar Neighborhoods, https://doi.org/10.18777/ieashc-task63-2024-0003.

Solar Neighborhood Decision-Making Tool

To support the early planning of neighborhoods, a tool was also developed in MS Excel. This solar neighborhood decision-making tool offers a structured approach to selecting sustainable solar strategies for neighborhood development, catering to professionals such as architects, urban planners, energy planners, and policymakers. The tool considers various passive and active solar strategies, including window placement, solar chimneys, PV systems, and solar thermal collectors, to enhance building performance and reduce energy consumption. Users can customize their selections based on specific criteria such as neighborhood type, climate conditions, and objectives and assign weights to decision criteria like ease of implementation, cost, accessibility, environmental impact, and acceptance. The tool calculates an adoption score for each strategy, summarizing its overall impact and relevance, and offers both single and composite objectives to cater to different user needs. Single objectives include daylight, passive heating or cooling, energy efficiency, electrical or thermal generation. Available composite objectives are total energy consumption, low operational cost, low/net zero carbon or net zero energy neighborhoods. The tool's output provides recommendations for suitable solar strategies based on user inputs, helping users make informed decisions towards achieving their sustainability goals. Examples demonstrate how the tool can select solar strategies for specific objectives in different climate types, providing valuable insights for sustainable neighborhood development.

Read more in report A2, Decision-Making Tool for Solar Neighborhood Planning: User Manual, https://doi.org/10.18777/ieashc-task63-2024-0004 and tool, Solar Neighborhood Decision-Making Tool, https://task63.iea-shc.org/decision-making-tool.

Opportunities for Improved Workflows in Solar Neighborhood Planning

When planning actual neighborhoods and urban areas, many parameters need to be considered. In SHC Task 63, the experts gathered data on the current state-of-the-art tools for solar neighborhoods. Examples of workflow stories were presented; a model describing a specific design and/or planning project showcasing how tools were used during this process.

The workflow stories showed exciting examples of projects and workflows where tools have played a significant role. Although the sample is low, it can be concluded that tools within the visual programming environments are extensively used in the industry and academia. At the same time, there are few examples of GIS tools that can provide the same assessment possibilities.

From the workflow stories, CAD and BIM environments seem to be the most common choice as modeling environment when designing new neighborhoods. Combined with the possibilities of a visual programming language like Grasshopper, advanced daylight and solar energy analyses have become closer to the tool workflow of architects. Another clear benefit is that, in most cases, only one model has to be constructed for multiple types of analyses. However, data handling for larger neighborhoods in those environments can still be challenging. Therefore, GIS is the common choice of tool for existing buildings and larger neighborhoods, but it might be difficult to convert the geometry to a fitting format. Also, data handling processes are more advanced. However, the field of advanced simulation is evolving quickly and will be influenced by Artificial Intelligence and Machine Learning, enabling quicker, more advanced analyses for larger neighborhoods.

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For an optimal solar neighborhood design, a district should be planned to consider not only the district itself but also how it could complement other districts or the entire city. Whereas GIS enables work at a city scale, the resolution (spatial, temporal, LOD) is usually much coarser than reached by district-scale tools. It would, therefore, be relevant to identify possibilities for working with high-definition tools.

Read more in report C1, Identification of Existing Tools and Workflows for Solar Neighborhood Planning, https://doi.org/10.18777/ieashc-task63-2022-0001.

The Role of Solar Maps

Solar maps show the potential of installing active solar energy systems on existing buildings. They are often used as a first step to acquire information about this potential. Nevertheless, the rapid expansion of these tools makes them more attractive in supporting local stakeholders such as authorities, citizens, industries, etc. The available data in these solar maps differ from map to map and country to country. Moreover, the same type of data (for example, the solar irradiance or the investment cost) can be presented in very different ways through different indicators and thresholds.

A solar cadaster, in its simplest form, can be defined as a map (usually a GIS representation) that represents how much irradiance (the incoming solar energy) is received on the buildings (mainly roofs) within a city or a specific region. For that aim, it is necessary to know at least the local typical weather conditions and building shapes and locations. SHC Task 63 experts identified and studied 56 solar cadasters from 30 countries. Where historically solar cadasters were primarily located in Europe, North America, and Australia, an increasing number of cities in Africa, Central Asia, and Central America have now also access to solar cadasters. Solar cadasters are visual tools that aim to be used by various actors, from building owners curious about their roofs' solar potential to cities investigating which buildings may have the best potential for a solar installation. For that purpose, the choice of indicators is crucial. In total, 70 metrics were referenced in the 56 solar cadasters. These metrics were classified into five categories: I) Energy, II) Technical, III) Economical, IV) Environmental, and IV) Other. More details about these indicators can be found in report C2, *Opportunities for Improved Workflows and Development Needs of Solar Planning Tools*, https://doi.org/10.18777/ieashc-task63-2024-0006.

Figure 2. Key benefits of solar mapping and stakeholder engagement. (Report C2, Opportunities for Improved Workflows and Development Needs of Solar Planning Tools)

Stakeholder engagement is vital in urban solar mapping to enable the inclusion of institutions, industry players, financiers, and consumers/prosumers for their expertise and insights (IEA, 2019). This collaborative approach facilitates accurate data collection, policy development, and conflict resolution, thereby enhancing project outcomes. Moreover, transparent communication among the actors involved in the urban planning/project process fosters the integration of solar infrastructure, informs zoning regulations, and secures community support, underpinning the project's success.

The concept of integrating solar mapping with stakeholder engagement aims to enhance solar energy technologies. By involving a diverse range of public and private stakeholders in the process, it promotes the development, implementation, and acceptance of solar solutions. The benefit of such a process can be presented as shown in Figure 2. Stakeholders can make informed decisions about where to invest in solar systems in built environments by using solar maps, which can enhance urban energy planning and optimize solar system installation. By identifying the most irradiated urban surfaces, solar maps can support and inform investors and financial institutions in assessing the viability and

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profitability of solar energy projects and systems at the building, neighborhood, and city scale. Solar maps can also serve as educational tools for the community, engaging and raising awareness about the benefits of solar energy and its feasibility. For projects requiring regulatory approval and permission, solar maps can provide necessary data and visualization to demonstrate compliance with local zoning laws and environmental regulations. This can speed up the approval process for solar systems integration into urban surfaces.

Opportunities of Using Solar Planning Tools

Solar planning tools offer significant opportunities to advance passive and active solar energy utilization. These tools enable the efficient deployment of solar systems, estimation of financial viability, daylight provision, and integration of solar energy in urban planning. However, continuous development and improvement of these tools are essential to enhance their accuracy and user-friendliness. By leveraging solar planning tools effectively, stakeholders can contribute to the growth and development of sustainable solar energy solutions.

