

2021 HIGHLIGHTS

Task 64 – Solar Process Heat

THE ISSUE

The industrial sector accounts for approximately 30% of the total energy consumption in the OECD countries. The major share of the energy that is needed in industrial companies, services and agriculture is used for heating and cooling of buildings and for production processes at temperatures from ambient up to approx. 400-500°C. This is a temperature range that can be addressed with solar thermal technologies at a high TRL.

To be able to make use of solar heat in industry and to support this market sector for the solar thermal industry, it is necessary to integrate solar thermal systems into the energy supply schemes in a suitable way.

OUR WORK

The goal of this joint project with the IEA SolarPACES TCP's Task IV is to help solar technologies be (and recognized as) a reliable part of process heat supply systems. Instead of focusing on component development, this Task is looking at the overall (solar) system at process temperatures from just above ambient temperature up to approximately 400°C-500°C. Open research questions are the standardization of integration schemes on process level and on supply level and the combination with other efficient heat supply technologies, such as combined heat and power plants, heat pumps, and power-to-heat. As a very important aspect, the experiences of numerous solar process heat markets throughout the world will be brought together to enable a market-oriented dissemination of existing and new knowledge.

The key objective of this work is to identify, verify, and promote the role of solar heating plants in combination with other heat supply technologies for process heat supply, such as fossil and non-fossil (biomass and biogas) fuel boilers, combined heat and power plants, high temperature heat pumps, or power-to-heat.

The Task is organized in 5 subtasks:

- A. Integrated energy systems
- B. Modularization
- C. Simulation and Design Tools
- D. Standardization/Certification
- E. Guideline to Market

Participating Countries

Austria

Brazil

Chile

Denmark

France

Germany

Greece

Mexico

South Africa

Spain

Switzerland

Turkey

United Kingdom

USA

Task Period

2020 – 2023

Task Leader

Andreas Häberle, SPF Institute for Solar Technologies, Switzerland

Email

andreas.haeberle@ost.ch

Website

<https://task64.iea-shc.org>

KEY RESULTS IN 2021

Compilation of Reference Applications for Integrated Energy Systems with Solar Heating Plants Including Representative Load Profiles

Task experts analyzed daily heat load profiles for reference process heat applications. Four clusters with different ambient temperature dependencies were defined and incorporated into an Excel tool that allows for the practical creation of typical load profiles (available at <https://task64.iea-shc.org/publications>).

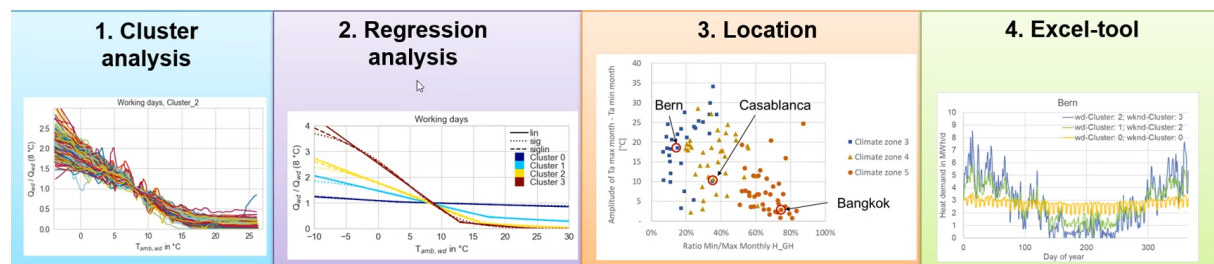


Figure 1. analysis of heat load profiles

There is a high degree of freedom and flexibility in the way to integrate renewable process heat in industrial processes. In nearly every industrial or commercial application, various heat sinks can be found suitable to be supplied by renewable heat, e.g., from solar thermal, heat pumps, biomass, or others. In contrast to conventional fossil fuel-powered heating systems, most renewable heating technologies are more sensitive to the requirements defined by the specific demand of the industrial company. Fossil fuel-based systems benefit from their indifference to process temperatures in terms of energy efficiency, their flexibility for part-load as well as on-off operation, and the fuel as an (unlimited) chemical storage. In contrast, the required temperature and the temporal course of the heat demand over the year determine whether a certain regenerative heat generator is technically feasible at all or can at least significantly influence parameters like efficiency or coverage rate.

