



Solar Heat for Industrial Processes

Worldwide Potential, Sectors, Processes and
Overview on Installed Systems

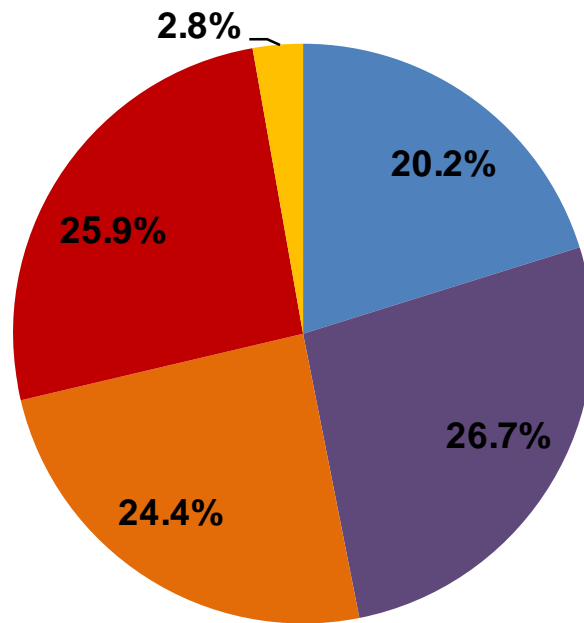
Werner Weiss

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AUSTRIA



Heat accounts for more than half of world's total final energy consumption today

World total final energy consumption, 2011 (322 EJ)

