Solar Heat for Industrial Processes

Worldwide Potential, Sectors, Processes and Overview on Installed Systems

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AUSTRIA

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

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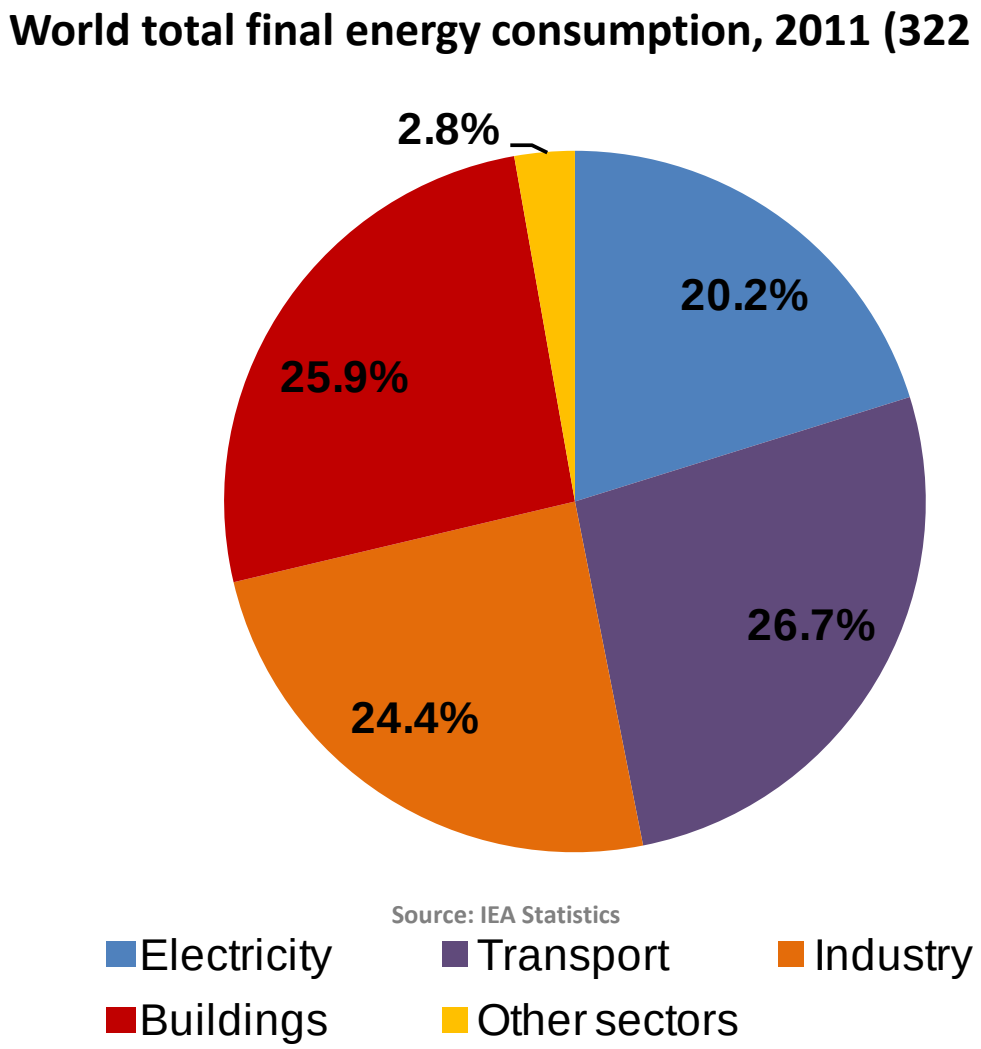
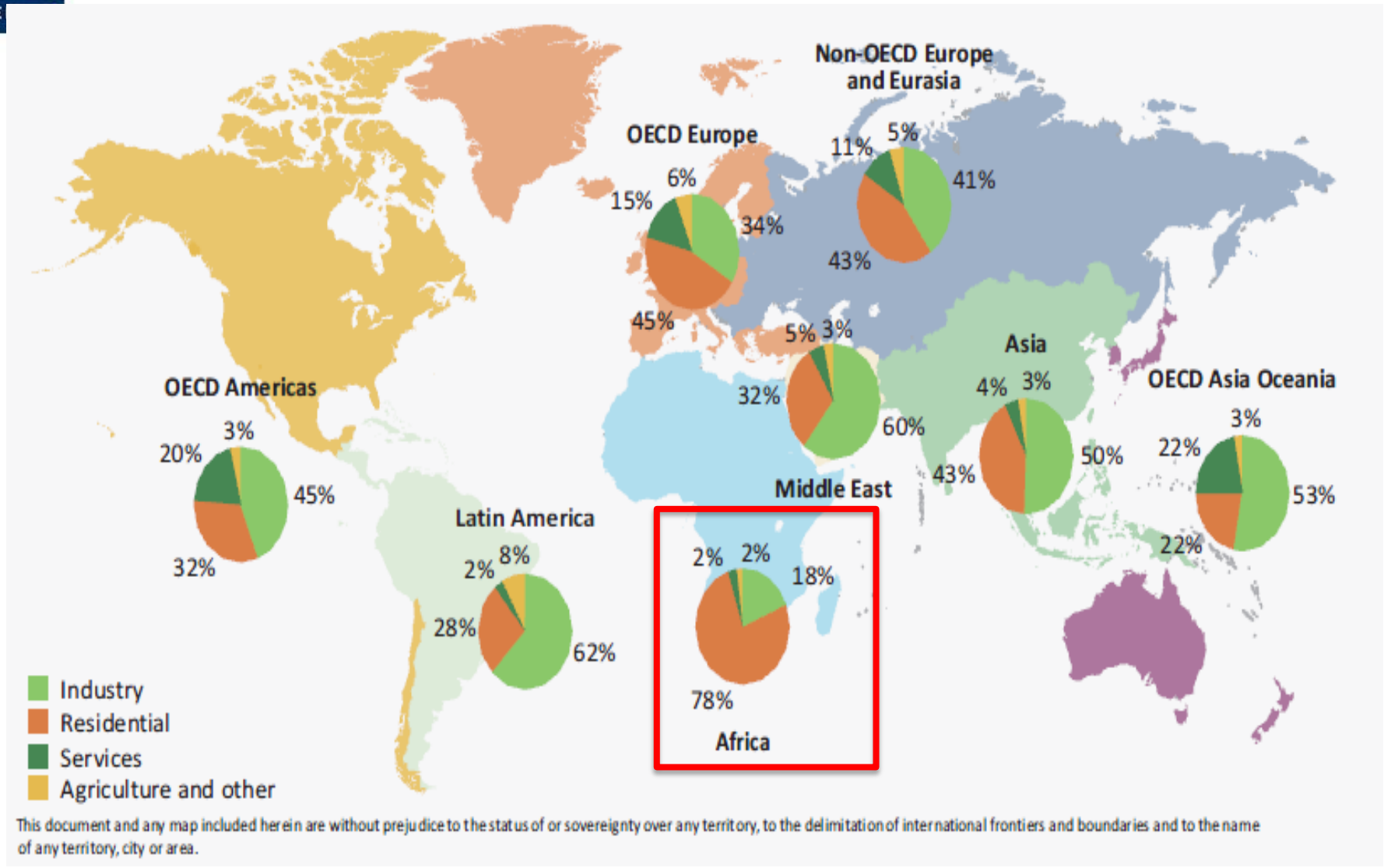


Source: Paolo Frankl, IEA, Paris

Heat plays important role worldwide



Note: Figure based on 2009 data

Source: Energy Technology Perspectives 2012

Source: IEA Technology Roadmap – Solar Heating & Cooling

Global Solar Heating and Cooling Markets

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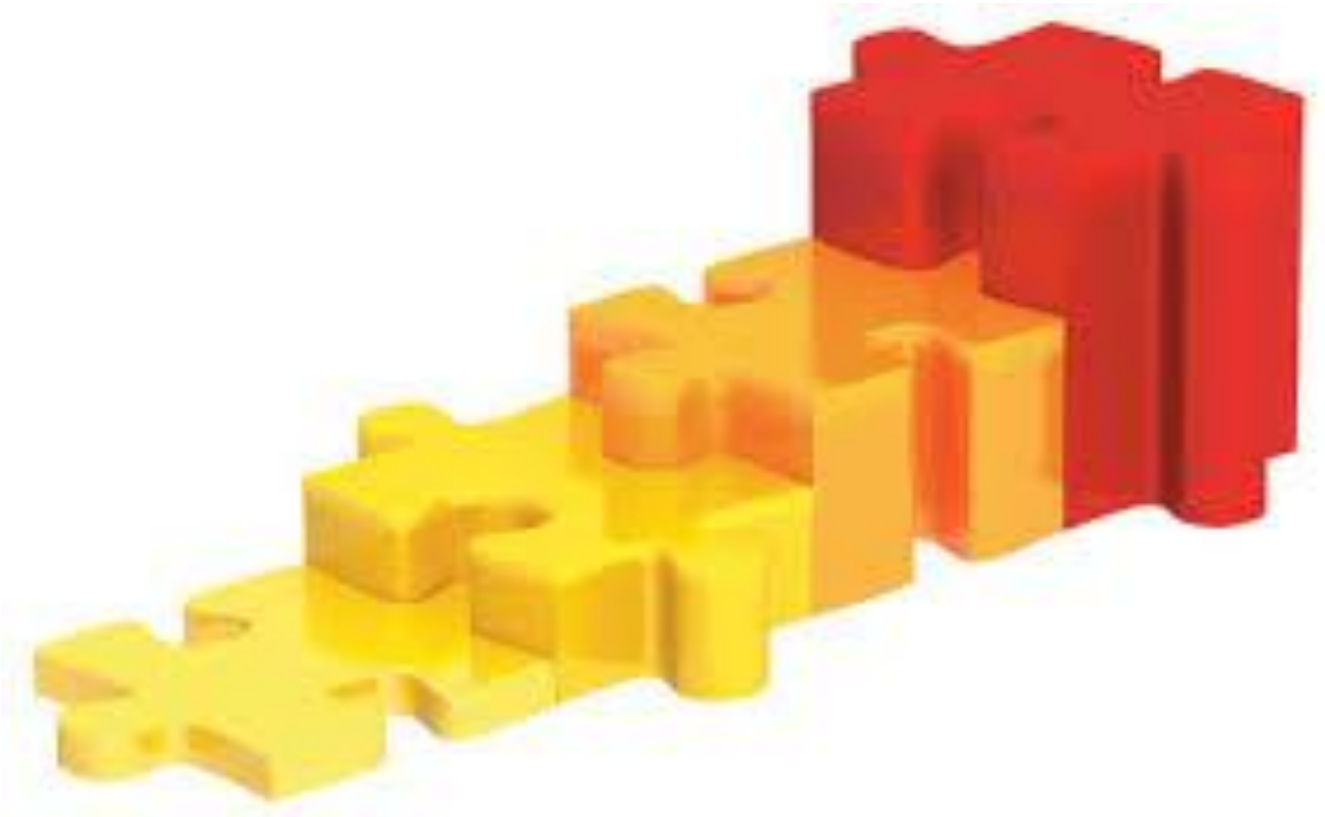
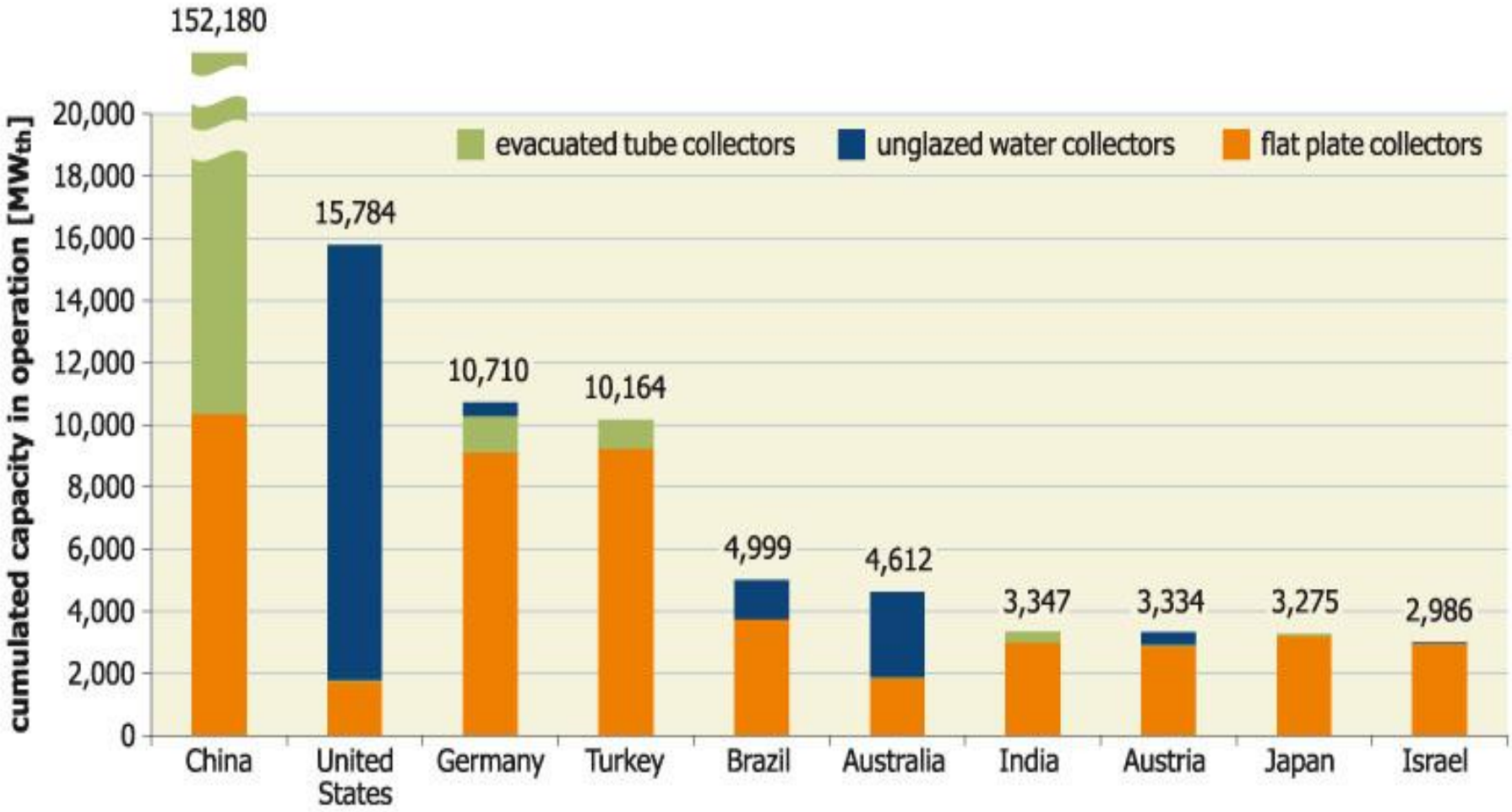
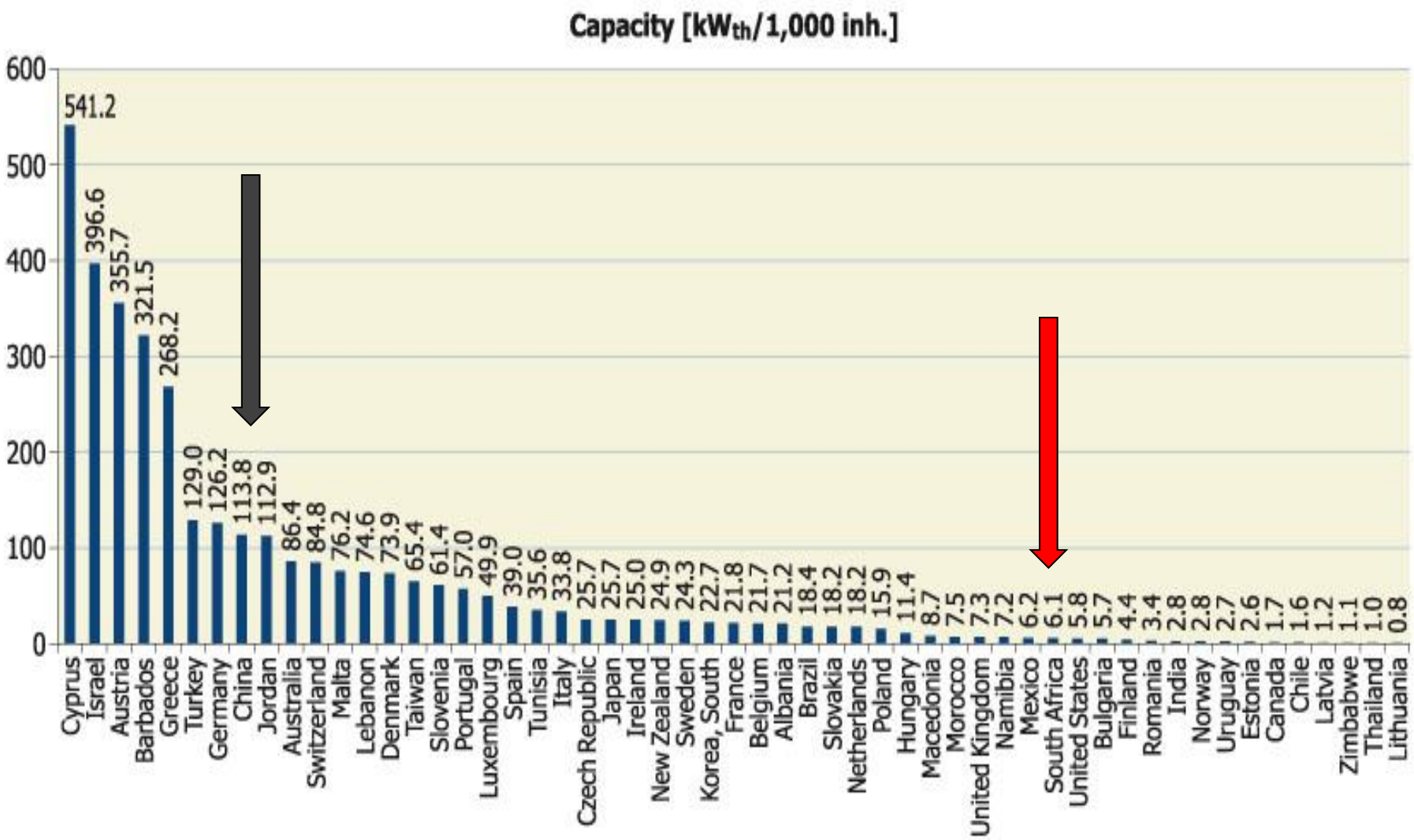


