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

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Solar Heat Worldwide – 2023 Edition

Our flagship report, Solar Heat Worldwide 2023 is the most comprehensive evaluation of solar heating and cooling markets with data from 71 countries. The 2023 edition is available for free on the IEA SHC website. Highlighted below are just a few of the findings from this year's report.

In 2022, **19 GWth** or **27 million square meters** of collectors were installed, generating 442 TWhth of green heat, saving **47.48 million tons of oil** and avoiding **153.3 million tons of CO_2**. And with **115 million systems** in operation, the total solar thermal capacity was **542 GWth**.

2022 was a mixed year for solar thermal – while many solar thermal markets grew, particularly in Europe, the global market was overshadowed by declines in two of the largest markets, China and India, leading to a 9.3% decline after last year's 3% growth. With China holding over 70% of the total market share, its decline of 12.4%, largely due to Covid-19 lockdowns, combined with a 21% drop in India due to subsidy changes and PV competition, the drag on the global market is evident.

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Lucio Mesquita of Canada Elected New SHC Executive Committee Chair

Lucio Mesquita of Natural Resources Canada is a familiar face to many of us and a longtime Task participant starting with Task 25 on Solar-Assisted Air Conditioning of Buildings in 1999.

Lucio has over 30 years of experience researching, designing, and testing solar thermal products and systems for industrial, commercial and residential applications in Canada, Brazil, China and the US. His work has included designing and commissioning more than 180 commercial solar thermal projects.

Tomas Olejniczak passed the "gavel" to Lucio at the June Executive Committee Meeting in France. Thank you Tomas for your leadership as Chair these past 2 years!

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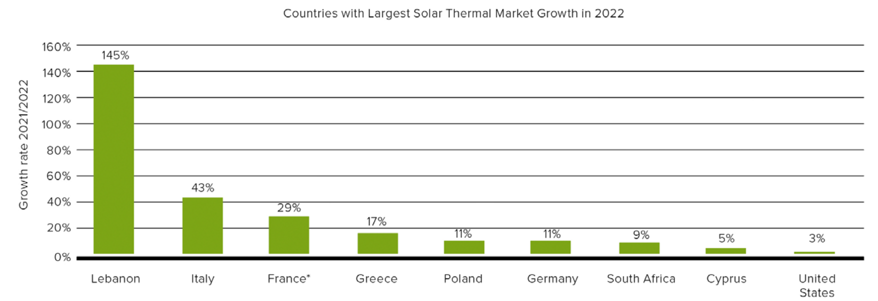
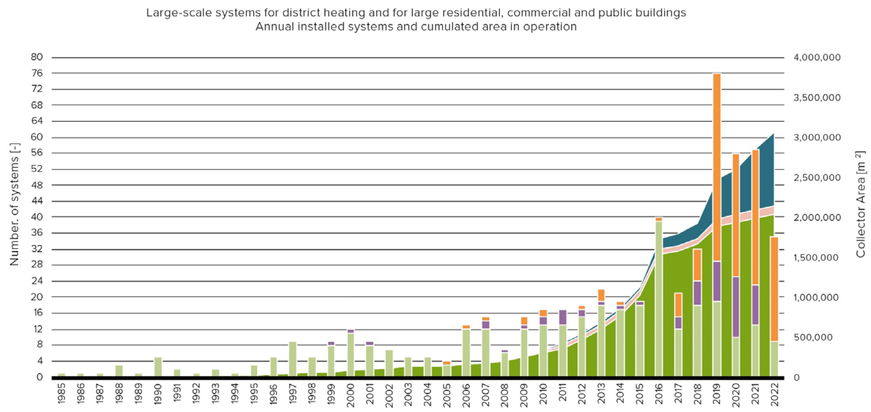
On the other end of the spectrum is Lebanon and its incredible 145% market growth, underscoring the power of subsidies and timing. This growth, mainly driven by the removal of electricity subsidies, rise in fuel prices, and currency depreciation, motivated consumers to install solar water heaters as an affordable alternative to electric heating. In Europe, Italy, Greece, and Poland recorded positive market developments for the second year in a row. After a staggering market growth of 83% in 2021, Italy's solar thermal market maintained its strong market growing by 43% in 2022. Greece experienced similarly positive development, with 18% growth in 2021 and 17% in 2022. Poland also witnessed consecutive years of strong market expansion, with 17% and 11% growth rates in 2021 and 2022, respectively. Additional positive developments occurred in France (29%), Cyprus (5%), and South Africa (9%).



Reporting countries with the highest growth rates in 2022

* preliminary data based on Uniclima Report



Large-scale systems for solar district heating and large residential, commercial and public buildings worldwide – annual installations and cumulated area in operation in 2022

Data sources: Daniel Trier - PlanEnergi, DK, Jan-Olof Dalenbäck - Chalmers University of Technology, SE, Sabine Putz - IEA SHC Task 55, AT, Bärbel Epp - solrico.com/, DE, AEE INTEC, AT, Janusz Starościk – SPIUG, PL, Zheng Ruicheng, China Academy of Building Research, CHN.

- Cumulated collector area in operation in Europe [m²]
- Cumulated collector area in operation in China [m²]
- Number of systems installed in "Other countries" [m²]
- Cumulated collector area in operation "Other countries" [m²]
- Number of systems installed in Europe [-]
- Number of systems installed in China [-]

* Other countries:
MENA countries: Dubai, Jordan, Kuwait, Morocco, Saudi Arabia, Tunisia, UAE
Latin America: Brazil, Colombia, Mexico
Asia excl, China: Cambodia, Japan, Kyrgyzstan, India, Russia, South Korea, Thailand, Turkey
Plus: Australia, Canada, South Africa, USA

No energy turnaround without a heat turnaround

Global final energy consumption for heating and cooling has remained virtually unchanged at around 50% for many years. According to the IEA Renewables 2022 report, industrial processes are responsible for 53% of the final energy consumed for heat, while another 44% is used in buildings for space and water heating. The remainder is used in agriculture, primarily for greenhouse heating.

Fossil fuels dominate the heating sector. Apart from traditional biomass, only 11% of global heating needs were met by modern renewables in 2021, underscoring the urgent requirement for sustainable heating solutions.

The IEA Renewables 2022 report projects global heat consumption – excluding ambient heat from heat pumps – to increase by almost 14 EJ (+6%) during 2022-2027. This demand will be met to a small extent by electrifying the heating sector. Meeting the majority of this demand, however, will necessitate the adoption of geothermal energy, modern use of biomass, and solar thermal energy.

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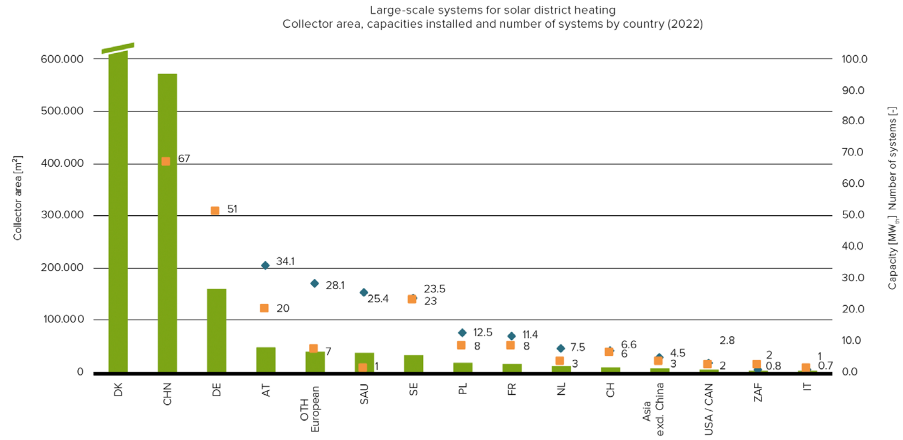
Solar Heat Worldwide *from page 2*

Data indicates a significant rise in **demand for large-scale solar thermal systems in 2023.** Considering the extended lead time for developing large-scale system solar district heating and industrial process heat systems, coupled with the recent implementation of renewable heat policies, the solar thermal industry is poised for substantial growth in the coming years.

Solar district heating plant uses 9,181 m² of vacuum tube collectors in Lemgo, Germany. (Photo credit: Stadtwerke Lemgo GmbH/Viessmann)

Clear upward trend in solar district heating in Europe

According to the German Steinbeis research institute Solites, in 2022, the total collector area for district heating in **Germany** grew by 30% compared to the previous year. This positive trend appears set to continue in 2023 and beyond. Nine systems representing a collector area of 28,000 m² (19.6 MWth) are under construction or in an advanced planning stage. Another 66 systems with a collector area of 454,550 m² (318 MWth) are under discussion. The construction of the largest solar district heating plant in Germany with a collector area of 65,000 m² (45.5 MWth capacity) was announced by Stadtwerke Leipzig in April 2023, with plans for commissioning in 2025.