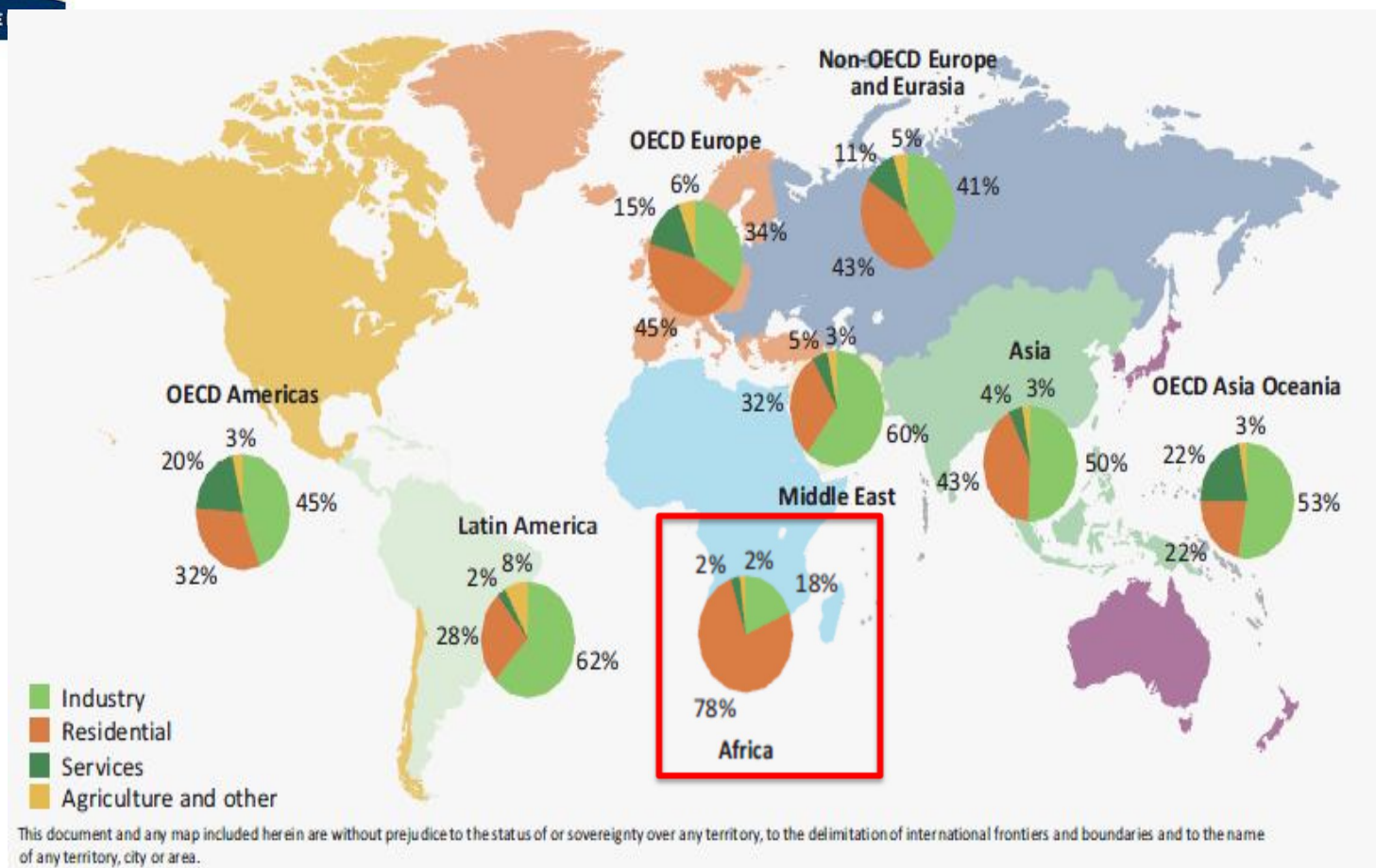


Source: IEA Statistics

■ Electricity ■ Transport ■ Industry
■ Buildings ■ Other sectors

Source: Paolo Frankl, IEA, Paris

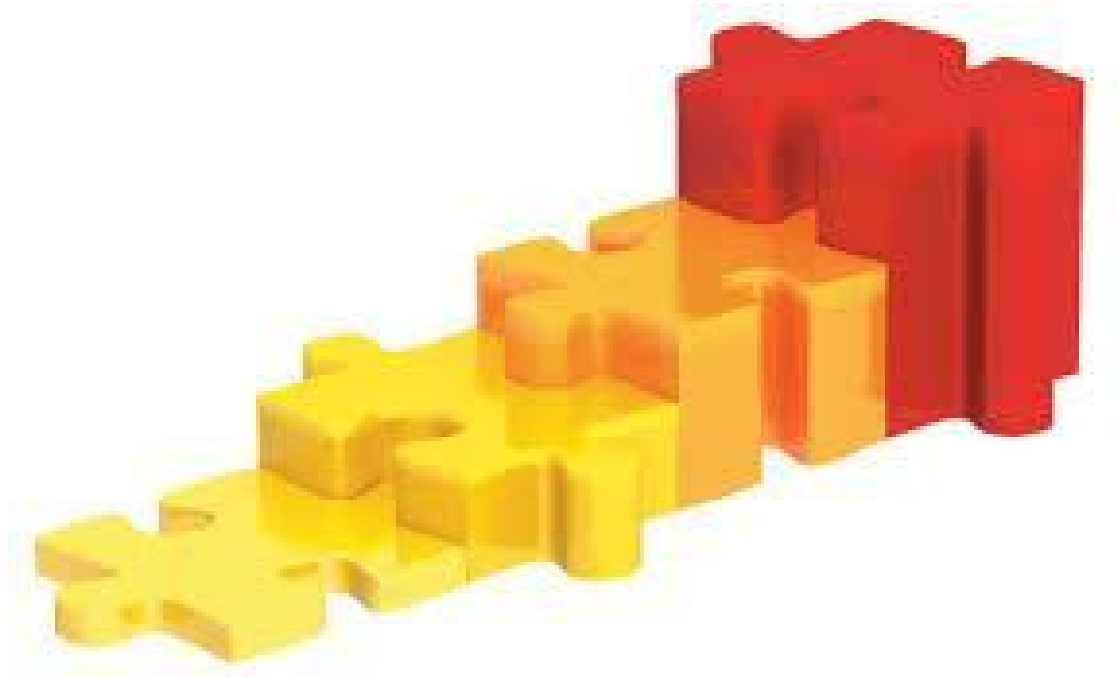
Heat plays important role worldwide



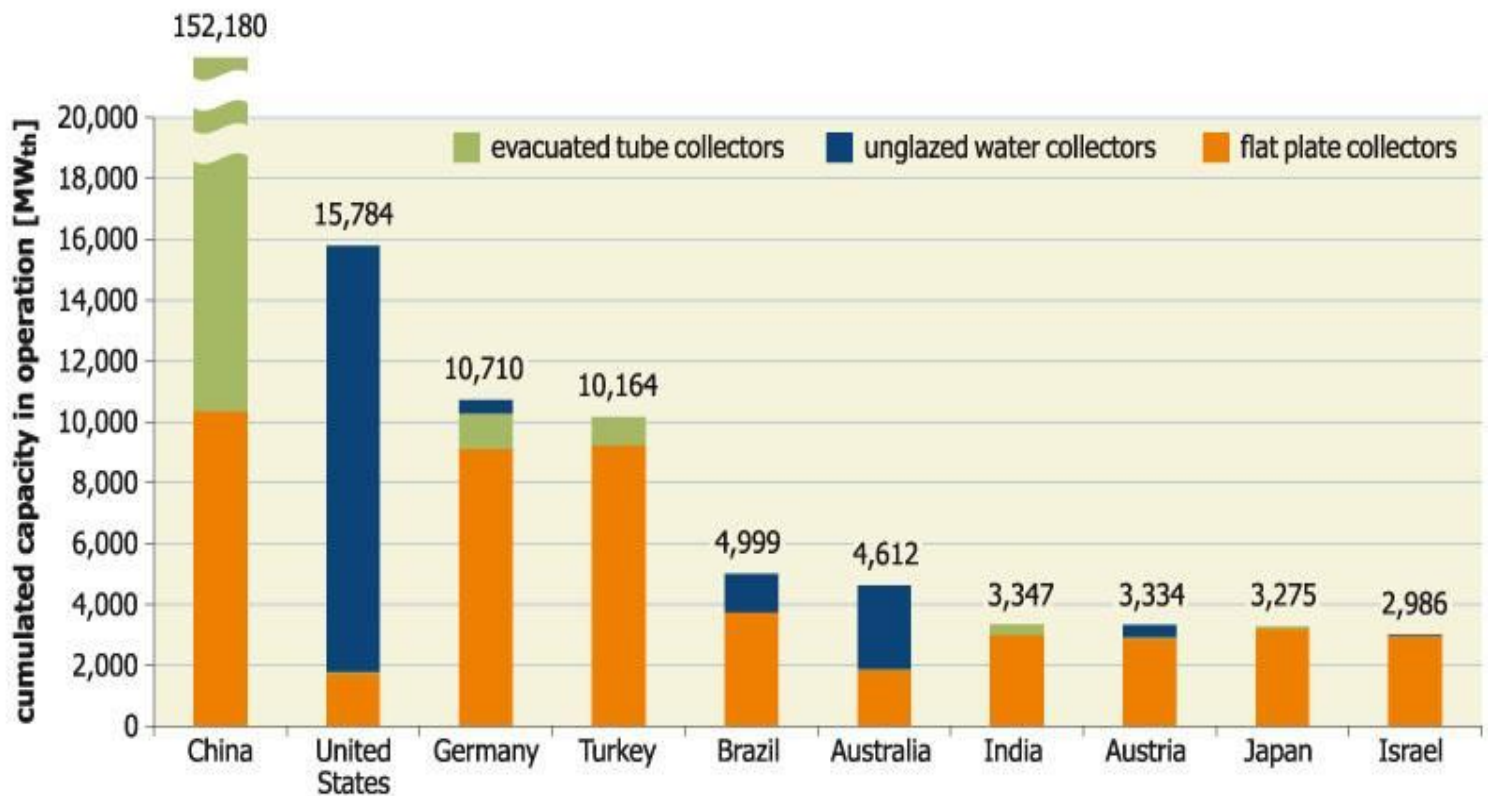
Note: Figure based on 2009 data

Source: Energy Technology Perspectives 2012

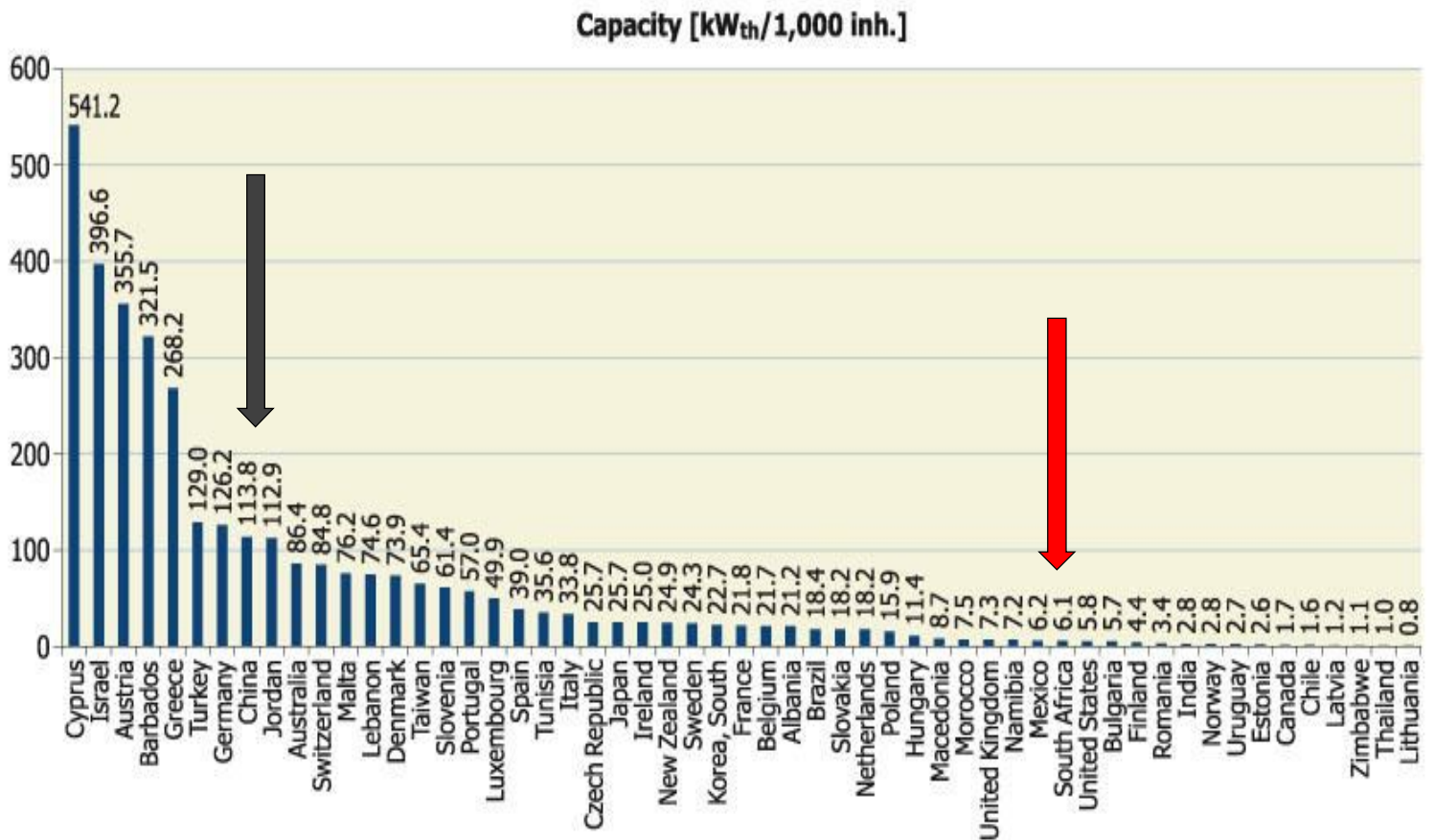
Source: IEA Technology Roadmap – Solar Heating & Cooling



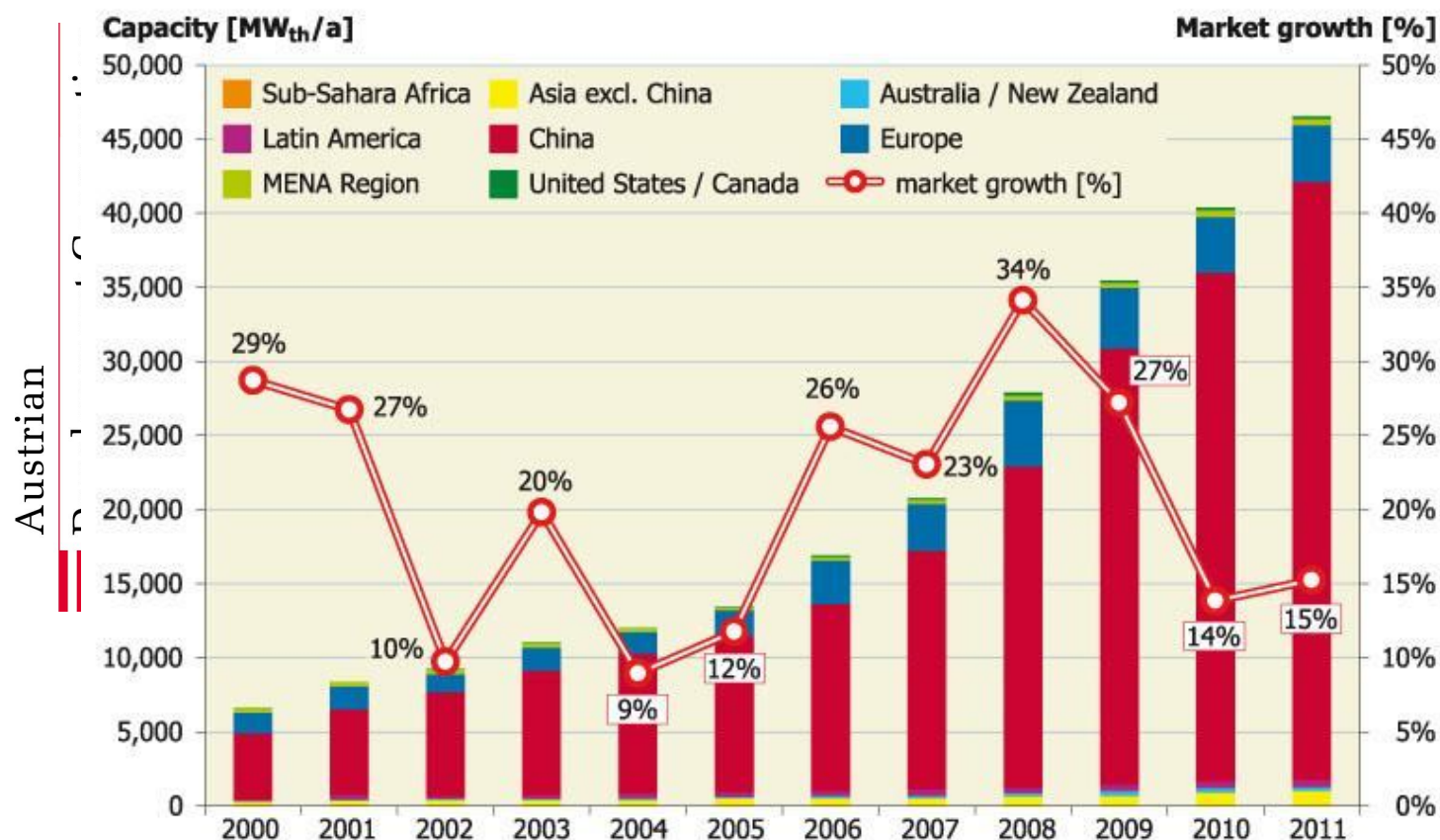
Total installed capacity of unglazed and glazed water collectors in operation in the 10 leading countries by the end of 2011



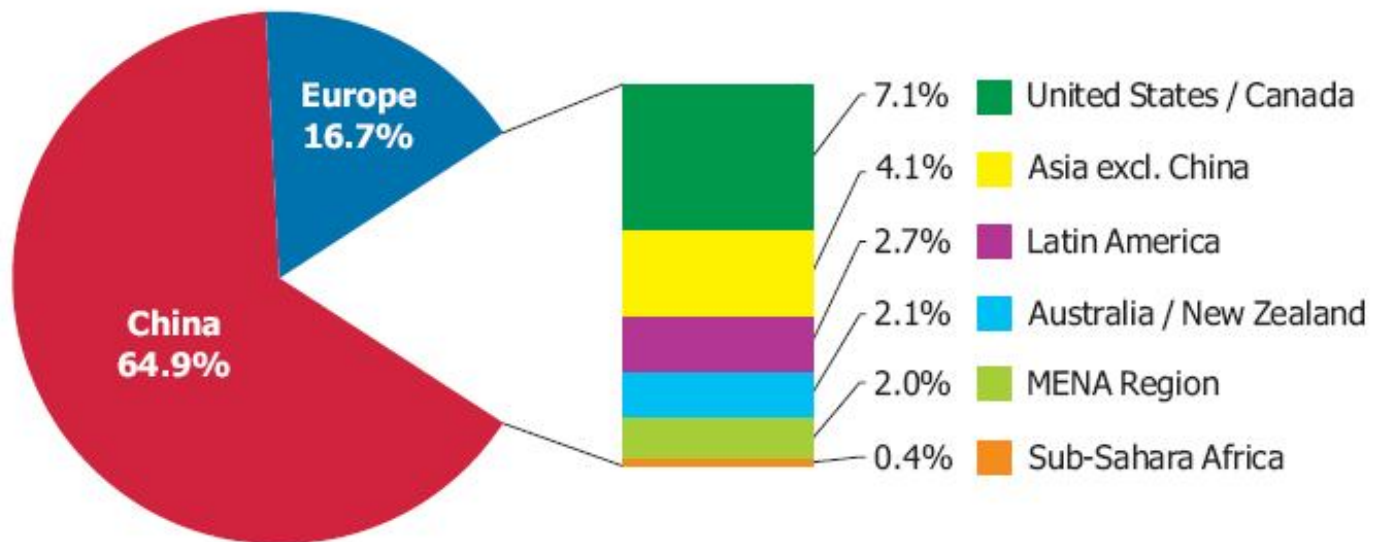
Total capacity of glazed flat plate and evacuated tube collectors in operation in kW_{th} per 1,000 inhabitants by the end of 2011



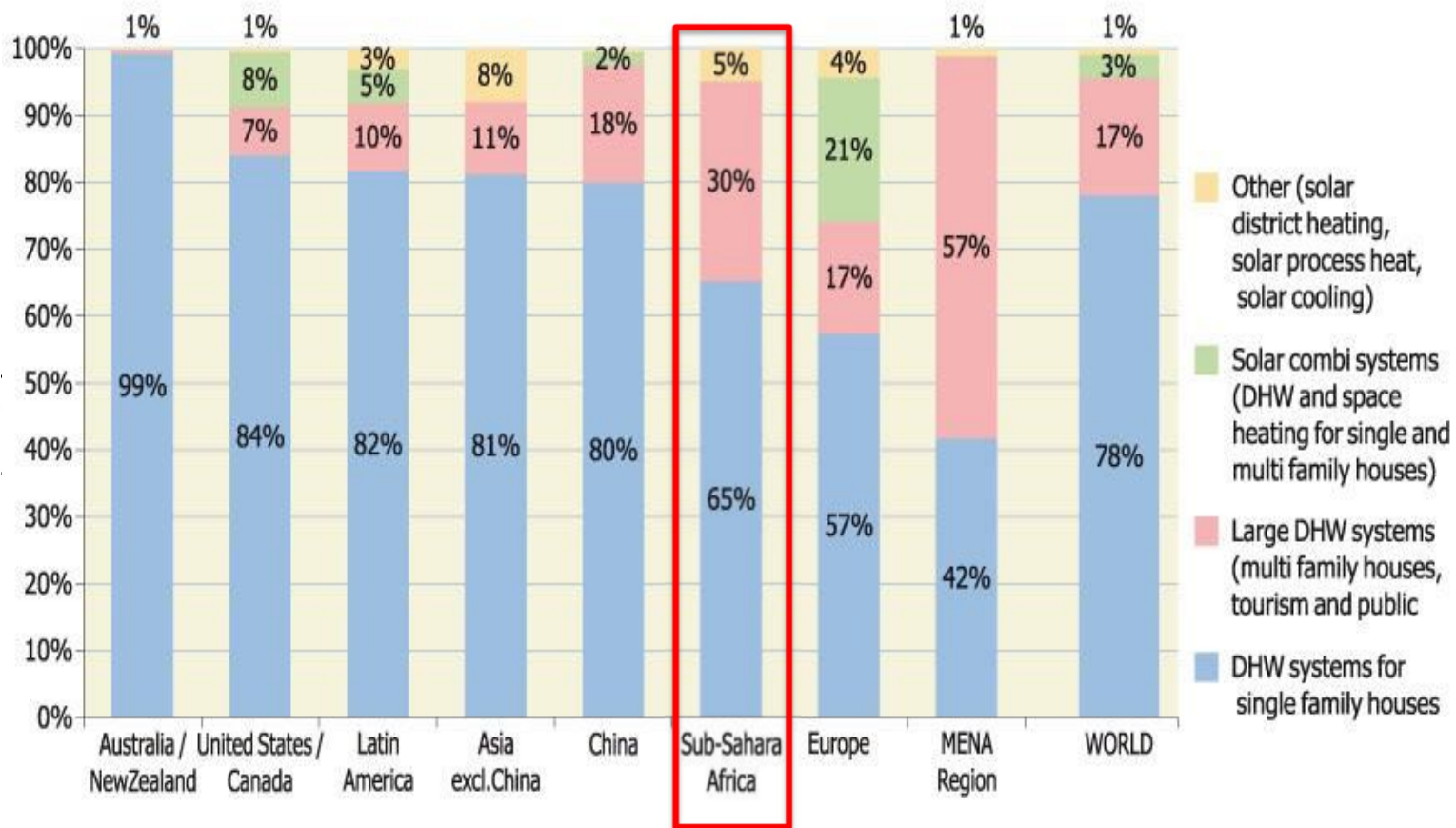
Annual installed capacity of flat plate and evacuated tube collectors from 2000 to 2011