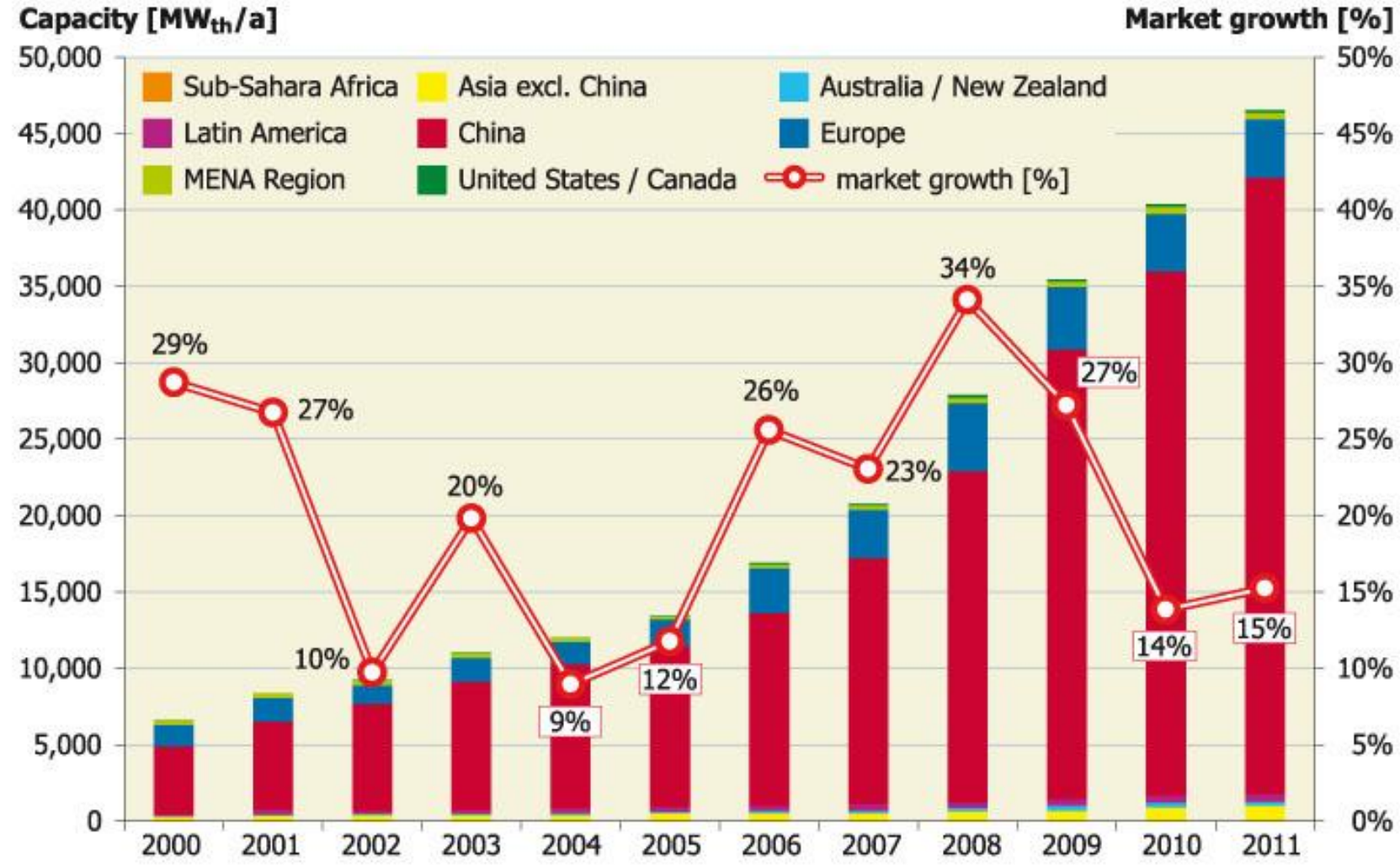
Total installed capacity of unglazed and glazed water collectors in operation in the 10 leading countries by the end of 2011



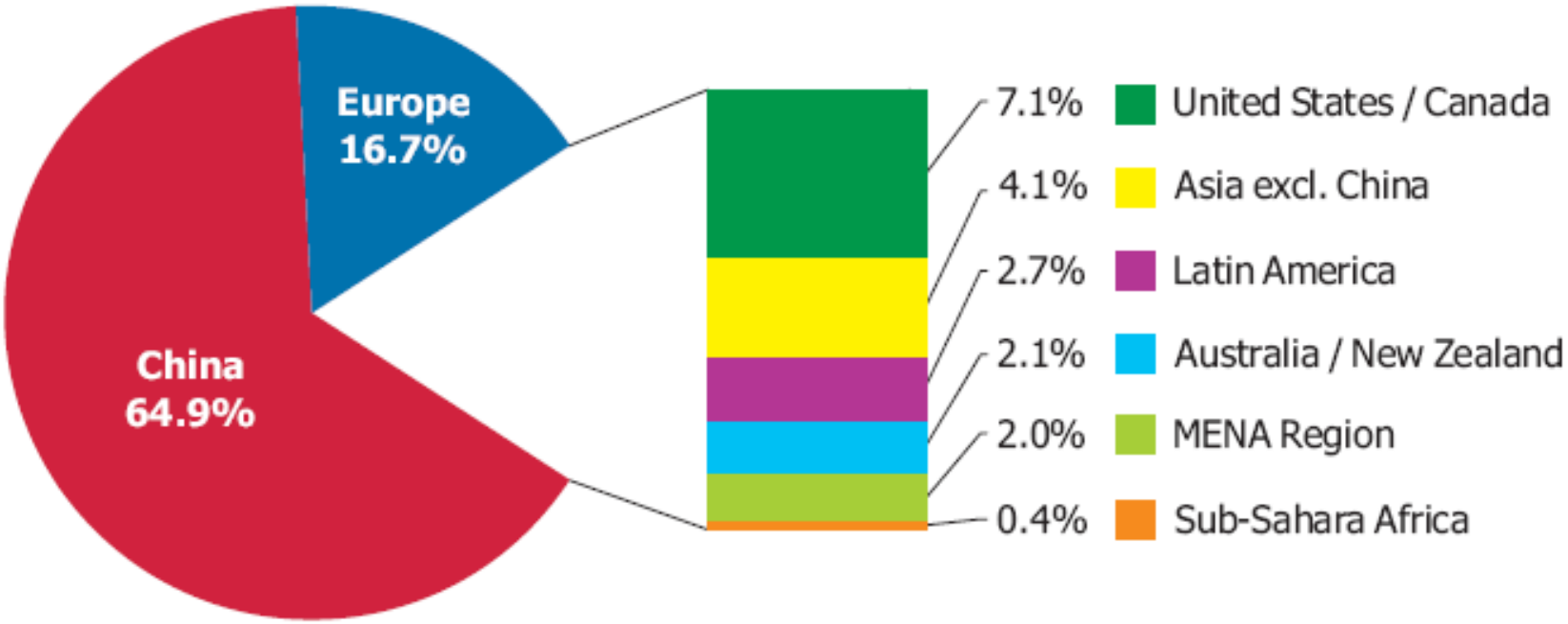
Total capacity of glazed flat plate and evacuated tube collectors in operation in kW_{th} per 1,000 inhabitants by the end of 2011



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



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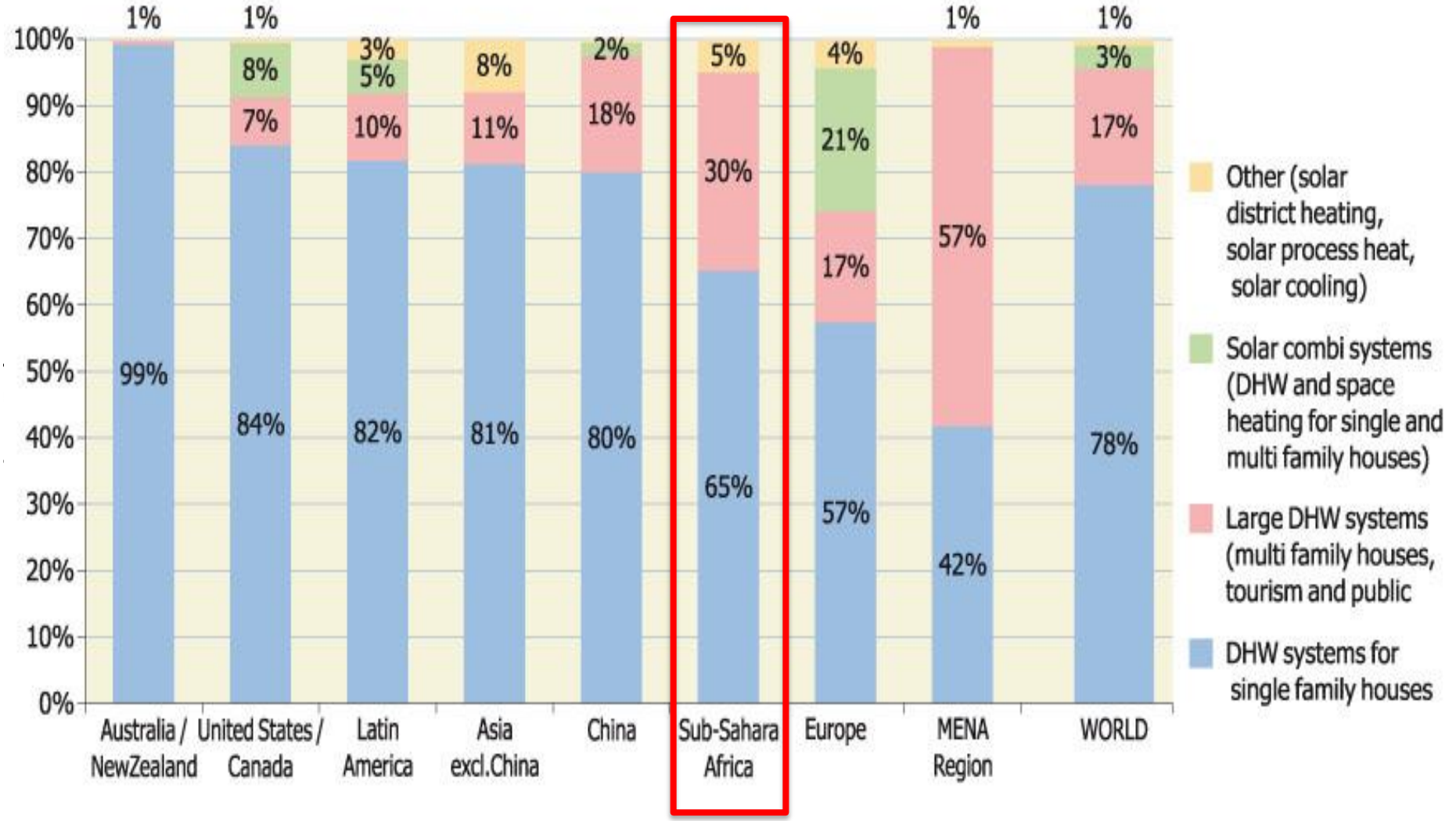
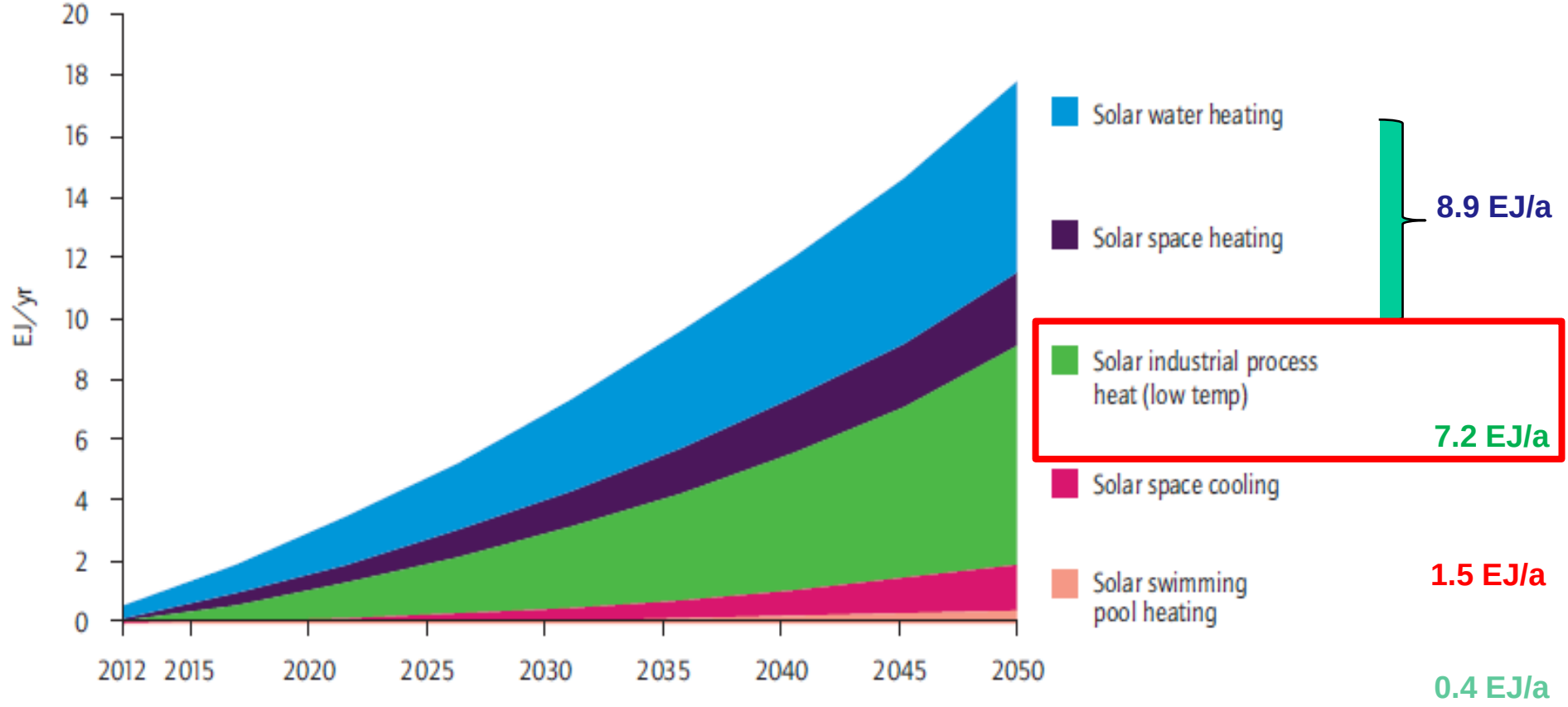
Distribution of solar thermal systems by application for the newly installed glazed water collector capacity of by economic region in 2011



SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

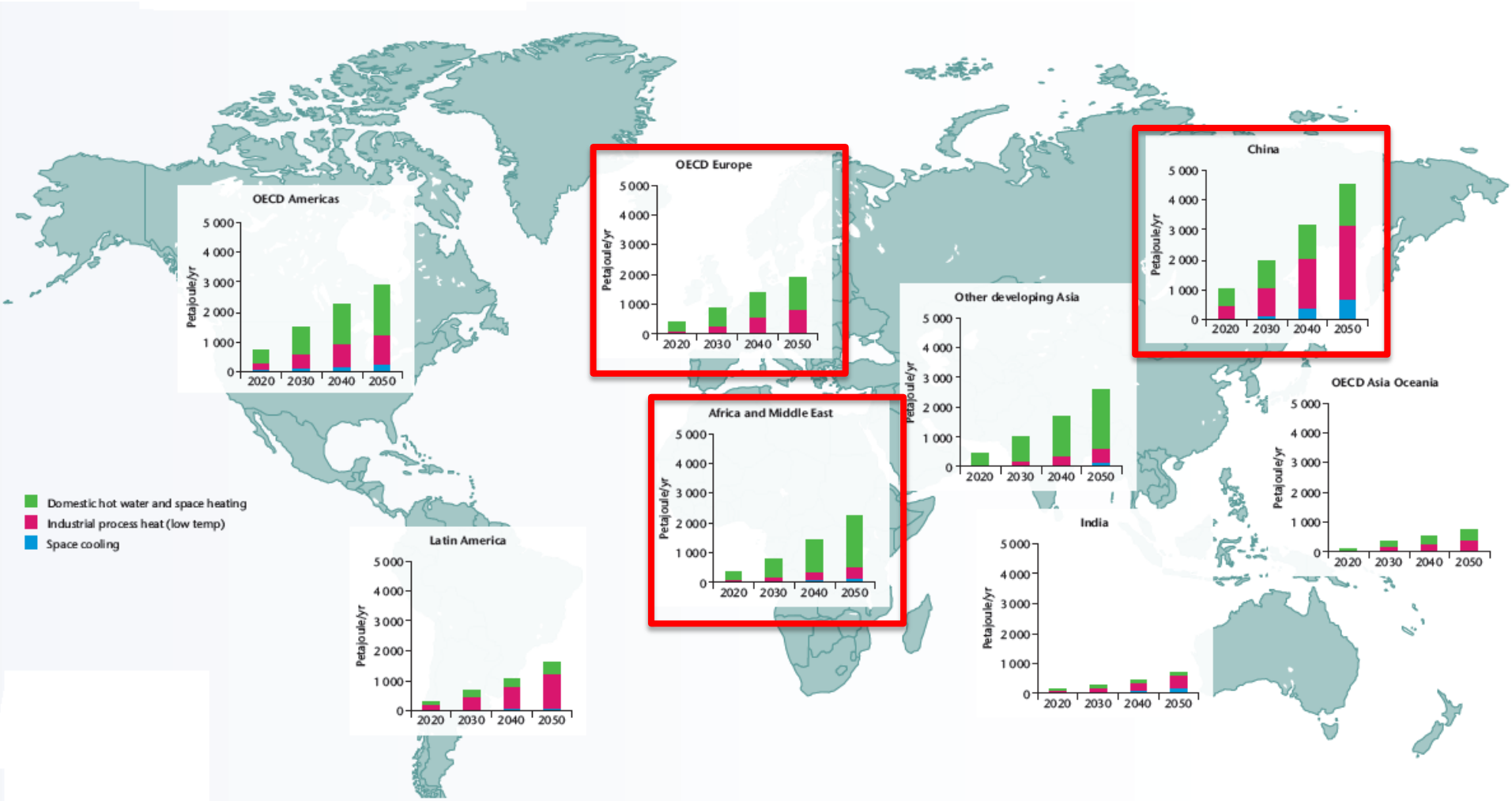
Potential of solar heating and cooling by sector (EJ/yr)



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

Temperature Levels

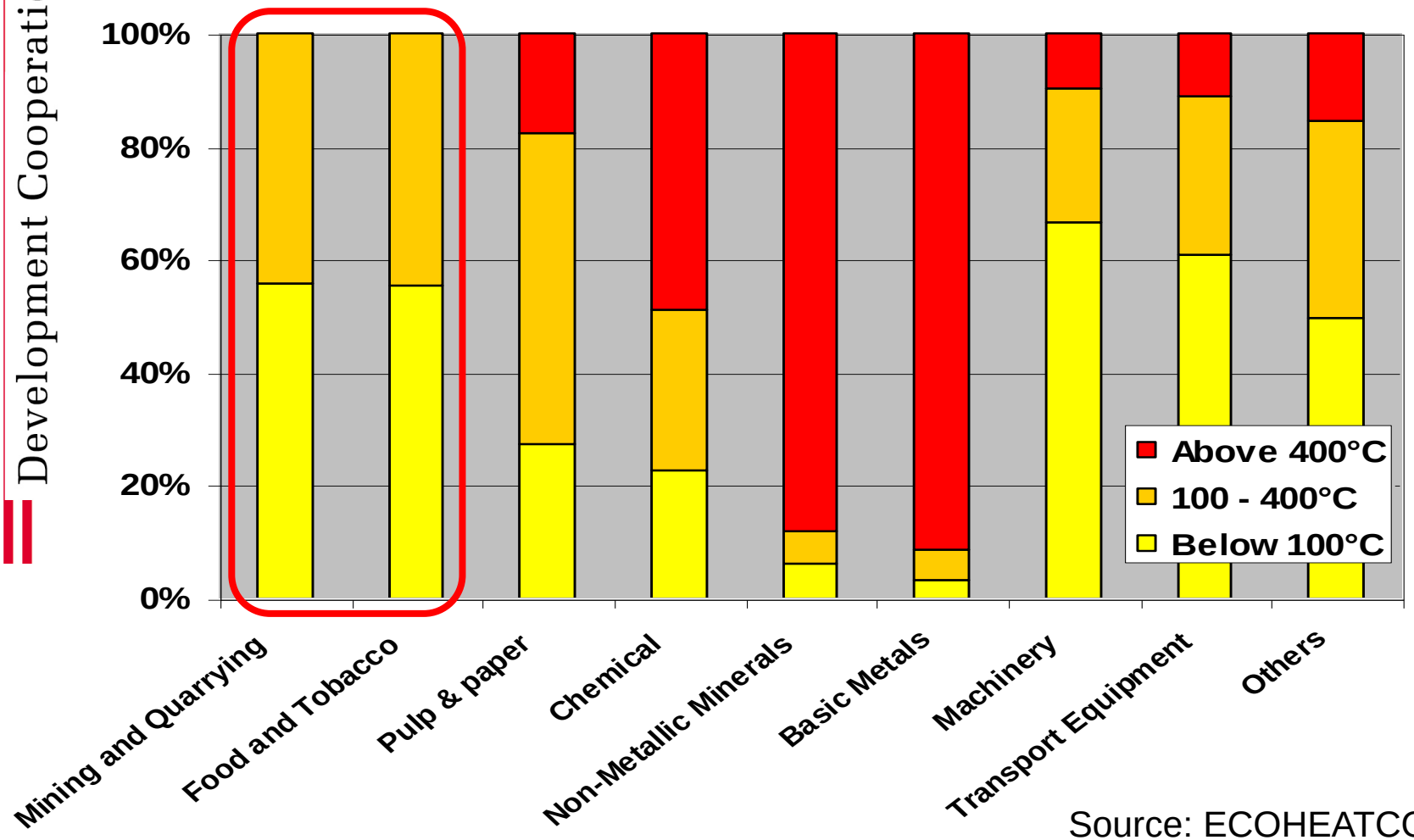
Three different temperature levels are used for describing the quality of the demand for heat in industries:

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 95ºC and 250ºC are defined "medium". This heat is normally supplied through steam.

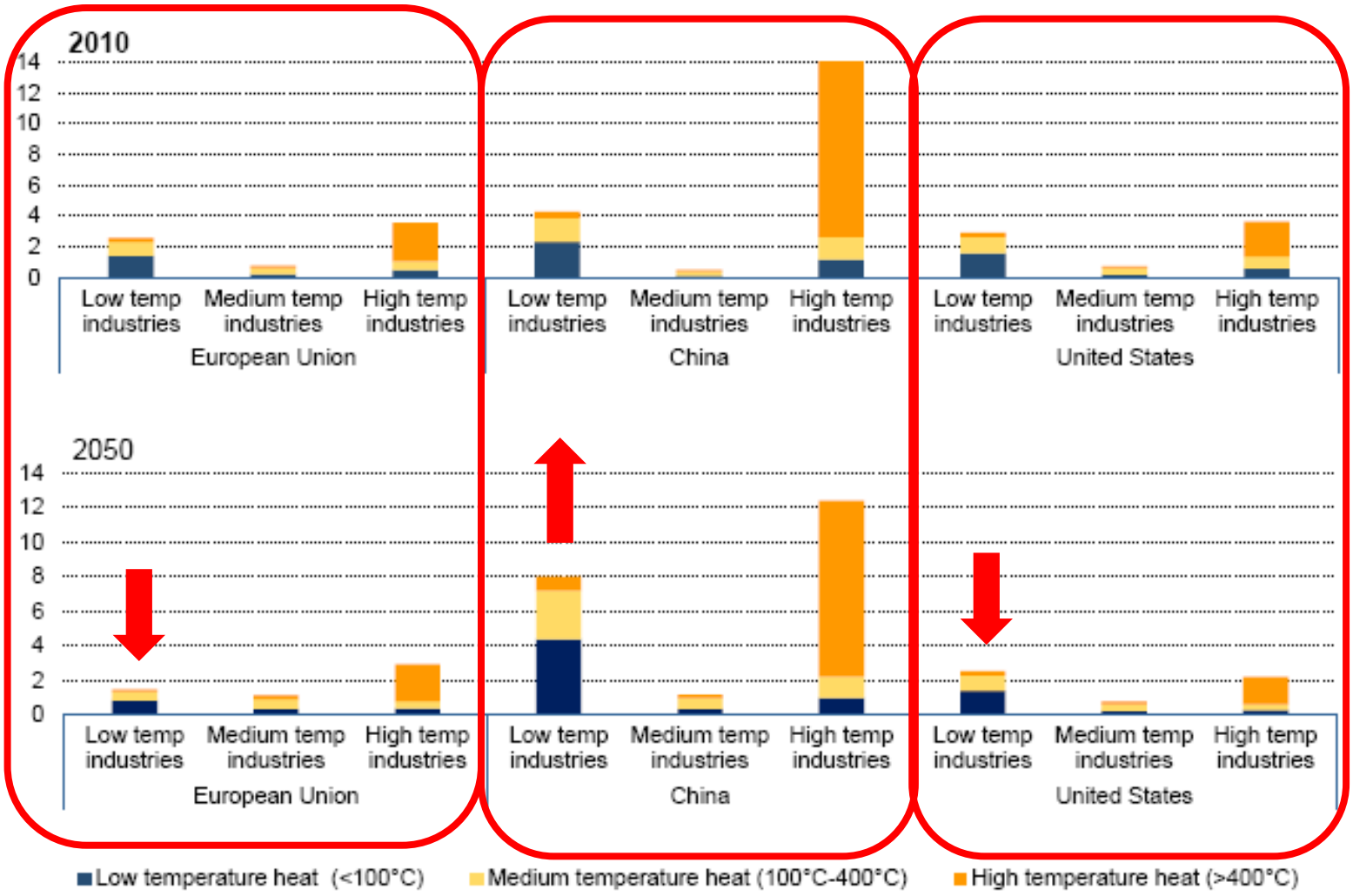
Temperatures over 250ºC are "high" and needed to manufacture metals, ceramics, glass etc.

