



SOLAR THERMAL ENERGY IN PROCESS INDUSTRY – STATE AND PERSPECTIVES

SOLARNA TERMIČKA ENERGIJA U PROCESNOJ
INDUSTRIJI – STANJE I PERSPEKTIVE

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1. Introduction

- Solar thermal energy has not played a important role for a long time.
- Almost 50% of total energy consumption refers to thermal energy (heat).
- The industrial sector has the highest share in total energy consumption
(in the OECD countries - around 30, in the EU - around 28%).
- The processing industry sectors use about 75% of their energy consumption as a heat, and most of it is used as heat at low and medium temperatures (below 250°C).





2. Solar thermal technologies

- In general, there are three groups of solar thermal technologies:
 - (1) liquid systems; (2) air systems ; (3) solar concentrators.
- Solar liquid systems: flat-plate collectors (FPC) or evacuated tube collectors (ETC). Advanced FPC and ETC can generate temperatures up to 250°C but, they are also more expensive.
- Solar air systems are: primarily in the food industry for drying.
- Solar concentrators : linear parabolic collectors, linear Fresnel collectors and parabolic dish collectors. Such type of collectors track the sunshine over day. They can generate heat to temperatures up to 400°C.



3. Requirements for temperature range for process heat

- The temperature level required for an industrial process is crucial for

assessment of the feasibility of solar heating

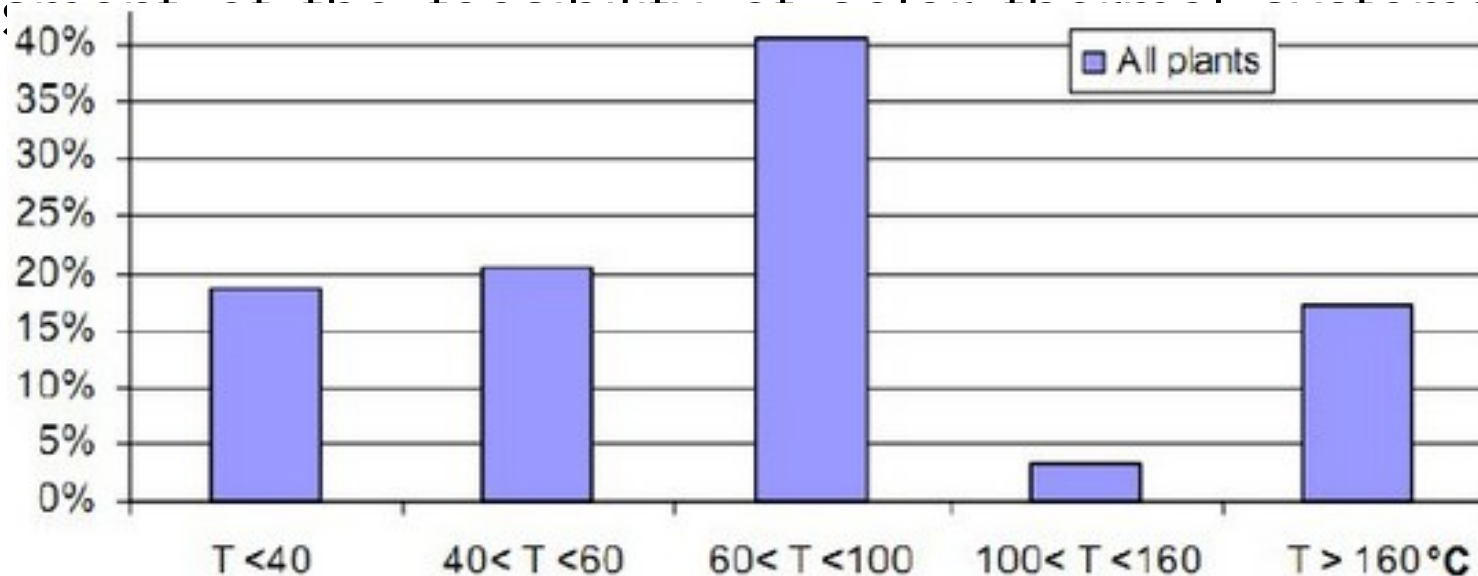


Fig.1: Temperature level of the supported processes

of existing solar heating systems, [5]