Total installed capacity in operation by economic regions at the end of 2011



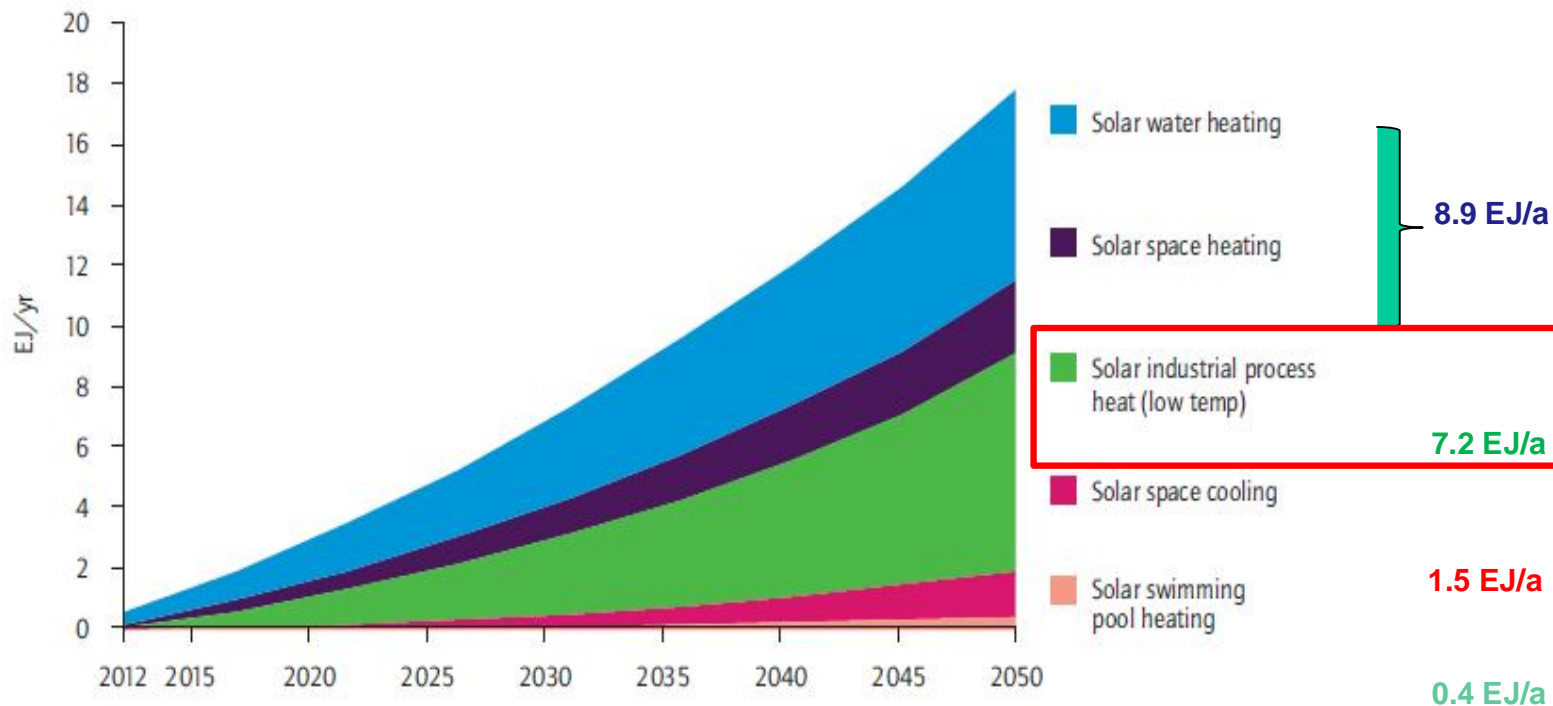
Distribution of solar thermal systems by application for the newly installed glazed water collector capacity of by economic region in 2011



Solar Process Heat



Potential of solar heating and cooling by sector (EJ/yr)

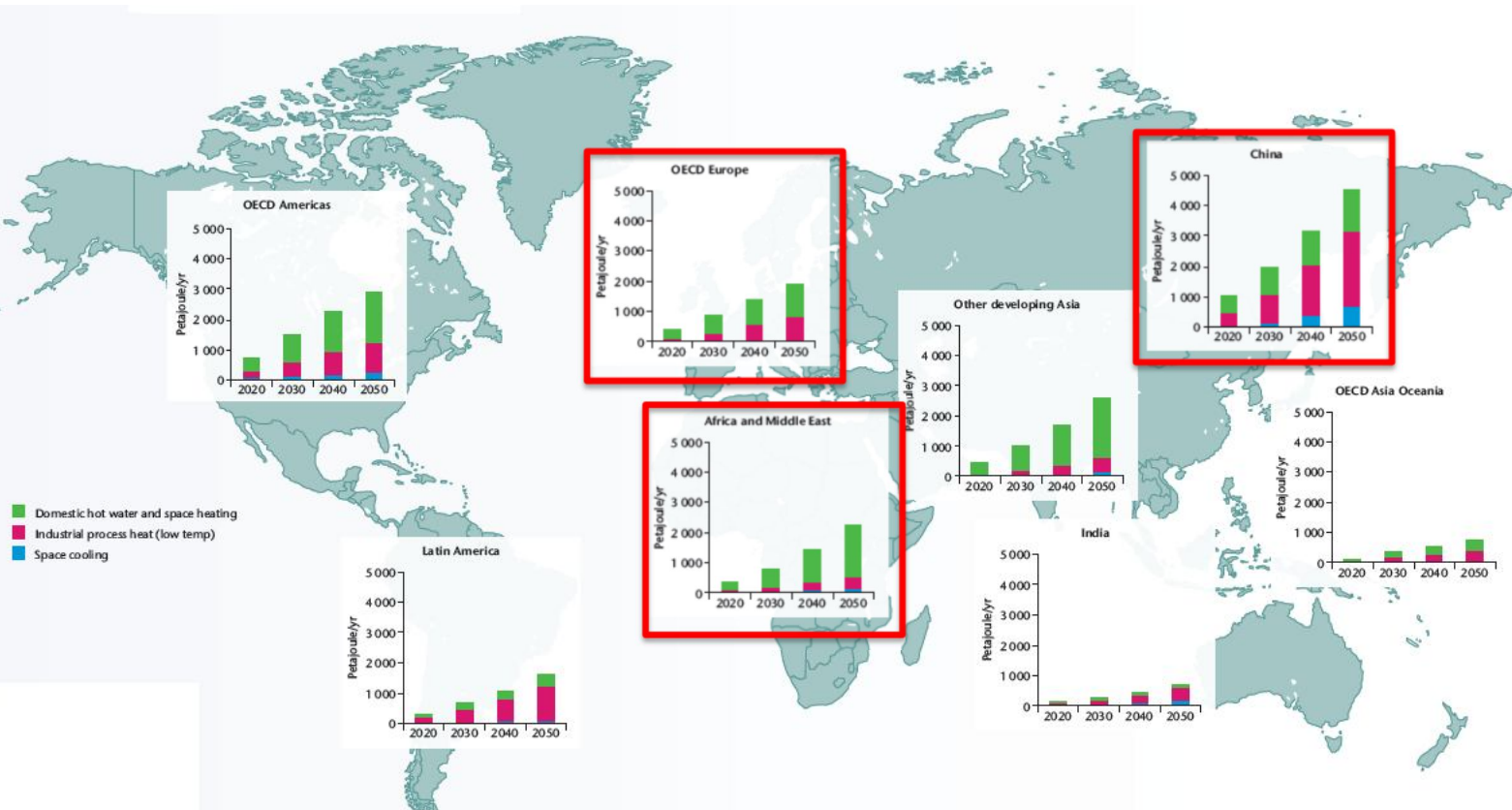


Solar heating and cooling capacity could produce annually by 2050:

- 16.5 EJ solar heat (16% of TFE low temp. heat)
- 1.5 EJ solar cooling (17% of TFE cooling)

Source: IEA Technology Roadmap – Solar Heating & Cooling

Regional solar heating and cooling generation in buildings and industry



Source: IEA Technology Roadmap – Solar Heating & Cooling

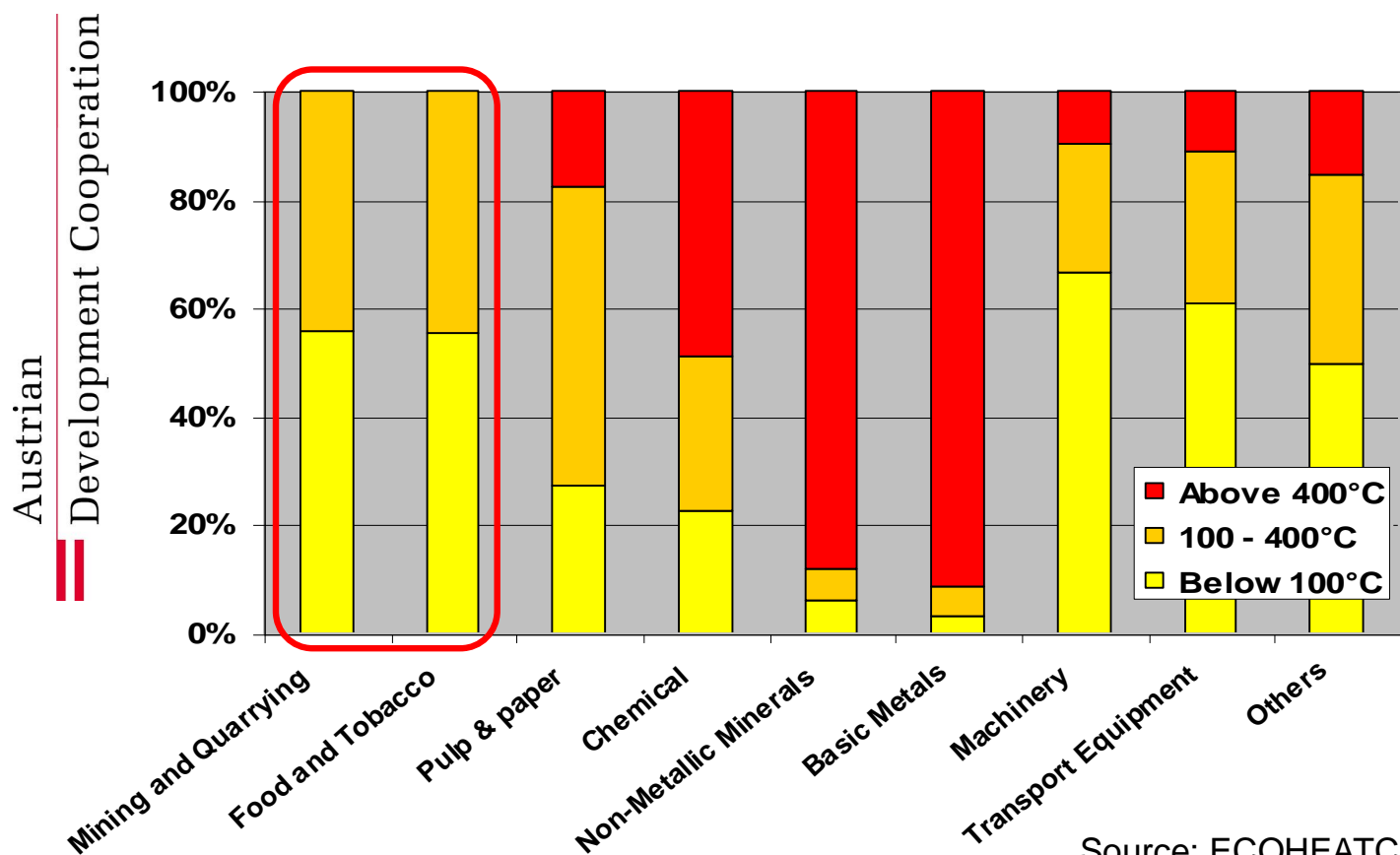
Three different temperature levels are used for describing the quality of the demand for heat in industries:

Low temperature level is defined as up to 95°C, corresponding to the typical heat demands for space heating or industrial processes like washing, rinsing and food preparation.

