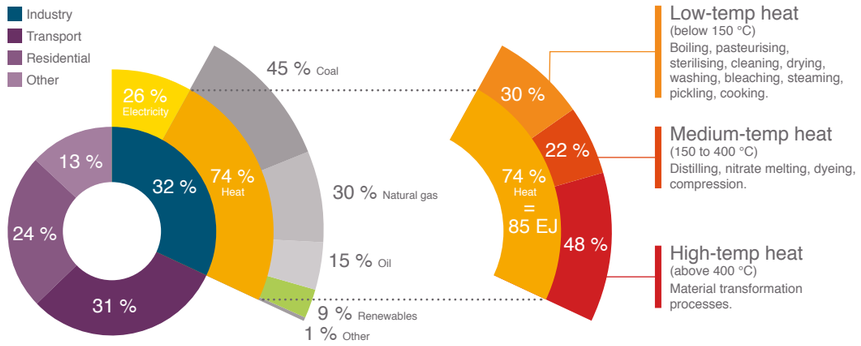
SOLAR HEAT FOR INDUSTRY

Solar Payback

INDUSTRIAL SOLAR HEAT PAYS OFF

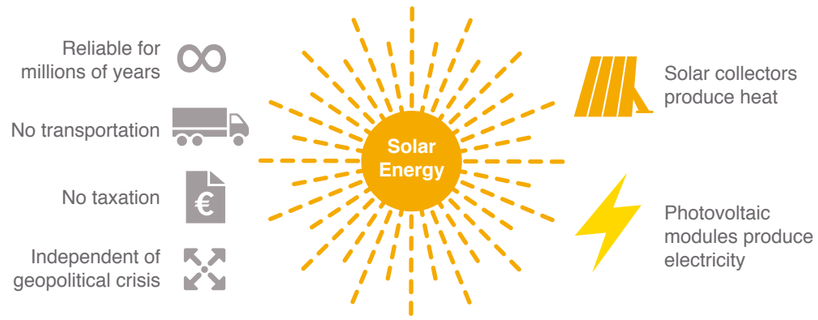
There is more final energy consumption of heat in the industrial sector than there is electricity consumed worldwide. Electricity, however, is talked about more.

ENORMOUS GLOBAL HEAT DEMAND IN INDUSTRY



TOTAL FINAL ENERGY CONSUMPTION 2014: 360 EJ (EXAJOULE, see Glossary page 17); IEA [1] IRENA [2]

POWERFUL RESOURCE



23.7 %
Renewable energy share (including hydropower) in final global **electricity** consumption across all sectors

9 %
Renewable energy share in final **heat** consumption of global industrial sector

0.001 %
Solar share in final heat consumption of global **industrial** sector

REN21

INDUSTRIAL HEAT DEMAND ON THE RISE

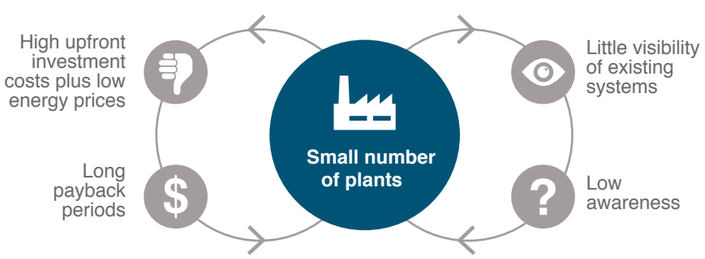
1.7 %
Average annual growth of industrial heat demand until 2030 [4]

90 %
Met by coal, oil and gas

IEA CONFIRMS

Solar heating and cooling not on track for 2 °C scenario

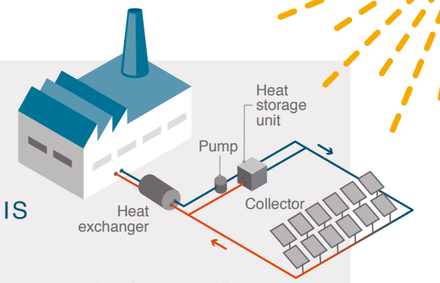
VICIOUS CIRCLE OF LOW DEPLOYMENT RATES



Three ways to break the vicious circle

More than **500** industrial manufacturers trust solar heat worldwide.

More than **400,000 m²** of collector and mirror area (≈ 280 MW_{th}) produce **Solar Heat for Industrial Processes** around the globe.



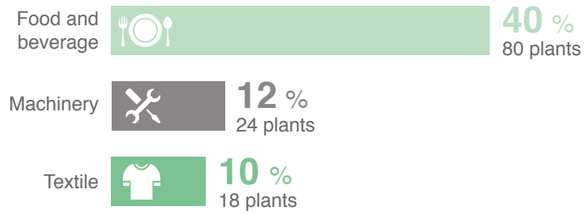
WHAT IS SHIP?

SHIP is the acronym for **Solar Heat for Industrial Processes** and describes systems which provide solar heat in a factory. A collector field heats a process fluid by means of solar radiation and a heat exchanger transfers this heat to a supply system or production process in the factory as hot water, air flow or steam. Storage units make it possible to use the generated heat at night-time.

ESTIF [4]

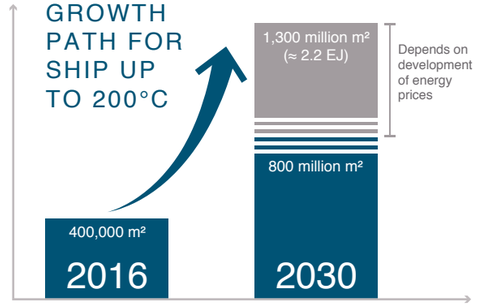
MAJOR INDUSTRIES

Industry segments with highest number of realised SHIP plants



SHIP-PLANTS.INFO [5]

GROWTH PATH FOR SHIP UP TO 200°C



ECONOMICALLY REALISABLE POTENTIAL GLOBALLY; IRENA [3]

FOUR REASONS FOR SOLAR HEAT

Greatly step up communication efforts to raise awareness of the technology among potential customers in industry.

70 % of turnkey SHIP suppliers (strongly) agree that SHIP has already been competitive in many markets, but is not known well enough to customers.

Support financing models to reduce risks and initial costs to small and medium industrial investors.

79 % of turnkey SHIP suppliers (strongly) agree that heat supply contracts / ESCO models are an important means of increasing deployment.

Implement measures for raising energy prices (e.g. carbon tax) or stipulating a renewable quota in certain industries.

YOU FIND ALL EXTERNAL REFERENCES ON PAGE 19 OF THIS BROCHURE. THE ADDITIONAL DATA IS BASED ON THE INTERNATIONAL SURVEY AMONG SHIP SUPPLIERS DESCRIBED ON PAGE 8/9.

SATISFIED INVESTORS

SOUTH AFRICA
Cape Brewing Company • Brewery

Photo: CBC

120 m²
(84 kW)
Gross collector area

ZAR 1.4 million
(USD 110,000)
Investment incl. installation

Heating of process water
70 - 90 °C

> The solar system was integrated within one day, so we succeeded to have minimum interruption of our day-to-day operation. At current rate, a realistic ROI is +/-6 years.

