Solar Heat for Industrial Production Processes - Latest Research and Large Scale Installations

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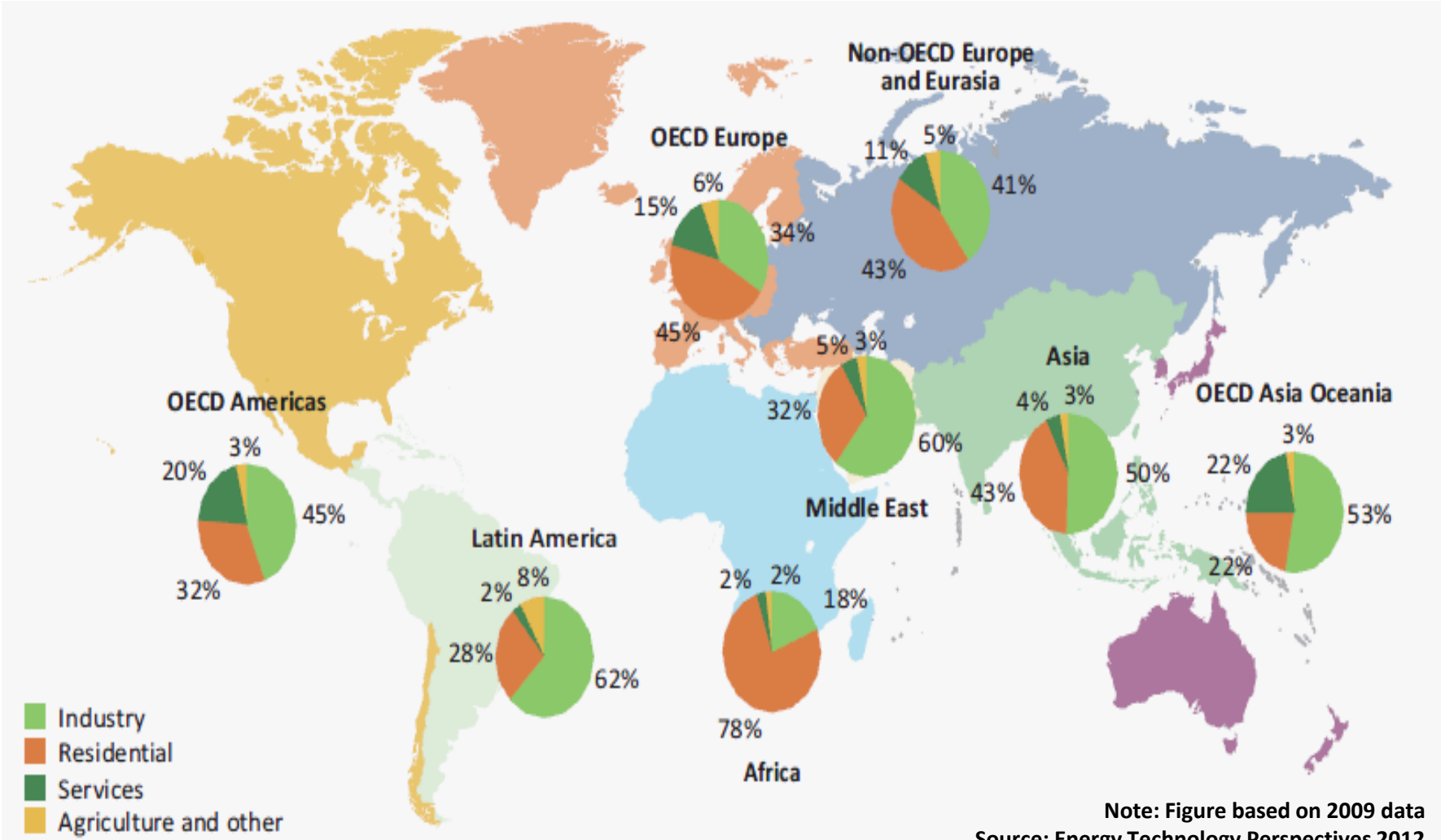
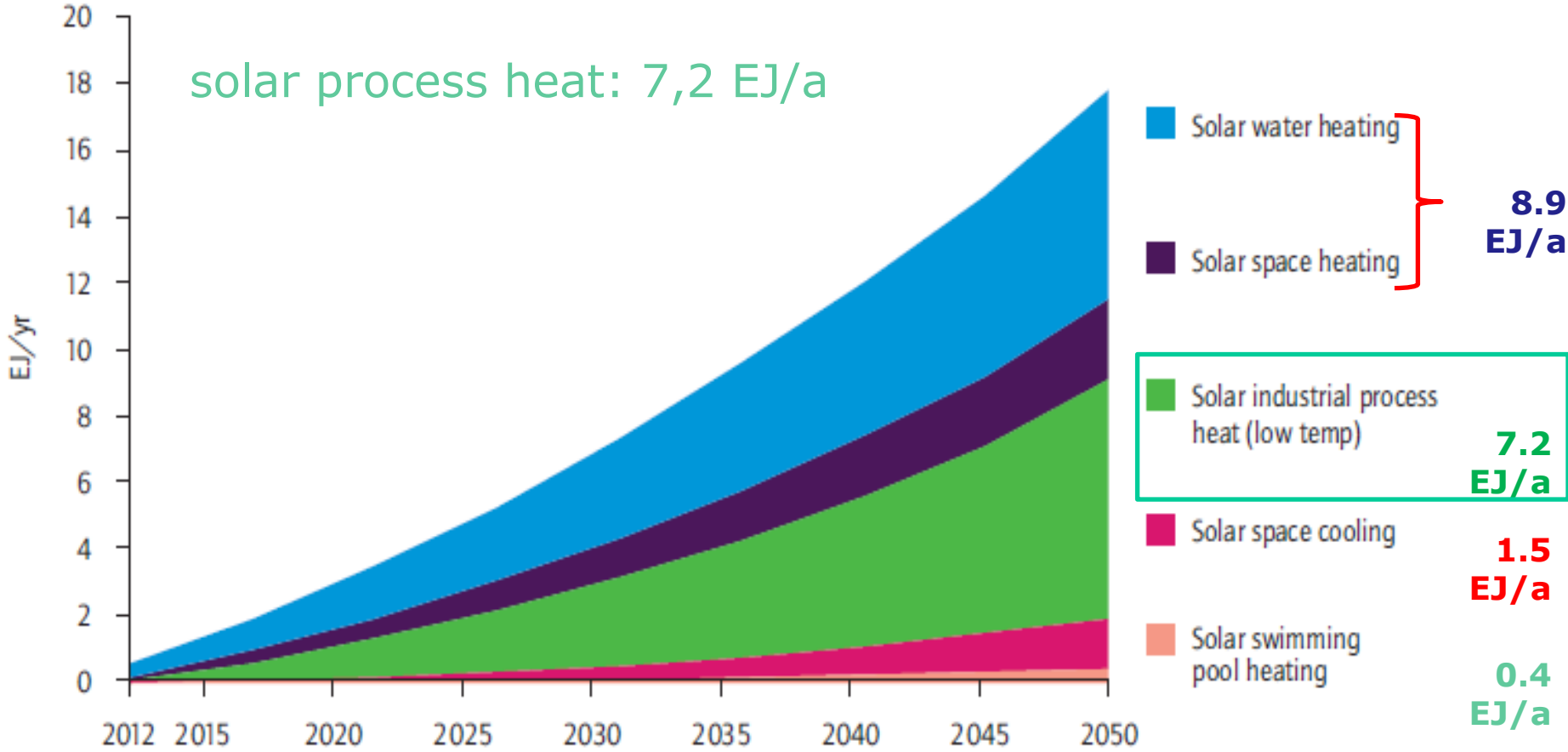
Industrial heat has an important role in the global economy



