SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

2024
Annual report

Feature Article

Efficient Solar District Heating Systems

Technology Collaboration Programme
by iea

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

2024
Feature Article

Efficient Solar District Heating Systems – Considering higher temperatures and digitalization measures

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Cover: Bird's view of the solar thermal plant at Leipzig, Germany with 45,6 MW (65,000 m²); under construction during spring 2025

Table of Contents

1. Message from the Chair 5
2. Solar Heating and Cooling Technology Collaboration Programme 6
IEA 6
SHC TCP 6
Members & Membership 7
Members 7
Benefits of Membership 7
How to Join 8
3. 2024 Recap 9
Solar Thermal Outlook 9
SHC Tasks 10
New Tasks 10
Completed Tasks 10
SHC Activities 10
Solar Heat Worldwide 10
International Conference on Solar Heating and Cooling for Buildings and Industry 10
Solar Academy 11
SHC Solar Award 11
Solar Update Newsletter 12
SHC Collaboration 12
Within the IEA 12
Outside the IEA 12
4. Feature Article 13
Efficient Solar District Heating Systems – Considering higher temperatures and digitalization measures 13
Introduction and Relevance 13
Current Status 14
Potential 16
Actions Needed 18
5. Completed Tasks 19
Task 63 – Solar Neighbourhood Planning 19
Task Overview 19
Key Results 20
Dissemination Activities 25
Task Meetings 52
SHC Task 63 Participants 53
Task 65 – Solar Cooling for the Sunbelt Regions 56
Task Overview 56
Key Results 58
Dissemination Activities 59

Task Meetings 68
SHC Task 65 Participants 69
Task 66 – Solar Energy Buildings 74
Task Overview 74
Key Results 77
Dissemination Activities 78
Task Meetings 83
SHC Task 66 Participants 84
Task 67 – Compact Thermal Energy Storage Materials within Components within Systems 86
Task Overview 86
Key Results 87
Dissemination Activities 90
Task Meetings 102
Task 67 Participants 102
6. Ongoing Tasks 106
Task 68 – Efficient Solar District Heating Systems 107
Task Overview 107
Work During 2024 108
Work Planned For 2025 110
Dissemination Activities in 2024 110
Dissemination Activities Planned For 2025 112
Task Meetings in 2024 and planned for 2025 113
Task 68 Participants 114
Task 69 – Solar Hot Water For 2030 117
Task Overview 117
Australia, Austria, Canada, China, Denmark, Greece, Italy, Norway, Portugal, Switzerland, GN SEC (Zimbabwe, Botswana, Lesotho, Namibia, South Africa, Zimbabwe), UK 118
Work During 2024 118
Work Planned For 2025 119
Dissemination Activities In 2024 120
Dissemination Activities Planned For 2025 121
Task Meetings Planned for 2025 122
SHC Task 69 Participants 122
Task 70 – Low Carbon, High Comfort Integrated Lighting 125
Task Overview 125
Work During 2023 126
Work Planned for 2024 127
Dissemination Activities In 2023 128
Dissemination Activities Planned For 2024 129
Task Meetings in 2023 and Planned for 2024 129
Task 70 I EBC Annex 90 Participants 130

Task 71 – Life Cycle and Cost Assessment for Heating and Cooling Technologies 133
Task Overview..... **Error! Bookmark not defined.**
Work During 2023..... **Error! Bookmark not defined.**
Work Planned For 2024 ..... **Error! Bookmark not defined.**
Dissemination Activities In 2023 ..... **Error! Bookmark not defined.**
Dissemination Activities Planned For 2024 ..... **Error! Bookmark not defined.**
Task Meetings in 2023 and planned for 2024..... **Error! Bookmark not defined.**
Task 71 Participants ..... **Error! Bookmark not defined.**
7. SHC TCP Contacts 141
Executive Committee Members 141
Task Managers 143
TCP Support 144

1. Message from the Chair

As we close 2024, we look back on another very busy and productive year for our TCP. Four Tasks concluded their work: Tasks 63, 65, 66, and 67. While the achievements of each Task are too numerous to detail here, readers can find comprehensive information in this report and on our website.

Here are a few key highlights: Be sure to explore the wealth of information available on our website.

- Task 67 – Compact Energy Storage Materials, led by Wim van Helden, marked another successful collaboration with our colleagues from the Energy Storage TCP. We're pleased to see ongoing discussions around one, possibly two, follow-up Tasks.
- Task 63 – Solar Neighborhood Planning ended on a bittersweet note. Despite its outstanding work and achievements, it also marked the retirement of one of our most cherished experts, Prof. Maria Wall from Sweden. To Maria, we extend our heartfelt thanks and best wishes for a retirement filled with health and happiness.
- Task 65 – Solar Cooling for Sunbelt Regions, led by Dr. Uli Jacob, brought together a diverse and impressive group of experts from around the world. This reflects the growing importance of cooling technologies in a warming climate and the challenges ahead.
- Task 66 – Solar Energy Buildings, led by Prof. Harald Drück, sparked important discussions around net-zero concepts and the impact of time-step calculations on final carbon emissions. The Task demonstrated that using annual net values can significantly underestimate a building's carbon footprint. It also developed a fascinating Technology Radar for Solar Energy Buildings—

In addition to these completions, two new Tasks were launched in 2024:

- Task 72 – Solar Photoreactors for the Production of Fuels and Chemicals, led by Dr. Bettina Muster-Slatwitsch.
- Task 73 – PVT Heating Systems, led by Dr. Korbinian Kramer.

Both Tasks cover exciting subject areas, are led by outstanding experts, and involve impressive international teams. We eagerly anticipate their results. If you're an expert in these fields, please visit the Task websites and reach out to the Task Managers to get involved.

It never ceases to amaze me that all Task work is carried out collaboratively. Our TCP does not fund research directly—everything is achieved through the joint efforts of our experts. The results speak volumes about what can be accomplished when we work together, accelerating both the quality and quantity of R&D outcomes. Yes, our experts can!

Farewell and Welcome

Last year also marked the retirement of our long-serving Secretariat, Mrs. Pam Murphy. For 28 years, Pam brought wisdom, knowledge, wit, and a wonderful sense of humor to our TCP. We wish her many relaxing summers—and winters—in her beloved Michigan.

As Pam stepped down, we welcomed Mr. Ben Stinson as our new Secretariat. Ben brings deep experience in solar heating and cooling, along with strong skills to support our Programme during these dynamic and challenging times.

Expanding Our Community

We were thrilled to welcome a new member country, Poland, and a new sponsor, Solar Heat Europe (SHE). We're already benefiting from the contributions of Poland's ExCo member, Prof. Justyna Martyniuk-Peczek, and other Polish experts. We also appreciate the valuable input from SHE, especially the participation of its Managing Director, Mrs. Valérie Séjourné.

Looking Ahead

To our experts, partners, collaborators, and members, thank you. This annual report shows an extraordinary amount of work accomplished in just one year. None of it would have been possible without your dedication and support.

While we've achieved a lot, there's still much to do. More than ever, we must emphasize the importance of international collaboration to deliver affordable and clean energy for all. Technology development plays a vital role in this mission.

We're working to strengthen our collaboration with other TCPs, recognizing that energy challenges are increasingly interdisciplinary. The best solutions often involve multiple technologies. Our TCP also needs a strong and diverse membership, with greater participation from a wider range of countries and regions. This will help us better understand how our technologies can support vulnerable communities affected by global warming and how the energy transition can promote social development.

Lucio Mesquita, *SHC Executive Committee Chair*

2. Solar Heating and Cooling Technology Collaboration Programme

IEA

The International Energy Agency (IEA) is an international organization at the heart of global dialogue on energy, providing authoritative analysis, data, policy recommendations, and real-world solutions to help countries provide secure and sustainable energy for all. Taking an all-fuel type, all-technology approach, the IEA advocates policies that enhance energy reliability, affordability, and sustainability. It examines the full spectrum of issues, including renewables, oil, gas, and coal supply and demand, energy efficiency, clean energy technologies, electricity systems and markets, access to energy, demand-side management, and much more. For more information on the IEA, visit http://www.iea.org.

SHC TCP

The Technology Collaboration Programme on Solar Heating and Cooling (SHC TCP) was established in 1977 as one of the first multilateral technology initiatives of the IEA. All our work is supporting our…

Vision

Solar heating and cooling for secure and sustainable energy for all.

Mission

To bring the latest solar heating and cooling research and information to the forefront of the global energy transition.

Our mission assumes a systematic approach to applying solar technologies and designs to whole buildings and industrial and agricultural process heat. Based on this mission, the SHC TCP will carry out and coordinate international R&D work and will continue to cooperate with other IEA Implementing Agreements and the solar industry to expand the solar market. Our activities support market expansion by providing reliable information on solar system performance, design guidelines and tools, data and market approaches, and developing and integrating advanced solar energy technologies and design strategies for the built environment and industrial and agricultural process heat applications.

Our target audiences are the design community, solar manufacturers, and the energy supply and service industries that serve the end-users as well as architects, cities, housing companies, and building owners.

Our scope includes the practical use of sunlight for heating, cooling, and daylighting. The core research areas are technologies for heating, ventilation, and air conditioning for (1) buildings and neighborhoods, (2) industry, and (3) agriculture. The Programme is technology neutral and aims to find the best available solar solution.

The primary activity of the SHC TCP is to develop research projects (Tasks) to study various aspects of solar heating and cooling. Each research Task is managed by a Task Manager selected by the Executive Committee.

The Tasks running in 2024 were:

Solar Cooling for the Sunbelt Regions (Task 65)	Efficient Solar District Heating Systems (Task 68)
Solar Energy Buildings (Task 66)	Solar How Water for 2030 (Task 69)
Compact Thermal Energy Storage Materials (Task 67)	Low Carbon, High Comfort Integrated Lighting (Task 70)
	Life Cycle and Cost Assessment for Heating and Cooling Technologies (Task 71)

Members & Membership

The overall management of the SHC TCP rests with the Executive Committee, which is comprised of representatives from each Contracting Party organization and Sponsor organization.

Members

Australia	Contracting Party	**Italy**	Contracting Party
Austria	Contracting Party	**Netherlands**	Contracting Party
Belgium	Contracting Party	**Norway**	Contracting Party
Canada	Contracting Party	**Poland**	Contracting Party
CCREEE[1]	Sponsor	**Portugal**	Contracting Party
China	Contracting Party	**RCREEE**[6]	Sponsor
Denmark	Contracting Party	**SACREEE**[7]	Sponsor
EACREEE[2]	Sponsor	**SICREEE**[8]	Sponsor
ECI[3]	Sponsor	**Slovakia**	Contracting Party
ECREEE[4]	Sponsor	**South Africa**	Contracting Party
European Commission	Contracting Party	**Spain**	Contracting Party
France	Contracting Party	**Sweden**	Contracting Party
Germany	Contracting Party	**Switzerland**	Contracting Party
ISES[5]	Sponsor	**Turkey**	Contracting Party
		United Kingdom	Contracting Party

1 Caribbean Centre for Renewable Energy & Energy Efficiency
2 East African Centre for Renewable Energy and Energy Efficiency
3 European Copper Institute
4 ECOWAS Centre for Renewable Energy and Energy Efficiency (West Africa region)
5 International Solar Energy Society
6 Regional Centre for Renewable Energy and Energy Efficiency (MENA region)
7 SADC Centre for Renewable Energy and Energy Efficiency (Southern Africa region)
8 Centre for Renewable Energy and Energy Efficiency of SICA countries (Central America region)

Benefits of Membership

The SHC TCP is unique in that it provides an international platform focused on solar thermal R&D. The benefits of membership are numerous.

- ***Accelerates*** the pace of technology development through the cross-fertilization of ideas and exchange of approaches and technologies.
- Promotes standardization of terminology, methodology, and codes & standards.

- Enhances national R&D programmes through collaborative work.
- Permits national specialization in technology research, development, or deployment while maintaining access to information and results from the broader project.
- Saves time and money by sharing expenses and work among the international team.

How to Join

To learn how your government agency or your international industry association, international non-profit organization, or international non-governmental organization can join, please contact the SHC Secretariat, secretariat@iea-shc.org.

3. 2024 Recap

Solar Thermal Outlook

Every year we publish *Solar Heat Worldwide: Markets and Contribution to the Energy Supply*, the only annual global solar thermal statistics report. The 2024 edition reports that in 2023, solar thermal technologies produced 454 TWh – which corresponds to an energy savings equivalent of 48.8 million tons of oil and 157.4 million tons of CO_2.

This annual report is the most comprehensive of its kind and is referenced by many international organizations, including the IEA, REN21, IRENA, and national governments. The report is free to download at http://www.iea-shc.org/solar-heat-worldwide. The figures below show a snapshot of the market.

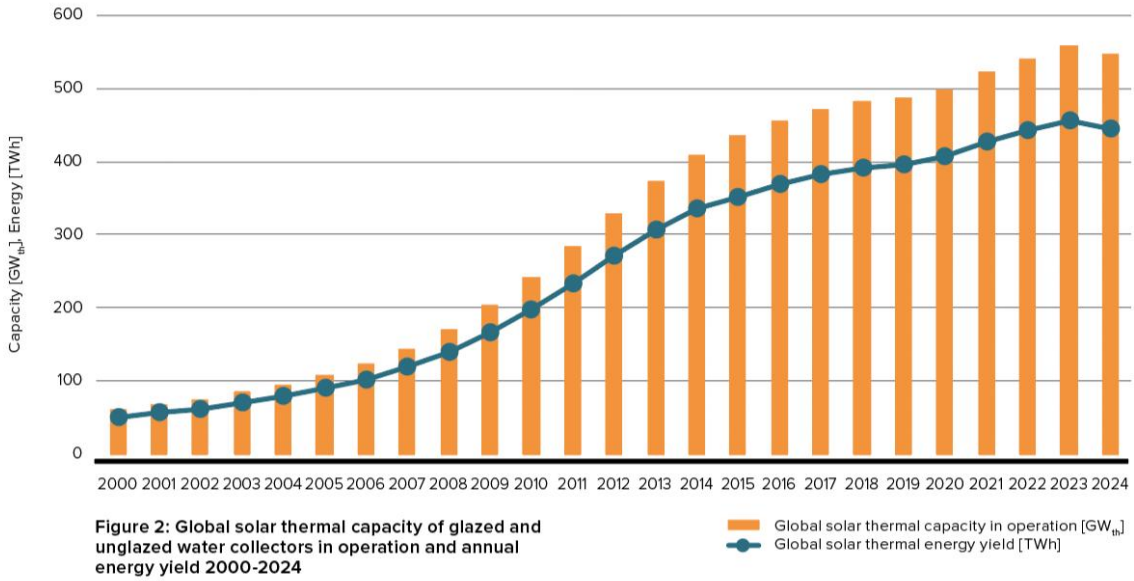

Figure 1 Global Solar Thermal Capacity of glazed and unglazed water collectors in operation and annual energy yield 2000-2024

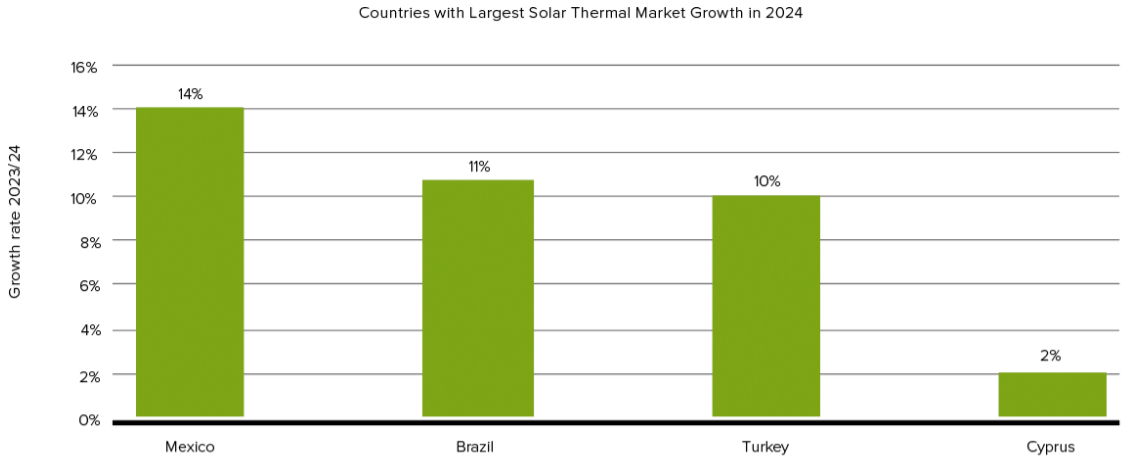

Figure 2 Countries with the Largest Solar Thermal Market Gain in 2024

SHC Tasks

New Tasks

The TCP continues to push forward on cutting-edge topics in solar thermal and the field of solar buildings, architecture, and lighting, all of which support our strategic focus on market deployment and R&D.

Of the seven running Tasks, the following were initiated (started or began Task Definition Phase in 2024):

- Task 72 Solar Powered Photo-Reactors (*Lead Country: Austria)*
- Task 73 Solar PVT Heating Systems (Lead Country: Germany)
- Task Definition Phase Thermal Energy Storage
- Task Definition Phase Solar Cooling for the Global South (*Lead Country: Germany)*

Completed Tasks

- Task 63 Solar Neighborhood Planning
- Task 65 Solar Cooling for the Sunbelt Regions
- Task 66 Solar Energy Buildings
- Task 67 Compact Thermal Energy Storage Materials within Components within Systems

SHC Activities

Each of the activities below serves to inform policy and decision-makers about the possibilities of solar thermal and the achievements of our TCP.

You can learn more about these activities and our work on our website, http://www.iea-shc.org.

Solar Heat Worldwide

This report is a primary source for the annual assessment of solar thermal. The report is the leading data resource due to its global perspective and national data sources. The installed capacity of the 71 documented countries represents 95% of the solar thermal market worldwide.

International Conference on Solar Heating and Cooling for Buildings and Industry

EuroSun 2024 was held in Limassol, Cypress, August 26-30, 2024. With over 200 attendees from more than 40 countries with 70 Poster and 84 Oral presentations. Our international conference provides a platform for experts to gather and discuss trending topics and learn about the work others are doing in the field of solar heating and cooling.

Figure 3 EuroSun Participants 2024, Limasol, Cyprus

In 2026, the SHC TCP, in partnership with the International Solar Energy Society (ISES), will once again co-organized EuroSun 2026 in Freiburg Germany, September 14-18, 2026.

Solar Academy

This activity is another vehicle to share our work and support solar heating and cooling R&D and projects worldwide. It includes 4 webinars every year, onsite training workshops at the request of SHC Executive Committee members, and a video series. In 2024, the webinars were, Making Low Carbon District Heat a Reality in the UK, Solar Heat Worldwide 2024, Manufacturing and Design for Reliability and Durability in Solar Thermosyphon Hot Water Systems. Webinars were also held by Task 69 – solar thermosyphon systems, Task 68 – German solar district heating systems.

SHC Solar Award

Our prestigious award recognizes individuals, companies, and institutions that have made significant contributions to the growth of solar thermal. The SHC TCP has presented this award 13 times since 2003. In 2024 the SHC Solar Award was present at EuroSun in Limassol, Cyprus to Newheat for their LACTOSOL industrial process heat project in Verdun, France. 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.

Figure 4 Newheat Lactosol Installation

Figure 5 SHC Solar Award Winners New Heat with representatives from SHC & Solar Heat Europe.

Solar Update Newsletter

Bi-annual newsletter highlighting Task work and solar thermal programmes/activities in our member countries and organizations.

SHC Collaboration

To support our work, the SHC TCP is collaborating with other IEA Technology Collaboration Programmes and solar organizations.

Within the IEA

District Heating and Cooling TCP are collaborating in Task 68: Efficient Solar District Heating Systems and Task 71: Life Cycle and Cost Assessment for Heating and Cooling Technologies

Energy in Buildings and Communities TCP is collaborating in SHC Task 70/EBC Annex 90: Low Carbon High Comfort Integrated Lighting.

Energy Storage TCP is jointly managing SHC Task 67/ES Task 40: Compact Thermal Energy Storage Materials within Components and Systems.

Heat Pump Technologies TCP is collaborating in Task 65: Solar Cooling for the Sunbelt Regions and Task 69: Solar Hot Water for 2030.

PVPS TCP is collaborating in Task 69: Solar Hot Water for 2030, Task 71: Life Cycle and Cost Assessment for Heating and Cooling Technologies and Task 66: Solar Energy Buildings.

SolarPACES, IETS, DHC, India (Ministry of New and Renewable Energy) and **Brazil, ABRASOL** (Brazilian solar thermal trade association) presented at 2024 SHC ExCo meetings.

Outside the IEA

International Solar Energy Society co-organized EuroSun 2024 and hosts our Solar Academy webinar series.

ISO TC 180, the SHC TCP, specifically through Tasks, supports the work of ISO TC 180.

Mission Innovation Challenge 7: Affordable Heating and Cooling of Buildings is supporting the work of Task 65: Solar Cooling for the Sunbelt Regions

Solar Heat Europe, now a sponsor member of the SHC TCP, co-organizes industry and regional workshops.

Heat Changers and the SHC share mutual support for communications and promotion and Marisol Oropeza presented at the November ExCo meeting about the Mexican solar thermal market and further opportunities for collaboration.

UNIDO supports our GN-SEC Centre Sponsor members.

Conferences, TCP presentations at the *Asia Pacific Solar Research Conference,* and *Solar World Congress 2025*.

2024 MEETINGS	2025 MEETINGS
95th ExCo Meeting (hybrid) **Oslo, Norway June 4 – 7**	**97th ExCo Meeting (hybrid)** **Bratislava, Slovakia June 3 – 5**
96th ExCo Meeting (hybrid) **Berlin, Germany November 5 – 7**	**98th ExCo Meeting (Online)** **November 18 – 20**

4. Feature Article

Efficient Solar District Heating Systems – Considering higher temperatures and digitalization measures

Introduction and Relevance

Climate change, primarily fuelled by our reliance on fossil fuels and the detrimental greenhouse gases (GHGs) they release, is increasingly harming both the global ecosystem and the lives of millions. This is evident in the alarming rise and severe repercussions of extreme weather events. Despite this, our energy supply continues to depend heavily on fossil fuels, accounting for over 75% of our energy sources, as illustrated in Figure 2. Therefore, it is imperative to reduce our fossil fuel consumption and enhance the adoption of renewable energy sources.

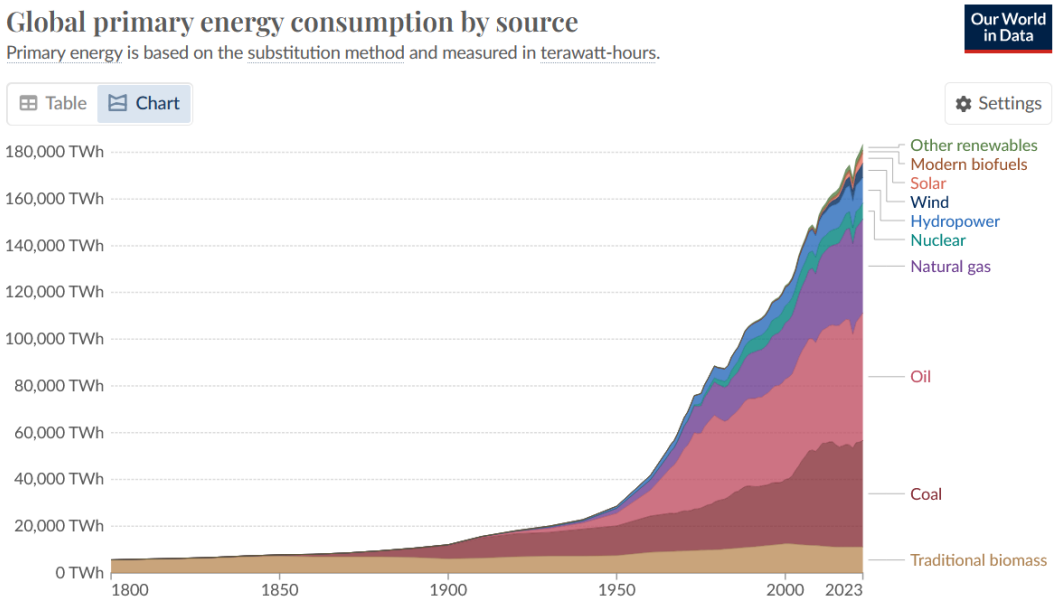

Figure 2 Historic development of global energy consumption by source, from (Ritchie, 2020)

An important lever for increasing the share of renewables is targeting the heat supply. This is because heat constitutes almost 50% of the final energy consumption globally, as illustrated in Figure 3/left. This is also emphasised by **#HeatIsHalf** (see Logo in Figure 3/right) to highlight the – often underestimated – importance of heat for the global energy demand.

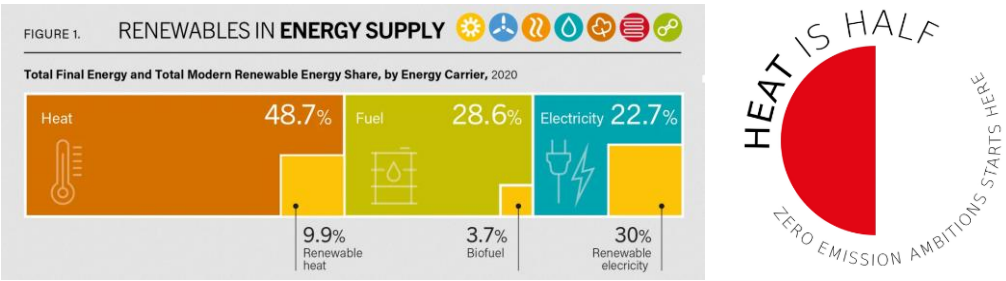

Figure 3 Energy demand, including share of renewables adapted from Renewables 2023 Global Status Report, https://www.ren21.net/gsr-2023/ and #HeatIsHalf logo, https://heatishalf.com.

For decarbonization of the heating sector, two key technologies have emerged, see e.g. (Kelch, 2024):

- **Compression heat pumps,** which can be powered by renewable electric energy and are particularly well-suited for sparsely populated areas.
- **District heating (DH) systems** are ideally suited for densely populated areas (like cities and compact villages). DH systems allow for the integration of various heat sources, including combined heat and power plants, biomass plants, industrial waste heat, heat from waste incineration and heat from future key elements of the energy system (like electrolysers and methanization reactors).

An important renewable heat source to be considered and, if possible, integrated into district heating systems, is solar heat. As an abundant, and fully renewable energy source with very low operational cost, **solar district heating** should be an obvious choice to increase the share of renewable energy in district heating. The structure of such a system is illustrated in Figure 4.

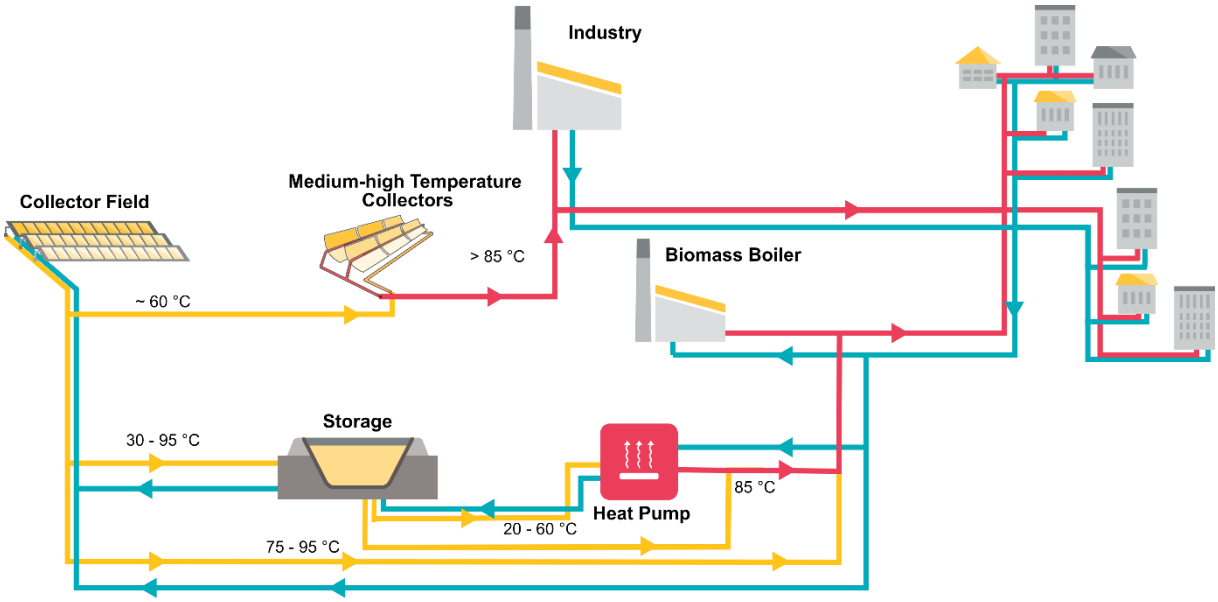

Figure 4 District heating system with integration of low- and medium-temperature collectors, thermal storage, heat pumps and a biomass boiler (as example for a different renewable heat source)

In practice, however, there are reservations against solar technology, or it is not even considered as a viable option, often due to misconceptions or the rather short-sighted perspective on heat planning. IEA SHC Task 68 aims to correct such deficiencies and demonstrate the benefits of solar thermal in district heating systems.

Current Status

Solar District Heating (SDH) is a mature technology and is currently one of the most prominent and important applications of solar thermal technology. For relatively high temperatures (e.g. 100°C), modern collectors have a high heat yield, Figure .

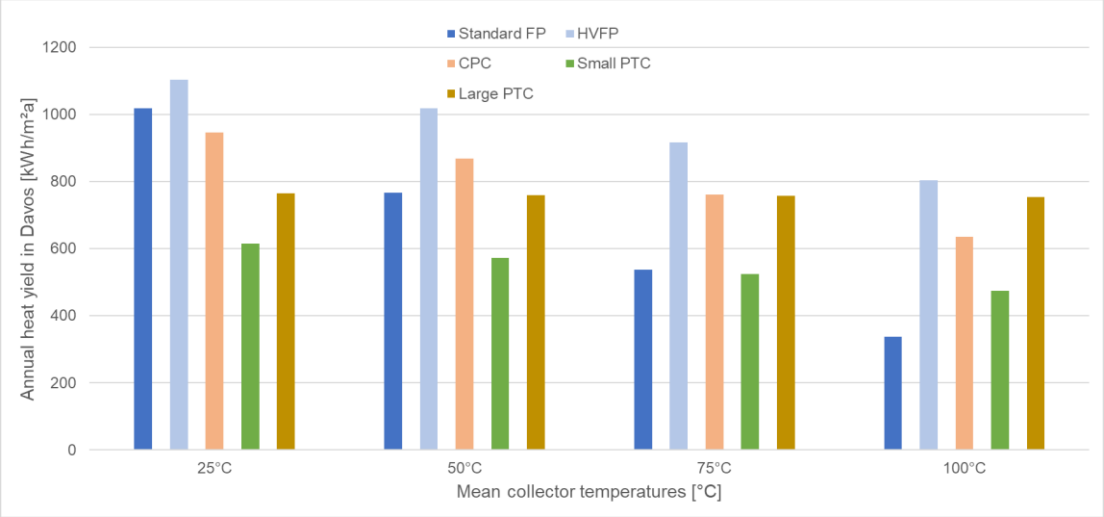

Figure 5 Comparison of gross thermal yield in Davos for different operating temperatures, based on Solar Keymark data and ScenoCalc calculations, from (Tamm, 2024), for standard flat-plate collectors (FP), high-vacuum flat plate (HVFP), compound parabolic concentrator (CPC) and parabolic trough collectors (PTC).

In Northern climates, such as Europe, solar thermal solutions for single family homes have been replaced with Photovoltaics (PV) and heat pumps. While for small-scale solutions (like single family homes), solar solutions based on photovoltaics (PV) and heat pumps have largely supplanted solar thermal systems, for district heating (as well as for other applications like industrial heat), solar thermal systems have several advantages:

- **High Efficiency:** Solar thermal collectors achieve excellent performance at high temperatures, as required in most larger district heating systems. Different types of collectors available in the market can be used for different target temperatures, as shown in Figure .
- **Convenient Energy Storage:** Thermal energy, efficiently provided by solar thermal systems, can be stored, in large volumes, in a cost effective and environmentally friendly ways.
- **Global Market:** While the market for PV modules is almost entirely derived from China, some 90%. Solar thermal has a diversity of manufacturers from various countries. The production of solar thermal collectors also requires considerably less amounts of critical raw materials.
- **Mature Technology**: While other technologies like high-temperature heat pumps are possible heat sources for this application, they are not as easy to integrate and cannot yet be considered a mature, well-established technology.

Around the world there are several successful (technological and economical) implementations of SDH, including plants with high-performance flat-plate collectors or concentrating solar collectors and systems with seasonal heat storage. An overview of the installed systems is given in Figure 6.

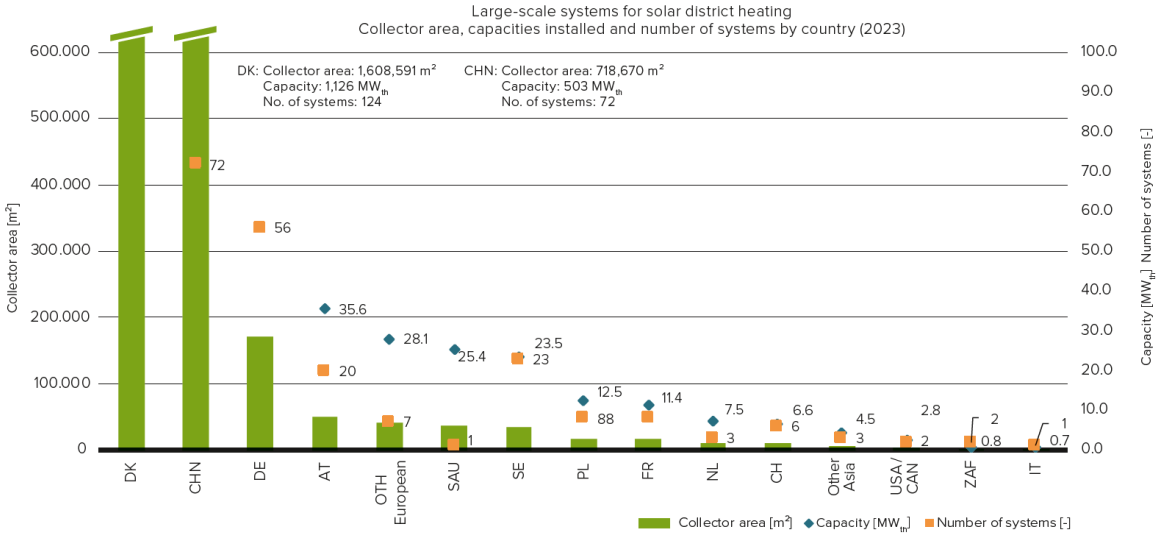

Figure 6 Large-scale systems for solar district heating – capacities, collector area installed and number of systems by the end of 2023, adapted from Fig.~8 of (Weiss, 2024)

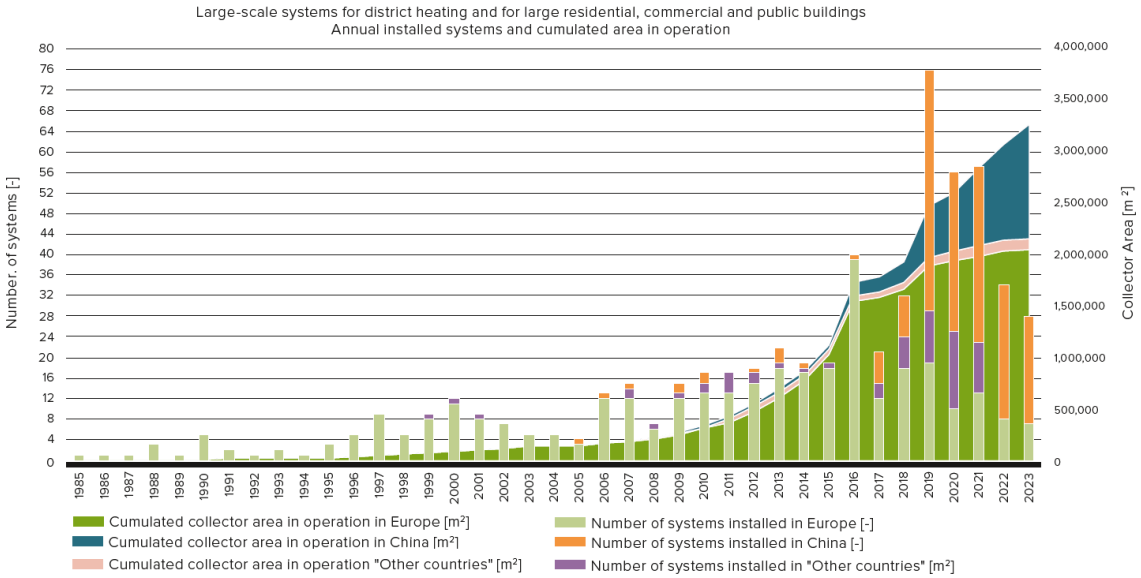

Figure 7 Large-scale systems for solar district heating and large residential, commercial, and public buildings worldwide – annual installations and cumulated area in operation, adapted from Fig.~7 of (Weiss, 2024)

The historic view in Figure 7, shows that the number of annual installations has – after a phase of almost exponential growth – has decreased since 2020. The increase of area in operation is driven by installations in a single country (China), while in Europe, installations have plateaued.