Andy Kung, Chief Operating Officer, Cape Brewing Company

Year of installation 2015	
Solar fraction	**29.6 %** of total paraffin demand
Subsidy	**EUR 30,000** from SOLTRAIN
Annual savings	**19,386** litres of paraffin
Turnkey supplier	**E3 Energy** South Africa

Photo: Bärbel Epp

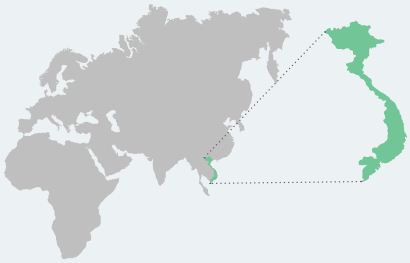
VIETNAM
ISA TanTec • Tannery

Photo: ISA TanTec

1,050 m²
(735 kW)
Gross collector area
(Non-pressurised)

USD 350,000
Investment incl. installation

Retanning
70 °C



> Solar heat helps us to reduce energy costs significantly and more important, it keeps them predictable and stable. In fact, it also makes us more competitive and attractive on the market, as our customers are increasingly looking for eco-friendly suppliers.

Tom Schneider, Co-founder, ISA TanTec

Year of installation 2010	
Solar fraction	**15 %** of total factory Approx. **30 %** of retanning process
Annual savings	**120,000 kg** compressed natural gas
Turnkey supplier	**Aschoff Solar** Germany

Photo: ISA TanTec

Process heat for the paint shop
50 °C

394 m²
(276 kW)
Gross collector area

CHF 477,737
(USD 475,000)
Investment incl. installation

SWITZERLAND
Zehnder Group Produktion Gränichen • Heating / Cooling / Ventilation Appliances

Photo: Zehnder Group International

We want to be the most attractive provider of energy-efficient solutions for healthy and comfortable room conditions. Not only for our products and system solutions, but also for our own buildings and production plants.

Heiner Schürch, Project Manager, Zehnder Group International

Photo: Zehnder Group International

Year of installation 2012	
Solar fraction	**50 %** of the total heat demand in the paint shop
Subsidy	**CHF 164,000** (USD 163,000)
Annual savings	**16,800 kg** liquefied petroleum gas
Turnkey supplier	**Eisenmann / Ritter XL Solar,** Germany

Steam heating for milk pasteurisation, evaporation and sterilisation
140 °C

561 m²
(393 kW)
Aperture mirror area

INR 15,682,635
(USD 942,000)
Investment incl. installation

INDIA
Amul Fed Dairy • Dairy

Photo: Amul Fed Dairy

We strongly believe green energy to be the future of sustainable development. The concentrating solar thermal project was implemented as a pathbreaking showcase, with more to come. It delivers the projected output, and we are exploring to replicate this at several other union member's dairy plants.

Arvindkumar Dhagat, Senior General Manager, Amul Fed Dairy

Photo: Amul Fed Dairy

Year of installation 2016	
Solar fraction	**0.59 %** of total steam demand of dairy plant
Subsidy	**INR 3,322,944** (USD 46,500)
Annual savings	**53,000 m³** natural gas
Turnkey supplier	**Thermax** India

AUSTRIA

Fleischwaren Berger

• Meat Products

Photo: Fleischwaren Berger

1,067 m²
(747 kW)
Gross collector area

EUR 735,000
(USD 780,000)
Investment incl. installation

Preheating of feed water for steam boiler
30 - 90 °C
Hot water for cleaning and drying
40 - 70 °C

"Year in, year out, we had thought about using solar energy for our ham production. What ultimately helped us to turn this idea into a reality was the in-depth advice and expertise of Austrian service providers. Running an environmentally friendly business is a wonderful experience.

Rudolf Berger, Chief Executive Officer, Fleischwaren Berger

Year of installation 2013	
Solar fraction	**3.1%** of total heat energy demand (2016)
Subsidy	**15 %** from Austrian government **50 %** from EU project INSUN
Annual savings	**62,500** litres of oil
Turnkey supplier	**S.O.L.I.D.** Austria

Photo: Fleischwaren Berger

JORDAN

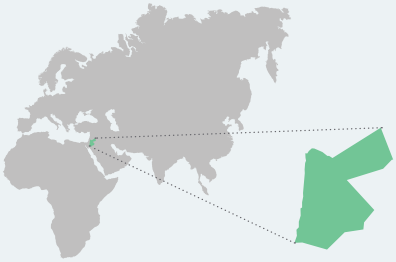
RAM Pharma

• Pharmaceuticals producer

Photo: RAM Pharma

396 m²
(277 kW)
Mirror area
(Direct steam generation)

Steam heating, (sterilisation, drying, fermenting)
160 °C



"RAM Pharma is committed to reduce its CO_2 emissions. We decided to use Fresnel collector technology, as it's the best option for generating solar process steam. Our system was commissioned in March 2015 and cut diesel consumption by 42 %, exceeding expectations.

Dr. Mahmoud Al Najami, General Manager, RAM Pharma

Year of installation 2015	
Solar fraction	**30 - 40 %** of annual diesel demand for all processes
Turnkey supplier	**Industrial Solar** Germany

Photo: Silke Anders

Pasteurisation of fresh milk
78 °C

420 m²
(294 kW)
Aperture mirror area

MXN 1,837,800
(USD 105,000)
Investment incl. installation

We have greatly profited from our solar investment. It not only allows us to use the sun's energy to pasteurise 350,000 litres of milk ten hours a day, but pasteurisation has become easier to manage. The solar heat system provides much more stable temperatures than the steam boilers we use.

Mario Tellez, Chief Operating Officer, Lechera Guadalajara

MEXICO
Lechera Guadalajara
• Dairy

Photo: Inventive Power

Photo: Inventive Power

Year of installation 2016	
Solar fraction	**35 %** of the heat demand in the pasteurisation process
Annual savings	**85,038 m³** natural gas
Turnkey supplier	**Inventive Power** Mexico

Drying of precast reinforced concrete elements
50 - 90 °C

1,410 m²
(987 kW)
Gross collector area

EUR 1 million
(USD 942,000)
Investment incl. installation

We use the sun's power to dry precast concrete elements in summer and heat our facilities in winter. It is a most effective way of preparing for the challenges ahead and boosting competitiveness and productivity.