Collector area [m²] ◆ Capacity [MW_{th}] ■ Number of systems [-]

Large-scale systems for solar district heating – capacities and collector area installed and number of systems by the end of 2022

Data sources: Daniel Trier - PlanEnergi, DK, Jan-Olof Dalenbäck - Chalmers University of Technology, SE, Sabine Putz - IEA SHC Task 55, AT, Bärbel Epp - solrico.com, DE[9].

DK: Collector area: 1,606,591 m²
Capacity: 1,124 MW_{th}
Number of systems: 123

CHN:: Collector area: 571,464 m²
Capacity: 400 MW_{th}
Number of systems: 67

[9] Usually, countries report single systems that are documented regarding project name, country and installed collector size. In 2021 and 2022 China reported total collector area and average system size for solar district heating systems.

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Things are also on the move in the **Netherlands**. A large-scale solar district heating system will be completed in the first quarter of 2023 in the city of Groningen. This plant has a collector area of 48,000 m² (33.6 MWth capacity).

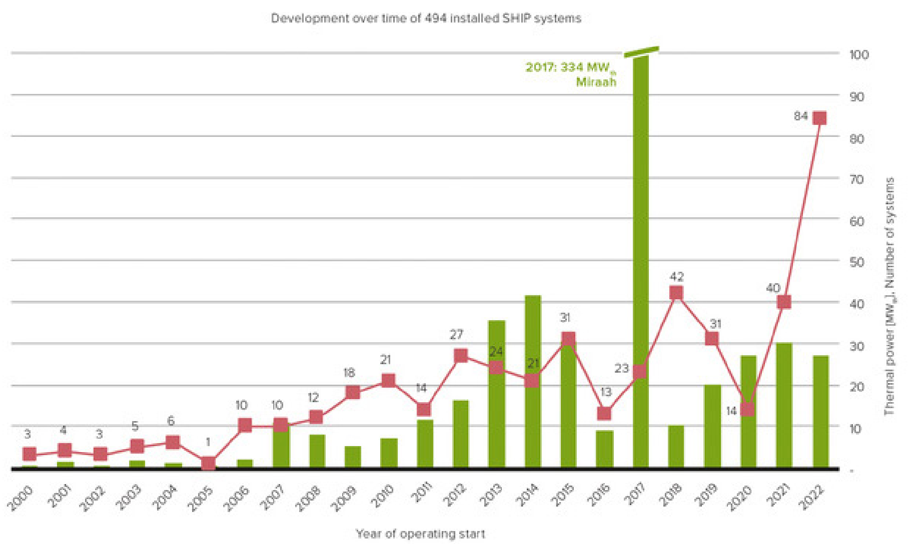
And the **Western Balkan** countries of Kosovo and Serbia are emerging as dynamic players in solar district heating. Advanced planning is underway for a solar plant in Pristina, the capital city of Kosovo, including a 58,000 m² collector area (40.6 MWth capacity) and a 408,000 m³ seasonal, set to come online in 2024. And two district heating plants are planned for Serbia. The feasibility study for a 35,000 m² (24.5 MWth capacity) plant in the city of Pancevo is completed, and plans are underway for a solar district heating plant in the range of 45 to 136 MWth in combination with seasonal storage for the city of Novi Sad.

A new dimension is opening up in China

In China, a groundbreaking solar plant with a 79.8 MWth capacity is under construction, providing heat to the Handan Bay Water World resort. The impressive 114,000 m² parabolic trough collector system will supply the hotel's HVAC and hot water systems, indoor swimming pool, and ice and snowmaking facilities for an indoor ski slope. Completion and commissioning are scheduled for the second quarter of 2023.

Positive outlook for solar industrial heat plants

Another sector showing promising signs of growth in 2023 is solar heat for industrial processes (SHIP). According to solarthermalworld, a significant increase in plants using solar process heat above 100 °C is expected. And the number of multi-MW plants to be commissioned in Europe in 2023 promises a sevenfold increase. These projects include a 2.5 MWth chemical plant in Turnhout, Belgium, and two brewery systems in Spain, 28.5 MWth and 4 MWth, respectively. Additionally, a solar thermal heating plant, heat pumps, and a storage facility for a malting plant in Croatia are being implemented, with commissioning scheduled for the first quarter of 2024.



Development over time of the 494 installed SHIP systems from which detailed data are available Source: SHIP database

The first GW-scale solar heat plant for an industrial application

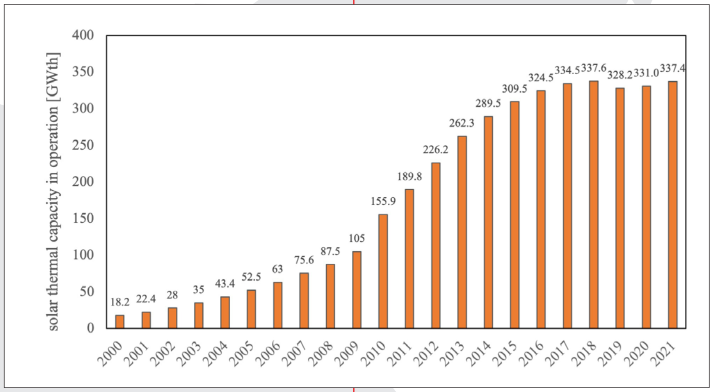
By far, the largest solar process heat plant is in the planning stage in **Saudi Arabia.** Saudi Arabia's leading mining company signed an MOU in 2022 to facilitate a study to develop the first solar steam project in the kingdom to decarbonize an alumina refinery. When complete, the 1.5 GWth solar steam plant will reduce carbon emissions by over 600,000 tons annually, more than a 50% reduction in the refinery's carbon footprint.

Article contributed by Werner Weiss of AEE INTEC and co-author of Solar Heat Worldwide and the Austrian IEA SHC Executive Committee member.

China's Solar Thermal Market Shifting from Individual Installations to Large-scale Projects

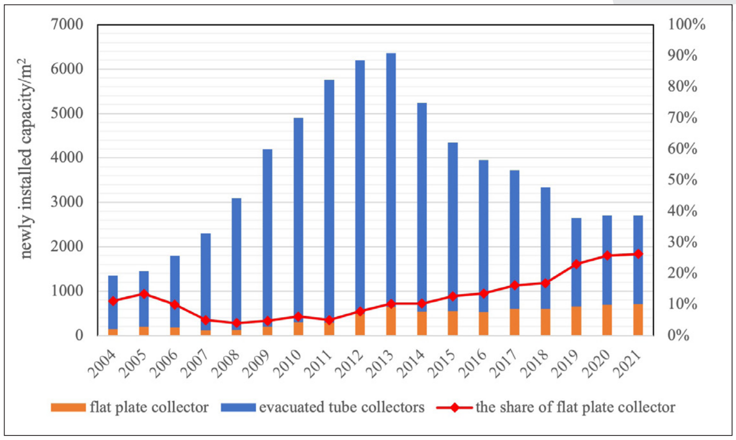
In 2021, the cumulative operation capacity of solar thermal systems in China reached 481.94 million square meters, accounting for 72.8% of the world's installed area. The installed capacity of solar thermal power generation is 588 MW, accounting for 8.3% of the global cumulative installed capacity of solar thermal power generation. In recent years, the total installed solar thermal capacity has plateaued due to competition from heat pumps and photovoltaic systems and a slowing growth rate in the number of traditional small-scale and household solar water heating systems installed. In addition, the overall solar thermal industry growth rate is on a downward trend due to the impact of COVID-19.

In 2021, China added 27.05 million square meters of installed solar thermal capacity, an increase of 0.04% year-on-year and 71.5% of the world's new installed capacity. Currently, evacuated tube collectors are the dominant product in the market, accounting for about 73.64% of the total new installed capacity in 2021. However, the number of flat plate collectors has been growing from 2004 to 2021. In 2004 it was 4.67% of the market, and today is 26.27%. The market is experiencing gradual changes in the type of collectors, from evacuated tube collectors to flat plate collectors, which are easier to integrate into building structures.