Note: Figure based on 2009 data

Source: Energy Technology Perspectives 2012

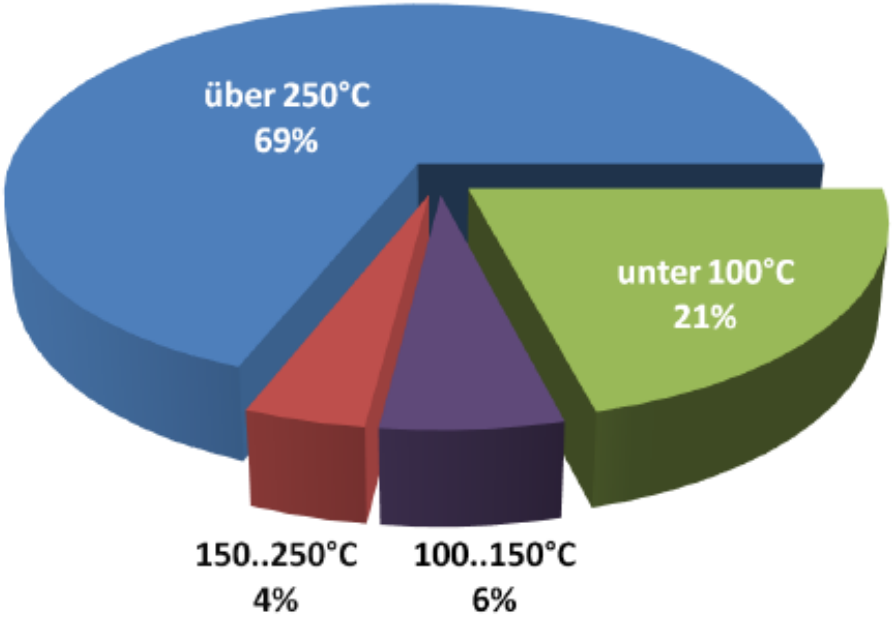
IEA Roadmap: Vision for solar heating and cooling (by sector in EJ/a)