Anton Karner, Managing Director, Habau Group

AUSTRIA
Habau Group
• Construction Industry

Photo: Habau Group

Photo: Gasokol

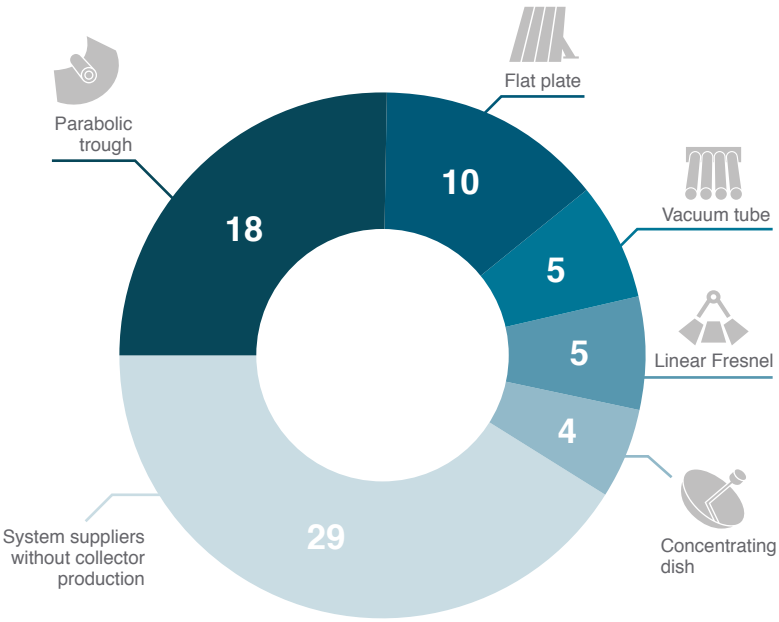
Year of installation 2014	
Solar fraction	**35 %** of heat demand for drying
Subsidy	**30 %** from Austrian government
Annual savings	**70,000 m³** natural gas for solar process heat and space heating
Turnkey supplier	**Gasokol / FIN - Future is Now Kuster Energielösungen,** Austria

SURPRISINGLY POPULAR

Solar Heat for Industrial Processes (SHIP) is still far from being a standard, but the market has already grown to a considerable size: The first **World Map of Solar Process Heat Specialists 2017** (see page 10/11) shows, all in all, **71 suppliers of turnkey SHIP systems.** The following charts show the most relevant results from the accompanying survey (see glossary, page 17).

Parabolic trough is the most common collector type

42 turnkey SHIP suppliers depicted on the world map own collector facilities



Turnkey suppliers that sold SHIP systems with a total of more than 10,000 m²

Austria
S.O.L.I.D.

Chile
Pampa Elvira Solar

China
Sunrain Group
Vicot Solar Technology
Himin Solar
Linuo Paradigma

Denmark
Aalborg CSP

India
Inter Solar Systems

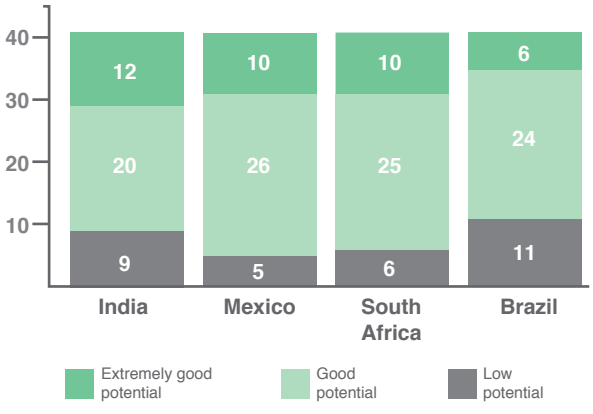
Germany
Soliterm Group

Turnkey suppliers based on number of reference projects

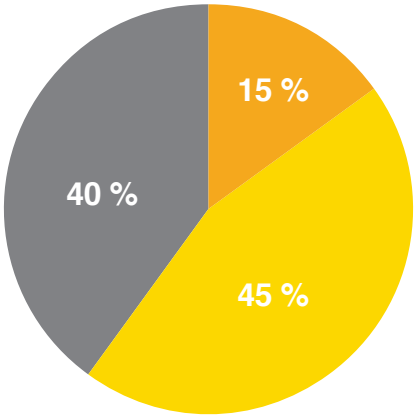
49	**Sunrain Group** China
35	**Inventive Power** Mexico
33	**Modulo Solar** Mexico
29	**Ritter XL Solar** Germany
24	**Linuo Paradigma** China
21	**Millennium Energy Industries,** Jordan
20	**Vicot Solar Technology** China
20	**Inter Solar Systems** India
18	**SEA Sistemas de Ecotecnias Ambientales,** Mexico
15	**Sunda Solar Energy Technology,** China
12	**Soliterm Group** Germany
12	**Taylormade Solar Solutions,** India
10	**Megawatt Solutions** India
8	**Aschoff Solar** Germany
8	**Industrial Solar** Germany

High rating for Solar Payback markets

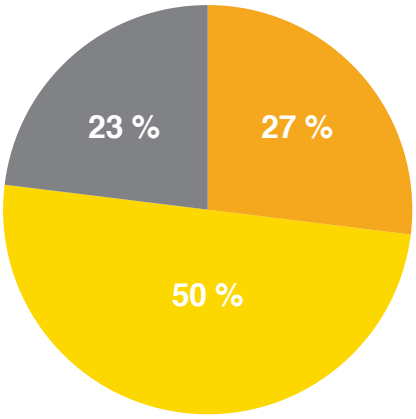
An overwhelming majority of SHIP suppliers acknowledged the (extremely) good market potential of the four Solar Payback countries.



Were you satisfied with your business development in 2015?



All **71** turnkey suppliers



26 turnkey suppliers from the Solar Payback countries* were more satisfied than turnkey suppliers globally

Extremely / very satisfied

Satisfied

(Fairly) dissatisfied

*India, Mexico, South Africa and Brazil

HEAT SUPPLY CONTRACTS ARE AN IMPORTANT MEANS TO INCREASE DEPLOYMENT

Most turnkey SHIP suppliers (strongly) agree with the following statements:

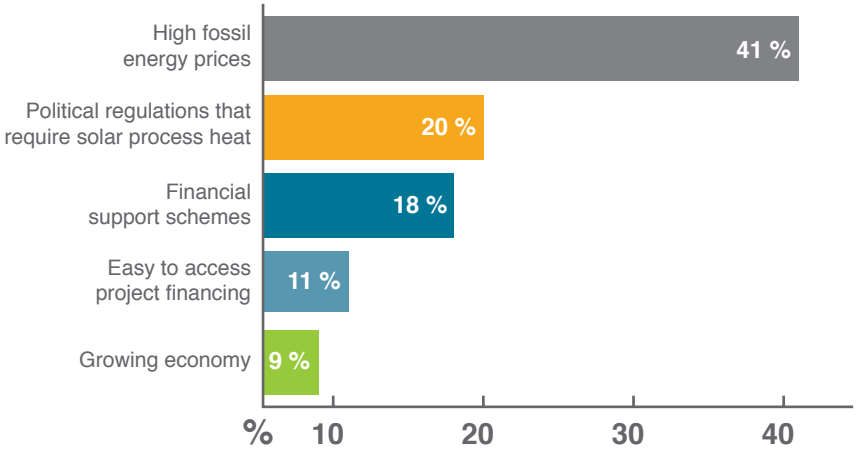
- **54 % mention difficulties with securing funds as one of the main retarding factors**
- **63 % believe that huge efforts are needed to make solar process heat projects bankable**
- **79 % see heat supply contracts / ESCO models as an important means to increase deployment**
- **Only 34 % have offered solar heat supply contracts so far**

To foster the growth of the industry, ESCOs will need much more support in the form of low-interest loans and contingency or cancellation insurance.