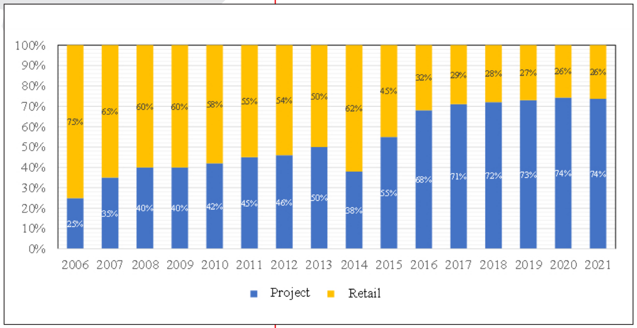


▲ **Figure 1. Solar thermal capacity in operation in China from 2000 to 2021.**

In recent years, China's solar thermal heating market has gradually occupied the main business segment of the market, of which the overall share of the project market reached 74% in 2021 and the retail market 26%. Sales of domestic hot water systems are continuing to decline.



▲ **Figure 2. New installed capacity of the solar thermal system from 2004 to 2021.**



▲ **Figure 3. New solar thermal system types from 2006 to 2021.**

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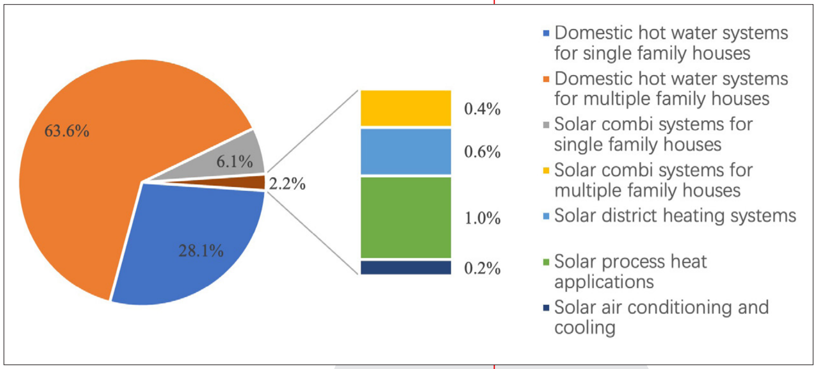
Figure 4 shows that the largest share of the collector area installed in 2021 is domestic hot water systems for multi-family houses, which accounted for about 63.6% of installations in 2021. The share of domestic hot water systems for single-family houses was 28.1%, and solar combi systems for single-family houses accounted for about 6.1%. The share for other applications, such as solar process heating, solar air conditioning, and solar district heating, is about 2.2% in China.



▲ Figure 4. The proportion of new solar thermal systems of different application types in 2021.

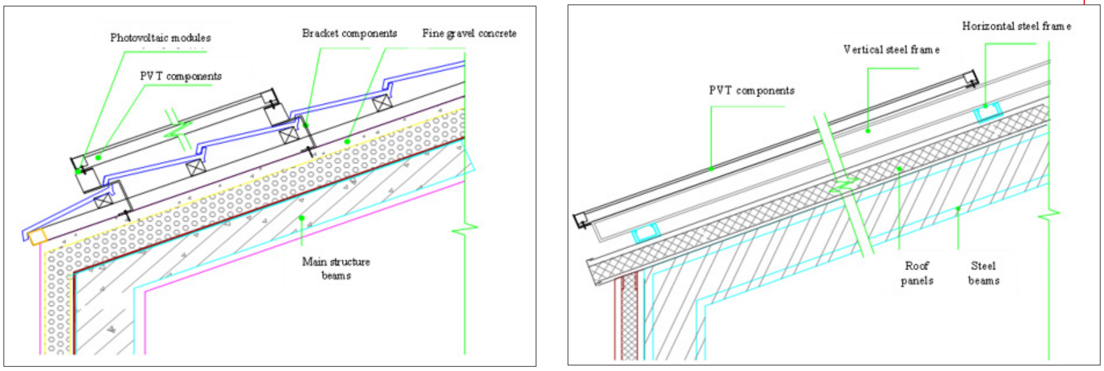
Research Highlights

In the last decade, China's policy has increased the policy guidance on using clean energy to improve the ecological environment and reduce carbon emissions. Among them, there is no more significant impact on the solar thermal industry than the official implementation of the clean heating policy in 2015 and the "carbon peak and carbon neutrality" policy proposed in 2020. The former has shown a solid impetus for the emergence of many "solar+" heating systems in rural areas in northern China. The latter has given rise to considerable research and applications for carbon reduction. Essentially, they all improve the efficiency of renewable energy use. Next, we will highlight a few solar thermal heating projects from two aspects: comprehensive utilization system of solar energy and application cases.

Comprehensive Utilization of Solar Energy

In response to the clean heating policy, various "solar+" heating models appeared, and relevant technology evolved rapidly. At the same time, under the guidance of the "carbon peak and carbon neutrality" policy, research on large-scale comprehensive utilization of solar energy systems is gradually springing up, dedicated to improving the consumption of wind and solar energy to meet the demand for heating.

For residential "solar+" heating systems, the Dalian University of Technology proposed a heat pump-type PVT ventilation roof and designed a PVT module array and rural residential slope roof integration component. By applying this component, the average temperature amplitude attenuation coefficient in summer increased by 10%, and the total daily heat gain and peak cooling load decreased by 54.4% and 76.7%, respectively. The PVT ventilated slope roof has significant energy savings and consumption reduction in summer.



(a) Combination of PVT modules and tile roofing construction method

(b) The combination of PVT module and color steel roofing construction method

◄ Figure 5. PVT module and roofing integrated construction combination.

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It is essential to optimize the control strategy of solar heating systems for large comprehensive solar energy systems. Shanghai Jiaotong University proposed an optimal allocation method for multiple energy storages for the comprehensive utilization of solar energy systems, established a two-layer optimization model for the entire lifecycle of cooling, heating and power dispatch, and studied the profitability of storage of cooling, heating, power and hybrid storage in the case of comprehensive utilization of solar energy systems operation. The calculation results show that the comprehensive utilization of an aggregated solar energy system using cooling and heat storage profits significantly.

The Tibet Langkazi project.

Application Cases

Two examples of large solar thermal projects are highlighted below – the Tibet Langkazi solar district heating project and the China Zhongchuan Xinneng Ulath 100MW solar thermal power plant project.

The Tibet Langkazi project was completed in 2018 in Langkazi County, Shannan City, Tibet, with a total heating area of 82,600 m^2 and a total heat load of 4.3 MW. The heating outdoor design temperature is -14.4°, with an extreme minimum temperature of -37° and a heating period of 251 days. The project adopts high-efficiency prominent flat-plate solar collectors, with a heat-collecting area of 22,300 m^2 and a heat storage volume of 20,000 m^3. The measured value of the solar energy guarantee rate is 93%. The project can produce about 17000 MWh of total energy, save 6,800 tons of standard coal and reduce 164,949 tons of CO_2 emissions annually.

The Zhongchuan Xinneng solar thermal power plant project.

Located in Bayannur City, Inner Mongolia, the Zhongchuan Xinneng Ulath 100MW solar thermal power plant project is the largest single parabolic trough solar thermal power plant, which has achieved continuous stable and high-load operation, generating a cumulative total of about 540 million kWh. Its optical index has reached 98%, one percentage point higher than the current international level. It has a maximum power generation of 105.54 MW and a maximum power generation of 2.192 million kWh in a single day, exceeding the design value. At a high latitude of 41.5, the operating efficiency of the localized parabolic trough collector exceeded expectations.

Conclusion

With the maturity of high-efficiency collector technology, large-scale heat storage technology and regional comprehensive utilization of solar heating scenarios continue to increase, and large-scale solar heating technology will develop rapidly in the following decades. In addition, solar thermal power generation technology has great potential for development. In the IEA Solar Heating and Cooling Programme, Chinese experts point out that solar thermal utilization is gradually shifting from single-family solar water heating to solar-based multi-energy complementary systems. And they look forward to future collaborative projects in this area.

Article contributed by He Tao of the China Academy of Building Research (CABR) and the Chinese IEA SHC Executive Committee member and Ye Shuang of CABR.

MEMBER NEWS

European Solar Research Infrastructure for Concentrated Solar Power Begins Operation

EU-SOLARIS ERIC, the European Solar Research Infrastructure for Concentrated Solar Power, held its constitutive meeting and first General Assembly on January 12th, 2023, marking the beginning of its operation.

Joining four member countries – Cyprus, France, Germany and Spain – and one Observer – Portugal, EU-SOLARIS ERIC arises from a long and successful collaboration between European research centers operating concentrating solar thermal (CST) research facilities, acknowledging that the development of solar energy, using concentrating systems, has a supra-national dimension that demands a strong alliance between research teams with a particular focus on the Research Infrastructures (RI) to enhance the research efficiency and the technology development.