In most parts of the world, SDH should thrive as a reliable and cost-effective method to decarbonize the heating sector yet has stagnated or not yet managed to be properly recognized.

The reasons for this unfortunate situation are most likely not technological ones, but more related to high investment costs (CAPEX), which are often difficult to raise without public funding – though they are readily offset in operation by the very low operational expenses (OPEX) and the security of supply, guaranteed by the independence of fuel imports.

Potential

Of all renewable energy sources, solar energy is rated as the one with the most potential. Most analyses, from MacKay (2009, Ch. 30) to IEA (2024, Ch. 3) agree that the de-fossilisation of our energy system will have to rely largely on solar energy, combined in an elaborate way with other renewable energy sources.

While the demand of energy for heating is expected to drop slightly due to improved building efficiency in the form of better insulation, etc., and due to climate change, the situation depicted in Figure 3 will not change dramatically. Heat will remain a large part of the total global energy demand, and, in addition to industrial process heat, buildings will continue to account for a large percentage of total consumption. Thus, there is great potential for solar district heating.

For heating purposes, the often-cited Solar Fraction (SF) is assumed to be 20% This can be reached by making use of solar energy during summer and on sunny days during transition periods (with little contributions during winter). In such an approach, additional heating technologies with sufficient peak power to satisfy the maximum heat demand are still required.

While the space demand for such solutions is an obstacle, it is by no means insurmountable. Figure shows the space requirements for 20% SF for a few selected cities. The space demand is comparable to those of other infrastructure projects, e.g., airports, highways junctions or golf courses. In contrast to other infrastructure, the ground under solar thermal collectors is not sealed, biodiversity increases, and the area can be used twice for collectors and as grazing land for sheep (Tamm, 2024).

Figure 8 Illustration on the space demand of a solar thermal plant to satisfy 20% of the heat demand for Bratislava (1 171 280 m² area, 229 491 MWh/a), Klagenfurt (474 012 m² area, 109 205 MWh/a), Riga (6 741 504 m² area, 967 116 MWh/a) and Zaragoza (755 392 m² area, 287 793 MWh/a), from https://solardistrictheating.eu/ (currently restricted website), based on Google Maps and on an analysis done by Absolicon

Solar district heating systems with relatively high solar fractions have already been demonstrated, e.g., St. Ruprecht, Austria, with 15% SF, Silkeborg, Denmark, with 17-20% SF, and Tåårs, Denmark, with 22% SF (Fogelström, 2025).

While aiming for 20% SF is already a bold step beyond the usual state of art (solar thermal plants typically contribute a few percent to the total supply of district heating), it is by no means the limit. Significantly higher solar fractions can be achieved by use of seasonal storages or smart combinations with other technologies like shallow geothermal and heat pumps. By transferring heat from summer to winter, such systems can push the limit. For the city of Dronninglund, Denmark, 40% SF was achieved through the use of a 60,000 m³ pit storage. While additional heat sources are usually still required to compensate for heat losses and corresponding temperature drops, solar fractions above 50% are possible, (Klöck, 2023), (SOLID, 2024). The integration of seasonal storages into district heating systems has further advantages, since other heat sources (like industrial waste heat or heat from CHP plants) can be operated and decoupled from the present heat demand.

If we assume that 50% of the population live in areas suitable for district heating and of these 50% would connect to the grid (with the rest using local heat pumps, biomass boilers etc.), about 11 EJ per year of heat demand could be covered by district heating. Directly replacing natural gas by solar thermal energy would yield the following CO_2 savings:

- 20% SF would lead to a reduction of emissions by 123 Mt CO_2/a
- 50% SF would lead to a reduction of emissions by 307 Mt CO_2/a

The savings are even higher if other fossil fuels (oil, coal) are replaced. Thus, the consequent expansion of SDH, combined with seasonal storage, has the potential of eliminating more than 1% of the global emissions (currently about 40 Gt $CO_{2\text{-equiv}}$/a) just for space heating. With parts of the industrial heat demand covered with higher shares of solar energy, even greater reductions are possible.

In contrast to alternative approaches (e.g., large scale retrofit of building insulation and installation of heat pumps), these savings could be achieved within a relatively short timeframe of only a few years, as shown in (Kelch, 2024). Thus, the advantages of solar thermal plants as a renewable heat source for district heating grids are numerous. The ability to provide low cost for heat (calculated over lifetime) and price stability provided by fuel independence are particularly striking ones.

There are, however, also significant barriers that have prevented the widespread adoption of solar thermal plants for this purpose. The first being the “high-CAPEX-low-OPEX” situation, which is quite characteristic for renewable

energy sources. The technology is attractive for long-term planning but not appealing for the short-term maximization of profit. In addition, the space demand can be problematic, and there is often little knowledge or understanding about the potential of this technology. This uncertainty is perceived as weakness and therefore not considered viable.

Lowering the entry barrier can be achieved by several means:

- Dissemination of successful installations of solar district heating, towards planners and investors not yet aware of the benefits and possibilities.
- Acceleration of the planning phase through standardization of processes and improved information/data flow between parties.
- Offering different options, with solutions tailored to meet the needs of the client, e.g., either as turnkey solutions or as heat purchase agreements, which reduce risk to the customer.
- New financing schemes, including crowd funding
- Governmental and general investment policies more oriented towards sustainable long-term perspective

Actions Needed

To support the rapid decarbonization of district heating, the table below highlights some of the challenges and the actions needed to overcome them.

Challenge	Action needed	Action by whom
Collector technologies	While high-temperature solar collectors have reached a high degree of maturity, further R&D work on raising efficiency and reducing production costs would be beneficial for the field.	Collector manufacturer (in cooperation with universities / research centres)
Combination of Technologies	Establish systems to combine different renewable energy production and storage technologies to establish fully renewable heating and cooling with high shares of solar energy.	System designers together with R&D partners (universities, research centres)
Monitoring, Evaluation, Control and Data Science	Raise level of digitalization of solar thermal plants and district heating systems (by installing and integrating more sensors) Adopt advanced yield monitoring (e.g., by using the SunPeek software) and fault detection software in order ensure high yield and proper operation during the service life. Implement advanced (model-predictive) control for higher system efficiency and better integration in the overall energy management system.	Plant / district heating system owner or operator (possibly in cooperation with R&D partners)
Cost reduction, and policy design	Increase public funding to renewable energy sources like solar thermal as a lever to motivate DH operators to quickly switch to renewable energy sources instead of sticking to conventional technology they already know. Reduce bureaucratic burden for project development (e.g., by speeding up routine environmental checks) Energy contracting or crowdfunding to lower the barrier posed by high investment costs	Policy/decision makers Contracting or financing institutions
Effective dissemination	Build awareness for the possibilities offered by solar thermal solutions (which are often still not very well known in the DH community), e.g. by providing easy to use calculation tools and presenting successful use cases, to reduce the average time from contact to contract.	IEA TCPs (SHC, DHC, …), ISES, universities, research centres, manufacturers

5. Completed Tasks

Task 63 – Solar Neighbourhood Planning

Maria Wall
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Task Manager for the Swedish Energy Agency

Task Overview

The main objective was to support key players to achieve solar neighbourhoods that facilitate long-term solar access for energy production and daylighting buildings and outdoor environments – resulting in sustainable and healthy environments. Key players include, e.g., developers, property owners/associations, architects, urban planners, municipalities, and institutions.

The scope of the Task includes solar energy aspects related to:

1. New neighbourhood development
2. Existing neighbourhood renovation and development

Solar energy aspects include active solar systems (solar thermal and photovoltaics) and passive strategies. Passive solar strategies include passive solar heating and cooling, daylighting, and thermal/visual comfort in indoor and outdoor environments.

To achieve these objectives, the work focused in four main topics:

1. Solar planning strategies and concepts for achieving net zero energy/emission neighbourhoods.
2. Economic strategies, including added values and stakeholder engagement.
3. Solar planning tools for new and existing neighbourhoods.
4. Case studies and stories to test Task developments in dialogue with key players, implement and disseminate.

Participating Countries

	Research Institutes	Universities	Companies
Australia	1		
Canada		4	
China	2	2	
Denmark			2
France	1	1	
Italy	1	1	
Norway	1	1	1
Slovakia		1	
Sweden		1	1
Switzerland		1	

Task Duration

This Task started in **September 2019** and ended in **April 2024**. All deliverables have been finalized and published online.

Collaboration with Other IEA TCPs

N/A

Collaboration with Outside Organizations/Institutions

N/A

Collaboration with Industry

Local collaboration with municipalities and key actors in participating countries.

Key Results

The main accomplishments of this Task are highlighted below. More details and specific deliverables can be found on the SHC Task 63 webpage and in the activities of the specific Subtasks:

Subtask A: Solar Planning Strategies and Concepts (Subtask Leader: Caroline Hachem-Vermette, University of Calgary and (from Sep.2022) Kuljeet Singh Grewal, University of Prince Edward Island, Canada)

A1: **Strategies for the design of new and existing high energy performance solar neighbourhoods**

This activity included:

a) Review of existing concepts and targets that underlie neighbourhood design, both new and existing, and to develop (criteria for) the design of representative archetypes / prototypes in existing and new neighbourhoods.

b) Develop and carry out two "fall schools" for PhD students and advanced master's students: 1) Simulations and analyses of neighbourhood archetypes, September – October 2021 (virtual), and 2) Planning Solar Neighbourhoods: Strategies, Tools, and Perspectives, 6-22 September 2022 (Calgary and virtual).

c) Report on strategies for the design of new and existing high energy performance solar neighbourhoods.

The work was compiled into Report A1: Strategies for the Design of New and Existing High Energy Performance Solar Neighbourhoods. This report provides a comprehensive overview of solar neighbourhoods, including their definition, applications, standards, and regulations. It outlines the methodology and tools used to develop archetype designs and analyses solar strategies at both building and neighbourhood levels. The report presents selected archetypes from Canada, France, Italy, Norway, Sweden, and Switzerland and provides a decision-making tool for solar strategies. The target audience for this report includes architects, urban planners, policymakers, and anyone interested in sustainable and energy-oriented developments.

A2: **Decision-Making Tool for Solar Neighbourhood Planning – with user guide**

This deliverable consists of a tool and a report (user guide; Report A2). The "Solar Strategies Decision Making Tool" was developed as a MS Excel tool, open for public use. The tool offers a structured approach to selecting sustainable solar strategies for neighbourhood 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 neighbourhood 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. The output of the tool 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 be used to select solar strategies for specific objectives in different climate types, providing valuable insights for sustainable neighbourhood development.

Subtask B: Economic strategies and stakeholder engagement (Subtask Leader: Silvia Croce and Daniele Vettorato, EURAC Research, Italy)

B1: **Surface Uses in Solar Neighbourhoods. Definition of the most suitable surface uses to prevent conflicts and create synergies**

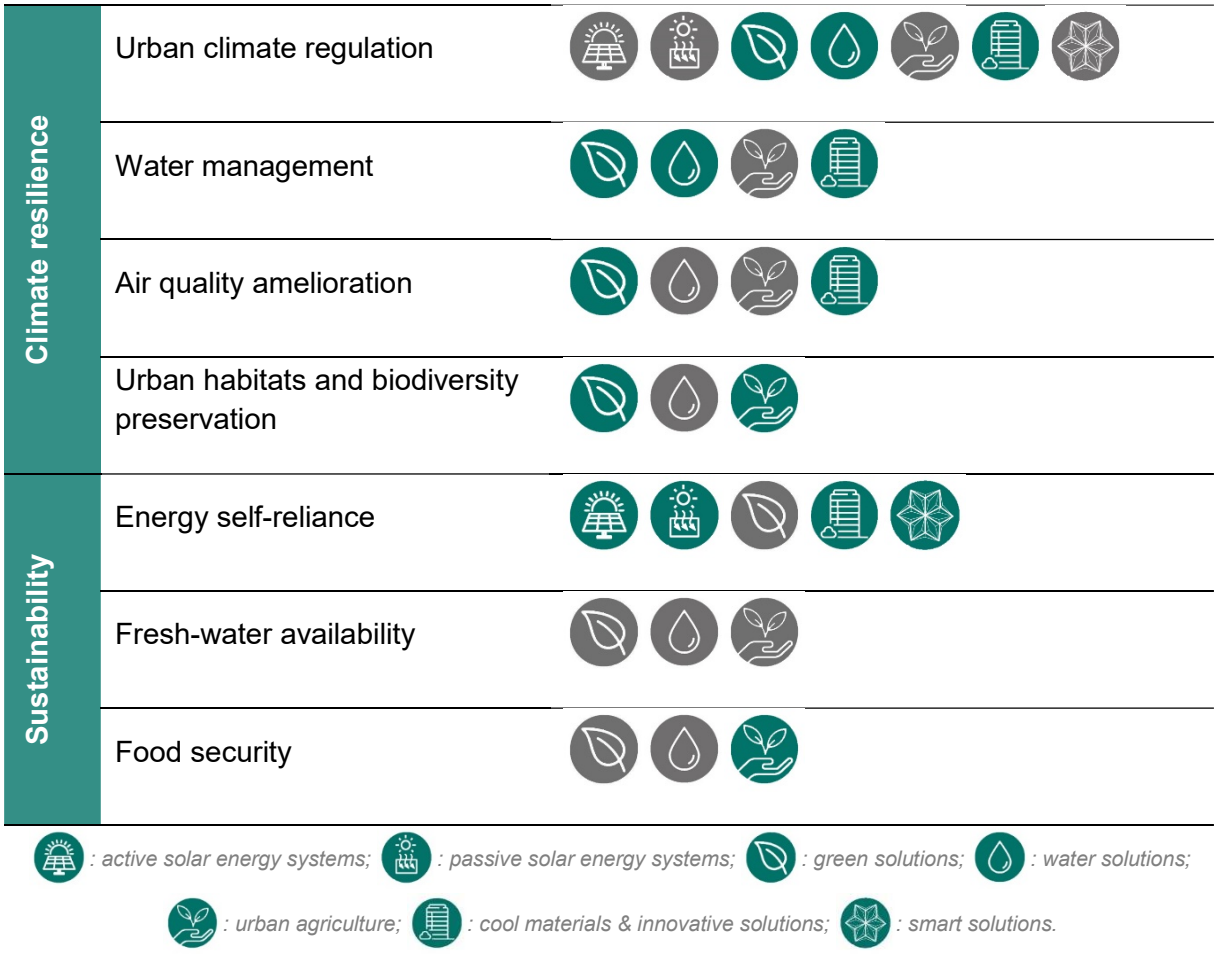
This work demonstrated the major role that urban surfaces play in the response to issues related to climate change and urbanization. An increased utilization of all the surfaces of solar neighbourhoods might offer several opportunities not only for producing renewable energy and correctly managing passive solar gains and daylight, but

also for enhancing urban sustainability and climate resilience, and providing environmental, social, and economic benefits.

The main goal was to collect available solutions for the use of urban surfaces in solar neighbourhoods, and to shed light on the major role that these might play in enhancing climate resiliency and sustainability. Based on an extensive literature review and on the discussion within Task 63, the suitable surface uses were classified in 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 were discussed, together with their contribution to the climate resilience and sustainability objectives. The results were schematized in tables with the aim to provide an overview readily understandable from stakeholders involved in planning decisions, such as urban planners, designers, and municipalities (Table 1).

Urban planning may play a key role in reducing conflicts and promoting the notion of urban surfaces as resources in the view of urban sustainability and climate resilience. The information presented in this report aims at supporting the selection of urban surface uses in all phases of the design of solar neighbourhoods (Report B1).

Table 1: Overview of the objectives each surface use cluster contributes to. Primary contribution in green, secondary in grey. (Report B1)



EXTRA: Design guidelines for urban surface uses in solar neighbourhoods

In addition to Report B1, guidelines for the design of urban surface uses in solar neighbourhoods have been developed, coordinated by Silvia Croce. These guidelines are made as a PowerPoint presentation and are linking to all main results and deliverables in Task 63.

B2: **Solar Neighbourhood Financing Mechanisms and Business Models – Economic incentives and business models that promote the diffusion of solar neighbourhoods**

Solar neighbourhood developments offer unique economic benefits versus typical solar developments. Since solar neighbourhoods 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 neighbourhood 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. Solar neighbourhood developments can utilize traditional financing mechanisms, such as equity-based financing, debt-based financing, and grants, or innovative financing mechanisms such as power purchase agreements (PPAs) and feed-in tariffs. In addition, crowdfunding mechanisms, such as solar leasing and subscription-based models, increase community involvement in these projects. As a result of the work, three business models were developed to be flexible in terms of 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 sponsors of the project or as part of a customer base leasing or subscribing to the project's output (Report B2).

B3: **An Integrated Framework for Stakeholder and Citizen Engagement in Solar Neighbourhoods – ENGAGED framework for stakeholder engagement and behavioural design**

This report proposes an integrated framework for stakeholder engagement in solar neighbourhoods, informed by practical insights from behavioural science (a practice known as behavioural design).

The state-of-the-art on stakeholder engagement methods in urban planning practice was the first part of this work. Insights from behavioural science and detail how their application can enrich participatory processes, contextualizing these insights to the case of solar neighbourhood planning were presented. A stakeholder ENGAGEment/behavioural Design framework (ENGAGED) was then developed. The framework is intended to inform engagement processes in solar neighbourhood planning and highlight how several phases in the development of a solar project can be informed by engagement activities and citizen participation. A series of solar neighbourhood 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.

The report highlights that stakeholder engagement activities in solar neighbourhoods at present can take many different 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, such as in the developed ENGAGED framework, engagement activities can be enriched throughout the life cycle of a solar project, leading to co-created outcomes that are informed by a participatory process. Finally, while behaviours of end-users are often considered, there is still ample opportunity to integrate behaviour-change considerations in a wider engagement process. Insights from behavioural science could be leveraged not only to promote virtuous energy behaviours that support the integration of solar technologies, but also to increase participation in outreach events targeting citizens. Ultimately, the goal with this report is to bring further awareness to the importance of engaging with different stakeholder groups in the context of solar neighbourhood planning, and provide practical guidance in this direction (Report B3).

Subtask C: Solar planning tools (Subtask Leader: Jouri Kanters, Lund University, Sweden, and Martin Thebault, University Savoie Mont-Blanc – INES, France)

C1: **Identification of Existing Tools and Workflows for Solar Neighbourhood Planning**

This report focuses on the current state-of-the-art of tools for solar neighbourhoods through:

- A literature review.
- An analysis of National Common Indicators.
- Workflow stories: a model describing a specific design and / or planning project showcasing how tools were used during this process.
- A comparison of numerical tools, to study calculated differences in solar irradiation on roofs and facades in urban environments.

National Common Indicators (NCIs) measuring the performance of solar neighbourhoods, were gathered through the participation of the Task experts of the participating countries. Within the European Union, there is an extensive range of different indicators. However, there is hardly any legislation on (direct) solar access or other related indicators for outdoor environments. There is also a lack of coordination of NCI definitions and thresholds between countries.

Workflow stories were documented, showing interesting examples of projects and / or workflows where tools have played an important role. Although the sample is low, it can be concluded that tools within the visual programmeming environments are extensively used in the industry and academia and that there are not many examples of GIS tools that are able to provide the same assessment possibilities. GIS is the common tool of choice for existing buildings and larger neighbourhoods, but it might be difficult to convert the geometry to a fitting format. Also, data handling processes are more advanced. The field of advanced simulation is evolving quickly and will be influenced by Artificial Intelligence and Machine Learning enabling to run quicker, more advanced analyses for larger neighbourhoods.

Finally, a comparative study of numerical tools was carried out. This study showed a critical comparison of the results obtained with some popular simulation tools for urban solar radiation studies. In total ten tools were studied for three scenarios: an isolated building (unshaded), a building in an aligned district (homogeneous), and a building in a more random district (heterogeneous). Each tool simulated the hourly solar irradiation on the envelope (façades and roof), for two representative days, one in August and the other in February. This comparative study highlighted that, depending on the tool and settings that are used, unneglectable deviations in the hourly results can be expected, especially for complex geometries (Report C1).

C2: **Opportunities for Improved Workflows and Development Needs of Solar Planning Tools**

In the strategic planning of new urban areas and the expansion of existing ones, it is crucial to integrate solar energy strategies early in the decision-making process. This can be effectively achieved using simulation tools. Recent advancements in simulation technology have empowered planners to make informed choices regarding solar integration in neighbourhood design.

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

Consideration of the current use of tools clearly shows that throughout the different planning stages, the Level of Detail of all aspects - data availability, KPIs, and analyses - increases. During the first stage of the Urban Planning Process, there is little known about the planned (solar) neighbourhood. Simple tools or even rules of thumb are often used to gain an understanding of how much solar energy could contribute to these goals. In the next stage of the Urban Planning Process, building volumes are known, enabling a deeper analysis of the role of solar energy to the neighbourhood. As you progress to the Building Design Process, more details about the buildings and requirements from the building occupants are known. With the help of tools, details on a system level can be studied.

A large part of the building stock is already existing, and the planning strategies for solar deployment then relies on efficient mapping of the existing opportunities. To that aim, solar cadasters are tools used to evaluate the potential for solar installations on buildings, catering to various users including homeowners and city planners. They compile data on energy production, technical feasibility, economic viability, and environmental benefits using a range of indicators. Key metrics include potential electrical output, installation costs, and CO_2 savings. These tools support decision-making for solar projects by providing essential information on the economic and environmental impacts of solar energy, while also considering local constraints such as heritage preservation. Overall, solar cadasters are instrumental in advancing the adoption of solar technology.

There are increasing opportunities for using tools. Advanced tools can be of added value to improve living and working conditions in neighbourhoods and buildings. It is, for instance, advantageous to be able to perform multiple types of simulations (e.g. daylight provision, irradiation analysis, direct solar access, energy performance) based on one geometric model. For key actors in the planning and building design process, advanced simulations could provide not only a set of design solutions to meet current legislation but also assess solutions that go beyond what is legislatively mandated. However, some advanced tools still require a high proficiency of skills to master (Report C2).

Subtask D: Case studies (Subtask Leader: Gabriele Lobaccaro and Mattia Manni, NTNU, Norway, supported by Subtask Leaders (A-C) and Task Manager)

Case study collection

Twenty-two case studies from 10 countries show interesting examples of neighbourhoods, where solar strategies, among other strategies, have been applied. All cases were described and structured according to a developed common template; highlighting main features; the planning process; applied solar strategies and energy systems; surface uses; financial mechanisms and stakeholder engagement; insights from key actors; environmental, social, and other impacts; tools and workflow and 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 for the case. All together, the case studies aim to inspire and encourage others to develop solar neighbourhoods. The case studies are described in documents and available online via a map. Each case can be downloaded as a pdf-file. The case studies from the earlier Task 51 Solar Energy in Urban Planning are also available via this map. Below the map on the website, journal articles that relate to the case studies are listed.

Other results from Task 63

Apart from many individual reports, articles, seminars, conference presentations (see Dissemination Activities), joint work was also carried out to publish specific articles related to the work in Task 63:

Technology Position Paper: Solar Neighbourhood Planning. M. Wall, IEA SHC Task 63, 2024, https://doi.org/10.18777/ieashc-task63-2024-0005

This position paper provides an overview of solar strategies for neighbourhood planning, outlining their importance, potential, and development. It addresses issues for policy and decision makers, other stakeholders, and influencers and presents high-level information as a basis for the uptake and further development of this application. It concludes by highlighting existing challenges and the actions needed to best utilize solar radiation in urban environments.

Ten questions concerning planning and design strategies for solar neighbourhoods
Authors: Manni, M., Formolli, M., Boccalatte, A., Croce, S., Desthieux, G., Hachem-Vermette, C., Kanters, J., Ménézo, C., Snow, M., Thebault, M., Wall, M. & Lobaccaro G. In *Building and Environment*, Volume 246, 2023, 110946, ISSN 0360-1323, https://doi.org/10.1016/j.buildenv.2023.110946

This article (open access) was written by experts within Task 63, as an overview of the work done within Task 63 and the earlier project Task 51, with the goal to disseminate our results within the research community. The ten questions answered in this article provide a critical overview of the technical, legislative, and environmental aspects to be considered in the planning and design of solar neighbourhoods. The article moves from the categorization of “Solar Neighbourhood” and the analysis of the state-of-the-art of passive and active solar strategies to the identification of challenges and opportunities for solar solutions’ deployment. Insights into legislative aspects and lessons learned from case studies are also provided. Ongoing trends in solar energy digitalization, competing use of urban surfaces, and multi-criteria design workflows for optimal use of solar energy are outlined, emphasizing how they generate new opportunities for urban planners, authorities, and citizens. A framework is introduced to guide the potential evolution of solar neighbourhoods in the next decade and to support the design of urban areas and landscapes with architecturally integrated solar energy solutions.

Towards the development of legislative framework for solar neighbourhoods
Hachem Vermette C, Yadav S, Brozovsky J, Croce S, Desthieux G, Formolli M, Grewal KS, Kanters J, Lobaccaro G, Manni M and Wall M. In *Front. Built Environ.* 10:1352844, 2024. https://doi.org/10.3389/fbuil.2024.1352844

Task 63 experts were also editors of a special issue ”Solar Neighbourhood Planning: Optimize Solar Energy Use in Cities Through the Digitalization of the Built Environment” within the framework of the scientific journal “Frontiers in Built Environment”. A number of articles in this issue were written as a collaboration between experts in Task 63. One example is this article, summarized below:

The growing implementation of sustainable urban infrastructure, utilizing solar energy for heat and power generation, daylighting, and thermal comfort, has intensified the focus on sustainability standards and guidelines. Nevertheless, a noticeable deficiency persists in regulations that specifically address solar energy access and protection, posing a barrier to the diffusion of solar-centric neighbourhoods. This paper examines the traditional

urban regulatory frameworks and the state of solar energy regulations and practices within five countries (i.e., Canada, Italy, Norway, Sweden, and Switzerland). The aim of the study is to (i) identify gaps in existing regulations, standards, and codes, (ii) highlight the need for future regulations to protect solar access and rights, and (iii) support the deployment of solar technologies on a large scale. The results underline that climate-related regulations often fall short of specificity tailored to regional and local climates, relying on generalized climate considerations. Solar energy legislation is generally scarce and lacks comprehensive planning. Finally, despite various financial incentives for the installation of active solar strategies, their impact remains limited, impeding the wide spread of solar technology as a primary source of energy production in urban environment.

Dissemination Activities

Reports, Online Tools, etc.

Author / Editor	Title	Bibliographic Reference	Target Audience
Main Task Deliverables			
Hachem-Vermette, C., Grewal K. S. & Wall, M. (eds.)	Strategies for the Design of New and Existing High Energy Performance Solar Neighbourhoods	SHC Task 63/Report A1, May 2024 https://doi.org/10.18777/ieashc-task63-2024-0003	Architects, urban planners, policymakers, and others
Grewal, K.S., Hachem-Vermette, C.	Decision-Making Tool for Solar Neighbourhood Planning – User manual	SHC Task 63/Report A2, May 2024 https://doi.org/10.18777/ieashc-task63-2024-0004 Including MS Excel tool: https://task63.iea-shc.org/decision-making-tool	Architects, urban planners, energy planners, policymakers, educators
Croce, S. (ed.)	Surface Uses in Solar Neighbourhoods. Definition of the most suitable surface uses to prevent conflicts and create synergies	SHC Task 63/Report B1, September 2022 https://doi.org/10.18777/ieashc-task63-2022-000	Urban planners, designers, municipalities
Wilczynski, E.	Solar Neighbourhood Financing Mechanisms and Business Models	SHC Task 63/Report B2, March 2024 https://doi.org/10.18777/ieashc-task63-2024-0002	Project sponsors, developer, project host, investors, local/regional/national governments, utilities, etc.

Author / Editor	Title	Bibliographic Reference	Target Audience
Caballero, N., Balest, J. & Giacovelli, G. (eds.)	An Integrated Framework for Stakeholder and Citizen Engagement in Solar Neighbourhoods - ENGAGED framework for stakeholder engagement and behavioural design	SHC Task 63/Report B3, March 2024 https://doi.org/10.18777/ieashc-task63-2024-0001	Actors in industry, academia, civil society, governments, environment, and un-organized public
Kanters, J. & Thebault, M. (eds.)	Identification of existing tools and workflows for solar neighbourhood planning	SHC Task 63/Report C1, June 2022 https://doi.org/10.18777/ieashc-task63-2022-000	Architects, consultants, urban planners, researchers
Kanters J. & Thebault M. (eds.)	Opportunities for Improved Workflows and Development Needs of Solar Planning Tools	SHC Task 63/Report C2, July 2024 https://doi.org/10.18777/ieashc-task63-2024-0006	Users of tools for solar neighbourhood planning, relevant stakeholders in the design process, legislators.
Manni, M., Lobaccaro, G. & Wall, M. (eds.)	A case study collection on solar neighbourhood planning	SHC Task 63/Case study collection, June 2024 https://task63.iea-shc.org/case-studies	Urban planners, architects, consultants, municipalities
Croce, S.	Design guidelines for urban surface uses in solar neighbourhoods	SHC Task 63, PowerPoint presentation, September 2024 https://www.iea-shc.org/article?NewsID=543	Urban planners, architects, consultants, municipalities
Other			
Arx iT, HEPIA	Web interface of the solar cadaster tool of Greater Geneva	https://apps.sitg-lab.ch/solaire/	Public
Matteo Formolli	Optimisation of solar energy use with a dynamic integrated photovoltaic shading device	Master Thesis, Norwegian University of Science and Technology (NTNU) (07, 2020)	Students and researchers

Author / Editor	Title	Bibliographic Reference	Target Audience
Benjamin Govehovitch	Implementation of an integrated methodology assessing photovoltaic potential at the city scale - Cases of vertical facades	PhD thesis, University Claude Bernard Lyon 1 (2021) In French: Implémentation d'une méthodologie intégrée de l'évaluation du potentiel photovoltaïque à l'échelle de la ville – Cas des façades verticals	
Silvia Croce	Urban surface use optimisation for energy production, energy efficiency and microclimate management	PhD thesis, University of Padova / Eurac (2021)	
Hachem-Vermette, C., Singh, K., Campamà Pizarro, R., Wall, M. (eds.)	Incorporation of Solar Design Strategies in Neighbourhoods' Planning. Review of existing and new practices.	SHC Task 63/Report A0, January 2022 (internal report)	Task 63 experts
Paparella R., **Zanchetta C.**	IL BIM TRA MODELLO E DOCUMENTO	Società Editrice Esculapio, Bologna, 2022 ISBN 978-88-9385- 270-8	
Snow, Mark	Opportunities for Australian solar neighbourhood planning following COVID-19	Nov 2021 APVI https://apvi.org.au/opportunities-for-australian-solar-neighbourhood-planning-following-covid-19	Key urban stakeholders
Brozovsky, Johannes	The Climate Dimension in the Design of Resilient Urban Neighbourhoods in Norway	Doctoral thesis (05, 2022)	Students, researchers, practitioners, and municipalities

Author / Editor	Title	Bibliographic Reference	Target Audience
Yupeng Wang, Xiuxiu Gao / Xiaotong Zhang, Chaofeng Shao, Liang Zhou	Promoting Energy Conservation and Emission Reduction in Scientific Research Office Buildings Through Green Building Innovation: A case study of No.7 building of Xi'an Jiaotong University (XJTU) Science and Technology Innovation Port	12, 2022 Web (English) Print (Chinese) National Engineering Research Center for Human Settlements/ Economic Information Daily of Xinhua News Agency, College of Environmental Science and Engineering, Nankai University, 2022.	Researchers, architects, policymakers, and practitioners interested in advancing low-carbon technologies in buildings and tracking the progress of SDG 11 implementation in China.
Czachura, A.	Solar access indicators for urban planning	Lund University, licentiate thesis. Lund, February 2023. https://portal.research.lu.se/en/publications/solar-access-indicators-for-urban-planning	
Campamà Pizarro, R., Krezlik, A., Bernardo, R.	CHAPTER: Simulating energy renovation towards climate neutrality—Digital workflows and tools for life cycle assessment of collective housing in Portugal and Sweden	BOOK: In: Barberio, M., Colella, M., Figliola, A., Battisti, A. (eds) Architecture and Design for Industry 4.0. Lecture Notes in Mechanical Engineering. Springer, Cham. October 2023. https://doi.org/10.1007/978-3-031-36922-3_3	Practitioners within the AEC sector
Xiuxiu Gao, Xiaotong Zhang, Rui Cao	Research on Low Carbon Development Technology Needs of Guilin City under Carbon Neutrality Vision	12, 2023 Print (in Chinese)	Project partners and Guilin Municipal Bureau of Science and Technology

Journal Articles, Conference Papers, etc.