Source: IEA Technology Roadmap – Solar Heating & Cooling

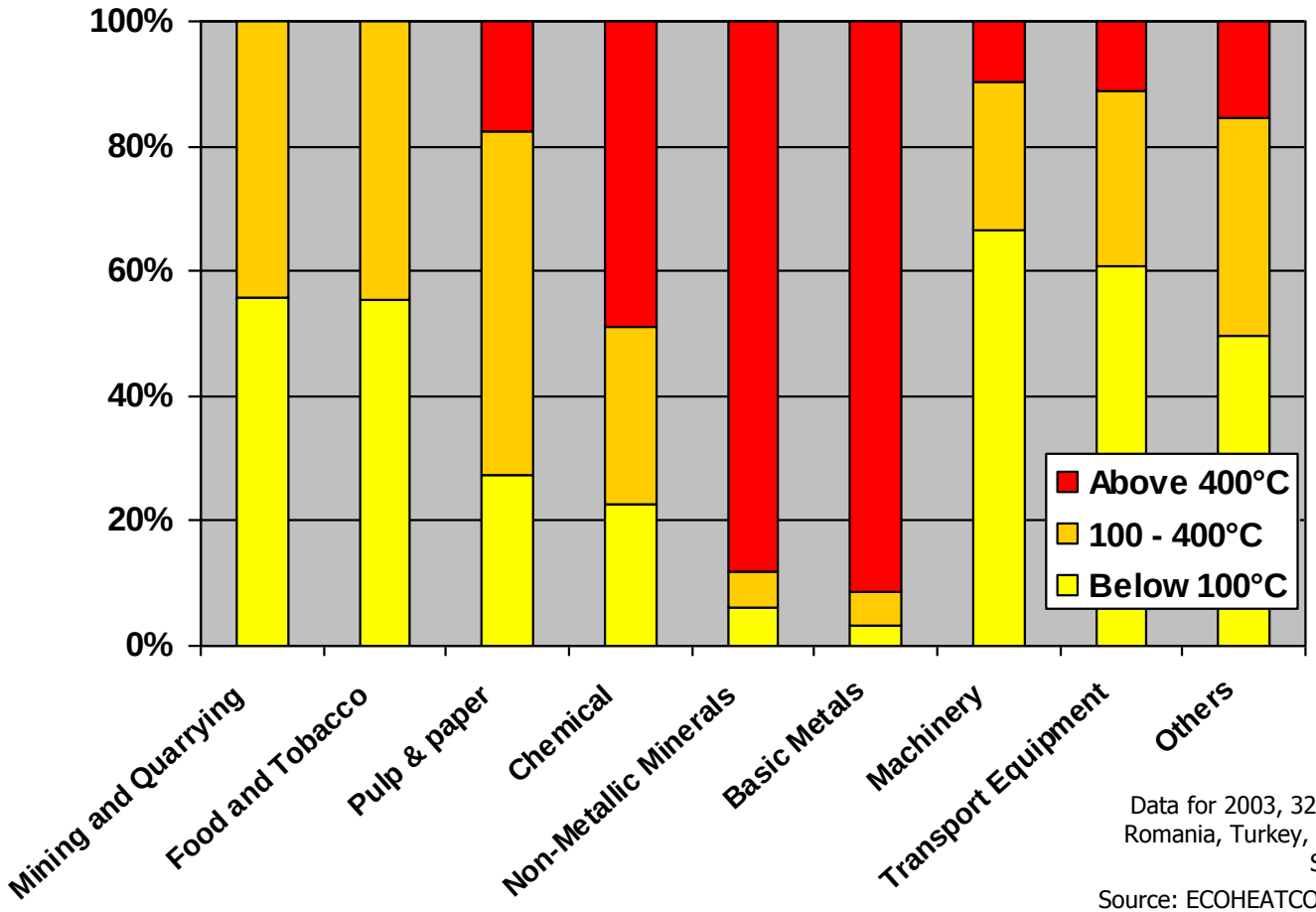
Potential

- Potential of solar process heat <250°C
  - Austria: 1,5 TWh/a = 3,3 Mio. m² [Weiss, 2006]
  - Germany: 16 TWh/a = 36 Mio. m² [Lauterbach, 2011]
  - EU 25: ca. 70 TWh/a = 155 Mio. m² [Vannoni, 2008]



Industrial heat demand by temperatures Germany 2007 *[Lauterbach, 2011]*

Temperature levels in different industries



Data for 2003, 32 Countries: EU25 + Bulgaria, Romania, Turkey, Croatia, Iceland, Norway and Switzerland.

Source: ECOHEATCOOL (IEE ALTENER Project), The European Heat Market, Work Package 1, Final Report published by Euroheat & Power

Steps of energy efficiency analysis and implementation of renewable energy

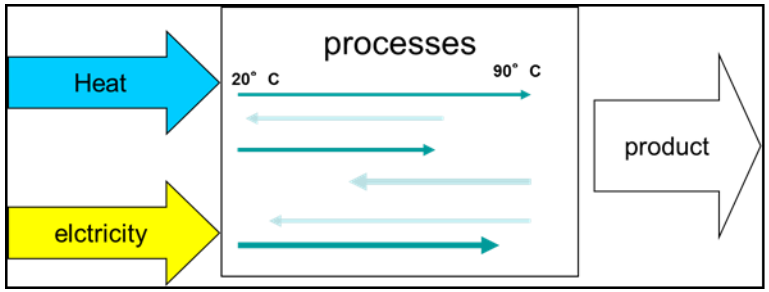
Collection and measurements of energy relevant data, mass and energy balance, visualization of the production process with flow sheet and Sankey diagram

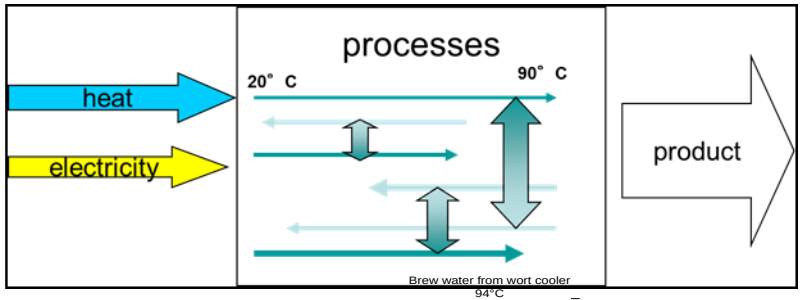
Technology optimization – use of energy efficient process technologies, optimized heat and mass transfer; lower the supply temperature

System optimization, energy efficent production, heat recovery, Pinch analysis, storage management

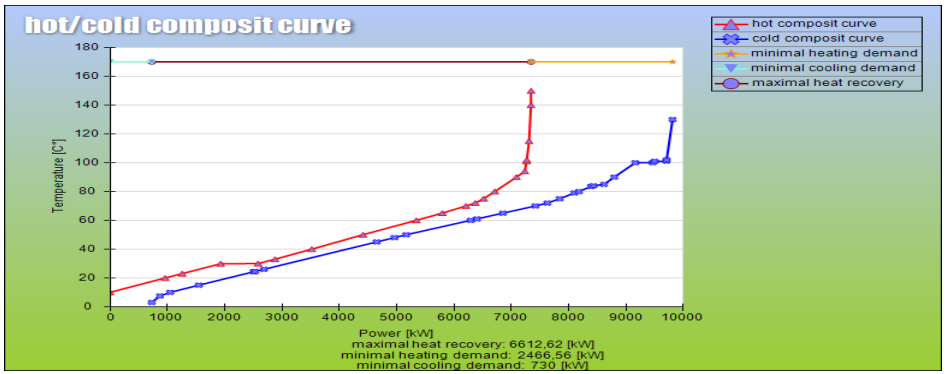
Implementation of renewable energy technologies; waste to energy, solar thermal energy, biomass