Additionally, the feasibility and performance of renewable heating systems are also significantly influenced by the availability of heat sources (solar irradiation, ambient heat, etc.), which vary in time. To compare the potential of the coverage and the performance of renewable heating systems globally, first, it is necessary to attain an in-depth overview of the variety of reference conditions for renewable heating systems. The following reference conditions of industrial processes are decisive:

- Temporal course of heat demand (load profile):
While several methods are available to estimate the expected load profiles of residential buildings, little is known about the load profiles in the industrial and commercial sectors, especially when there is a high share of industrial process heat to the overall heat demand. To fill this knowledge gap, industrial gas consumption profiles were collected. In some cases, natural gas might be used as material, but in most cases, it is burned and transformed to heat in gas boilers. Therefore, the gas consumption is assumed to be equal to the heat demand. Eight hundred profiles in an hourly resolution of natural gas consumption from industrial and large commercial, residential and public consumers (> 1.5 GWh/a) were collected from German consumers. Using this database, the Task is developing a methodology to categorize and create standard heat demand profiles.
- Temperature requirements determined by heat sinks:
Suitable temperature levels were selected according to studies on temperature requirements of a broad range of heat sinks available in the literature.
- Availability of renewable heat sources:

As heat sink and source characteristics are dependent on the location, a method to characterize the seasonality of the temperatures and heat loads at different locations was developed. Based on this methodology, representative locations were selected.

This work defines process heat demand as the overall heat demand of an industrial company, which comprises traditional process heat demand, e.g., heating baths or streams of diverse fluids and space heating. Usually, one system and one heating network cover the total heat demand. Thus, aiming at the highest decarbonization possible, it is not useful to distinguish between these applications as a 100% renewable heating system must provide heat for both.

This work aims to create an overview of the requirements of renewable heating systems by defining reference applications composed of a load profile, a temperature level, and a location. These reference applications represent a broad range of different industry sectors and locations. And, all the defined reference applications combined are intended to represent the entire range of possible variability of heat sinks worldwide.

Collection of Available Solar Process Heat Related National and Trans-National Research and Funding Programs

Solar Heat for Industrial Processes (SHIP) is a ready-to-market technology that can provide renewable heat to industry. The "Guideline to Market" aims to support faster and broader market rollout by demonstrating that SHIP technologies are innovative, affordable, and profitable.

To accelerate innovation and improve competitiveness, programs and instruments of public funding and incentives can be issued, supporting the Task's objectives. To disseminate opportunities provided by such instruments, a survey on available funding programs for SHIP-related research and funding/incentive programs and instruments for SHIP installations was conducted of experts involved or connected to this Task. The results include incentives for SHIP installations and research funding programs from 18 countries (out of 32 countries approached) and are detailed in a [report](#).

The funding programs for SHIP installations use different incentive types like a grant on investment, tax exemptions, loan programs, or others. The incentive type used most amongst the responses is a direct grant on the initial investment of SHIP plants (in place in 9 countries), followed by advantageous taxation or even tax exemptions (8 countries) and loan programs (6 countries). In five countries, other types of incentives are installed.

A comparison of the funding programs to the status of SHIP installations in the investigated countries, represented by the number of plants and the total installed gross collector area (collected from the SHIP projects database, www.ship-plants.info), allowed for a qualitative check on whether a broad SHIP rollout is correlated to the availability of funding programs. The analysis shows that those countries with the most advanced SHIP rollout had funding instruments available. However, the availability of funding instruments alone seems insufficient for a successful broad SHIP rollout.

Based on the survey results, the subsequent analysis of the feedback and discussions recommends incentive/funding instruments to support SHIP technologies' faster and broader market rollout. Based on the input from relevant technology suppliers, direct subsidies on the initial investment of a SHIP installation (CAPEX) are the preferred option of funding/incentive programs as it is easiest to include in an economic assessment approach, for communication with end-users and by this, to support actual implementation including financing. But as diverse as SHIP plants are, just as important are specific solutions for all relevant stakeholders along the different project phases, including industrial end-users and technology suppliers as well as plant operators and investors.