Author(s)	Title	Publication / Conference	Bibliographic Reference
Manni, M., Lobaccaro, G., Goia, F., Nicolini, A., Rossi, F.	Exploiting selective angular properties of retro-reflective coatings to mitigate solar irradiation within the urban canyon	Solar Energy	189, pp. 74-85. (2019)
Taveres-Cachat, E., Lobaccaro, G., Goia, F., Chaudhary, G.	A methodology to improve the performance of PV integrated shading devices using multi-objective optimization	Applied Energy	247, pp. 731-744. (2019)
Lobaccaro, G., Lisowska, M.M., Saretta, E., Bonomo, P., Frontini, F.	A methodological analysis approach to assess solar energy potential at the neighbourhood scale	Energies	12 (18), art. no. 3554. (2019)
Lobaccaro, G., Croce, S., Lindkvist, C., Munari Probst, M.C., Scognamiglio, A., Dahlberg, J., Lundgren, M., Wall, M.	A cross-country perspective on solar energy in urban planning: Lessons learned from international case studies	Renewable and Sustainable Energy Reviews	108, pp. 209-237 (2019)
Brozovsky, J.; Corio, S.; Gaitani, N.; Gustavsen, A.	Microclimate analysis of a university campus in Norway	IOP Conference Series: Earth and Environmental Sciences	352, art. no. 012015. (2019)
Paparella, R., Caini, M.	Analysis of the solar potential of urban public areas for the installation of integrated photovoltaic systems	IOP Conference Series. Hearth and Environmental Science	ISSN:1755-1315 vol. 296 (2019)
Croce, S.; Vettorato, D.; Paparella, R.	A Systemic Approach for the Optimization of Urban Surfaces Usage	IOP Conference Series. Hearth and Environmental Science.	ISSN:1755-1315 vol. 290 (2019)
D'Alpaos, C., Moretto, M.	Do smart grid innovations affect real estate market values?	AIMS Energy 7(2), pp. 141-150	7(2), 2019, pp. 141-150
D'Alpaos, C., Bragolusi, P.	Prioritization of energy retrofit strategies in public housing: An AHP model	In: Calabrò F., Della Spina L., Bevilacqua C. (eds) New Metropolitan Perspectives. ISHT 2018. Smart, Innovation, Systems and Technologies	vol 101, 2019, Springer, Cham, pp. 534-541 https://doi.org/10.1007/978-3-319-92102-0_56

Author(s)	Title	Publication / Conference	Bibliographic Reference
Bottero, M., D'Alpaos, C., Dell'Anna, F.	Boosting investments in buildings energy retrofit: The role of incentives	In: Calabrò F., Della Spina L., Bevilacqua C. (eds) New Metropolitan Perspectives. ISHT 2018. Smart Innovation, Systems and Technologies	vol 101, 2019, Springer, Cham, pp. 593-600 https://doi.org/10.1007/978-3-319-92102-0_63
Epp, B.	Solar planning experts meet in France	News article written by Bärbel Epp based on material from Maria Wall, Lund University (kick-off meeting)	Sep 2019. https://task63.iea-shc.org/article?NewsID=284 Solar planning experts meet in France | Solarthermalworld
Thebault, M., Berrah, L.A., Desthieux, G., Ménézo, C.	Towards a Solar Cadastre For The Monitoring of Solar Energy Urban Deployment: The Case of Geneva.	Solar World Congress 2019	04-07 November 2019, Santiago, Chile. DOI:10.18086/swc.2019.51.0
Thebault, M., Clivillé, V., Berrah, L.A., Gaillard, L., Desthieux, G., Ménézo, C.	Multi-criteria decision aiding for the integration of photovoltaic systems in urban environment: the case of the Greater Geneva agglomeration.	Territorio Italia - Land Administration, Cadastre, Real Estate	1(1), 2020, https://doi.org/10.1016/j.scs.2020.102259
D'Alpaos C., Andreolli F.	The value of investing in domestic energy storage systems.	Computational Science and Its Applications – ICCSA 2020: Lecture Notes in Computer Science	2020, vol 12250 – Part II, pp. 148-161
Andreolli F., D'Alpaos C., Moretto M.	Investing in a Solar Home Systems by a grid-connected household: investment timing, technological choice and the value of flexibility	EFI5 - Energy Finance Italia Edn. 5	Roma Tre University - Department of Economics
Stendardo, N.; Desthieux, G.; Abdennadher, N.; Gallinelli	GPU-Enabled Shadow Casting for Solar Potential Estimation in Large Urban Areas. Application to the Solar Cadaster of Greater Geneva.	Applied Sciences	2020, 10, 5361. https://doi.org/10.3390/app10155361
Thebault, M., Clivillé, V., Berrah, L.A., Desthieux, G.	Multi-criteria roof sorting for the integration of photovoltaic systems in urban environments	Sustainable Cities and Society	60, pp.102259, 2020 https://doi.org/10.1016/j.scs.2020.102259

Author(s)	Title	Publication / Conference	Bibliographic Reference
Manni, M., Lobaccaro, G., Lolli, N., Bohne, R.A.	Parametric Design to Maximize Solar Irradiation and Minimize the Embodied GHG Emissions for a ZEB in Nordic and Mediterranean Climate Zones	Energies	2020, vol. 13, n. 4981. DOI: 10.3390/en1318498
Devetaković, M., Djordjević, D., Radojević, M., Krstić-Furundžić, A., Burduhos, B. G., Martinopoulos, G., Neagoe, M., Lobaccaro, G.	Photovoltaics on Landmark Buildings with Distinctive Geometries	Applied Sciences	2020, vol. 10, n. 6696. DOI: 10.3390/app10196696
Manni, M., Bonamente, E., Lobaccaro, G., Goia, F., Nicolini, A., Bozonnet, E., Rossi, F.	Development and validation of a Monte Carlo-based numerical model for solar analyses in urban canyon configurations	Building and Environment	2020, vol. 170, DOI: 10.1016/j.buildenv.2019.106638
Manni, M., Cardinali, M., Lobaccaro, G., Goia, F., Nicolini, A., Rossi, F.	Effects of retro-reflective and angular-selective retro-reflective materials on solar energy in urban canyon	Solar Energy	2020, vol. 209, pp. 662-673. DOI: 10.1016/j.solener.2020.08.085
D'Alpaos C., Andreolli F.	The economics of solar home systems: State of art and future challenges in local energy markets	Valori e Valutazioni	24, 2020, pp. 77-96. ISSN:2036-2404
Hasan, J., Horvat, M. and K. Saunders	The Application of Solar Envelope Zoning for the Enhancement of Solar Access in a Densely Populated Neighbourhood	EuroSun 2020, Sept 1st -3rd, 2020, Athens, Greece	Conference proceedings: http://proceedings.ises.org/paper/eurosun2020/eurosun2020-0005-Hasan.pdf
Epp, B.	Lessons learned from first IEA SHC online meetings	Solarthermalworld. News article written by Bärbel Epp based on material from Maria Wall, Lund University	May 2020 https://task63.iea-shc.org/article?NewsID=307 Lessons learned from first IEA SHC online meetings | Solarthermalworld

Author(s)	Title	Publication / Conference	Bibliographic Reference
Epp, B.	Surface synergies and conflicts in smart cities	Solarthermalworld. News article written by Bärbel Epp based on material from Silvia Croce, Eurac Research	Dec 2020. https://task63.iea-shc.org/article?NewsID=341 Surface synergies and conflicts in smart cities | Solarthermalworld
D'Alpaos C., Bragolusi P.	The Market Price Premium for Residential PV Plants	New Metropolitan Perspectives. NMP 2020. Smart Innovation, Systems and Technologies	2021, vol. 178, pp. 1208-1216. Bevilacqua C., Calabrò F., Della Spina L. (eds). Springer, Cham
De Luca, F., Naboni, E., Lobaccaro, G.	Tall buildings cluster form rationalization in a Nordic climate by factoring in indoor-outdoor comfort and energy	Energy and Buildings	Volume 238, 2021, 110831, ISSN 0378-7788, https://doi.org/10.1016/j.enbuild.2021.110831
D'Alpaos C., Andreolli F.	Renewable Energy Communities: The Challenge for New Policy and Regulatory Frameworks Design	New Metropolitan Perspectives. NMP 2020. Smart Innovation, Systems and Technologies	2021, vol. 178, pp. 500-509. Bevilacqua C., Calabrò F., Della Spina L. (eds). Springer, Cham
D'Alpaos C.	Do policy incentives to buildings energy retrofit encourage homeowners' free-rider behavior?	Appraisal and Valuation - Green Energy and Technology	2021, pp. 105-116 Morano P., Oppio A., Rosato P., Sdino L., Tajani F. (eds). Springer, Cham.
Thebault, M., Gaillard, L.	Optimization of the integration of photovoltaic systems on buildings for self-consumption–Case study in France	City and Environment Interactions	2021
Rezaei, A., Samadzadegan, B., Rasoulian, H., Ranjbar, S., Samareh Abolhassani, S., Sanei, A., & Eicker, U.	A New Modeling Approach for Low-Carbon District Energy System Planning	Energies	2021, 14(5), 1383.
Bambara, J., Athienitis, A.K., Eicker, U.	Residential Densification for Positive Energy Districts	Front. Sustain. Cities	2021, 3, 3. https://doi.org/10.3389/frsc.2021.630973

Author(s)	Title	Publication / Conference	Bibliographic Reference
Hasan, J., and Fung, AS.	Building Integrated Photovoltaic/Thermal (BIPV/T) Air Based System and its Potential Application in Canada	Published in eSim2021, June 15th – 16th, Vancouver, Canada.	Link to conference proceedings: https://www.conftool.com/esim2020/index.php?page=browseSessions&presentations=show&search=hasan
Brozovsky, J.; Corio, S.; Gaitani, N.; Gustavsen, A.	Evaluation of Sustainable Strategies and Design Solutions at High-Latitude Urban Settlements to Enhance Outdoor Thermal Comfort	Energy and Buildings	244 (12), 2021, 111037, DOI: https://doi.org/10.1016/j.enbuild.2021.111037
Hasan, J., Horvat M. Riddell, C., Wang, R.	The impact of roof morphology on solar potential: making Toronto suburbs solar ready	CISBAT 2021, Sept 8th – 10th, Lausanne, Switzerland.	Link to conference proceedings: https://iopscience.iop.org/article/10.1088/1742-6596/2042/1/012101
Kanters, J., Gentile, N. & Bernardo, R.	Planning for solar access in Sweden: routines, metrics, and tools	Urban, Planning and Transport Research	https://www.tandfonline.com/doi/full/10.1080/21650020.2021.1944293
Czachura, A., Gentile, N., Kanters, J., Wall, M.	Selection of Weather Files and Their Importance for Building Performance. Simulations in the Light of Climate Change and Urban Heat Islands	SWC 2021	https://doi.org/10.18086/swc.2021.46.02
Xiang C., Lobaccaro, G., Szybinska Matusiak, B.	Toward Architectural Design Method for Coloured Façade Integrated Photovoltaics, an Example from the Nordic Context	Solar World Congress (SWC) 2021	doi: https://doi.org/10.18086/swc.2021.46.0
Brozovsky, J.; Simonsen, A.; Gaitani, N.	Validation of a CFD model for the evaluation of urban microclimate at high latitudes: A case study in Trondheim, Norway	Building and Environment	205, 2021, 108175, DOI: https://doi.org/10.1016/j.buildenv.2021.108175

Author(s)	Title	Publication / Conference	Bibliographic Reference
Thebault, M., Govehovitch, B., Bouty, K., Caliot, C., Compagnon, R., Desthieux, G., Formolli, M., Giroux-Julien, S., Guillot, V., Herman, E., Kämpf, J.H., Kanters, J., Lobaccaro, G., Ménézo, C., Peronato, G. and Petersen, A.J.	A comparative study of simulation tools to model the solar irradiation on building façades	Solar World Congress (SWC) 2021	Virtual Congress, Proceedings - ISES Solar World Congress 2021 doi:10.18086/swc.2021.38.04
De Luca, F., Naboni, E., Lobaccaro, G.	Tall buildings cluster form rationalization in a Nordic climate by factoring in indoor-outdoor comfort and energy	Energy and Buildings	Volume 238, 2021, 110831, ISSN 0378-7788, https://doi.org/10.1016/j.enbuild.2021.110831
Formolli, M., Lobaccaro, G., Kanters, J.	Solar Energy in the Nordic Built Environment: Challenges, Opportunities and Barriers	Energies	2021, 14, 8410. https://www.mdpi.com/1996-1073/14/24/8410
Bertolazzi, A. (Corresponding), Foutsitzoglou, A., D'Agnolo, E., Croatto, G., Paparella, R., Turrini, U.	Methodological features and guidelines for the refurbishment of Mediterranean hotels. The case study of Halkidiki peninsula.	Sustainable Mediterranean Construction	ISSN: 2420-8213 Naples: Luciano editore
Croce, S. (Corresponding), D'Agnolo, E., Caini, M., Paparella, R.	The use of cool pavements for the regeneration of industrial districts	Sustainability	2021, 13, 6322, ISSN: 2071-1050, Editor MDPI AG; http://dx.doi.org/10.3390/su13116322
Almeida, R., Hachem-Vermette, C., Singh, K.	Implementation of solar strategies within different urban layouts	SWC 2021	2021, DOI: https://doi.org/10.18086/swc.2021.44.01
Hachem-Vermette, C. and Singh, K.	Energy systems and energy sharing in traditional and sustainable archetypes of urban developments	Journal of Sustainability (Open access)	2021, DOI: https://doi.org/10.3390/su14031356
Hachem-Vermette, C. and Singh, K.	Optimization of energy resources in various building cluster archetypes	Renewable & Sustainable Energy Reviews	2021, DOI: https://doi.org/10.1016/j.rser.2021.112050

Author(s)	Title	Publication / Conference	Bibliographic Reference
Snow, M. and Wall, M.	IEA SHC Task 63 Solar Neighbourhood Planning – An overview	Asia Pacific Solar Research Conference	16-17 December 2021 https://apvi.org.au/solar-research-conference/wp-content/uploads/2022/02/Snow-Mark-IEA-SHC-Task-63-Solar-Neighbourhood-Planning-%E2%80%93-An-overview.pdf
Hasan, J., Fung, A. and Horvat, M.	A Comparative Evaluation on the Case for the Implementation of Building Integrated Photovoltaic/Thermal (BIPV/T) Air Based Systems on a Typical Mid-rise Commercial Building in Canadian Cities	Journal of Building Engineering	Available online as of Sept, 2021 at https://doi.org/10.1016/j.jobe.2021.103325
Thebault, M., Gaillard, L.	Optimization of the integration of photovoltaic systems on buildings for self-consumption – Case study in France	City and Environment Interactions	2021. https://doi.org/10.1016/j.cacint.2021.100057
Govehovitch, B., Thebault, M., Bouty, K., Giroux-Julien, S., Peyrol, E., Guillot, V., Ménézo, C., Desthieux, G.	Numerical Validation of the Radiative Model for the Solar Cadaster Developed for Greater Geneva	Applied Sciences	2021, 11(17), 8086; https://doi.org/10.3390/app11178086
Bambara, J., Athienitis, A.K., Eicker, U.	Residential Densification for Positive Energy Districts	Front. Sustain. Cities	2021, 3, 3. https://doi.org/10.3389/frsc.2021.630973
Rezaei, A., Samadzadegan, B., Rasoulian, H., Ranjbar, S., Samareh Abolhassani, S., Sanei, A., & Eicker, U.	A New Modeling Approach for Low-Carbon District Energy System Planning	Energies	2021, 14(5), 1383.
Bambara, J., Athienitis, A.K., Eicker, U.	Decarbonizing local mobility and greenhouse agriculture through residential building energy upgrades: a case study for Québec	Energies	2021, 14(20), 6820; https://doi.org/10.3390/en14206820

Author(s)	Title	Publication / Conference	Bibliographic Reference
Samadzadegan, B., Samareh Abolhassani, S., Dabirian, S., Ranjbar, S., Rasoulian, H., Sanei, A., & Eicker, U.	Novel Energy System Design Workflow for Zero-Carbon Energy District Development	Frontiers in Sustainable Cities	2021, 3. https://doi.org/10.3389/frsc.2021.662822
Bragolusi, P., D'Alpaos, C. (corresponding author)	The willingness to pay for residential PV plants in Italy: A discrete choice experiment	Sustainability (Switzerland)	Vol. 13(19), article number 10544, year 2021
Epp, B.	Workflow stories describe use of solar neighbourhood planning tools	Solarthermalworld. News article written by Bärbel Epp based on material from Jouri Kanters, Lund University, and Martin Thebault, University Savoie Mont-Blanc – INES	July 2021 https://task63.iea-shc.org/article?NewsID=367 Workflow stories describe use of solar neighbourhood planning tools | Solarthermalworld
Epp, B.	Tackling the complexity of urban-level energy simulations	Solarthermalworld. News article written by Bärbel Epp based on material from Caroline Hachem-Vermette, University of Calgary	November 2021 https://task63.iea-shc.org/article?NewsID=377 Tackling the complexity of urban-level energy simulations | Solarthermalworld
Hachem-Vermette, C.	Taking Solar Neighbourhood Tools to the Classroom	IEA SHC Solar Update Newsletter	Volume 74, December 2021 2021-12-Task63-Taking-Solar-Neighbourhood-Tools-to-the-Classroom.pdf (iea-shc.org)
Formolli, M., Croce, S., Vettorato, D., Paparella, R., Scognamiglio, A., Mainini, A.G., Lobaccaro, G.	Solar Energy in Urban Planning: Lesson Learned and Recommendations from Six Italian Case Studies	Applied Sciences	2022, 12(6), 2950; http://dx.doi.org/10.3390/app12062950
Bragolusi, P., D'Alpaos, C. (corresponding author)	The valuation of buildings energy retrofitting: A multiple-criteria approach to reconcile cost-benefit trade-offs and energy savings	Applied Energy	Vol. 310, art number 118431, year 2022

Author(s)	Title	Publication / Conference	Bibliographic Reference
Andreolli, F., D'Alpaos, C. (corresponding author), Moretto, M.	Valuing investments in domestic PV-Battery Systems under uncertainty	Energy Economics	Vol. 106,art number 105721, year 2022
Hasan, J., and Horvat M.	An Investigation on the Influence of Neighbourhood Morphology on Outdoor Thermal Comfort in Toronto's Public Spaces	A paper accepted to the 5th International Conference on Building Energy and Environment, COBEE 2022, Montreal, Canada	COBEE 2022, Montreal, Canada. Chapter: https://link.springer.com/chapter/10.1007/978-981-19-9822-5_301
Czachura A, Kanters J, Gentile N, Wall M.	Solar Performance Metrics in Urban Planning: A Review and Taxonomy.	Buildings	Build 2022;12. https://doi.org/10.3390/buildings12040393.
Manni, M., Nocente, A., Stenerud, K., Skeie, Bellmann, M., Lobaccaro, G.	A Comparative Study on Solar Radiation Datasets for Photovoltaic Energy Prediction at High Latitudes	EuroSun 2022	Conference Proceedings
Jouttijärvi, S., Lobaccaro, G., Kamppinen, A., Miettunen, K.	Benefits of bifacial solar cells combined with low voltage power grids at high latitudes	Renewable and Sustainable Energy Reviews	Volume 161June 2022 Article number 112354 https://doi.org/10.1016/j.rser.2022.112354
Formolli, M., Kleiven, T., Lobaccaro, G.	Solar Accessibility at the Neighbourhood Scale: A Multi-Domain Analysis to Assess the Impact of Urban Densification in Nordic Built Environments	Solar Energy Advances	Volume 2, 2022, 100023 https://doi.org/10.1016/j.seja.2022.100023
Thebault M., Desthieux G., Berrah L., Castello R.	Large-scale evaluation of the suitability of buildings for photovoltaic integration: Case study in Greater Geneva	Applied Energy	316, 2022, https://doi.org/10.1016/j.apenergy.2022.11912
Hachem-Vermette, C.	Fall School 2022 – Solar Neighbourhood Strategies & Concepts	IEA SHC Solar Update Newsletter.	Volume 75, July 2022 2022-07-Task-63--Fall-School-2022.pdf (iea-shc.org)
Shristi Bhusal, Supervisor: Dr. Miljana Horvat	Investigating the Effect of Neighbourhood Morphology on Outdoor Thermal Comfort in Public Spaces of Six Canadian Cities	Master Research Project (MRP) at Toronto Metropolitan University	Completed August 2022. Will be posted at university digital commons

Author(s)	Title	Publication / Conference	Bibliographic Reference
Yangchao Li, Supervisor: Dr. Miljana Horvat	Optimization of Neighbourhood Form for Maximizing PV Production and Potential for Transformation into a Net-Zero Energy Neighbourhood	Master Research Project (MRP) at Toronto Metropolitan University	Completed August 2022. Will be posted at university digital commons
Czachura A, Gentile N, Kanters J, Wall M.	Identifying potential indicators of neighbourhood solar access in urban planning	Buildings	Buildings. 2022, 12. http://doi.org/10.3390/buildings12101575
Brozovsky, J.; Radivojevic, J.; Simonsen, A.	Assessing the impact of urban microclimate on building energy demand by coupling CFD and building performance simulation.	Journal of Building Engineering	55, 2022, 104681. DOI: https://doi.org/10.1016/j.jobe.2022.104681
Paparella R., Caini M.	Sustainable Design of Temporary Buildings in Emergency Situations	Sustainability 2022, 14(13), 8010; (Basel, Switzerland), MDPI, ISSN: 2071-1050	https://dx.doi.org/10.3390/su14138010
Manni, M., Nocente, A., Kong, G., Fan, H., Stenerud Skeie, K., Lobaccaro, G.	Solar energy digitalization at high latitudes: A model chain combining solar irradiation models, a LiDAR scanner, and high-detail 3D building model	Frontiers in Energy Research	2022, 10, art. no 1082092 https://doi.org/10.3389/fenrg.2022.1082092
Hachem-Vermette, C.	Role of solar energy in achieving net zero energy neighbourhoods	Solar Energy Advances	Volume 2, 2022, 100018, https://doi.org/10.1016/j.seja.2022.100018
Hachem-Vermette, C., Singh, K.	Energy systems and energy sharing in traditional and sustainable archetypes of urban developments	Journal of Sustainability	2022, 14(3):1356. DOI: https://doi.org/10.3390/su14031356
Singh, K., Hachem-Vermette, C.	Novel approach of urban energy simulations using EnergyPlus and programmeming language	Energy and Buildings	Volume 263, 15 May 2022, 112040. https://doi.org/10.1016/j.enbuild.2022.112040
Raybaud B., Desthieux G.	Adapted strategy for large-scale assessment of solar potential on facades in urban areas focusing on the reflection component	Solar Energy Advances	Volume 2, 2022, 100030. https://doi.org/10.1016/j.seja.2022.100030

Author(s)	Title	Publication / Conference	Bibliographic Reference
Campamà Pizarro, R., Bernardo, R., Wall, M.	Streamlining Building Energy Modelling Using Open Access Databases—A Methodology towards Decarbonisation of Residential Buildings in Sweden	Sustainability	Sustainability 2023, 15(5), 3887; https://doi.org/10.3390/su15053887
Andreolli F., D'Alpaos C., Kort P.	Does P2P Trading Favor Investments in PV-Battery Systems?	Working paper FEEM	02.2023, Milano, Italy: Fondazione Eni Enrico Mattei https://www.feem.it/publications/does-p2p-trading-favor-investments-in-pv-battery-systems/
Paparella R., Caini M.	Strategie progettuali per la valorizzazione e riqualificazione dell'ex Palazzo del Turismo nel contesto dell'area degli scavi archeologici di Montegrotto Terme	2030 d.C. PROIEZIONI FUTURE PER UNA PROGETTAZIONE SOSTENIBILE	ISBN:978-88-492-4558-5
Giorio M., Bertolazzi A., Paparella R., Savino M.	Edilizia pubblica incompiuta italiana: Il progetto di riuso e ri-funzionalizzazione dell'ex Ospedale Psichiatrico di Laghetto (VI)	2030 d.C. PROIEZIONI FUTURE PER UNA PROGETTAZIONE SOSTENIBILE	ISBN:978-88-492-4558-5 ISBN:978-88-492-4558-5
Manni, M., Nocente, A., Bellmann, M., Lobaccaro, G.	Multi-Stage Validation of a Solar Irradiance Model Chain: An Application at High Latitudes	Sustainability	2023, 15(4), 2938; https://doi.org/10.3390/su15042938
Formolli, M., Kleiven, T., Lobaccaro, G.	Assessing solar energy accessibility at high latitudes: A systematic review of urban spatial domains, metrics, and parameters	Renewable and Sustainable Energy Reviews	Volume 177, May 2023, N. 113231 https://doi.org/10.1016/j.rser.2023.113231
Manni, M., Mohammadreza Aghaei, M., M.M. Sizkouhi, A., R.R. Kumar, R., Stølen, R., Steen-Hansen, A.-E., Di Sabatino, M., Moazami, A., Völler, S., Jelle, B.J., Lobaccaro, G.	Solar Energy in the Built Environment	Book Chapter in Encyclopedia of Sustainable Technologies, 2E (Elsevier)	Reference Module in Earth Systems and Environmental Sciences, 2023. https://doi.org/10.1016/B978-0-323-90386-8.00049-8

Author(s)	Title	Publication / Conference	Bibliographic Reference
Epp, B.	How planners use tools to assess solar potential in neighbourhoods	Solarthermalworld. News article written by Bärbel Epp based on material from Jouri Kanters, Lund University, and Martin Thebault, University Savoie Mont-Blanc	January 2023 https://task63.iea-shc.org/article?NewsID=444 How planners use tools to assess solar potential in neighbourhoods | Solarthermalworld
Epp, B.	Paving the way for solar access in Sweden and Norway	Solarthermalworld. News article written by Bärbel Epp based on material from Jouri Kanters, Lund University, Sweden, and Ida Bryn, Multiconsult, Norway.	March 2023 https://task63.iea-shc.org/article?NewsID=453 Paving the way for right to solar access | Solarthermalworld
Epp, B.	Interdisciplinary author team answers ten questions concerning planning and design strategies for solar neighbourhoods	Solarthermalworld. News article written by Bärbel Epp based on material from Maria Wall and research article.	November 2023. https://task63.iea-shc.org/article?NewsID=486 Interdisciplinary author team answers ten questions concerning planning and design strategies for solar neighbourhoods | Solarthermalworl
Pamela Murphy	Task 63: Ten Questions on Solar Neighbourhood Planning and Design Strategies	Solar Update	December 2023
Czachura, A., Gentile, N., Kanters, J., Wall, M.	Vertical Sky Component (VSC) and daylight regulation compliance by the EN 17037 and BFS 2011:6 standards	CISBAT 2023. Journal of Physics: conference series 2600 112018	2023 https://doi.org/10.1088/1742-6596/2600/11/112018
Campamà Pizarro, R.	Solar PV integration in multifamily buildings renovation: an effective strategy towards climate neutrality.	SWC 2023	2023
Campamà Pizarro, R.	Efficient building energy renovation strategies: benchmarking optimization algorithms for enhanced decision-making.	SWC 2023	2023

Author(s)	Title	Publication / Conference	Bibliographic Reference
Hachem-Vermette, C., Singh, K., Jolly, K., Yadav, S.	Decision making method to prioritize and implement solar strategies on neighbourhood level	18th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES), Dubrovnik, September, 2023.	2023
Desthieux G., Gressin A., Ingensand J., Raybaud B.	Solar potential on facades at urban scale: an integrated approach combining solar and digital building modelling (accepted paper, to be published in the Journal of Physics – Conference series)	CISBAT 2023 international conference (Built environment in transition)	2023
Desthieux, Manni, Lobaccaro, Kanters, Croce, Hachem-Vermette	Co-editors of the special issue “Solar Neighbourhood Planning: Optimize Solar Energy Use in Cities Through the Digitalization of the Built Environment”	Journal Frontiers in Built Environment - section Sustainable Design and Construction	2023-2024
Hasan, J., Zheng, E., Horvat, M.	A least squares regression-based approach in the investigation of the influence of density metrics of 14 distinct Toronto neighbourhoods on the roof and facade solar potential	Frontiers in Built Environment	September 2023, https://doi.org/10.3389/fbuil.2023.1248259
Giorio, M. & Paparella, R.	A methodology to improve energy efficiency and sustainability in urban environments	Applied Sciences, 2023	https://www.mdpi.com/2076-3417/13/17/9745
Zanchetta, C., Donatiello, M.G., Gabbanoto, A. & Paparella, R.	Digitalization of building systems using IFC to support performance analysis and code checking: standard limits and technological barriers. A case study on fire safety.	Rivista Tema, 09(01), 2023	https://doi.org/10.30682/tema0901l
Giorio, M. & Paparella, R.	Climate Mitigation Strategies: The Use of Cool Pavements	Sustainability 2023, 15(9),7641;	https://dx.doi.org/10.3390/su15097641

Author(s)	Title	Publication / Conference	Bibliographic Reference
Paparella, R., Zanchetta, C., Giorio, M. & Donatiello, M.G.	BIM Based rating of urban and architectural surfaces to refine Solar Potential Analysis	Proceedings 2023 European Conference on Computing in Construction 40th International CIB W78. Heraklion, Crete, Greece, July 10-12, 2023	ISBN: 978-0-701702-73-1. DOI: https://doi.org/10.35490/EC3.2023.271
Andreolli F., D'Alpaos, C. & Kort, P.	Does P2P Trading Favor Investments in PV-Battery Systems?	Working paper FEEM 02.2023	https://www.feem.it/publications/doesp2p-trading-favorinvestments-in-pvbattery-systems/
Jouttijärvi S., Thorning J., Manni M., Huerta H., Ranta S., Di Sabatino M., Lobaccaro G., Miettunen K.	A comprehensive methodological workflow to maximize solar energy in low-voltage grids: A case study of vertical bifacial panels in Nordic conditions	Solar Energy	Vol. 62, art. no. 111819, 2023 https://doi.org/10.1016/j.solener.2023.111819
Manni M, Formolli M, Boccalatte A, Croce S, Desthieux G, Hachem-Vermette C, Kanters J, Ménézo C, Snow M, Thebault M, Wall M, Lobaccaro G.	Ten questions concerning planning and design strategies for solar neighbourhoods	Journal Building and Environment (2023), Elsevier.	https://doi.org/10.1016/j.buildenv.2023.110946
Abolhassani, S. S., Joybari, M.M., Hosseini, M., Parsaee, M., & Eicker, U.	A systematic methodological framework to study climate change impacts on heating and cooling demands of buildings	Journal of Building Engineering	Volume 63, Part A (2023): 105428. https://doi.org/10.1016/j.jobe.2022.105428
Abdelnour, N., Braun, R., Torio, H., Eicker, U.	A simulation-based study to evaluate the cooling potential of nocturnal radiative cooling systems for residential buildings in Egypt	Solar Energy Advances	Volume 3, 2023. https://doi.org/10.1016/j.seja.2023.100044
Rafati, N., Hazbei, M., Eicker, U.	Louver configuration comparison in three Canadian cities utilizing NSGA-II	Building and Environment	Volume 229, 2023, 109939, ISSN 0360-1323, https://doi.org/10.1016/j.buildenv.2022.109939
Singh, K., Hachem-Vermette, C., D'Almeida, R.	Solar neighbourhoods: the impact of urban layout on a large-scale solar strategies application	Scientific Reports	Sci Rep 13, 18843 (2023). https://doi.org/10.1038/s41598-023-43348-8

Author(s)	Title	Publication / Conference	Bibliographic Reference
Desthieux G., Gressin A., Ingensand J., Raybaud B.,	Solar potential on facades in urban areas: an integrated approach combining solar and digital built facade modelling	Journal of Physics, conference series (publication of conference papers CISBAT 2023). Prize of Best Paper Award.	CISBAT, 13-15 September 2023, EPFL, J. Phys.: Conf. Ser. 2600 042004, https://doi.org/10.1088/1742-6596/2600/4/042004
Desthieux G., Thebault M	Solar governance at the level of the transborder agglomeration of the Greater Geneva based on the solar cadaster	Frontiers in Built Environment	10:1347056, 2024, https://doi.org/10.3389/fbuil.2024.1347056
Manni M., Jouttijärvi S., Ranta S., Miettunen K., Lobaccaro G.	Validation of model chains for global tilted irradiance on East-West vertical bifacial photovoltaics at high latitudes	Renewable Energy	Volume 220, art. no. 119722, 2024 https://doi.org/10.1016/j.renene.2023.119722
Akbarinejad T., Machlein E., Bertolin C., Ogut O., Lobaccaro G., Salaj A.T.	Harvesting Solar Energy for Sustainable and Resilient historical areas. A Norwegian Case study.	Procedia Structural Integrity	Volume 55, pp. 46 - 56, 2024 https://doi.org/10.1016/j.prostr.2024.02.007
Formolli M., Schön P., Kleiven T., Lobaccaro G.	Solar accessibility in high latitudes urban environments: A methodological approach for street prioritization	Sustainable Cities and Society	Volume 103, art. no. 105263, 2024 https://doi.org/10.1016/j.scs.2024.105263
Hachem-Vermette C., Yadav, S., Brozovsky, J., Croce S., Desthieux G., Formolli M., Grewal K. S., Kanters J., Lobaccaro G., Manni M., Wall, M.	Towards the development of legislative framework for solar neighbourhoods	Frontiers in Built Environment	10:1352844, 2024 https://doi.org/10.3389/fbuil.2024.1352844
Czachura, A., Kanters, J., Wall, M., Gentile, N.	Enhancing daylighting predictions in urban planning: A workflow for setting bespoke Vertical Sky Component (VSC) targets	Building and Environment	Volume 266, 2024, 112066, ISSN 0360-1323 https://doi.org/10.1016/j.buildenv.2024.112066
Epp, B.	ENGAGED – a multi-stage framework for participatory urban planning	Solarthermalworld. News article written by Bärbel Epp based on Report B3, Task 63	May, 2024 https://task63.iea-shc.org/article?NewsID=511 https://solarthermalworld.org/news/engaged-a-multi-stage-framework-for-participatory-urban-planning/

Author(s)	Title	Publication / Conference	Bibliographic Reference
Wall, M. with input from Subtask Leaders	Technology Position Paper: Solar Neighbourhood Planning	IEA SHC Technology Position Paper	May 2024 https://doi.org/10.18777/ieashc-task63-2024-0005
Wall, M.	Task 63: Planning for Enhanced Solar Access and Utilization in Neighbourhoods	SHC Solar Update	July 2024 2024-07-Task63-Planning-for-Enhanced-Solar-Access-and-Utilization-in-Neighbourhoods.pdf (iea-shc.org)
Epp, B.	22 inspiring Solar Neighbourhoods Depicted on a Map	Solarthermalworld. News article written by Bärbel Epp based on Task 63 case studies and the Task 63 guideline	November 2024 https://task63.iea-shc.org/article?NewsID=549 https://solarthermalworld.org/news/22-inspiring-solar-neighbourhoods-depicted-on-a-map/

Conferences, Workshops, Seminars

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees	If Task Hosted: Organized with, # participants
COST Action PEARL PV – Cross fertilization S3 Simulation of complex shading for BIPV	Oral presentation on Solar energy in Nordic climate: overshadowing effect on BIPV façade in Nordic urban environment: a case study of Trondheim. Presenter: Gabriele Lobaccaro, NTNU.	26.02.2020 Utrecht (The Netherlands)	20	

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees	If Task Hosted: Organized with, # participants
Seminar: Energy communities in housing associations and apartment buildings. + Exhibition: coloured solar panels, solar roof, street furniture with solar energy as stand-alone	Organizing the event. Introducing Task 63 in Denmark. Karin Kappel, Solar City Denmark	27.02.2020 Copenhagen	70 persons mainly from housing associations but also PV suppliers and energy companies	
EFI5 - Energy Finance Italia Edn. 5	Investing in a Solar Home System by a grid-connected household: investment timing, technological choice and the value of flexibility by Andreolli F., D'Alpaos C., Moretto M.	10-11 February 2020 Roma Tre University - Department of Economics	About 40	
APVI Workshop IEA work	Presentation on Task 63 progress by Mark Snow	9 December 2020 Virtual meeting	45	
Guest lecture at Xi'an Jiaotong-Liverpool University in Suzhou, China	Oral presentation entitled "Solar Energy in Urban Environment: Opportunities, Challenges and Barriers" by Gabriele Lobaccaro NTNU, Norway	13.09.2021 Online	12	
JNES 2021	Oral presentation "Benchmark study of simulation tools to model the solar irradiation on building facades, by M. Thebault, France	25 - 27 August 2021, Odeillo, France	100	
Building Simulation 2021	Oral presentation "Large-scale multicriteria sorting for the integration of photovoltaic systems in the urban environment" by C. Ménézo, France	8 – 10 September, 2021, Bruges, France	thousands	

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees	If Task Hosted: Organized with, # participants
Seminar / The role of photovoltaic in the sustainable transition	Design approach to sustainable urban development that includes solar energy Cases: Naturbyen Middelfart and Hyllegaard Ecovillage Organized by Karin Kappel, Solar City Denmark	04.11.2021 Building Green Copenhagen: exhibition fair with seminars for sustainable construction and architecture	125 persons architects, urban planners, building designers, contractors etc.	
CAE Roadmap to Resilient Ultra-Low Energy Built Environment with Deep Integration of Renewables in 2050 – Low-Carbon and Positive Energy Resilient Communities Webinar	Presentation by Gilles Desthieux	12 October 2021 Webinar	100	
COST PED-EU-NET 1st URBAN STAKEHOLDERS WORKSHOP “Sharing best practices and facilitating the science-policy dialogue” COST ACTION CA19126 Positive Energy Districts European Network	Presentation by Gilles Desthieux	6 October 2021 Rome/online	>100	
The Canadian Association of Engineers CAE-Roadmap for resilient communities	Caroline Hachem – Vermette represented the IEA SHC Task 63	October 2021		

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees	If Task Hosted: Organized with, # participants
SHC Task 63 Fall school - simulations of neighbourhoods	Caroline Hachem - Vermette organized the course	Sept-Oct 2021, online	14 students + instructors from 9 different institutions (mostly from Task 63)	
Guest lecture at University of Turku, Finland	Oral presentation by Gabriele Lobaccaro, entitled “Solar Energy in Nordic Built Environments: Opportunities, Challenges and Barriers”	09.12.2021 Online lecture	15	
COST Action CA16235 PEARL PV workshop entitled "Photovoltaic Systems in the Built Environment"	Oral presentation by Gabriele Lobaccaro, entitled “Solar Energy in Nordic Built Environments: Opportunities, Challenges and Barriers”	19.01.2022 Online	20	
Toronto 2030 District: Building Mounted Solar Project	J. Hasan presented the solar potential assessment for select Toronto neighbourhoods in the ‘Toronto 2030 District’.	18 February 2022, Toronto, Canada		
COST Action CA16235 PEARL PV - PV in the built environment (WG4)	Oral presentation by G. Lobaccaro, entitled “Solar Energy in Urban Environment: Opportunities, Challenges and Barriers”	15.03.2022 Hybrid event	40	
SHC ExCo Meeting	Oral presentation by G. Desthieux, of the research activities related to SHC Task 63	1 June 2022, Rapperswil (Switzerland)	100	
APVI SHC knowledge sharing meeting	Mark Snow. Update on Task 63 progress.	22 July 2022 Virtual meeting	14	

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees	If Task Hosted: Organized with, # participants
5th International Conference on Building Energy and Environment (COBEE 2022)	J. Hasan presented on the topic of "An Investigation on the Influence of Neighbourhood Morphology on Outdoor Thermal Comfort in Toronto's Public Spaces".	27 July 2022, Montreal, Canada		
EvEuCoP workshop	Oral presentation by C. D'Alpaos, title "Do redistributive effects of incentives to buildings energy retrofitting hamper fuel poverty reduction in public housing?"	6 July 2022 Coimbra (Portugal) - online	200	
MIT A+B	Oral presentation by C. D'Alpaos, title "Impact of P2P trading on the decision to invest in domestic PV-Battery Systems"	5-8 July 2022 MIT Cambridge (USA) - online	1100	
Seminar on Solar neighbourhoods: strategies and application case studies	Task 63 experts and invited presenters. Organized as part of IEA SHC Task 63 Presentations available here: IEA-SHC-Task63-Seminar 2022 Booklet.pdf	23 September 2022, Calgary, Canada:	Approx. 40 persons onsite, plus more than 45 online	Government, industry, municipalities, academia. From Task 63 countries mainly.
Seminar: Solar energy and sustainable constructions: how to achieve the best environmentally friendly PV solutions. Organized by Solar City Denmark, Karin Kappel.	Presenters: NREP real estate investor and innovator: strategy for 3 mio. m² property portfolio. Ennogie: Sønderhaven Solar Polaris: how to achieve successful solar integration	3.11.2022 Building Green Copenhagen: seminars for sustainable construction and architecture	130 persons: architects, urban planners, building designers, contractors, etc.	
Lyskonferansen 2023	Helene Solvang, Multiconsult, title "Dagslysplanlegging i fremtidens byrom og bygninger"	2 February 2023, Bergen	~100	

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees	If Task Hosted: Organized with, # participants
Open international seminar: Solar and daylight planning in the built environment	Task 63 experts and invited presenters. Organized as part of IEA SHC Task 63, and the HELIOS project. In total 16 presentations by Norwegian and international experts, 10 posters and four panel sessions. Video recordings available here: IEA SHC || Task 63 || Public seminar on solar and daylight planning in urban environments (iea-shc.org)	10.03.2023 Hybrid event Trondheim, Norway.	111 (85 in person and 26 online)	Research and industry. 25% professionals, 44% academics, 26% students and 5% common public.
CISBAT 2023	Poster presentation: "Vertical Sky Component (VSC) and daylight regulation compliance by the EN 17037 and BFS 2011:6 standards" by Agnieszka Czachura, Lund University, Sweden	13-15 September 2023 in Lausanne		
Workshop for XI'AN Jiaotong University HSCE Building project Participants: Jianqing He, Professor level senior urban planner, Jingru Zheng, Manager, Ying Cao, Professor Level Senior Engineer, Yuyang Wen, Engineer, Siyao Li, Engineer, Xin Wan, Assistant engineer Xiangzhao Meng, Ph.D., Full Professor, Yupeng Wang, Ph.D., Professor, Xin Cui, Ph.D., Associate Professor	Jianqing He, Ying Cao, Yupeng Wang China Architecture Design & Research Group, Xi'an Jiaotong University	7 March 2023, XI'AN Jiaotong University HSCE Building, Xi'an, Shaanxi		

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees	If Task Hosted: Organized with, # participants
SWC 2023	Oral presentation: “Solar PV integration in multifamily buildings renovation: an effective strategy towards climate neutrality“ by Rafael Campamà Pizarro, Lund University, Sweden	29 October – 4 November 2023, New Delhi		
SWC 2023	Poster presentation: ”Efficient building energy renovation strategies: benchmarking optimization algorithms for enhanced decision-making” by Rafael Campamà Pizarro, Lund University, Sweden	29 October – 4 November, New Delhi		
Public international seminar: Future challenges in fostering the energy transitions: sustainable innovation, prosumers’ engagement, and energy communities.	Task 63 experts and invited presenters. Organized as part of IEA SHC Task 63. In total 12 presentations by Italian and international experts.	29.10.2023 Hybrid event Padua	Approx. 40	Academia and industry.