Integrating the European Strategy Forum on Research Infrastructures (ESFRI) Roadmap since 2012, EU-SOLARIS ERIC aims to become the European reference research infrastructure in the technological development of CST and solar thermal electricity (STE) systems and related applications by offering the best conditions for the development of research activities for the scientific and industrial communities.

During 2023 EU-SOLARIS ERIC will consolidate its operational status and open a call for projects to develop standards, tools, and procedures to improve the interoperability and the quality of the services offered to research infrastructures users.

An example of EU-SOLARIS related facilities is the Hydrosol experimental platform for hydrogen production at Plataforma Solar de Almeria in Spain.

EU-SOLARIS ERIC is in a privileged position to contribute to the development of the IEA SHC Programme's mission by providing access to both the scientific and industrial community and world-class research facilities and supporting the development of a wide range of concentrating solar thermal technologies and applications, including not only power production but also solar heat for industrial processes and solar fuels production. Opportunities for synergy with IEA SHC can be found beyond R&D in activities such as disseminating CST technologies, applications and the value of training young researchers and professionals.

For more information, please visit https://eu-solaris.eu/.

Constitutive meeting of the European Solar Research Infrastructure for Concentrated Solar Power in January 2023.

Montmélian is Still as Sunny as Ever After a Decade...

The advantage of public action is that it allows projects to be implemented over the long term. This is precisely what the town of Montmélian (Ville de Montmélian), aka Montmélian la Solaire, can boast when it comes to solar energy.

Winner of the IEA Solar Heating and Cooling Programme's 2014 Solar Award, this medium-sized town in the heart of France's Alps is as committed as ever to deploying solar technology.

Daniel Mugnier, Chair of the IEA SHC Programme between 2018 and 2021 and one of the two French Executive Committee delegates, met with Beatrice Santais, the town's mayor and recipient of the town's IEA SHC Solar Award, recently to take stock of the town's solar activities since 2014.

Over the past nine years, the town has not just maintained its solar swimming pool, retirement home, which is equipped with several hundred m² of panels, and the 84 m² installation combining domestic hot water preheating and solar heating at the town's Gendarmerie. But it is expanding its solar park. One hundred thirty social housing units in five buildings in the Commune now have solar thermal collectors. And the technical services department notes that all the systems are operating smoothly, although they would prefer having simpler tools to monitor system performance.

Montmélian Mayor Béatrice Santais and Daniel Mugnier, French IEA SHC Executive Committee member, meet to catch up on the town's solar thermal activities since winning the IEA SHC Solar Award in 2014.

One of the main reasons for the town's focus on solar thermal, explains Madame Santais, beyond the national thermal regulations, is the presence of an exemplary Local Urban Planning Scheme (PLU). So exemplary, in fact, that it has inspired the Schéma Directeur Territorial (SCOT), according to the local councilor, to impose a minimum requirement that 50% of the thermal needs of buildings must be covered by local renewable energy. And that means, first and foremost, solar!

Since 2014, the Communauté de Communes Cœur de Savoie (Coeur de Savoie), of which Madame Santais is also currently president, has been very active on the subject of solar energy, carrying out a whole series of developments to facilitate solar projects, notably the establishment of a solar cadastre. As the Coeur de Savoie energy manager points out, several thousand inquiries about solar thermal possibilities are received every year—even more inquiries than received about photovoltaic solar possibilities in the region. Solar thermal DNA is well established in Montmélian!

There is no stopping Montmélian's solar thermal enthusiasm. In the coming years, an ambitious solar thermal production system for a heating network with inter-seasonal storage to supply around a thousand homes and tertiary activities will be built on the edge of town. According to Madame Santais, this project will be carried out in stages and is capitalizing on the recent significant progress in mastering the technology of large-scale installations with storage, both internationally and in France.

Montmélian la Solaire deserves its name more than ever!

Article contributed by Daniel Mugnier, French IEA SHC Executive Committee member.

Solar Energy's Potential for Water and Wastewater Treatment

Within the industry's transition to a circular economy, sustainable wastewater treatment and recovery should be reached without excessive strain on limited energy supplies and by decreasing fossil energy consumption. The efficient supply of energy, the best possible integration of renewable energy sources, and the recovery of resources in a circular economy must go hand in hand. Experts from 14 countries analyzed the potential for solar heat and photons for wastewater treatment in industry and municipal wastewater treatment. This article highlights the most promising outcomes.

Eighty percent of the world's energy needs are met by fossil fuels. In addition to renewable energy supply, wastewater purification is also a significant issue globally due to regional water shortages and in water-rich industrialized nations due to the explosive nature of microplastics and poorly degradable trace substances. After all, industry accounts for 20% of global water use. The value of water as a resource is made clear by the fact that water represents a closed cycle on Earth. And the potential of solar energy is highlighted by the fact that a thousand times the world's energy requirement hits the earth via solar radiation. Against this backdrop, solar energy represents an enormous but largely untapped potential in industrial wastewater treatment. The efficient interaction – the nexus between solar energy and water – offers new and innovative approaches and was the focus of the work in the IEA SHC Task on Solar Energy in Industrial Water and Wastewater Management (IEA SHC Task 62).

New Technologies and Application Areas: Nexus Energy & Water

Within IEA SHC Task 62, a network of experts addressed the opportunities, challenges, and benefits of integrating solar energy (solar thermal, photons) in the treatment of wastewater in an industrial context. The main objective was to increase the use of solar energy in industry, develop new collector technologies, and demonstrate industrial and municipal water treatment as a new application area with high market potential for solar energy. The nexus between solar energy, water treatment and industry enables the development of innovative technology combinations for a more sustainable, resource and energy-efficient industry.

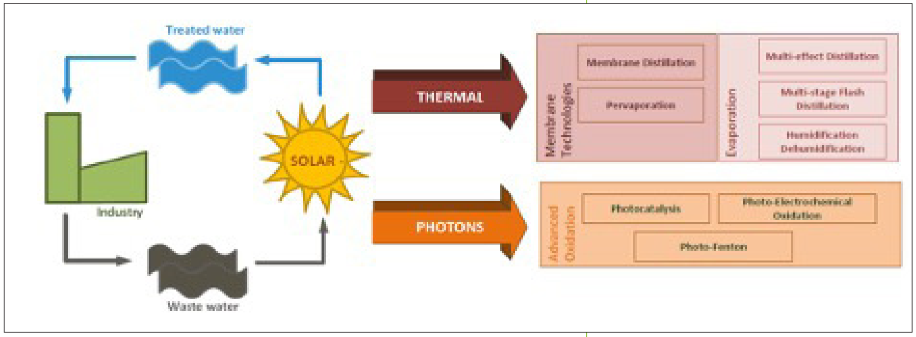

Figure 1. Overview of technologies potentially being supplied by solar thermal energy or solar photons. (Source: AEE INTEC)

Water treatment technologies are already available on the market for different application targets. For distillation (evaporation of water), technologies include multi-stage flash distillation (MSF), multi-effect distillation (MED), and humidification dehumidification (HDH). Separation and filtration processes based on membranes include:

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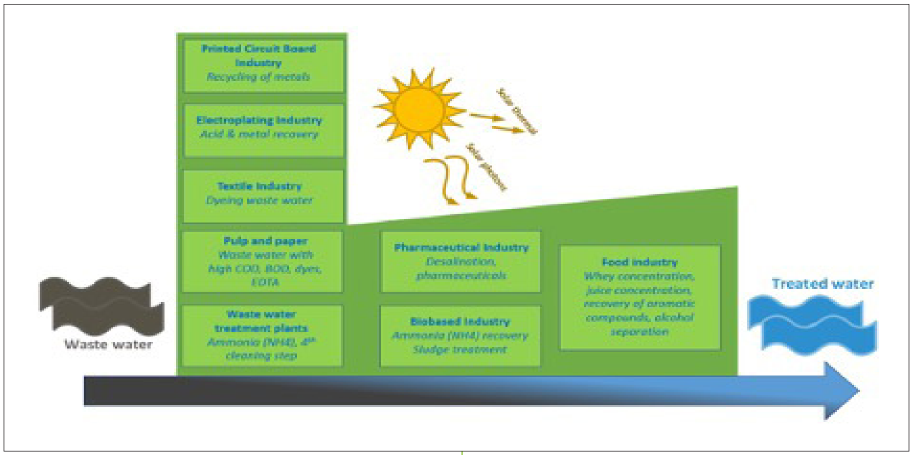
- pressure-driven processes like reverse osmosis (RO) and Ultra-, Nano-, Microfiltration (UF, NF, MF),
- electrically driven processes like electrodialysis (ED),
- concentration-driven processes like diffusion dialysis (DD), pervaporation and
- thermally driven processes like membrane distillation (MD).