Temperatures between 95°C and 250°C are defined “medium”. This heat is normally supplied through steam.

Temperatures over 250°C are “high” and needed to manufacture metals, ceramics, glass etc.

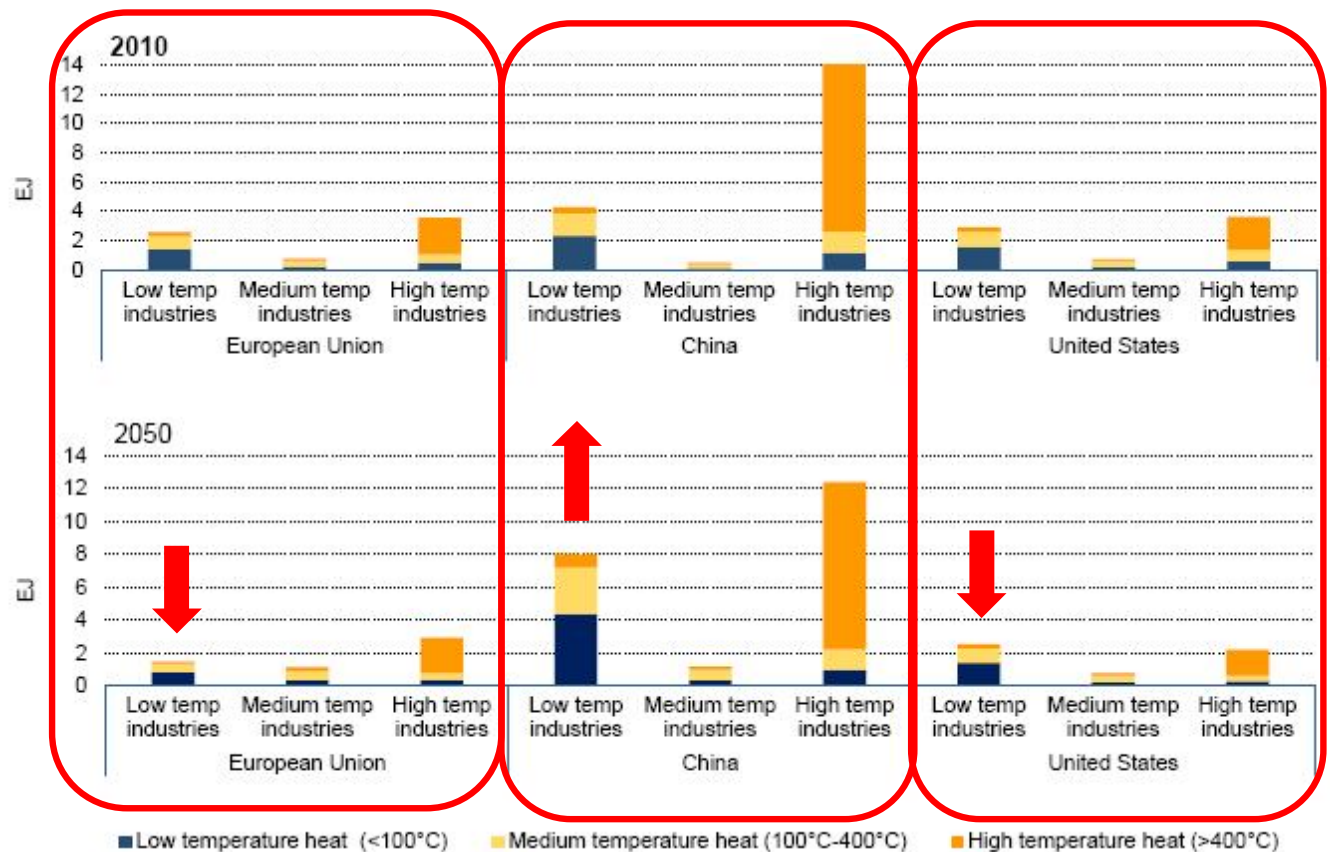
Industrial heat demand by temperature level and industrial sector



Source: ECOHEATCOOL

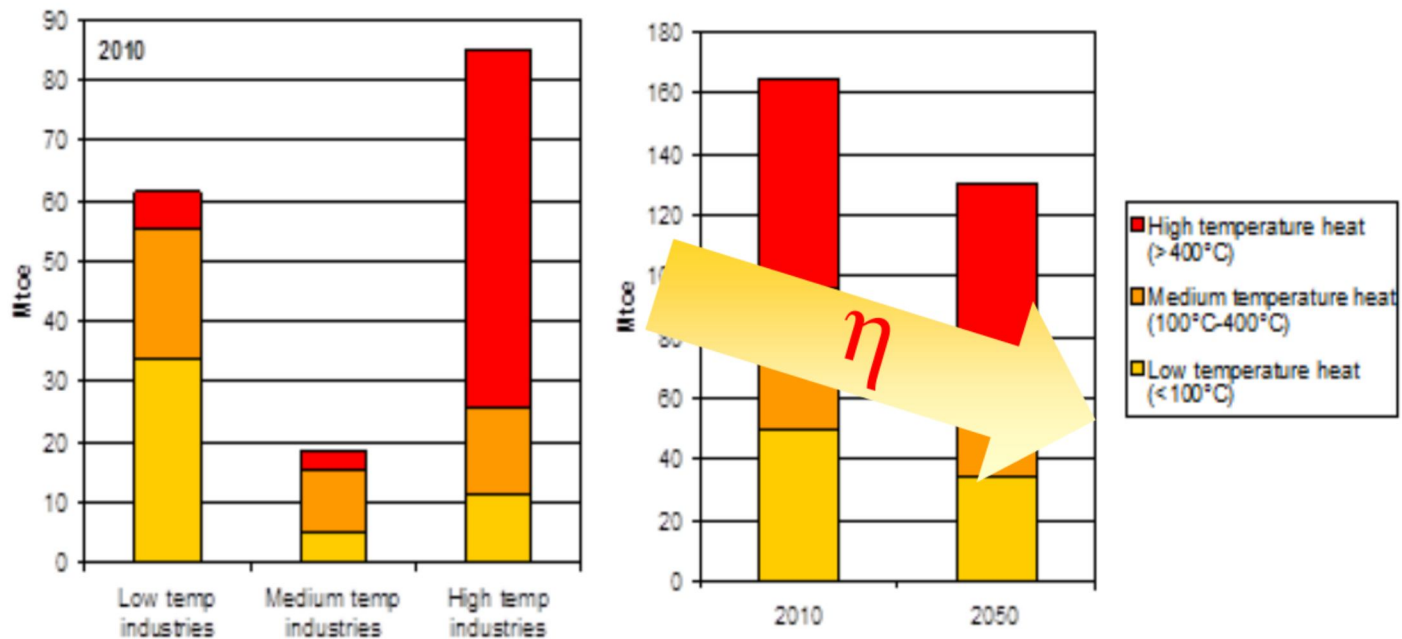
Industrial Heat Demand

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Development Cooperation



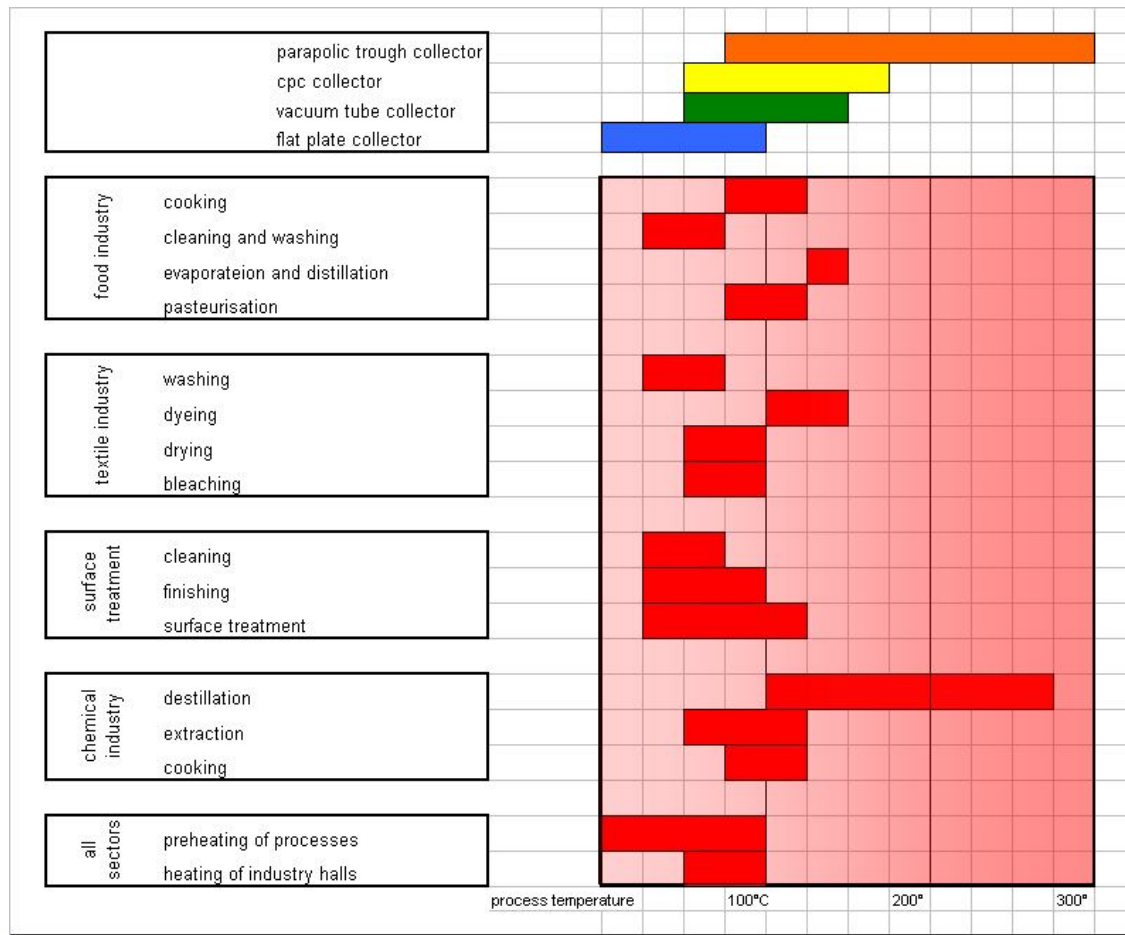
Source: IEA ETP 2012

Industrial heat demand by temperature level and industrial sector



Industrial heat demand by temperature level in the EU in 2010 (left) and industrial heat demand in the EU in 2010 and expected demand in 2050 (right). Source: OECD / IEA (2012).