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees	If Task Hosted: Organized with, # participants
Workshop on the application of photovoltaic technology in rural residential buildings Participants: Jianqing He, Professor level senior urban planner, Jingru Zheng, Manager, Xi Zhao, Research Fellow, Xiuxiu Gao, PhD, Siyao Li, Engineer, Yuyang Wen, Engineer, Wei Gao, Engineer, Haiyue Lyu, Engineer, Guonian Hong, Secretary, of Li'ao, Gaoyan Wang, Deputy, secretary of Li'ao	Introducing the applications, development progress and the benefits of photovoltaic technology, by Jianqing He, Xi Zhao, Guonian Hong. China Architecture Design & Research Group, China National Engineering Research Center for Human Settlements, Chinese Society for Sustainable Development, Li'ao community	2 November 2023, Li'ao Community, Ningbo, Zhejiang Province		
Seminar: Presenting international work and results from Task 63, and Danish cases. Organized by Solar City Denmark / Karin Kappel	Presenters: Task leader Maria Wall, and the subtask leaders Gabriele Lobaccaro and Jouri Kanters. From Denmark: Ennogie, Bjerg Arkitektur, DEM and Solar City Denmark	29.11.2023, Copenhagen, Denmark	Approx. 30	
SDEWES (conference)	Decision making method to prioritize and implement solar strategies on neighbourhood level. Presentation by C. Hachem-Vermette, Concordia University, Canada	2023, Dubrovnik		
PassivHAUS, Montreal (seminar)	Bâtiments et Quartiers Solaires: Planification et Conception Holistiques. Presentation by C. Hachem-Vermette	2024, Montreal, Canada		

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees	If Task Hosted: Organized with, # participants
Seminar: Solar neighbourhood planning / solenergi i stadsplanering (in English / Swedish)	Task 63 results, presented by Task 63 experts and local actors. Organized by Lund University, supported by the Swedish Energy Agency	14 May 2024, Lund, Sweden.	Approx. 35	Researchers, municipalities, consultants. Presentations by Task 63 leaders and experts from Switzerland, Norway, Italy, Denmark, Sweden.
IEA SHC ExCo meeting: seminar	Task 63 experts presenting results from Task 63	4 June 2024, Oslo, Norway		

Task Meetings

To develop the Task, the following Task Definition Workshops were held:

1. Lund, Sweden October 2018
2. Bolzano, Italy March 2019

Over the entire term of the Task a total of nine Experts Meetings were held and four included an additional workshop, symposium or other event.

Meeting	Date	Location	# of Participant (# of Countries)
Experts Meeting **1**	22-24 October 2019	Le Bourget-du-Lac, France	25 (9)
Experts Meeting **2**	10-11 March 2020	Virtual meeting	42 (10)
Experts Meeting **3**	22-25 September 2020	Virtual meeting	38 (9)
Experts Meeting **4**	22-25 March 2021	Virtual meeting	44 (10)
Experts Meeting **5**	20-23 September 2021	Virtual meeting	35 (9)
1st Fall School	30 September – 21 October 2021	Virtual course	14 PhD students (5)
Experts Meeting **6**	28-31 March 2022	Virtual meeting	40 (9)
Experts Meeting **7**	19-23 September 2022	Calgary, Canada (hybrid)	29

Meeting	Date	Location	# of Participant (# of Countries)
2nd Fall School	In conjunction with the 7th Task meeting	Calgary, Canada (hybrid)	14
Public seminar	In conjunction with the 7th Task meeting	Calgary, Canada (hybrid)	90
Experts Meeting **8**	6-10 March 2023	Trondheim, Norway (hybrid)	29 (8)
Public seminar	In conjunction with the 8th Task meeting	Trondheim, Norway (hybrid)	111
Experts Meeting **9** (Final)	26-29 September 2023	Padua, Italy (hybrid)	34 (9)
Public seminar	In conjunction with the 9th Task meeting	Padua, Italy	40

SHC Task 63 Participants

Country	Name	Institution / Company	Role
SWEDEN	**Maria Wall**	**Energy and Building Design, Lund University**	**Task Manager**
AUSTRALIA	Mark Snow	Australian PV Institute (APVI)	National Expert
CANADA	Caroline Hachem-Vermette	Concordia University	Subtask A Leader + co-leader Subtask D
CANADA	Somil Yadav	Concordia University	National Expert
CANADA	Ricardo D'Almeida	University of Calgary	National Expert
CANADA	Kuljeet Sing Grewal	University of Prince Edward Island	Subtask A Leader + co-leader Subtask D
CANADA	Olivia Alarcon Herrera	University of Calgary	National Expert
CANADA	Ayoyimika Edun	University of Calgary	National Expert
CANADA	Miljana Horvat	Toronto Metropolitan University, Department of Architectural Science	National Expert
CANADA	Javeriya Hasan	Toronto Metropolitan University, Department of Architectural Science	National Expert
CANADA	Ursula Eicker	Concordia University	National Expert

CANADA	Andreas Athienitis	Concordia University	National Expert
CANADA	James Bambara	Concordia University	National Expert
CANADA	Azin Sanei	Concordia University	National Expert
CANADA	Mostafa Saad	Concordia University	National Expert
CHINA	Haiyue Lyu	China National Engineering Research Center for Human Settlements, CAG	National Expert
CHINA	Xiuxiu Gao	China National Engineering Research Center for Human Settlements, CAG	National Expert
CHINA	Ying Cao	China National Engineering Research Center for Human Settlements, CAG	National Expert
CHINA	Xi Zhao	China National Engineering Research Center for Human Settlements, CAG	National Expert
CHINA	Xiaotong Zhang	China National Engineering Research Center for Human Settlements, CAG	National Expert
CHINA	Xin Cui	Xi'an Jiaotong University (XJU)	National Expert
CHINA	Wei Chen	Xi'an Jiaotong University (XJU)	National Expert
CHINA	Xiangzhao Meng	Xi'an Jiaotong University (XJU)	National Expert
CHINA	Yang Wang	China Agricultural University in Beijing	National Expert
CHINA	Xiaomeng Chen	China Agricultural University in Beijing	National Expert
DENMARK	Olaf Bruun Jørgensen	Danish Energy Management (DEM)	National Expert
DENMARK	Karin Kappel	Solar City Denmark	National Expert
FRANCE	Christophe Ménézo	University Savoie Mont-Blanc - INES	National Expert
FRANCE	Alessia Boccalatte	University Savoie Mont-Blanc - INES	National Expert
FRANCE	Martin Thebault	University Savoie Mont-Blanc - INES	Subtask C Leader + co-leader Subtask D

FRANCE	Joyce De Sousa	University Savoie Mont-Blanc - INES	National Expert
FRANCE	Stéphanie Giroux	Centre for Energy and Thermal Sciences of Lyon (CETHIL)	National Expert
ITALY	Daniele Vettorato	EURAC Research	Subtask B Leader + co-leader Subtask D
ITALY	Silvia Croce	EURAC Research	Subtask B Leader + co-leader Subtask D
ITALY	Jessica Balest	EURAC Research	National Expert
ITALY	Grazia Giacovelli	EURAC Research	National Expert
ITALY	Eric Wilczynski	EURAC Research	National Expert
ITALY	Nicolas Caballero	EURAC Research	National Expert
ITALY	Rossana Paparella	Civil, Environmental and Architectural Engineering, Padua University	National Expert
ITALY	Mauro Caini	Civil, Environmental and Architectural Engineering, Padua University	National Expert
ITALY	Chiara D'Alpaos	Civil, Environmental and Architectural Engineering, Padua University	National Expert
ITALY	Francesca Andreolli	Civil, Environmental and Architectural Engineering, Padua University	National Expert
ITALY	Fabio Bignucolo	Industrial Engineering, Padua University	National Expert
NORWAY	Gabriele Lobaccaro	NTNU – Norwegian University of Science and Technology	Subtask D Leader
NORWAY	Mattia Manni	NTNU – Norwegian University of Science and Technology	Subtask D Leader
NORWAY	Martina Giorio	NTNU – Norwegian University of Science and Technology	National Expert
NORWAY	Tahmineh Akbarinejad	NTNU – Norwegian University of Science and Technology	National Expert
NORWAY	Johannes Brozovsky	SINTEF	National Expert
NORWAY	Tommy Kleiven	NTNU – Norwegian University of Science and Technology	National Expert

NORWAY	Matteo Formolli	NTNU – Norwegian University of Science and Technology	National Expert
NORWAY	Ida Bryn	Multiconsult	National Expert
NORWAY	Wolfgang Kampel	Multiconsult	National Expert
NORWAY	Tobias Kristiansen	Multiconsult	National Expert
NORWAY	Rein Kristian Raaholdt	Multiconsult	National Expert
SLOVAKIA	Peter Durcansky	University of Zilina	National Expert
SWEDEN	Jouri Kanters	Energy and Building Design, Lund University	Subtask C Leader + co-leader Subtask D
SWEDEN	Rafael Campamà	Energy and Building Design, Lund University	National Expert
SWEDEN	Agnieszka Czachura	Energy and Building Design, Lund University	National Expert
SWEDEN	Marja Lundgren	White Arkitekter AB	National Expert
SWEDEN	Viktor Sjöberg	White Arkitekter AB	National Expert
SWEDEN	Nicholas Baker	White Arkitekter AB	National Expert
SWEDEN	Caroline Cederström	White Arkitekter AB	National Expert
SWEDEN	Alejandro Pacheco Dieguez	White Arkitekter AB	National Expert
SWITZERLAND	Gilles Desthieux	HES-GE/Hepia Geneva	National Expert

Task 65 – Solar Cooling for the Sunbelt Regions

Dr. Uli Jakob
Dr. Jakob energy research GmbH & Co. KG
Task Manager for the German Government (PtJ for BMWi

Task Overview

The goal of the Task 65 was to focus on **innovations for affordable, safe and reliable Solar Cooling systems** for the Sunbelt regions worldwide – the Global South. Generally, this required a combination of cost reduction, simplifications of the systems and stimulation of market conditions through policies. The implementation/adaptation of components and systems for the different boundary conditions was forced by cooperation with industry and with support of target countries like UAE and India through Mission Innovation (MI) Innovation Challenge "Affordable Heating and Cooling of Buildings" (IC7). It was the expectation that this new approach of linking SHC Task work with MI IC7 activities and funding opportunities for Solar Cooling helps to develop a market uptake of Solar Cooling in the Sunbelt regions.

Moreover, Task 65 provided a platform for the transfer and exchange of know-how and experiences from OECD countries, with experience in Solar Cooling, towards Sunbelt countries (e.g. Africa, MENA, Asia, …) and vice versa. An important focus here was also on cooperation with the GN-SEC Centres. In general, the innovation driver and the **keyword was Adaptation** of existing concepts/technologies to the Sunbelt regions using solar energy either

solar thermal or solar PV. Task 65 aimed to cover the small to large size segment of cooling and air conditioning (between 2 kW and 5,000 kW).

The key objective of Task 65 was to adapt, verify and promote Solar Cooling as an affordable and reliable solution in the rising cooling demand across Sunbelt countries. The (existing) technologies needed to be adapted to the specific boundaries and analysed and optimized in terms of investment and operating cost and their environmental impact (e.g. solar fraction) as well as compared and benchmarked on a unified level against reference technologies on a life cycle cost basis.

To achieve these objectives, the work focused on four main topics:

5. Subtask A: Adaptation
6. Subtask B: Demonstration
7. Subtask C: Assessment and tools
8. Subtask D: Dissemination

Participating Countries

	Research Institutes	Universities	Companies	Consultants
Australia		1		
Austria		2	5	2
China		4		
Denmark			1	
France	1	1		
Germany	3	1	7	1
Italy	1	2	1	
Slovakia		1		
Spain		2	1	
Sweden			1	
Switzerland			1	
The Netherlands			1	
UK		1	1	
USA (Sponsor)			1	
EACREEE		1		
RCREEE		1		1
SACREEE		2		
Total	5	19	20	4

Task Duration

This Task started in July 2020 and ended in June 2024. All deliverables have been published in 2023 and 2024.

Collaboration with Other IEA TCPs, Outside Organizations/Institutions

A constant and detailed exchange took place with IEA HPT Annex 53 on Advanced Cooling/Refrigeration Technologies Development including two successfully conducted joint industry workshops organized by Task 65. Moreover, some information exchange and participation in Task meetings were organized with SHC Tasks 64 and 71, also the lively exchange with Mission Innovation, Innovation Community 7 (IC7).

Collaboration with Industry

The strong interest and involvement from industry and business are reflected in the number of Task 65 participants from solar thermal collector manufacturers, sorption chiller manufacturers, system suppliers, consultancies, business developers, and ESCOs – overall, in 2022, about 50% of the Task experts are from industry and SMEs.

Key Results

The main accomplishments of this Task are highlighted below. More details and specific deliverables can be found on the SHC Task 65 webpage (https://task65.iea-shc.org/publications) and in the activities of the specific Subtasks:

Subtask A: Adaptation

(Subtask Leader: Dr. Salvatore Vasta, CNR-ITAE, Italy)

In Subtask A climatic conditions, applications, components and systems have been investigated and adapted tools and systems for Sunbelt countries have been developed. A GIS-based tool is now available for the global identification of possible solar cooling locations, considering technical as well as socio-economic factors. Designing effective solar cooling systems in Sunbelt regions requires a comprehensive understanding of the prevailing climatic conditions as well as a holistic approach considering a wide range of climatic factors. By tailoring systems to these conditions and promoting sustainable practices, a region can harness its abundant solar resources for efficient and eco-friendly cooling solutions.

Subtask B: Demonstration

(Subtask Leader: Wolfgang Weiss, ergSol Inc, USA)

Subtask B put the focus on design guidelines, performance indicators and standardization. An analysis of multiple case studies has been undertaken and lessons learned have been compiled. Solar thermal cooling has a long history (with first commercial examples having been built in the 1990's), however a real commercial market did not establish itself anywhere in the world. Roughly 2,000 solar (thermal) cooling systems exist worldwide. Most of them can be declared as customized, early-stage systems. PV supported cooling developed in the recent years, mainly driven by the cost decrease for PV modules in the recent decade. PV cooling has become the dominant type of solar cooling system globally due to its simplicity in installation and low cost. No robust numbers exist for installed PV cooling systems globally, but, as an example, several millions of these systems are in operation in Australia alone. The technology for both solar thermal and solar PV cooling is commercially available worldwide. However, mostly economic reasons are still preventing solar cooling from gaining a wider global market uptake, especially in Sunbelt regions with lower purchasing power. One important approach for introducing these technologies into Sunbelt countries is a wide range of demonstrations locally. It must be assured that solar cooling is seen as technically reliable, economically viable, and smart.

Subtask C: Assessment and tools

(Subtask Leader: Dr. Daniel Neyer, Neyer Brainworks GmbH, Austria)

In Subtask C, design tools have been analysed as well as assessment mechanisms have been developed. A variety of tools for solar cooling design is available. The concurrent technical, economic and financial assessment of solar cooling options is of high importance in each stage of the life cycle of a project, starting with comparison of different technology options and pre-design, detailed planning, optimizing of operation but also for policy design with proven concepts. In all life cycle phases, it is crucial to have corresponding tools that deliver the necessary information and key performance indicators for the different stakeholder. The KPIs need to take into consideration economic, financial, social and environmental issues as well as other 'Multiple Benefits'. Tools and their specific outputs permit to provide guidance on optimized system design and implementation and show the level of quality of both the most critical components and systems.

Subtask D: Dissemination

(Subtask Leader: Prof. Dr. Paul Kohlenbach, Berliner Hochschule für Technik, Germany)

Subtask D focused mainly on distributing the Task 65 results but also developed new roadmaps for Sunbelt countries regarding the implementation of solar cooling systems. Financing models have been analyzed and recommendations for policy makers are given as a result. A wide penetration of solar cooling in Sunbelt countries is not only depending on the accomplishment of technical barriers. Non-technical barriers often have a critical role. Financing, policy advise, and dissemination/communication of success stories are among the important activities to overcome also non-technical barriers. The focus is on the implementation of target specific promotion activities based on the collected results, upgrade of material for dissemination for external communication, the

implementation of knowledge transfer measures towards the technical stakeholders, the development of instruments and their provision for policy makers.

In 2025 a Technology Position Paper on Solar Cooling for the Sunbelt Regions will be published for policymakers, decisionmakers, and influencers. It presents high-level information as a basis for Solar Cooling uptake and further developments.

Dissemination Activities

The Task participants disseminated the Task results through the following channels.

Task Reports, Online Tools, Videos

Author / Editor	Title	Bibliographic Reference	Target Audience
Richard Gurtner, Tobias Schmetzer & Manuel Riepl	Climatic Conditions & Applications	SHC Task 65/Report A1, June 2023	Architects, consultants, energy planners, policymakers, and others
Marina Bonomolo & Michael Strobel (eds.)	Building and Process Optimization Potential	SHC Task 65/Report A4, July 2023	Architects, urban planners, energy planners, policymakers, and others
Nayrana Daborer-Prado, Daniel Neyer, Lu Aye & Uli Jakob	Design Tools and Models	SHC Task 65/Report C1, August 2023	Consultants, energy planners, and others
Monika Weiss (ed.)	Lessons Learned (Technical and Non-technical)	SHC Task 65/Report B5, August 2023	Architects, consultants, urban planners, energy planners, policymakers, and others
Puneet Saini & Wolfgang Weiss (eds.)	Design Guidelines	SHC Task 65/Report B2, September 2023	Consultants, energy planners, and others
Marco Beccali, Marina Bonomolo, Francesca Martorana, Ben Alex Baby, Marco Pellegrini & Salvatore Vasta	Show Cases on System and Component Level & Adapted Components	SHC Task 65/Report B1-A2, March 2024	Architects, consultants, urban planners, energy planners, policymakers, and others
Wolfgang Weiss, Uli Jakob, Monika Weiss & Boaventura Cuamba (eds.)	Standardized Solar Cooling Kits	SHC Task 65/Report B4, April 2024	Consultants, energy planners, and others

Manuel Ostheimer (ed.)	Adapted Systems	SHC Task 65/Report A3, May 2024	Consultants, energy planners, and others
Salvatore Vasta & Alessio Sapienza	Standardization Activities	SHC Task 65/Report A5, May 2024	Consultants, energy planners, policymakers, and others
Jan W. Bleyl (ed.)	Business Models and Financing Options for Solar Cooling	SHC Task 65/Report D2, May 2024	Consultants, urban planners, energy planners, policymakers, and others
Michael Strobel & Uli Jakob (eds.)	Roadmaps for Solar Cooling in Sunbelt Countries	SHC Task 65/Report D3, May 2024	Consultants, urban planners, energy planners, policymakers, and others
Paul Kohlenbach & Uli Jakob	Summary Report of Task Workshops & Trainings	SHC Task 65/Report D5, June 2024	Architects, consultants, urban planners, energy planners, policymakers, and others
Paul Kohlenbach & Uli Jakob	Summary Report on List of Stakeholders and Activities	SHC Task 65/Report D6, June 2024	Architects, consultants, urban planners, energy planners, policymakers, and others
Daniel Neyer, Jan W. Bleyl & Lars Munkoe (eds.)	Technical and Economic Database for Assessment of Solar Cooling	SHC Task 65/Report C2, July 2024	Consultants, urban planners, energy planners, policymakers, and others
Daniel Neyer, Manuel Ostheimer & Jan W. Bleyl (eds.)	Adapted Assessment Tool & Collection of Technical and Economic KPIs	SHC Task 65/Report C3-B3, September 2024	Consultants, energy planners, policymakers, and others
Daniel Neyer, Manuel Ostheimer, Jan W. Bleyl, Richard Gurtner, Tobias Schmetzer, Lars Munkoe & Uli Jakob	Technical and Economic Benchmarking for Solar Cooling Plants	SHC Task 65/Report C4, September 2024	Architects, consultants, urban planners, energy planners, policymakers, and others

Paul Kohlenbach & Uli Jakob (ed.)	Affordable and green cooling for Sunbelt regions – Results of IEA-SHC Task 65	SHC Task 65/Booklet D4, planned February 2025	Architects, consultants, urban planners, energy planners, policymakers, and others

Journal Articles, Published Conference Papers

Author(s)	Title	Publication / Conference	Bibliographic Reference
Bärbel Epp	Global support for solar cooling in sunbelt regions	solarthermalworld.org	September 2019
Uli Jakob	Solar Cooling reduces electricity consumption by a factor 2 to 3	Interview at SWC 2019	2019
Bärbel Epp	Solar Cooling concepts for hot climates	solarthermalworld.org	July 2020
Daniel Neyer / Uli Jakob	Solar Cooling for the Sunbelt regions – a new IEA SHC task	EUROSUN 2020	September 2020, DOI:10.18086/eurosun.2020.02.08
Uli Jakob	Solar Cooling buildings and processes	ISES SWC50 conference	December 2020
Bärbel Epp	IEA SHC Solar Cooling Task: “We can make a difference”	solarthermalworld.org	September 2021
Uli Jakob / Daniel Neyer	Refrigeração solar para as regiões do Sunbelt, incluindo Brasil	FotoVolt	Ano 7, No 42, October 2021, pp. 30-41
Uli Jakob / Daniel Neyer / Salvatore Vasta / Wolfgang Weiss / Paul Kohlenbach	Solar Cooling for the Sunbelt regions	ISES SWC 2021 conference	October 2021, DOI: 10.18086/swc.2021.30.01
Lu Aye / Nayrana Daborer-Prado / Daniel Neyer / Uli Jakob	An Update on Activity C1 Design Tools and Models, Task 65 Solar Cooling Sunbelt Regions	Asia-Pacific Solar research Conference 2021, Sydney / Australia	December 2021
Daniel Neyer / Uli Jakob	Solar Cooling for the Sunbelt regions IEA SHC Task 65	ISEC 2022 conference	April 2022
Uli Jakob / Paul Kohlenbach / Monika Weiss / Wolfgang Weiss	Integration of Solar-Assisted Cooling and Freezing into a Micro-Brewery Process Using a Hybrid Vapour-Compression/Sorption System	15th IIR Gustav Lorentzen Conference on Natural Refrigerants, Trondheim / Norway	June 2022, DOI: 10.18462/iir.gl2022.0165
Marco Beccali / Salvatore Vasta / Wolfgang Weiss / Ben Alex Baby / Marina Bonomolo	Adapted components and showcases on solar cooling systems in Sunbelt region countries	EUROSUN 2022 conference, Kassel / Germany	September 2022, DOI: 10.18086/eurosun.2022.06.02

Paul Kohlenbach / Uli Jakob / P. Munzinger / A. Werntges	How To Cool A Warming World? – The Potential of Photovoltaic Green Cooling with Natural Refrigerants in Sunbelt Countries	EUROSUN 2022 conference, Kassel / Germany	September 2022
Bärbel Epp	Future potential of solar cooling	solarthermalworld.org	October 2022
Lu Aye / Nayrana Daborer-Prado / Daniel Neyer / Uli Jakob	Second Update on Activity C2 Design Tools and Models, Task 65 Solar Cooling Sunbelt Regions	Asia-Pacific Solar research Conference 2022, Newcastle / Australia	Nov.-Dec. 2022
Bärbel Epp	Business and financing models – a clear distinction	solarthermalworld.org	February 2023
Uli Jakob / Daniel Neyer / Salvatore Vasta / Richard Gurtner	Solar Cooling for the Sunbelt regions - first results of Task 65 Activtiy A1 Climatic conditions and applications	4th International Conference on Solar Technologies & Hybrid Mini Grids to improve energy access, Palma de Mallorca / Spain	April 2023
Michael Strobel / Uli Jakob / Wolfgang Streicher / Daniel Neyer	Spatial Distribution of Future Demand for Space Cooling Applications and Potential of Solar Thermal Cooling Systems	Sustainability	2023, 15 (12), p. 9486. DOI: 10.3390/su15129486
Paul Kohlenbach / Uli Jakob / P. Munzinger / A. Werntges	The Potential of Photovoltaic Green Cooling with Natural Refrigerants	ICR 2023, 26th International Congress of Refrigeration Paris / France	August 2023, DOI: 10.18462/iir.icr.2023.0660
Marina Bonomolo / Uli Jakob / Daniel Neyer / Michael Strobel / Salvatore Vasta	Integration of solar cooling systems in buildings in Sunbelt region: an overview.	Buildings	2023, 13 (9), p. 2169. DOI: 10.3390/buildings13092169
Uli Jakob / Daniel Neyer / Salvatore Vasta / Wolfgang Weiss / Paul Kohlenbach	Solar Cooling for the Sunbelt regions – Results from task 65 activities	ISES SWC 2023 conference, New Delhi / India	Oct.-Nov. 2023, DOI: 10.18086/swc.2023.04.09
Michael Strobel / Uli Jakob / Manuel Ostheimer / Daniel Neyer	Solar Heating and cooling solutions in energy efficient buildings in Nepal	ISES SWC 2023 conference, New Delhi / India	Oct.-Nov. 2023, DOI: 10.18086/swc.2023.04.13
Uli Jakob / Michael Strobel	Investigation of a solar cooling and process heat system in hot climates for steam, heat and cold supply in industry	ISES SWC 2023 conference, New Delhi / India	Oct.-Nov. 2023, DOI: 10.18086/swc.2023.04.08
Bärbel Epp	IEA SHC Solar Academy training in Cape Verde with high visibility	solarthermalworld.org	November 2023
Lu Aye / Nayrana Daborer-Prado / Daniel Neyer / Uli Jakob	Third Update on Activity C2 Design Tools and Models, Task 65 Solar Cooling Sunbelt Regions	Asia-Pacific Solar research Conference 2023, Melbourne / Australia	Nov.-Dec. 2023
Bärbel Epp	Overview of design tools and models for solar cooling systems	solarthermalworld.org	January 2024

Uli Jakob / Daniel Neyer / Manuel Ostheimer	Solar Cooling for the Sunbelt regions – Highlights from Task 65 activities	ISEC 2024 conference	April 2024
Paul Kohlenbach / Uli Jakob / Salvatore Vasta / Wolfgang Weiss / Daniel Neyer	Solar Cooling for the Sunbelt regions – Final results from IEA-SHC Task 65	EUROSUN 2024 conference, Limassol / Cyprus	August 2024, DOI:
Christian Schweigler / Felix Ziegler / Walter Mittelbach / Matteo Calo / Andrea Baelz / Stefan Petersen / Jose Luis Corrales / Maider Epelde / Salvatore Vasta / Alessio Sapienza / Andrea Frazzica	Developing and demonstrating innovative solutions for renewable and waste heat-driven cooling technologies in industries: the RE-WITCH project	EUROSUN 2024 conference, Limassol / Cyprus	August 2024, DOI:
Michael Strobel / Uli Jakob	Modelling and Analysis of Building Optimisation and Solar thermal Cooling Technology in Nepal	EUROSUN 2024 conference, Limassol / Cyprus	August 2024, DOI:
Paul Kohlenbach / Uli Jakob / P. Munzinger / A. Werntges	How to cool a warming world? – The potential of photovoltaic green cooling with natural refrigerants in sunbelt countries	Solar Energy Advances	2024, 4 (4). DOI: 10.1016/j.seja.2024.100070

Conferences, Workshops, Seminars

Conference / Workshop / Seminar	Activity	Date & Location	Number of Attendees	Task Organized
Austrian workshop on Solar Cooling for the Sunbelt regions	Oral presentation by Daniel Neyer, title "Solar Cooling for the Sunbelt regions"	September 2019, Wels (Austria)		Yes
Symposium Energy Efficiency in the Industry	Oral presentation by Uli Jakob, title "Solar Cooling – a sleeping giant"	October 2019, Dubai (UAE)		No
SPF Symposium Solarenergie und Wärmepumpen	Oral presentation by Daniel Neyer, title "Kälte aus Solarenergie – Überblick über technische Möglichkeiten"	October 2019, Rapperswil (Switzerland)		No
FH OÖ Tagung klima:aktiv	Oral presentation by Daniel Neyer, title "Solare Kühlung"	November 2019, Wels (Austria)		No
WREN Seminar: Renewable Energy & Climate Change, Energy Efficiency, Conservation,	Oral presentation by Bob Critoph, title	February 2020, Bahrain		No

Cooling and Green Buildings Design	"Solar/ Renewable Cooling"			
3rd Experts' Meeting IEA-HPT Annex 53	Oral presentation by Uli Jakob, title "Solar Cooling for the Sunbelt regions"	June 2020, virtual		No
EUROSUN 2020	Oral presentation by Uli Jakob, title "Solar Cooling for the Sunbelt regions – a new IEA SHC task"	September 2020, virtual		No
SunHorizon Workshop	Oral presentation by Daniel Mugnier, title "Solar PV and Thermal Cooling"	September 2020, virtual		No
SHC Solar Academy Training for CCREEE	Task 65 experts. Organized as part of IEA SHC Task 65	10.11.2020, virtual	30	Yes
ISES SWC50 conference	Oral presentation by Uli Jakob, title "Solar Cooling buildings and processes"	December 2020, virtual		No
6th Yangzi River Delta International Conference on New Energy	Oral presentation by Daniel Neyer, title "Solar Cooling for the Sunbelt regions – IEA SHC Task 65 – Introduction and cooperation possibilities"	December 2020, Nanjing (China) + hybrid	100	No
1st Austrian National Workshop Task 65	Task 65 experts. Organized as part of IEA SHC Task 65	24.03.2021, virtual	23	Yes
1st Industry Workshop Task 65	Task 65 experts and invited presenters. Organized as part of IEA SHC Task 65	25.03.2021, virtual	50	Yes
4th Experts' Meeting IEA-HPT Annex 53	Oral presentation by Uli Jakob, title "Solar Cooling for the Sunbelt regions"	June 2021, virtual		No
Web-Forum Solarthermie Bauzentrum München	Oral presentation by Gerrit Füldner, title "Solare Kühlung und Klimatisierung – Technologie und Entwicklungen"	July 2021, virtual		No
ISES SWC 2021 conference	Oral presentation by Uli Jakob, title "Solar Cooling for the Sunbelt regions"	October 2021, virtual		No

SHC Solar Academy Training for SACREEE	Task 65 experts. Organized as part of IEA SHC Task 65	08.-09.11.2021, Stellenbosch (South Africa)	46	Yes
MI 2.0 Workshop	Oral presentation by Uli Jakob, title "Heating/cooling with PV/Solar thermal for the Sunbelt regions"	30.11.2021, virtual		No
sol.e.h.^{2} & IEA SHC Task 65 International workshop	Task 65 experts and invited presenters. Organized as part of IEA SHC Task 65	02.12.2021, virtual	45	Yes
sol.e.h.^{2} & IEA SHC Task 65 International Workshop	Oral presentation by Uli Jakob, title "Solar Cooling for the Sunbelt regions – Introduction of IEA SHC Task 65"	December 2021, virtual		Yes
Asia-Pacific Solar research Conference 2021	Oral presentation by Lu Aye, title "An Update on Activity C1 Design Tools and Models, Task 65 Solar Cooling Sunbelt Regions"	December 2021, Sydney (Australia)		No
6th Experts' Meeting IEA-HPT Annex 53	Oral presentation by Uli Jakob, title "Solar Cooling for the Sunbelt regions – Update"	February 2022, virtual		No
ISEC 2022 conference	Poster presentation by Daniel Neyer, title "Solar Cooling for the Sunbelt regions IEA SHC Task 65"	April 2022, Graz (Austria)		No
Web-Forum Solarthermie Bauzentrum München	Oral presentation by Manuel Riepl, title "Solare Kühlung und Klimatisierung – Technologie und Entwicklungen"	May 2022, virtual		No
15th IIR Gustav Lorentzen Conference on Natural Refrigerants	Poster presentation by Uli Jakob, title "Integration of Solar-Assisted Cooling and Freezing into a Micro-Brewery Process Using a Hybrid Vapour-Compression/Sorption System"	June 2022, Trondheim (Norway)		No
EUROSUN 2022 conference	Keynote by Uli Jakob, title "The future of solar cooling"	September 2022, Kassel (Germany)		No

EUROSUN 2022 conference	Oral presentation by Ben Alex Baby, title "Adapted components and showcases on solar cooling systems in Sunbelt region countries"	September 2022, Kassel (Germany)		No
EUROSUN 2022 conference	Oral presentation by Paul Kohlenbach, title "How To Cool A Warming World? – The Potential of Photovoltaic Green Cooling with Natural Refrigerants in Sunbelt Countries"	September 2022, Kassel (Germany)		No
SHC Solar Academy webinar on Solar Cooling	Task 65 experts. Organized as part of IEA SHC Task 65	25.+ 27.10.2022, virtual (hosted by ISES)	155 and 42	Yes
Asia-Pacific Solar research Conference 2022	Oral presentation by Lu Aye, title "Second Update on Activity C2 Design Tools and Models, Task 65 Solar Cooling Sunbelt Regions"	November-December 2022, Newcastle (Australia)		No
7th Experts' Meeting IEA-HPT Annex 53	Oral presentation by Uli Jakob, title "Solar Cooling for the Sunbelt regions – Update"	December 2022, virtual		No
2nd Industry Workshop Task 65	Task 65 experts and invited presenters. Organized as part of IEA SHC Task 65	24.03.2023, Innsbruck (Austria)	26	Yes
2nd Austrian National Workshop Task 65	Task 65 experts. Organized as part of IEA SHC Task 65	24.03.2023, virtual	26	Yes
4th International Conference on Solar Technologies & Hybrid Mini Grids to improve energy access	Oral presentation by Daniel Neyer, title "Solar Cooling for the Sunbelt regions - first results of Task 65 Activtiy A1 Climatic conditions and applications"	April 2023, Palma de Mallorca (Spain)		No
Coffee talk – Solar Heat Europe	Oral presentation by Uli Jakob, title "Cooling down with the sun"	May 2023, virtual		Yes
ICR 2023, 26th International Congress of Refrigeration	Oral presentation by Paul Kohlenbach, title "The Potential of Photovoltaic Green Cooling with Natural Refrigerants"	August 2023, Paris (France)		No

SHC Solar Academy Training for ECREEE	Task 65 expert. Organized as part of IEA SHC Task 65	10.-11.10.2023, Praia (Cape Verde)	27	Yes
ISES SWC 2023 conference	Keynote by Uli Jakob, title “Solar Cooling technologies for emerging markets”	October-November 2023 New Delhi (India)		No
ISES SWC 2023 conference	Oral presentation by Michael Strobel, title “Solar Heating and cooling solutions in energy efficient buildings in Nepal”	October-November 2023 New Delhi (India)		No
ISES SWC 2023 conference	Poster presentation by Michael Strobel, title “Investigation of a solar cooling and process heat system in hot climates for steam, heat and cold supply in industry”	October-November 2023 New Delhi (India)		No
Asia-Pacific Solar research Conference 2023	Oral presentation by Lu Aye, title “Third Update on Activity C2 Design Tools and Models, Task 65 Solar Cooling Sunbelt Regions”	November-December 2023, Melbourne (Australia)		No
SHC Solar Academy Training for TTMD	Task 65 experts. Organized as part of IEA SHC Task 65	13.-14.12.2023, virtual	15	Yes
3rd Austrian National Workshop Task 65	Task 65 experts. Organized as part of IEA SHC Task 65	08.04.2024, Graz (Austria)	8	Yes
ISEC 2024 conference	Poster presentation by Manuel Ostheimer, title “Solar Cooling for the Sunbelt regions – Highlights from Task 65 activities”	April 2024, Graz (Austria)		No
EUROSUN 2024 conference	Oral presentation by Salvatore Vasta, title “Solar Cooling for the Sunbelt regions – Final results from IEA-SHC Task 65”	August 2024, Limassol (Cyprus)		No
EUROSUN 2024 conference	Oral presentation by Salvatore Vasta, title “Solar Cooling for Developing and demonstrating innovative solutions for renewable and waste heat-driven cooling technologies	August 2024, Limassol (Cyprus)		No

	in industries: the RE-WITCH project"		
EUROSUN 2024 conference	Oral presentation by Michael Strobel, title "Modelling and Analysis of Building Optimisation and Solar thermal Cooling Technology in Nepal"	August 2024, Limassol (Cyprus)	No

Task Meetings

To develop the Task, the following Task Definition Workshops were held:

3. Santiago de Chile November 2019
4. Virtual meeting March 2020

Over the entire term of the Task a total of 8 Task Meetings were held *and* five national workshops, two industry workshops, and five SHC Solar Academy trainings/webinars.