Industrial heat demand by temperature level and industrial sector



Source: ECOHEATCOOL

Industrial Heat Demand



Source: IEA ETP 2012

Industrial heat demand by temperature level and industrial sector

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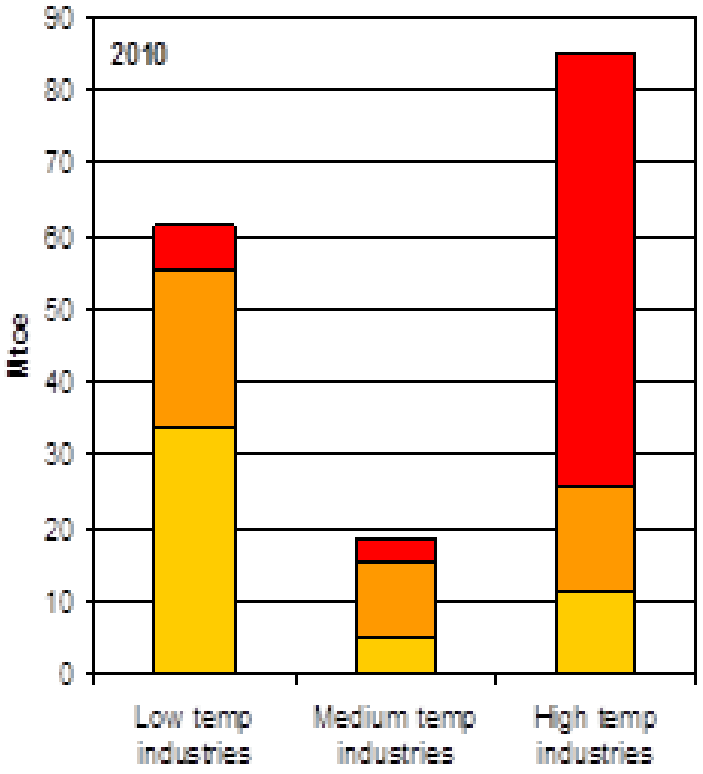
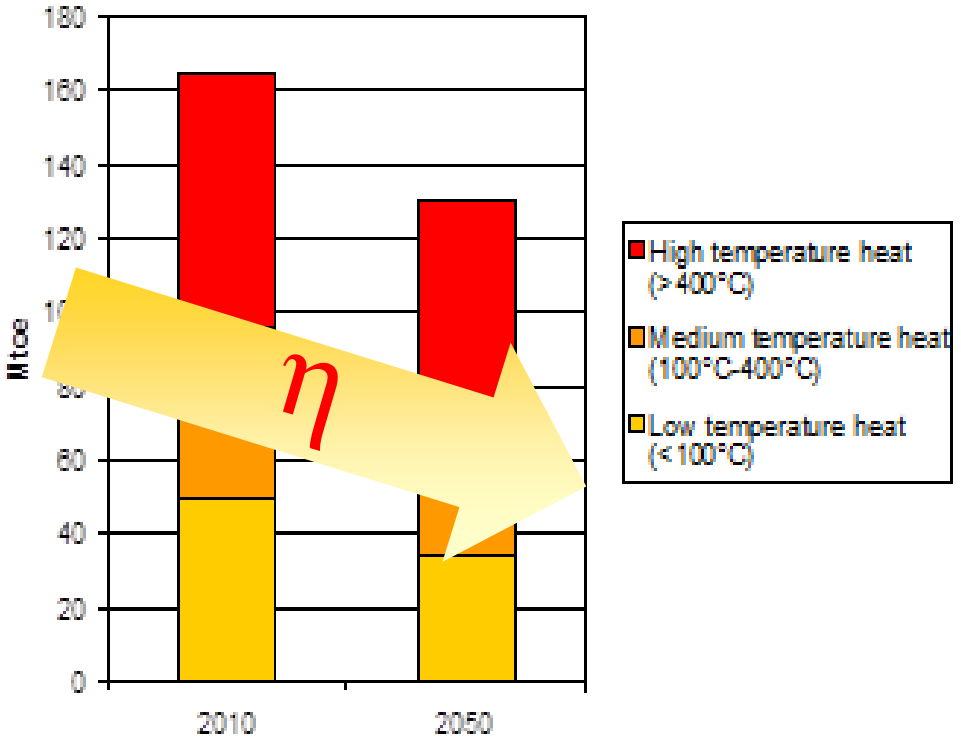
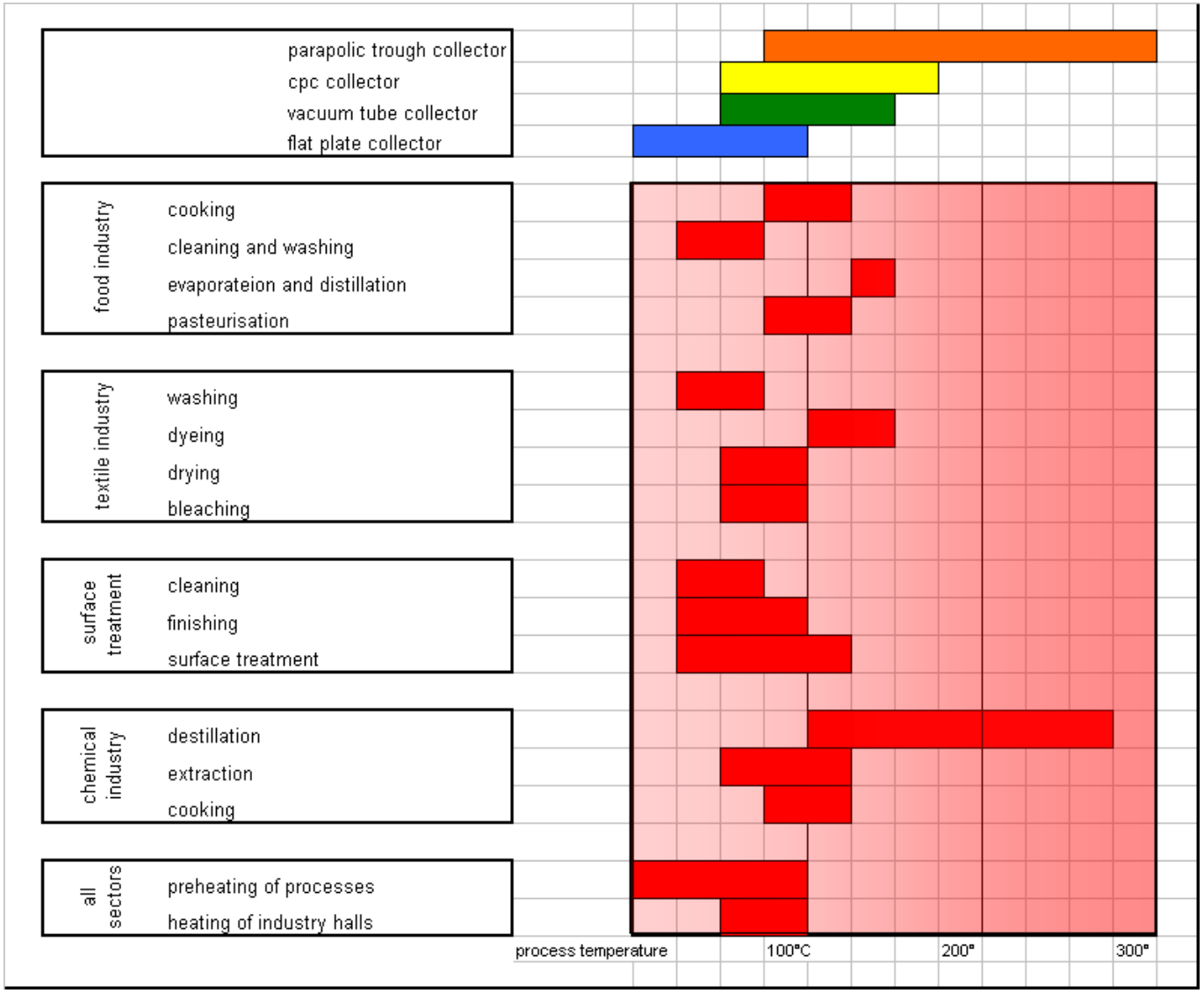




Industrial heat demand by temperature level in the EU in 2010 (left) and industrial heat demand in the EU in 2010 and expected demand in 2050 (right). Source: OECD / IEA (2012).

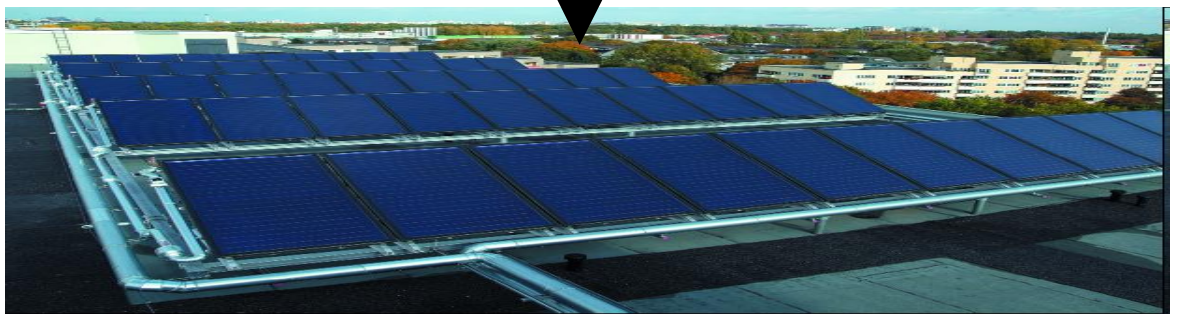
Temperature levels of processes



Efficiency first

1st step

2nd step: Solar Thermal Energy



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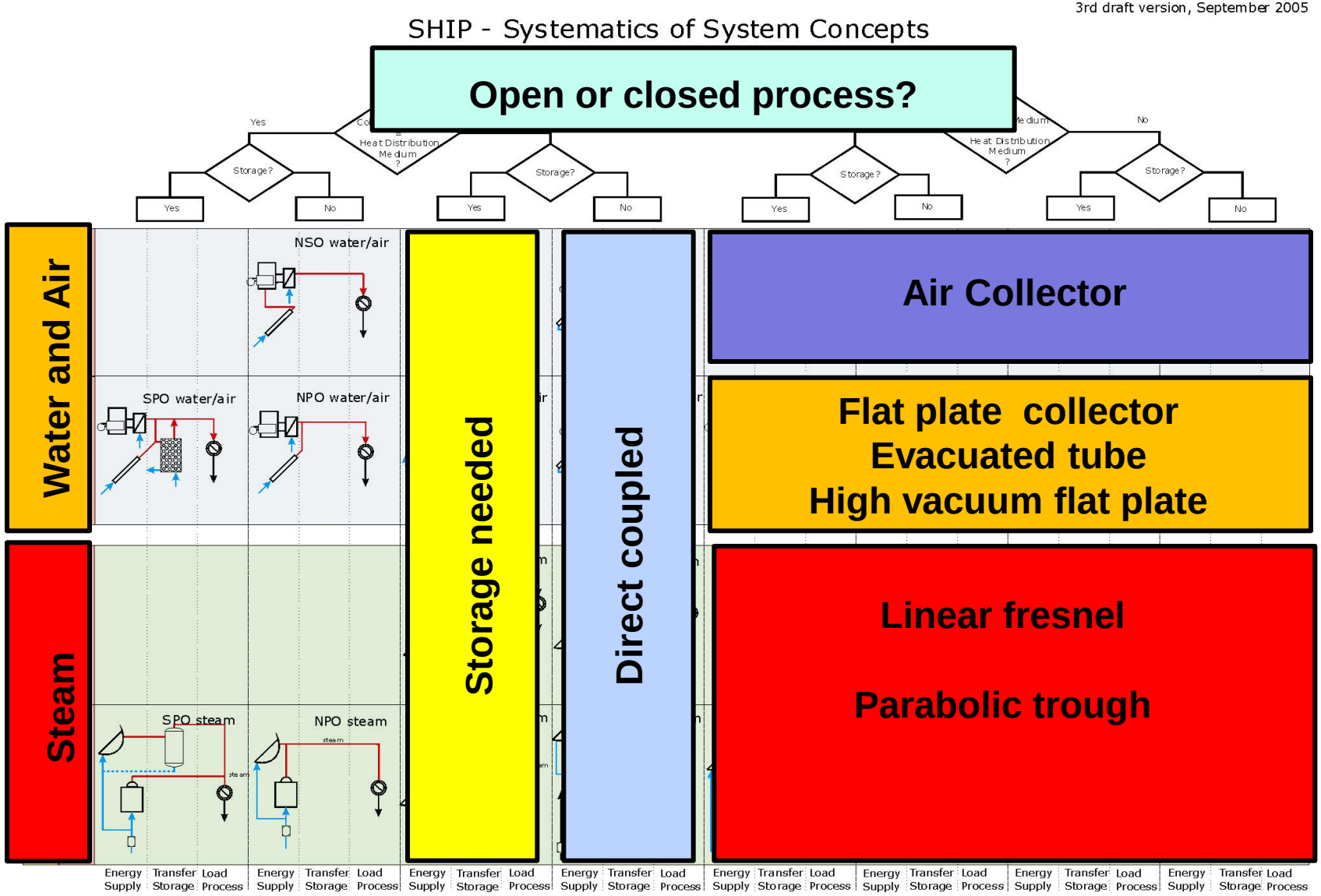
Generic Solar Heat Integration Concepts

3rd draft version, September 2005



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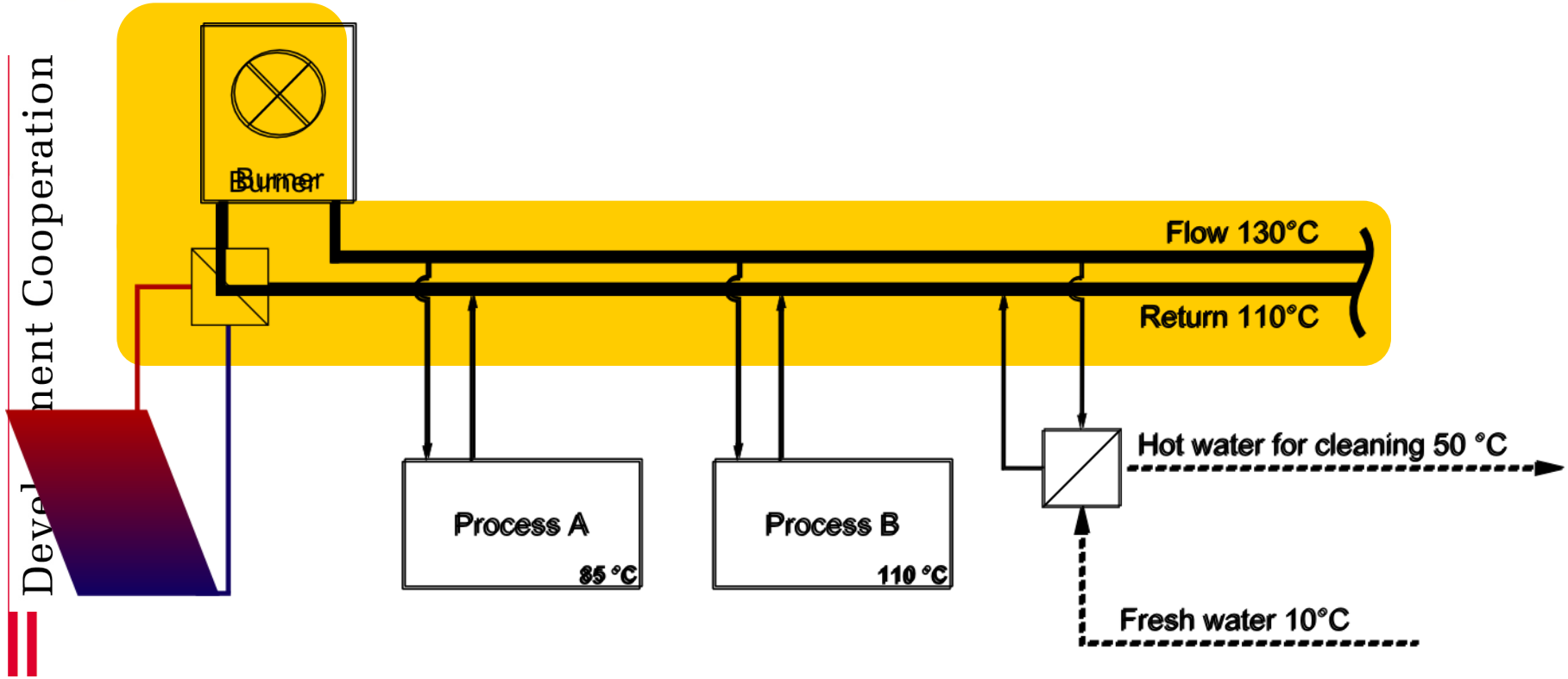
Integration on supply level – hot water