▲ **Figure 2. Applications in various industrial sectors for solar water treatment.** (Source: AEE INTEC)

In terms of decontamination and disinfection systems, advanced oxidation processes (AOPs) for degrading contaminants in wastewater are available. Examples are photocatalysis or Photo-Fenton processes.

Among these technologies, thermally driven membrane and evaporative technologies, in particular, show high solar thermal energy potential, while solar photons are interesting for use in advanced oxidation processes (see Figure 1).

To better understand the current market, the Task participants conducted a market study. The results showed that solar-driven technologies (via solar thermal and photons) are available, but mainly on a low TRL 3 level (tested at laboratory scale), with only a few technologies at a TRL 8 level (available on the market) and even fewer in operation.

Potential of Thermal Water Treatment and Recovery of Valuable Materials

One research focus area of the Task was the combination of solar thermal collectors with technologies for wastewater treatment. This work aimed to create an innovative and, above all, economically attractive solution for industry. Using thermally driven separation technologies, such as membrane distillation in combination with solar process heat, is a promising alternative to conventional electrically driven separation technologies (e.g., micro-, ultra-, nanofiltration, reverse osmosis).

Another project area was solar-powered water treatment. Task experts worked on new applications and defined research and development issues. Figure 2 shows the potential application areas for industrial solar wastewater treatment.

A Task highlight is the work on membrane distillation (MD) for ammonium recovery in wastewater. Along with the research group, Water and Process Technologies, at AEE INTEC in Austria, which has been researching this application for several years, a pilot plant operating 24/7 at a municipal wastewater treatment plant was realized. Because temperatures of 35°C to 40°C are required on the evaporation side of the MD plant, this application is perfectly suitable for solar energy.

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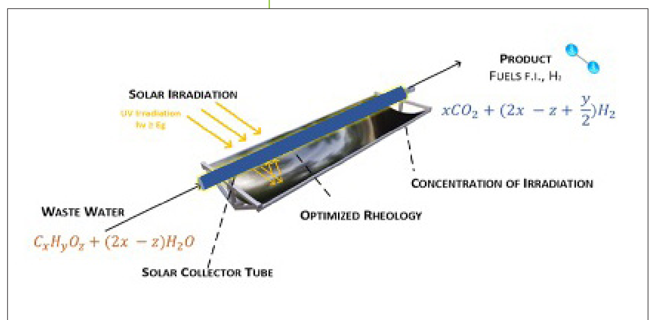
Great Potential for Solar Waster Decontamination and Disinfection via New Solar Concepts

In addition to thermal technologies, SHC Task 62 analyzed technologies that use direct radiation (UV/VIS) in solar water decontamination and disinfection systems. Task experts identified new industrial applications and summarized the technical, economic, and policy barriers to new application areas to facilitate their integration and increase the number of applications. An example of a research project is the Austrian "Solar Reactor," funded by the Climate and Energy Fund under the 7th Call for Proposals for Energy Research in Austria. This solar reactor aims to convert water into hydrogen (H^2) in an efficient photo-electrochemical process while treating wastewater by directly utilizing solar radiation. Through a multidisciplinary approach, the development of the reactor combines competencies from solar collector development, efficient reactor systems, photo-electrochemical material research, wastewater chemistry, and the innovative production of alternative fuels such as H^2. The concept is shown in Figure 3.

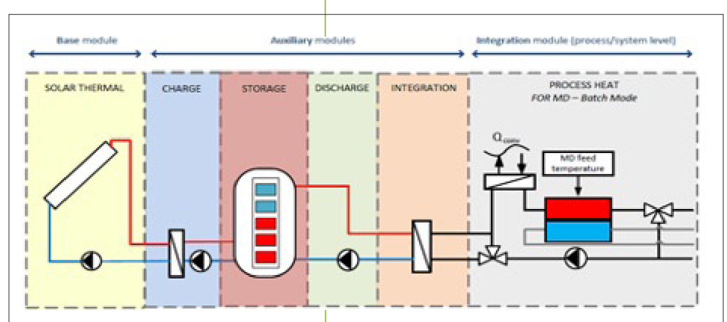


▲ **Figure 3. Concept of the "Solar Reactor." (Source: AEE INTEC)**

Concepts like this are helping to overcome current solar integration obstacles, such as complex systems, numerous components, losses along the supply chain, low efficiencies, and high system costs.

The transition to an intensified and combined unit is a leap in innovation in solar process supply for industrial processes and opens new market potential.

Guidance in System Integration and Decision Making



▲ **Figure 4. Example of an integration concept combining solar thermal for the process heat supply of Membrane Distillation.**

To deliver system integration and decision support for end-user needs within the Nexus of Energy & Water, SHC Task 62 elaborated on system integration concepts on 1) how solar thermal energy can be integrated in combination with thermal separation technologies like Membrane Distillation (MD) and 2) can provide the thermal energy demand in a renewable way. The integration concepts are modular. Each concept has at least one base module for the renewable process heat supply, like solar thermal (illustrated in Figure 4) or a heat pump. Also, the possibility of waste heat integration is available.

The developed concepts for the integration of solar energy into wastewater treatment are available for stakeholders (industrial companies, plant planners, technology providers, etc.) in a decision-making tool to support detailed planning of overall systems (further combination with waste heat, combination with other renewable energies such as heat pumps, etc.). This tool helps users to overcome implementation obstacles due to a lack of user know-how and facilitates the market penetration of solar separation technologies.

continued on page 13

Solar Energy Potential for Wastewater *from page 12*

Conclusion

The work within SHC Task 62 shows solar energy's great potential in wastewater treatment. Nevertheless, there is still the need to take further action.

Using separation technologies such as membrane distillation in combination with solar process heat represents an innovative leap in the industry. The technical and economic potential assessment for using solar-driven water treatment sets the course for further research and development projects in the most significant industrial sectors and municipal wastewater treatment, but also for use in rural areas (e.g., Africa) for applications like drinking water production. With an overview of the identified potentials and research and development needs, follow-up projects for the demonstration of solar supply and separation technologies for wastewater are required to increase awareness and experiences.

In addition to thermal technologies, decontamination, and disinfection processes are paramount in wastewater treatment. Developing new decontamination and disinfection systems using solar photons must gain significant attention and visibility as a promising solution for achieving effective and sustainable disinfection. Further, the simultaneous harnessing of heat and UV light in one technology (solar reactor) represents a leap forward in innovation compared to the state-of-the-art.

An important application area for solar reactors is the production of new energy vectors (e.g., hydrogen from wastewater, reducing carbon dioxide to methanol and other fuels). Sunlight-based photo reforming (e.g., photocatalysis) shows great potential to revolutionize the energy sector, providing a clean and sustainable energy source for various applications. However, many challenges remain to overcome, such as improving the efficiency and scalability of the energy conversion processes and reducing the costs associated with producing and distributing solar fuels.

The good news is that the SHC Programme is starting a new Task on energy sources from solar-powered reactors. To learn more, see the sidebar "New Task Under Development."

Article contributed by Christoph Brunner (SHC Task 62 Manager) and Sarah Meitz of AEE INTEC, Austria.

New Task Under Development

Using Radiation to Produce Hydrogen and Other Fuels

The demand for "green" energy sources is on the rise! And as countries strive to decarbonize, hydrogen is emerging as an essential commodity. However, the challenge this presents lies in the fact that 99% of hydrogen production still relies on non-renewable sources. Similarly, other fuels like methane, methanol, and ethanol face this production predictment. Plus, even if these green fuels were exclusively used for industrial purposes, freight and air transportation, the surplus electricity generated from renewable sources such as wind and photovoltaics (PV) combined with electrolyzers could adequately fulfill the demand. Therefore, it is crucial to explore alternative methods - solar energy - to generate these "green gases." And the IEA SHC Programme is stepping up.

A new project is under development on energy sources from solar-powered reactors.

This proposed Task plans to focus on technologies that use solar radiation to produce hydrogen and other fuels via thermo-catalytic, photothermal, photocatalytic, and photo-electrochemical processes. During this Task, materials researchers and solar experts will exchange knowledge and share new possibilities and developments on reactor designs, system integrations, and potential new product segments.

This Task is in the definition phase, so if you are interested in learning more or are from an IEA SHC member country or organization and would like to join the first Task Definition Meeting, please contact the Task Organizer, Dr. Bettina Muster-Slawitsch at b.muster@aee.at.

