



**SolarPACES Annex IV**

**IEA SHC Task 49**

**Solar Process Heat for Production and Advanced Applications**

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## **Updated Efficiency Finder**

Version 1.0, December, 2015

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# 1 IEA Solar Heating and Cooling Programme

The Solar Heating and Cooling Technology Collaboration Programme was founded in 1977 as one of the first multilateral technology initiatives ("Implementing Agreements") of the International Energy Agency. Its mission is *"to enhance collective knowledge and application of solar heating and cooling through international collaboration to reach the goal set in the vision of solar thermal energy meeting 50% of low temperature heating and cooling demand by 2050."*

The members of the IEA SHC collaborate on projects (referred to as "Tasks") in the field of research, development, demonstration (RD&D), and test methods for solar thermal energy and solar buildings.

A total of 57 such projects have been initiated, 47 of which have been completed. Research topics include:

- ▲ Solar Space Heating and Water Heating (Tasks 14, 19, 26, 44, 54)
- ▲ Solar Cooling (Tasks 25, 38, 48, 53)
- ▲ Solar Heat or Industrial or Agricultural Processes (Tasks 29, 33, 49)
- ▲ Solar District Heating (Tasks 7, 45, 55)
- ▲ Solar Buildings/Architecture/Urban Planning (Tasks 8, 11, 12, 13, 20, 22, 23, 28, 37, 40, 41, 47, 51, 52, 56)
- ▲ Solar Thermal & PV (Tasks 16, 35)
- ▲ Daylighting/Lighting (Tasks 21, 31, 50)
- ▲ Materials/Components for Solar Heating and Cooling (Tasks 2, 3, 6, 10, 18, 27, 39)
- ▲ Standards, Certification, and Test Methods (Tasks 14, 24, 34, 43, 57)
- ▲ Resource Assessment (Tasks 1, 4, 5, 9, 17, 36, 46)
- ▲ Storage of Solar Heat (Tasks 7, 32, 42)

In addition to the project work, there are special activities:

- SHC International Conference on Solar Heating and Cooling for Buildings and Industry
- Solar Heat Worldwide – annual statistics publication
- Memorandum of Understanding – working agreement with solar thermal trade organizations
- Workshops and seminars

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## 2 Relevance of process classification in SHIP projects

Due to the wealth of different process technologies, the variety of possible concepts for solar process heat systems seems to be very large. However, as basic unit operations repeat themselves in industry and process technologies realising these unit operations are similar in different sectors, a classification of processes makes sense in order to classify and specify possible solar integration concepts and complete solar process heat system concepts. Basically, we find similar technical solutions for many process steps, and for these similar SHIP integration possibilities exist.

## 3 Efficiency Finder – overview

The Efficiency Finder, also known as Zero Emission WikiWeb or Matrix of Indicators is a reference book that contains important information on unit operations, energy supply technologies, process technologies, best practice examples, and guidelines for implementation of efficiency measures and renewable energy technologies. The website (<http://wiki.zero-emissions.at/>) can be used as an inter-active compendium by process engineers, energy managers, RES experts, etc. to support their work e.g. by providing measures for energy efficiency and finding suitable solar applications in production processes.

page discussion view source history

EFFICIENCY FINDER

	general description	solar integration schemas	integration of biomass	industry sectors			
				Subsection DA food	Subsection DB textiles	Subsection DJ metals	Subsection DG chemicals
		INFO	INFO	INFO	INFO	INFO	INFO
CP, EE, RE, PI				x	x	x	x
UNIT OPERATIONS							
CLEANING	info	info		x	x	o	o
DRYING	info	info		x	x	o	o
EVAPORATION AND DISTILLATION	info	info		x			o
BLANCHING	info	info		x			
PASTEURIZATION	info	info		x			o
STERILIZATION	info	info		x			o
COOKING	info	info		x	x		
OTHER PROCESS HEATING	info			x	x	o	o
GENERAL PROCESS HEATING	info	info		x	o	o	o
HEATING OF PRODUCTION HALLS	info	info		x	o	o	o
COOLING OF PRODUCTION HALLS	info			x			o
COOLING PROCESSES	info			x		o	o
MELTING	info			x	x		
EXTRACTION	info			x			
BLEACHING	info			x	x		
PAINTING	info				x	o	o
SURFACE TREATMENT	info	info				o	

Figure 1: Main page of the Efficiency Finder (<http://wiki.zero-emissions.at/>)

The Efficiency Finder is organized as a matrix as shown in Figure 1. It is divided into industry sectors, product lines, and products on the one hand and unit operations and temperature ranges on the other. Therefore, it contains general descriptions of multitude unit operations and specific information on four different industry sectors (Food and Beverages, Textiles, Metals, and Chemicals). For every sector, the Efficiency Finder has an own sub section with, more specific information of unit operations based on the product that is produced.