3. Requirements for temperature range for process heat

- High percentages of heat demands in the low temperature range are found in food, beverages, paper and textiles industries, while in the medium temperature range heat is needed in the plastic and chemical industries.
- More than 60% of total process heat is required in a temperature range of up to 250°C for various applications such as drying, cooking, cleaning, extraction and many others.
- Solar thermal cooling (absorption, adsorption, desiccant) requires heat at temperatures in the range 80-110°C, while

two-



4. Solar heat in process industry - current state

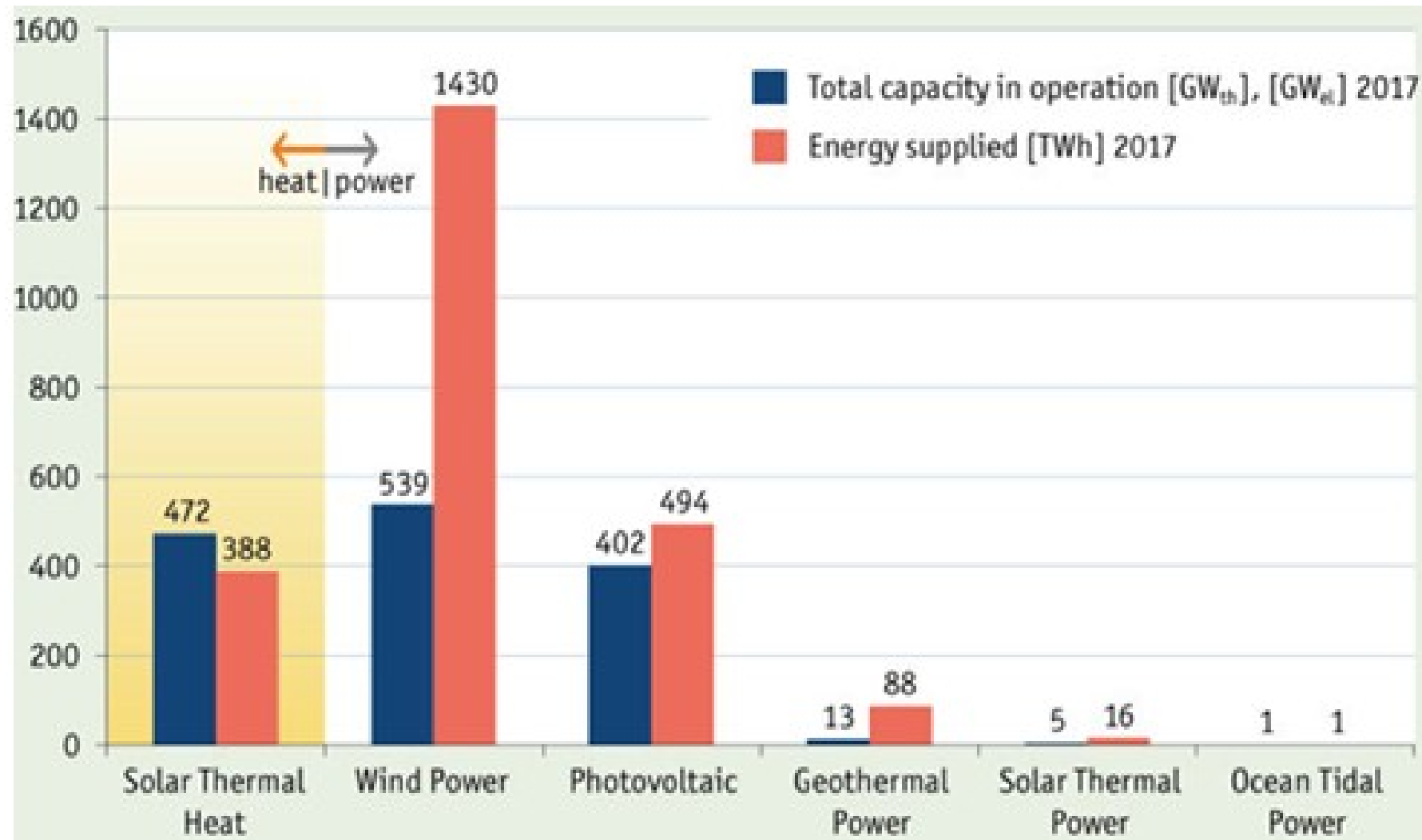
-Solar heating and cooling was the largest solar sector.

-The two key areas of

growth were solar heat for industrial

processes and

Fig.2: Total capacity in operation and energy delivered in solar district heating and energy delivered





Solar heat in process industry - current state

- A record years when it comes to the use of solar heat in industrial processes were 2017 and 2018.
- The 2017 is ended with 124 new solar thermal systems installed worldwide (192580 m²).
- India and Mexico are at the top by the number of new plants, while the largest plants were built in Oman and China.
- The 2018 was very similar to 2017 (105 systems, 200140 m²; 140 MW_{th}).