Temperature levels of processes



Efficiency first



Process

1st step



2nd step: Solar Thermal Energy

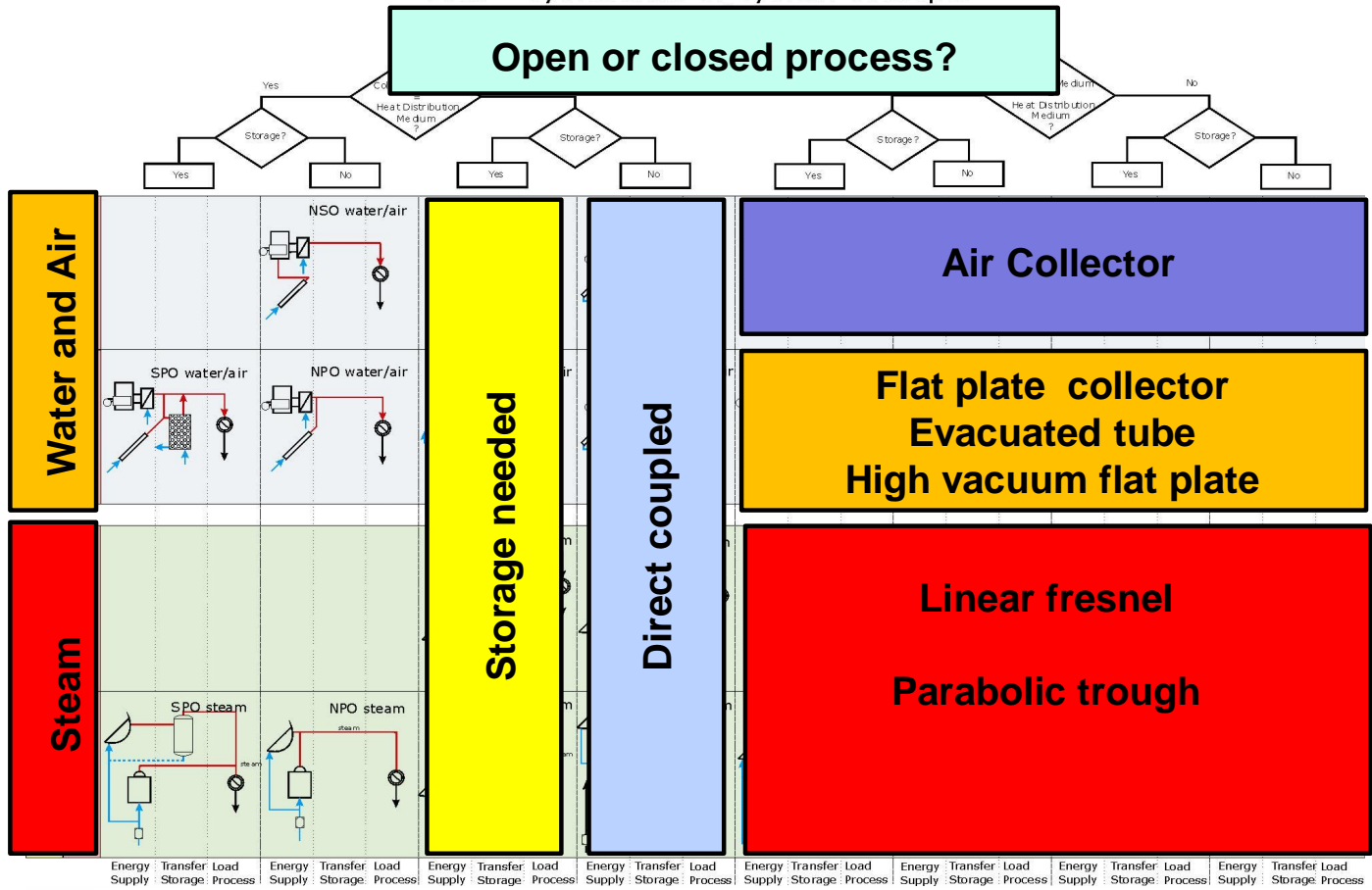


Generic Solar Heat Integration Concepts

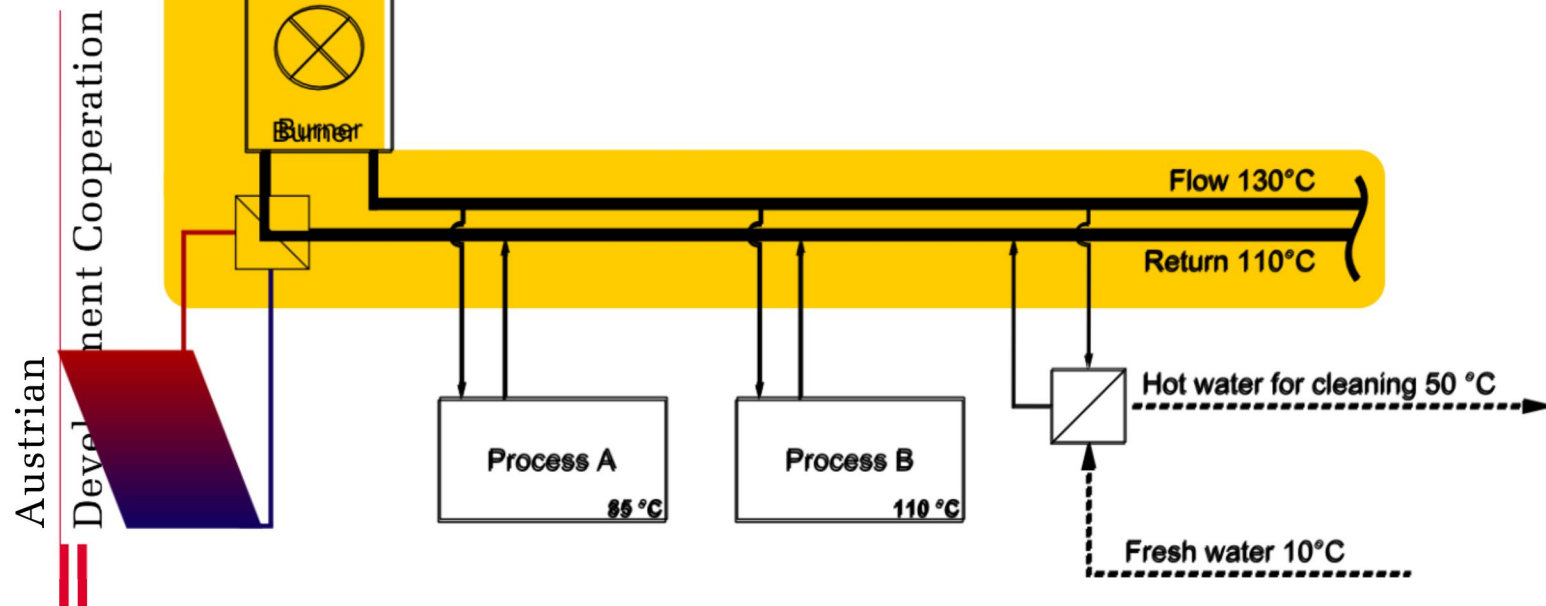
3rd draft version, September 2005

SHIP - Systematics of System Concepts

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Integration on supply level – hot water



Feed-in solar energy in heating circuit

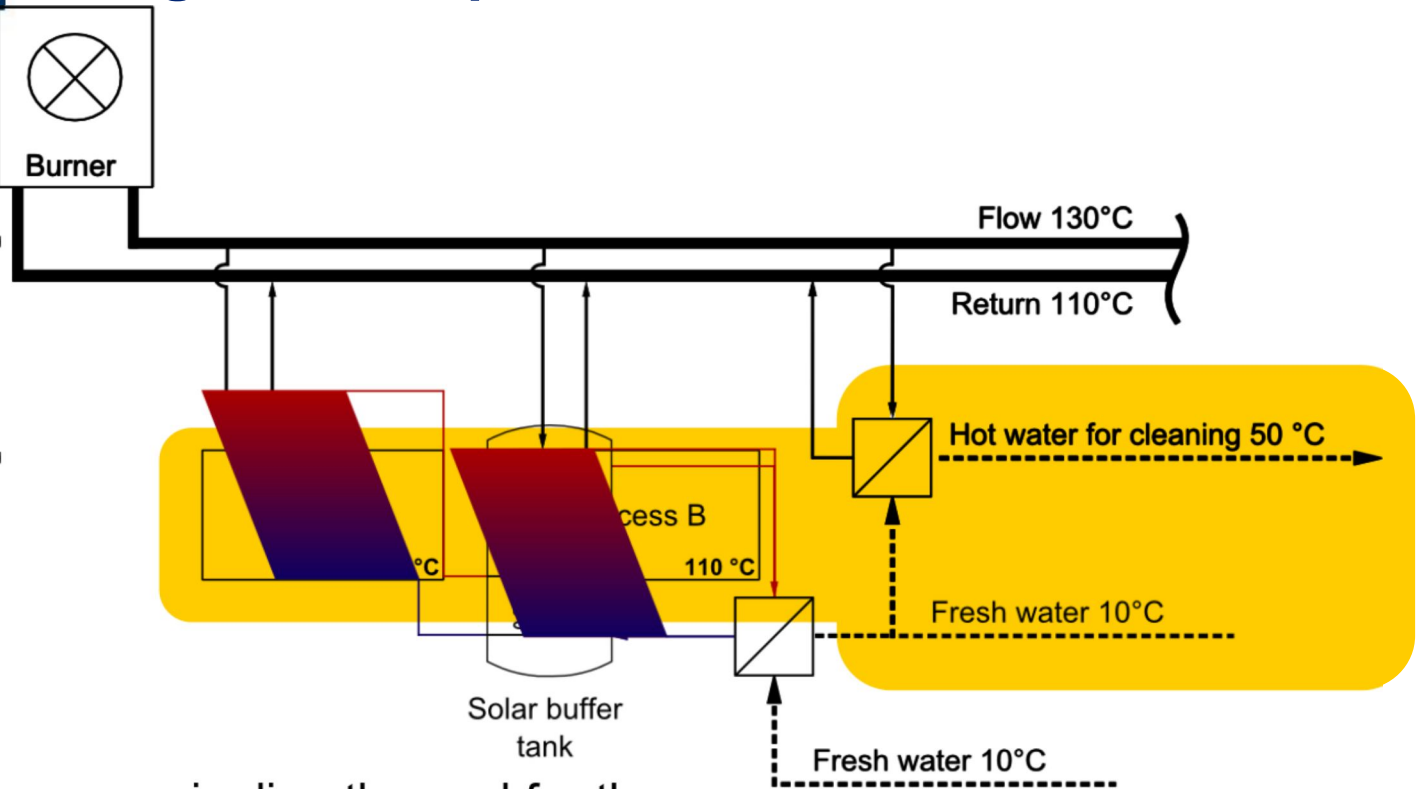
High set temperature

Simple system integration

Small number of system layouts

Integration on process level

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Solar energy is directly used for the process

Different system layouts possible

Often complex system integration

Parabolic Trough Baking Device developed in Lesotho

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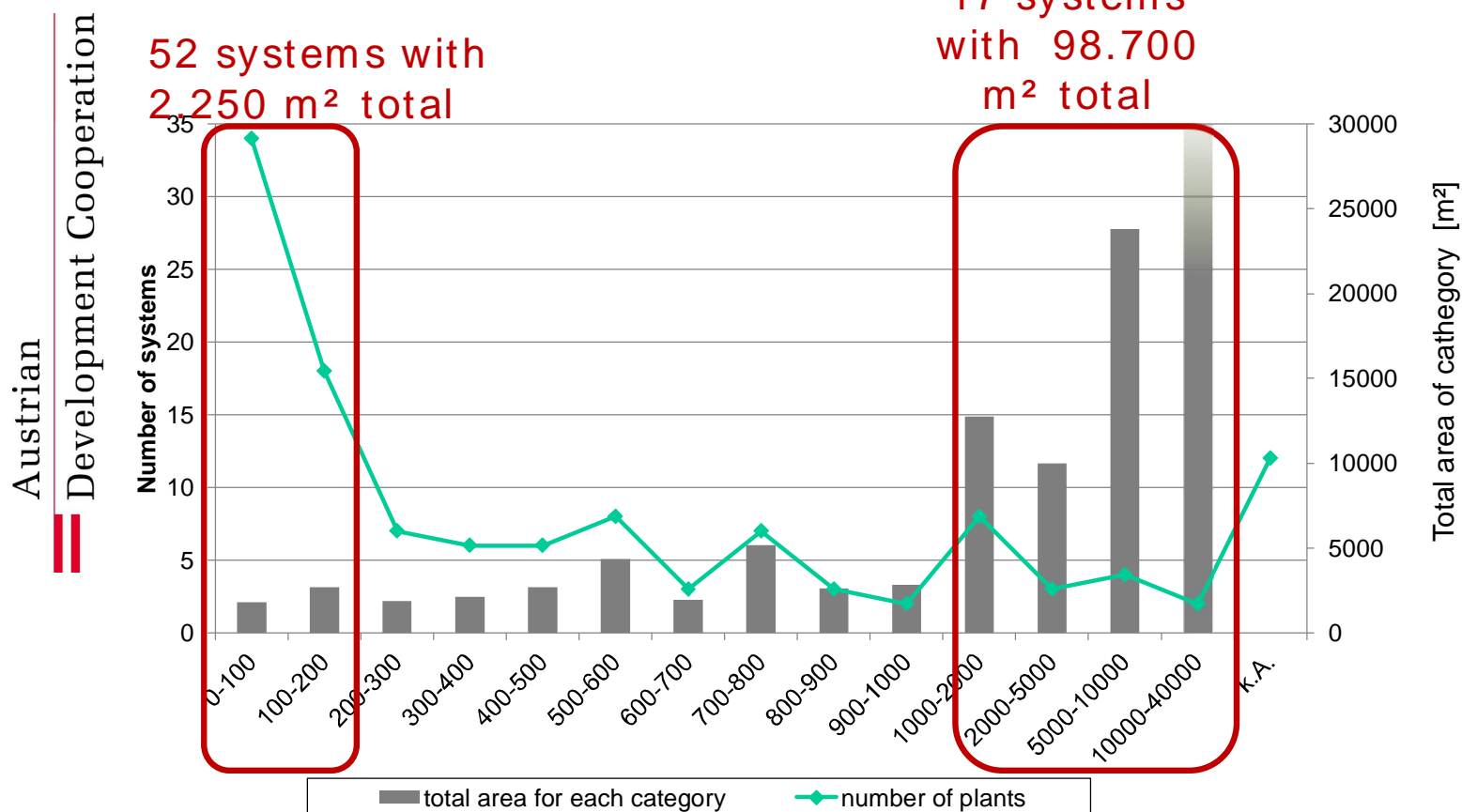
Source: Ivan Yaholnitsky, BBCDC