Meeting	Date	Location	# of Participants (# of Countries)
Task Meeting 1	28.-29.10.2020	Virtual meeting	50 participants 16 countries + 1 Sponsor
1st SHC Solar Academy Training	10.11.2020	Virtual meeting (hosted by CCREEE)	30 participants
1st CN National Workshop	05.12.2020	Nanjing, China (Hybrid meeting)	100 participants
1st AT National Workshop	24.03.2021	Virtual meeting	23 participants
Task Meeting 2	24.-25.03.2021	Virtual meeting	35-45 participants 19 countries + 1 Sponsor
1st Industry Workshop	25.03.2021	Virtual meeting jointly with HPT Annex 53	50 participants
2nd SHC Solar Academy Training	08.-09.11.2021	Stellenbosch, South Africa (hosted by SACREEE)	46 participants
Task Meeting 3	10.11.2021	Virtual meeting	30 participants 10 countries + 1 Spons.
2nd CN National Workshop	02.12.2021	Virtual meeting (hosted by UIBK/JER)	45 participants
Task Meeting 4	23.03.2022	Virtual meeting	25 participants

			8 countries + 1 Sponsor
Task Meeting 5	29.09.2022	Uni Kassel, Germany	21 participants 11 countries + 1 Spons.
3rd SHC Solar Academy Webinar	25.+27.10.2022	Virtual meeting (hosted by ISES)	155 and 42 participants
Task Meeting 6	23.-24.03.2023	Uni Innsbruck, Austria (Hybrid meeting)	35 participants (13 on-site) 9 countries + 1 Sponsor
2nd Industry Workshop	24.03.2023	Uni Innsbruck, Austria (Hybrid meeting)	26 participants
2nd AT National Workshop	24.03.2023	Uni Innsbruck, Austria (Hybrid meeting)	26 participants
4th SHC Solar Academy Training	10.-11.10.2023	Praia, Cape Verde (hosted by ECREEE)	27 participants
Task Meeting 7	24.-25.10.2023	Virtual meeting	22 participants 7 countries
5th SHC Solar Academy Training	13.-14.12.2023	Virtual meeting (hosted by TTMD)	15 participants
Task Meeting 8	07.-08.03.2024	CNR-ITAE, Italy (Hybrid meeting)	21 participants (13 on-site) 9 countries + 1 Sponsor
3rd AT National Workshop	08.04.2023	Graz, Austria	8 participants

SHC Task 65 Participants

Country	Name	Institution / Company	Role
GERMANY	**Uli Jakob**	**JER / Green Chiller**	**Task Manager**
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Austria	Harald Dehner	FH OÖ / ASIC	National Expert

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Austria	Hannes Poier	SOLID Solar Energy Systems	National Expert
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Germany	Walter Mittelbach	Sorption Technologies	Observer
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Germany	Tobias Schmetzer	ZAE Bayern	National Expert
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Italy	Marco Pellegrini	UNIBO	National Expert
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Italy	Alessandro Guzzini	UNIBO	National Expert
Italy	Marco Beccali	UNIPA	National Expert

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UK	Jake Locke	University Warwick	National Expert
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USA	Monika Weiss	ergSol	Sponsor
USA	Pam Murphy	KMGroup	Observer
Zimbabwe	Samson Mhlanga	National University of Science and Technology	National Expert

Task 66 – Solar Energy Buildings

Task Manager
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Task Overview

The main objective of Task 66 was the development of economic and ecologic feasible solar energy supply concepts for heat and electricity with high solar fractions for new and existing buildings and communities. To achieve these objectives, the work focused on 3 main topics:

1. Boundary Conditions, KPIs, Definitions and Dissemination
2. New and existing buildings and building blocks / communities
3. Current and future technologies and components

Participating Countries

Country / Sponsors	National Participation Letter (Y/N)	Number of Research Institutes	Number of Universities	Number of Companies
Albania	N		1	
Australia	N		1	1

Austria	Y	1	1	
China	Y	1	2	
Denmark	Y		1	
Germany	Y	2	4	1
India	N	1	1	1
Italy	N			
Mexico	N		1	
Portugal	Y	1		
Slovakia	Y		1	
Switzerland	N			1
UK	N		1	1
USA (Sponsor)	N			1
Total	**6 Y**	**7**	**13**	**6**

Task Duration

The Task started on July 1st, 2021, and was completed on September 30th, 2024.
Final deliverables will be completely published by the end of April 2025.

Collaboration with Other IEA TCPs

During the operation of Task 66 a collaboration with the following IEA Annexes and Tasks was performed:

- IEA EBC Annex 83 (Positive Energy Districts)
- IEA PVPS Task 15 (Enabling Framework for the Development of BIPV)

Collaboration with Outside Organizations/Institutions

Furthermore, there was a collaboration with:

- IRENA - International Renewable Energy Agency
- SHE – Solar Heat Europe / ESTIF – European Solar Thermal Industry Federation
- Himalayan Institute of Alternatives, Ladakh, India
- KTH Royal Institute of Technology, Sweden
- Centre for Sustainable Energy Technologies Energy and Environment Institute, United Kingdom
- Higher Institute of Applied Sciences and Technology of Sousse, University of Sousse, Tunisia
- Polytechnic Institute of Setubal, Portugal
- CERES the Libyan center for solar energy research and Studies, Libya
- Korea Institute of Energy Research, KIER, South Korea
- Malaviya National Institute of Technology, India
- Institute for Technological Research of State of Sao Paulo, Brazil
- Institute for Thermal Engineering, (North) Macedonia
- AIT Austrian Institute of Technology GmbH, Austria

Collaboration with Industry

Representatives of the following industry firms participated in meetings of Task 66:

- Viessmann Climate Solutions SE, Germany
- eVERA GmbH, Germany
- hc-solar innovative solar solutions, Germany
- Prime Laser Technology SA, Greece
- Sunovate, Australia
- Jenni Energietechnik, Switzerland

- Naked Energy, United Kingdom
- STEAG Energy Services Pvt. Ltd., India
- Bosch Solarthermie, Germany

Representatives of the following industry firms and institutions participated in workshops and other events organized by Task 66:

- AIT Austrian Institute of Technology GmbH, Austria
- Ascent Solar Technologies, Inc, United States of America
- Badenova Wärmeplus GmbH & Co. KG, Germany
- Bosch Solarthermie GmbH, Germany
- Bosch Thermotechnik GmbH, Germany
- Bural Solar, Turkey
- Consolar Solare Energiesysteme GmbH, Germany
- Cowi Holding A/S, Denmark
- Crano Technology (Pvt) Ltd., Zimbabwe
- Dalkia Electrotechnics Holding SAS, Courbevoie, France
- Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany
- ECONSULT Lambrecht Jungmann Partner, Germany
- effiziente.st Energie- und Umwelt-Consulting e.U., Austria
- Emporium Legacy (pty) ltd, Botswana
- Energetyka Solarna Ensol Sp. z o.o., Poland
- Energieeffizientes und solares Bauen Architekturbüro Reyelts, Germany
- Energy Transitions Ltd., United Kingdom
- ESP-Weimar Energie, Germany
- Exyte Central Europe GmbH, Germany
- Fichtner GmbH & Co. KG, Germany
- FischTank PR (Ascent Solar Tech.), United States of America
- Giersch Enertech GmbH, Germany
- hc-solar innovative solar solutions, Germany
- Hewalex Sp. z o.o. Sp.k., Poland
- i2KT Gmbh & Co. KG, Germany
- IBS Ing.-Büro Dr. Schiebl GmbH, Germany
- Inergya Ingenieros SAC, Peru
- Ingenieurbüro für rationelle Energieanwendung, Germany
- Ingenieurbüro Matthaei, Germany
- IsoSol UG, Germany
- Jenni Energietechnik, Switzerland
- KAplus - Ingenieurbüro Vollert, Germany
- KHB-Creativ Wohnbau GmbH, Germany
- KREISEL Electric, Germany
- Lichtblau Architekten BDA, Germany
- MediWatt S.A., Luxemburg
- Naked Energy, United Kingdom
- PA-ID Process GmbH, Germany
- Pleion S.p.A, Italy
- Prime Laser Technology SA, Greece
- QSBR Innovations Inc., Canada
- REKS GmbH & Co. KG, Germany
- Renogreen Energy UG, Böblingen, Germany
- Ritter Energie- und Umwelttechnik GmbH & Co. KG, Germany
- Ritter Solartechnik GmbH & Co. KG, Germany
- Savemax Solar Systems Pvt Ltd., India
- Savosolar GmbH (Meriaura), Finland
- sbp sonne gmbh, Germany

- Schweyher Engineering. Planer, Germany
- Seenso Renoval, S.L., Spain
- Senergy Innovations Ltd., Ireland
- siz energieplus / dp-quadrat, Germany
- Solamatic us VSI Technologies Inc., Zimbabwe
- Solar-Experience GmbH, Germany
- Solrico – Bärbel Epp, Germany
- SOLVIS GmbH, Germany
- Stantec Inc., United States of America
- STEAG Energy Services (India) Pvt. Ltd., India
- Sunmaxx PVT GmbH, Germany
- Sunovate Pty Ltd., Australia
- Suter Consulting, Switzerland
- tewag Technologie - Erdwärmeanlagen - Umweltschutz GmbH, Germany
- Transsolar Energietechnik GmbH, Germany
- TVP SOLAR SA, Switzerland
- Viessmann Climate Solutions SE, Germany
- Vision Green Solutions GmbH, Germany
- Volkswohnung GmbH, Germany

Key Results

The main accomplishments of this Task are highlighted below. More details and specific deliverables can be found on the SHC Task 66 webpage https://task66.iea-shc.org/ and in the activities of the specific Subtasks:

Subtask A: Boundary Conditions, KPIs, Definitions and Dissemination

Subtask Leader: Frank Späte, Ostbayerische Technische Hochschule Amberg-Weiden (OTH-AW), Germany

- Definition of Key Performance Indicators (KPIs) for Solar Energy Buildings
- Definition of Reference Solar Energy Buildings
- Information brochure for Investors related to Solar Energy Buildings
- Information brochure for Politicians related to Solar Energy Buildings
- Organization and conduction of 5 industry workshops and one event for the presentation of the final task results within total approx. 320 participants
- Preparation of two videos - Task 66 information video (link)
  - Task 66 final result video (link)

  Note: The Task 66 information video and the Task 66 final task video are with around 450 views within one year the most popular SHC Task videos.
- IEA SHC Solar Academy Webinar on Solar Energy Buildings with 222 participants

Subtask BC: New and existing buildings and building blocks / communities

Subtask Leader: Elsabet Nielsen, Technical University of Denmark (DTU), Denmark
Subtask Co-Leader: Xinyu Zhang and Wenbo Cai, China Academy of Building Research (CABR), Beijing, China

- Elaboration of a collection of 27 Demonstration Cases of Solar Energy Buildings including guidelines for monitoring and reporting
- Analyses and Description of Processes and Tools for designing and Planning Solar Energy Buildings based on interviews with 46 stakeholders
- Catalogue on Optimized Solar Energy Buildings with 7 different solutions of Solar Energy Building concepts for communities
- Survey related to stakeholder viewpoints for the realizing Solar Energy Buildings

Subtask D: Current and future technologies and components
Subtask Leader: Michael Gumhalter and Thomas Ramschak, AEE INTEC Austria

- Summary with description of Current Technologies for Solar Energy Buildings based on the investigation of 126 case studies
- Selection of new Technologies and Components for Solar Energy Buildings
- Technology Radar for Solar Energy Buildings

Dissemination Activities

The Task participants disseminated the Task results through the following channels.

Task Reports, Online Tools, Videos

Author / Editor	Title	Bibliographic Reference	Target Audience
Frank Späte et. al.	Solar Energy Buildings - Information for Investors	https://task66.iea-shc.org/Data/Sites/1/publications/Task66_D.A5_info_invest1.pdf	Investors
Frank Späte et. al.	Solar Energy Buildings - Information for Policymakers	https://task66.iea-shc.org/Data/Sites/1/publications/Task66_D.A6_info_policiy1.pdf	Policymakers
Several	Task 66 final results video	https://task66.iea-shc.org/task-66-final-results-video	Industry Researchers Investors Policymakers Private persons
Several	Task 66 Information Video	https://task66.iea-shc.org/videos/intro	Industry Researchers Investors Policymakers Private persons
Harald Drück, Frank Späte, Elsabet Nielsen, Michael Gumhalter	ISES Solar Academy Webinar: Task 66 - Solar Energy Buildings	https://www.ises.org/what-we-do/events/webinar/iea-shc-solar-academy-task-66-solar-energy-buildings-1	Industry Researchers Investors Policymakers Private persons
Claudia Scholl-Haaf, Harald Drück	Task 66 Info Flyer	https://task66.iea-shc.org/Data/Sites/1/publications/Task66_Flyer1.1.pdf	Industry Researchers Private persons

Journal Articles, Published Conference Papers

Author(s)	Title	Publication / Conference	Bibliographic Reference
Harald Drück, Claudia Scholl-Haaf	Solar Energy Buildings – The new building standard	SOLAR UPDATE Vol. 80 and IEA SHC Task66 website December 2024	http://www.iea-shc.org/Data/Sites/1/publications/2024-12-Task66-Solar-Energy-Buildings-The-New-Building-Standard.pdf
Harald Drück	Task 66 Interview Solar Energy Buildings	SOLAR UPDATE Vol. 80 and IEA SHC Task66 website December 2024	http://www.iea-shc.org/Data/Sites/1/publications/2024-12-Task66-Interview-Harold-Druck.pdf
Bärbel Epp	Technology Radar for Solar Energy Buildings	solarthermalworld.org November 2024	https://solarthermalworld.org/news/technology-radar-for-solar-energy-buildings/
Elisa Venturi et al.	Evaluation of positive energy districts with district heating and heat pumps	Eurosun 2024 Conference Aug. 26th - 30th, 2024, Limassol, Cyprus	*to be published*
Fabian Ochs et al.	Characteristic load curves for positive energy districts	Eurosun 2024 Conference Aug. 26th - 30th, 2024, Limassol, Cyprus	*to be published*
Henner Kerskes et al	Development and verification of a thermochemical heat storage system in a district heating networ	Eurosun 2024 Conference Aug. 26th - 30th, 2024, Limassol, Cyprus	*to be published*
Henner Kerskes et al.	Optimization and testing of an air-based solar heating system for residential building	Eurosun 2024 Conference Aug. 26th - 30th, 2024, Limassol, Cyprus	*to be published*
Elsabet Nielsen et al.	Yearly thermal performances of Danish solar heating plants	Eurosun 2024 Conference Aug. 26th - 30th, 2024, Limassol, Cyprus	*to be published*
Mark Dannemand et al.	How does the thermal characteristics of PVT panels influence the performance of PVT heat pump system	Eurosun 2024 Conference Aug. 26th - 30th, 2024, Limassol, Cyprus	*to be published*

Peer Huber et al.	Development of a new generation of cold district heating systems with water as heat transfer medium	Eurosun 2024 Conference Aug. 26th - 30th, 2024, Limassol, Cyprus	*to be published*
Franziska Bockelmann et al.	Energy Concepts With High Solar Fraction For Multi-Family Houses	Eurosun 2024 Conference Aug. 26th - 30th, 2024, Limassol, Cyprus	*to be published*
Bärbel Epp	Stakeholder viewpoints on solar energy buildings	solarthermalworld.org April 2024	https://solarthermalworld.org/news/stakeholder-viewpoints-on-solar-energy-buildings/
Fabian Ochs et al.	Towards Positive Energy Districts	ISEC – International Sustainable Energy Conference 09.-11.04.2024, Graz, Austria	https://doi.org/10.52825/isec.v1i.1206
Elisa Venturi et al.	Techno-Economic Analysis of the Heating System Robustness	ISEC – International Sustainable Energy Conference 09.-11.04.2024, Graz, Austria	https://doi.org/10.52825/isec.v1i.1171
Elsabet Nielsen	Solar Energy Buildings Around the World	SOLAR UPDATE Vol. 78 and IEA SHC Task66 website December 2023	http://www.iea-shc.org/Data/Sites/1/publications/2023-12-Solar-Energy-Buildings-Around-the-World.pdf
Bärbel Epp	Demo projects of high-solar-fraction buildings carefully analyzed	solarthermalworld.org, October 2023	https://solarthermalworld.org/news/demo-projects-of-high-solar-fraction-buildings-carefully-analysed/
Bärbel Epp	Solar thermal achieves highest level of “real” climate neutrality	solarthermalworld.org, August 2023	https://solarthermalworld.org/news/solar-thermal-achieves-highest-level-of-real-climate-neutrality/
Thomas Ramschak, Michael Gumhalter	Internationale Ko-operation: Innovative Technologien und	Nachhaltige Technologien	

	Strategien für Solar Energy Buildings	AEE INTEC March 2023	
Harald Drück et al.	Wie klimaneutral ist die Solarthermie	Solarthermie-Jahrbuch 2023	
Stephanie Banse	Analysing 126 solar energy buildings across Europe	solarthermalworld.org December 2022	https://solarthermalworld.org/news/analysing-126-solar-energy-buildings-across-europe/
Stephanie Banse	Optimised PVT and heat pump combinations for heating and cooling of buildings	solarthermalworld.org, October 2022	https://solarthermalworld.org/news/optimised-pvt-and-heat-pump-combinations-for-heating-and-cooling-of-buildings/
Harald Drück, Dominik Bestenlehner	Definitions for Climate Neutrality and their Relevance for the Assessment of Solar Energy based Heating Systems	EuroSun 2022 conference, Sept. 22 - 29, 2022, Kassel Germany	http://ises-proceedings.pse-co.de/paper/eurosun2022/eurosun2022-0188-Druck.pdf
Dominik Bestenlehner, Harald Drück	Theoretical investigations for electric heating concepts for residential buildings	EuroSun 2022 conference, Sept. 22 - 29, 2022, Kassel Germany	
Elsabet Nielsen, Simon Furbo	Solar energy buildings with high degree of independence of energy supply from grids	EuroSun 2022 conference, Sept. 22 - 29, 2022, Kassel Germany	http://ises-proceedings.pse-co.de/paper/eurosun2022/eurosun2022-0008-Nielsen.pdf
Thomas Ramschak et al.	Participation potentials for energy active facades in future flexibility markets	EuroSun 2022 conference, Sept. 22 - 29, 2022, Kassel Germany	http://ises-proceedings.pse-co.de/paper/eurosun2022/eurosun2022-0020-Ramschak.pdf
Jens Ullmann, Harald Drück, Bernd Hafner	Development of a combined model predictive and adaptive control strategy for the operation of a cold district heating network	EuroSun 2022 conference, Sept. 22 - 29, 2022, Kassel Germany	http://ises-proceedings.pse-co.de/paper/eurosun2022/eurosun2022-0036-Ullmann.pdf
Stefanie Lott, Stephan, Fischer,	Quasi-Dynamic Testing of Thermal Sun-Air-Collectors	EuroSun 2022 conference,	http://ises-proceedings.pse-

Harald Drück, Bernd Hafner	and Numerical Simulations of a Cold District Heating Network	Sept. 22 - 29, 2022, Kassel Germany	co.de/paper/eurosun2022/eurosun2022-0027-Lott.pdf
Harald Drück & Dominik Bestenlehner	Die Definition von Klimaneutralität und ihre Relevanz für die Solarthermie	Symposium Solarthermie und innovative Wärmesysteme, 03.–05. Mai 2022, Bad Staffelstein	
Elena Engelniederhammer	How to get renewable energy to buildings in dense urban areas	solarthermalworld.org April 2022	https://solarthermalworld.org/news/how-to-get-renewable-energy-to-buildings-in-dense-urban-areas/
Harald Drück et al.	Mit Eis und Sonne heizen	GebäudeEnergieberater Juli 2021	
Bärbel Epp	How to design an 85 % solar-heated and 100 % solar air-conditioned house	solarthermalworld.org, April 2021	https://solarthermalworld.org/news/how-design-85-solar-heated-and-100-solar-air-conditioned-house/
Harald Drück, Joachim Berner	SHC Task 66: Mehr Sonne ins Haus	Solarthermie-Jahrbuch 2021	https://www.solarthermie-jahrbuch.de/shc-task-66-mehr-sonne-ins-haus/
Bärbel Epp	Solar-heated multi-family buildings gain popularity in Germany	solarthermalword.org, October 2020	https://solarthermalworld.org/news/solar-heated-multi-family-buildings-gain-popularity-germany/
Bärbel Epp	Solar houses: above 95 % solar fraction is possible	solarthermalword.org, October 2020	https://solarthermalworld.org/news/solar-houses-above-95-solar-fraction-possible/
Bärbel Epp	Solar Energy Buildings to make cities fit for the future	solarthermalword.org, February 2020	https://solarthermalworld.org/news/solar-energy-buildings-make-cities-fit-future/

Conferences, Workshops, Seminars

Conference / Workshop / Seminar	Activity	Date & Location	Number of Attendees	Task Organized
Presentation of Task 66 results	7 Oral presentations	27.08.2024 Limassol, Cyprus	Approx. 50	Yes (partly)
Industry Workshop No 5	6 Oral presentations	06.02.2024 Virtual	93	Yes
Joint Workshop with Annex 83 of IEA EBC	7 Oral presentations	10.10.2023 Graz, Austria	23	Yes
Industry Workshop No 4	6 Oral presentations	09.10.2023 Graz, Austria	18	Yes
Industry Workshop No 3	7 Oral presentations	07.02.2023 Virtual	47	Yes
Industry Workshop No 2	10 Oral presentations	29.09.2022 Kassel, Germany	31	Yes
Industry Workshop No 1	5 Oral presentations	23.03.2022 Virtual	56	Yes

Note: The agendas and presentations of all events mentioned above are available on the IEA SHC website of Task 66: https://task66.iea-shc.org/meetings

Task Meetings

To develop the Task, the following Task Definition Workshop was held:

Online (due to the Covid19 Pandemic) on May 25, 2020, with 45 participants from 15 countries

Over the entire term of the Task a total of 9 Task Meetings were held *and 5 included a public workshop, symposium, or other event.*

Meeting	Date	Location	# of Participants (# of Countries)
Task Meeting 1	01.-02.07.2021	Virtual	37 (14)
Task Meeting 2	04.-05.11.2021	Virtual	37 (14)
Task Meeting 3	23.-24.03.2022	Virtual	29 (12)
Industry Workshop No 1:	Solar Energy Buildings Worldwide		56 /14)

Task Meeting 4	29.-30.09.2022	Kassel, Germany	17 (7)
Industry Workshop No 2:	Solar thermal and/or PVT combined with heat pumps as an innovative energy supply solution		31 (9)
Task Meeting 5	06.02.2023	Virtual	25 (9)
Industry Workshop No 3:	Demonstration projects of Solar Energy Buildings around the globe		47 (10)
Task Meeting 6	09.10.2023	Graz, Austria	17 (6)
Industry Workshop No 4:	Solar energy supply concepts for buildings and districts in an international context		18 (7)
Task Meeting 7	05.-06.02.2024	Virtual	20 (8)
Industry Workshop No 5	Solar Energy Buildings – Design, Planning and Operation in Practice		93 (26)
Task Meeting 8	11.06.2024	Virtual	14 (6)
Task Meeting 9	26.08.2024	Limassol, Cyprus	11 (5)
Final Task Event:	Presentation of Task 66 final results		Approx 50 (20)

SHC Task 66 Participants

Country	Name	Institution / Company	Role
Germany	**Harald Drück**	**University of Stuttgart, IGTE**	**Task Manager**
Germany	Frank Späte	Ostbayrische Technische Hochschule OTH	Subtask A Leader
Denmark	Elsabet Nomonde Nielsen	Technical University of Denmark (DTU)	Subtask BC Leader
China	Xinyu Zhang	China Academy of Building Research (CABR)	Subtask BC Co-Leader
China	Wenbo Cai	China Academy of Building Research (CABR)	Subtask BC Co-Leader
Austria	Thomas Ramschak	AEE - Institut für Nachhaltige Technologien	Subtask D Leader (until Dec 2023)
Austria	Michael Gumhalter	AEE - Institut für Nachhaltige Technologien	Subtask D Leader (from Jan 2024)

Germany	Claudia Scholl-Haaf	University of Stuttgart, IGTE	Task Administrator
Austria	Elisa Venturi	University of Innsbruck	Expert
Austria	Fabian Ochs	University of Innsbruck	Expert
Germany	Franziska Bockelmann	Steinbeis-Innovations-zentrum energie+	Expert
Denmark	Simon Furbo	Technical University of Denmark (DTU)	Expert
Portugal	Jorge Facao	LNEG	Expert
Germany	Lukas Oppelt	TU Bergakademie Freiberg	Expert
Germany	Andreas Gäbler	TU Bergakademie Freiberg	Expert
Solvakia	Roman Rabenseifer	Slovak University of Technology in Bratislava	Expert
Germany	Markus Peter	dp-quadrat	Expert
Germany	Bernd Hafner	Viessmann Climate Solutions SE	Expert
Germany	Stefanie Lott	University of Stuttgart, IGTE	Expert
Germany	Henner Kerskes	University of Stuttgart, IGTE	Expert
Germany	Gerhard Mengedoht	Technische Hochschule Ulm (THU)	Expert
Australia	Rebecca Yang	RMIT University Melbourne	Expert
Australia	Glen Ryan	Sunovate	Expert
Germany	Tillmann Gauer	Technische Universität Kaiserslautern	Expert
USA	Joel H. Goodman	University of Minnesota (former)	Expert
China	Tao Ma	Shanghai Jiao Tong University	Expert
Germany	Dominik Bestenlehner	University of Stuttgart, IGTE	Expert
Germany	Peer Huber	University of Stuttgart, IGTE	Expert
Belgium	Pedro Dias	ESTIF	Expert

China	Boyuan Wang	China Academy of Building Research	Expert
Germany	Arun Kumar	STEAG Energy Services (India) Pvt. Ltd.	Expert
China	Zhiyong Tian	Huazhong University of Science and Technology	Expert
Germany	Yong Chen	IRENA International Renewable Energy Agency	Expert
Gemany	Niclas Rennert	Bosch Solarthermie	Expert
UK	Zanil Narsing	Naked Energy	Expert

Task 67 – Compact Thermal Energy Storage Materials within Components within Systems

Dr. Wim van Helden
AEE – Institute for Sustainable Technologies
Task Manager for The Republic of Austria

Task Overview

The purpose of Task 67 is to push forward the compact thermal energy storage (CTES) technology developments to accelerate the market introduction of these technologies through the international collaboration of experts from materials research, components development and system integration, and industry and research organizations.

The main objectives of the Task are to 1) better understand the factors that influence the storage density and the performance degradation of CTES materials, 2) characterize these materials in a reliable and reproducible manner, 3) develop methods to determine the State of Charge of a CTES effectively, and 3) increase the knowledge base on how to design optimized heat exchangers and reactors for CTES technologies.

The Task is organized into five subtasks**:**

- Subtask A: Material Characterization and Database *(Lead Country: Austria)*
- Subtask B: CTES Material Improvement *(Lead Country: Spain)*
- Subtask C: State of Charge – SoC Determination (Lead Countries: Denmark (PCM) and Canada (TCM))
- Subtask D: Stability of PCM and TCM (*Lead Country: Germany)*
- Subtask E: Effective Component Performance with Innovative Materials *(Lead Countries: Spain (PCM) and Switzerland (TCM))*

Scope

CTES technologies are the subject of the Task. These technologies are based on the classes of phase change materials (PCM) and thermochemical materials (TCM). Materials from these classes will be studied, improved, characterized, and tested in components. The main components for these technologies are heat exchangers and reactors, which are also studied and further improved in the Task. The temperatures of the heat that the thermal storage will supply are determined by the areas of application and range from 0°C to 20°C for cooling purposes, from 40°C to 95°C for buildings, between 60°C and 130°C in DHC networks, and 80°C to more than 500°C for industry and vehicles. Due to the underlying physical and chemical processes, the charging and discharging temperatures, especially with TCM, can have very different values, with charging temperatures determined mainly by the applied heat source.

Subtask A: Material Characterization and Database
The subtask's main objective is to develop and validate several standardized measurement procedures for CTES materials and further expand and maintain the materials and knowledge databases.

Subtask B: CTES Material Improvement
The subtask's main objective is to identify proper strategies that allow for tuning the reactivity of CTES materials, thus improving their properties and final performances.

Subtask C: State of Charge – SoC Determination
The subtask's main objective is to develop techniques with which the SoC of a CTES can be determined in a reliable and cost-efficient way.

Subtask D: Stability of PCM and TCM
The subtask's main objective is to arrive at PCM and TCM with predictable and improved stability.

Subtask E: Effective Component Performance with Innovative Materials
The subtask's main objective is to improve material-component interaction for optimal system performance.

Collaboration with Other IEA TCPs

Task 67 is a fully joint Task with the IEA Energy Storage (ES) TCP Task 40. The Task Manager for the ES Task 40 part is Andreas Hauer, ZAE Bayern, Germany.

Collaboration with Industry

Three industries are participating in the Task: Sunamp (United Kingdom), Engineer (Portugal), and Rubitherm Technologies (Germany).

Participating Countries

Austria, Canada, China, Denmark, France, Germany, Italy, Netherlands, Norway, Portugal, Slovenia, Spain, Switzerland, United Kingdom, United States

Key Results

Subtask A: Material Characterization and Database

A1: **Standardized measurement procedures and round robin tests**

Several round robin tests were 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.

The summarized lessons learned from the round robins:

- The equipment variability supposes a challenge to establish a standardized measurement protocol and needs more effort in the beginning of a round robin test.
- Experimental and systematic uncertainty must be accounted to compare the results. In some cases, the uncertainty reported was below the equipment error, due to
    - not enough repetitions,
    - not accounted for equipment error,
    - or not enough samples tested.
- The occurrence of water in the sample (especially for TCM, e.g. hydrated or sorption samples) can lead to different sample states in the beginning of the measurement and should be examined in more detail before the measurement.
- Meaningful results are only possible with an adequate number of participants.

During this Task we could achieve round robin results and improvements for all above mentioned quantities.

A2: **CTES Materials database and knowledge platform**

In the second activity of Subtask A, the requirements of a new Thermal Energy Storage Material Database were defined and evaluated. A database has already been developed in the previous Tasks (https://thermalmaterials.org/), which is to be filled with new data and structurally adapted in the future. One of these structural changes is the link to existing databases such as the slPCMlib database (https://slpcmlib.ait.ac.at/). Several changes of the existing database were proposed to the experts of Subtask A and assessed based on a survey.

The main outcome of these activities is the finalization of the Software Requirements Specification document (SRS) for the new version of the CTES materials database. The document details all the requirements identified as highly relevant by most of the task members who participated in the database survey.

Subtask B: CTES Material Improvement

B1: **Exploring potential materials for CTES**

The objective of B1 is: To arrive at tailor made materials with tuned thermodynamic properties, i.e. with high energy storage capacity or working temperature aligned with the application.

An inventory was made of strategies with which the properties of compact thermal energy storage materials systematically can be improved. These are: theoretical prediction and experimental determination of solid-liquid phase diagrams; blends of plastic crystals; combining solid-liquid and solid-solid PCMs; hybrid PCM-TCM concept; doping of an active material in a carrier material; composite materials (combining sorption and chemical reactions); et cetera. The main strategies explored in Subtask B are included in a scientific article (now under review) submitted to an international journal.

B2: **Improving the performances and increasing versatility: Advanced composites for CTES and best conditioning**

The objective of B2 is: Get improved materials in terms of energy storage capacity and heat and mass transfer ability. Look for best conditioning in view of their integration into application.

The experts had several discussions on how to quantify how the materials improvement can impact the TES-system performance. It is still an open discussion, with some first direction found for PCM systems, with the use of so-called Ragone plots for selected materials and properties. The method uses the outcomes of experiments with a PCM storage device, determining the fluid outlet temperature as function of the state-of-charge of the device, for several cooling rates. The curves are transformed to curves in a plot the gives the specific power of the device as function of the specific energy stored. This could be a first step to define the state of the art related to those specific materials. This approach could be extended to other classes of materials and properties in a second stage. The work could not be finalized in the Task period and will be taken further in a follow-up Task.

Subtask C: State of Charge – SoC Determination

The objective of Subtask C was to collect, classify, and disseminate promising techniques with which the state of charge (SoC) of a CTES unit can be determined.

Subtask C experts defined a thermal battery as a TES system with instantaneous SoC determination. Therefore, SoC is a component level property, and its determination utilizes measurement techniques of material bulk response.