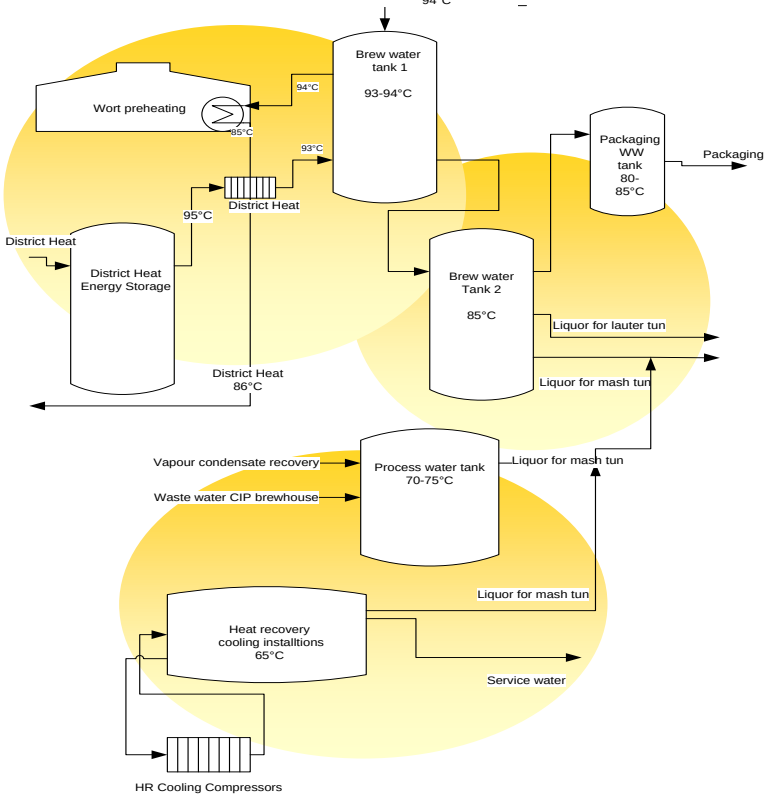
Heat exchanger network and heat storage management





- Minimum energy demand for heat and cold
- Heat exchanger network
- Design of heat storages
- Optimum integration point for RES





Principles of system integration

Supply level

Process level

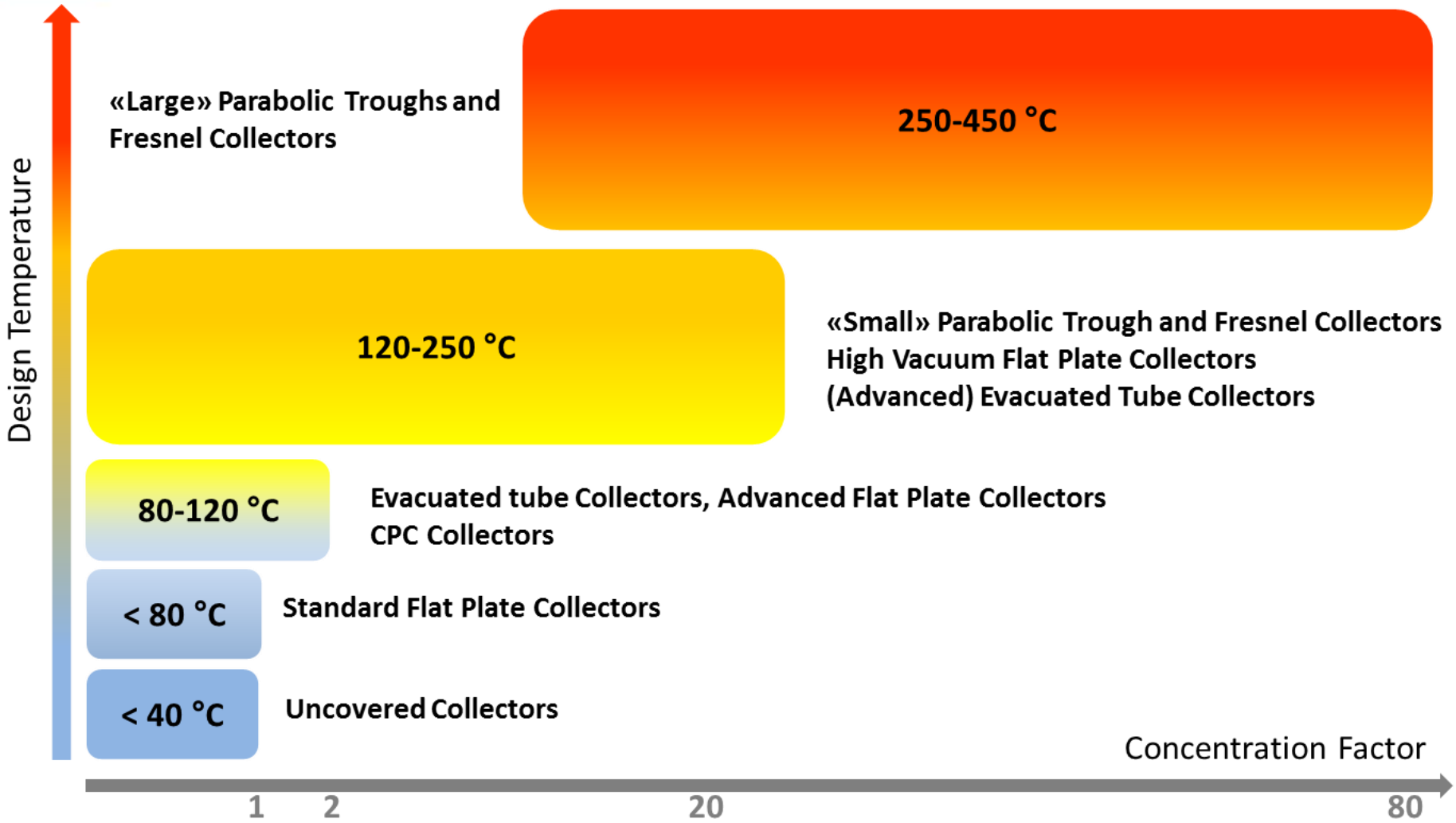
What is a process heat collectors?

below 100°C	100 °C .. 250 °C	above 250 °C
"low" temperature collector or application	"mid" temperature collector or application	"high" temperature collector or application

"reasonable" collector output for "mid" and "high" temperture for the application for industrial application