HIGH FOSSIL FUEL COSTS AND ENVIRONMENTAL REGULATIONS STRENGTHEN INDUSTRY

When asked about market barriers, the SHIP planners often mentioned low fossil fuel prices. Other frequently cited issues were the high cost of systems and, consequently, long payback periods. Hence, **41 %** of respondents chose high energy prices as the most important factor in growing the market.

Which are the most relevant criteria for a good market development? (two answers possible)



Answers from 71 SHIP suppliers

> The acute lack of awareness about how solar heat can be a reliable and economically feasible option for high-temperature supply can be addressed by pioneering efforts and showcase projects.
>
> ***Bhoovarhan Thirumala***
> CEO of Aspiration Energy, India

71 suppliers of turnkey solar process heat systems in 22 countries

Publisher: Sun & Wind Energy, www.sunwindenergy.com
Financial support: Solar Payback project by the International Climate Initiative (German Federal Environment Ministry)
Editors: Bärbel Epp, Eva Augsten, *www.solrico.com*
Design: Eilers-Media, *www.eilers-media.de*
Date: January 2017
Sources: Data from manufacturers, November/December 2016 survey

Legend

3 (670 m²)	Number and total area of supplier's turnkey systems
n/a	Companies with reference projects, but did not deliver figures
Companies without references	Companies that are listed without any references are ready to offer turnkey solar process heat systems. Still, they may have experiences with commercial solar installations, e.g., for cooling or power generation.

Several businesses also produce collectors:

- Flat plate
- Vacuum tube
- Concentrating dish
- Parabolic trough
- Linear Fresnel

Company name* — Prototype collector

Company offers solar heat supply contracts (ESCO)

Examples:

Ritter XL Solar 29 (5,165 m²) — Ritter XL Solar manufactures vacuum tube collectors. The company has set up 29 turnkey solar process heat installations totalling 5,165 m² of collector area.

Chromasun — Chromasun does not produce collectors and has not yet carried out any projects matching the definition of solar process heat below. It is ready to offer solar heat supply contracts.

Definition: Solar process heat plants supply heat to manufacturing companies for production processes, cleaning or sterilising. This definition does not include installations for solar cooling, electricity generation or energy use in service sector applications, e.g., for laundries and catering.

WORLD MAP OF SOLAR PROCESS HEAT SPECIALISTS 2017

SWEDEN
Absolicon 2 (300 m²)
Aalborg CSP 1 (51,505 m²) Solar Tower Plant
DENMARK
Solarlite
SunOyster
Phönix Sonnenwärme
Protarget 3 (1,500 m²)
Enersolve 4 (1,100 m²)
Soliterm 12 (20,000 m²)
GERMANY
newHeat
Aschoff Solar 8 (5,490 m²)
Ritter XL Solar 29 (5,165 m²)
Industrial Solar 8 (n/a)
FRANCE
CitrinSolar
Consolar
Ecotherm
Fresnex
Feichtinger*
Gasokol 7 (2,568 m²)
TVP Solar 2 (n/a)
SWITZERLAND
AUSTRIA
S.O.L.I.D. 7 (10,017 m²)
Trivelli Energia
Helioclim
Sunti
Suncnim
Soltigua (n/a)
ITALY
Inersur 1 (174 m²)
SPAIN
GREECE
Sole S.A.* 3 (670 m²)
Anitcam Sunstrip*
TURKEY
Tigi 6 (1,000 m²)
Millennium Energy 21 (3,111 m²)
JORDAN
ISRAEL

CANADA
Rackam 5 (1,941 m²)
Skyfuel 1 (690 m²)
Solargenix
USA
Chromasun
Inventive Power 35 (3,300 m²)
Artic Solar
Energias Saubere
Investti
Solarqro 1 (n.a.)
Ausgreen 2 (360 m²)
SEA 18 (1,800 m²)
Agbel 7 (140 m²)
Modulo Solar 33 (9,820 m²)
MEXICO
BRAZIL
Enalter
Bosch/Heliotek
Imax Energia
Konus Icesa
Sunshine Engenharia
CHILE
Pampa Elvira Solar 2 (45,570 m²)
Reinstein
PAKISTAN
Sunda Solar 15 (8,820 m²)
Himin 2 (12,500 m²)
Linuo Paradigma 24 (n/a)
Krypton Energy
CHINA
Sunrain/Micoe 49 (42,356 m²)
Vicot Solar 20 (20,000 m²)
SOUTH AFRICA
AUSTRALIA
NEP Solar

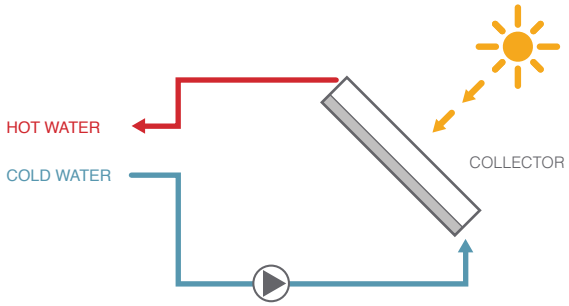
South Africa
Energyweb 1 (120 m²)
Holms and Friends
Reach Renewable
Greenability
E3 Energy 1 (120 m²)
Solarzone 1 (96 m²)

India
PAKISTAN
CHINA
Inter Solar Systems 20 (10,000 m²)
Megawatt Solutions 10 (9,500 m²)
Quadsun Solar
Taylormade Solar Solutions 12 (1,800 m²)
A.T.E. Enterprises 1 (44 m²)
Akson's Solar Equipment 6 (600 m²)
Oorja Energy 6 (1,000 m²)
Aspiration Energy 3 (2,100 m²)

SOLAR COLLECTORS FOR INDUSTRIAL APPLICATIONS

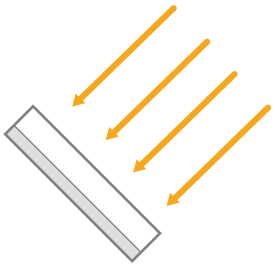
COLLECTOR

A solar thermal collector captures solar radiation hitting a surface, the absorber, to heat a fluid in a hydraulic circuit.