To work towards the objective, Subtask C experts conducted three steps. First, an inventory of promising material properties and related measurement techniques was made. Regarding PCM, twenty technique submissions were collected. Eleven of them described techniques utilizing temperature measurements of the PCM medium and control volume boundary heat exchange. Regarding TCM, six main TCM SoC measurement techniques were submitted. Most, if not all these methods work at material level and worked either in a laboratory experimental environment or at pilot scale. The two most promising methods to achieve higher TRL include (i) enthalpy balance SoC determination technique during system operation, and (ii) TCM mass or adsorbate mass balance SoC determination technique. As the second step, a collection of experimental and numerical proofs of concept were presented and explained in more detail. Third, descriptions of application requirements of four prototype systems, where a direct interaction of material bulk response with the control system is in place, were prepared.

Subtask D: Stability of PCM and TCM

The main goal of Subtask D is to come to a better understanding of the stability of PCM and TCM and, thereby, derive recommendations for an application-oriented stability testing.

D1: **Mapping degradation mechanisms for CTES material classes**

Different templates that help to structure the CTES material stability in a graphical way were proposed, discussed and tried out. The choice was made for a spreadsheet-based method that shows the different degradation mechanisms, the factors that degrade and the effect the degradation has on the storage material and on the TES system. Examples of the mapping were made for different PCM and TCM. It was concluded that such a mapping diagram properly informs about the effect of different types of degradation on the CTES material and system.

D2: **Recommendations for stability testing**

The development of the method described above is a good basis for the work on recommendations for stability testing. Due to lack of time, this work could not be taken up in the Task67 and will be transferred to the follow-up Task.

Subtask E: Effective Component Performance with Innovative Materials

Subtask E focused on material-component interaction for an improved storage system performance. This was attained by defining performance parameters, understanding the mechanisms that determine the performance-based interaction between storage material and components, and identifying methods for improved component and material design. Work was split up between PCM and TCM experts, and the outcomes are presented separately.

E1: **PCM**

Performance indicators for PCM components (mainly heat exchangers) were defined and agreed upon. These indicators allow a fair comparison of latent heat thermal energy storage units. This has not been possible so far. For example, a comparison of the average thermal power is strongly influenced by the initial and boundary conditions during the experiment. Three methods were developed by the Task participants to minimize these influences and enable a comparable analysis.

The idea behind the first method is to normalize the heat transfer rate $\dot{Q}$ by the volume and a reference temperature difference, calculate a mean value and present the results plotted over a normalized mean value of the capacity flow of the heat transfer fluid.

The second method, called *three sections approach*, helps finding suitable stop criterion for calculating a mean value of the power of latent heat thermal energy storage units. The discharging process is divided into several sections, and the end is determined based on their intersections with each other and with the zero-power line, respectively.

The third method is based on a small number of standardized charging and discharging measurements with a constant volume flow and constant inlet temperature. The resulting power curves are normalized and converted from the time domain to the energy domain. The curves are plotted in such a way that the actual usable heat content of the storage can be determined for specified values for the set thermal power, the temperature, and the maximum volume flow.

E1: **TCM**

In the case of TCM components, there is a need for a standardized evaluation of sorption heat storage components and systems with respect to the material performance given by the vapor pressure versus temperature relationship of various concentrations or mass fractions. This standard evaluation will make it possible to quantify development success. A mapping technique was developed, using a concentration vs. gross temperature lift diagram, which incorporates the sorbent's equilibrium line and the deviation caused by the non-linear temperature-heat relationship. This mapping helps visualize the operational constraints and the potential performance of the system.

To overcome the problem of incomparable test results from different test methods, a uniform test guideline for building applications was proposed. The proposed guideline defines specific static test temperatures that correspond to realistic operating conditions for desorption, condensation and evaporation.

This guideline standardizes the evaluation of sorption heat storage systems by ensuring that materials, components, and systems are tested under comparable and realistic conditions.

Dissemination Activities

Reports, Published Books

Author(s) / Editor	Title	Report No.
W. van Helden, W., Fumey, B., Englmair, G., Kerscher, F., Cuypers, R., Groulx, D., Lager, D., Doppiu, S., Rathgeber, C.	Technology Position Paper: Compact Thermal Energy Storage	Technology Position Paper: Compact Thermal Energy Storage. International Energy Agency, SHC TCP.
A. Hubman, J. Volavšek, T. Urbič, N. Zabukovec Logar, F. Merzel	Water–aluminum interaction as driving force of Linde Type A aluminophosphate hydration	https://dirros.openscience.si/IzpisGradiva.php?id=16888, DOI: 10.3390/nano13172387.
Andreas König-Haagen; Moritz Faden; Gonzalo Diarce.	A CFD results-based reduced-order model for latent heat thermal energy storage systems with macro-encapsulated PCM	Journal of Energy Storage. 73, Elsevier Ltd, 2023.
L. Quant, G. Diarce, L. Bouzas, A. García-Romero	A comprehensive study of the phase segregation of a urea-based phase change material tested under thermal cycling conditions	Journal of Energy Storage. 60, 2023.
A. König-Haagen et al	Analysis of the discharging process of latent heat thermal energy storage units by means of normalized power parameters	Journal of Energy Storage. 72, Elsevier Ltd, 2023.
A. König-Haagen, G. Diarce	Comparison of Corrected and Uncorrected Enthalpy Methods for Solving Conduction-Driven Solid/Liquid Phase Change Problems.	Energies. 16, 2023.
A. König-Haagen; G.Diarce.	Prediction of the discharging time of a latent heat thermal energy storage system with a UA approach.	Journal of Energy Storage. 73, Elsevier Ltd, 2023.
M. Navarro, G. Diarce, A. Lázaro, A. Rojo	Comparative study on bubbling and shearing techniques for the crystallization of xylitol in TES systems	Results in Engineering. 17, 2023.

G. Englmair	Case 1: DTU optimerer faseskiftende materialers høje energitæthed til kompakt og decentral energilagring. In Status Styrker Synergier: DaCES Rapport om Energilagring i Danmark 2023 (pp. 15).	DaCES – Dansk Center for Energilagring (website)

Journal Articles, Conference Papers, etc.

Author(s) / Editor	Title	Publication / Conference	Bibliographic Reference
O. Galteland, M. Gouis, J. Salgado-Beceiro and A. Evault	Fourteen months operation of a 200-kWh latent heat storage pilot	2023 8th International Conference on Smart and Sustainable Technologies - SpliTech	IEEE, pg. 1-5
Jorge Salgado Beceiro, Ragnhild Sæterli, Magnus Rotan, Jan Hendrik Cloete, Margaux Gouis and Alexis Sevault	Thermochemical Energy Storage: an approach to integration pathways	2023 8th International Conference on Smart and Sustainable Technologies - SpliTech	IEEE, pgp. 1-4
Fride Vullum-Bruer, Magnus Rotan, Jorge Salgado-Beceiro, Olai Brevik Mykland, Ragnhild Saeterlie, Alexis Sevault, José Lara Cruz, Jawad Rabbi, Jean-Pierre Bedecarrats	Exploring supercooling phenomena through extensive experimental method design	Eurotherm Seminar #116 - Innovative Solutions For Thermal Energy Storage Deployment	May 2023
Jorge Salgado-Beceiro and Alexis Sevault	Experimental investigation of phase change material integrated in a gasketed-plate heat exchanger	Eurotherm Seminar #116 - Innovative Solutions For Thermal Energy Storage Deployment	May 2023
Edurne Erkizia, Christina Strunz, Jean-Luc Dauvergne, Guido Goracci, Ignacio Peralta, Ángel Serrano, Amaya Ortega, Beatriz Alonso, Francesca Zanoni, Michael Düngfelder, Jorge S. Dolado, Juan Jose Gaitero, Christoph Mankel & Eduardus Koenders	Cement Based Materials with PCM and Reduced Graphene Oxide for Thermal Insulation for Buildings	SynerCrete 2023	https://doi.org/10.1007/978-3-031-33211-1_113
Ángel Serrano, Sergio Santos, Jean-Luc Dauvergne, Juan Miguel López del Amo, Mikel Durán, Maria Taeño, Stefania Doppiu, Elena Palomo Del Barrio	Effect of processing on thermal properties of pentaglycerine-based solid-solid phase change materials	Materials Today Energy	https://doi.org/10.1016/j.mtener.2023.101472
Taeño, M.; Adnan, A.; Luengo, C.; Serrano, Á.;	Improved Thermophysical and Mechanical Properties	Nanomaterials	https://doi.org/10.3390/nano14010078

Dauvergne, J.-L.; Crocomo, P.; Huerta, A.; Doppiu, S.; Palomo del Barrio, E.	in LiNaSO4 Composites for Thermal Energy Storage		
Jorge L. Lopez-Morales, Jonatan Perez-Arce, Angel Serrano, Jean-Luc Dauvergne, Nerea Casado, Aginmariya Kottarathil, Elena Palomo Del Barrio, Eduardo J. Garcia-Suarez	Protic dialkylammonium-based ionic liquids as promising solid-solid phase change materials for thermal energy storage: Synthesis and thermo-physical characterization	Journal of Energy Storage	https://doi.org/10.1016/j.est.2023.108379
Artem Nikulin, Yaroslav Grosu, Jean-Luc Dauvergne, Asier Ortuondo, Elena Palomo del Barrio	Physical dealloying for two-phase heat transfer applications: Pool boiling case	International Communications in Heat and Mass Transfer	https://doi.org/10.1016/j.icheatmasstransfer.2023.106913
Duran, M., Nikulin, A., Serrano, A., Dauvergne, J. L., Grosu, Y., Labidi, J., & Del Barrio, E. P.	Jet-Injection In Situ Production of PVDF/PCM Composite Fibers for Thermal Management	ACS omega	https://doi.org/10.1021/acsomega.3c02318
König-Haagen, A.*, Höhlein, S., Lazaro, A., Delgado, M., Diarce, G., Groulx, D., Herbinger, F., Patil, A., Englmair, Wang, G., Abdi, A., Chiu, J.N.W., Xu, T., Rathgeber, C., Pöllinger, S., Gschwander, S., Gamisch, S.	Analysis of the discharging process of latent heat thermal energy storage units by means of normalized power parameters	Journal of energy storage	Journal Of Energy Storage, 2023, V. 72, 108428.
Azad, M., Groulx, D*, Donaldson, A.	Solidification of phase change materials in horizontal annuli	Journal of Energy Storage	Journal Of Energy Storage, 2023, V. 57, 106308
D'oliveira, E.J.*, Costa, T., Zabiegaj, D., Azimov, U., Groulx, D., Costa Pereira, S.C.	Experimental investigation on the thermal performance of low temperature om55/gnps/span80 nanocomposites	Heat Powered Cycles Conference 2023	Heat Powered Cycles Conference 2023, Edinburgh, UK, 2023, 15 pg.
Callaghan, R.L., D'oliveira, E.J., Groulx, D.*, Costa Pereira, S.C.	Characterization of a small-scale pcm-heat exchanger: impact of pcm selection	17th International Heat Transfer Conference	17th International Heat Transfer Conference, Cape Town, South Africa, 10 pg.
Callaghan, R.L.*, Groulx, D.	Experimental characterization of a pcm-heat exchanger: impact of pcm properties on comparison metrics	Experimental characterization of a pcm-heat exchanger: impact of pcm properties on comparison metrics	Eurotherm Seminar: Innovative Solutions For Thermal Energy Storage Deployment, Lleida (Spain), 2023 4 pg.
Thonon M., Fraisse G., Zalewski L., Pailha M.	Simultaneous charging and discharging processes in latent heat thermal energy storage: A review.	Thermal Science and Engineering Progress	47 (2024) 102299. Accepted 20/11/2023, https://doi.org/10.1016/j.tsep.2023.102299

Wenye Lin, Stefan Gschwander, Wenji Song, Ziping Feng, Mohammed M. Farid	Preparation, characterisation and property modification of a calcium chloride hexahydrate phase change material slurry with additives for thermal energy transportation	International Journal of Refrigeration	International Journal of Refrigerantion, vol.160, pp. 312-328. DOI: https://doi.org/10.1016/j.ijrefrig.2024.02.010
E. Legotin, G. Issayan, B. Zettl, M. Brandstetter, C. Rankl, F. Winter	Near-infrared sensor for in-line state-of-charge determination of zeolite-based heat storages	NIR 2023, Innsbruck, Austria, 21st International Conference on Near Infrared Spectroscopy	https://doi.org/10.1177/09603602311652217
Kieskamp, B., Mahmoudi, A., Shahi, M	Reaction kinetics of the hydration of potassium carbonate including the influence of metastability	Eurotherm Seminar #116	https://doi.org/10.21001/eurotherm.seminar.116. 2023
Kieskamp, B., Mahmoudi, A., Shahi, M	A novel multi-reactor system for thermochemical heat storage through detailed modeling of K2CO3 particles	Journal of Energy Storage	https://doi.org/10.1016/j.est.2023.110028
Aastha, A., Mahmoudi, A., Shahi, M	Volume variation in a thermochemical material-An experimental study	Eurotherm Seminar #116	https://doi.org/10.21001/eurotherm.seminar.116. 2023
Aastha, A., Mahmoudi, Donkers, P. A. J., Brem, G.A., Shahi, M	Microstructural changes in thermochemical heat storage material over cycles: Insights from micro-X-ray computed tomography	Renewable Energy	https://doi.org/10.1016/j.renene.2024.120045
Aastha, A., Mahmoudi, A., Jorge Martinez-Garcia & Philipp Schuetz, Shahi, M	Characterizing Changes in Salt Hydrates using Micro X-Ray Computed Tomography for Improved Cyclability in Thermochemical Materials	ICT'24 conference	https://www.fh-ooe.at/ict2024/abstractbooklet/
Werner, Jakob Smith, Jakob Stöger, Berthold Artner, Werner Werner, Andreas Weinberger, Peter	Characterization of Ca-Dicarboxylate Salt Hydrates as Thermochemical Energy Storage Materials	Journal Article	Werner, J., et al. Crystals, 2023. **13**, DOI: 10.3390/cryst13101518.
Smith, Jakob Werner, Andreas Weinberger, Peter	Dehydration performance of a novel solid solution library of mixed Tutton salts as thermochemical heat storage materials	Journal Article	Journal of Energy Storage. 2024. 78, DOI: 10.1016/j.est.2023.110003
Sebastian Gamisch, Moritz Kick, Franziska Klünder,	Thermal Storage: From Low-to-High-Temperature	Journal Energy Technology	Energy Technology 2023, 2300544,

Julius Weiss, Eric Laurenz, Thomas Haussmann	Systems		https://doi.org/10.1002/ente.202300544
Kieskamp, B., Mahmoudi, A., Shahi, M	Reaction kinetics of the hydration of potassium carbonate including the influence of metastability	Eurotherm Seminar #116	https://doi.org/10.21001/eurotherm.seminar.116.2023
Kieskamp, B., Mahmoudi, A., Shahi, M	A novel multi-reactor system for thermochemical heat storage through detailed modeling of K2CO3 particles	Journal of Energy Storage	https://doi.org/10.1016/j.est.2023.110028
Aastha, A., Mahmoudi, A., Shahi, M	Volume variation in a thermochemical material-An experimental study	Eurotherm Seminar #116	https://doi.org/10.21001/eurotherm.seminar.116
Aastha, A., Mahmoudi, Donkers, P. A. J., Brem, G.A., Shahi, M	Microstructural changes in thermochemical heat storage material over cycles: Insights from micro-X-ray computed tomography	Renewable Energy	https://doi.org/10.1016/j.renene.2024.120045
Aastha, A., Mahmoudi, A., Jorge Martinez-Garcia & Philipp Schuetz, Shahi, M	Characterizing Changes in Salt Hydrates using Micro X-Ray Computed Tomography for Improved Cyclability in Thermochemical Materials	ICT'24 conference	https://www.fh-ooe.at/ict2024/abstractbooklet/
Werner, Jakob Smith, Jakob Stöger, Berthold Artner, Werner Werner, Andreas Weinberger, Peter	Characterization of Ca-Dicarboxylate Salt Hydrates as Thermochemical Energy Storage Materials	Journal Article	Werner, J., et al. Crystals, 2023. **13**, DOI: 10.3390/cryst13101518
Smith, Jakob Werner, Andreas Weinberger, Peter	Dehydration performance of a novel solid solution library of mixed Tutton salts as thermochemical heat storage materials	Journal Article	Smith, J., et al. Journal of Energy Storage. 2024. 78, DOI: 10.1016/j.est.2023.110003
Sebastian Gamisch, Moritz Kick, Franziska Klünder, Julius Weiss, Eric Laurenz, Thomas Haussmann	Thermal Storage: From Low-to-High-Temperature Systems	Journal Energy Technology	Energy Technology 2023, 2300544, https://doi.org/10.1002/ente.202300544
Andreas König-Haagen, Stephan Höhlein. Ana Lazaro, Monica Delgado, Gonzalo Diarce, Dominic Groulx, Florent Herbinger , Ajinkya Patil, Gerald Englmair, Gang Wang, Amir Abdi, Justin N.W.	Analysis of the discharging process of latent heat thermal energy storage units by means of normalized power parameters	Journal of Energy Storage	Journal of Energy Storage 72 (2023) 108428, DOI: https://doi.org/10.1016/j.est.2023.108428

Chiu, Tianhao Xu, Christoph Rathgeber, Simon Pöllinger, Stefan Gschwander, Sebastian Gamisch			
Čebulj, Daša, Mal, Suzana, Ristić, Alenka, Zabukovec Logar, Nataša	Synthesis of Al-doped hierarchical silicate for sorption thermal battery	29th Annual Meeting of the Slovenian Chemical Society, 13.-15. september 2023, Portorož, Portorose, Slovenija	
Smith, Jakob, Werner, Jakob, Kapsamer, Frieda Maria, Ristić, Alenka, Werner, Andreas, Weinberger, Peter	Exploring the synergies of gamma alumina and sulfate salt hydrates in thermochemical energy storage.	29th Annual Meeting of the Slovenian Chemical Society, 13.-15. september 2023, Portorož, Portorose, Slovenija	.
Marčec, Jan, Djinović, Petar, Zabukovec Logar, Nataša, Ristić, Alenka	Transition metal modified microporous materials for thermal battery	FEZA 2023: 9th Conference of the Federation of the European Zeolite Associations, Portorž-Portorose Slovenija, 2-6 July 2023	https://feza2023.org/en/
Marčec, Jan, Zabukovec Logar, Nataša, Ristić, Alenka	Towards green synthesis of ZIF-90 for thermal battery application	5th European Conference on Metal Organic Frameworks and Porous Polymers), Granada, Spain 24-27 September 2023	https://www.euromof2023.com/images/site/Abstract_EUROMOF2023.pdf
Byrne, Ciara Susan, Vodlan, Katja, Golobič, Amalija, Zabukovec Logar, Nataša	Noval synthesis methods of ZIF-71 and ZIF-93 for sorption based applications	34. Deutsche Zeolith-Tagung : 21-23 February 2023, Universität Wien, Österreich	
Byrne, Ciara Susan, Vodlan, Katja, Lacomi, Paul, Golobič, Amalija, Zabukovec Logar, Nataša	Green synthesis methods of ZIF-71 and ZIF-93 for thermal battery applications	5th European Conference on Metal Organic Frameworks and Porous Polymers (EuroMOF2023): Granada, 24-27 September 2023	
Vodlan, Katja, Byrne, Ciara Susan, Golobič, Amalija, Zabukovec Logar, Nataša	Green synthesis of ZIF-71 and ZIF-93 with preliminary evaluation for heat storage applications	29th Annual Meeting of the Slovenian Chemical Society, 13.-15. september 2023, Portorož, Portorose, Slovenija	
Mlakar, Urška, Ristić, Alenka, Stritih, Uroš.	Experimental system for testing adsorption heat storage materials	Eurotherm Seminar #116 : Innovative solutions for thermal energy storage deployment : 24-26 May 2023, Lleida, Spain	https://repositori.udl.cat/items/29285fea-468a-4225-abe3-97d7010136a7
Miguel Navarro, Gonzalo Diarce, Ana Lázaro, Ander Rojo, Mónica Delgado	Comparative study on bubbling and shearing techniques for the crystallization of xylitol in TES systems	Results in Engineering	Results in Engineering 17 (2023) 100909, DOI: https://doi.org/10.1016/j.rineng.2023.100909

Andreas König-Haagen et al.	Analysis of the discharging process of latent heat thermal energy storage units by means of normalized power parameters	Journal of Energy Storage	Journal of Energy Storage 72, Part C (2023) 108428, DOI: https://doi.org/10.1016/j.est.2023.108428
Andreas König-Haagen, Gonzalo Diarce ENEDI Research Group, Department of Energy Engineering, Faculty of Engineering of Bilbao, University of the Basque Country UPV/EHU, Bilbao, Spain	Prediction of the discharging time of a latent heat thermal energy storage system with a UA approach	Journal of Energy Storage	Journal of Energy Storage 73 (2023): 108849
Pablo Moreno; Gonzalo Diarce; Olatz Irulegi; Alba Arias; Iñaki Gomez-Arriaran.	Study of an underground cistern as a thermal storage with HVACR system via heat pump assisted by PV: the case of the IWER building in Pamplona.	EESAP 14 - 14th International Conference on Energy Efficiency and Sustainability in Architecture and Urbanism	
Pablo Moreno; Gonzalo Diarce; Olatz Irulegi; Alba Arias.	Analysis of an existing cistern as thermal storage at the rehabilitation of the IWER building in Pamplona and assessment of the solar assisted HVACR production control	CNIT 13 - 13th National and 4th International Conference in Engineering Thermodynamics	
Lourdes Bouzas; Ana Garcia-Romero; Pello Larrinaga; Gonzalo Diarce.	Experimental Assessment of a Plate-Based LHTES: Comparison Between Compressed Expanded Graphite Plates Infiltrated with a PCM, and Bulk PCM Plates Macroencapsulated n Aluminum	CNIT 13 - 13th National and 4th International Conference in Engineering Thermodynamics	
Eukene Garcia; Gonzalo Diarce.	On the use of TGA for the study of degradation of thermal energy storage materials:analysis of the influence of evaporation	CNIT 13 - 13th National and 4th International Conference in Engineering Thermodynamics	
Eukene Garcia; Gonzalo Diarce.	On the use of TGA for the study of degradation of thermal energy storage materials: analysis of the influence of evaporation and mass sample	Medicta 2023, Oporto	
A. Crespo, A. Frazzica, C. Fernández, A. de Gracia	Optimizing the discharge process of a seasonal sorption storage system by means of design and control approach	Journal Publication	Journal of Energy Storage, Volume 60, April 2023, 106652, DOI: 10.1016/j.est.2023.106652

G. Airò Farulla, V. Palomba, D. Aloisio, G. Brunaccini, M. Ferraro, A. Frazzica, F. Sergi	Optimal design of lithium-ion battery thermal management systems based on phase change material at high current and high environmental temperature	Journal Publication	Thermal Science and Engineering Progress, Volume 42, 1 July 2023, 101862. DOI: 10.1016/j.tsep.2023.101862
G. Airò Farulla, V. Brancato, V. Palomba, Y. Zhang, G.E. Dino, A. Frazzica	Experiments and Modeling of Solid–Solid Phase Change Material-Loaded Plaster to Enhance Building Energy Efficiency	Journal Publication	Energies, Volume 16, March 2023 2384. DOI: 10.3390/en16052384
A. Frazzica, V. Palomba, A. Freni	Development and Experimental Characterization of an Innovative Tank-in-Tank Hybrid Sensible–Latent Thermal Energy Storage System	Journal Publication	Energies, Volume 16, February 2023 1875, DOI: 10.3390/en16041875
Talebi, Elija; Morgenstern, Leander; Würth, Manuel; Kerscher, Florian; Spliethoff, Hartmut	Effect of particle size distribution on heat transfer in bubbling fluidized beds applied in thermochemical energy storage	Journal Publication	Fuel 344, 2023
Morgenstern, L.; Talebi, E.; Kerscher, F.; Spliethoff, H.	Experimental investigation of CaO/Ca(OH)2 for thermochemical energy storage – commissioning of a 0.5 kWh experimental setup	Journal Publication	Fuel 345, 2023
Morgenstern, L.; Ohmstedt, S.; Kerscher, F.; Spliethoff, H.	Particle Properties of CaO/Ca(OH)2 Throughout Cyclisation in a Fluidized Bed for Thermochemical Energy Storage – Consequences for Fluidization	Conference Proceedings	Heat Powered Cycles Conference 2023, 2023, pg. 520 - 528
Benjamin Fumeya, Robert Weber, Luca Baldini	Heat transfer constraints and performance mapping of a closed liquid sorption heat storage process	Publication	Applied Energy 335 (2023) 120755
Zhu, Y., Englmair, G., Huang, H., Dragsted, J., Yuan, Y., Fan, J., & Furbo, S.	Numerical investigations of a latent thermal energy storage for data center cooling.	Applied Thermal Engineering	Applied Thermal Engineering, 236 Part B, Article 121598. https://doi.org/10.1016/j.applthermaleng.2023.121598
Filonenko, K., Dominkovic, D. F., Jensen, A. U., & Englmair, G.	Investigation of cold storage integration in a Danish data center.	Building Simulation Conference Proceedings	In Building Simulation Conference Proceedings (Vol. 18, pp. 2875 - 2878). International Building Performance Simulation

			Association, DOI: https://doi.org/10.26868/25222708.2023.1560
König-Haagen, A., Höhlein, S., Lázaro, A., Delgado, M., Diarce, G., Groulx, D., Herbinger, F., Patil, A., Englmair, G., Wang, G., Abdi, A., Chiu, J. N. W., Xu, T., Rathgeber, C., Pöllinger, S., Gschwander, S., & Gamisch, S.	Analysis of the discharging process of latent heat thermal energy storage units by means of normalized power parameters.	Journal of Energy Storage	Journal of Energy Storage, 72, Article 108428, DOI: https://doi.org/10.1016/j.est.2023.108428
Dannemand, M., Englmair, G., Kong, W., & Furbo, S.	Experimental investigations of multiple heat storage units utilizing supercooling of sodium acetate trihydrate: Stability in application size units.	Journal of Energy Storage	Journal of Energy Storage, 86, Article 111194, DOI: https://doi.org/10.1016/j.est.2024.111194
Simonsen, Galina; Ravotti, Rebecca; O'Neill, Poppy; Stamatiou, Anastasia	Biobased phase change materials in energy storage and thermal management technologies.	Renewable and sustainable energy reviews, 184, 2023, 113546	
Martinez Garcia, Jorge; Gwerder, Damian; Guarda, Dario; Fenk, Benjamin; Stamatiou, Anastasia; Worlitschek, Jörg; Schütz, Philipp	Study of the solidification behaviour of calcium chloride hexahydrate by in-situ X-ray computed tomography.	Research and Review Journal of Nondestructive testing, 1(1), 2023, 1-6	
Martinez Garcia, Jorge; Gwerder, Damian; Wahli, Fabian; Guarda, Dario; Fenk, Benjamin; Stamatiou, Anastasia; Worlitschek, Jörg; Schütz, Philipp	Volumetric quantification of melting and solidification of phase change materials by in-situ X-ray computed tomography.	Journal of energy storage, 61, 2023, 106726	
Anastasia Stamatiou, Jorge Martinez-Garcia, Rebecca Ravotti, Poppy O'Neill, Benjamin Fenk, Dario Guarda, Simone Mancin, Damian Gwerder, Ludger J. Fischer, Jörg Worlitschek, Philipp Schuetz	Using in-situ X-ray computed tomography to study the crystallization of salt hydrates.	Proceedings of the Eurotherm Seminar "Innovative solutions for thermal energy storage deployment" 2023	

Conferences, Workshops, Seminars

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# Attendees
Thermal Energy Storage Workshop 2023	Organized by Jorge Salgado-Beceiro and Ragnhild Sæterli (SINTEF Energy Research)	November 30 – December 1, 2023 Trondheim, Norway	100+

Eurotherm Seminar #116	Development of protective coatings for lithium/sodium sulfate salts intended for high-temperature thermal energy storage, Ángel Serrano (CIC energiGUNE)	May 2023 Lleida, Spain	
13CNIT	Oral presentation: Bayón R, Rabasco P. Study of different fatty acids as PCM for latent storage: dependence of thermal degradation with molecular structure	November 29 – December 1, 2023 Castellón de la Plana, Spain	
Eurotherm Seminar #116	Oral presentation Mina Shahi	May 2023 Lleida	~30
Exner Lectures 2023	Presentation. “Crystals and gases unite to save energy” Smith, Jakob	May 2023 Vienna, Austria	~100
Exner Lectures 2023	Poster presentation. “From waste to resource: investigating calcium dicarboxylate hydrates as thermochemical energy torage materials for waste heat storage” Werner, Jakob	Exner Lectures 2023	~100
36th Workshop on Novel Materials and Superconductors	Poster: Novel Materials and Superconductors Smith, Jakob	February 2023 Schladming, Austria	~50
36th Workshop on Novel Materials and Superconductors	Poster: “Synthesis and characterization of novel calcium salt dicarboxylate hydrates as thermochemical energy storage materials” Werner, Jakob	February 2023 Schladming, Austria	~50
6th EuChemS Inorganic Chemistry Conference	Poster: Exploring the Synergies of Gamma Alumina and Tutton Salt Hydrates in Thermochemical Energy Storage	September 2023 Vienna, Austria	~500
6th EuChemS Inorganic Chemistry Conference	Poster: “Solving energy challenges through chemical bonds: calcium dicarboxylate hydrates as thermochemical energy storage materials” Werner, Jakob	September 3 – 7, 2023 Vienna, Austria	~500
Zbornik povzetkov Slovenski kemijski dnevi 2023	Exploring the synergies of gamma alumina and sulfate salt hydrates in thermochemical energy storage	September 2023 Portorož, Slovenia	~200
International Renewable Energy Storage Conference IRES 2023	Presentation “Comparison Of Ageing At Elevated Temperature And Cycling Experiments Of HD-PE: A Degradation Study”, Franziska Klünder	Aachen, Germany	

Lecture at a foreign university EIRES Lunch lecture at Eindhoven Institute for Renewable Energy Systems	Invited lecture: Recent advances in materials for sorption-based thermal batteries Dr. Alenka Ristić and prof. dr. Nataša Z. Logar	May 2023 EIRES, The Netherlands	50
6th EuChemS Inorganic Chemistry Conference	Invited keynote lecture: Development of advanced materials for adsorption thermal battery, Dr. Alenka Ristić	September 2023 Vienna, Austria	400
ECOS, The 36th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems	Oral Presentation. Design and evaluation of a stirred tank for its use as a thermal energy storage system using xylitol. Miguel Navarro	June 202 Gran Canaria, Spain	
International Conference on Polygeneration- ICP 2023	Oral Presentation. Use of a low-cost phase change material emulsion in de-centralized thermal energy storage for district heating network enlargement, José María Marín	July 2023 Kuta, Indonesia	
International Conference on Polygeneration- ICP 2023	Oral Presentation: Study on crystallization of sugar-alcohols. Comparison between xylitol, erythritol and its mixtures. Miguel Navarro	July 2023 Kuta, Indonesia	
XIII National and y IV International Conference on Engineering Thermodynamics (13Cnit)	Poster: Experimental setup to test heat exchanger using PCM slurries as heat transfer fluids. Ana Lázaro	November 2023 Castellón, Spain	
XIII National and y IV International Conference on Engineering Thermodynamics (13Cnit)	Oral Presentation: Validation of a CFD model for the simulation of a stirred tank containing a PCM emulsion. Ana Lázaro	November 2023 Castellón, Spain	
XIII National and y IV International Conference on Engineering Thermodynamics (13Cnit)	Oral Presentation: Nucleation modelling of xylitol in a stirred tank. Miguel Navarro	November 2023 Castellón, Spain	
IEA SHC Task 67 - 5th Task Meeting	T67T40 Viscosity RRT progress. Miguel Navarro	September 2023 Lyon, France	
IEA SHC Task 67 - 4th Task Meeting	T67T40 Viscosity RRT progress. Mónica Delgado	April 2023 Halifax, Canada	
IEA SHC Webinar	Task67/Task40 Compact thermal energy storage materials within components within systems. Wim van Helden	21 November 2023 Online	
Heat Powered Cycles Conference 2023	Presentation: Leander Morgenstern	September 2023	~ 120

Fluidization XVII 2023	Presentation: Leander Morgenstern	May 2023	~ 100
Fluidization XVII 2023	Presentation: Elija Talebi	May 2023	~ 100
Eurotherm Seminar #116 Advances in Thermal Energy Storage	Presentation: Daniel Lager, Evaluation of thermochemical materials for thermal energy storage applications using TGA-DSC and existing material databases	May 2023 Lleida, Spain	>100
Sorption Friends 3	Presentation: Benjamin Fumey. Mission Innovation Heating and Cooling – Sorption Heat Pump Systems	May 2023 Taormina, Italy	50
PhD "Winter School of ScAIEM" on "Sustainable Energy Transition – Technology and Management Perspecitves"	Guest Lecture: G. Englmair on "Thermal Energy Storage"	March 2023 Stockholm, Sweden	30
IEA Energy Storage Task 41 – 2nd expert meeting on "Economics of Energy Storage"	Presentation: G. Englmair, PCM cold storage for flexible server room cooling – Cool-Data project	May 2023 Linz, Austria	25
Presentation to the Thermal Storage group at DaCES – Danish Center for Energy Storage.	Presentation: G. Englmair, Compact Thermal Energy Storage	Online Denmark	20
SHC Solar Academy Webinar on IEA SHC Task 67 "Compact Thermal Energy Storage"	Presentation: G. Englmair, State of Charge Determination Utilizing Material Response in Compact Thermal Energy Storage	Online hosted by IEA SHC TCP	~120
Conference on "Advanced Energy Storage"	Presentation: G. Englmair, Compact Thermal Energy Storage – Status, perspectives and research example (Cool-Data)	November 2023 Aarhus, Denmark	75
11th Swiss Thermal Energy Storage Symposium	Presentation: G. Englmair, Cool-Data: PCM Cold Storage for Server Room Cooling; Participation in penal debate	January 2024 Lucerene, Switzerland	100
Slovenian Chemistry days	Oral Presentation: The polymorphism of phase-change materials: new discoveries and approaches, Rebecca Ravotti	September 2023 Portoroz, Slovenia	1
European Conference on Non-Destructive Testing (ECNDT)	Oral Presentation: Study of the solidification behaviour of phase change materials by in-situ X-ray computed tomography, Jorge Martinez Garcia	July 2023 Lisbon, Portugal	1
Eurotherm Seminar 2023	Oral Presentation: Using in-situ X-ray computed tomography to	May 2023	2

	study the crystallization of salt hydrates, Anastasia Stamatiou	Lleida, Spain	

Task Meetings

Meeting	Date	Location	# of Participants (# of Countries)
Task Meeting 1	27-29 Oct 2021	Vitoria Gasteiz, Spain	24 (in person), 35 (virtual) 15 countries
Task Meeting 2	4-5 April 2022	Graz, Austria	38, 13 countries
Task Meeting 3	29-30 Sep 2022	Kassel, Germany	41, 12 countries
Task Meeting 4	April 24-26, 2023	Halifax, Canada	30, 11 countries
Task Meeting 5	September 25-27, 2023	Lyon, France	29 (in person), 6 (virtual), 11 countries
Task Meeting 6	April 22-24, 2024	Lucerne, Switzerland	24 (in person), 8 (virtual), 12 countries

Task 67 Participants

Country	Name	Institution / Company	Role
GERMANY	**Wim van Helden**	**AEE INTEC**	**SHC Co-Task Manager**
GERMANY	**Andreas Hauer**	**ZAE Bayern**	**ES Co-Task Manager**
AUSTRIA	Daniel Lager	AIT Austrian Institute of Technology GmbH	Subtask A Leader
AUSTRIA	Fabrizia	Giordano	National Expert
AUSTRIA	Peter Weinberger	TU Vienna	National Expert
AUSTRIA	Frieda Kapsamer	TU Vienna	National Expert
AUSTRIA	Jakob Smith	TU Vienna	National Expert
AUSTRIA	Jakob Werner	TU Vienna	National Expert
AUSTRIA	Andreas Werner	TU Vienna	National Expert
AUSTRIA	Bernhard Zettl	University of Applied Sciences Upper Austria	National Expert
AUSTRIA	Gayaney Issayan	University of Applied Sciences Upper Austria	National Expert
CANADA	Dylan Bardy	CanmetENERGY	National Expert
CANADA	Lia Kouchachvili	CanmetENERGY	National Expert
CANADA	Reda Djebbar	CanmetENERGY	Subtask C Leader
CANADA	Dominic Groulx	Dalhousie University	National Expert

CANADA	Handan Tezel	University of Ottawa	National Expert
CANADA	Neothermal ES Inc.	Louis Desgroseilliers	National Expert
CHINA	Wenye Lin	Guangzhou Institute of Energy Conversion (GIEC)	National Expert
GERMANY	Maike Johnson	DLR	National Expert
GERMANY	Larissa Dietz	DLR	National Expert
GERMANY	Peter Vetter	DLR	National Expert
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GERMANY	Sebastian Gamisch	Fraunhofer ISE	National Expert
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GERMANY	Konstantina Damianos	Rubitherm Technologies GmbH	National Expert
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GERMANY	Leander Morgenstern	Technische Universität München	National Expert
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DENMARK	Alireza Afshari	Aalborg University	National Expert
DENMARK	Gerald Englmair	DTU	Subtask C Leader
DENMARK	Jianhua Fan	DTU	National Expert
DENMARK	Adriano Sciacovelli	DTU	National Expert
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FRANCE	Lingai Luo	CNRS, University of Nantes	National Expert
FRANCE	Frederic Kuznik	INSA-Lyon	National Expert
FRANCE	Kevyn Johannes	INSA-Lyon	National Expert

FRANCE	Alexandre Malley-Ernewein	INSA-Lyon	National Expert
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FRANCE	Jonathan Outin	LOCIE Laboratory	National Expert
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ITALY	Elpida Piperopoulos	University of Messina, Department of Engineering	National Expert
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NETHERLANDS	Ruud Cuypers	TNO	National Expert
NETHERLANDS	Jochem Jongerius	TNO	National Expert
NETHERLANDS	Mina Shahi	University Twente	National Expert
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NORWAY	Fride Vullum-Bruer	Sintef	National Expert
NORWAY	Galina Simonsen	Sintef	National Expert
NORWAY	Asmira Delic	Sintef	National Expert
NORWAY	Margaux Gouis	Sintef	National Expert

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PORTUGAL	José Costa	University of Coimbra	National Expert
PORTUGAL	Marco Fernandes	University of Coimbra	National Expert
PORTUGAL	Adélio Gaspar	University of Coimbra	National Expert
SLOVENIA	Alenka Ristic	NIC	National Expert
SLOVENIA	Urska Mlakar	University of Ljubljana	National Expert
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SPAIN	Eduardo Garcia-Suarez	CIC EnergiGune	National Expert
SPAIN	Elena Palomo del Barrio	CIC EnergiGune	National Expert
SPAIN	Jean-Luc Dauvergne	CIC EnergiGune	National Expert
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SPAIN	Maria Taeno	CIC EnergiGune	Subtask B Leader
SPAIN	Oscar Seco Calvo	CIEMAT	National Expert
SPAIN	Rocio Bayón	CIEMAT	National Expert
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SPAIN	Monica Delgado	Universidad Zaragoza	Subtask E Leader
SPAIN	Miguel Navarro	Universidad Zaragoza	Subtask E Leader
SPAIN	David Verez	Universitat de Lleida	National Expert
SPAIN	Emiliano Borri	Universitat de Lleida	National Expert
SPAIN	Gabriel Zsembinszki	University of Lleida	National Expert
SPAIN	Luisa Cabeza	Universitat de Lleida	National Expert
SPAIN	Camila Barreneche	University of Barcelona	National Expert
SPAIN	Ines Fernandez	University of Barcelona	National Expert
SPAIN	Rebeca Salgado	University of Barcelona	National Expert
SPAIN	Adela Svobodova	University of Barcelona	National Expert
SPAIN	Andreas König-Haagen	University of the Basque Country	Subtask E Leader
SPAIN	Gonzalo Diarce	University of the Basque Country	National Expert
SPAIN	Ane Garcia	University of the Basque Country	National Expert

SWITZERLAND	Benjamin Fumey	Lucerne University of Applied Sciences and Arts	Subtask E Leader
SWITZERLAND	Anastasia Stamatiou	Lucerne University of Applied Sciences and Arts	National Expert
SWITZERLAND	Rebecca Ravotti	Lucerne University of Applied Sciences and Arts	National Expert
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UNITED KINGDOM	Phil Eames	Loughborough University	National Expert
UNITED KINGDOM	Lukas Bergmann	Sunamp	National Expert
UNITED KINGDOM	Jon Elvins	Swansea University	National Expert
UNITED KINGDOM	Sara Walsh	Swansea University	National Expert
UNITED KINGDOM	Bahaa Abbas	Swansea University	National Expert
UNITED KINGDOM	Sahand Hosouli	Swansea University	National Expert
UNITED KINGDOM	Bob Critoph	University of Warwick	National Expert
UNITED KINGDOM	Sai Yagnamurthy	University of Warwick	National Expert
UNITED STATES	Sumanjeet Kaur	Lawrence Berkeley National Laboratory	National Expert
UNITED STATES	Sven Mumme	DoE – Building Technologies Office	National Expert
UNITED STATES	Kyle Foster	NREL	National Expert
UNITED STATES	Jason Woods	NREL	National Expert

6. Ongoing Tasks

2024 was a busy year for the SHC TCP with the conclusion of 4 Tasks, four ongoing Tasks, two planned Tasks and two more in the development phase. 72 - Solar Photoreactors for Fuels and Chemicals was officially approved at the June ExCo and held its Task kick-off meeting held Dec 2024. Task 73 – PVT for Heating Systems was officially approved at the November ExCo meeting and follow-up Tasks are in the works for Task 67 – Thermal Storage and Task 65 – Solar Cooling in the Sunbelt Region.