- Of the 635 documented systems by the end of 2017, 271 has more



Solar heat in process industry - current state

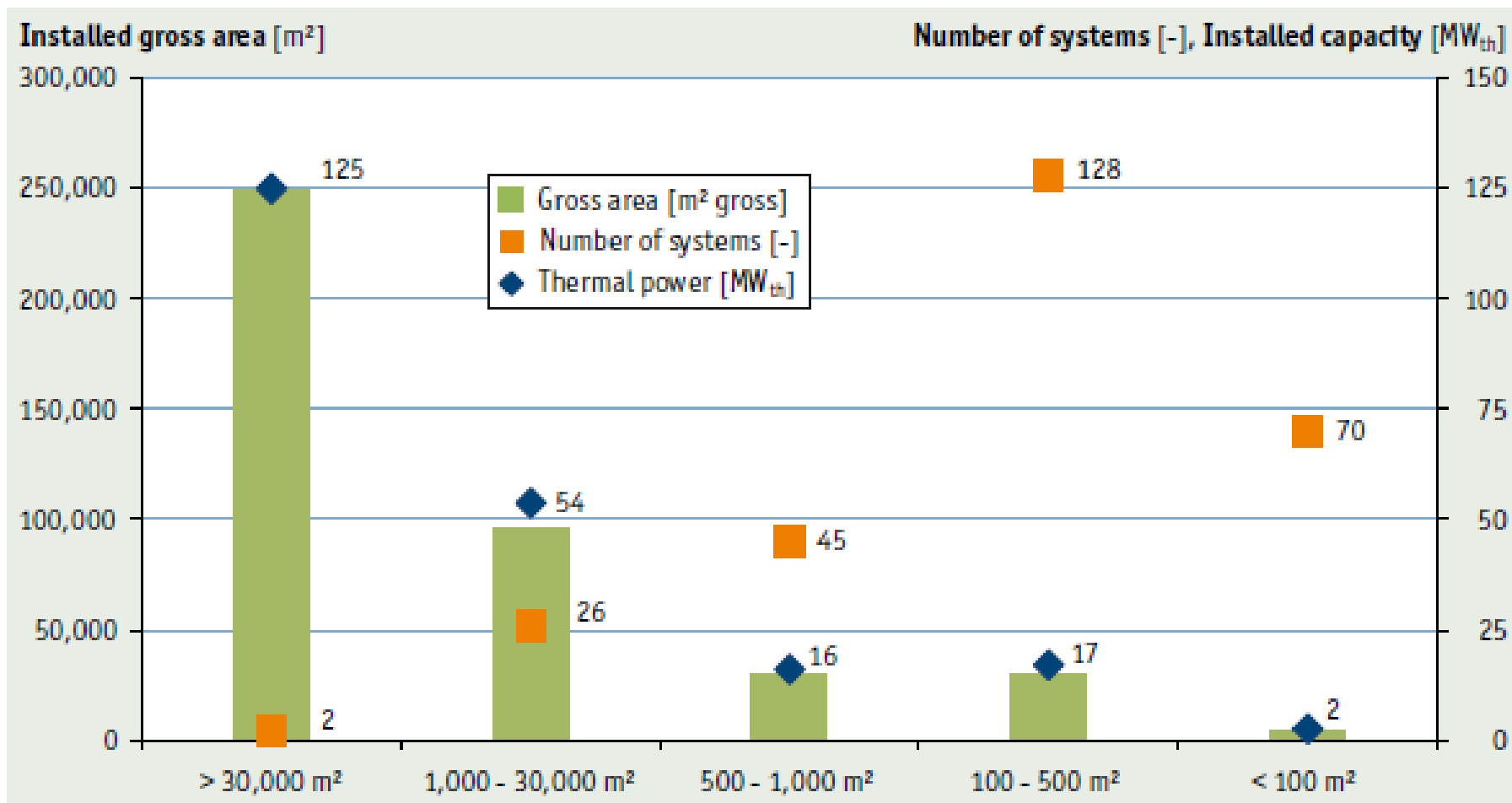


Fig. 3: Solar process heat plants in operation