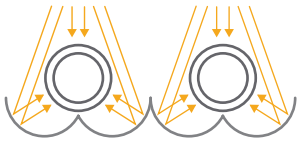


COLLECTOR TYPES

Stationary
Fixed tilt or seasonally adjusted

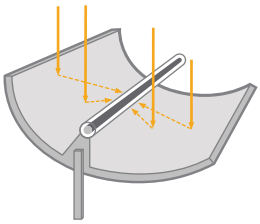


- Flat plate collector
- Vacuum tube collector

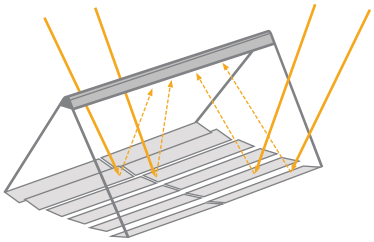


- Vacuum tube collector with compound parabolic concentrator (CPC)

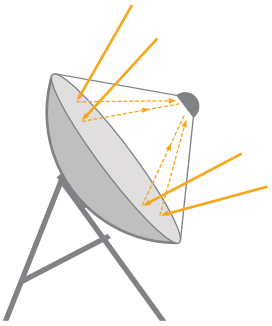
Tracking
Linear or two-axis tracking



- Parabolic trough collector



- Linear Fresnel collector



- Concentrating dish collector

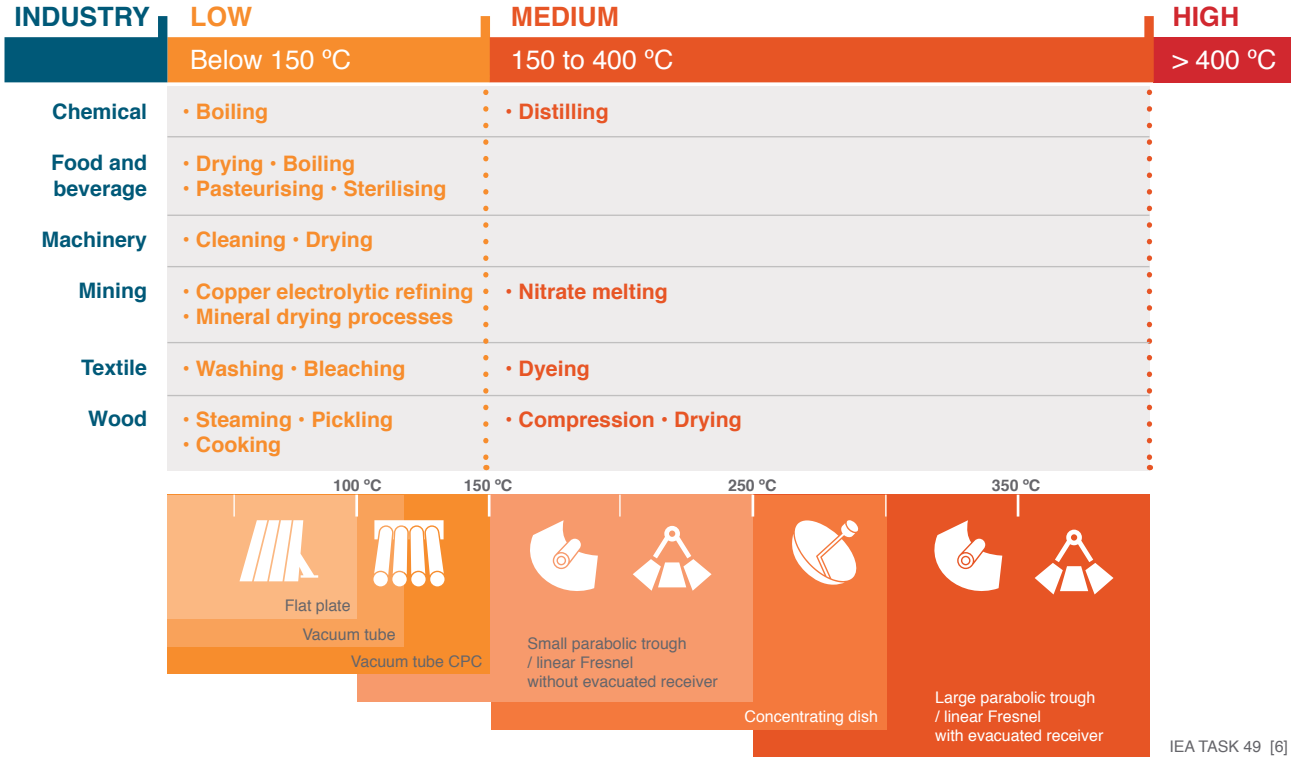
WHAT TO CONSIDER WHEN CHOOSING A COLLECTOR TYPE

- **Typical operation temperature of the collector type meets the requirements for the industrial heat (see next page)**
- **Design accommodates chosen heat transfer fluid**
- **Certified according to national or international standard, such as:**
  - Solar KEYMARK (Europe)
  - Solar Rating & Certification Cooperation, SRCC (USA)
  - Bureau of Indian Standards (BIS)
  - NMX-ES-001-NORMEX (Mexico)*
  - South African Bureau of Standards (SABS)*
  - National Institute of Metrology, Quality and Technology, INMETRO (Brazil)*
  - Chinese National Standard *
- **Energy output certified by accredited third party**
- **Enough pressure resistance**
- **Adequate stagnation handling and overheating prevention (see glossary, page 17)**
- **Suitable weight for rooftop installation or appropriate size for ground-mounting**

* These standards do not yet include concentrating collectors.

MARKET SEGMENTS

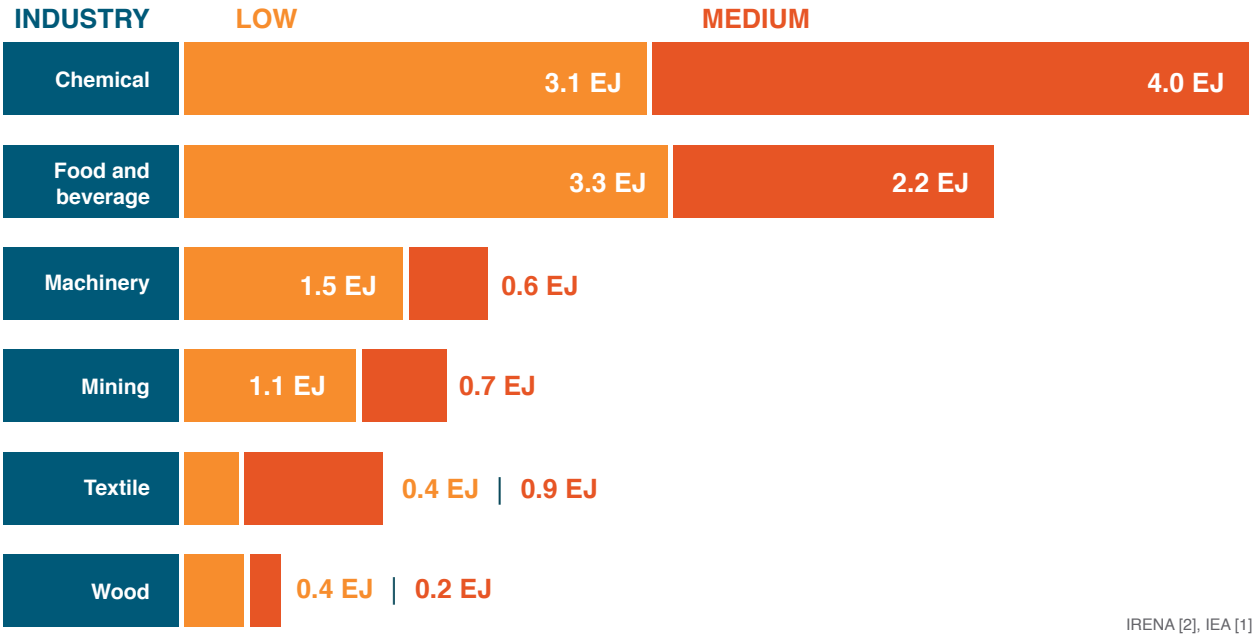
Solar collectors supply heat at different temperatures for production processes in several industries. The chart below shows the market segments most suitable for each collector type.