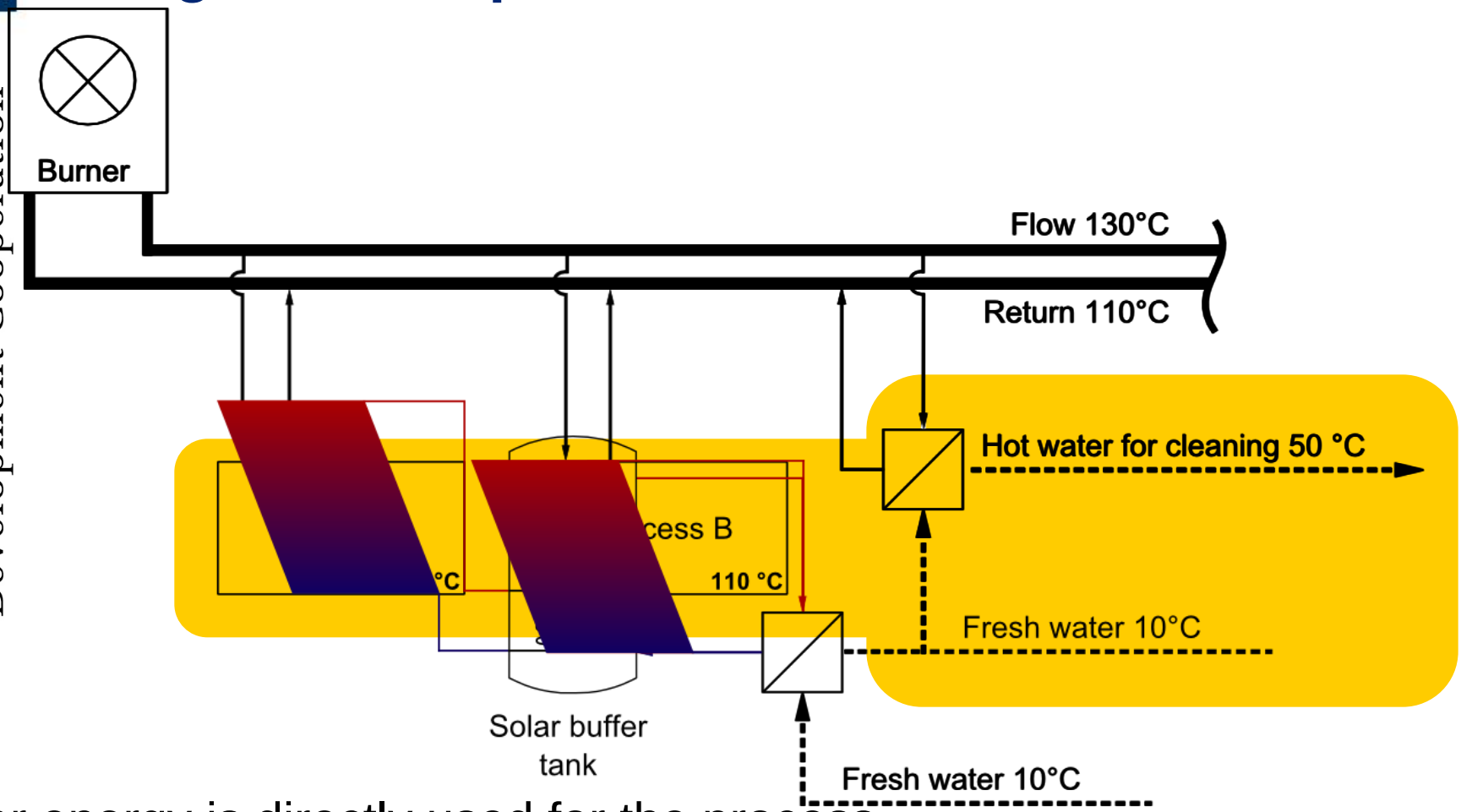
Feed-in solar energy in heating circuit

High set temperature

Simple system integration

Small number of system layouts

Integration on process level

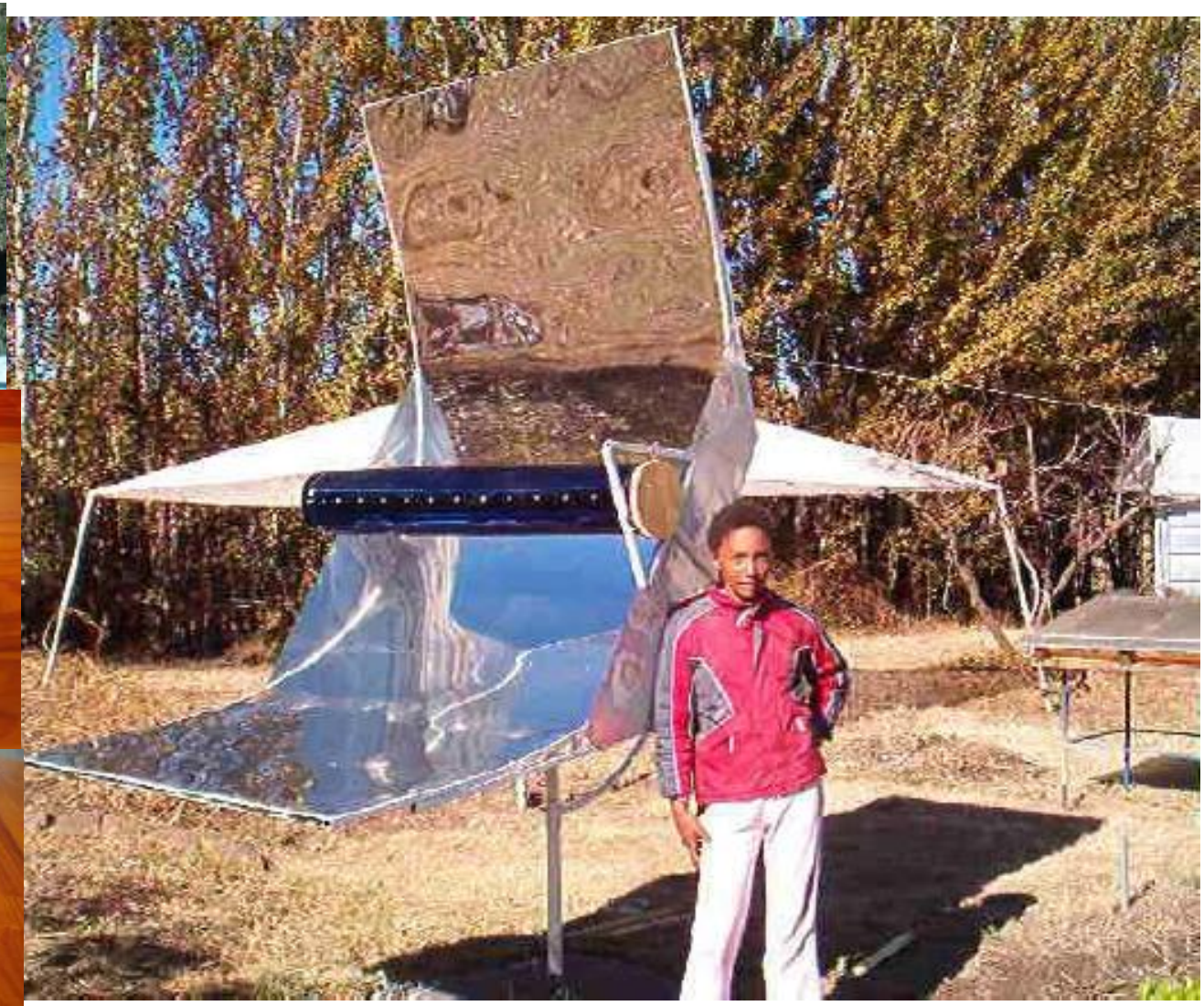


Solar energy is directly used for the process

Different system layouts possible

Often complex system integration

Parabolic Trough Baking Device developed in Lesotho



Source: Ivan Yaholnitsky, BBCDC

Mzuri Sana Farm - Zimbabwe

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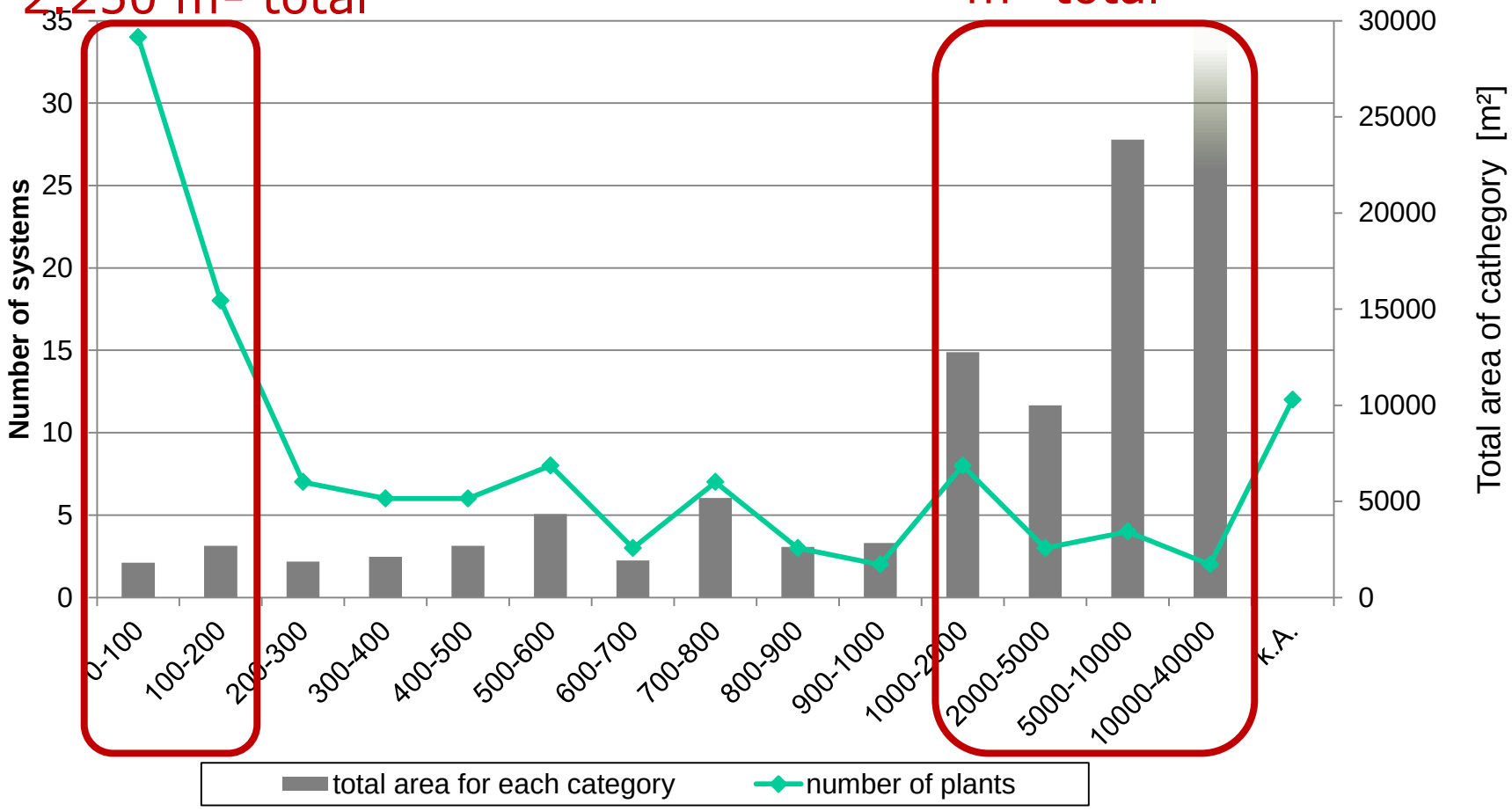
First Results – IEA SHC Task 49 Data base