Solar heat in process industry - current state

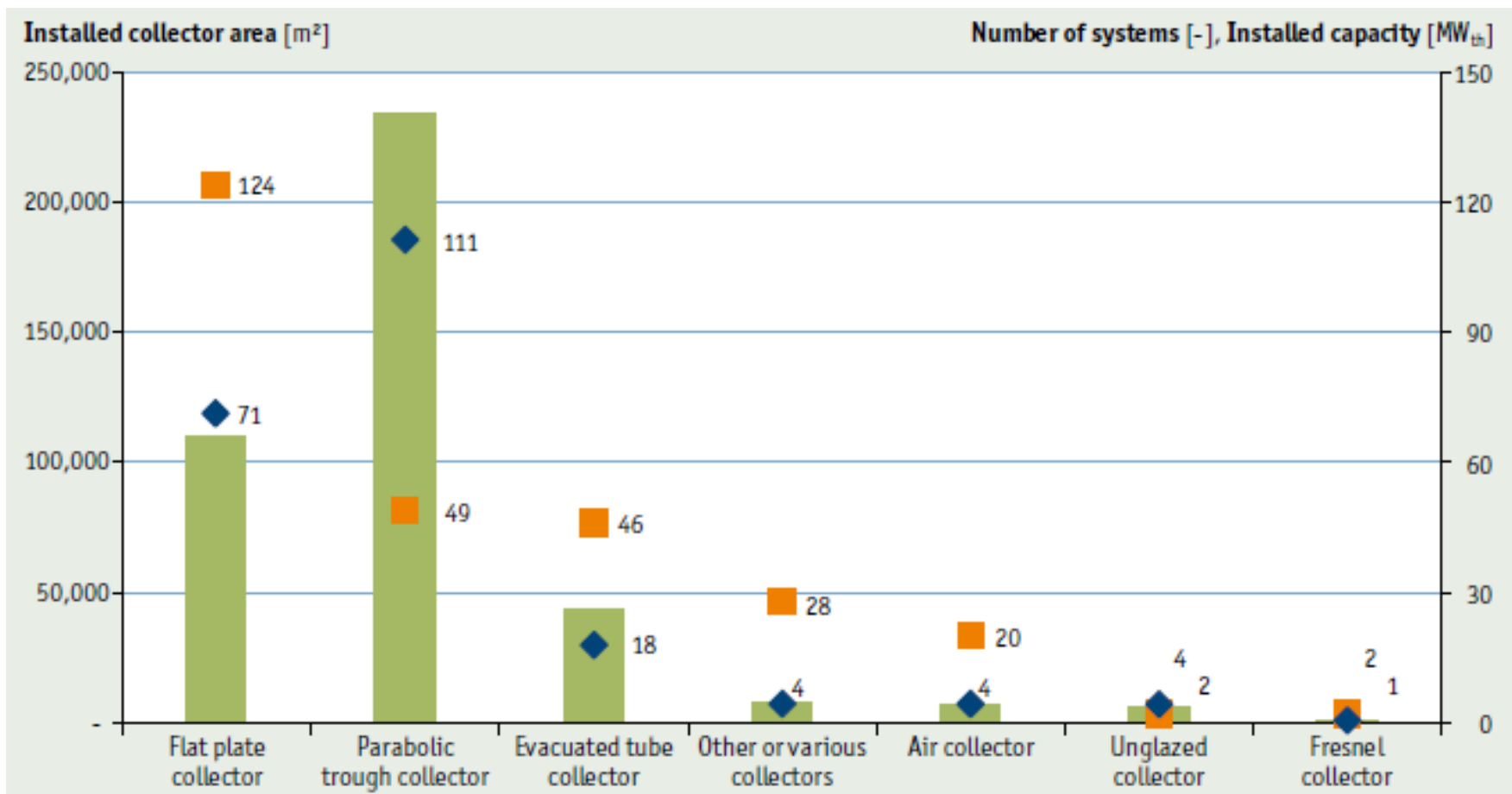


Fig. 4: Solar process heat application by type of collector



Solar heat in process industry - current state

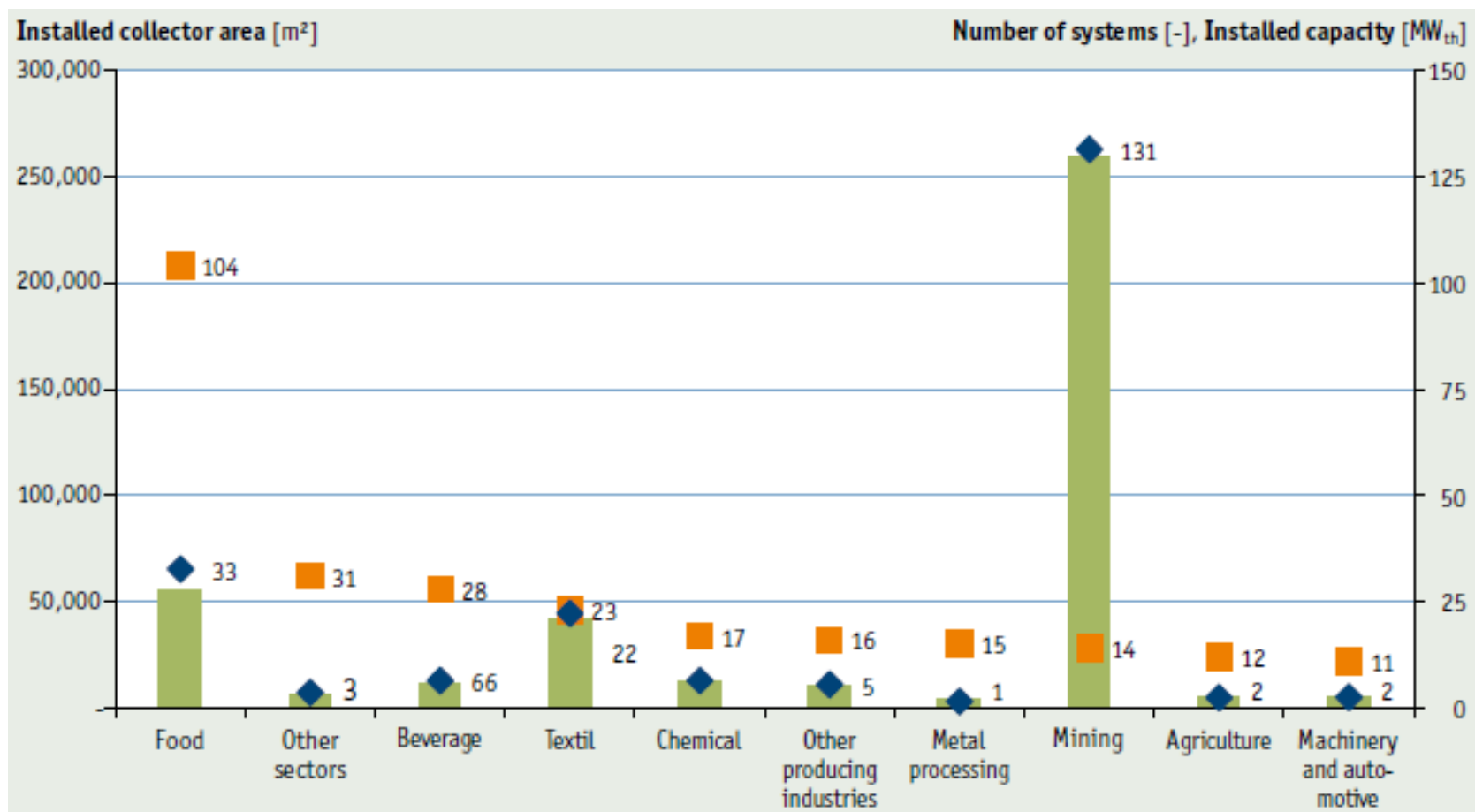