IEA TASK 49 [6]

HEAT DEMAND

The total heat demand for low and medium temperature applications accounts for **44 EJ** (exajoule) globally (≈12,222 TWh). The chart below shows this heat demand in selected industries.



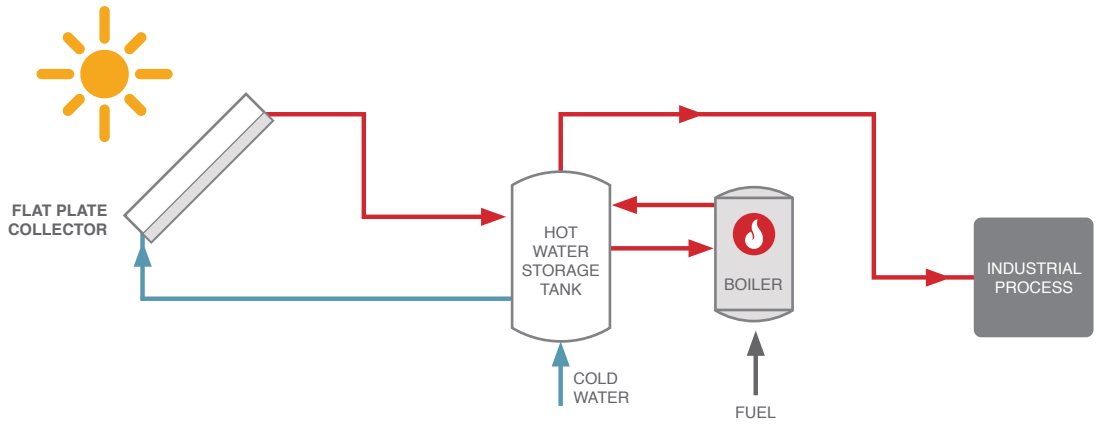
IRENA [2], IEA [1]

SYSTEM INTEGRATION

Solar heat can be provided at different integration points. Preheating is the most common method of incorporating solar heat into the production cycle. However, it can also be used to generate steam or fed directly into the process loop.

Preheating

Cold water is preheated in the solar field and fed into a storage tank where it is heated up by a fossil fuel boiler to the required temperature of the production process.

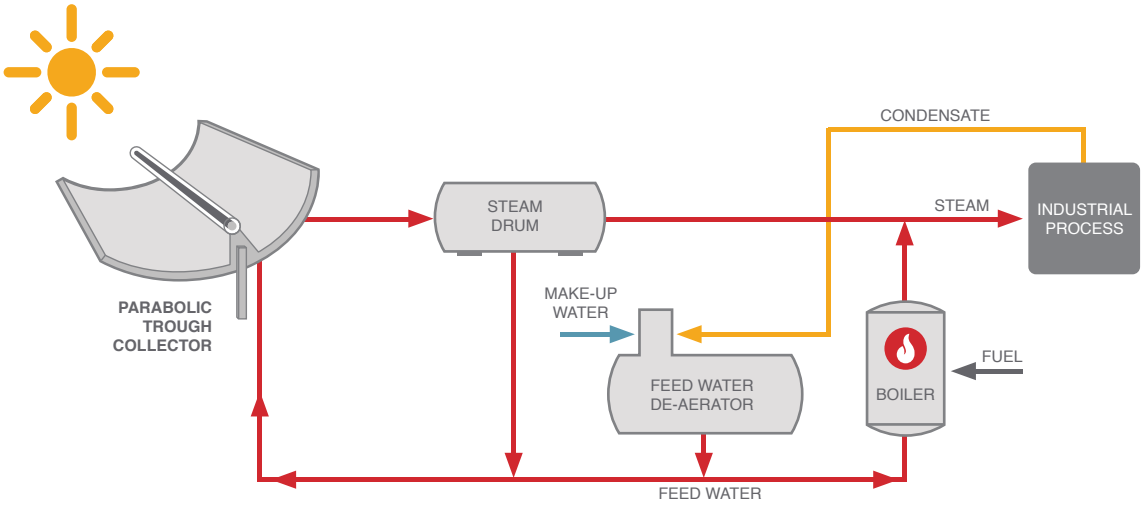


Example of solar thermal integration for preheating

IRENA [8]

Direct steam generation

Water is partly evaporated in the concentrating collectors. The solar-heated steam is then separated from the remaining water in the steam drum before being supplied to the industrial process or the steam network of the factory. The treated condensate – also called feed water – is fed back to the collector field. Another option is **indirect steam generation.** In this case, the collector field heats water or thermal oil in a closed circuit to generate steam via a heat exchanger.

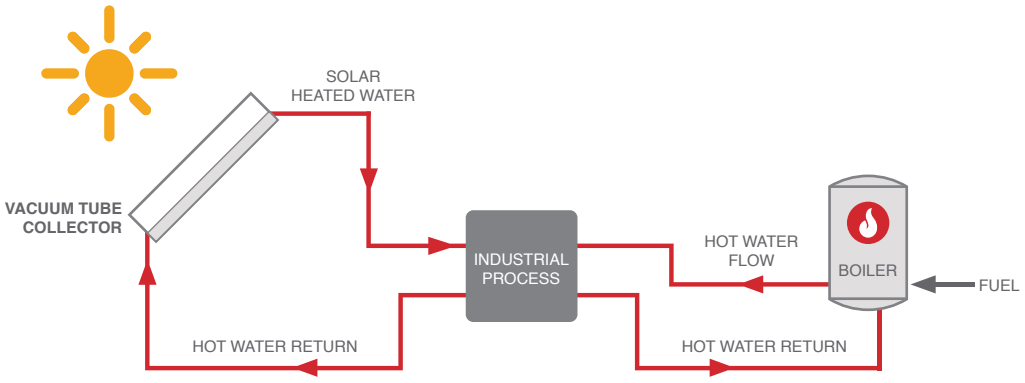


Example of solar heat integration to generate steam

IEA TASK 49 [9]

Process heating

The solar field provides heat at a certain temperature to maintain the temperature of a bath or a thermal separation process. Additional heat is provided to the production process by a fossil fuel boiler. Both circuits are closed so that the cooled off water returns to the collector field or the boiler respectively.



Example of a solar system which supplies heat directly to an industrial process IRENA [8]

CHALLENGES

Integrating solar heat systems into industrial processes requires customised SHIP designs based on which production methods a company employs, which conventional heating system it has installed and which fuel is used. What do experts believe are the major barriers to successful integration?

"Despite there being a wide variety of low-temperature industrial processes, heat supply in industry often relies on steam boilers and steam distribution networks. The integration of solar process heat is a challenge in that it either acts directly on the processes, an approach that the industry is reluctant to implement, or on the heat supply system at the boiler preheating or steam network stage, which means higher pressures and temperatures than those required for the processes."