TASK 62 INTERVIEW

Solar Energy in Industrial Water and Wastewater Management

Christoph Brunner

The SHC Programme finalized its work on Solar Energy in Industrial Water and Wastewater Management (SHC Task 62) at the end of 2022. To learn first-hand about the Task's impact, we asked the Task Manager, Christoph Brunner of AEE, to share his thoughts on this 4-year project.

Why was a project like this needed?

Christoph Brunner (Christoph): A project like this is needed to address the challenges and opportunities related to sustainable wastewater treatment and energy supply in the industrial sector. With 80% of the world's energy needs still being met by fossil fuels, there is a pressing need to transition to renewable energy sources. At the same time, wastewater treatment is a significant global issue due to water shortages and contaminants like microplastics. By exploring the integration of solar energy in water and wastewater treatment, this project aimed to develop innovative, resource-efficient, and economically viable solutions to reduce the reliance on fossil energy and promote a circular economy.

What is the current status of the technology?

Christoph: The current status of the technology is varied. The market study conducted in this SHC Task revealed that solar-driven technologies for water treatment are available, but most are still in the early stages of development (Technology Readiness Level, TRL 3 - tested at laboratory scale). Only a few technologies have reached the market (TRL 8), and the number implemented still needs to be increased. However, promising developments in thermal technologies, such as membrane distillation and evaporative technologies, show high potential for utilizing solar thermal energy. Plus, there are opportunities to use solar photons in advanced oxidation processes for decontamination and disinfection of wastewater.

Is there one result/outcome that surprised you?

Christoph: One notable outcome of this Task work is the successful implementation of a pilot plant utilizing membrane distillation (a separation process that uses a hydrophobic membrane to separate water vapor from a liquid phase) for ammonium recovery from wastewater. This application was suitable for using solar energy because of the required temperatures on the evaporation side of the plant. Using solar thermal energy to recover valuable materials from wastewater is a promising alternative to conventional separation technologies from both an energy and economic perspective. Another surprising technology with huge potential is using photons to convert water and wastewater into emerging energy vectors like hydrogen or methanol by photocatalytic technologies.

Do you have a Task success story from an end-user or industry to share?

Christoph: The really promising combination of solar collector development and membrane distillation technology is the product of Solardew for purifying water. This, for sure, was a success story within Task 62.

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

Christoph: This Task brought together experts from 14 countries to analyze the potential of solar energy in water and wastewater treatment. By sharing knowledge, conducting studies, and exploring new technologies and application areas, the project helped build expertise in integrating solar energy into industrial and municipal water treatment processes. The developed concepts and decision-making tools can support stakeholders, including industrial companies, plant planners, and technology providers, in making informed decisions and planning overall systems that incorporate solar energy.

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

Christoph: This Task highlights the need for follow-up projects to demonstrate and increase awareness of solar supply and separation technologies for wastewater treatment. Integrating thermal technologies, like membrane distillation with solar process heat, holds promise for more sustainable and energy-efficient industry practices. And a growing focus is on developing decontamination and disinfection systems using solar photons. Sunlight-based photo reforming, like photocatalysis, shows great potential to revolutionize the energy sector, providing a clean and sustainable energy source for various applications. The future of all these technologies relies on advancements in efficiency, scalability, and cost reduction, along with supportive policies and market incentives for renewable energy and sustainable wastewater treatment.

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

Christoph: Running this project as an IEA SHC Task had several benefits. First, it allows for international collaboration and knowledge exchange among experts from different countries, fostering a global perspective on solar energy and wastewater treatment. The Task provides a platform for experts to collectively address challenges, share best practices, and develop innovative solutions. Second, it facilitates the dissemination of research findings, enabling broader awareness and adoption of sustainable practices in industrial water and wastewater treatment. The SHC Task framework provides a structured and coordinated approach, ensuring the project's objectives align with global energy and environmental goals.

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

Christoph: Given the importance of renewable energy and sustainable wastewater treatment, it is likely that the IEA SHC Programme will continue to support and promote research, development, and implementation efforts in this area. The success and outcomes of Task 62 will no doubt inspire further work and collaboration within the Programme to advance the integration of solar energy in water and wastewater treatment technologies. In fact, a new Task on solar reactors for producing new energy vectors (hydrogen from wastewater, reducing carbon dioxide to, for example, methanol) is under preparation.

To learn more about the new Task see the sidebar on page 13.

NEW WORK

Solar Cooling for Emerging Economies

Our solar cooling work will continue! In June, the Executive Committee approved the development phase for a new Task on Solar Cooling for Emerging Economies. This new work will build on five earlier SHC Tasks, particularly our current Task, Solar Cooling for the Sunbelt Regions. This new Task is focused on three areas, solar cooling for industrial applications, thermal energy storage, and industrial waste heat recovery. Its aim is to demonstrate the potential for sustainable and efficient heating/cooling solutions as a systems approach in Southeast Asia, the Pacific region, Africa and South America.

The scope will be small to large-scale commercial and industrial applications for agri-food, manufacturing, and tourism. Three main areas that will be addressed are:

- Subtask A: Adaption components level
- Subtask B: Application and system level
- Subtask C: Business level
- Subtask D: Stakeholder, dissemination and communication

Interested in getting in on the ground floor to help define this project? Then now is the time to contact the Task Organizer, Dr. Uli Jakob, uli.jakob@drjakobenergyresearch.de. The success of the Task will depend on the work of a group of experts with diverse skill sets – solar technology (heat and electricity), sorption technology (chiller, heat pump, hybrid, and storage), conventional cooling and air-conditioning technology (especially on natural refrigerants), heat pumps, storage, heating and cooling integration, testing methods and standardization, RES financing structure, business models and subsidy structures, and marketing and business development.

Harnessing the power of solar energy, this collaborative project will demonstrate the potential of cooling solutions as a system approach for commercial and industrial applications.

ULI JAKOB
Task Organizer

Task 64

New Conversion Factor for Concentrating Collector Statistics

A factor of 0.7 kWth per square meter of aperture collector area for the conversion of area to power for statistics on concentrating collectors is an essential step for international market statistics for new solar heat capacities. So far, the factor 0.7 kWth/m² is only used for non-tracking collectors, following a recommendation published by IEA SHC in 2004. However, sales of concentrating collectors are growing worldwide and also need a conversion factor to account for this dynamically developing market segment in global market statistics.

Scientists from the joint project on Solar Process Heat (IEA SHC Task 64/IEA SolarPACES Task IV) outline the application of the conversion factor for concentrating collectors in an 8-page Technical Note.

According to Dirk Krüger from the German Aerospace Centre and Peter Nitz from the Fraunhofer ISE, the two main authors of the Technical Note: "For some solar thermal systems, only the area and no power is specified. That's why this conversion factor is so important. We need the installed thermal power of all systems in kW or MW so that solar thermal energy is clearly visible in international statistics."

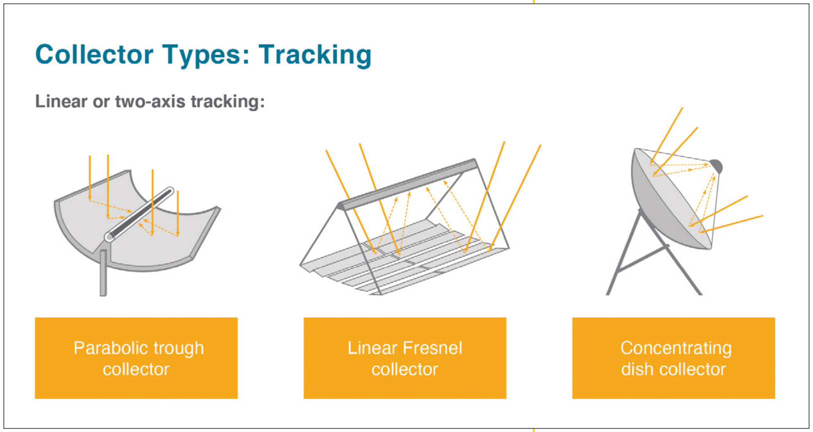
▲ **Parabolic troughs used for preheating water at a tequila plant in Guadalajara, Mexico, installed by Inventive Power.** (Photo credit: Inventive Power)

The Task experts jointly recommend using 0.7 kWth/m² "uniformly for the following concentrating collector types: single-axis tracking parabolic troughs and linear Fresnel collectors, as well as double-axis tracking systems such as parabolic dishes and Fresnel lens collectors. The conversion factor, however, is not meant to be applied to solar tower plants, as this technology was not checked and included in the assessment."