Fig. 5: Solar process heat application by industry sector



Solar heat in process industry - current state

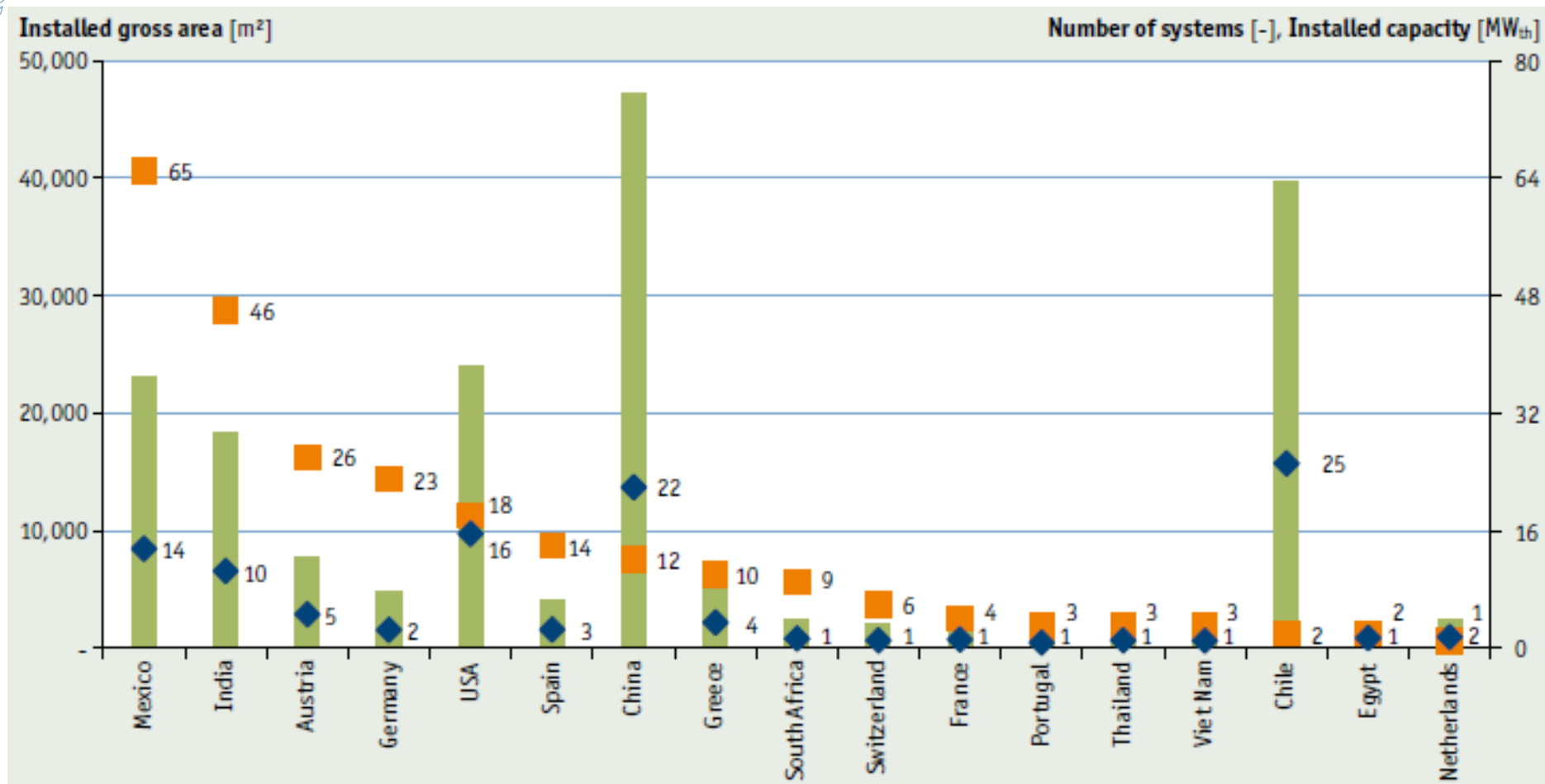


Fig. 6: Solar process heat plants in operation by country



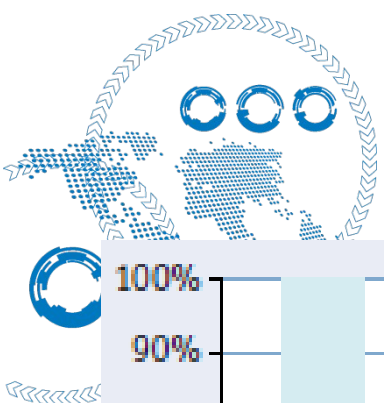
Solar heat in process industry - current state

-Solar cooling is growing worldwide and has huge potential.

-Approximately 70 % of the small and medium capacity (<350 kW) solar cooling systems are installed in Europe