Solar planning tools play a crucial role in optimizing solar energy utilization, promoting energy-efficient design practices, and facilitating the development of solar neighborhoods and sustainable urban environments. As the demand for solar energy and daylight access continues to grow, innovative and user-friendly solar planning tools will be essential in realizing the full potential of solar energy in our cities and communities.

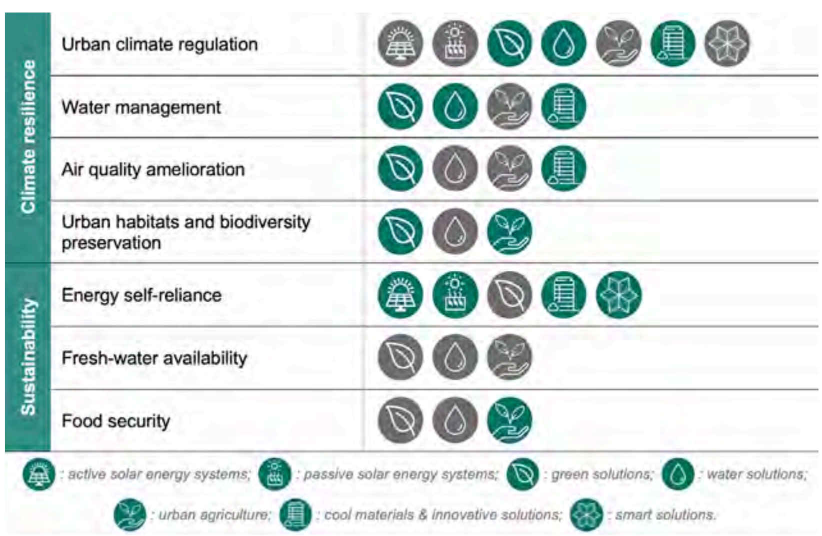
Read more in report C2, Opportunities for Improved Workflows and Development Needs of Solar Planning Tools, https://doi.org/10.18777/ieashc-task63-2024-0006.

Conscious Use of Surfaces in Neighborhoods

Urban surfaces play a major role in responding to climate change and urbanization issues. Increased utilization of all the surfaces of neighborhoods offers several opportunities not only for producing renewable energy and correctly managing passive solar gains and daylight, but also for enhancing urban sustainability and climate resilience and providing environmental, social, and economic benefits.

Within SHC Task 63, available solutions for using urban surfaces in solar neighborhoods were collected to shed light on the major role that these might play in enhancing climate resiliency and sustainability. The suitable surface uses were classified into eight major clusters (i.e., active solar energy systems, passive solar energy systems, green solutions, water solutions, urban agriculture, cool materials and innovative solutions, smart solutions, and traditional uses/materials). Furthermore, the most relevant solutions for each cluster were analyzed, and the suitability of urban surfaces to integrate these solutions was discussed, together with their contribution to the climate resilience

Table 1. Overview of the objectives each surface use cluster contributes to. Primary contribution in green, and secondary in grey



(Report B1, Surface Uses in Solar Neighborhoods).

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and sustainability objectives. The results were schematized in tables to provide an overview readily understandable by stakeholders involved in planning decisions, such as urban planners, designers, and municipalities. Table 1 shows an overview of surface uses.

For more information about the suitability of urban surfaces for the application of each usage cluster, see report B1, Surface Uses in Solar Neighborhoods, which also gives examples of different applications. In addition to this report, "Guidelines for the Design of Urban Surface Uses in Solar Neighborhoods" will be published on the SHC Task 63 website. This guide will propose a workflow for the design of neighborhood surfaces and will also refer to supporting documents and results from SHC Task 63.

Economic Strategies

Another part of our work in SHC Task 63 dealt with economic strategies. Solar neighborhood developments offer unique economic benefits; see the overview in Table 2. Since solar neighborhoods often span multiple land use spaces, local community members are key stakeholders in these developments. As such, involving the community can help promote and accelerate the investment and dissemination of these developments. In doing so, certain solar neighborhood business models can include individuals who otherwise cannot gain direct benefits from solar projects due to not having the ability to purchase their own solar equipment.

Table 2. Summary of economic benefits of solar neighborhoods

Consumers (individual)	Neighborhood/society	Developers
• No need for property ownership (renters can participate) • No rooftop space necessary • Lower risk • Opportunities for lower income consumers • No upfront costs • Save on bill costs	• Land use reappropriation • Increased energy independence • Increase property values • Landowner benefits • Job creation	• Lower operating costs • Additional technology options • Land use/solar incentives

(Report B2, Solar Neighborhood Financing Mechanisms and Business Models)

The market potential for neighborhood solar is promising due to the different forms these projects can take, including the different technologies that can be utilized and the flexible size/capacity options. However, several risks exist for these developments, ranging from changes in policies that offer tax incentives for renewable energy projects to the consequences of an economic downturn that reduces the level of investment and available capital.

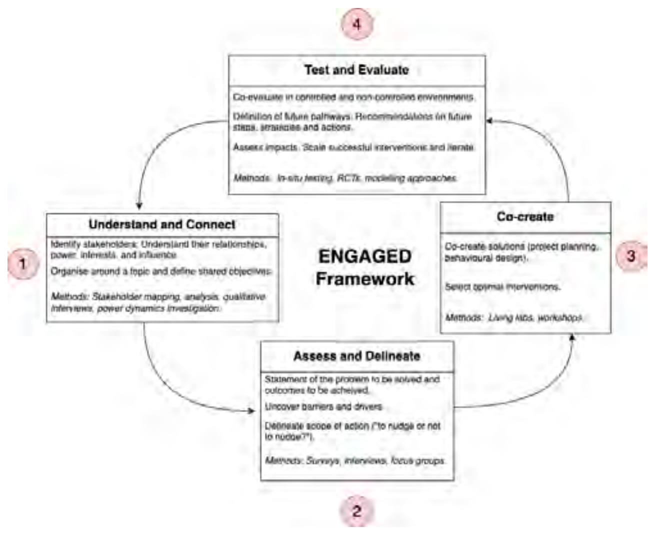
SHC Task 63 experts were engaged in discussions on the categorization of business model frameworks during project meetings, and the feedback was incorporated into the decision-making process for defining the design of relevant business models. Business models were developed to be flexible regarding who sponsors the project versus who ultimately owns/hosts the completed development. This allows for models where community members can be involved in some way—either as project sponsors or as part of a customer base leasing or subscribing to the project's output.