Mzuri Sana Farm - Zimbabwe

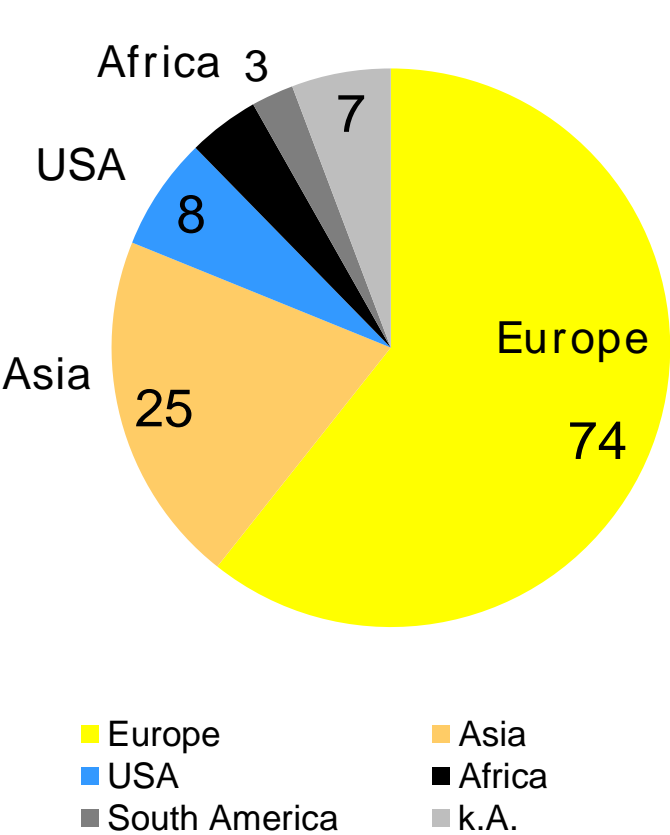


First Results – IEA SHC Task 49 Data base

122 systems, 125,600 m² , 87.8 MW

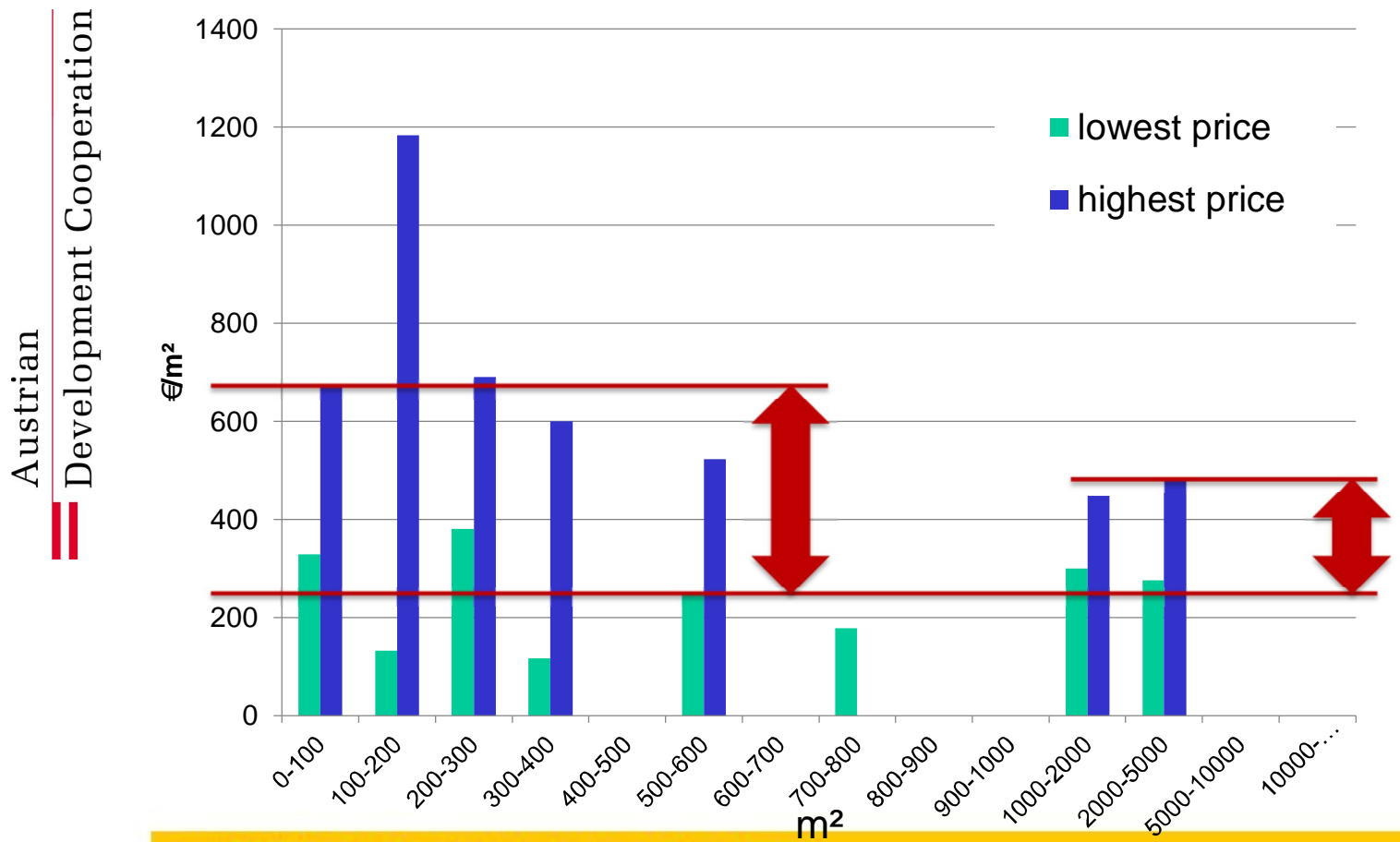


First Results IEA SHC Task 49 - Countries



Country	quantity
Austria	20
Germany	13
Greece	13
Spain	12
Portugal	4
Switzerland	4
France	2
Romania	2
Cyprus	1
Czech Republic	1
Sweden	1
Turkey	1
India	8
China	5
Thailand	3
Vietnam	3
Indonesia	1
Saudi Arabia	1
Jordan	4
USA	8
Panama	1
Argentina	1
Chile	1
Costa Rica	1
k.A.	7

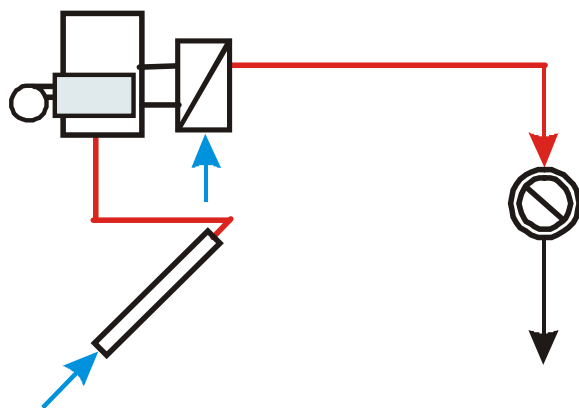
System price related to system size



Drying Applications



Generic System - 1Nso



Main Applications

- ☐ Coffee Drying
- ☐ Tea Drying
- ☐ Maize Drying
- Tobacco Drying

Temperature range for the processes: 30 - 80°C

Heat carrier: air

Recommended Collector Types:

☐ glazed or unglazed air collector

☐ Solar Wall ®

Air based Drying System



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Air based Drying Systems in India



Leather Drier with Solar Hot Air Ducts

M/S M.A. KHIZAR HUSSAIN & SONS, RANIPET

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Source: C.PALANIAPPAN, PAN

Sadesa Leather (1)

Sadesa, Thailand

Tanery

Hot water for tanning process

System

Aschoff solar

Start of operation: 2013

1.890 m² Vacuum tube collector

35 m³ heat store

30 - 80 °C



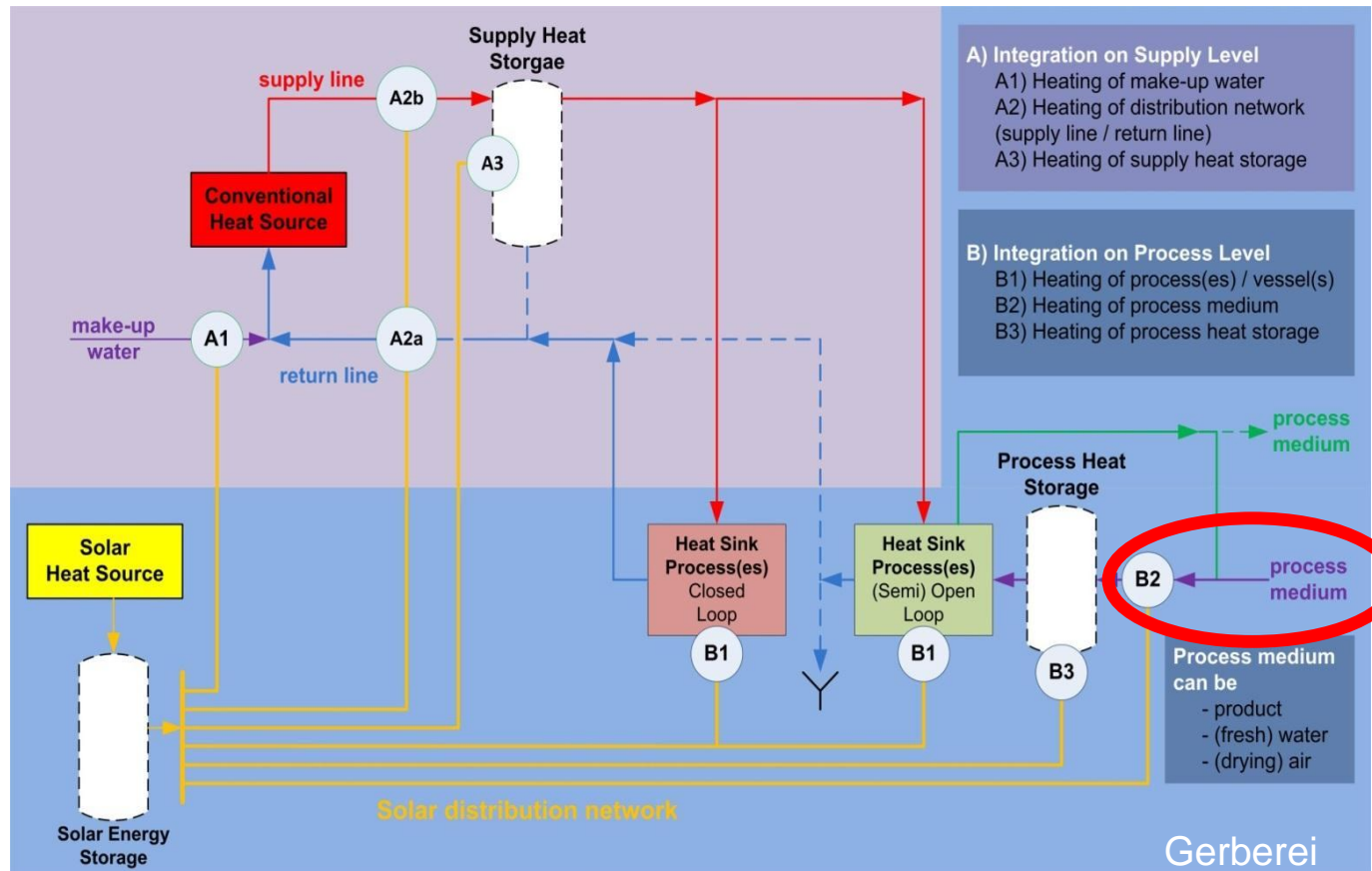
IEA SHC Task 49

Sadesa Leather (2)