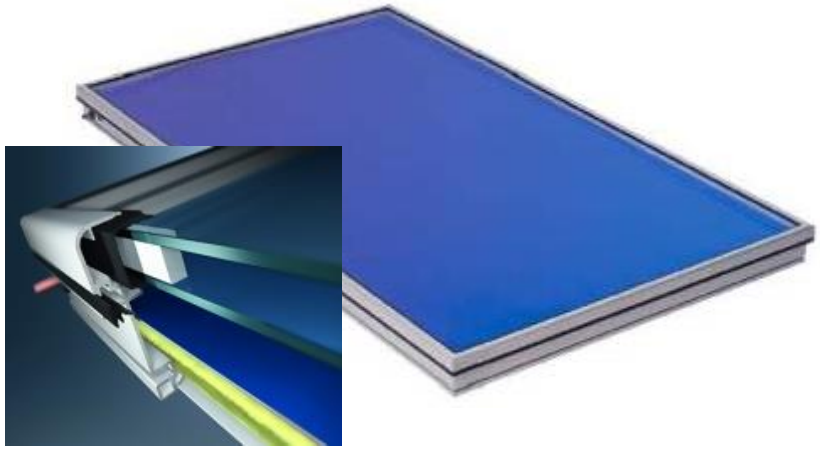
output exceeds 300 W/m² gross collector area (1000 W/m² hemispherical irradiance, 15 % diffuse fraction and 20 °C ambient temperature at an operating temperature of > 100 °C (mid temp) and > 250 °C ("high" temp)