For more information, see report B2, Solar Neighborhood Financing Mechanisms and Business Models, https://doi.org/10.18777/ieashc-task63-2024-0002.

Stakeholder Engagement in Solar Neighborhood Planning

An integrated framework for stakeholder engagement in solar neighborhoods was also proposed, informed by practical insights from behavioral science

▼ **Figure 3. ENGAGED Framework Stages.** (Report B3, An Integrated Framework for Stakeholder and Citizen Engagement in Solar Neighborhoods)



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(a practice known as behavioral design). A stakeholder ENGAGEment-behavioral Design framework (ENGAGED) was developed (Figure 3). This framework is intended to inform engagement processes in solar neighborhood planning and highlight how engagement activities and citizen participation can inform several phases in the development of a solar project. A series of solar neighborhood stakeholder engagement case studies were collected from Task experts and presented. The reported activities were discussed through the lens of the ENGAGED framework, highlighting strengths and limitations. Conclusions were made, and the work formed Report B3, *An Integrated Framework for Stakeholder and Citizen Engagement in Solar Neighborhoods - ENGAGED* framework for stakeholder engagement and behavioral design. This report highlights that stakeholder engagement activities in solar neighborhoods can take many forms. In some cases, these activities are central to the planning process, while in others, their role is primarily to inform citizens and other stakeholders. By adopting a multi-stage approach, as developed in the ENGAGED framework, engagement activities can be enriched throughout the life cycle of a solar project, leading to co-created outcomes informed by a participatory process. Finally, while end-user behaviors are often considered, there are still many opportunities to integrate behavior-change considerations in a wider engagement process. Insights from behavioral science could be leveraged to promote virtuous energy behaviors that support the integration of solar technologies (as is the case in a few of the reported case studies) and increase participation in outreach events targeting citizens. Ultimately, this work aimed to bring further awareness to the importance of engaging with different stakeholder groups in the context of solar neighborhood planning and provide practical guidance in this direction.

To read more, see Report B3, An Integrated Framework for Stakeholder and Citizen Engagement in Solar Neighborhoods - ENGAGED framework for stakeholder engagement and behavioral design, https://doi.org/10.18777/ieashc-task63-2024-0001.

Case Studies Exemplify Key Aspects, Challenges, and Opportunities

▲ **Figure 4. Three case study examples from left to right Sønderhaven, Denmark; Li'ao Community, China; Eve Park, Canada**

Case studies were central to SHC Task 63, connecting many of the above topics. More than 20 case studies from 10 countries show interesting examples of neighborhoods where solar strategies, among others, have been applied. All cases were described and structured according to a common template, highlighting main features, the planning process, applied solar strategies and energy systems, surface uses, financial mechanisms, stakeholder engagement, insights from key actors, environmental, social and other impacts, tools and workflow, tools for informed design support, and finally lessons learned and recommendations. Depending on the case study, different topics were selected and described based on relevance to the case. The case studies aim to inspire and encourage others to develop solar neighborhoods. All the case studies are detailed on the Task webpage, https://task63.iea-shc.org/case-studies.

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Conclusions

The work within SHC Task 63 shows the importance of bringing in solar strategies as a central part of planning neighborhoods to make them "solar-ready." By ensuring long-term solar access for buildings and outdoor environments, the solar potential will be high. As outlined in the SHC Task 63 *Technology Position Paper*, solar neighborhoods have the potential to create environments that are:

- Energy (resource) self-sufficient
- Using a high share of RES
- Resilient to energy price fluctuations or dependence on energy imports
- Achieving and guaranteeing high levels of thermal and visual comfort, both indoors and outdoors, and improving air quality - resulting in a healthy and livable environment for citizens
- Supporting the creation of climate-proof cities.

To read the full Technology Position, visit https://task63.iea-shc.org/Data/Sites/1/publications/IEA-SHC-Task63--Technology-Position-Paper-Solar-Neighborhood-Planning-May2024.pdf.

The Task's work on strategies, methods, and tools to support such developments shows that good examples exist, and progress is definitely being made. However, despite ongoing developments, significant challenges and barriers remain. These are related to the lack of regulations on the exploitation of sunlight and access to light, sun and shade, social acceptability and/or lack of knowledge about solar strategies, competing uses of urban surfaces, drawbacks of some technologies, complex modeling of urban areas, and low profitability or failure to consider added values of solar strategies (Manni et al., 2023). On the positive side, the opportunities are many and the interest from stakeholders is growing – there is plenty of light in the tunnel!

Article contributed by Maria Wall of Lund University and Task Manager of SHC Task 63: Solar Neighborhood Planning.

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TASK 63 INTERVIEW

Solar Neighborhood Planning

Maria Wall

The SHC Programme finalized its work on Solar Neighborhood Planning (SHC Task 63) this past April. To learn first-hand about the Task's impact, we asked the Task 63 Manager, Maria Wall of Lund University, to share her thoughts on this 4-year project.

Why was a project like this needed?

Maria Wall (Maria): This project was important since an increased use of solar energy is central for sustainable development, where the urban fabric needs to utilize passive solar gains and daylight to reduce energy consumption in buildings and improve indoor and outdoor comfort for inhabitants. In addition, active solar energy systems integrated in the urban context contribute to the production of renewable energy in the form of heat and electricity. We need to push for solar planning since all these solar strategies support cities and citizens in achieving sustainable and healthy developments.

In particular, results from our earlier SHC Task 51 on Solar Energy in Urban Planning underlined the need for further work on a neighborhood scale, especially looking at solar planning strategies and concepts, economic strategies, and stakeholder engagement. In addition, solar planning tools and their coupling in an efficient workflow were becoming more and more important due to an increasing need for decision support tools in the early planning phases. Urban planning and design are complex in that many aspects need to be considered in parallel, and when available, information to support decisions is limited.

What is the current status of applications used for solar planning?

Maria: We can see that although the extensive use of passive and active solar strategies can pave the way for more sustainable urban environments, there are still major challenges to overcome. Pressures from population growth call for more dense cities, which may cause difficulties in creating good solar access in urban areas. Due to this, we need a "right-to-light" for indoor daylighting, a healthy outdoor environment, and to ensure solar access for active solar panels on buildings and outdoor areas. In some countries, solar easements are in place to protect the installed capacity of solar energy systems. Climate change and increasing heat waves also highlight the need for "right-to-shade," especially in areas experiencing urban heat island (UHI) effects. However, there is a lack of specific standards regulating these aspects.