By entering a sub-section for a specific industry sector, the general structure of the WikiWeb remains, however leading to a more detailed set of information. Figure 2 shows the sub-section of Food & Beverage. In this sub-section typical processes are assigned to the general unit operations e.g. cleaning of bottles, washing of products, and cleaning of productions halls and equipment for the general unit operation of cleaning. Additionally, different subsectors such as milk processing,

manufacturing of chocolate, meat products, or beer are included. The different unit operation and typical processes are assigned to these different subsectors. Therefore, specific information e.g. for pasteurization within milk processing industry is given. This includes general flow sheets of the process and details, such as temperature and resident time of different milk products or available technologies that can be applied for pasteurization.

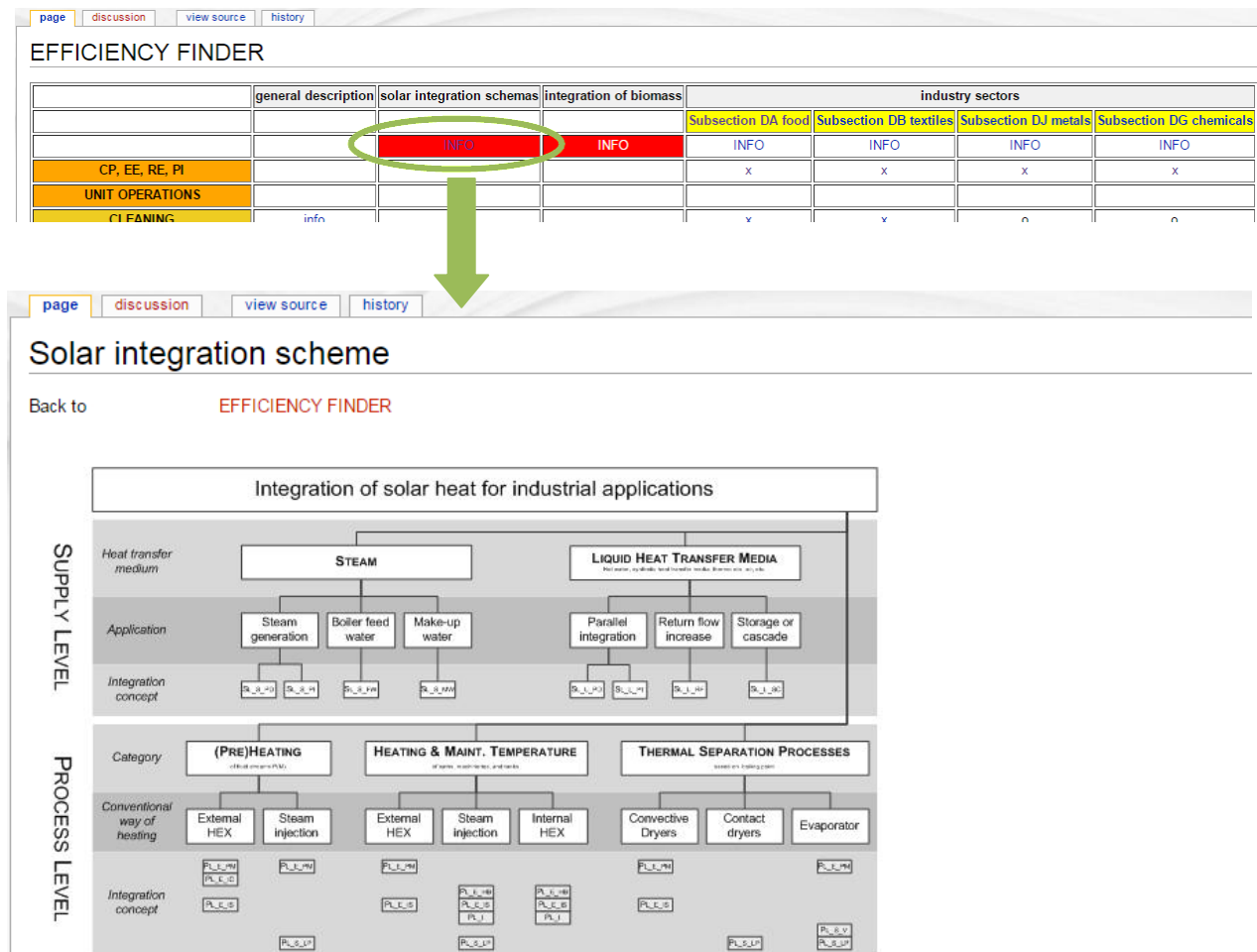
Unit Operations	Typical processes	milk products	fruits/ vegetables/ herbs	sugar	beer	fats/ oils	chocolate/ cacao/ coffee	starch/ potatoes/ grain mill products	bread/ biscuits/ cakes	wine/ beverage	meat	fish	aroma	baby food	solar integration	emerging technologies process intensification	heat integration
CLEANING	Cleaning of bottles and cases	x	x		x	x				x	x	x			x	x	
	Washing products	x	x		x	x		x		x	x	x			x		x