Fig. 7: Solar cooling systems – market development



Solar heat in process industry - current state

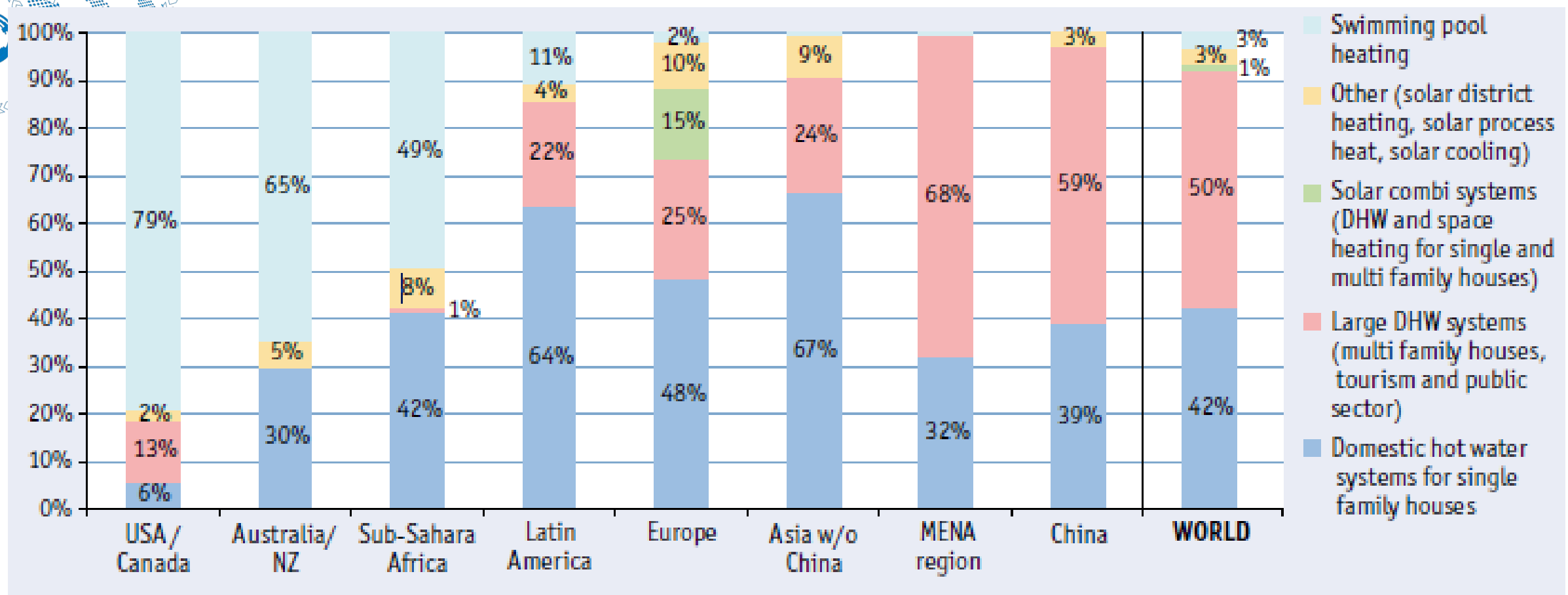


Fig. 8: Distribution of ST systems by application and by regions installed in 2016