Good examples of solar neighborhoods show the overall high potential but also show the need for new business models, and ones that include and elucidate added values (human health and well-being, resilience, energy security, biodiversity, etc.) in such business models.

With an increasing need for and use of solar energy, challenges also arise from the competing uses of urban surfaces and the implementation of active and passive solar strategies in urban planning. It is, therefore, important to consider solar strategies in the early urban planning phase and use supportive tools starting in the urban design phase. However, despite the large number of tools available today, many of them still lack interoperability. At the same time, the field of advanced simulation is evolving rapidly and will be influenced by Artificial Intelligence and Machine Learning, allowing for faster and more advanced analyses for larger neighborhoods and different time horizons, which may create new opportunities.

Is there one result/outcome that surprised you?

Maria: Nothing really surprised me, but I was glad to see engaged stakeholders in different initiatives working on solar planning through the case studies we present in Task 63. This, although we were hit by the pandemic, which caused problems and delays in the realization of some of the neighborhoods. The pandemic made it very clear how important face-to-face meetings and collaborations are!

What is a Task success story from an end-user or industry?

Maria: I think there are many success stories within the case studies, in particular where different stakeholders engaged and took part in the process of developing their neighborhood. Such engagement increases the possibility of a successful implementation.

How has the Task's work supported capacity and skill building?

Maria: We learned from each other, when we worked in the Task to develop material. For example, most of the experts (including me) were not experts in financing mechanisms and business models. We were lucky to have an expert on this from Eurac/Italy leading this activity, but he on his side was not an expert in solar energy strategies. As a win-win, we learned from each other, and he applied his knowledge of economics

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and business models to solar planning with feedback from the solar experts. As a result, we got a basic understanding of potential business models to support solar energy in neighborhood planning, and the expert in economics learned about solar planning. We needed each other to create skill building outside our own competencies.

Of course, when reaching outside the Task team, an essential part of capacity and skill building was the communication and cooperation around the case studies from different countries. We also organized public seminars presenting results from the Task and invited stakeholders to present their views and experiences.

What is the future of solar planning – new developments, markets, policies, etc.?

Maria: We will definitely see more energy communities, positive energy districts, solar neighborhoods – different concepts and naming to identify energy and environmental strategies for groups of buildings and urban areas.

Also positive is the push from governments and cities, which will help to speed up the developments. The global Covenant of Mayors emphasizes the importance of climate change mitigation and adaptation and increased access to clean and affordable energy. The Covenant of Mayors in Europe has a vision that by 2050, everyone will live in decarbonized and resilient cities with access to affordable, secure, and sustainable energy. Solar strategies have an important role here. However, since the built environment has a long lifetime, we must also ensure long-term solar access for buildings and outdoor environments when developing neighborhoods and cities. Therefore, we need to promote legal reforms to solar access protection and improved planning approval processes where informed decisions can be made.

I think the possibilities to plan and evaluate strategies for neighborhoods and cities using a multi-criteria approach will continue to increase due to the continuous development of digital tools, a co-simulation approach, and advanced computer techniques, such as machine learning and AI. This will enable more reliable and detailed digital models of buildings and cities.

AND more: the never-ending story of development needed to improve the architectural integration of solar panels (solar thermal, PV, PVT) into the built environment! Personally, at home on our single-family house, we are on the way to installing orange PV panels on our roof since I could not accept putting black panels on our orange-tiled roof, as many others have done. However, it was a struggle to find the right contacts and companies that could help – a builder to do the work in collaboration with a company delivering such orange panels. When we asked for orange/red panels during the last years, many simply asked back, "Does it exist?" In Sweden, we have many companies offering to install PV panels, but all are black. Since we plan for a large increase of solar panels in the built environment, we need to ensure that the architecture is not damaged or lost during the implementation of solar systems.

What were the benefits of running this as an IEA SHC Task?

Maria: By working together in an international environment, we learn from each other and can accomplish results that are difficult or impossible to do locally by ourselves. It also minimizes the risk of doing the same work in parallel in different regions. Some aspects, like definitions of suitable design criteria and thresholds, benefit from international cooperation and agreement. Thus, the benefits are enormous – not to mention that it is great fun. I truly enjoy the solar family we have. You get friends for life.

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

Maria: Yes, I hope so. More developments are needed, so I definitely think the work will continue. For me, however, it was my last Task. I am slowly planning for my retirement when I can start enjoying the sun more regularly.

Poland Joins SHC Programme

The members of the SHC Programme look forward to forging a productive partnership with Poland in the years ahead.

The road to membership was a bit long and winding. However, with the perseverance of the new SHC Polish Executive Committee member, Justyna Martyniuk-Peczek of the Gdansk University of Technology will now represent Poland. As noted by Professor Martyniuk-Peczek, the Polish government's interest grew through grassroots initiatives, with people expressing their desire to participate in IEA programmes. For her, it all began in 2019 with her initial contacts with the Ministry of Energy. Over the years, the ministries were restructured and reorganized with international cooperation activities eventually finding their home in the Ministry of Climate and Environment.

The momentum to integrate Poland into IEA Technology Collaboration Programmes (TCPs), of which SHC is one, intensified in 2023. On March 23, 2023, a Polish TCP Coordination Day was organized, and six TCPs participated: Hydrogen TCP, Bioenergy TCP, Greenhouse Gas R&D (GHG TCP), Photovoltaic Power Systems (PVPS TCP), Wind Energy (Wind TCP), and Clean and Efficient Combustion (Combustion TCP). The day focused mainly on sectors identified as priorities in the national policy "Energy Policy of Poland until 2040."

At the same time, people interested in participating in other TCPs, such as Solar Heating and Cooling SHC TCP and Energy in Buildings and Communities (EBC TCP), were invited. The meeting aimed to promote TCP participation and gauge interest from experts, businesses, and academia. Following this event, agreements between the government and delegated institutions were discussed and prepared. And the government continued to promote collaboration with the TCPs, for example, through the website https://www.gov.pl/web/klimat/programy-wspolpracy-technologicznej-tcp.

Those interested in the SHC TCP were directed to cooperate with the Department of Heat Transformation and Energy Efficiency of the Ministry of Climate and Environment. With an official home established, discussions about membership in the SHC TCP became possible. Although parliamentary elections in autumn 2023 temporarily halted the decision-making process, by January 2024, efforts resumed to establish cooperation between the Ministry and the Gdansk University of Technology as a delegate of the Polish government in the SHC TCP.