There is growing interest worldwide in solar heat solutions providing more than 100°C. In 2022, already 16% of the collectors installed for solar process heat were concentrating variants. The market will see strong growth in the coming years as more multi-MW plants come online, like the two new systems for Heineken breweries in Spain with 30 and 3.5 MW systems and the 79.8 MW system in China for a tourist resort.

As noted above, this conversion factor is for calculations for market statistics.

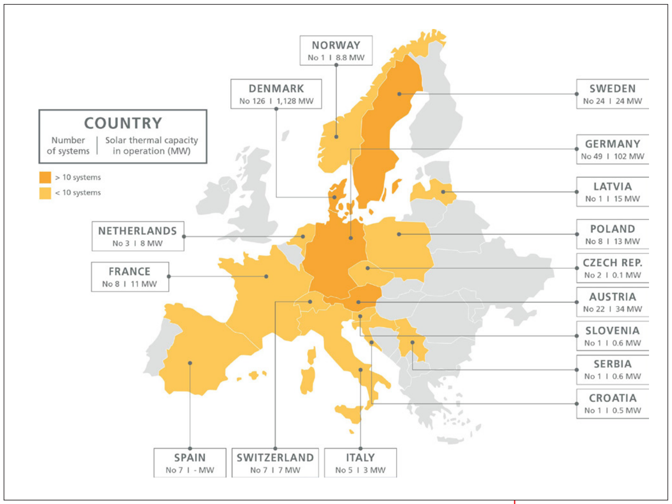
For more information visit the SHC Task 64 webpage, https://task64.iea-shc.org/.



(Source: Solar Payback)

Solar District Heating Info Package for Cities and Towns

Among the 6,000 cities and towns in Europe with district heating, 266 already feed solar heat into their grid. For municipalities that plan to expand and develop new district heating systems to reduce their dependency on fossil fuels, IEA SHC Task 68: Efficient Solar District Heating (SDH) Systems has developed a solar district heating info package. The 45-page presentation answers the key questions that city officers will have when considering solar heat as part of their energy infrastructure planning. Together with Euroheat & Power and the Covenant of Mayors, SHC Task 68 experts organized three webinars, which shed light on SDH from different angles.



"The Signatories of the Covenant of Mayors learned from the SHC Task 68 info package how some cities have successfully implemented solar district heating projects and received tips and tricks for the planning and the tendering process," said Julien Joubert, Project Manager from the Covenant of Mayors Office. They also heard about the hands-on project development experiences of utility companies and municipalities.

Showcase Project

The Latvian utility company Salaspils Siltums has undergone a modernization process over the last 10 years to become almost completely independent from natural gas. The Managing Director, Ina Berzina-Veita, shared her experiences during webinars one and two as noted.

Latvian utility company is cutting down on fossil fuel use

INA BERZINA-VEITA
Managing Director at Salaspils Siltums

"We've been working on this project since we visited Denmark in 2016 to attend a conference on district heating. The aim is to reduce our carbon footprint and become less reliant on fossil fuels."

Photo: Salaspils Siltums

One showcase project is the 15 MW solar district heating plant with 1,720 collectors near Riga in Latvia. "We had a very old infrastructure from the former Soviet times back in 2011, and we were fully dependent on fossil fuels," describing the starting point. "We first increased the efficiency of the system – so you have to check everything from the client to the heat production," notes Berzina-Veita. The next steps were the purchase of a 7 MW wood chip boiler in 2012, followed by a flue gas condenser in 2015, and a 15 MW solar district heating plant in 2019 with a total active collector area of 21,762 m^2.

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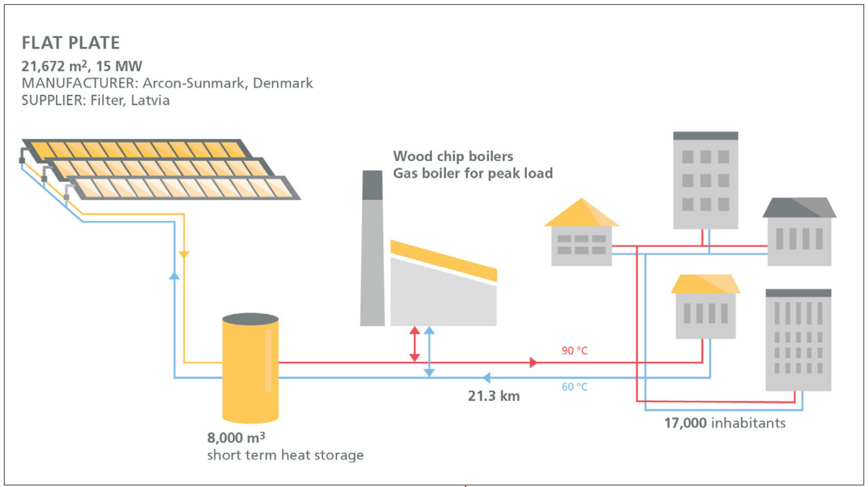
You need a lot of courage to follow this path, confirmed Berzina-Veita. What convinced her was the fact that Latvia, despite its northern location, has better solar radiation than many sites in Denmark, where more than 120 cities and municipalities are using solar district heating.

The solar heat plant in Salaspils contributed 16% in the first years after commissioning. Since the sun covers 20% of the annual heat demand in the local district heating grid. The reason for the improvement lies in the optimized usage of the multi-day storage volume of 8,000 m³. If the weather forecast is good and sunny days are expected, the storage is emptied and reserved for the solar energy to come. If rainy weather is forecasted, the storage is charged using the biomass boiler, allowing a longer boiler run without interruption.



Contribution to total heat demand	65 GWh / year
Solar thermal	16 %
Biomass boilers + flue gas condenser	72 %
Gas boilers	12 %
Ø solar yield 2020/2021	486 kWh/m²a

▲ **Schematic and key figures for the district heating plant in Salaspils, Latvia.** (Source: IEA SHC Task 68)

The good news for the customers – clients of Salaspils Siltums profit from lower heat costs compared to many other district heating utilities in Latvia, so more and more clients want to connect, says Berzina-Veita. As President of the Latvian District Heating Association, she has been campaigning for the spread of solar heating in her country for eight years, and this work is slowly paying off, with a few small SDH pilot plants now up and running.

The Solar District Heating Info Package plus the recordings of the three webinars are available online:

1. The Rise of Solar District Heating – webinar organized by Euroheat & Power on March 28, 2023:
2. Solar heating: how can cities decarbonize their district heating? – Session #1 organized by Covenant of Mayors on May 17, 2023 – report and recording
3. Solar heating: how can cities decarbonize their district heating? – Session #2 organized by Covenant of Mayors on June 5, 2023-z

If you have questions about the SHC Task 68 work, you can email the Task Manager, Viktor Unterberger, viktor.unterberger@best-research.eu.

New LCA and LCoH Task Welcomes Participants & Collaboration

As announced in the Solar Update Newsletter, Issue 76 (December 2022), IEA SHC Task 71 on Life Cycle and Cost Assessment for Heating and Cooling Technologies began work earlier this year and found itself right in the midst of a heated debate on heating systems for single-family homes in Europe. But, this topic is not exclusive to central Europe as governments around the world realize the importance of heating within the energy sector. The good news is that this Task is still open to experts interested in joining.

Due to the fast dynamics in the field of Heating and Cooling Technologies and the consequent rapid development of their regulation, countries are discussing the most effective guidelines, and many are introducing specific legislation and standards to ensure a positive environmental impact of Heating and Cooling Technologies. For this reason, SHC Task 71 will focus on ecological (LCA) and economic (LCoH) assessments, analyze the differences in regulations, and observe their dynamic development throughout the Task duration.

Countries have chosen a variety of approaches, from financial incentives to efficiency standards. What they all have in common is the aim to expand the renewable energy supply and maximize its ecological use. Subtask A is collecting specific regulations and describing them along four key features:

1. Certification standards
2. Emission standards
3. Disposal and recycling
4. Grid requirements

At the end of this year, Subtask A will publish an overview of the data. The goal is to allow easier comparability and produce implementation strategies. Furthermore, the Task is focused on cooperation with other IEA Technology Collaboration Programmes (TCPs) and aims to include as many technologies and regulations as possible.

To expand the scope, SHC Task 71 wants to emphasize that contributions and new Task members are always welcome!