IEA SHC Task 49

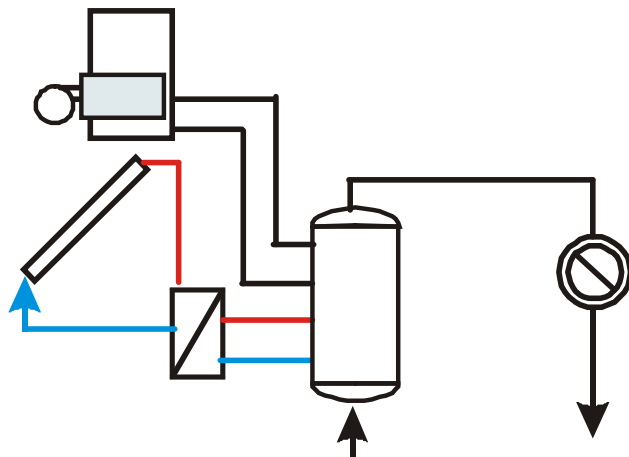
Sadesa Leather (3)



IEA SHC Task 49



Washing processes with open hot water loop - generic system concept



Main Applications

cleaning of:

- bottles
- textile
- cars

Temperature range for the processes: 40 - 90°C

Heat carrier: water

Recommended Collector Types:



flat-plate collector

Washing Processes



Parking service Castellbisbal SA, container washing, Barcelona, Spain.
Installed capacity: 357 kWth. Source: Aiguasol Engineering, Spain.

MOGUNTIA Meat Spices, Kirchbichl Tyrol

Installed Capacity: 150 kW_{th} (215 m² FPC)



TiSUN®
Made in Tirol by Teufel & Schwarz

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Year of Installation: 2007

Installed Capacity: 150 kW_{th} (215 m² collector area)

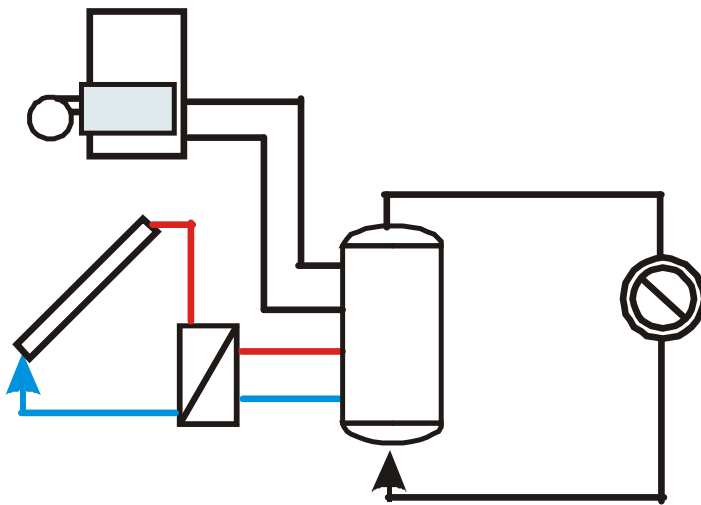
Storage Volume: 10 m³

Daily Hot Water Demand: 8000 Liter

Solar Fraction: 45%

Processes: Cleaning of stainless steel containers for spices
 Cleaning of dispersing machines
 Hot water for processing liquid spices and pastes
 Dehydration of production halls in summer

Closed Systems



Main Applications :

- Textile Industry
- Tanneries
- Dairy
- Breweries
- Beverage Industry

Temperature range for the processes : 30 - 110°C

Heat carrier: Water / Steam

Recommended Collector Types : FK, CPC, VR

Tyras dairy, Trikala, Greece

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Dairy, TYRAS S.A. , Trikala, Greece
Installed Capacity: 728 kW_{th} (1040 m² FK)



Prestage Food (1)

 North Carolina, USA

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Prestage Food (2)

Poultry Company in NC, USA

Energy-Contractor: FLS Energy  Owner of the Solar System

Demand 568 [m³/d] Hot water at (>60 °C) for Cleaning processes

System

Start of operation 2012

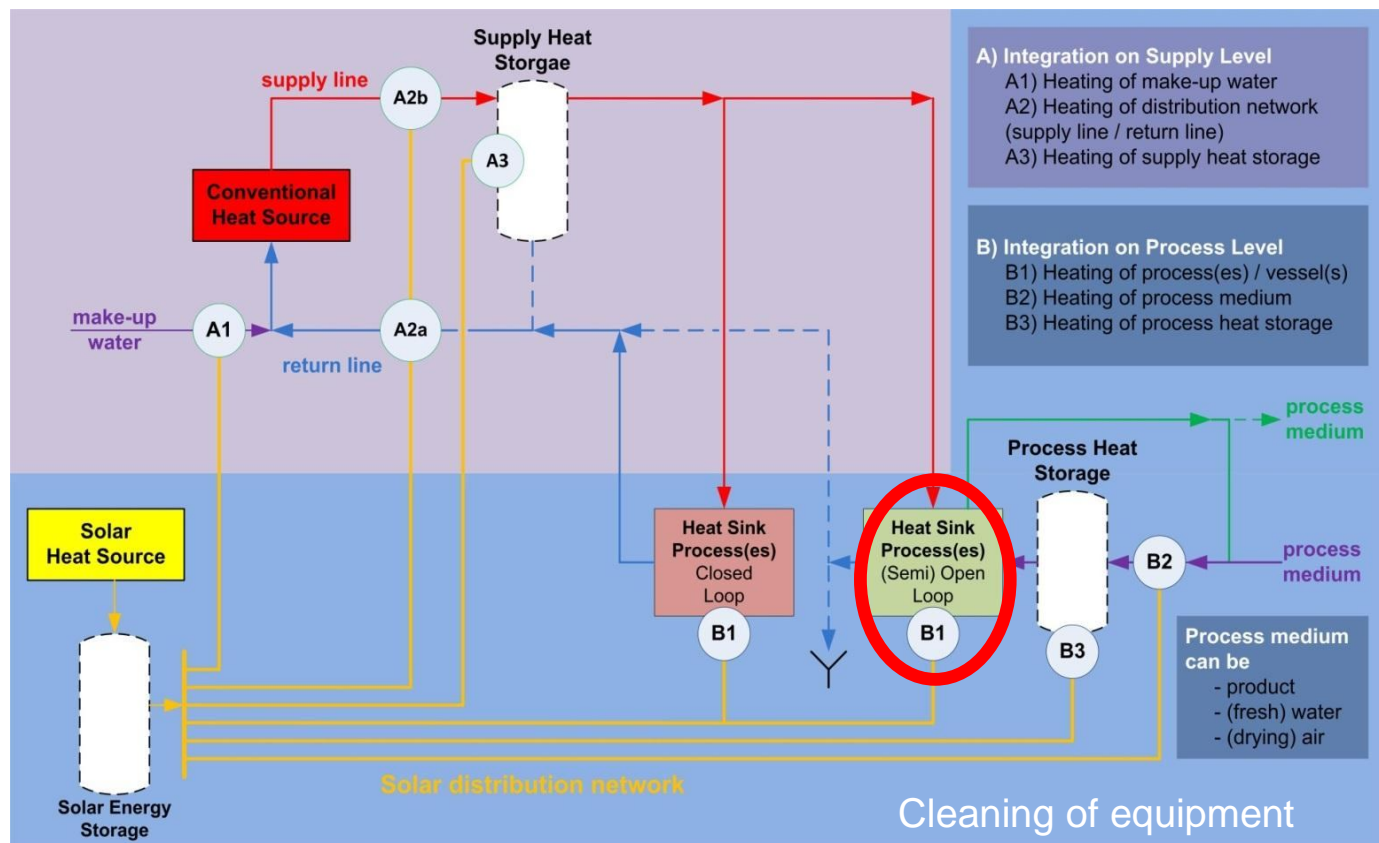
7,804 m² Flat plate collectors

852 m³ Heat Storage (10 x 85 [m³])

50% Solar Fraction (Hot water)

Source of pictures: FLS Energy

Prestage Food (3)





Nestle Waters (1)



Al Manhal, Riad, Saudi Arabia

System

Millennium Energy Industries

Start of operation: January 2012

515 m² Flat plate collectors

15 m³ Heat Storage

Replacement of electricity for bottle washing (~ 70 °C)

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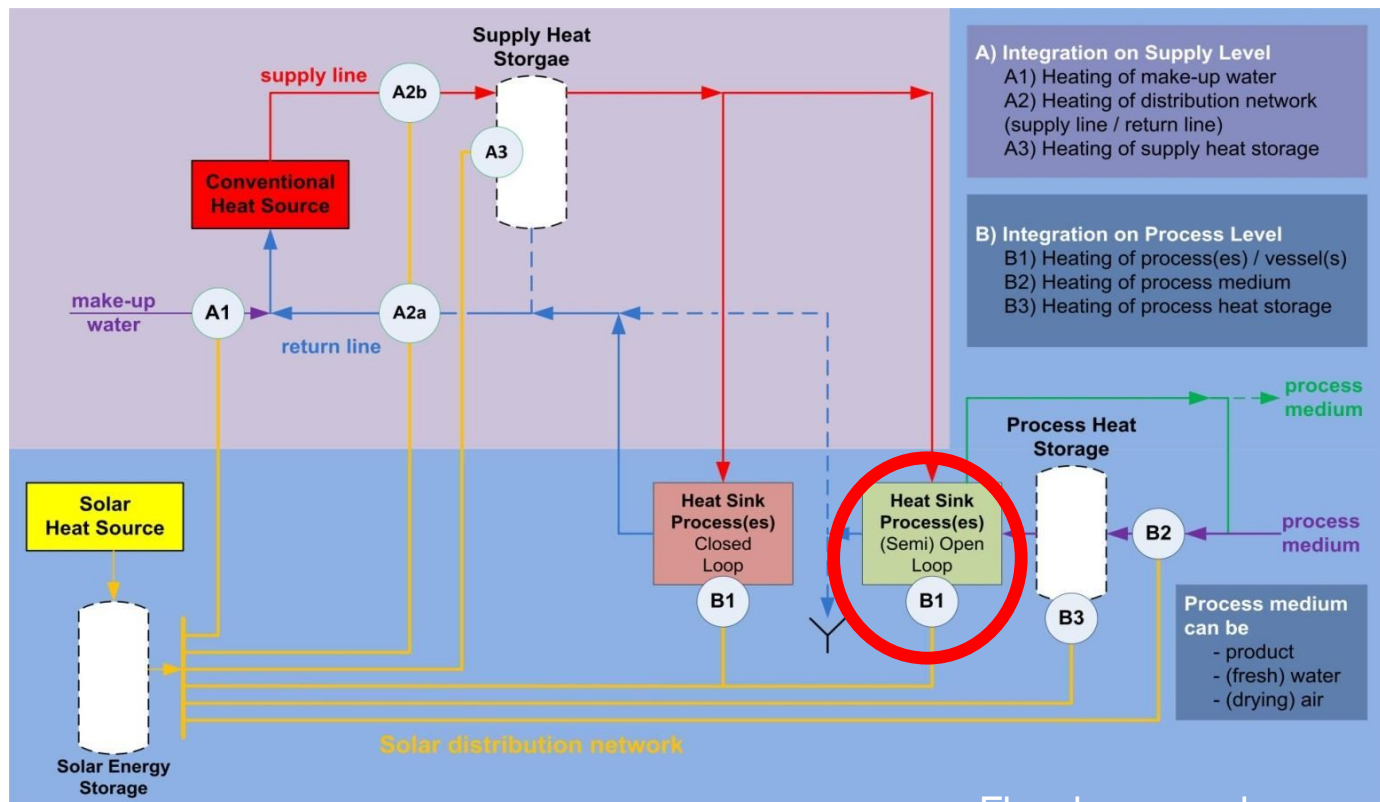
Nestle Waters (2)



IEA SHC Task 49

Nestle Waters (3)

Al Manhal, Riad, Saudi Arabia



IEA SHC Task 49



Gatorade (PepsiCo)

Phoenix, AZ, USA

892 m² solar collectors

38 m³ buffer tank

Pre-Heating fresh water for the soft-drink production at 35° C/ 95° F

Annual Energy gains =
more than 1 Mio. kWh !!!
(= more than 1200 kWh/ (m²* y) !)