	Cleaning of production halls and equipment	x	x	x	x	x	x	x		x	x	x			x		x
DRYING	Drying	x	x	x	x	x	x	x		x	x	x		x	x		x
EVAPORATION AND DISTILLATION	Evaporation	x	x		x	x	x							x	x		x
	Distillation				x	x							x		x		x
	Deodorization					x	x								x		x
BLANCHING	Blanching		x					x			x				x		x
PASTEURIZATION	Pasteurization	x	x		x				x	x				x	x		x
STERILIZATION	Sterilization	x	x							x					x		x
COOKING	Cooking and boiling		x		x		x	x		x		x	x		x		x
OTHER PROCESS HEATING	Pre-heating and Process Water	x	x		x				x								x
	Soaking		x		x		x					x					
	Thawing	x									x	x					x
	Peeling	x	x														x
GENERAL PROCESS HEATING	Boiler feed-water preheating	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
HEATING OF PRODUCTION HALLS	Heating of production halls	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
COOLING OF PRODUCTION HALLS	Cooling of production halls	x	x	x	x	x	x	x	x	x	x	x	x	x			x
COOLING PROCESSES	Cooling, chilling and cold stabilization	x	x	x	x	x	x	x	x	x	x	x			x		x
	Ageing	x			x					x	x	x					x
MELTING	Melting	x				x											x
EXTRACTION	Extraction		x	x		x	x										x
BLEACHING	Bleaching		x														x
FERMENTATION	Fermentation	x			x				x	x	x	x					x
Temperaturelevel																	
20-40°C		x	x		x		x		x	x							
40-60°C		x	x		x		x		x	x	x		x				
60-80°C		x	x	x	x	x	x	x	x	x	x	x					
>80°C		x	x	x	x	x	x	x	x	x			x				