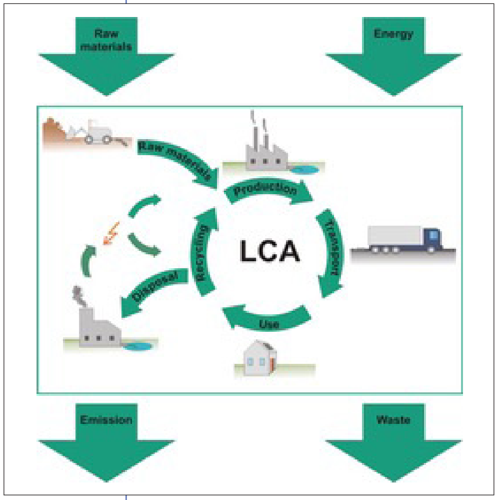
Any projects researching regulations can contact the Task Manager, Dr. Karl-Anders Weiss. Task membership also includes updates on regulation changes. Future laws might focus more on the circular economy, recycling solar modules, and reducing negative environmental impacts during the Life Cycle.

The Task work is divided into five Subtasks:

- Subtask A: Cooperation with ongoing or upcoming SHC Tasks and related Tasks from other TCPs

Users and investors want heating that is sustainable and efficient. But so far there is no way to assess heating technologies across the board. SHC Task 71 aims to close this gap by introducing methodologies and comparable data formats and providing heating reference systems and scenarios.

KARL-ANDERS WEISS
Task Manager



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New LCA and LCoH Opportunity *from page 19*

- Subtask B: Methodology adaption
- Subtask C: Data of different technologies and components
- Subtask D: Reference systems and their requirements, scenarios and optimization
- Subtask E: Dissemination, networking and policy involvement

Even though countries are still joining – China, Spain, France, Italy, Germany, and the UK have officially joined – work has begun in all the Subtasks. With the countries already participating and more interested in joining, Task 71 will draw from a wide range of expertise.

One of the main focuses of our Task is cooperation with other IEA TCPs – PVPS (Photovoltaic Power Systems), DHC (District Heating and Cooling), EBC (Energy in Buildings and Communities), HPT (Heat Pumping Technologies), ES (Energy Storage), IETS (Industrial Energy-Related Technologies and Systems), SolarPACES (Solar Power & Chemical Energy Systems), and Hydrogen.

Collaboration Opportunities with Other IEA Technology Collaboration Programmes

The Task kicked off online in late March 2023 with scientists and experts from Europe and beyond. The two-day event showed great anticipation by everyone to finally get working.

Early on, the team decided to get partners from the industrial sector even more involved. To accomplish that, it was decided to link existing events, such as trade shows and congresses, with SHC Task 71 workshops. At the next Task Meeting in October 2023, the first workshop with industry partners will be held.

The upcoming Task Meeting will be the first one held in person. It will take place on October 18 - 20, 2023, at the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg, Germany. It starts with a public Industry Workshop and an agenda that includes time for an in-depth look at the current challenges and requirements. After the Task Subtask Leaders will introduce their Subtasks and what they have achieved so far. And German PV and heating industry representatives will present their views on the market situation and LCA and LCOH for their respective products. The main focus will be to encourage a lively discussion between the participants and the experts and to define new ways for industry to contribute to the Task.

The Task Meeting will focus on the ongoing work and the national projects in the participating countries. In addition, there will be a session on collaboration with other IEA TCPs where they can present their TCP and discuss links between the TCPs. The Task Meeting will end with a lab tour on Friday.

Are you interested in participating in the Industry Workshop? Email Kyra Sophie Rimrodt at Kyra.sophie.rimrodt@ise.fraunhofer.de.

Are you interested in learning more or in joining this SHC Task? Contact the Task Manager, Karl-Anders Weiss at karl-anders.weiss@ise.fraunhofer.de.

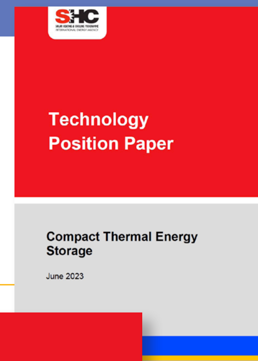
SHC Publications

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.

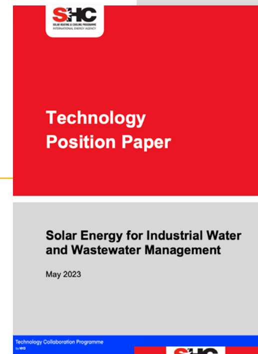
TECHNOLOGY POSITION PAPERS

Three new papers! Each Technology Position Paper concisely explains the relevance, current status, potential, and actions needed for the uptake and further development of a specific technology or application.



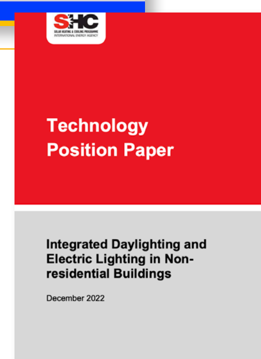
Compact Thermal Energy Storage

Recognizing the fact that - half of the world's final energy demand is used for heating and cooling and the transition to renewables can only succeed with storage – this paper highlights applications with potential and identifies drivers and actions needed to implement successful compact thermal energy storage.



Solar Energy for Industrial Water and Wastewater Management

Recognizing the fact that – water resources are finite and sustainably managing them is a critical challenge for industry and the worldwide economy – this paper presents potential applications and actions needed from water treatment demonstration projects to new energy vectors.



Integrated Daylighting and Electric Lighting in Nonresidential Buildings

Recognizing the fact that – lighting consumes 15% of the global electricity consumption and accounts for 5% of global CO_2 emissions – this paper shows what is needed to provide lighting that is not only energy efficient and sustainable but meets the needs of users.

SOLAR HEAT WORLDWIDE 2023

This year's comprehensive report on the solar thermal market and trends collected data from 71 countries. The report is divided into two parts: Chapters 3-5 cover the 2022 global market development and trends for different applications and Chapters 5-8 present detailed market figures for 2021.

SHC ANNUAL REPORT 2022

Reports on our 2022 activities and plans for 2023. Includes a Feature Article on Integrating Daylighting and Electric Lighting into Non-residential Buildings

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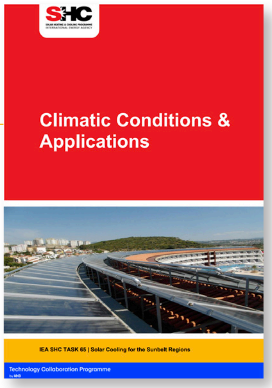
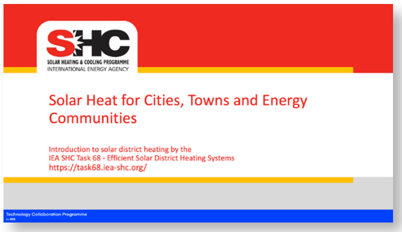
Publications *from page 21*

SOLAR COOLING FOR THE SUNBELT REGIONS

Climatic Conditions & Applications

This report documents how GIS software can combine geographic data in a way that local reference boundary conditions for solar cooling systems in the Sunbelt regions can be determined and used for evaluation. And explains how this method can be used to gather information on possible locations and the potential of specific solar cooling systems.





EFFICIENT SOLAR DISTRICT HEATING SYSTEMS

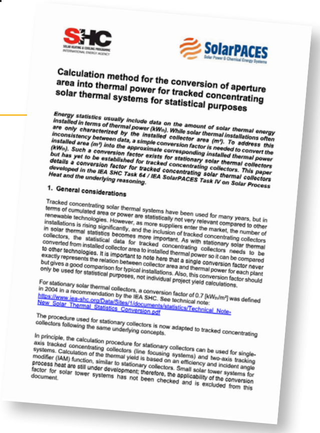
Solar Heat for Cities, Towns and Energy Communities

This 40-page presentation spotlights 10 solar district heating case studies in Europe. With the help of these flagship projects, the most important questions asked about solar district heating when discussing green heating opportunities are answered.

SOLAR HEAT FOR INDUSTRIAL PROCESSES

Technical Note for Tracked Concentrated Solar Collectors

This document describes in detail the new calculation method for converting m² to KWth for tracked concentrating solar thermal systems for statistical purposes.



TASK HIGHLIGHTS

Every year we publish short summaries on what our Tasks are accomplishing.

IEA programme | SHC

The International Energy Agency was formed in 1974 within the framework of the Organization for Economic Cooperation and Development (OECD) to implement a program of international energy cooperation among its member countries, including collaborative research, development and demonstration projects in new energy technologies. The members of the IEA Solar Heating and Cooling Agreement have initiated a total of 71 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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SOLARUPDATE
The Newsletter of the IEA Solar Heating and Cooling Programme

Vol. 77, July 2023

Prepared for the IEA Solar Heating and Cooling Executive Committee
by
KMGroup, USA

Editor:
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