Solar heat in process industry - current state

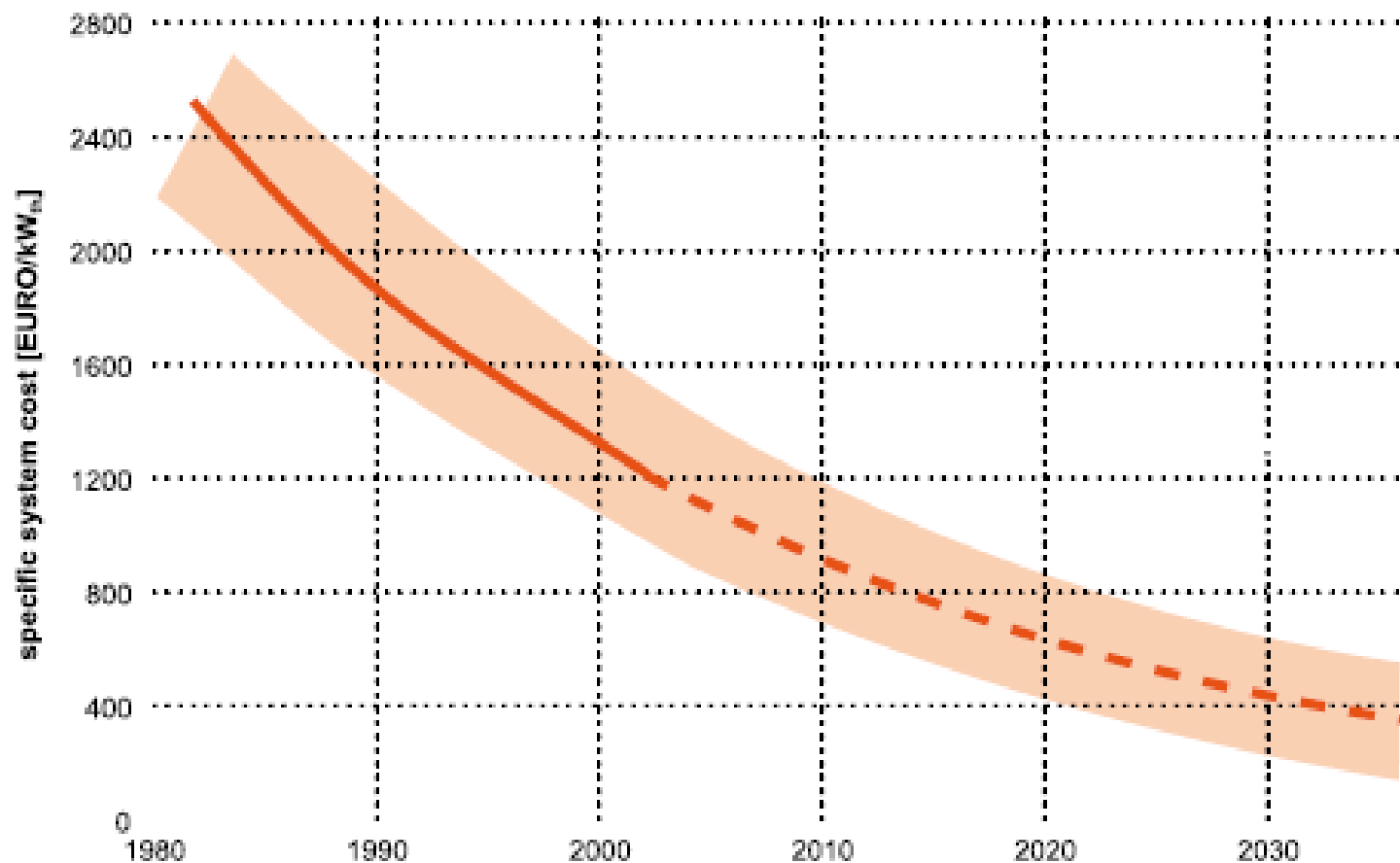


Fig.9: Trend of changing specific invest costs of small systems in central Europe



5. Perspectives and challenges for future development

- The use solar thermal energy in processes industry is currently at the relatively early stage.
- With technological development and changes in energy prices, more and more medium temperature applications, of up to 250°C, will become market feasible.
- Some studies have concluded that solar thermal systems in the EU could provide nearly 4% of heat demand to the industrial sector, while optimistic prediction sead that at global level

there is a potential up to about 10% to 2030 while in the future





Perspectives and challenges for future development

- A comprehensive approach is needed:
 - improvement of technological processes, reduction of heating and cooling demands, implementation of energy efficiency measures...
- Key areas for technological and market development are:
 - development medium-temperature collectors and components,
 - thermodynamic optimization of processes,
 - development of design procedures,
 - reduction of investment costs,
 - financial incentives and widespread public-funded demonstration projects,



Perspectives and challenges for future development

- The current costs of industrial solar thermal systems are determined by a relatively small number of suppliers.
- The IEA suggests that costs can be reduced by as much as 20% when a country's total installed capacity doubles.
- IEA estimates that there will be a reduction in the costs of 35-50% for solar heating and 35-45% for solar cooling by 2030, and that investment costs can be reduced by 60% between 2007 and 2050.
- Key factors for cost reductions are: automation of production processes, modular designs for easier installation, optimised tracking



Perspectives and challenges for future development

- Europe is leader of solar thermal technology, manufacturing capacity is growing significantly, primarily in relatively high-technological developed countries.
- Solar thermal can become a job motor, in 2016. provided about 35000 full-time positions and in optimistic prediction of ESTTP [1], this figure is expected to increase to 220,000 by 2030.
- Solar and wind jobs are growing at a rate 12 times as fast as the rest of the US economy.



Perspectives and challenges for future development

The key drivers for application solar heating and cooling technologies

in industrial processes are:

- reducing risks due to unstable and rising prices for fossil fuels;
- reducing energy costs;
- reducing carbon emissions and meeting energy needs by

localised

production.

The main barriers are follows:

- high investment costs;
- fossil fuel pricing (subsidise);
- lack of information and lack of social awareness;
- lack of suitable design guidelines;
- the availability of space.



Conclusions

- The process industry has a large share of total final energy consumption, it uses about 75% of its energy consumption as a heat, therefore this area is very perspective for the application of solar thermal technology.
- In article was given an overview of the actual state in the global market in terms of the number and capacity of installed solar systems, types of solar collectors, industrial sectors and countries of application.

- It was attempted to identify areas with potential for the application