Task 68 – Efficient Solar District Heating Systems

Dr. Klaus Lichtenegger
BEST – Bioenergy and Sustainable Technologies GmbH
Task Manager for The Republic of Austria

Task Overview

Solar technologies offer an efficient option for using CO_2-free technologies for local/district heating systems. The SHC TCP work on solar district heating systems is continuing in this new Task. Task 68 provides a platform for research and industry to work together on the opportunities, challenges, and benefits of solar district heating. The Task is organized into four subtasks:

- Subtask A: Concepts for Efficiently Providing Solar Heat at Medium-high Temperature Level *(Lead Country: Germany)*
- Subtask B: Subtask B: Data Preparation & Utilization *(Lead Country: Austria)*
- Subtask C: Business Models (Lead Country: Netherlands)
- Subtask D: Use Cases and Dissemination *(Lead Country: Sweden)*

Scope

Subtask A: Concepts for Efficiently Providing Solar Heat at Medium-high Temperature Level
The main objective of Subtask A is to develop concepts, models, and performance measures to efficiently provide solar heat by SDH systems, with focus on medium-high temperature heat. Specific objectives of Subtask A are:

- Requirements and concepts for planning and designing SDH systems, with a special focus on medium-high temperature heat.
- Configuration/scaling of systems
- Modelling of different technologies on component and system level
- Performance and efficiency definitions
- Testing methods and standardization

Subtask B: Data Preparation & Utilization
The main objective of Subtask B is to increase the efficiency of SDH by taking **the** next step regarding digitalization aspects**,** especially on data preparation and utilization. Specific objectives of Subtask B are**:**

- Automated gathering, storing and distribution of data
- Validation of data
- Analysis/monitoring/detection techniques
- Advanced control strategies for plants/systems
- Open data approaches

Subtask C: Business Models
The main objective of Subtask C is to evaluate and identify new business models as well as find ways to make SDH systems more **business-appealing** (e.g.**,** by reducing costs). Specific objectives of Subtask C are**:**

- Investigate current risks and barriers for the success of SDH systems
- Investigate the requirements and needs of district heating grids to integrate solar heat
- Investigate and propagate financing and investment schemes for SDH systems
- Ways and possibilities of cost reduction for SDH systems regarding CAPEX and OPEX
- Investigate how energy policy can function as an enabling factor for SDH systems aiming at a medium-term subsidy-free situation.

Subtask D: Use Cases and Dissemination
The main objective of Subtask D is to gather data and insights from real installations and to disseminate the knowledge to industry and **the** public. Specific objectives of Subtask D are**:**

- Description of installations
- Summary of demo applications
- Policy-oriented document for the promotion of efficient temperature SDH systems, especially focusing on medium-high temperatures
- Country reports regarding SDH systems to derive a holistic view of the global situation
- Industry workshops

Collaboration with other IEA TCPs

IEA DHC Annex TS5, *Integrating Renewables*. Obviously, since solar thermal is an important renewable heat source for district heating and cooling, this annex is an important collaboration partner. Constructive collaboration has been used by incorporating insights for decentral integration of renewable heat sources in heating grids from DHC TS5 into SHC Task 45 (particularly useful for Deliverable RB3), and by providing know-how on solar thermal integration and use cases from SHC Task 45 to DHC TS5. The main link was the participation of the SHC Task 45 Task Manager as expert in DHC TS5.

IEA Bioenergy Task 44, *Flexible Bioenergy, and System Integration*. Since flexible bioenergy nicely complements solar energy, collaboration with this Task has significant potential. There have been several common activities in 2023 (e.g. a joint workshop). While in 2024, there were no similar events, there is still knowledge exchange via common experts, particularly Dr. Markus Gölles.

IEA Energy Storage Task 45, *Accelerating the uptake of Large Thermal Energy Storages*. Large thermal storage is essential for reaching higher solar fractions; this newly established Task is a natural collaboration partner. Contact was established via a common Task experts and partner organizations, and it was decided to hold a common Task meeting (February 2025, in Stuttgart).

Collaboration with Industry

The cooperation rate with industry is high, about 50% among the Task participants. Currently, it is dominated by manufacturers of collectors and solar-based systems. Efforts are required to better integrate general district heating planners and operators, utilities and companies from the field of digitalization into the Task or its planned follow-up.

Task Duration

This Task started on April 2022 and will end March 2025.

Participating Countries

Austria, *China*, Denmark, Germany, *Italy*, *Israel*, Netherlands, *Finland**, Poland, Spain, Sweden, Switzerland, *Türkiye*, United Kingdom

Work During 2024

Subtask A: Concepts for Efficiently Providing Solar Heat at Medium-high Temperature Level

Based on input from Task experts and on discussions in particular during the 5th Task meeting (April, in Graz), the first deliverable of Subtask A, RA1, *Comparison of Different Collector Technologies* was finalized, published and well-received (see section on publications). Work on the other deliverables has started, including an extensive survey on simulation tools.

Subtask B: Data Preparation and Utilization

The first deliverable of Subtask B, RB1, *Efficient Gathering, Storing, Distributing and Validation of Data*, was published, and the main focus of the Subtask group moved to RB4, concerning the use of Open Data in the solar thermal life cycle. On this topic, workshops were held at the 5th Task meeting (April, in Graz) and at the 6th Task meeting (August, in Limassol), and an electronic survey has been sent to Task experts and other interested professionals. In addition, work has started on the other two deliverables, RB2 (on performance evaluation) lead by AEE INTEC, RB3 (on control strategies) lead by BEST. The planned structure for the technical sections of RB3 is:

3 Component-Level Control
- 3.1 non-concentrating solar collectors
  - 3.1.1 Static control of feed temperature
  - 3.1.2 Dynamic control of feed temperature considering delay times
  - 3.1.3 Operation of heat exchanger
- 3.2 Further collector types
  - 3.2.1 Control of Concentrating collectors
  - 3.2.2 Hybrid collectors (PVT)

3.3 Auxiliary technologies
3.3.1 Absorption heat pump
3.3.2 Compression heat pump
3.3.3 Thermal storage tanks
3.4 Possible additional or different control tasks for special plants
4 Some notes on Mid-Level Control
4.1 Supervisory Control of Solar Thermal Plants
4.2 Interaction with the Control of DHC networks
4.2.1 Adjustment of the feed temperature
4.2.2 Adjustment of the pressure and mass flow conditions
4.2.3 Reduction of the operating temperatures in DH systems
5 System-Level Control
5.1 Basic considerations
5.2 Supervisory control by rules for the choice of the operating mode based on expert knowledge
5.2.1 Strategies only considering the current state of the system
5.2.2 Strategies additionally using forecasts
5.3 Optimization- and AI-based control strategies
5.3.1 Optimization-based predictive supervisory control
5.4 Rule-based control strategies 25
5.4.1 Predictive Solar District Heating
5.4.2 Combination of solar collectors and compression heat pump
5.4.3 Other Rule-based Approaches
5.4.4 Cooperative control of district heating networks
5.4.5 Methods based on Machine Learning
5.5 Further considerations

Subtask C: Business Models

Additional input for report RC1, *Overview of financing and investment schemes and possible new business models,* were gathered, and the report is close to complete. The overall goals of the report are, as outlined in the last annual report:

- Focus mainly on the activities of 2023.
- Meant to give inspiration to policy makers (not an encyclopaedia of policy measures)
- Not quantity but quality: a few nice policy examples
- Input from collector manufacturers and project developers is highly appreciated
- Link to RED III (Renewable Energy Directive)

In addition, work on reports RC2 (*Standards and quality criteria for planners and designers of SDH systems*) and RC3 (Measures and possibilities to reduce the costs of SDH systems) was continued.

Subtask D: Use Cases and Dissemination

Examples for particularly efficient or otherwise noteworthy solar thermal installation have been collected in RD1, which will provide a useful overview of best-practice examples. The report is close to being finished.

General Work

At both Task Meetings 2024, workshops on possible follow-up activities have been held, and a condensed version of how such a Task could be structured was presented to the Executive Committee at its 96th meeting in Berlin.

Work Planned For 2025

Subtask A: Concepts For Efficiently Providing Solar Heat at Medium-high Temperature Level

- Finalize and publish the deliverable RA2
- Finalize and publish the deliverable RA3
- Disseminate the deliverables, making use of suitable channels.
- Evaluate whether the work in the subtask can lead to a scientific paper or a joint project
- Identify technological questions that may be relevant for a follow-up Task

Subtask B: Data Preparation and Utilization

- Finalize and publish the deliverable RB2
- Finalize and publish the deliverable RB3
- Finalize and publish the deliverable RB4
- Continue the work on writing a joint paper addressing the issues of RB4
- Evaluate whether the work in the subtask can lead to another scientific paper or a joint project

Subtask C: Business Models

- Finalize and publish the deliverable RC1
- Finalize and publish the deliverable RC2
- Finalize and publish the deliverable RC3
- Evaluate whether the work in the subtask can lead to a scientific paper or a joint project

Subtask D: Use Cases and Dissemination

- Finalize and publish the deliverable RD1
- Find a way to meet the objectives of deliverable RD2
- Carry out further Industry workshops, if still possible
- Summarize the results of the industry workshops as (brief) deliverable RD3
- Tackle the issues of the dissemination website for the Task results
- Publish news articles and post in social media
- Find a way to bring solar thermal district heating back on track after a period of almost stagnation
- Evaluate whether the work in the subtask can lead to a scientific paper or a joint project

Dissemination Activities in 2024

Reports, Published Books

Report RB1: Lukas Feierl, Sabine Putz, Viktor Unterberger, Mohamad S. Mortada, Yuvaraj Pandian, Adam R. Jensen, Thomas Natiesta, Stefan Mehnert, Daniel Tschopp, Philip Ohnewein: *Efficient Gathering, Storing, Distributing and Validation of Data*, 29.01.2024, 27 pages, DOI: 10.18777/ieashc-task68-2024-0001, available on https://task68.iea-shc.org/Data/Sites/1/publications/IEA-SHC-Task68--Report-RB1.pdf

Report RA1: Silas Tamm, Magdalena Berberich; Stefan Abrecht, Dominik Bestenlehner, Luuk Beurskens, Andreas Bohren, Lukas Feierl, Dirk Krüger, Klaus Lichtenegger, Alex Mellor, Yuvaraj Pandian, Dimitris Papageorgiou, Pedro Rubio, Sebastian Schramm, Luis M. Serra, Marcel Wagner, Johannes Werner, Michael Zellinger: *Solar Collector Technologies for District Heating*, 25.11.2024, (version 1.1), DOI: 10.18777/ieashc-task68-2024-0002, available on https://task68.iea-shc.org/Data/Sites/1/publications/IEA-SHC-Task68--Report-RA1.pdf. Impressions of the report are shown in Figure 8.

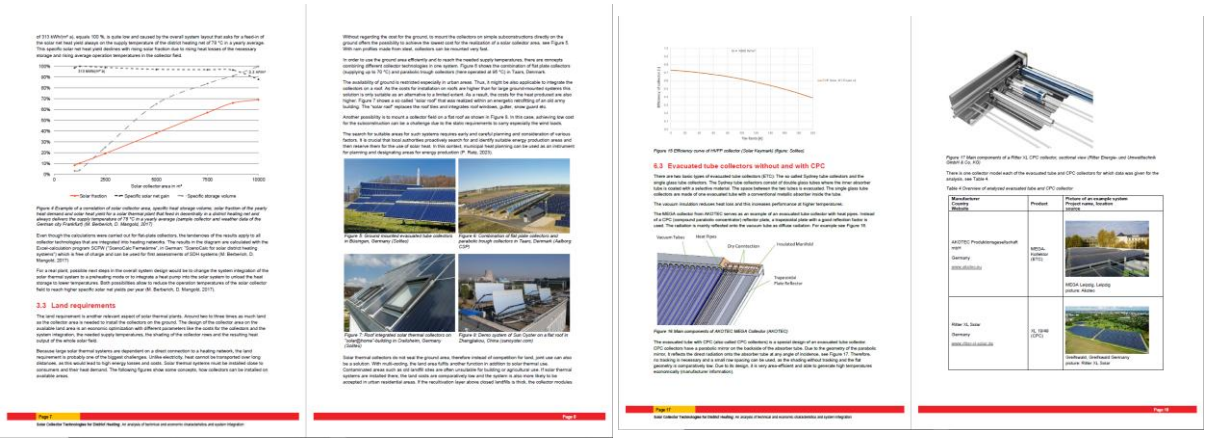

Figure 8: Subtask A – some impressions from first report RA1

Journal Articles, Conference Papers, etc.

Author(s)	Title	Publication / Conference	Bibliographic Reference
Viktor Unterberger, Klaus Lichtenegger, Markus Gölles	Predictive Rule-Based Control Strategy for Optimizing the Operation of Solar District Heating Plants	EuroSun 2024	To be published in the conference proceedings
A. Dahash, F. Giordano and A. Serageldin	Enhancing efficiency and feasibility of large-scale thermal energy storage in district heating	Proceedings of BauSim Conference 2024: 10th Conference of IBPSA-Germany and Austria, Vienna, Austria, 23-26 September 2024	
Daniel Tschopp, Philip Ohnewein, Marnoch Hamilton-Jones, Peter Zauner, Lukas Feierl, Maria Moser, Michael Zellinger, Christian Kloibhofer, Martin Koren, Stefan Mehnert, Alexis Duret, Xavier Jobard, Stefano Pauletta, Federico Giovannetti, Bert Schiebler	SunPeek Open-Source Software for ISO 24194 Performance Assessment and Monitoring of Large-Scale Solar Thermal Plants	ISEC 2024	https://doi.org/10.52825/isec.v1i.1248
Daniel Tschopp, Philip Ohnewein, Lukas Feierl, Marnoch Hamilton-Jones	Digital Tools for Solar Thermal Plant Monitoring. A Handbook for Plant Operators and Associated Stakeholders	DIH (Digital Innovation Hub) Süd report.	https://doi.org/10.5281/ZENODO.12523699

Conferences, Workshops, Seminars

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees

Applied CPS workshop	Philip Ohnewein, Daniel Tschopp, Marnoch Hamilton-Jones, Lukas Feierl, Maria Moser, Christoph Rohringer, Michael Zellinger: Digitalization of solar-thermal plants and monitoring https://www.applied-cps.at/event_kalender/sunpeek-open-source-software-for-monitoring-of-large-scale-solar-thermal-plants/	28.02.2024	13
IEA SHC Solar Academy	Magdalena Berberich: Current market status of Solar District Heating systems in Germany and Government support measures; https://youtu.be/2qS8C6ZfJIU, https://solarthermalworld.org/news/district-heating-has-never-had-such-a-high-significance-in-germany/	14.03.2024, online,	141
ISEC 2024	Presentation of Task structure and objectives with a poster; several presentations and posters by several Task Members, including Lukas Feierl, Klaus Lichtenegger and Philip Ohnewein.	April 11-13, 2024, Graz, Austria	~ 400
BSW — Bundesverband Solarwirtschaft e. V. (German Solar Association) internal working group	Magdalena Berberich: Solare Wärmenetze, Technologieübersicht und Wärmespeicher	30.04.2024, online	30
Solar Thermal Workshop by TRI4 Heating & Cooling Office, Clean Energy Transition Partnership (CETP)	Talk of Klaus Lichtenegger on Task 68 in general and Magdalena Berberich on German solar district heating systems, https://cetpartnership.eu/index.php/accelerating-clean-energy-shift-solar-thermal-workshop-cetpartnership-tri4-heating-cooling	May 8, 2024, online (Webinar),	116
BSW Heat is Half, InterSolar	Magdalena Berberich: Current Market Status of Solar District Heating	19.06.2024, Munich	40
Digital Tools for Solar Thermal Plant Monitoring	Online Workshop by Philip Ohnewein and the SunPeek team	25 June 2024	
ConnectHeat Project-Webinar 3	Solites: Solare Wärmenetze und Wärmespeicher	11.07.2024, online	50
EuroSun 2024	Presentation of Task structure and objectives with a poster; several presentations and posters by Task Members, including Klaus Lichtenegger, Magdalena Berberich, Bärbel Epp, Alice Tosatto, Fabian Ochs, Jianhua Fan, Lukas Feierl, Paul Volk, Silas Tamm and Stefano Pauletta. In addition, Task members have also been active as moderators and in panel discussions	August 27-29, 2024; Limassol, Cyprus	~ 100
IEA SHC National Day	Magdalena Berberich: Market development of Solar District Heating in Germany	5.11. 2024, Berlin	110
IEA SHC Solar Academy	Talks of Philip Ohnewein, Klaus Lichtenegger and Lukas Emberger on key results of the Task (moderated by ISES and Bärbel Epp), https://www.iea-shc.org/solar-academy/webinar/Solar-Thermal-District-Heating	November 19 and 21; online (Webinar)	> 100

Dissemination Activities Planned For 2025

- Joint Task Meeting with Energy Storage Task 45
- Draft of scientific paper on Open Data (in conjunction or as implementation of DEL RB4)
- Dissemination activities in social media for further deliverables

Task Meetings in 2024 and planned for 2025

Meeting	Date	Location	# of Participants (# of Countries)
Task Meeting 5	April 9-10, 2024	Graz, Austria, *in conjunction with ISEC 2024*	19 physical, 17 virtual; 14 countries/sponsors
Task Meeting 6	August 26-27, 2024	Limassol, Cyprus, *in conjunction with the EuroSun 2024*	11 physical, 17 virtual 9 countries
Task Meeting 7	February 24-25, 2025	Stuttgart, Germany, combined meeting with ES Task 45	29 physical and 7 virtual registrations, 9 countries

Task 68 Participants

Country	Name	Institution / Company	Role
AUSTRIA	Klaus Lichtenegger	BEST – Bioenergy and Sustainable Technologies GmbH	Task Manager
AUSTRIA	Markus Gölles	BEST – Bioenergy and Sustainable Technologies GmbH	National Expert
AUSTRIA	Sandra Staudt	BEST – Bioenergy and Sustainable Technologies GmbH	National Expert
AUSTRIA	Daniel Muschick	BEST – Bioenergy and Sustainable Technologies GmbH	National Expert
AUSTRIA	Christoph Rohringer	AEE INTEC - Institut für Nachhaltige Technologien	National Expert
AUSTRIA	Daniel Tschopp	AEE INTEC - Institut für Nachhaltige Technologien	National Expert
AUSTRIA	Philip Ohnewein	AEE INTEC - Institut für Nachhaltige Technologien	National Expert
AUSTRIA	Ralf-Roman Schmidt	AIT – Austrian Institute of Technology GmbH	National Expert
AUSTRIA	Thomas Natiesta	AIT – Austrian Institute of Technology GmbH	National Expert
AUSTRIA	Maria Moser	SOLID Solar Energy Systems GmbH	Subtask B Leader
AUSTRIA	Lukas Emberger (formerly Feierl)	SOLID Solar Energy Systems GmbH	Subtask B Co-Leader
AUSTRIA	Fabian Ochs	UIBK – Universität Innsbruck	National Expert
AUSTRIA	Alica Tosatto	UIBK – Universität Innsbruck	National Expert
CHINA	Li Bojia	China Academy of Building Research	National Expert
CHINA	Jiao Qingtai	Sunrain Solar	National Expert
CHINA	Wandong Zheng	Tianjin University	National Expert
DENMARK	Andreas Zourellis	Aalborg CSP A/S	National Expert
DENMARK	Jianhua Fan	Technical University of Denmark	National Expert
DENMARK	Jakob Jensen	Heliac A/S	National Expert

DENMARK	Geoffroy Gauthier	PlanEnergi	National Expert
FINLAND*	Kaj Bishop	Savo Solar	National Expert
GERMANY	Magdalena Berberich	Solites – Steinbeis Research Institute	Subtask A Leader
GERMANY	Silas Tamm	Solites – Steinbeis Research Institute	National Expert
GERMANY	Dirk Mangold	Solites – Steinbeis Research Institute	National Expert
GERMANY	Stefan Mehnert	Frauenhofer ISE	National Expert
GERMANY	Dominik Bestenlehner	IGTE – University of Stuttgart	National Expert
GERMANY	Dirk Krüger	DLR (Institute of Solar Research, German Aerospace Center)	National Expert
GERMANY	Julian Jensen	ISFH (Institute for Solar Energy Research in Hamelin)	National Expert
GERMANY	Yuvaraj Sathiyadev Pandian	Solarlite CSP Technology GmbH	National Expert
GERMANY	Bärbel Epp	SOLRICO	National Expert
GERMANY	Thorsten Urbaneck	Technische Universität Chemnitz	National Expert
GERMANY	Karin Rühling	TU Dresden	National Expert
GERMANY	Christian Stadler	VIESSMANN	National Expert
GERMANY	Andreas Burger	Industrial Solar GmbH	National Expert
GERMANY	Paulina Majewska	Industrial Solar GmbH	National Expert
GERMANY	Joachim Krüger	Industrieverband Deutsche CSP	National Expert
GERMANY	Bert Schiebler	Institute for Solar Energy Research Hamelin (ISFH)	National Expert
GERMANY	Julian Schumann	Institute for Solar Energy Research Hamelin (ISFH)	National Expert
GERMANY	Janybek Orozaliev	Kassel University	National Expert
GERMANY	Paul Volk	Kassel University	National Expert
GERMANY	Stefan Abrecht	Solar-Experience GmbH	National Expert
GERMANY	Jan Kelch	Uni Kassel	National Expert
ITALY	Maurizio Repetto	Politecnico di Torino	National Expert

ITALY	Ivan Mariuzzo	Politecnico di Torino	National Expert
NETHERLANDS	Luuk Beurskens	TNO	Subtask C Leader
POLAND	Armen Jaworski	CIM-mes Projekt	National Expert
POLAND	Michal Wielgosz	CIM-mes Projekt	National Expert
SPAIN	Eduardo Antonio Pina	GITSE-I3A, University of Zaragoza (Spain); IPESE, École Polytechnique Fédérale de Lausanne (Switzerland)	National Expert
SPAIN	Luis M. Serra	University of Zaragoza	National Expert
SPAIN	Ana Lazaro	University of Zaragoza	National Expert
SWEDEN	Benjamin Ahlgren	Absolicon	National Expert
SWEDEN	Joakim Byström	Absolicon	Subtask D Leader
SWEDEN	Daniel Bergqvist	Absolicon	National Expert
SWEDEN	Bengt Söderbergh	Absolicon	National Expert
SWEDEN	Max Bonnier Eklund	Absolicon	National Expert
SWEDEN	Gunnar Lennermo	Energianalys AB	National Expert
SWITZERLAND	Alexis Duret	Laboratory for Solar Energetics and Building Phyics (LESBAT), School of Engineering and Management Vaud	National Expert
SWITZERLAND	Xavier Jobard	Laboratory for Solar Energetics and Building Phyics (LESBAT), School of Engineering and Management Vaud	National Expert
SWITZERLAND	Florian Ruesch	OST – Ostschweizer Fachhochschule, SPF Institut für Solartechnik	National Expert
SWITZERLAND	Dimitris Papageorgiou	TVP Solar SA	National Expert
SWITZERLAND	Guglielmo Cioni	TVP Solar SA	National Expert
SWITZERLAND	Florent Saunier	TVP Solar SA	National Expert
UNITED KINGDOM	Alex Mellor	Naked Energy	National Expert
UNITED KINGDOM	William R H Orchard	Orchard Partners London Ltd	National Expert

*Finland participates through the DHC TCP.

Task 69 – Solar Hot Water For 2030

Task Managers (joint)

Prof. Robert A. Taylor
University of New South Wales, Sydney, Australia

&

Prof. He Tao
China Academy of Building Research, Beijing, China

Task Overview

Hot water demand is continuously growing globally, and many IEA SHC member countries have 2030 commitments/targets to achieve a higher solar fraction of their economies. At present, ~16% of residential energy consumption in IEA countries goes to water heating (according to 2018 IEA data). However, the solar share of this is low—**only 2.1%** of space and water heat demand was met by solar thermal in 2018, and this mainly come from evacuated tube systems installed in China (according to a recent IEA Report). This same report states, "to be in line with the Sustainable Development Scenario (SDS), the share of clean energy technologies needs to exceed 50% of new heating equipment sales by 2030." Thus, the general scope of this Task is to investigate the best way for solar hot water configurations to fill this gap. The Task will focus on the development path and best practices for two technologies which are expected to play the biggest role in the solar hot water market in 2030: solar thermal thermosyphon and solar photovoltaic (PV) derived hot water heating systems.

Scope

Overview: The Task will define the market status, core technical issues for development, and the trainings/standards needs for two cost-effective and reliable solar water heater technologies (*thermosyphon and* PV solar hot water heating systems). The Task will rely heavily on international knowledge among participants from the different IEA SHC member country regions, to consider differences in economic development, solar resources, regulations, and other factors (i.e., GN SEC vs. Europe). A key part of the scope is to investigate 'smart' systems for thermosyphons and 'integrated' systems for PV-driven systems, including how to overcome barriers to further deployment (e.g., harmonisation) in different climates and markets. As such, the Task will identify opportunities to improve the performance, cost, and reliability of solar water heaters, aiming to accelerate the rollout of best practices for these technologies.

Subtask A: State-of-the-art and Operating Environments in Different Regions (Leader: Daniel Tschopp/Christoph Rohringer - AEE INTEC, Austria, d.tschopp@aee.at)

Analyzing data related to global solar hot water installations, including operating environment, trends, best practices, regulations, and major technical and non-technical barriers to adoption.

Subtask B: Thermosyphon Hot Water Systems (Leader: Bojia Li -- China Academy of Building Research, China, libojia@outlook.com)

Investigating how thermosyphons can be modernized via new technologies, system durability and reliability, and the potential of new technologies to save energy and reduce GHG emissions compared to conventional systems.

Subtask C: Solar Photovoltaic Hot Water Systems (Co-Leaders - Dean Clift - RMIT/Rheem, Australia, dean.clift@rheem.com.au & Tony Day – Sr. Consultant, UK, Tony@tonyday.co.uk)

Evaluating environmental, social, and economic implications of increased deployment of solar PV diverter and PV2Heat technologies.

Subtask D: Training and Standards (Leader: Jianhua Fan - Technical University of Denmark, Denmark, jifa@dtu.dk)

Using Task results to recommend improvements and revisions to current standards and new standards for PV SHWs, and to prepare training materials on SHW principles, sizing and installation.

Collaboration with Other IEA TCPs

Task 69 is in collaboration with the Photovoltaic Power Systems Programme (PVPS) and the Heat Pumping Technologies (HPT) TCPs.

Collaboration with Industry

The following companies have devoted experts to Task 69:

- Rheem Pty Ltd. (Australia)
- Apricus (Australia)
- Reclaim Energy Pty Ltd. (Australia)
- Sunspin Pty Ltd. (Australia)
- Exemplary Energy (Australia)
- Sustainable Energy Transformation Pty Ltd. (Australia)
- GreenoneTEC (Austria)
- Solareast Holdings Co. (China)
- Haier (China)
- Pleion SpA (Italy)
- Inventasolar (Norway)

Task Duration

This Task started in July 2022 and has been extended to the end of 2025.

Participating Countries

Australia, Austria, Canada, China, Denmark, Greece, Italy, Norway, Portugal, Switzerland, GN SEC (Zimbabwe, Botswana, Lesotho, Namibia, South Africa, Zimbabwe), UK

Work During 2024

Overall Task Progress

2024 was a productive year for Task 69. A major knowledge sharing activity happened in October when our Task Meeting #5 was held 11 Oct 2024 followed by a large conference co-ordinated by the China Academy of Building Research (hybrid) in Lianyungang, China. At the end of 2024, 7 Draft Task Reports/Deliverables were ALMOST done: A.1, A.2, B.1, B.2, B.3, C.2/3 (combined), D.1, all of which should be able to be reviewed and published early in 2025. The Task also facilitated a Solar Academy Webinar (25th + 27th Sept.) on Thermosyphon hot water systems. Other Task progress included making contributions to News items and Solar Heat Worldwide, along with holding regular leadership and subtask meetings throughout the year. As noted below, each Subtask has made significant progress according to the Work Plan.

Subtask A: *State-of-the-art and Operating Environments in Different Regions*

Subtask A had the following accomplishments in 2024:

- Side-by-side comparison study of solar hot water technologies: Container & components delivered to installation site at Namibia University of Science and Technology. Planned start of monitoring Nov/Dec 2024.
- D A.1: Data analysis of the questionnaire finalized for all countries, plus a detailed description of main markets finalized. Completion planned for Nov 2024.
- D A.2: 3 Best Practice examples finalized. Contributions for 7 additional examples confirmed, report compilation in progress. Completion planned for Jan 2025 (on track).
- D A.3: First inputs on emerging products and research trends gathered. Expert meeting scheduled for Nov/Dec 2024. Completion planned for July 2025 (on track).
- On-going meetings with experts from the 8 market regions have been held, as well as meetings with SOLTRAIN+ experts together with STB.

Subtask B: *Thermosyphon hot water systems*

Subtask B has had the following accomplishments in 2024:

- 12 Chinese manufactures, equaling the vast majority of thermosyphon manufacturing capacity in China, have answered the survey (in Chinese) and the Chinese Statistics report was finished in the first half 2024.
- Linuo (a Chinese manufacture) provided an introduction on their intelligent controller for Thermosyphon systems as input for Deliverable B.1.
- Failure modes and effects: A meeting with SOLTRAIN experts was held in March 2024, and more experts from GN-SECs and Latin America were involved in the Deliverable B.2 and B.3. With their input, Deliverable B.2 is close to being finished. The involvement of GN-SEC & LATAM countries has been very important & fruitful.
- GHG reduction testing in China: Initial results on energy-saving & GHG reduction have been reported at the plenary meeting in Dec 2023 & Apr 2024. They will be the inputs for Deliverable B.4.
- An on-site Solar Academy session held in Lianyungang, China on Oct 2024, Initial results on failure modes and GHG reduction testing have been introduced and discussed with Chinese experts.
- Progress of deliverables has been discussed in detail at the task meeting in Oct 2024.

Deliverable B.1, B.2, B.3 will have a target to finish before Jan 2025.

Deliverable B.4 opens for input for a longer time starting in Feb 2025 and finishing by April 2025.

Subtask C: *Solar Photovoltaic Hot Water Systems*

Subtask C had had the following accomplishments in 2024:

- Expert survey complete - results presented at the last meeting
- A Report of Solar Heat Worldwide was prepared, based upon the STC
- C.2/C.3 report near completion. Request that these deliverables be combined.
    - PV2Heat Systems (off-grid)
    - PV Self-Consumption Hot Water Systems (partially coupled)
    - Grid-tied PV Hot Water Systems
    - Emerging markets
    - Transitioning mature markets
- **3** Journal Papers as an output from this Task are getting cited and having impact in 2024!!
    - Clift et al. “Assessment of advanced demand response value streams for water heaters in renewable-rich electricity markets” Energy, 267, 2023. https://doi.org/10.1016/j.energy.2022.126577.
    - Clift et al., “Maximizing the benefit of variable speed heat-pump water heater with rooftop PV and intelligent battery charging” Solar Energy, 112049, 2023. https://doi.org/10.1016/j.solener.2023.112049
    - Clift et al. “Peer-to-peer energy trading for demand response of residential smart electric storage water heaters” Applied Energy, In press, 2023.
- Australian technical work under the ‘SolarShift’ RACE CRC project, detailed modelling and analysis conducted throughout the year

Subtask D: *Training and standards*

Subtask D had had the following accomplishments in 202:

- Global Solar Hot Water Standards assessment report drafted, with input from most of the key global regions
- Training session 2 (of 2)
- A self-organized Solar Academy Webinar
- 2 sessions, 1 for each of the Eastern & Western hemisphere in December 2023).
- Well received, particularly the in-person session

Work Planned For 2025

Subtask A: *State-of-the-art and Operating Environments in Different Regions*

According to the Work Plan, subtask A will commence all three of the planned activities, which are as follows:

A1	Report on most dominant solar water heating systems and state-of-the-art reviews for thermosyphon and PV2Heat technologies, analysis of market regions and potential for solar water heating
A2	Documentation of success stories and market barriers in relevant regions
A3	Report on emerging products and research trends for SHW

Note: A3 is due mid-2025.