Figure 2: Sub-section Food & Beverages of the Efficiency Finder

Besides this sector specific information on applied processes and technologies, the Efficiency Finder contains additional information on how to reduce the energy consumption and carbon emissions within these industry sectors. Therefore, specific information is given for Cleaner Production, Eco Efficiency, Renewable Energy Sources, and Process Integration.

# 4 Integration solar process heat – Status of Efficiency Finder 2015

Within Task 49 the wiki database “Efficiency Finder” was updated with new information of Subtask B. After publication of Del B.2 of Task 49 (Integration Guideline [1]), the developed Integration Schemes [2] for solar heat have been included in the Efficiency Finder. Therefore, the overall classification of industrial heat consumers on supply- and process level was included and briefly explained. Within the Efficiency Finder, this information can be found by entering the ‘INFO’ section of the category ‘solar integration schemes’ (cp. Figure 3). Based on this, the developed solar integration schemes were assigned to the different unit operations of Efficiency Finder. Today, users of the Efficiency Finder can find one or even several integration schemes for the majority of existing unit operations.



The figure shows the classification of industrial heat consumers for the integration of solar heat for industrial applications. To find a suitable integration concept for a heat consumer that was chosen to be supplied with solar heat the level of integration has to be distinguished at first. For an integration point at supply level, a distinction is drawn between steam and liquid heat transfer media. The integration concepts for liquid heat transfer media are valid for hot water, synthetic media, or thermal oils. The different media will only lead to differences in the required heat exchanger type. In principle the integration concepts for liquid heat transfer media are also valid for air as heat transfer medium.

By using steam three different integration concepts are possible: solar steam generation (parallel integration), heating of boiler feed water and heating of make-up water (both serial integration). The parallel integration can be realized directly or indirectly (e.g. with thermal oil or pressurized water). The concepts for serial integration to heat boiler feed water or make-up water differ mainly in the respective temperature level and potential heat recovery measures that have to be considered. Besides the parallel and serial integration of solar heat in conventional heat supply systems with liquid heat transfer media there is

**Figure 3: General information on solar integration schemes within the Efficiency Finder**

Next to this general information, the developed integration concepts were included within the Efficiency Finder. As shown in Figure 4, the concepts for integrating solar heat at supply level, were assigned to the category 'General Process Heating'. By clicking on the 'info' link, seven integration concepts are given and explained.

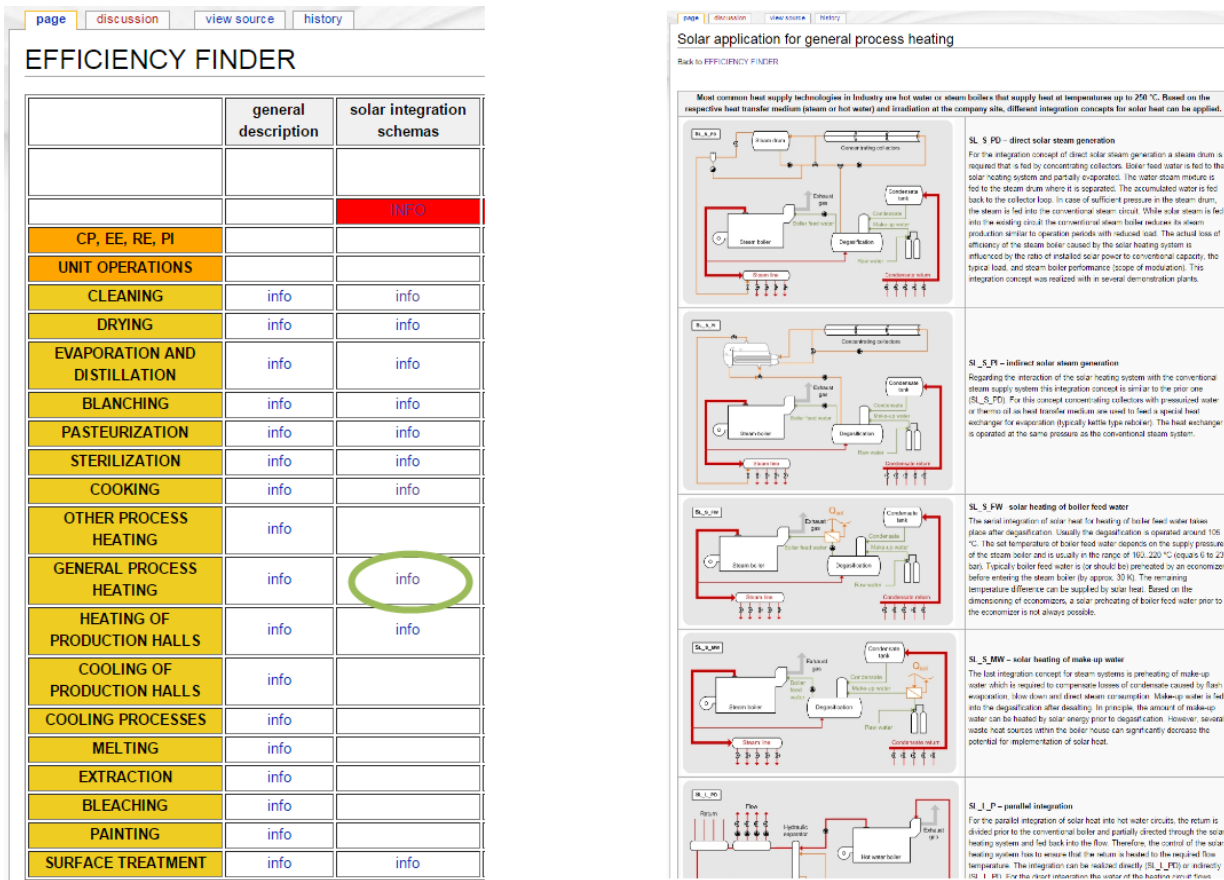


Figure 4: Solar integration schemes for supply level within the Efficiency Finder