Overview collectors



Flat plate collectors

80-120 °C



www.schueco.com

SCHÜCO

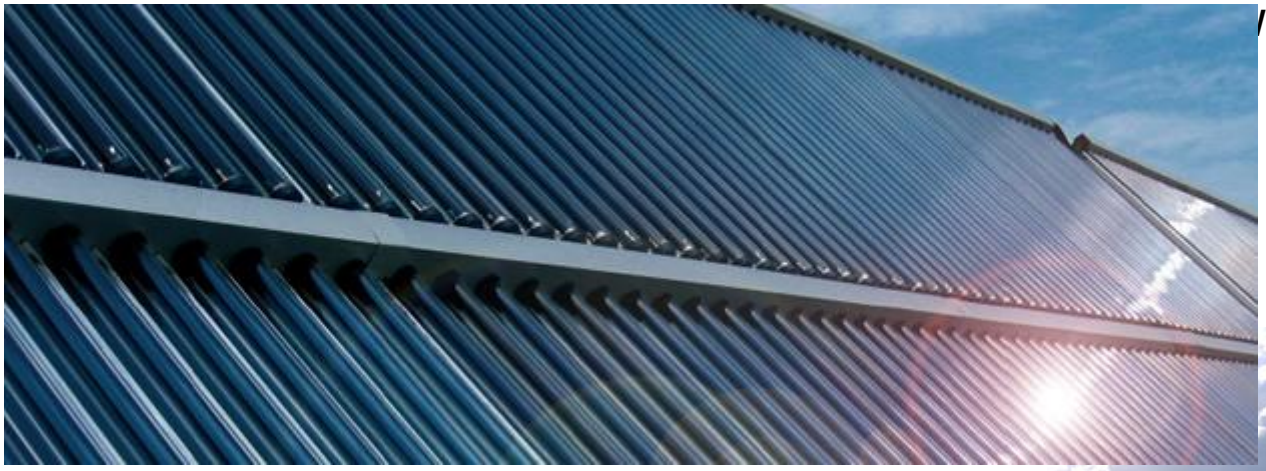
www.solid.at

SOLID solarinstallation+design

Vacuum tubes collectors

80-120 °C

120-250 °C



ww.ritter-gruppe.com

www.kollektorfabrik.de

Flat plate collectors with vacuum

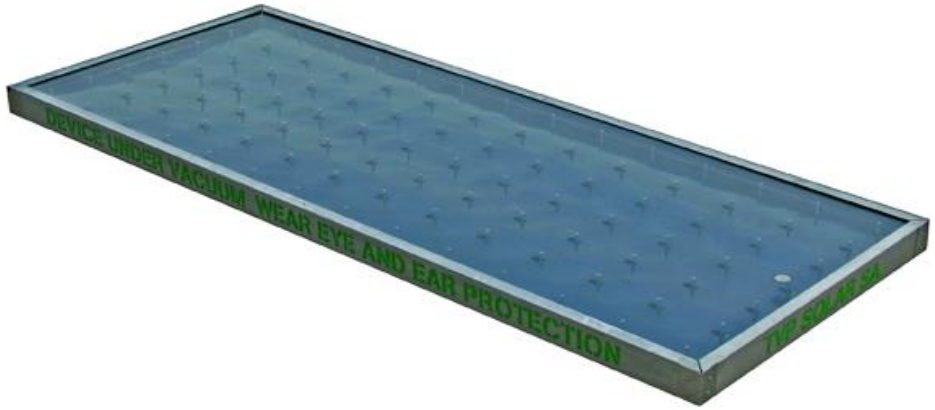
80-120 °C

120-250 °C

www.srbenergy.com

SRB ENERGY

CERN SWISS TECHNOLOGY



www.tvpsolar.com

TVP SOLAR