Poland & SHC Collaboration

According to the report EU Tracker – Local heating and cooling plans in Poland, Poland is not yet prepared for the smooth implementation of the Energy Efficiency Directive (EED). This poses significant challenges at the national,

MEET
Justyna

Prof. Martyniuk-Peczek is an architect by education and professionally works in urban planning. At Gdansk University of Technology, she leads the "Light and Energy" research group, and since 2023 has headed the international research group, "Research group - SUP&ER - Solar Urban Performance and Energy Efficiency." Her work involves both buildings and neighborhoods, as well as strategic urban development programs.

As a member of the SHC TCP, Prof Martyniuk-Peczek looks forward to finding solutions to foster energy efficiency at the architectural and urban scale. Her connection with the SHC Programme began as an observer of SHC Task 61: Solutions for Daylighting & Electric Lighting. She is currently participating in SHC Task 70: Low Carbon, High Comfort Integrated Lighting, where she looks forward to analyzing urban-scale solutions that simultaneously reduce CO_2 emissions and ensure the well-being of residents.

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OPINION

Reflections from the Chair

In June, we saw the publication of the 2024 edition of Solar Heat Worldwide. This flagship publication has been made available to the public since 2005, in a great effort from our Austrian colleagues led by Werner Weiss and Monika Spörk-Dür from AEE Intec. This year's edition, reflecting basic market data for 2023 and detailed data for 2022, brings a mixed bag of news. The bad news is that the market saw a decline of 7% in new installed collector area, mostly due to a drop in activity in the world's largest solar heating market, China, caused by a slowdown in the real estate sector. Despite that, we saw a global 3% growth in net installed capacity (newly installed minus decommissioning) and a good level of activity accompanied by a growing pipeline of projects in the industrial and district heating markets. We also saw strong growth in PV for heating applications, as in South Africa.

Heating represents 50% of energy end-use, and it is going to take an array of technologies and solutions to decarbonize the heating sector at the required speed. Our sector and our Programme are ready to meet this challenge with reliable and cost-effective solutions.

Last, we had a very busy ExCo meeting this past June in Oslo. I want to thank our colleagues from Norway again, particularly Michaela Meir, for the warm welcome and great job organizing the meeting, which included a very interesting tour of Inaventa Solar's manufacturing facility. The meeting in Oslo saw the departure due to retirement of two professionals that have had a significant impact on SHC. Prof Maria Wall, from Sweden, has contributed not only as an expert on solar neighborhoods and buildings but also as a very effective Task Manager, the last time for the recently finished Task 63 - Solar Neighborhood Planning. Werner Weiss had many roles within SHC, from Task expert to Austrian ExCo member. Werner always brought not only knowledge, but also a profound commitment to the development of the solar heating and cooling sector. He created and led our Solar Heat Worldwide publication and has been instrumental in growing our Solar Academy activities. To Maria and Werner, our most sincere thank you, and we wish you the best of luck in this next chapter.

Lucio Mesquita
SHC Executive Committee Chair

Member News: Poland *from page 19*

regional, and municipal levels. To address these challenges, information, knowledge, and expertise are needed, which are not limited to a single area of action.

Poland's membership in the SHC TCP will bring numerous benefits for both academia and business, comments Prof. Martyniuk-Peczek. To begin, it will enable interested groups to participate in international projects, facilitating the exchange of experiences and knowledge regarding local conditions and best practices in solar energy and energy efficiency. In Poland, there are individuals with extensive business experience and international work backgrounds who are eager to collaborate. Through this international collaboration with experts and institutions from other countries, Polish participants can leverage their expertise, potentially leading to faster and more efficient implementation of innovative solutions.

For Prof. Martyniuk-Peczek, she sees this participation as significantly strengthening Poland's capacity to achieve the objectives outlined in the Energy Efficiency Directive (EED) and helping secure funding and technical support for the development of solar energy and heating projects, which ultimately will benefit both the economy and the environment in Poland.

Design Guidelines for Solar Cooling Applications

The widespread adoption of solar cooling technology in the market is not solely driven by the system's technical and economic aspects. Equally important is having a systematic approach for designing and installing systems in different climates and technology that can be easily managed by professionals who are not experts on the specific technology. It is for this reason, IEA SHC Task 65 on Solar Cooling for the Sunbelt Regions has published "Design Guidelines."

Design Guidelines, is a summary of case studies (practical or theoretical) that demonstrate novel and updated system concepts for solar thermal and PV cooling applications.

The method involved collecting information through questionnaires and analyzing the case studies received. A comprehensive questionnaire detailing various solar cooling components, design, sizing, and other sub-systems, such as heat rejection units and cold distribution systems, was sent to 74 Task 65 experts. The report presents the collection of design and system integration guidelines for solar cooling projects. Data from 10 case studies show the performance of solar cooling systems under different boundary conditions. The report covers three additional case studies, each with its own scope and unique characteristics.

The report's main findings are:

- **Industrial cooling** offers significant opportunities for solar thermal cooling applications. These systems can achieve a high solar fraction, leading to substantial reductions in CO_2 emissions compared to conventional electricity-powered chillers. Overall, the simulated system results of a solar field with a parabolic trough collector (PTC) area of 150,040 m^2 (27,280 PTCs, each 5.5 m^2), a cold storage volume of 35,000 m^3 (6 tanks, each 5,840 m^3) and double-effect water-LiBr absorption chillers (110 MW) can save nearly 25,000 tons of CO_2 annually compared to the base case. This equates to a 53% reduction in annual CO_2 emissions.
- **Integrating solar PV with vapor compression chillers** is an emerging solution for decarbonizing cooling systems. A comparative analysis of different load and weather profiles suggests that solar PV cooling can result in lower levelized costs of cooling compared to solar thermal cooling. As highlighted by this study, solar cooling using parabolic trough collectors and double-effect absorption chillers is less competitive than retrofitting a modern vapor compression chiller with a high coefficient of performance (COP) with a photovoltaic system. Absorption chillers with solar thermal are useful for replacing low COP compression chillers (see Figure 1).
- **Hybrid chillers emphasize the potential of combining electrical and thermal chillers.** Both simulation and practical results indicate a significant reduction in power consumption when using the topping cycle of an adsorption chiller. The results show that lowering the heat source temperature from 85°C to 70°C reduces the chiller's performance from 6% to 10% for the Energy Efficiency Ratio (EER) and cooling capacity. Such a reduction of cooling capacity and EER with the temperature is slightly higher for higher evaporation temperatures (around 15% for chilled water temperature of 0°C and above). The adsorption

Data from 10 case studies show the performance of solar cooling systems under different boundary conditions.