122 systems, 125,600 m² , 87.8 MW

52 systems with 2,250 m² total

17 systems with 98.700 m² total



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Source: IEA SHC Task 49

First Results IEA SHC Task 49 - Countries

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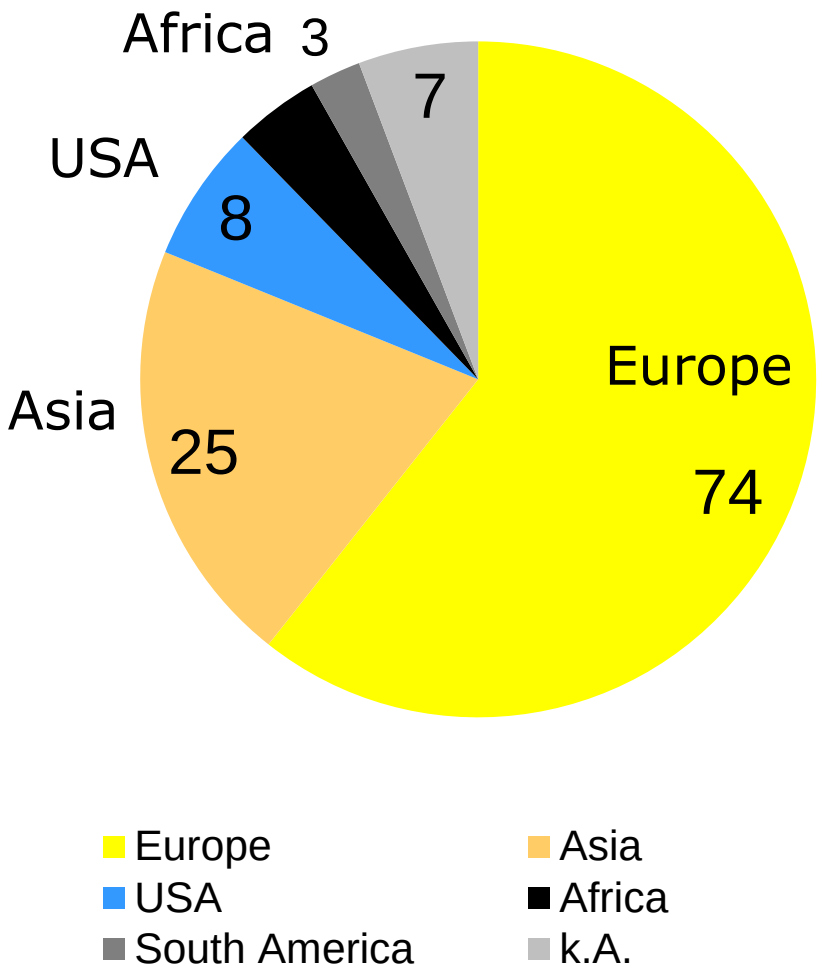
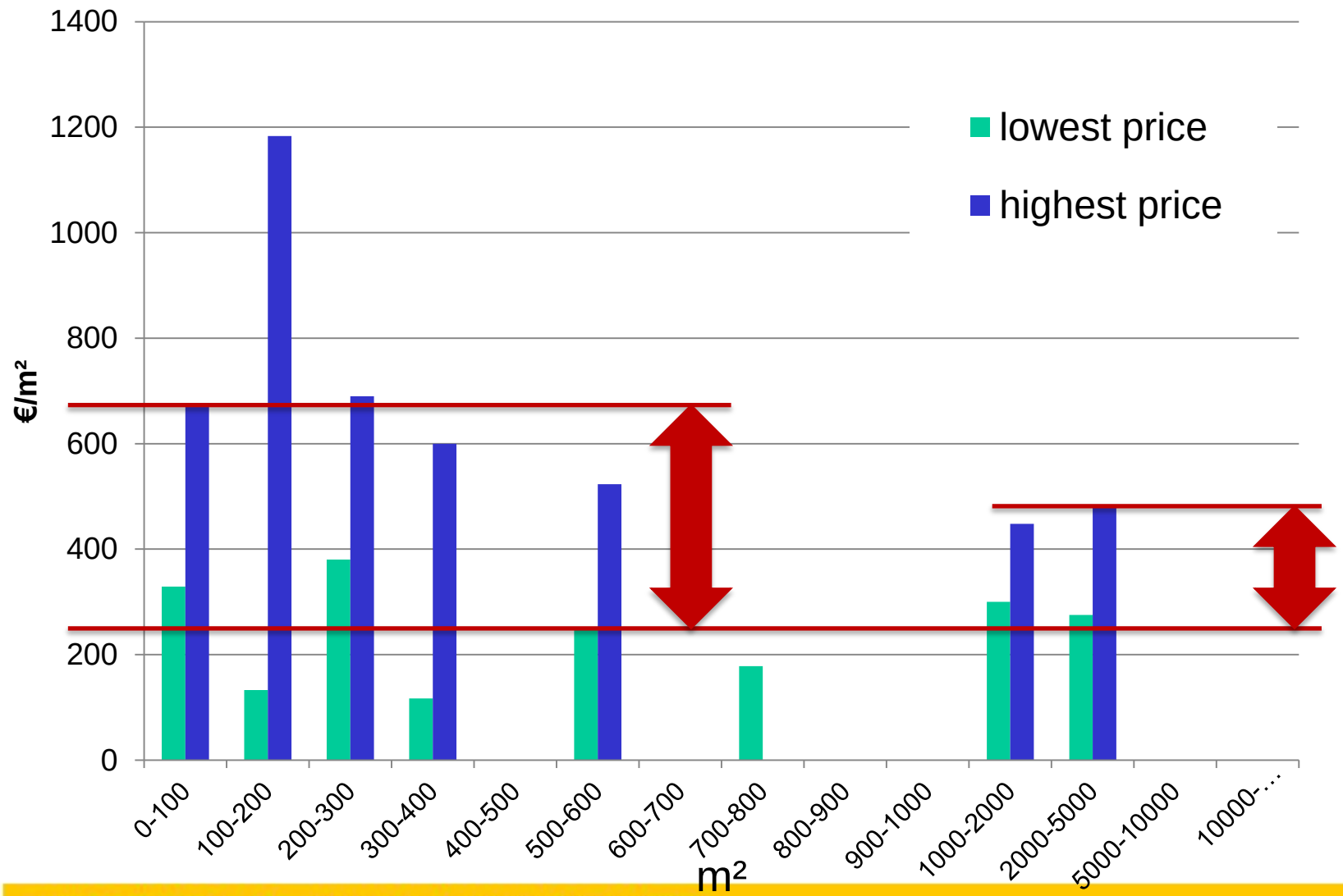


Country	quantity
Austria	20
Germany	13
Greece	13
Spain	12
Portugal	4
Switzerland	4
France	2
Romania	2
Cyprus	1
Czech Republic	1
Sweden	1
Turkey	1
India	8
China	5
Thailand	3
Vietnam	3
Indonesia	1
Saudi Arabia	1
Jordan	4
USA	8
Panama	1
Argentinia	1
Chile	1
Costa Rica	1
k.A.	7

Source: IEA SHC Task 49

System price related to system size



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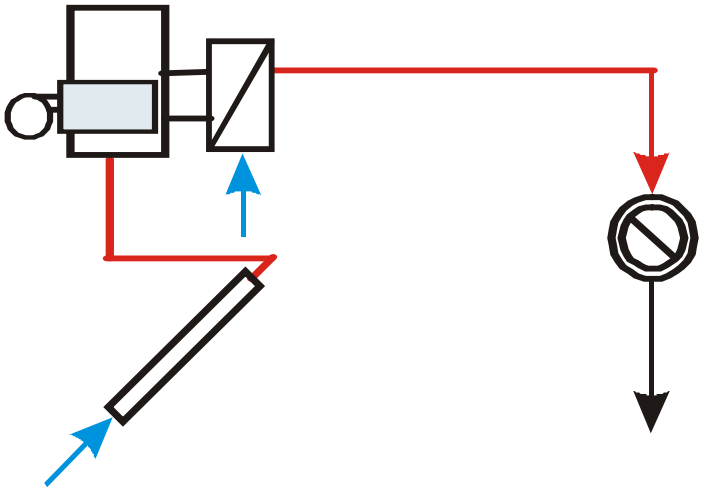
Drying Applications

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 ®**

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Air based Drying System

Air based Drying Systems in India

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Leather Drier with Solar Hot Air Ducts

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

Sadesa Leather (1)

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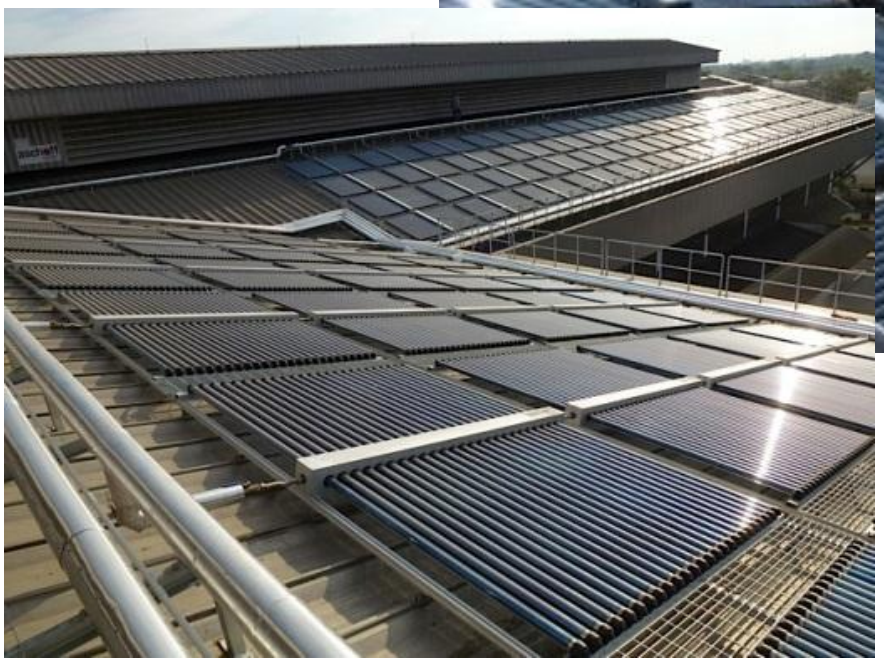
Sadesa, Thailand

- Tanery
- Hot water for taning process

System

- Aschoff solar
- Start of operation: 2013
- 1.890 m² Vacuum tube collector
- 35 m³ heat store
- 30 - 80 °C

Sadesa Leather (2)



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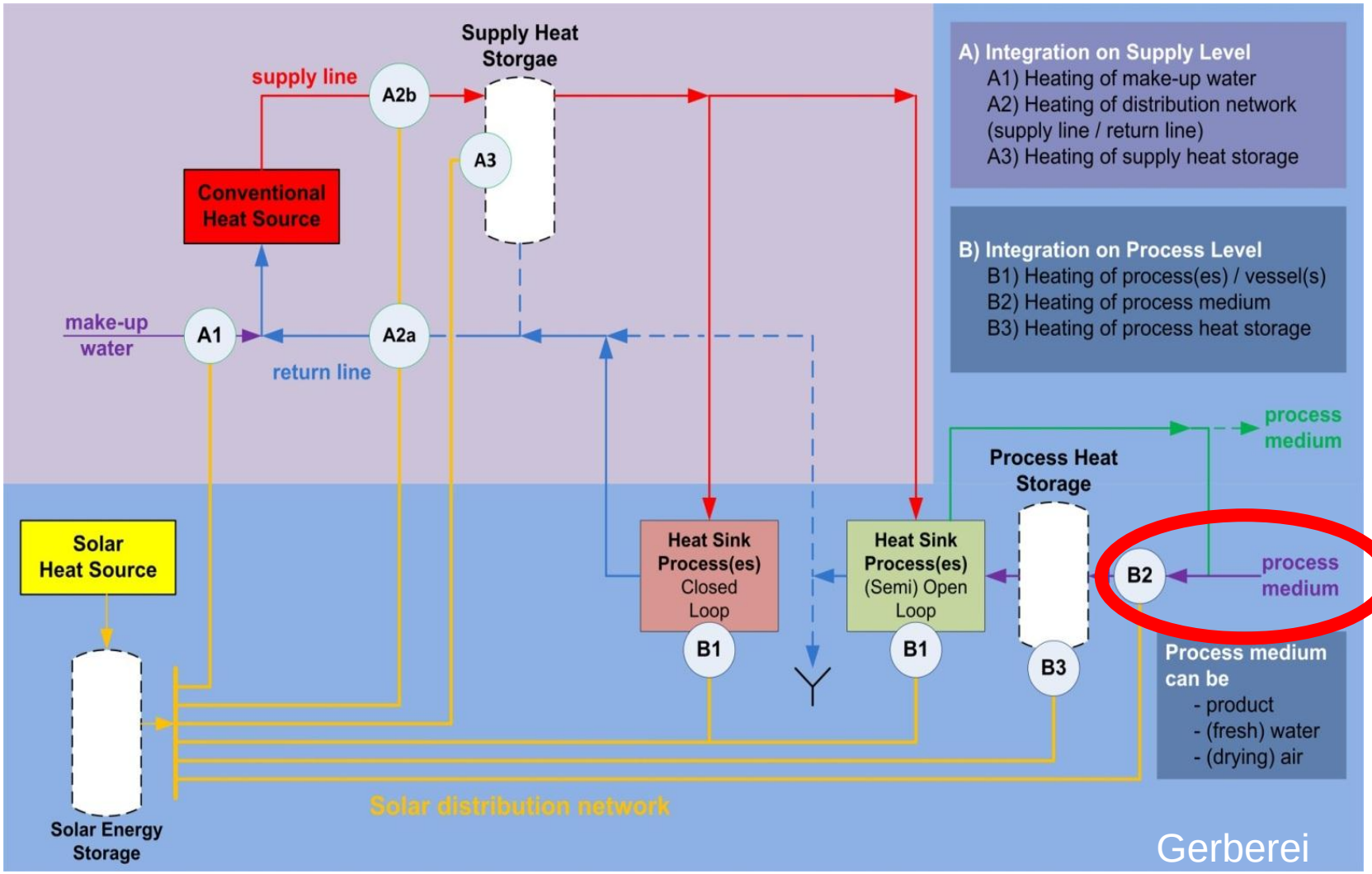
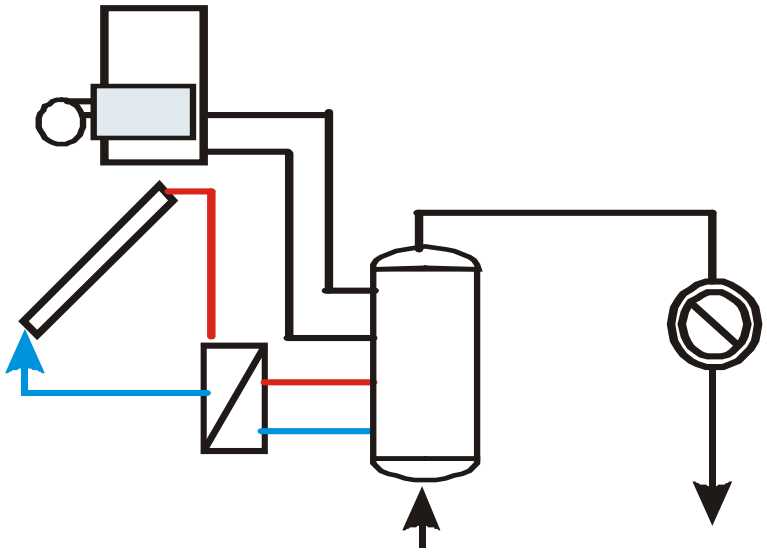
Sadesa Leather (3)



IEA SHC Task 49

Food Industry

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

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MOGUNTIA Meat Spices, Kirchbichl Tyrol

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Year of Installation: 2007

Installed Capacity: 150 kW_{th} (215 m^2 collector area)

Storage Volume: 10 m^3

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

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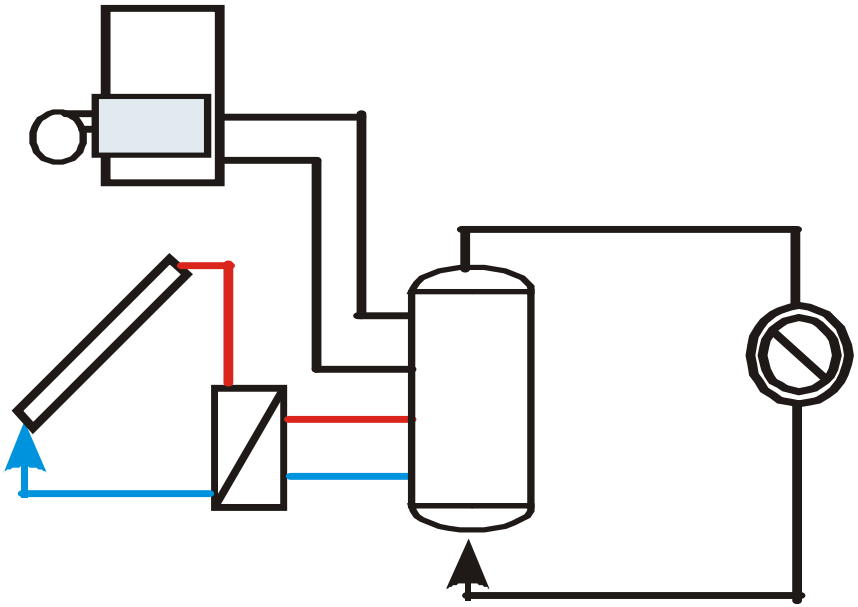


Main Applications :