For the integration of solar heat at process level, general integration concepts were implemented within the Efficiency Finder. For almost every unit operation, one or even more suitable integration concepts with a detailed description were included. This is shown in Figure 5 using the unit operation ‘cleaning’ as example. By clicking the ‘info’ link, five general integration concepts are illustrated and explained that can be generally applied for cleaning processes based on the respective installation.

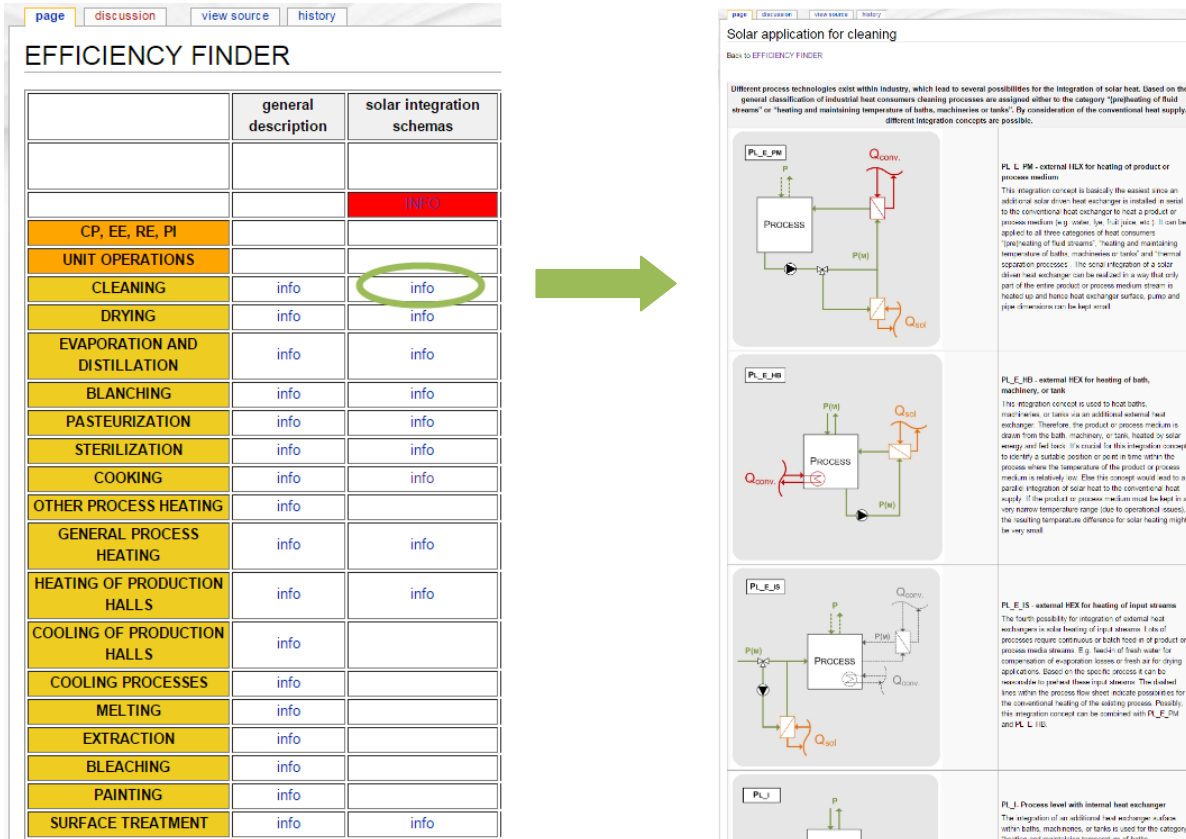


Figure 5: General solar integration schemes for unit operations (e.g. cleaning, drying, cooking) within the Efficiency Finder



By entering the Sub-section of Food and Beverage production, additional concepts for solar heat integration for specific processes were included. This sub-section includes several processes within the unit operation ‘cleaning’. By choosing the process ‘cleaning of bottles and cases’, two specific integration concepts are illustrated and explained (cp. Figure 6).