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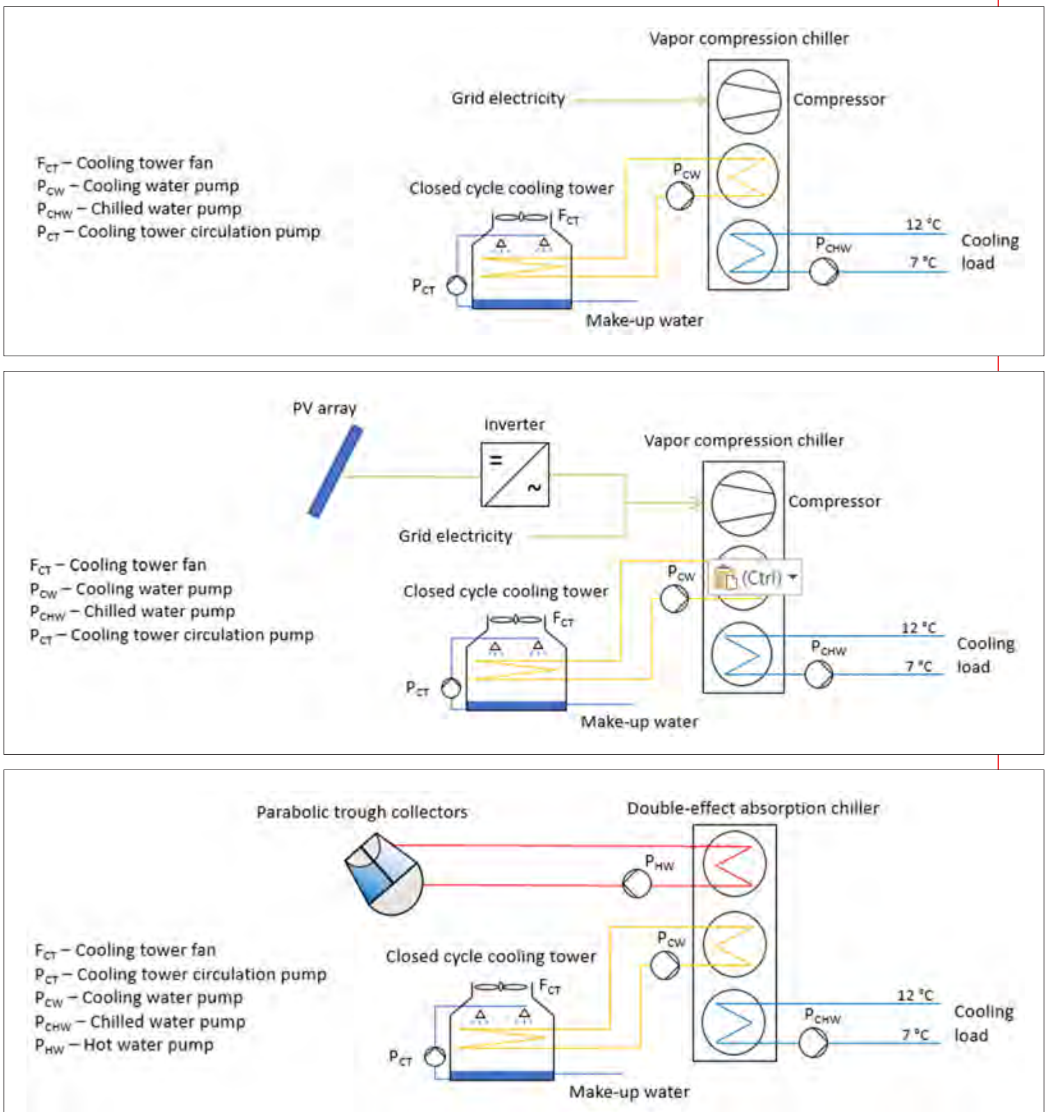


Figure 1. The most important components are 1) a reference cooling system (top), 2) a PV cooling system (middle), and 3) a solar thermal cooling system (bottom).
Source: Absolicon

chiller uses silica gel/water for the sorption cycle and a low Global Warming Potential (GWP) refrigerant, propene, for the compression cycle. It has been found that electricity energy savings from 15% to 25% can be achieved when using a hybrid system over a compression one with the same cooling capacity.

These case studies collectively demonstrate the transformative potential of cooling solutions in shaping a greener and more energy efficient cooling future to support the Global Cooling Pledge, launched at COP28.

Article contributed by SHC Task 65 Task Manager Uli Jakob (JER) and Task experts Puneet Saini (Absolicon) and Wolfgang Weiss (ergSol). For more information on SHC Task 65: Solar Cooling for the Sunbelt Regions, visit https://task65.iea-shc.org/.

Standardizing Thermal Energy Storage Measurement Procedures

Round Robin Tests and Materials Database

The IEA SHC Programme and the IEA Energy Storage Programme began collaborating in 2009. In this third joint Task on Compact Thermal Energy Storage: Materials within Components within Systems (SHC Task 67/ES Task 40), the objective is to accelerate the market introduction of Thermal Energy Storage (TES) materials. Over the past three years, one critical area of work has been developing and validating standardized TES measurement procedures for Phase Change Materials (PCM) and ThermoChemical Materials (TCM) and maintaining material databases.

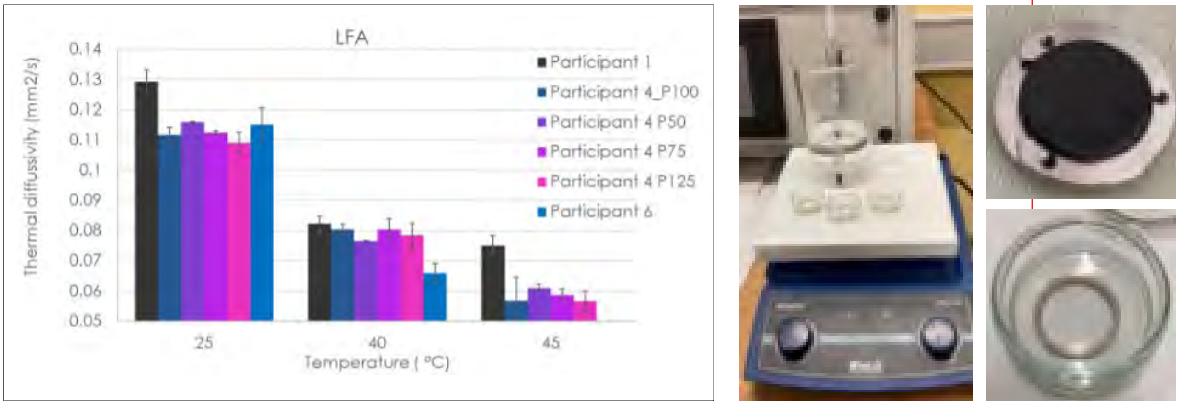
In the second joint Task, Material & Components for Thermal Energy Storage (SHC Task 58 /ES Task 33), new TES materials were found or developed in research projects of the Task participants. Now, in SHC Task 67/ES Task 40, participants are continuing to validate measurement procedures to identify the main physical or chemical parameters.