Subtask B: *Thermosyphon hot water systems*

According to the Work Plan, subtask B will have commenced all four of the planned activities by the end of 2025, which are as follows:

B1	Report of thermosyphon system potential
B2	Survey of failure modes and effects and suggestions
B3	Report on durability and reliability improving research and technical results
B4	Report on energy-saving & GHG reduction methods along with current and future trends

Note: B4 is due in mid-2025.

Subtask C: *Solar Photovoltaic Hot Water Systems*

According to the Work Plan, several of the subtask C Activities are scheduled to commence or complete in 2024, which are as follows:

C1	Expert Network, Expert Questionnaire / Interviews and Case Studies
C2/C3	Literature + Market Review & Technology
C4	Policy Brief

Note: C2/3 were combined and due to publish early 2025. C4 is planned for 2025.

Subtask D: *Training and standards*

According to the Work Plan, three of the subtask D Activities are scheduled to commence in 2024, which are as follows:

D1	Report on 'Solar Hot Water Standards and Certifications – Pathways to 2030'
D2	Facilitate Training
D3	Needs Assessment Report (Training for Solar Energy Practitioners)

Note: D2 & D3 are on-going in 2025.

Dissemination Activities In 2024

Conferences, Workshops, Seminars

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees	If Task Hosted: Organized with, # participants
SSBI 2024	Together with Task meeting, SSBI 2024 had presentations and a facility tour (Sunrain)	Oct 12th-13th & Lianyungang, China on	**>160** experts from IEA SHC Task 69, universities, research institutes, industries attended on-site. > 8000 attendees from Live Stream.	> **160** experts from IEA SHC Task 69, universities, research institutes, industries attended on-site. >**8000** attendees from Live Stream.

Dissemination Activities Planned For 2025

As noted in the 2024 Activities above, 7 items are due for completion in 2023. The results from both will be disseminated in 2024 (as reports and conference/journal papers).

Journal Articles, Conference Papers, etc.

Author(s)	Title	Publication / Conference	Bibliographic Reference
Joseph Shigwedha, Fenni Shidhikai, Helvi Ileka, Daniel Tschopp, Rudi Moschik, Penti Paulus	Monitoring and evaluation of thermosyphon and PV Hot Water systems under the same operating conditions in a side-by-side experimental setup	ISEC (International Sustainable Energy Conference) 2024	
Harald Kicker, Gernot Wallner, Daniel Tschopp, Rudi Moschik, Wolfgang Gruber-Glatzl, Fenni Shidhikai, Helvi Ileka, Joseph Shigwedha	Life Cycle Assessment of thermosyphon and PV Hot Water systems under the same operating conditions in a side-by-side experimental setup: Initial results and data comparison with existing installations	ISEC (International Sustainable Energy Conference) 2024	
Li Bojia, Bian Mengmeng, Jiao Qingtai	Energy-saving & GHG reduction performance evaluation on thermosyphon systems		

Task Meetings Planned for 2025

Meeting	Date	Location	# of Participants (# of Countries)
Task 69: Meeting 6	May 26, 2025	Hybrid (w/ In-person meeting in Windhoek, Namibia)	Up to 30 in total (10)
Task 69: Meeting 7	November, 2025	Online	Up to 50 in total (10)

SHC Task 69 Participants

Country	Name	Institution / Company	Role	Involvement Level
Australia	Saeed Tehrani	Apricus	Expert	Low
Australia	David Ferrari	Exemplary Energy (Australia)	Expert	Low
Australia	Harry Suehrcke	Sunspin	Expert	Low
Australia	Robert A Taylor	University of New South Wales	**Task Manager (Joint)**	**High**
Australia	Osama Bany Mousa	University of New South Wales	*Task Development*	*Medium*
Australia	Ken Guthrie	SE Transformation	*Key ExCo Stakeholder (AU)*	*High*
Australia	Lu Aye	University of Melbourne	Expert	Medium
Australia	Zheng Wang	Deakin University	Expert	Low
Australia	Doug Smith	PVT Lab	Expert	Low
Australia	Baran Yildiz	University of New South Wales	Expert	Medium
Australia	GRAHAM MORRISON	University of New South Wales	Expert	Low
Australia	Jose Bilbao	University of New South Wales	Expert	Low
Australia	Dean Clift	RMIT/Rheem	**Subtask C Leader (Joint)**	**High**
Australia	Alistair Sproul	University of New South Wales	Expert	Medium
Australia	Ned Ekins-Daukes	University of New South Wales	Expert	Low
Austria	Christoph Rohringer	AEE INTEC	*Task Development (STA)*	*High*
Austria	Daniel Tschopp	AEE INTEC	**Subtask A Leader**	**High**
Austria	Harald Poscharnig	GREENoneTEC Solarindustrie GmbH	Expert	Low
Austria	Harald KICKER	University of Linz	Expert	Low
Austria	Gernot Wallner	University of Linz	Expert	Low
Austria	Veronika Hierzer	AEE INTEC	Expert	Medium
Canada	Christopher McNevin	NRCAN	Expert	Low
Canada	Stephen Harrison	Queen's University	Expert	Medium
China	Bojia LI	China Academy of Building Research (CABR)	**Subtask B Leader**	**High**
China	Tao He	China Academy of Building Research (CABR)	**Task Manager (Joint)**	**High**
China	Sun Zhifeng	China Academy of Building Research (CABR)	Expert	Low
China	Yan Li	Ocean University of China	Expert	Low

China	Xianping Liu	Hunan University of Science and Technology	Expert	Low
China	Qingtai Jiao	Solareast	Expert	Low
China	Ma Guangbai	-	Expert	Low
China	Lianggong Ma	Dalian University of Technology	Expert	Low
China	Zhenhua Quan	-	Expert	Low
China	Wu Yunqimuge	-	Expert	Low
China	Jili Zhang	Dalian University of Technology	Expert	Low
China	Han Yuan	Ocean University of China	Expert	Low
China	Ning MEI	Ocean University of China	Expert	Low
China	Peng Wang	Dalian University of Technology	Expert	Low
China	Lincheng WANG	-	Expert	Low
China	Yan LI	Ocean University of China	Expert	Low
China	Han Yuan	Ocean University of China	Expert	Low
China	Yubo Yang	-	Expert	Low
China	Weiwei Zhao	-	Expert	Low
China	Bin Liu	Haier	Expert	Low
China	Zhenzhen Fan	Linuo-Ritter International	Expert	Low
Denmark	Jianhua Fan	Technical University of Denmark	**Subtask D Leader**	High
Denmark	Elsabet Nielsen	Technical University of Denmark	**Subtask D: Key Expert**	High
Denmark	Ivan Katic	Teknologisk Institute	Expert	Low
EU	Altin Maraj	Polytechnic University of Tirana	Expert	Low
EU - Germany	Harald Drueck	University of Stuttgart	Expert	Low
EU - Greece	Vasiliki Drosuou	Center for Renewable Energy Sources (CRES)	Expert	Low
EU - Norway	Michaela Meir	Inaventa Solar	Expert	Low
Germany	Stephan Fischer	University of Stuttgart	Expert	Low
Germany	Korbinian Kramer	Fraunhofer ISE	Expert	Low
GN SEC	Musaope Kondwelani Mtamba	Sutsol	Expert	Low
GN SEC	Kudakwashe (Kuda) Ndhlukula	SACREEE	*Key ExCo Stakeholder (GN SEC)*	Medium
GN SEC	Fenni Shidhika	Namibia University of Science and Technology- Namibia Energy Institute	Expert	Low
GN SEC	Helvi Ileka	Namibia University of Science and Technology- Namibia Energy Institute	Expert	Low
GN SEC	Khalid Salmi	RCREEE	Expert	Low
GN SEC	Sebota Mokeke	GN SEC	Expert	Low
GN SEC	Karen Surridge	South Africa	Expert and SA ExCo member	Low
GN SEC	Fernando Chichango	GN SEC	Expert	Low
GN SEC	Tawanda Hove	University of Zimbabwe	Expert	Low
GN SEC	Reis Chirinze	GN SEC	Expert	Low

GN SEC	Selma Festus	GN SEC	Expert	Low
GN SEC	Goddy Muhumuza	GN SEC	Expert	Low
GN SEC - Zimbabwe	Blessed Sarema	National University of Science and Technology	Expert	Low
GN SEC - Botswana	Kevin Nwaigwe	Clean Energy Research Centre, University of Botswana	Expert	Low
GN SEC - Lesotho	Anadola Tsiu	Precise Technical Solutions	Expert	Low
GN SEC - SACREE	Kornelia Iipinge	SACREEE	Expert	Low
GN SEC - SACREE	Eugenia Masvikeni	SACREEE	Expert	Low
GN SEC - Zimbabwe	Samson Mhlanga	Namibia University of Science and Technology- Namibia Energy Institute	Expert	Low
GN SEC - Zimbabwe	Shaibu Tambula	GN SEC	Expert	Low
GN SEC - Zimbabwe	Downmore Musademba	Chinhoyi University of Technology	Expert	Low
GN SEC?	Wally Weber	Blackdot Energy	Expert	Low
Italy	DARIO SAGGIORO	Pleion SpA	Expert	Low
Italy	Zeno Benciolini	Pleion SpA	Expert	Low
Mexico	Ivan Patricio Acosta Pazmiño	IEEE	Expert	Low
Europe	Pedro Dias	Solar Heat Europe	Expert	Low
SHC	Pam Murphy	SHC Secretariat	*Key ExCo Stakeholder (Sectretariat)*	Low
Sweden	Diogo Cabral	University of Gävle	Expert	Low
Sweden	Björn O. Karlsson	University of Gävle	Expert	Low
Sweden	Siddhi Bagde	-	Expert	Low
Switzerland	Andreas Häberle	OST Switzerland	Expert	Low
Switzerland	Michel Haller	SPF Institute for Solar Technology - Eastern Switzerland University of Applied Sciences (OST)	Expert	Low
UK	George Bennett	UK Department for Business, Energy & Industrial Strateg	**Subtask C Leader (Joint)**	High
UK	Dr Chris Horne	MyEnergi	Expert	Low
UK	Tom Oldfield	Mixergy Ltd -Oxford UK	Expert	Medium
UK	Andrew Ireland	MyEnergi	Expert	Low
USA?	Shawn Martin	The Solar Rating & Certification Corporation	Expert	Low
-	Md Mehedi Hassan	-	Expert	Low
-	Mariya Thuruthikkattu Joy	-	Expert	Low

Task 70 – Low Carbon, High Comfort Integrated Lighting

Dr. Jan de Boer
Fraunhofer Institute for Building Physics
Task Manager for the German Government (PtJ for BMWi)

Task Overview

The overall objective of the activity is to identify and support implementing the potentials of lighting (electric, façade: daylighting & passive solar) in the decarbonization on a global perspective while aligning the new integrative understanding of humans' light needs with digitized lighting on a building and a building related urban scale. This can be subdivided into the following specific objectives.

- Actively support broadening the view on lighting solutions in the context of decarbonization. Help bridge the gap between a component view (manufacturer's focus) and design-oriented system approaches. Support the transition from a relatively pure energy-focused view to a life cycle assessment (LCA) perspective. On this basis, identify key impact factors and develop the most effective strategies and roadmaps while including regional specifics.

- Contextualize this with the fast-developing digitization of buildings/lighting installations on the technology, design, and operational side. Add to selected open points in the digital chain like better design processes.

- Align this with the still growing understanding of user needs; here it especially builds upon results from earlier tasks (e.g., Task 61).

- Integrate competencies: Bring the different players involved (electric lighting, façade, industry, controls) that have not been connected to low-carbon solutions together in workshops and specific projects. Create added value by transferring into standardization, regulations, and building certificates.

- Foster the broad implementation of low-carbon solutions, especially in developing countries, by promoting tailored "Low Tech – High Impact solutions" through demonstrations, design guidelines, and workshops.

Scope

The scope of the Task is on general lighting systems for indoor environments and the interrelation of buildings (their facades) with urban settings. The focus is laid on lighting appliances in non-domestic buildings. Technically, the Task deals with integrating:

- daylight utilization by enhanced facade technologies and other architectural solutions,
- electric lighting schemes addressing technology and design strategies in the context of progressing digitalization, and
- lighting control systems and strategies with special emphasis on visual and non-visual user needs and the interface of day- and electric lighting.

This is under the constraint of low carbon emission to fulfill the lighting services in an LCA / circular economy context. The task targets building designers and consultants, industry (façade, electric lighting, and software companies), owners (investors), and authorities by providing strategic, technical, and economic information and with network activities helping these stakeholders overcome barriers in identifying and then pursuing and implementing low carbon lighting concepts and installations. Thus, a focus mainly on energy efficiency will be widened.

The Task is divided into four Subtasks:

- Subtask A: Low Carbon Lighting and Passive Solar: Scenarios, Strategies, Roadmaps *(Lead Country: China)*
- Subtask B: Visual and non-visual User Requirements *(Lead Country: United Kingdom)*
- Subtask C: Digitized lighting solutions (Technology & Design Tools / Process) *(Lead Country: Austria)*
- Subtask D: Application and Case Studies *(Lead Country: Sweden)*

Collaboration with Other IEA TCPs

Collaboration with IEA EBC was approved at the moderate SHC level at the 93rd EBC Executive Committee Meeting in June 2023. The EBC TCP refers to the Task as EBC Annex 90. Collaboration with ISO (ISO TC 274) and CIE planned.

Collaboration with Industry

Eight companies are participating in the task activities, and the big design and consulting companies AECOM and ARUP are considering joining. Two industry workshops were held.

Task Duration

The Task started in January 2023 and will end in June 2026.

Participating Countries

Australia, Austria, Belgium, Brazil, Canada, China, Denmark, Germany, Italy, Japan, Netherlands Norway, Poland, South Africa, Spain, Sweden, Switzerland, Türkiye, United States, United Kingdom.

* Participating through the EBC TCP: Brazil, Japan, Sweden, and US. Poland in process of joining SHC TCP.

Work During 2023

Subtask A: Low Carbon Lighting and Passive Solar: Scenarios, Strategies, Roadmaps

Status quo: Overview of Data, Methods, and Regulations
A survey was designed to assess the status of LCA in participating countries with respect to lighting. The survey is structured into general electric lighting and façades. Among others, input is requested on general market integration of LCA approaches, used databases, methods, and regulations. The survey was tested in China and Germany and then rolled out to all participating countries. Twelve countries have responded so far (Austria, Belgium, Brazil, China, Denmark, Germany, Greece, Japan, Norway, South Africa, Spain, and Türkiye), and the others are still invited to do so. A first evaluation of databases and cross-sectional evaluations on, e.g., carbon pricing of electricity, has been performed. The survey evaluation is planned to be finished by the end of the year. Earlier, detailed interviews with stakeholders were not deemed necessary, as the level of detail of the information obtained from the survey was sufficient.

Catalogues of Scenarios
The idea of scenarios was presented, discussed, and further elaborated. Based on this, the relevant state-of-the-art and promising future scenarios will be collected and detailed for electric lighting and facades. An outlook on how this catalog will be incorporated into a simple evaluation procedure and decision tool (A.3 and A.4) was given. This will be based on separating EPDs on the product side (taken from manufacturers' information) and operational carbon from lighting energy calculations. The activity integrates with and relies on the other Subtask. This was addressed in joint Subtask meetings.

Subtask B: Visual and non-visual User Requirements

The scope of B.1 was slightly corrected concerning the focus on the conflict (or balance) line between view access and glare protection. The development of a measurement protocol for view studies and a literature review on view and glare was initiated.

A collection of studies, initiatives, etc. on “view preferences/descriptors” was initiated to provide a starting point. The use of VR for view assessment and which characteristics describe views (e.g., how color and reflection play a role) were discussed. The organization of a set of “View workshops” for the 4th quarter of 2024 was discussed.

Different contributions of experts working in the field of “view out of the window and urban morphology” were made and discussed. Suggestions for first consolidations of knowledge proposed: Perform a literature review on urban morphology and view. Perform a sensitivity analysis of urban morphology parameters on view quality perception.

Subtask C: Digitized Lighting Solutions (Technology & Design Tools / Process)

A joint review will be done for C1 and C2 as both the literature review (academic) and the market review (published information & interviews) should be seen holistically as a technology overview covering systems and controls. Reports from the previous SHC projects, Task 50 and Task 61, will be used as a starting point for the reviews, especially for IOT & Controls. Existing information from these previous SHC lighting Tasks will be updated. The collection of EPDs will be adding relevant LCA aspects to the reviews.

A BIM and lighting survey is being prepared and will be evaluated in early 2024.

A survey on VR in lighting research and practice was designed and open until December 2023.

ISO Standardization project on BSDF: A new standardization effort on BSDF data generation and processing (based on Task 61 white paper and report) was proposed to ISO TC 274 “Light and Lighting” at their JWG 1 meeting in July 2023 and perceived positively. The next step is to set up a new ISO work item to start the standardization process. In support, a publication in Lighting Research and Technology, “Towards an international standard for generating BSDF data for daylight applications,” was prepared in November.

Subtask D: Application and Case Studies

Catalogue of Case Studies
Criteria for inclusion of case studies were finalized: Inclusion criteria: field study, laboratory study, living labs, and virtual reality. Focus on non-residential stock, but residential can be added. An overview of the current available case studies was provided. About 30-40% of case studies focus on daylighting/lighting components; the remaining are buildings. Typologies require different approaches for assessments. More than 40 case studies are listed.

Evaluation Procedure
“High quality” and “Low Carbon” will be assessed. The “High quality” discussion is on hold now, with the focus on LCA. The activity will closely be connected to Subtask A as input on evaluation LCA aspects is necessary. A current joint MSc thesis at Lund University with IREC, Spain, can serve as a basis for further procedure development. The goal is to have a simple visualization of the carbon impact of different solutions, expressed, e.g., in KgCO2e/lm.

Impact of Densification on Visual Comfort
Activities started with a literature review and case studies on an urban scale are being searched for the key elements “densification” and “daylight.”

Promotion of Highly Efficient Solutions for Sunbelt Regions
All task experts were asked to contribute to this activity. Workshops with sunbelt regions will focus on need analysis instead of promoting our activities. The workshop will focus on specific topics of relevance, e.g., (day)lighting for educational spaces, and low-budget retrofitting.

Work Planned for 2024

Subtask A: Low Carbon Lighting and Passive Solar: Scenarios, Strategies, Roadmaps

A.1.2	Working document “Status quo of data, methods, and regulations”	6/2024
A.2.2	Working document “Definition and Catalogue of Scenarios”	9/2024
A.3.1	Draft architecture of framework	6/2024

Subtask B: Visual and Non-visual User Requirements

B.1.1	Study the impact of eye physiology finished	6/2024
B.1.2	Study the impact of colored daylight finished	9/2024
B.2.2	Study of view preferences depending on activities finished	06/2024
B.3.1	Study of view content quality in different urban configurations with greenery included finished	12/2024
B.4.1	Literature study, internal draft finished	06/2024
B.4.2	Interviewers with experts finished	12/2024

B.5.1	Overview of accessible measurement and assessment methods	06/2024
B.5.2	Results from lab and/or field measurement	12/2024

Subtask C: Digitized Lighting Solutions (Technology & Design Tools / Process)

C.1.1	Analysis of digitalization needs completed	03/2024
C.1.2	Summary of activities related to critical path needs completed	12/2024
C.2.1	IOT state-of-the-art, potentials and barriers documented	12/2024
C.3.1	BIM workflows analyzed, and end-to-end parameter workflow specified	12/2024
C.4.1	State-of-the-art lighting simulation methods for non-visual quality criteria for integrative lighting solutions summarized	06/2024
C.4.2	Potentials of VR for lighting design investigated and documented	12/2024

Subtask D: Application and Case Studies

D.2.1	Approved whole life cycle approach methodology	12/2023->6/2024
D.2.2	Approved criteria for assessing visual and non-visual environment	12/2023->6/2024
D.3.1	Experience and data from early case studies (internal document)	06/2024
D.4.1	Format for reporting case studies	02/2024
D.4.2	Reporting of early case studies in the final format	06/2024
D.5.1	Report on minimum requirements for energy and daylight in existing standards	02/2024
D.6.1	1st Web workshop by 4-5 task experts and XXREEE representatives	06/2024
D.6.2	2nd Web workshop by 4-5 task experts and XXREEE representatives	11/2024

Dissemination Activities In 2023

Reports, Published Books

Author / Editor	*Title*	*Bibliographic Reference*
de Boer, J. et. al.	LED Guideline for the Promotion of Lighting Retrofitting	SHC website

Journal Articles, Conference Papers, etc.

Author(s)	Title	Publication / Conference	Bibliographic Reference
Geisler Moroder, D. et. al.	Towards an international standard for generating BSDF data for daylight applications	Lighting Research and Technology	Submission November 2023

Conferences, Workshops, Seminars

Conference / Workshop / Seminar Name	Activity & Presenter	Date & Location	# of Attendees	If Task Hosted: Organized with, # participants
1st Industry Workshop of IEA SHC Task 70	Presentations by Jan de Boer, Victor Ferreiram, Barbara Szybinska Matusiak, David Geisler-Moroder, Niko Gentile, Luca Papaiz	April 17, 2023 Caserta, Italy	55	
2nd Industry Workshop of IEA-SHC Task 70 / EBC Annex 90	Presentations by Jan de Boer, Luo Tao, Barbara Matusiak, Mandana Sarey Khanie, David Geisler-Moroder, Adam Bladowski, Michelangelo Scorpio, Niko Gentile, Anna Pellegrino, Valerio RM Lo Verso	October 2, 2023 London, UK	50	
All Energy Australia	Presentations by Ken Guthrie, Prof Lu Aye, Dean Clift, Veronica Garcia Hansen, Mikel Duke	October 25-26, 2023 Melbourne, Australia		

Dissemination Activities Planned For 2024

3rd industry workshop in Berkeley, USA, in April. Another workshop in the 4th quarter.

Task Meetings in 2023 and planned for 2024

Meeting	Date	Location	# of Participants (# of Countries)
Task Meeting 1 Plus 1st Industry Workshop	April 17-19, 2023	Caserta, Italy	49 (17)
Task Meeting 2 Plus 2nd Industry Workshop	October 3-5, 2023	London, United Kingdom	45 (16)
Task Meeting 3 Plus 3rd Industry Workshop	April 8-10, 2024	Berkeley, U.S.A.	

Task 70 I EBC Annex 90 Participants

Country	Name	Institution / Company	Role
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UNITED STATES	Eleanor Lee	Lawrence Berkeley National Laboratory	National Expert
UNITED STATES	Taoning Wang	Lawrence Berkeley National Laboratory	National Expert
UNITED STATES	Clotilde Pierson	Oregon State University	National Expert

* Participating through the EBC TCP: Brazil, Japan, Sweden, and the US. Poland is in the process of joining SHC TCP.

Task 71 – Life Cycle and Cost Assessment for Heating and Cooling Technologies

Dr. Karl-Anders Weiss
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Task Manager for the German Government (PtJ for BMWi)

Task Overview

SHC Task 71 addresses the challenge of finding ecological and economical solutions for homeowners and manufacturers by developing a transparent methodology to compare various heating and cooling options over time, enabling a fair evaluation of technologies.

The work includes Integrating Ecological (LCA) and Economic (LCoH) assessments of different heating and cooling technologies for the building sector with a comprehensive review of regulations.

The results will make it possible to compare the technologies from an environmental and economic point of view and can be used as input for regulations and standards.

The task work is divided into 5 subtasks: Subtask A. Cooperation with ongoing or upcoming SHC tasks and related tasks from other IEA TCPS, subtask B. Methodology adoption, subtask C. Data of different technologies and components, subtask D. Reference systems and their requirements, scenarios, and optimisation and subtask E. Dissemination, networking, and policy involvement. The work and work plans for each subtask are described separately in the following sections.

Scope

Subtask A: Cooperation with ongoing or upcoming SHC tasks and related tasks from other IEA TCPs
(Subtask Leader: Karl-Anders Weiss, Lead Country: Germany)
The scope of Subtask A is: Identification of relevant standards and regulations, updates of upcoming policy initiatives, establish close cooperation with ongoing related IEA activities, establish common understanding and approach on sustainability and cost assessments within the renewable energy community.

Subtask B: Methodology Adaptation
(Subtask Leader: Rene Itten, Lead Country: Switzerland)
Subtask B aims to develop methodological guidelines for the environmental and economic assessment of SHC systems. This includes specifications about functional units, system boundaries ecological impact assessment methods, an adaption for levelized cost of heat (LCoH() calculations for SHC systems, as well as requirements on reporting.

Subtask C: Data of different technologies and components
(Subtask Leader: Michaela Meir, Lead Country: Norway)
Subtask C will identify, compile and analyse existing inventories and other input data for Life Cycle Assessment and costing for SHC technologies and components. The compilation of reliable foreground data and provision of access to solid scientific unit process data sets will help to assess the environmental footprint and the heat costs of SHC technologies. Data will be collected and validated on used materials, manufacturing, O&M, lifetime, yield and recycling of the different technologies and components like e.g. solar thermal collectors, storage, heat pumps, gas boilers etc. The involvement of manufacturers is necessary to improve data availability.
The data will be collected in a specific database which shall be hosted by SHC to ensure that the data is validated and neutral and up to date.

Subtask D: Generic systems and their requirements, scenarios, and optimization
(Subtask Leader: Stephan Fischer, Lead Country: Germany)
The evaluation of the environmental performance and costs of technologies as part of heating systems needs the definition of generic heating and cooling loads (e. g. building loads, district heating loads, industrial process loads, etc.) as well as generic heating and cooling systems supplying the heat and cold to cover the respective loads (e. g. solar thermal systems, heat pump systems, etc.). The energy performance and environmental profiles of different current technologies will be assessed and compared with another and with conventional technologies. Prospective scenarios for LCA using changes in electricity mix, materials manufacture, climates and transport services will be investigated. Special attention will be paid to the effect of carbon taxes and subsidies on the economic optimisation of the heating systems. The quantification of the LCA and LCoH parameters for comparison, rating and optimisation of different heating technologies will be subject of discussion and investigation.

The main results of this Subtask are:

- Selection and definition of applications (households, district heating, etc.) as generic heat demand systems to be investigated based on the expertise of the participants (proposal: at least one per participating country)
- Selection and definition of heat demand reference systems (at least one per participating country)
- Selection of reference generic heating and cooling systems (proposal: at least one per participating country) suitable for covering the load of the generic heat demand systems for LCA and LCoH and definition of the functional unit and of relevant parameters of the reference generic heating and cooling systems

Subtask E: Dissemination, networking, and policy involvement
(Subtask Leader: Janne Dragsted, Lead Country: Denmark)
The aim of this subtask is to disseminate the results of the task. Among other things, support to the work of the other Subtasks will be given by outreach to industry and partners through appropriate channels. Also, to engage legislators, decision-makers, and policymakers and bring the information from the Task to stakeholders to ensure that the task results on LCA and LCoH are known.

Collaboration with Other IEA TCPs

Task 71 has contacted the programmes for collaboration purposes see under Subtask A.

Collaboration with Industry

The task participants are universities, research institutes and solar energy companies. The institutes have close cooperation with industry partners in the solar energy field. In this way information on marketed products and systems will be available for the task and the industry can benefit from the results of the task.

Task Duration

January 2023 - December 2025.

Participating Countries

A list of the participating countries:

China, Denmark, France, Germany, Italy, Norway, Portugal, Spain, Switzerland, United Kingdom

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Work During 2024

Subtask A: Cooperation with ongoing or upcoming SHC tasks and related tasks from other IEA TCPS

The focus of Subtask A was writing the report titled “Regulations for Heating Systems - National Situation and International Overview”. The report gives an overview on the situation in 11 countries by briefly describing the general national strategy and goals, and by grouping regulations addressing the Energy Efficiency in Buildings, District Heating and Cooling, and Renewable Energy.

It is important to mention that the report can only give a general overview and cannot provide a complete information for each specific country as the regulatory system in the heating sector is currently very dynamic throughout all countries reported on.

The Cooperations with the other Tasks and TCPs was mainly due to our Newsletter which were send out two times in 2024 containing an update about the work on the report as well we information about the current work in the whole Task. Therefore, the other interested tasks/TCPs were kept up to date but not flooded with information. Additionally bilateral meetings with interested contacts were held and the interested parties were kept up to date via the semi-regular LinkedIn posts.

Subtask B: Methodology adaptation

Subtask B aims to develop methodological guidelines for the environmental and economic assessment of SHC systems. This includes specifications regarding functional units, system boundaries ecological impact assessment methods, an adaptation for levelized cost of heat (LCOH() calculations for SHC systems, as well as requirements regarding reporting.

Subtask C: Data of different technologies and components

The collection of data continued and the work with the database has progressed.

Subtask D: Reference systems and their requirements, scenarios, and optimisation and subtask

For the demand side the following reference heat demand systems have been defined:

- Denmark: Single family house
- Switzerland: Single family house and multifamily house
- Germany: district heating system
- Spain: Commercial centre and residential district

Templates were finalised for buildings, district heating and industrial process (heat demand systems) to document the heating and cooling loads in a standardised way.

For the heat supply the following generic systems have been defined to cover the load of the defined heat demand systems:

- PVT plus heat pump system for single family house (Denmark)
- Solar plus gas combi system for single family house (Switzerland)
- Solar district heating system with seasonal storage, heat pump and biomass boiler (Germany)
- Combination of solar thermal, biomass and ORC for commercial centre (Spain)
- Combination of PV, wind, biomass, solar thermal and heat pump for residential district (Spain)

Templates were finalised to document head supply systems in a standardised way.

Subtask E: Dissemination, networking, and policy involvement

An article on Facilitating the private sector on the way to climate neutrality, and two articles on the 2nd Task workshop were prepared.

Additionally, the 2nd workshop was organized in connection with Task meeting at DTU in Kgs. Lyngby, Denmark in October 2024. 80 participants from consulting engineering firms, manufacturers, authorities, agencies, research institutes and universities including students attended the workshop to learn about the status on LCOH and LCA for heating and cooling technologies for buildings. The participants gave input and recommendations for the ongoing Task.

Work Planned For 2025

Subtask A: Cooperation with ongoing or upcoming SHC tasks and related tasks from other IEA TCPS

To share the results and findings of Subtask A the Report mentioned earlier will be officially in addition, we will write and publish a white paper detailing the key aspects and recommendations of our work in the last two years.

Furthermore, we want to organize a short webinar to discuss the report and the white Paper with our external collaborating experts

Subtask B: Methodology adaptation

A first draft of the methodology guidelines for environmental life cycle assessment of SHC systems had been established in 2023. At the beginning of 2024, the first round of review of the guidelines among the Task 71 members was successfully completed. A total of 10 experts from 8 institutions from 5 countries (Denmark, Germany, Italy, Portugal, Spain) submitted review contributions. The main topics on which most feedback was received included the projection of heat demand profiles, the allocation of costs and environmental impacts for PV/T systems, impact assessment methodologies, interpretation parameters, reporting requirements and system boundary definitions.

Once the comments had been categorized and evaluated, work began on integrating the feedback into the methodology guidelines. In parallel, progress was made regarding specifications for the economic assessment of

solar heating and cooling systems. Equations for calculating the levelized cost of heat (LCoH) were established and system boundaries were defined for three types of applications. In addition, efforts to harmonize the ecological and economic assessment criteria in the methodology guidelines were advanced.

Subtask C: Data of different technologies and components

The database will be finalised.

Subtask D: Reference systems and their requirements, scenarios, and optimisation and subtask

In 2025 the remaining reference heat demand and heat supply systems will be defined and documented in the corresponding info sheets. For selected systems (at least one per country) the calculation according to the first draft of the calculation guideline from subtask B will be carried out.

Subtask E: Dissemination, networking, and policy involvement

The focus for 2025 will be to link the different fact sheet and info sheets for different system configurations, along with finalizing guidelines for reporting on LCA and LCoH.

Dissemination Activities In 2024

Journal Articles, Published Conference Papers

Author(s)	Title	Publication / Conference	Bibliographic Reference
		Journal or conference name	DOI or website link
K.-A. Weiß; T. Schulz; K.S. Rimrodt	„International Vernetzt“ (Internationally Conntеced“	Website of the German project “Effizientes Heizen”	25.07.2024
S. Bachmann	Definition generischer Heizungsanlagen für den ökonomischen und ökologischen Vergleich	Symposium innovative Wärmesysteme	14-16.05.2024, Bad Staffelstein, Germany
S. Fischer	Definition der Randbedingungen zum ökonomischen Vergleich von Heizungstechnologien in Ein- und Mehrfamilienhäusern	Symposium innovative Wärmesysteme	14-16.05.2024, Bad Staffelstein, Germany
M. Fischer	Ganzheitliche Nachhaltigkeitsbewertung von Heizungssystemen in Wohngebäuden: Ansatz, Datenbedarf und Einbindung einer dynamischen Strommixentwicklung	Symposium innovative Wärmesysteme	14-16.05.2024, Bad Staffelstein, Germany
M. Fischer	Integrated Sustainability Assessment of a Residential Heat Pump System	3rd INTERNATIONAL SUSTAINABLE ENERGY CONFERENCE 2024	10.-11.04.2024, Graz, Austria
S. Fischer	Uniform Modeling of Heat Production Costs in Single-	3rd INTERNATIONAL SUSTAINABLE ENERGY CONFERENCE 2024	10.-11.04.2024, Graz, Austria

	Family and Multi-Family Houses		
B. Epp	Facilitating the private sector on the way to climate neutrality	Solarthermalworld.org	March 2024

Conferences, Workshops, Seminars

Conference / Workshop / Seminar	Activity	Date & Location	Number of Attendees	Task Organized
Workshop on Life Cycle and Cost Assessment of Solar Heating and Cooling Technologies	Oral presentations followed by group discussions In person & online	October 8., 2024, DTU, Kgs. Lyngby, Denmark	80	Yes
Hybrid oral presentations followed by group discussions. In person & online **Welcome**, Karl-Anders Weiss, ISE Fraunhofer **EU policy aspects, energy labeling and eco-design for sustainable products,** Philippe Riviere, European Commission **Transforming heating systems as part of the energy transition**, Mihai Tomescu, European Environment Agency **Life cycle analysis and renewables: A growing agenda and opportunity for Solar Heat?** Valérie Séjourné, Solar Heat Europe **National requirements on LCA for buildings and energy systems: A view on LCoH(E),** Lau Raffnsøe, Danish Green Building Council **IEA SHC Task 71: Life Cycle and Cost Assessment for Heating and Cooling Technologies: Investigated energy systems and database for energy systems**, Karl-Anders Weiss, ISE Fraunhofer **Quantifying the environmental implications of solar thermal technologies: A comprehensive examination of life cycle impacts and payback periods,** Maria Zagorulko, Naked Energy Ltd., United Kingdom				
Symposium innovative Wärmesysteme	"Discussion Table" Technology assessment – easy is good	15.05.2024, Bad Staffelstein, Germany	22	No

Dissemination Activities Planned For 2025

The plan is to have an online workshop presenting the outcome of Task 71. Whether the workshop also will be physical is not decided yet. The database and info sheet will be made available online through the webpage, and advertisement of the outcome will be carried out via email, LinkedIn and other channels. Additionally, the Report from Subtask A will officially be published and the White paper will be drafted and published.

Task Meetings in 2024 and planned for 2025

Meeting	Date	Location	# of Participants (# of Countries)
Task meeting 3	18-19 April 2024	Online	24 participants 10 countries

Task meeting 4	8-9 October 2024	Kgs. Lyngby, Denmark & online	13 participants 7 countries
Task meeting 5	5-7 May 2025	Wädenswil, Switzerland	
Task meeting 6	October 2025	Tbd	

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