Parabolic trough collectors

120-250 °C

www.smirro.de

www.nep-solar.com

Fresnel collectors

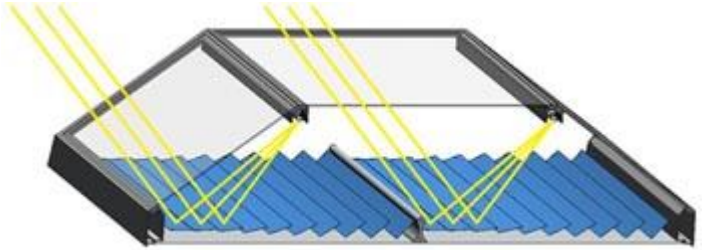
120-250 °C

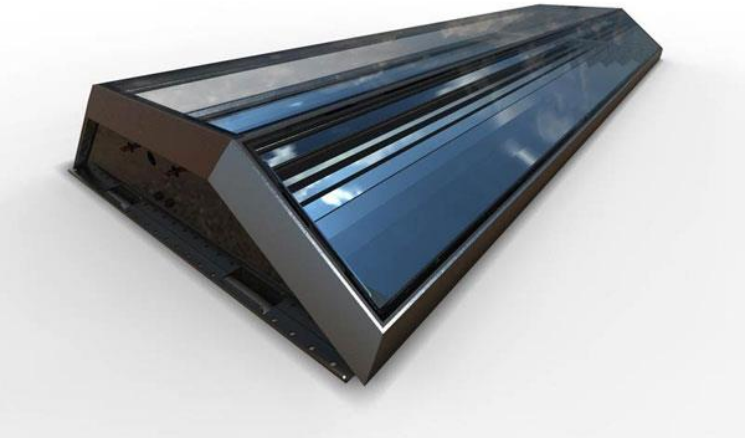
www.industrial-solar.de

INDUSTRIAL SOLAR
thermal solutions

www.chromasun.com

CHROMASUN



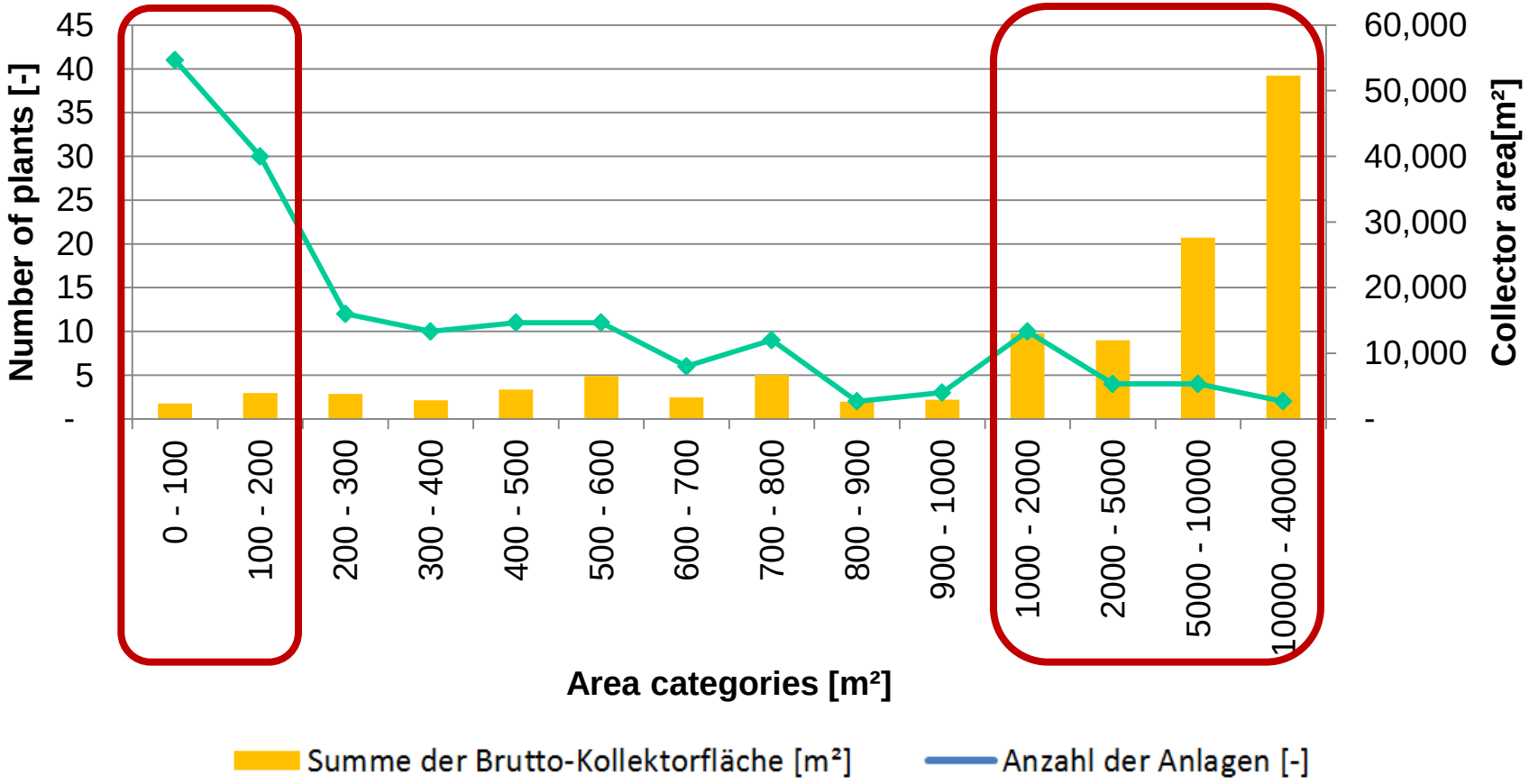


SHIP data base of realized plants

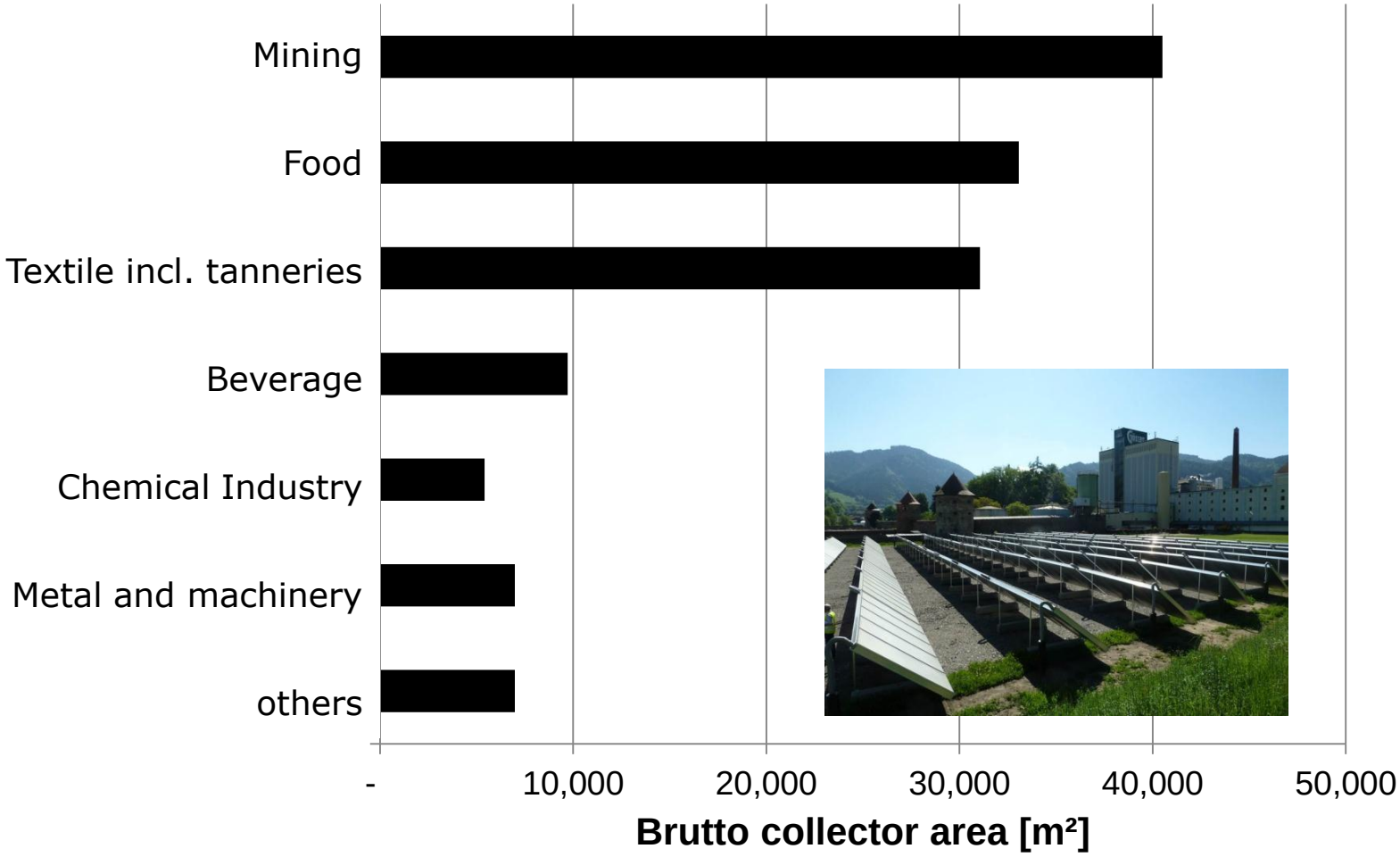
155 plants/ 144.406 m² collector area/ 101 MW