Several round robin tests have been conducted to evaluate thermal properties like thermal conductivity, thermal diffusivity, specific heat capacity, sorption enthalpy, density, and viscosity of different PCM and TCM candidates. Depending on the material type and measurement method, different measurement procedures were developed, tested, and evaluated to receive comparable results among the round robin participants.

As Task Subtask A leader Daniel Lager notes, “the round robin tests not only harmonized participants’ measurement procedures, allowing them to compare results for the different thermophysical properties of TES materials. The tests also opened the door to discussions on the cross-cutting topic of ‘measurement uncertainty’ to better understand the actual measurement accuracy and uncertainty of the collected results.”

In one of the round robins regarding the thermal transport properties, a PCM with a melting temperature between 53 and 58 °C (Paraffin CAS No. 8002-74-2, Product No. 327204) was analyzed in detail. In sum, 16 institutions from 9 countries participated in this activity using different measurement methods.

Figure 1 shows an example of a round robin result of the thermal diffusivity results based



▾ **Figure 1. Thermal diffusivity results based on the Laser Flash method (left) and sample preparation routine for a special liquid sample holder system (right) of the Paraffin PCM.**

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on Laser Flash measurements on the Paraffin, as mentioned above. In this round robin, one of the big challenges was to harmonize the sample preparation routine and the actual experiment parameters to receive comparable results among the participants. This was the case, particularly at temperatures around 50 °C. Transparency and softening of the paraffin sample led to difficult measurement conditions for the Laser Flash method.

To support the round robin testing, Task participants have been maintaining the Thermal Energy Material Database developed in the previous Tasks (https://thermalmaterials.org/). New data and structure will be added in the future. One structural change is linking existing databases, such as the slPCMlib (https://slpcmlib.ait.ac.at/) database. At this time, the Task is seeking bids from software development companies and looking for funding to implement the changes.

The Task will end in September 2024, but there is no doubt that this critical work on better understanding the application of uncertainty assessments based on applicable standards will continue. And hopefully, additional projects will be initiated to establish a comprehensive, updated, and user-friendly database for the material properties of thermal energy storage materials based on the inputs from the work of the IEA SHC and IEA ES Task experts.

Article contributed by Dr. Daniel Lager of AIT Austrian Institute of Technology GmbH and leader of SHC Task 67/ES Task 40 Subtask A: Material Characterization and Database.

SHC Publications

New Publications Online!

2024 is shaping up to be a big year for SHC publications. Below are reports and tools published since January. All are available for free online and to download. Our extensive 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.

SHC Annual Report

The 2023 report includes a feature article on compact thermal energy storage.

Technology Position Papers

IEA SHC Technology Positions are written with policy makers and key stakeholders in mind. Each SHC Task prepares a paper summarizing the relevance of their specific solar application/technology, its current status and potential, and the actions needed to strengthen its uptake and further development.

Solar Neighborhood Planning

This position paper provides an overview of solar strategies for neighborhood planning, outlining their importance, potential, and development. It concludes with clear actions needed to best utilize solar radiation in urban environments.

Solar Heat for Industrial Processes (SHIP)

This position paper explains the relevance, present status, and potential of the development and market for Solar Heat for Industrial Processes (SHIP). It concludes with clear actions needed for further and best exploitation of SHIP.

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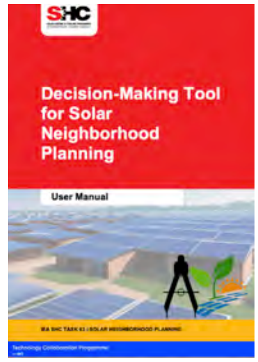
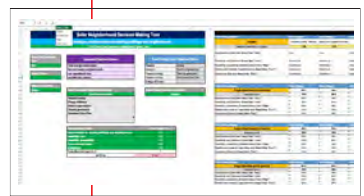
Solar Neighborhood Planning

Decision-Making Tool for Solar Neighborhood Planning



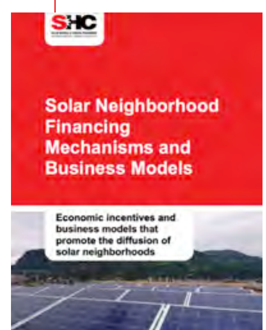


This decision-making tool and accompanying user manual provide a structured method for selecting sustainable solar strategies for neighborhood development. It is designed for professionals such as architects, urban planners, energy planners, and policymakers. The tool evaluates various passive and active solar strategies to improve building performance and reduce energy consumption. Based on user inputs, it offers recommendations for appropriate solar strategies, enabling users to make informed decisions to achieve their sustainability goals.

Case Studies

An interactive map details 26 case studies from 10 countries. Each case study has a brochure (.pdf file) describing the case study in detail, which you can download for free.

Solar Neighborhood Financing Mechanisms and Business Models



Business models were developed to be flexible regarding who sponsors the project versus who ultimately owns/hosts the completed development. This allows for models where community members can be involved in some way - either as project sponsors or as part of a customer base leasing or subscribing to the project's output.

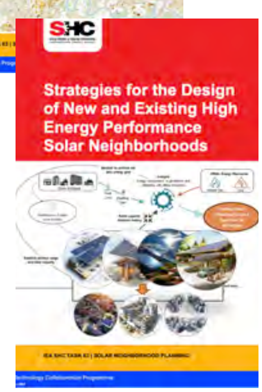
An Integrated Framework for Stakeholder and Citizen Engagement in Solar Neighborhoods

This report proposes an integrated framework, ENGAGEment-behavioral Design (ENGAGED), for stakeholder engagement in solar neighborhoods, informed by practical insights from behavioral science (a practice known as behavioral design). It includes insights from behavioral science and details how their application can enrich participatory processes, contextualizing these insights to the case of solar neighborhood planning.

Opportunities for Improved Workflows and Development Needs of Solar Planning Tools

This report highlights opportunities for maximizing the use of tools for solar neighborhood planning by analyzing the current use of tools in the design process, mapping the solar potential and installed capacity, and describing opportunities for an increase in the use of tools.