Source: SOLID GmbH. Graz Austria

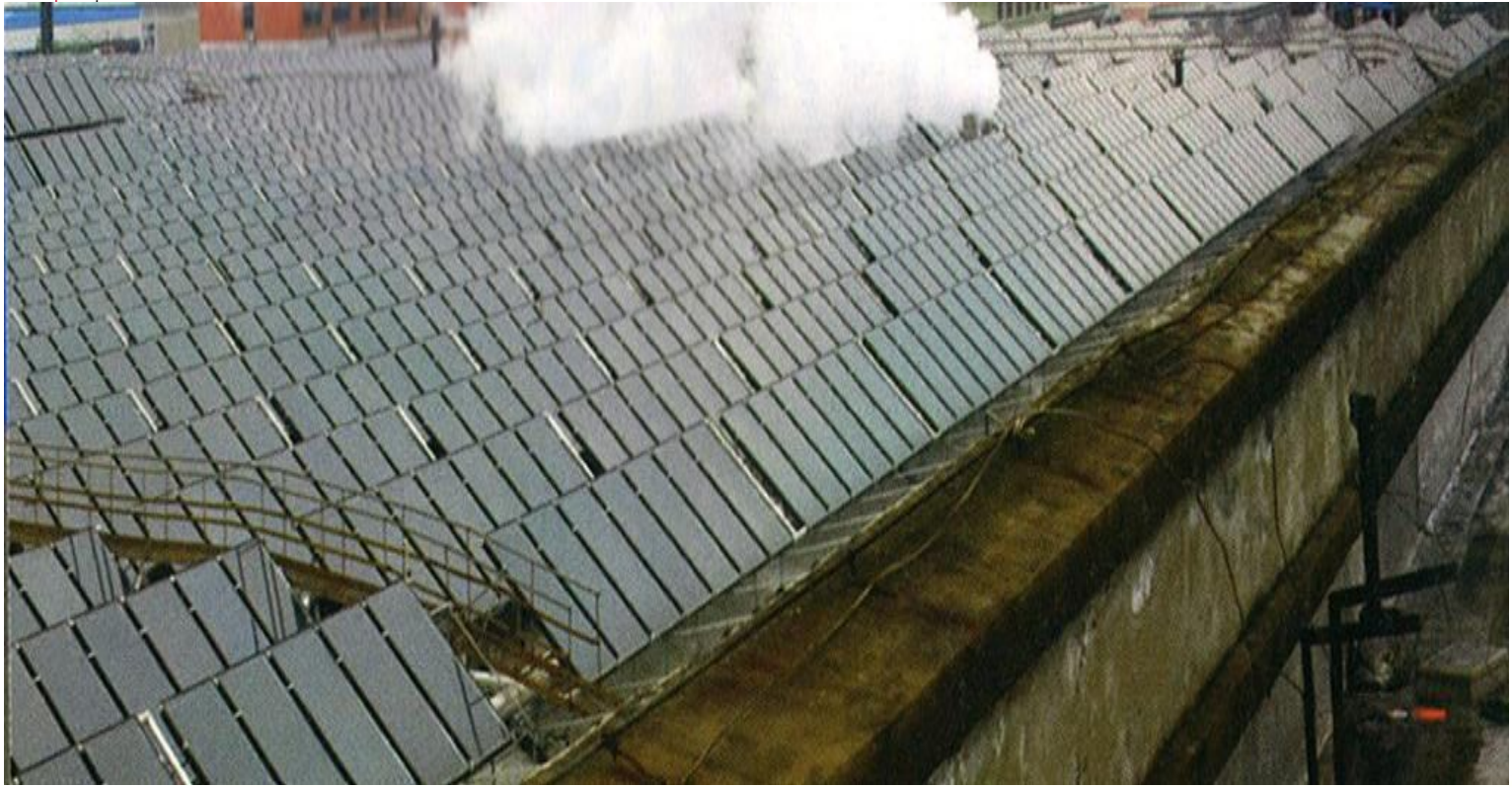


Source: SOLID GmbH. Graz Austria



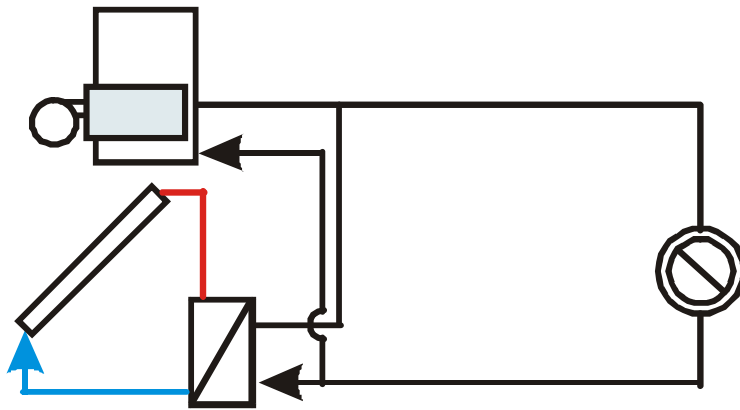
Textile Industry Hangzhou China 13000m² (9 MW_{th})

tion





Necessity of a Storage Tank



Main Applications

- Galvanic industry
- Food industry

Temperature range for the processes : 30 - 90°C

Heat carrier: Water

Recommended Collector Types: FP, ETC, CPC



Electroplating Bath in Ludhiana, India

500 m² collector area (350 kW_{th})

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The temperature of the electroplating bath is to be maintained at 55 to 60 °C for 12 hours a day.

158,000 m² of the total installed collector area in India was used for industrial applications (2009)

Sources: Greentech Knowledge Solution and Intersolar Systems, India



Solar Heat for Copper Mining in Cyprus - 0.5MWth

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Copper Mine in Chile - 26MW_{th}



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Copper Mine “Gabriela Mistral”, Chile

26MW_{th} ($39,300\text{ m}^2$)

AEE INTEC

Cooperation



Process



Electro winning of copper



Electrolyte is kept on a constant Temp. of $50\text{ }^{\circ}\text{C}$



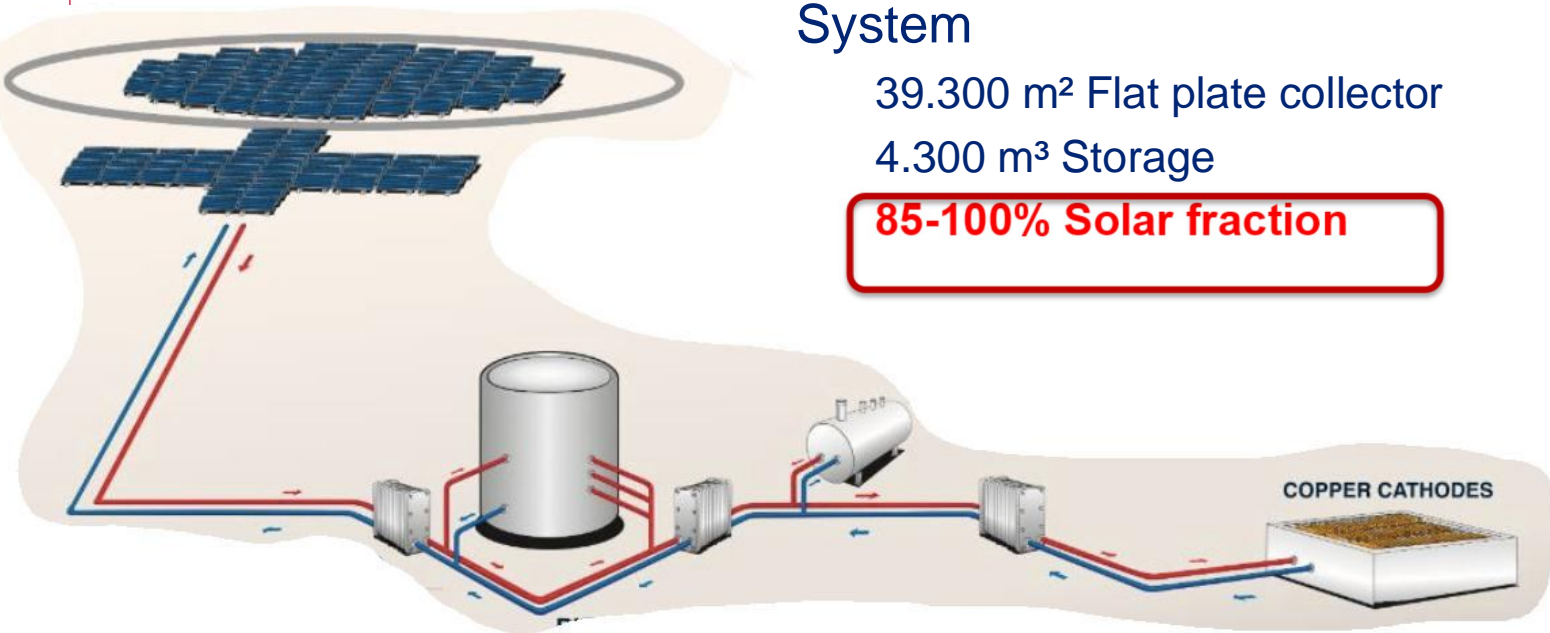
Cleaning Processes

System

39.300 m^2 Flat plate collector

4.300 m^3 Storage

85-100% Solar fraction



Copper Mine “Gabriela Mistral”, Chile

26MW_{th} (39,300 m²)



Source: SUNMARK

Copper Mine “Gabriela Mistral”, Chile

Facts and Challenges

Contracting System performed by Pampa Elvira Solar

Codelco has signed an agreement with the Chilean company Pampa Elvira Solar to deliver solar heat to the mining factory over a 10-year period.

Pampa Elvira Solar owns the solar field and is responsible for its operation.

Flow and return temperatures:

primary side: 85 / 55 °C

secondary side – supplying the mine - at 80 / 60 °C

Expected output: specific yield of 1,272 kWh/m²

Challenge:

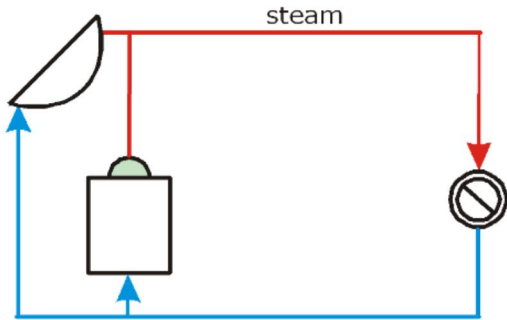
A special machine for dry-cleaning the collectors was developed by Sunmark. The Gaby mine is in one of the driest areas on earth, with rain only pouring down every 50 years.

Distilling and chemical processes

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Steam production via a flashing process - generic system concept



■ NASR Pharmaceutical Chemicals, Egypt. Installed capacity: 1,33 MWth

Source: Fichtner Solar GmbH. Germany



Biggest System Worldwide, Saudi Arabia

36.000 m² / 25 MW_{th}

Austrian



Biggest System Worldwide, Saudi Arabia

36.000 m² / 25 MW_{th}

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Biggest System Worldwide, Saudi Arabia

36.000 m² / 25 MW_{th}

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Biggest System Worldwide, Saudi Arabia

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Pipes and Heat Exchangers

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