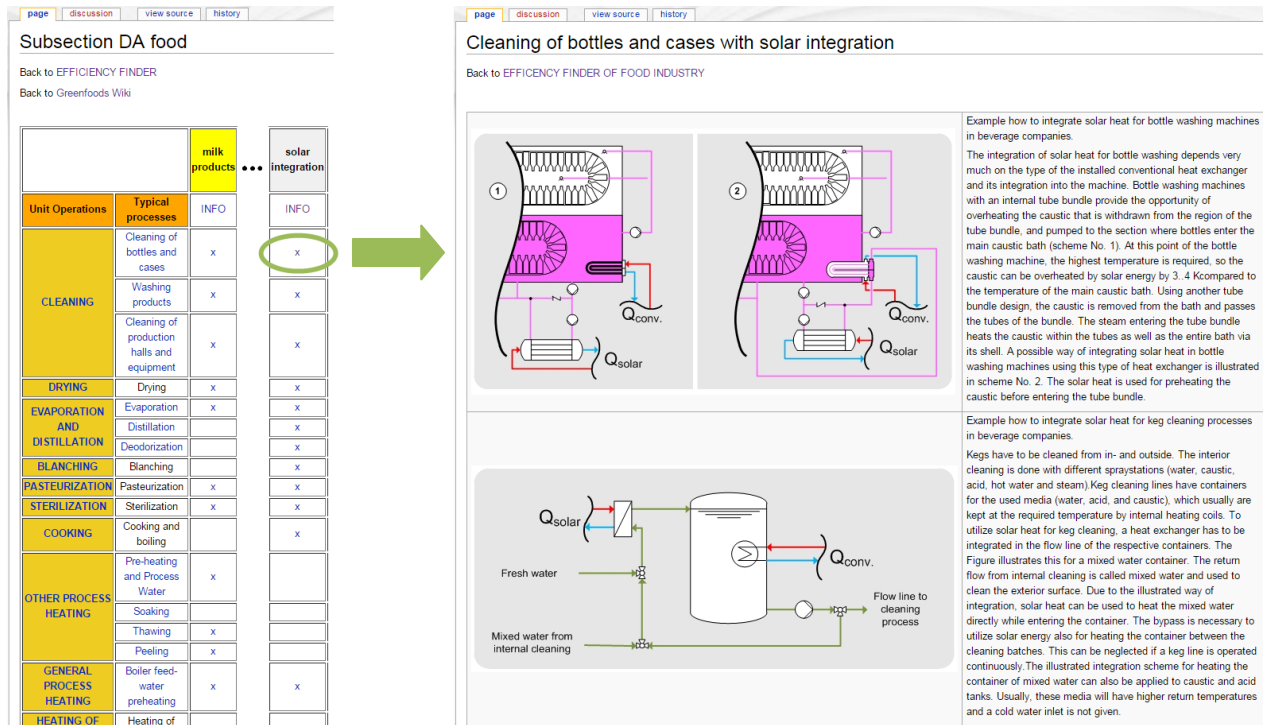


Figure 6: Solar integration schemes for specific processes (e.g. cleaning of bottles and kegs) within the Efficiency Finder

## 5 Conclusions & further work

The classification of solar integration concepts has shown that it is possible to give the planner a systematic guideline to find the appropriate concept for realising a solar process heat plant, based on the specifications of the targeted integration point. This is a huge step forward in making the planning and realisation of efficient SHIP systems easier.

In future, an expansion of the updated Efficiency Finder to more sectors would increase the practical application of the database and hopefully stimulate the realisation of more solar process heat applications.

### ACKNOWLEDGMENT

We acknowledge the funding of the updates for the Food industry within the project GREENFOODS, under the IEE Intelligent Energy Europe Programme ([www.greenfoods.eu](http://www.greenfoods.eu)).

## 6 Literature references

1. Muster-Slawitsch, B., et al., *Integration Guideline*, B. Muster-Slawitsch, Editor. 2015, IEA Task 49/IV.
2. Schmitt, B., *Integration of solar heating plants for supply of process heat in industrial companies*. 2014, University of Kassel: Shaker Verlag, Aachen, Germany.