Strategies for the Design of New and Existing High Energy Performance Solar Neighborhoods



This report provides a comprehensive overview of solar neighborhoods, including their definition, applications, standards, and regulations. It outlines the methodology and tools for developing archetype designs and analyzes solar strategies at building and neighborhood levels. Archetypes from Canada, France, Italy, Norway, Sweden, and Switzerland, as well as a decision-making tool for solar strategies, are included.

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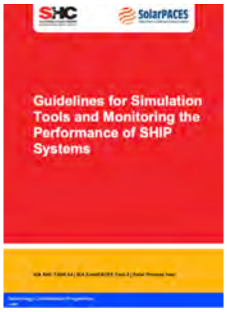
Solar Heat Processes



Guidelines for Simulation Tools and Monitoring the Performance of SHIP Systems

This report presents a comprehensive analysis of various methodologies regarding the design, implementation, and operational management of solar thermal plants. The focus of this analysis encompasses a broad spectrum of approaches that are fundamental to optimizing the efficiency and effectiveness of these renewable energy systems.

System/Component Modularization for SHIP Applications

This report defines modularized and "normalized" components/subsystems for SHIP applications (e.g., for the balance of plant, solar field, thermal energy storage, and hydraulic circuit).

Update on SHIP Technology Costs & SHIP Business and Financing Models

This report presents an update on Solar Heat for Industrial Processes (SHIP) technology costs and new trends in business models and financing schemes for SHIP plants.

Integration Concepts and Design Guidelines

This report covers analyzed integration concepts, system design recommendations, achievable solar fractions, and heat generator designs for SHIP plants.

Efficient Solar District Heating Systems

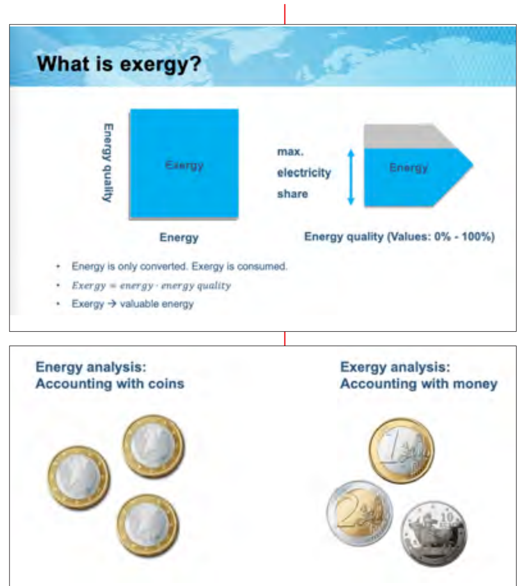
Efficient Gathering, Storing, Distributing and Validation of Data

This report focuses on efficient data gathering, storage, distribution, and validation, covering data management topics from sensor selection to permanent data storage. It provides checklists and recommendations. The target audience is system designers and plant operators.

New Twist on Solar Academy Webinars

The March IEA SHC Solar Academy webinar was a little different from the usual webinars. This webinar tackled a solar heat topic – solar thermal district heating – BUT focused on a specific audience, UK policymakers, and showed how deployment successes in Austria and Germany could be replicated in the UK.

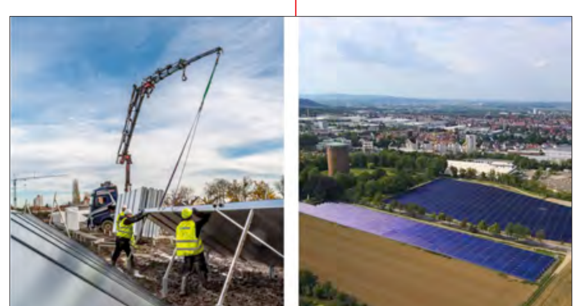
"Making Low Carbon District Heat a Reality in the UK" was the first 2024 webinar of the Solar Academy webinar series. The event opened with the concept of resource exergy analysis, which enables a comparison between heating options based on exergy (energy quantity x energy quality). This allows a focus not solely on energy used but also on overall resource consumption, including energy quality. We expect this to gain prominence as we seek fully sustainable solutions. Analysis based solely on energy will never give a true picture, simply because energy is never consumed, only converted.



▲ **What is exergy?** Source: Andrej Jentsch, IEA DHC

The day's presentations then focused on developments in Germany, where district heating has 'never had such high significance.' There are already 55 solar thermal district heating installations, serving small towns and villages as well as cities. Applying this model to the UK context could see a renewed focus on solar thermal-powered heat networks for small towns and villages, particularly for off-gas-grid locations not in scope for a potential hydrogen rollout. However, implementation of solar thermal is generally easier and cheaper where an existing heat network is already in place, which is not often the case in rural settings in the UK. In Germany, challenges in identifying land areas close to towns and cities and their heat networks can often be overcome; this is considered to be a barrier to solar thermal deployment in the UK.

The requirement under Germany's National Building Act means that every new heating system for houses not connected must either connect or otherwise have a minimum of 65% renewable energy supply. Further assistance for solar district heating will come not only from the €4bn efficient heat networks funding program (BEW) but is expected to focus on shortening the lengthy process of obtaining the necessary building permits. The UK government views heat networks as a vital part of the transition to net zero by 2050 and supports the sector through its Heat Network Transformation Programme (HNTP). As part of this program, the Green Heat Network Fund (GHNF) provides capital grants for low-carbon heat networks, including £485m of funding from 2025-2028. Solar thermal is an eligible heat source for funding under the GHNF. The UK is expecting rapid growth in heat network deployment as it introduces heat network zoning in 2025, anticipating it will deliver around 20% of total heat demand by 2050.



▲ **Example of solar district heating plant in Ludwigsburg, Germany.** Source: Guido Bröer

Upcoming Solar Academy webinars. Join us to learn about the SHC Programme's work and results.

- **Solar Hot Water for 2030** -- September 25th and September 27th rebroadcast and live Q&A.
- **Efficient Solar District Heating Systems** -- November 19th and November 21st rebroadcast and live Q&A.

For more information visit, https://www.iea-shc.org/solar-academy/webinars.

With the presentation of case study examples, the webinar promoted solar district heating as an important technology combination for securing a sustainable exergy future!

Article contributed by Robin Wiltshire, UK representative, and chair of IEA District Heating & Cooling Programme. To see webinar recording and download presentations, visit the IEA SHC Solar Academy webinar, Making Low Carbon District Heat a Reality in the UK.

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 over 70 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 Task Managers.

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