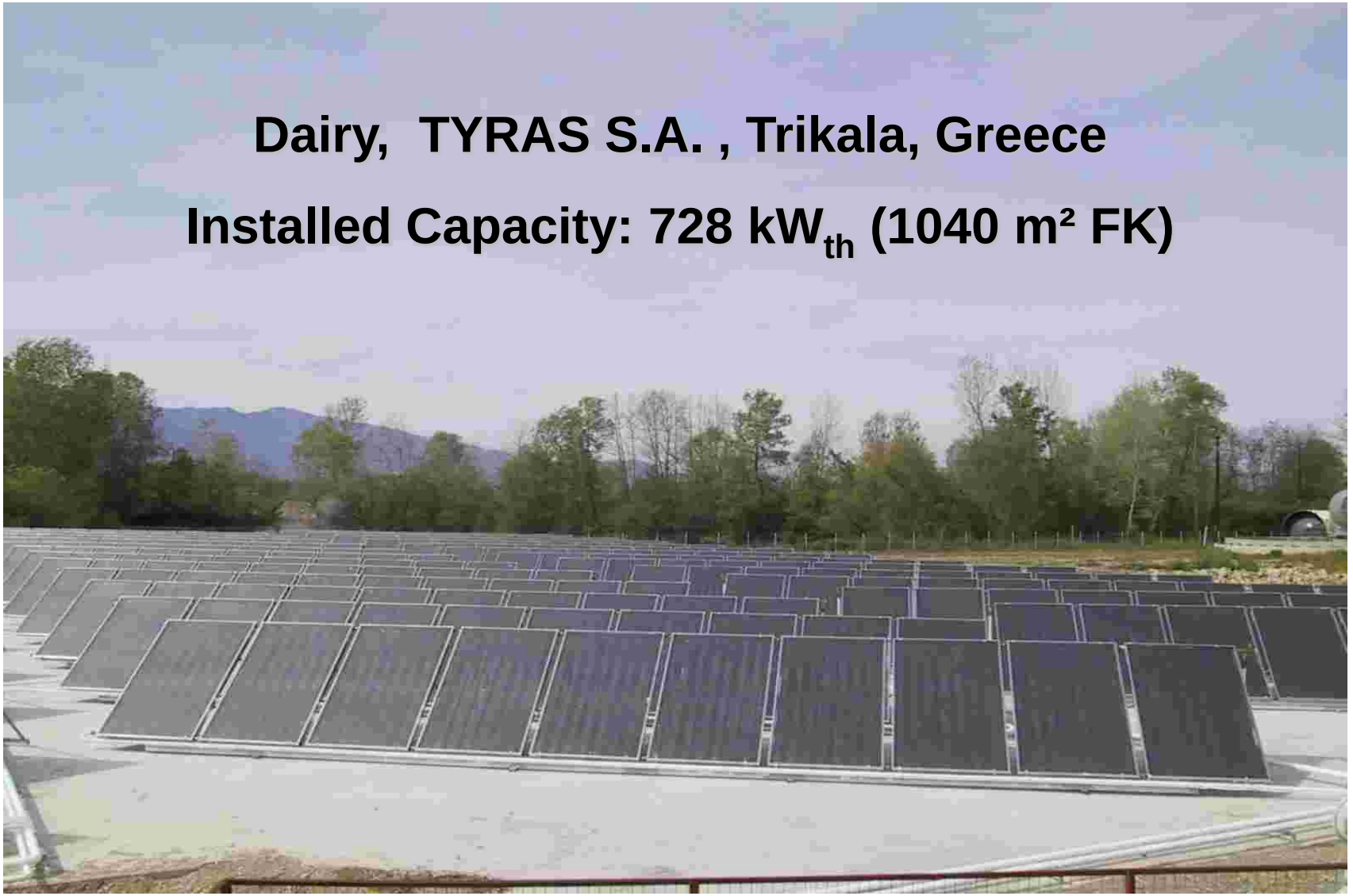
- Textile Industry
- Tanneries
- Dairy
- Breweries
- Beverage Industry

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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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)

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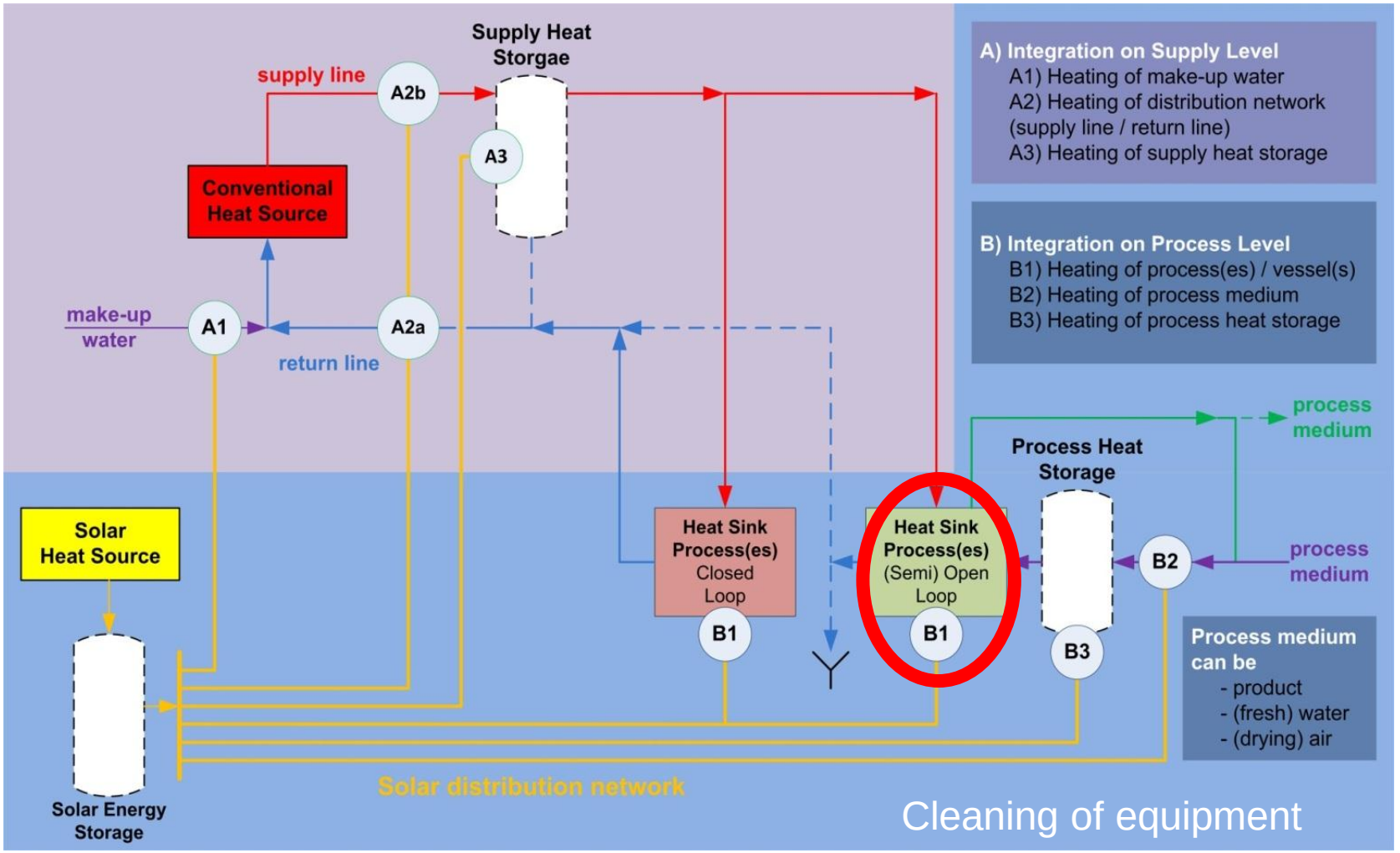

Beverage Industry

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Nestle Waters (1)

Al Manhal, Riad, Saudi Arabia

System

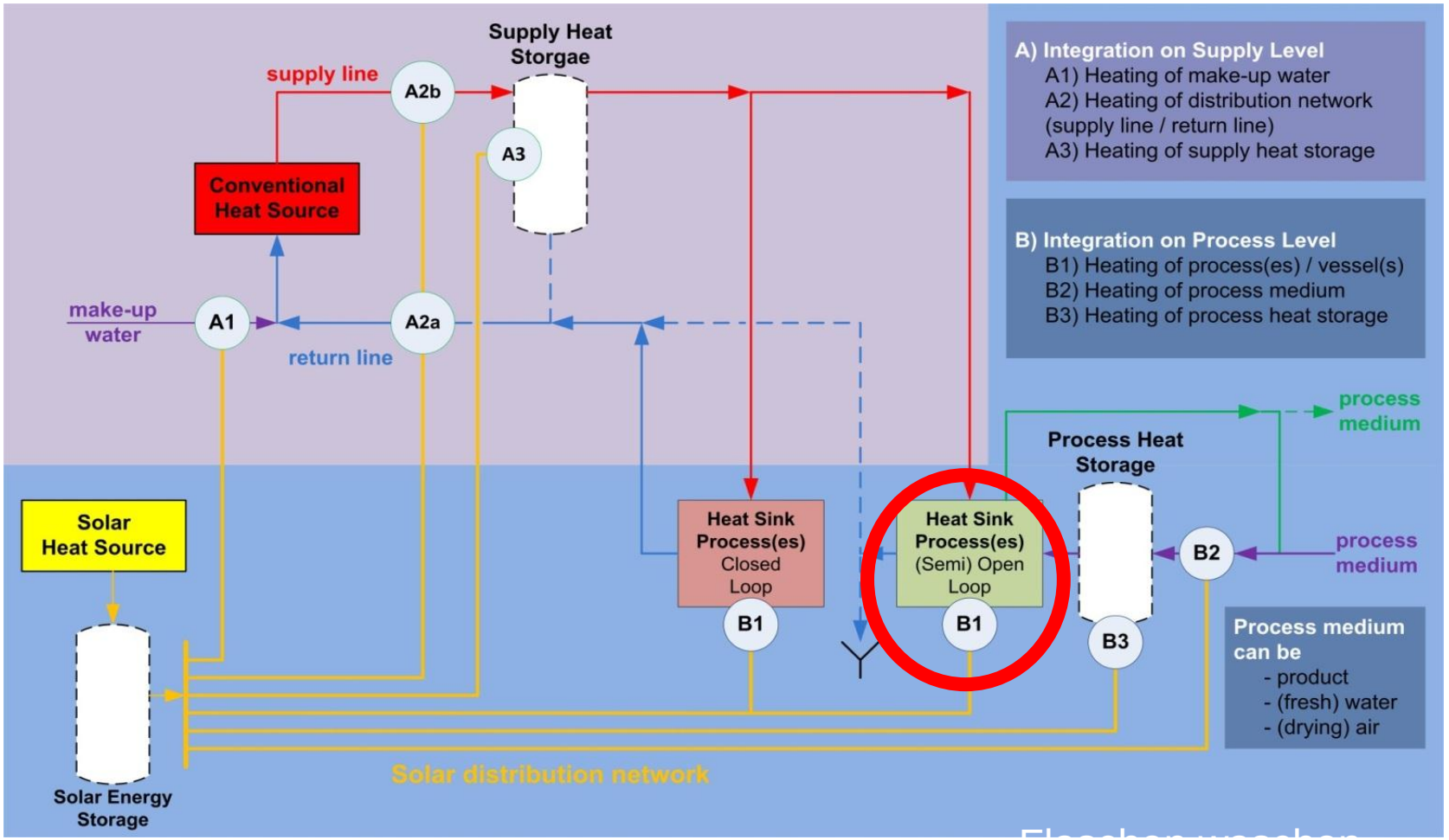
- Millennium Energy Industries
- Start of operation: January 2012
- 515 m² Flat plate collectors
- 15 m³ Heat Storage
- Replacement of electricity for bottle washing (~ 70 °C)

Nestle Waters (2)

IEA SHC Task 49

Nestle Waters (3)

Al Manhal, Riad, Saudi Arabia



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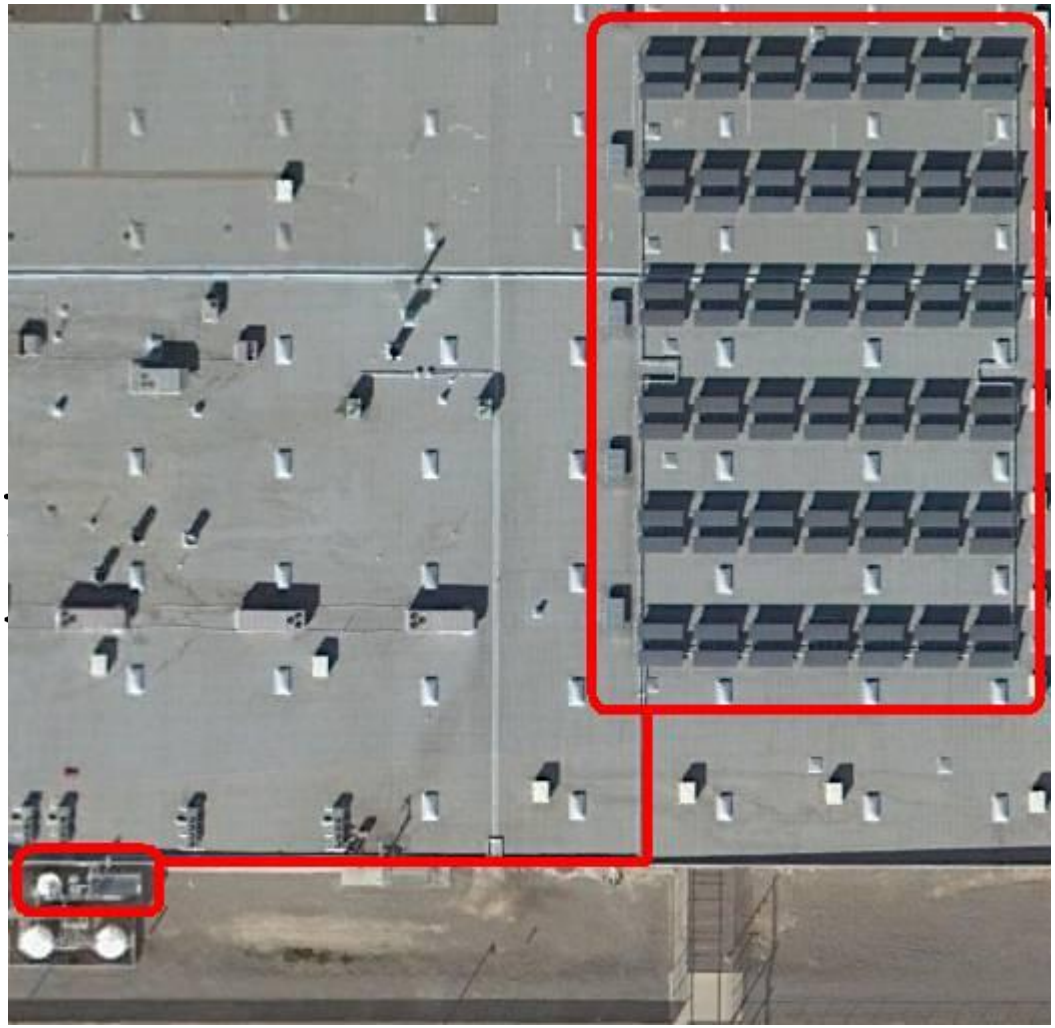
IEA SHC Task 49

