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Large scale solar process heat systems - planning, realization and system operation

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Abstract

Within the FP7-InSun project three different solar process heat systems have been installed and integrated in two different industrial processes. A 1067 m² advanced flat plate collector field and a 130 m² parabolic trough system have been installed at a ham and sausage production in Austria to preheat the feed water of a steam boiler and to prepare hot water for cleaning and drying processes. A 2640 m² Fresnel collector field installed at a brick fabrication in Italy produces steam at 180°C and 12 bars to heat air for a brick drying process. In this paper the experiences made during planning, installation, commissioning and regular system operation will be described and discussed together with measured performance data. Furthermore, system costs and cost improvements reached by optimization in the collector production and standardization of system integration devices are shown and discussed together with future application potentials on the basis of detailed simulation studies carried out during the project.

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Keywords: Fresnel; parabolic trough; Solar process heat; direct / indirect steam generation

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1. Introduction

The main idea of InSun was to demonstrate the reliability and quality of large scale solar thermal systems using different types of collectors (flat plate, concentrating Fresnel, concentrating parabolic trough) for the generation of heat employed in different industrial processes at different temperature levels.

Scientific and Technology Objectives (STO) of the InSun project were:

- to demonstrate the high potential and variety of solar thermal process heat
- to increasing the reliability by automated system observation and fault detection
- to reduce cost risk factors
- to provide guidelines and easy to use design tools
- to evaluate application and market potentials for different collector technologies

Two of the InSun collector systems including flat plate collectors and concentrating parabolic through collectors are installed in Austria at the company BERGER, which is dedicated to the production of cooked ham and sausages. The third solar thermal system including concentrating Fresnel collectors is installed in Italy at the brick factory Laterizi Gambettola.

All systems have been installed, commissioned and improved. For the commissioning and automated system observation new simulation and algorithm based fault detections methods have been developed and successfully applied to the solar systems installed. During commissioning several control problems and sensor errors could be detected. For the control optimization detailed dynamic simulation tools [1], [2] have been used, e.g. for the improvement of the parameterization of PID controllers. For the parabolic trough collector system of SOLERA operating as temperature booster for the flat plate collector of SOLID at BERGER, hardware-in-the-loop test (HiL) have been used by ZAFH. In this test, the real plant with its operational boundaries is dynamically simulated on a PC simulator. The laboratory HiL simulator PC has its own hardware interfaces and exchanges signals in real time with the PLC (Programmable Logic Controller). The control algorithms can be developed, optimized and validated efficiently and without safety risks. HiL tests overcome the mostly individual and costly control calibration on site. Furthermore, the controller can be tested under critical and varying conditions without safety risk. The application of this methodology significantly reduced the commissioning time.

The monitoring data for more than two years were collected and analysed for the large collector fields of InSun. The parabolic trough collector field was finalised during the last month of the project. For this system only one month of monitoring data could be collected, which was used for the advanced model based commissioning.

The handbook for planners developed within InSun summarises the experienced gained and the lessons learned during InSun and provides useful information for planners aiming to design and install solar process heat systems. For a fast check of expected energy yields the InSun SHIP easy to use internet based design tool aims to provide first useful information for different climatic conditions and system configurations.

The InSun team participated actively in the elaboration of the integration guideline within the IEA SHC TASK 49 [3]. The contribution focused on developing a decision making tool (matrix) to identify suitable integration points for solar heat. The so-called “Suitability indicator matrix” helps planners to identify good unit operations and integration levels within an existing factory.

Industrial process heat business models have been analysed and developed within the InSun project to find ways for a fast market penetration. Activities focused on the development of one-stop-shop models, ESCo models (IEA Task 45 participation [4]), promotional activities, EU and extra EU partnership development strategies, the identification of promising target application groups, price reduction potential through process optimization and incentive schemes. Based on all findings a roadmap for a fast market deployment has been developed.