Dr Pedro Horta
Head of Group Solar Process Heat and Industrial Systems, Fraunhofer Institute for Solar Energy Systems ISE, Germany

"Decision makers in manufacturing are sceptical. Production is their lifeblood. They are extremely reluctant to risk having a faulty or problematic system cause operational downtime."

Doran Schoeman
Group Director of E3 Energy, South Africa

"After having analysed many different production processes, I concluded that opportunities for solar integration heavily depend on the conventional heating equipment being used. A tunnel pasteuriser, which gets its heat from an external heat exchanger, is a suitable match for industrial solar heat, whereas commonly used flash pasteurisation is difficult to incorporate as an external solar heat source."

Dr Bastian Schmitt
Head of the Process Heat group at the Institute of Thermal Engineering (ITE) at University of Kassel, Germany

"SHIP is not just about switching from fossil fuels to renewables, but you will also have to identify waste heat potential if you want to achieve mostly shorter payback periods. Efficiency improvements could help many production businesses."

Christian Holter
Managing Director of S.O.L.I.D., Austria

SHIP SUPPLIERS

EXPERIENCED AND "MARKET-READY" SUPPLIERS OF TURNKEY SHIP PLANTS SHOWN ON THE **WORLD MAP OF SOLAR PROCESS HEAT SPECIALISTS 2017**

AUSTRALIA
NEP Solar: www.nep-solar.com

AUSTRIA
Ecotherm Austria: www.ecotherm.com
Feichtinger: www.feichtinger-gmbh.at
Fresnex: www.fresnex.com
Gasokol: www.gasokol.at
S.O.L.I.D.: www.solid.at

BRAZIL
Bosch/Heliotek: www.bosch.com.br/termotecnologia
Enalter Engenharia Indústria e Comércio: www.enalter.com.br
Imax Energia: www.imaxenergia.com.br
Konus Icesa: www.konus.com.br
Sunshine Engenharia: www.sunshineengenharia.com.br

CANADA
Rackam: www.rackam.com

CHILE
Pampa Elvira Solar: www.ellaima.cl
Reinstein: www.reinstein-energy.com

CHINA
Shandong Linuo Paradigma: www.linuo-paradigma.com
Beijing Sunda Solar Energy Technology: www.sundasolar.com
Himin Solar: www.himinsun.com
Sunrain Solar Energy (Micoe): www.en.sunrain.com
Vicot Solar Technology: www.vicot.com.cn

DENMARK
Aalborg CSP: www.aalborgcsp.com

FRANCE
Helioclim: www.helioclim.fr
newHeat: www.newheat.fr
Suncnim: www.suncnim.com
Sunti: www.sunti.fr

GERMANY
Aschoff Solar: www.aschoff-solar.com
CitrinSolar Energie- u. Umwelttechnik: www.citrinsolar.de
Consolar: www.consolar.de
Enersolve: www.enersolve.de
Industrial Solar: www.industrial-solar.de
KBB Kollectorbau www.kbb-solar.com
Phönix Sonnenwärme: www.sonnenwaermeag.de
Protarget: www.protarget-ag.com
Ratioplan: http://ratioplan.bayern
Ritter XL Solar: www.ritter-xl-solar.com
Solarlite CSP Technology: www.solarlite.de
Soliterm Group: www.solitermgroup.com
SunOyster Systems: www.sunoyster.com
Sunset Energietechnik: www.sunset-solar.de

GREECE
Sole: www.eurostar-solar.com

INDIA
ATE Enterprises: www.ategroup.com
Akson's Solar Equipment: www.aksonsolar.com
Aspiration Energy: www.aspirationenergy.com
Inter Solar Systems: www.intersolarsystems.com
Megawatt Solutions: www.megawattsolutions.in
Oorja Energy Eng`g Services: www.oorja.in
Quadsun Solar: www.quadsunsolar.com
Taylormade Solar Solutions: www.tss-india.com

ISRAEL
Tigi: www.tigisolar.com

ITALY
Soltigua: www.soltigua.com
Trivelli Energia: www.trivellienergia.com

JORDAN
Millennium Energy Industries: www.meisolar.com

MEXICO
Agbel Ingenieria y Servicios: agbelsadecv@gmail.com
Ausgreen Energia: ausbertov@ausgreenenergía.com.mx
Calentadores Solares Bicentenario (Solarqro): www.solarqro.com
Energias Saubere: www.ecosystems.com.mx
Inventive Power: www.inventivepower.com.mx
Investti: www.investtienergy.com
Modulo Solar: www.modulosolar.com.mx
SEA Sistemas de Ecotecnias Ambientales: www.seaecotecnias.com

PAKISTAN
Krypton Energy: www.kryptonenergy.com.pk

SOUTH AFRICA
Energyweb: www.energyweb.co.za
Greenability Installations: www.greenability.co.za
E3 Energy: www.e3energygroup.com
Holms and Friends: www.holmsandfriends.co.za
Reach Renewable: www.reach-renewable.com
Solarzone: www.solarzone.co.za

SPAIN
Inersur: www.inersur.com

SWEDEN
Absolicon Solar Collector: www.absolicon.com

SWITZERLAND
TVP Solar: www.tvpsolar.com

TURKEY
Anitcam Sunstrip: www.sunstrip.com.tr

USA
Artic Solar: www.articsolar.com
Chromasun: www.chromasun.com
Skyfuel: www.skyfuel.com
Solargenix: www.solargenix.com

Solar associations and partner institutes in the Solar Payback countries can provide additional solar thermal suppliers and manufacturers:

BRAZIL: Abrasol, www.abrasol.org.br
GERMANY: BSW-Solar, www.solarwirtschaft.de
INDIA: STFI, www.stfi.org.in
MEXICO: ANES, www.anes.org
SOUTH AFRICA: SANEDI, www.sanedi.org.za

SERVICES

FURTHER SOURCES OF INFORMATION

IEA SHC – Task 49

Solar Heat Integration of Industrial Processes
http://task49.iea-shc.org

SHIP Database

Database of Solar Heat Applications in Industrial Processes *http://ship-plants.info*

GLOSSARY

- **Exajoule** is a unit denoting large amounts of energy at regional or global level. The exa-prefix means that an amount is multiplied by a number which starts with a one followed by 18 zeros (10^{18} = quintillion). 1 EJ is roughly equal to 278 TWh (terawatt-hours).

- **Final Energy Consumption** is the energy amount delivered as fuel or electricity to anyone but the energy sector itself, meaning either a household or an organisation, such as a hospital or a manufacturing business. Losses from conversion, transport and distribution do not factor into the calculation.

- **SHIP** stands for Solar Heat for Industrial Processes and is used in this brochure as the standard acronym for technologies or plants which deliver solar heat to industrial facilities. Other publications use different abbreviations or names to describe this type of application: Solar Process Heat (Task 49 of the IEA Solar Heating and Cooling Programme); CST or Concentrating Solar Thermal (Ministry of New and Renewable Energy, India); SIPH or Solar Industrial Process Heat (National Renewable Energy Laboratory, NREL, USA).

- **Solar fraction** or solar saving fraction is the amount of energy provided by the solar technology divided by the total energy required.