Pre-Heating of Process Water



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

Pre-Heating of Process Water

Source: SOLID GmbH. Graz Austria

Textile Industry

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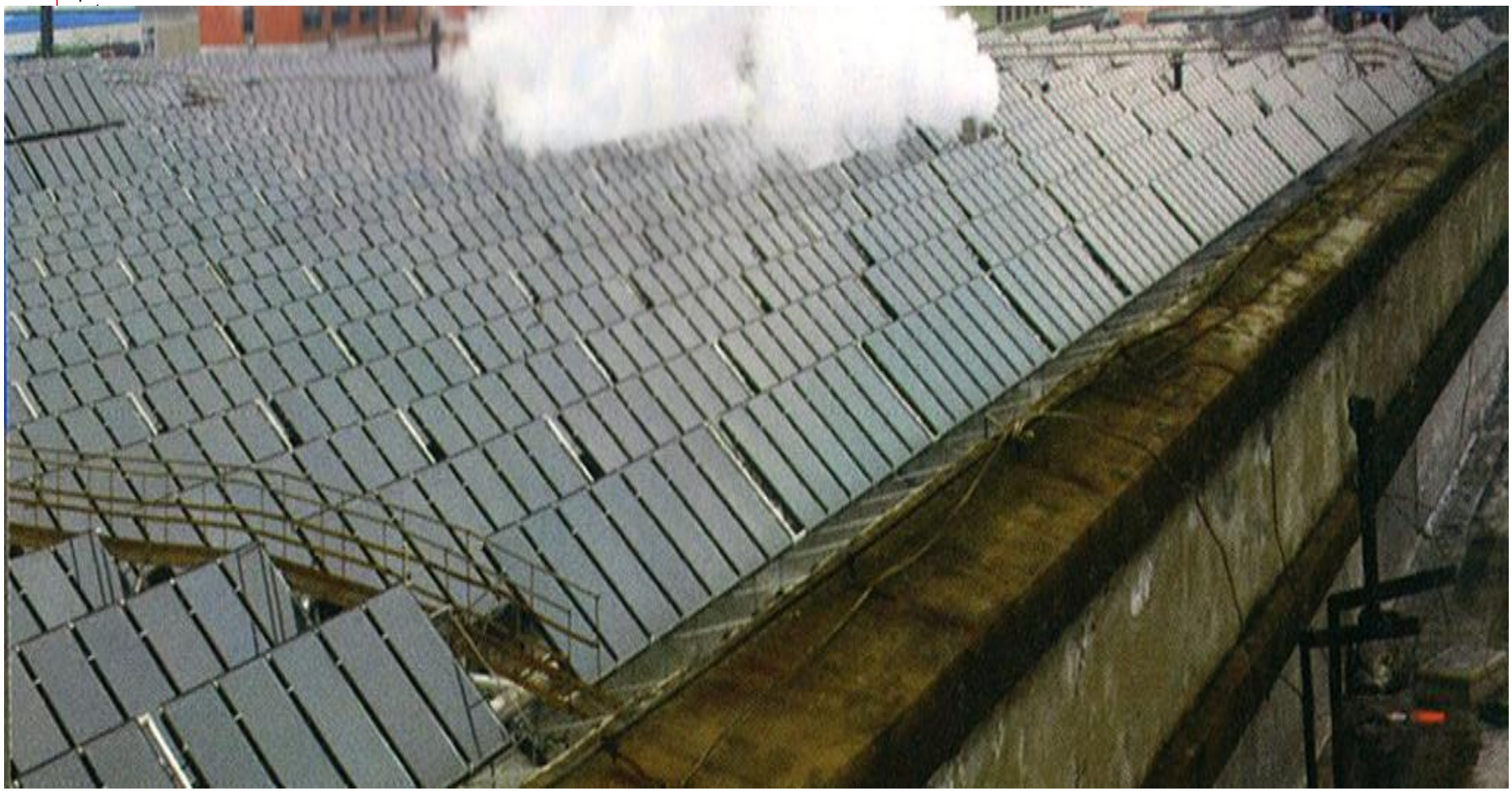
Textile Industry Hangzhou China 13000㎡ (9 MW_{th})



Metal Industry

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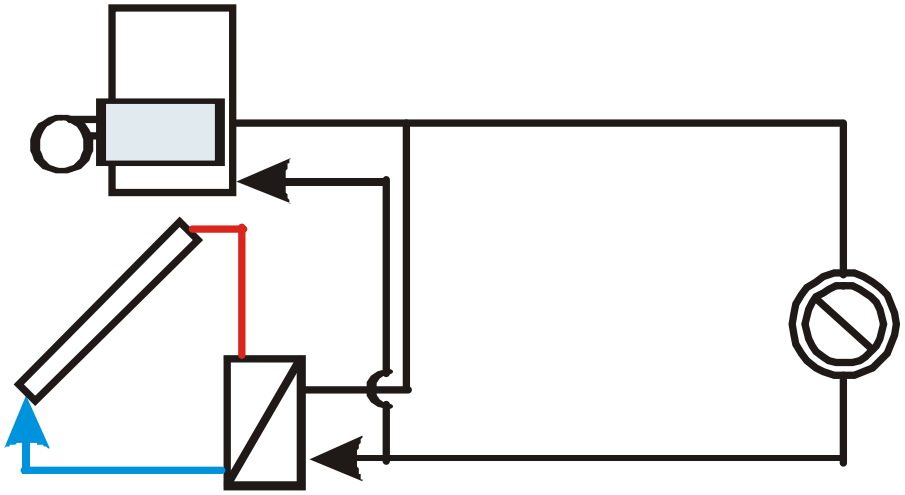
Necessity of a Storage Tank



Main Applications

- Galvanic industry
- Food industry

Temperature range for the processes : 30 - 90°C

Heat carrier: Water

Recommended Collector Types: FP, ETC, CPC

Demonstration Plants

Electroplating Bath in Ludhiana, India

500 m² collector area (350 kW_{th})

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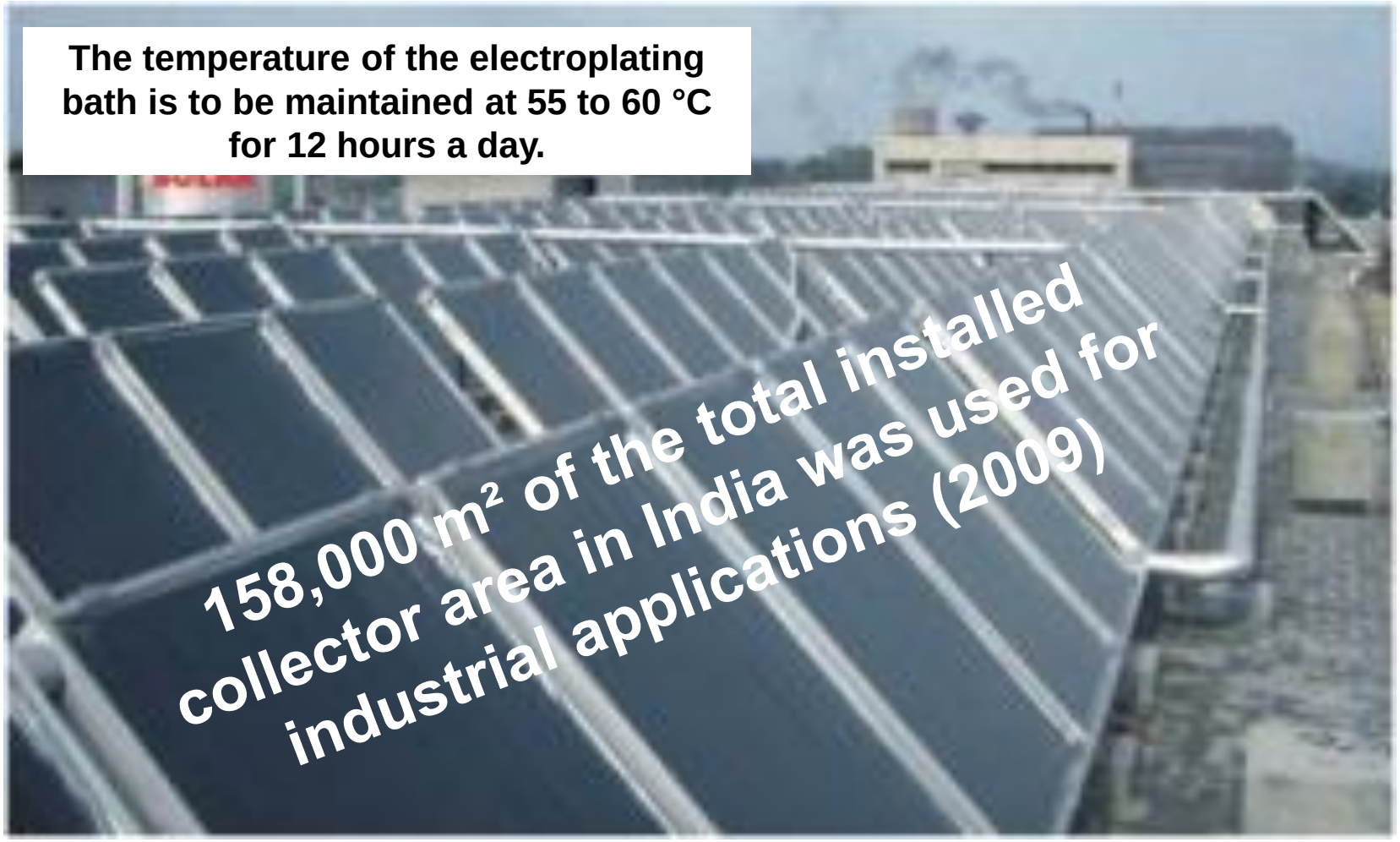

Sources: Greentech Knowledge Solution and Intersolar Systems , India

Mining

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Solar Heat for Copper Mining in Cyprus - 0.5MWth

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Copper Mine in Chile – 26MW$_{th}$

Copper Mine "Gabriela Mistral", Chile 26MW$_{th}$ (39,300 m²)

Cooperation

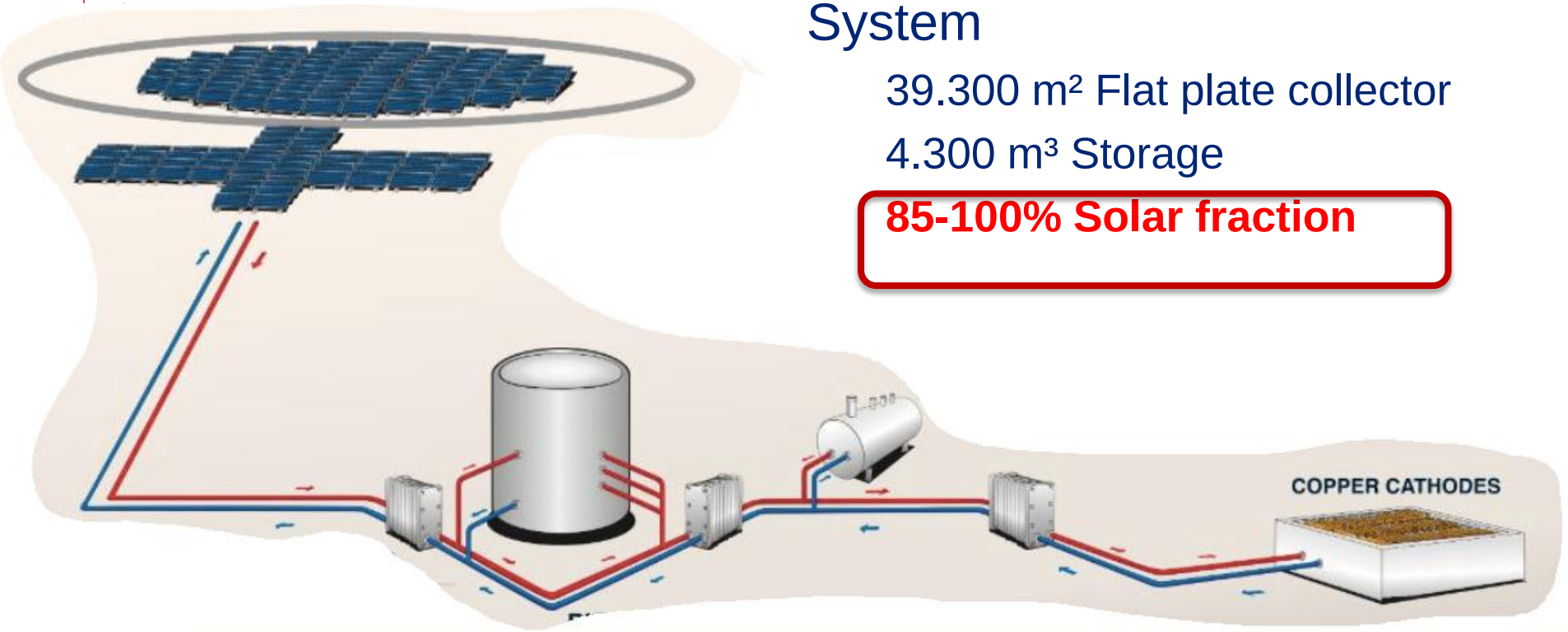
- **Process**
  - ⇨ Electro winning of copper
  - ⇨ Electrolyte is kept on a constant Temp. of 50 °C
  - ⇨ Cleaning Processes

System

39.300 m² Flat plate collector

4.300 m³ Storage

85-100% Solar fraction



Source: SUNMARK and IEA SHC Task 49

Copper Mine “Gabriela Mistral”, Chile
26MW$_{th}$ (39,300 m²)

Source: SUNMARK

Copper Mine "Gabriela Mistral", Chile
Facts and Challenges

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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/m^2

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.

Source: SUNMARK

Distilling and chemical processes

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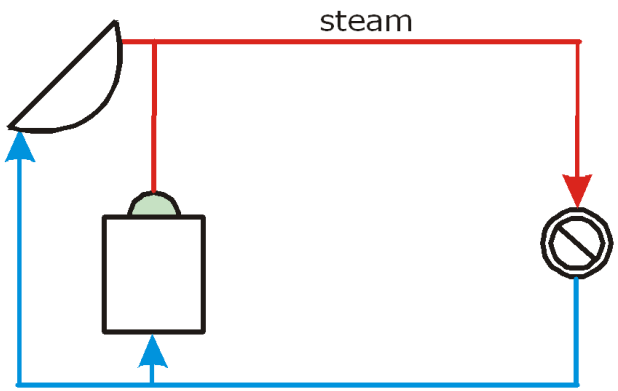
Steam production via a flashing process - generic system concept



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

Source: Fichtner Solar GmbH. Germany

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Biggest System Worldwide, Saudi Arabia

36.000 m² / 25 MW_{th}

Austrian

Biggest System Worldwide, Saudi Arabia

36.000 m² / 25 MW_{th}

Austrian Development Cooperation

Biggest System Worldwide, Saudi Arabia

36.000 m² / 25 MW_{th}

Austrian Development Cooperation

Biggest System Worldwide, Saudi Arabia

36.000 m² / 25 MW_{th}

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Pipes and Heat Exchangers

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