2020 Solar Thermal Trends

As 2020 comes to an end and 2021 begins, our team of SHC Task managers want to share some trends they see in their fields of expertise. We hope that by taking the time to stop and think about where solar thermal is headed, we can stay one step ahead of the technological advances and market changes.

TECHNOLOGY

Solar Cooling

Hybrid systems. More and more hybrid system solutions of all kinds in the field of solar cooling will come onto the market. They will offer high CO2 savings in small to medium cooling capacity ranges with good economic efficiency. There will be solutions with better efficiency and profitability in the area of **medium-temperature systems** (solar collector temperatures around 160-180°C) and double-effect absorption chillers. And with their smaller solar fields and lower heat rejection capacities, these systems have an **investment advantage of up to 40%** compared to conventional solar cooling systems.

PV/Thermal Systems

Market trends. There is increasing recognition that PVT (PV and Solar Thermal collectors combined) systems can deliver heat and electricity to homes as well as commercial and industrial buildings. And with this recognition comes growth. An estimated **3 million square meters of PVT will be installed by the end of 2021** as more examples of the technology at work continue to bolster this growing solar application. It is expected that more companies will be displaying their innovative PVT solutions and that the certification and official testing of PVT collectors will be easier and less costly for manufacturers.

Viable solar option. PVT glazed collectors are well suited for providing domestic hot water year round and delivering lots of electricity during sunny days for onsite use. In combination with a heat pump, unglazed PVT collectors provide the source of heat and some part of the electricity to run the heat pump, increasing the total solar fraction covered. Planners and installers will be considering the use of PVT to maximize the use of a roof, at least at the offer level when clients ask for PV.

BUILDINGS

Lighting

Lighting solutions. An integrative approach to lighting solutions in an indoor environment is picking up speed. After the technology transition to LED lighting, "Ledification," and a better and new understanding of human lighting needs, the **integration of electric lighting and daylighting** will continue to be assessed and advances made.

New alliances. Market actors once on opposite sides are building new partnerships. Luminaire manufacturers are teaming up with façade (glare protection and sun shading) and building automation suppliers. They are striving for **better user-centered lighting** while at the same time focusing on **energy savings**. For instance, new control concepts will improve lighting by positioning lighting directly in the field of view in workplaces rather than at some remote spot on the façade ceiling.

Standardization and certification. In 2021, we will probably see revisions to the main documents on lighting requirements (e.g., EN 12464-1) that introduce more differentiated requirements. Broadly used lighting design tools are expected to enhance **daylight modeling capabilities**, thus supporting practitioners in implementing integrative lighting solutions.

INDUSTRY

Solar District Heating

Energy management system (EMS). The coupling of different heating grids or the (frequently decentral) integration of renewable energy systems often leads to cross-ownership of an energy system, which raises the question, "How can we operate these systems optimally?" One answer is an **optimization-based predictive supervisory control** and a specific simulation that investigates different operating strategies. For example, social optimum could reduce the overall operating costs of a renewable district heating system by 9% and the overall CO2 emissions by 45%.

Model predictive control for large-scale absorption heat pumps. Varying operating conditions, as typically occur in solar district heating and cooling systems throughout the day and the year, are challenging for absorption heat pump systems. They can result in persistent actuator saturation, which in turn reduces their control performance. One **advanced control strategy, the model predictive controller (MPC)**, could reduce these periods of actuator saturation and limit their negative effects on absorption heat pump systems. A MPC control strategy's advantages can be appreciated when compared to a conventional PI controller using an absorption heat pump system simulation model and a solar cooling configuration with similar load profiles.

Concentrating systems for district heating integration – new Task concept. One insight from SHC Task 55 is that, aside from Denmark, many district heating systems are still operated with supply temperatures over 80 - 100°C, thus making it hard to transfer Denmark's solar district heating (SDH) concepts worldwide. These high temperatures are needed by the connected consumers (e.g., radiator heating systems) and allow for high heat storage capacity while having small mass flows (high exergy networks). Unfortunately, high-temperature heat is

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still typically produced by caloric power plants (often driven by coal) and seldom by solar technologies directly or indirectly (e.g., by combining solar collectors with heat pumps). However, there is a range of mature high-temperature collector systems on the market to efficiently produce higher temperatures > 100°C together with innovative new storage concepts for efficiently storing heat at high temperatures. Furthermore, introducing high temperature for large-scale solar thermal systems would facilitate integration and industrial applications (e.g., SHIP) provide possibilities for sector coupling with the electrical grid (e.g., using steam turbines). With this in mind, one main objective of the follow-on Task to SHC Task 55 will be to **develop concepts, collect system requirements, provide reliable performance measures and develop optimal control strategies** for the most efficient production, integration/distribution and storage of high-temperature heat for large-scale SDH systems. Another focus will be on digitalization measures for SDH.

Digitalization measures allow for more efficient monitoring, automatic fault diagnosis, predictive maintenance and advanced process control (e.g., mixed-integer model predictive controllers). If you are from a SHC member country and are interested in participating in the new Task's definition phase, contact Viktor Unterberger, viktor.unterberger@best-research.eu.

Nexus Water-Energy-Industry

Opportunities. About 20% of the world's water is used by industry, and therefore is an essential economic good. Water shortages in specific regions worldwide, as well as the need for CO2 reduction and primary energy savings, underline the interdependence of water and energy. The efficient supply of energy, the best possible integration of renewable sources, and the recovery of resources must go hand in hand. Theoretically, a **100% solar energy supply ratio for water treatment technologies** is possible as it is common to work with large volumes and buffer storages, allowing production capacity variation and solar availability.

Industrial (waste) water treatment. The integration of solar process heat in industrial (waste) water treatment technologies is an application area and new market for solar thermal systems with enormous technical and economic potential. Technological combinations include thermally driven water separation technologies with the recovery of valuable resources, for example, integrating **solar-driven membrane distillation and thermally driven technologies** like diffusion dialysis, pervaporation or selective crystallization. There are also emerging technologies integrating solar into **water decontamination and disinfection systems**. The increased efficiency due to solar may affect the quality of the conversion process and help define new solar collector concepts to reduce manufacturing costs by maintaining high efficiency in collecting UV photons for better performing chemical oxidation reactions.

Solar Process Heat

System integration. Solar process heat is seen as a reliable component within the energy supply system for industry. The total energy supply system comprises various technologies (storages, boilers, heat pumps, solar thermal and other renewables) that complement each other with the aim of reliably delivering heat at required temperatures, power and time patterns with as **little GWP (Global Warming Potential) as possible and for an affordable price.**

Modularization. The trend is to move from individually engineered custom solutions towards **standardized modular concepts** that can more easily be replicated without high engineering demand and corresponding costs and risks.

Digitalization. System simulation is more and more moving from academic to standard engineering tools. Also, digitalization is becoming a **standard prerequisite for system integration** with optimum complementation/interaction of various technologies

Standardization. Specific aspects of solar process heat technologies will be recognized in **international standards.**

Market introduction. New **large demonstration projects** in various countries support the technical concepts of solar process heat systems (they work) and the attractiveness for investors (they make money) with innovative financing models.