- **ESCO** is short for Energy Service Company and describes a business model in which the supplier offers its customers a heat supply contract instead of a turnkey system solution. ESCOs finance, operate and maintain SHIP systems while customers pay them either instalments based on the energy costs saved or fixed rates based on the energy amount delivered. In European directives, this model is termed EPC or Energy Performance Contracting. In US publications, it is called a third-party energy services agreement.

- **Survey among SHIP specialists.** In October/November 2016 solrico carried out a worldwide survey among turnkey suppliers of SHIP plants. The questionnaire defined turnkey as a system planned, supplied and installed by the seller. Of the approximately 130 companies contacted, 71 provided data and filled in a 4-page questionnaire. All 71 companies are shown on the world map (page 10/11).

- **Collector area** is one way to describe the size of a SHIP system. In the context of flat plate and vacuum tube collectors, the reference approach is based on **collector gross area,** the maximum projected area of the complete collector. In the case of concentrating collectors, the aperture area is used to describe the size of the collector field. Itis defined as the projected area of the reflectors/mirrors. With parabolic trough and concentrating dish collectors, the supplier refers to the flat, rectangular area specified by the outer perimeter of the mirrors (aperture). To arrive at a collector area for linear Fresnel technology, the usual method is to add together the flat area of all primary mirrors. In the case of solar tower plants, it is the total area of all heliostats (mirrors). These collector area definitions have been used on the world map and to calculate the total collector area of the reference cases on page 3.

- **Solar thermal capacity** is derived from the collector area by using a conversion factor of 0.7 kW_{th}/m^2. The IEA SHC Programme agreed with trade associations on this factor to allow for the comparison of solar thermal collectors with other energy technologies. The factor is used in the case studies on pages 4 to 7. The actual output of a square meter may vary based on local solar radiation and the temperature level required for the process. You can find a definition of the "reasonable" collector output in reference 7, page 7.

- **Stagnation** describes the condition in which a collector reaches the maximum temperature, because there is no demand for energy, the pump is switched off and collector losses are equal to the radiation absorbed by the system. To prevent technical failures, all solar loop components must be resistant to high temperatures and pressure loads during stagnation. Suitable measures for stagnation management are a good emptying behaviour of the collector field, a well-designed expansion vessel, a drainback concept (water from collector loop is drained into the tank during zero-demand periods) and the defocusing of concentrating collectors [see reference 10].

ABOUT SOLAR PAYBACK

OBJECTIVE

Promoting the use of Solar Heat for Industrial Processes (SHIP) across the four partner countries by raising awareness of its technical and economic potential, and increasing willingness to invest in it.

COUNTRIES

Brazil

ABRASOL
ASSOCIAÇÃO BRASILEIRA DE ENERGIA SOLAR TÉRMICA

www.abrasol.org.br

AHK Deutsch-Brasilianische Industrie- und Handelskammer
Câmara de Comércio e Indústria Brasil-Alemanha

www.ahkbusiness.de

Mexico

ANES®
Asociación Nacional de Energía Solar

www.anes.org

AHK Deutsch-Mexikanische Industrie- und Handelskammer
Cámara Mexicano-Alemana de Comercio e Industria | CAMEXA

www.mexiko.ahk.de

India

STFI
SOLAR THERMAL FEDERATION OF INDIA

www.stfi.org.in

AHK Indo-German Chamber of Commerce
Deutsch-Indische Handelskammer
Mumbai • Delhi • Kokata • Chennai
Bengaluru • Pune • Düsseldorf

www.indien.ahk.de

South Africa

sanedi
South African National Energy Development Institute (SOC) Ltd.

www.sanedi.org.za

AHK Deutsche Industrie- und Handelskammer für das südliche Afrika
Southern African-German Chamber of Commerce and Industry

www.suedafrika.ahk.de

DURATION

October 2016
to September 2019

BUDGET

Total funds available for all four countries: EUR 2,958,920

ACTIVITIES

- Drafting a National Solar Process Heat Potential Study
- Developing policy recommendations for the uptake of SHIP technologies at national level
- Organising train-the-trainer workshops on planning and designing SHIP plants
- Offering bankers and investors training on how to finance SHIP systems
- Organising a local industry and stakeholder conference
- Implementing an online matchmaking network for investors and technology providers
- Developing a funding and business tool for planners and investors to create preliminary analyses of SHIP plants
- Identifying reference cases in manufacturing to conduct three pre-studies, plus detailed monitoring of one site to facilitate the set-up of a demonstration system (in South Africa, Mexico and Brazil)
- Identifying reference cases among existing SHIP plants to carry out detailed monitoring of one system (in India)

Solar Payback

COORDINATOR

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Phone: +49 (0)30 297 778 813

www.solarwirtschaft.de

GERMAN IMPLEMENTING PARTNERS

Fraunhofer ISE
www.ise.fraunhofer.de

KFW DEG
www.deginvest.de

solrico
www.solrico.com

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www.iea.org/statistics/

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www.irena.org

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www.estif.org

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www.ship-plants.info

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www.task49.iea-shc.org

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www.irena.org

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www.task49.iea-shc.org

[10] IEA TASK 49, Overheating Prevention and Stagnation Handling in Solar Process Heat Applications, January 2015
www.task49.iea-shc.org

[11] REN21, Renewables 2016. Global Status Report, June 2016
www.ren21.net

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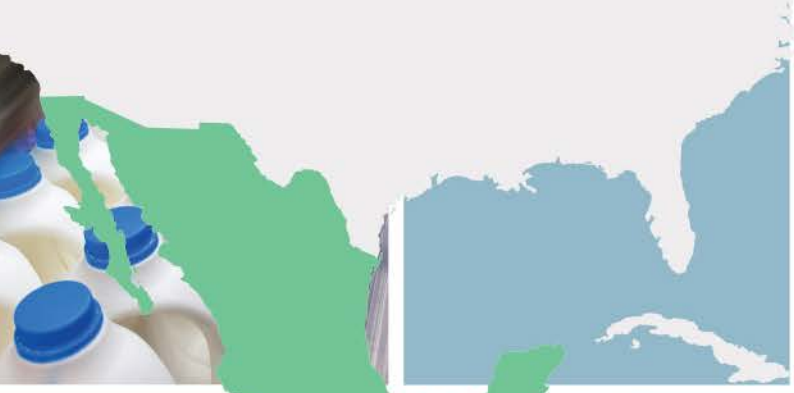

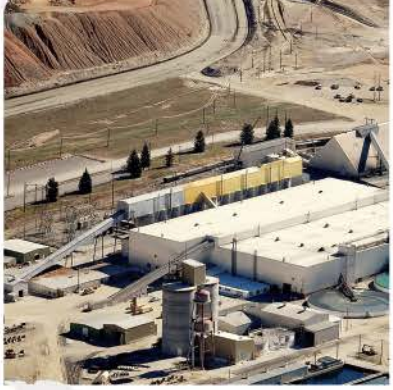

SUSTAINABILITY

INTEGRATION

OPTIMISATION

"This project is part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety supports this initiative on the basis of a decision adopted by the German Bundestag."

Supported by:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

based on a decision of the German Bundestag

SOLAR HEAT FOR INDUSTRY

FSC

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