71 plants with
4,4 MW

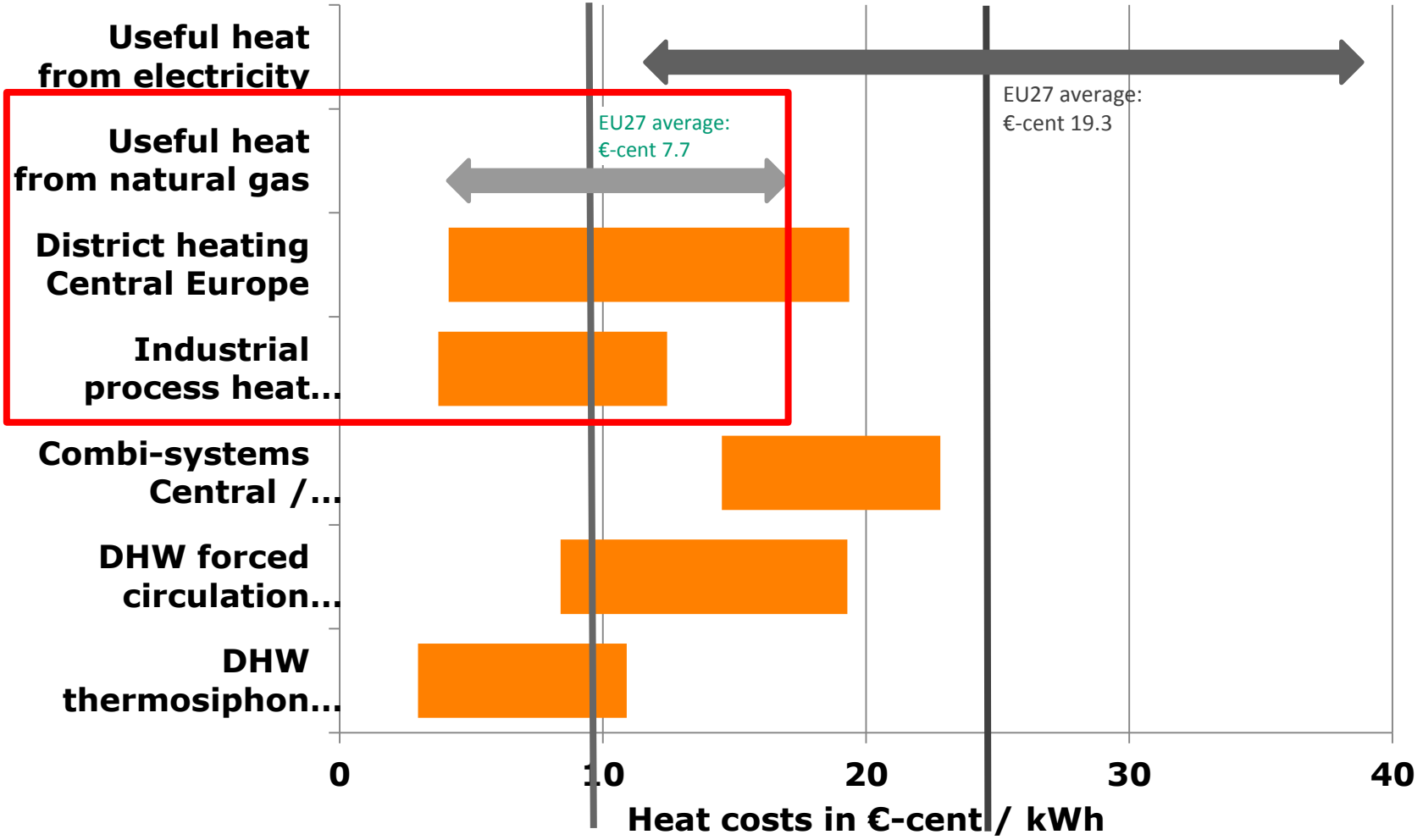
20 plants with
73 MW



Industry sectors



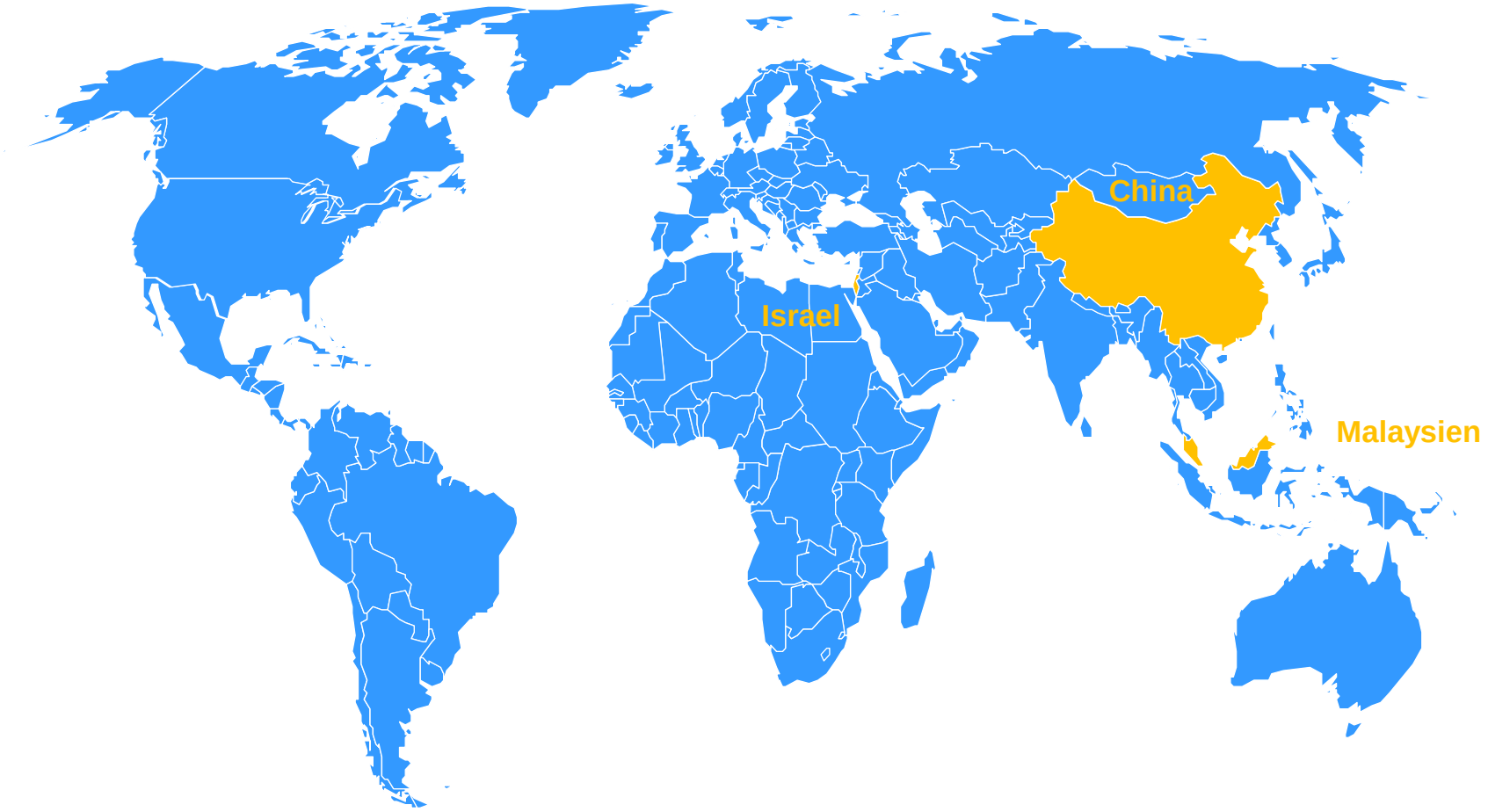
Heat Costs Comparision



Quelle: ETP RHC (2013)

ship-plants.info

SHIP in Asia



China's Solar Roadmap

- **Since 2013, the space of solar industrial and agricultural thermal application system increased rapidly.**
- **By 2020, 1.5% of industrial and agricultural thermal demand will be supplied by solar thermal**
- **During 2020-2030, there'll be an annual increase of 12% of solar thermal industrial and agricultural application space;**
- **During 2030-2050, the annual increase will reach 6%.**

China – high number of very large systems

- **Foshan Jialida textiles Co. LTD.**
- **Collector area: 3000 m²**
- **Application: dyeing**
- **Completion: 2006**
- **Shenzhen Qinger Solar Energy Co.**

- **Dali Textiles Co. LTD. Xinchang**
- **Collector area: 13000 m²**
- **Application: dyeing**
- **Completion: 2008**
- **Shenzhen Qinger Solar Energy Co.**

China – high number of very large systems

- **Changshu printing and dyeing Co Ltd**
- **Collector area: 7460 m2**
- **Application: dyeing**
- **Completion: Sept. 2010**
- **Jiangsu Sunrain Solar Energy Co.**

Malaysia – start of the SHIP program in 2014 with GEF UNIDO and Research Institutions

GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

- Realize 10 large-scale solar plants in combination with energy efficiency measures for industrial companies in Malaysia
- Start a training program with trainings for technicians and policy makers
- Development of a funding program for a sustainable support of future project developments
- Promising industrial sectors:
  - **Textiles**
  - **Food**
  - **Metals**
  - **Chemicals**
  - **Rubber**

SHIP in Africa

DUSTII – use of concentrating collectors

- **Pre-selection of companies based on ANME data and studies (20 candidates)**
- **Company visits and questionnaires (Top 6 Ranking)**
- **Energy-Audits and pre-feasibility study (Top 3 Ranking)**
- **Feasibility Study (1-2 partner-companies)**

Costs of Energy

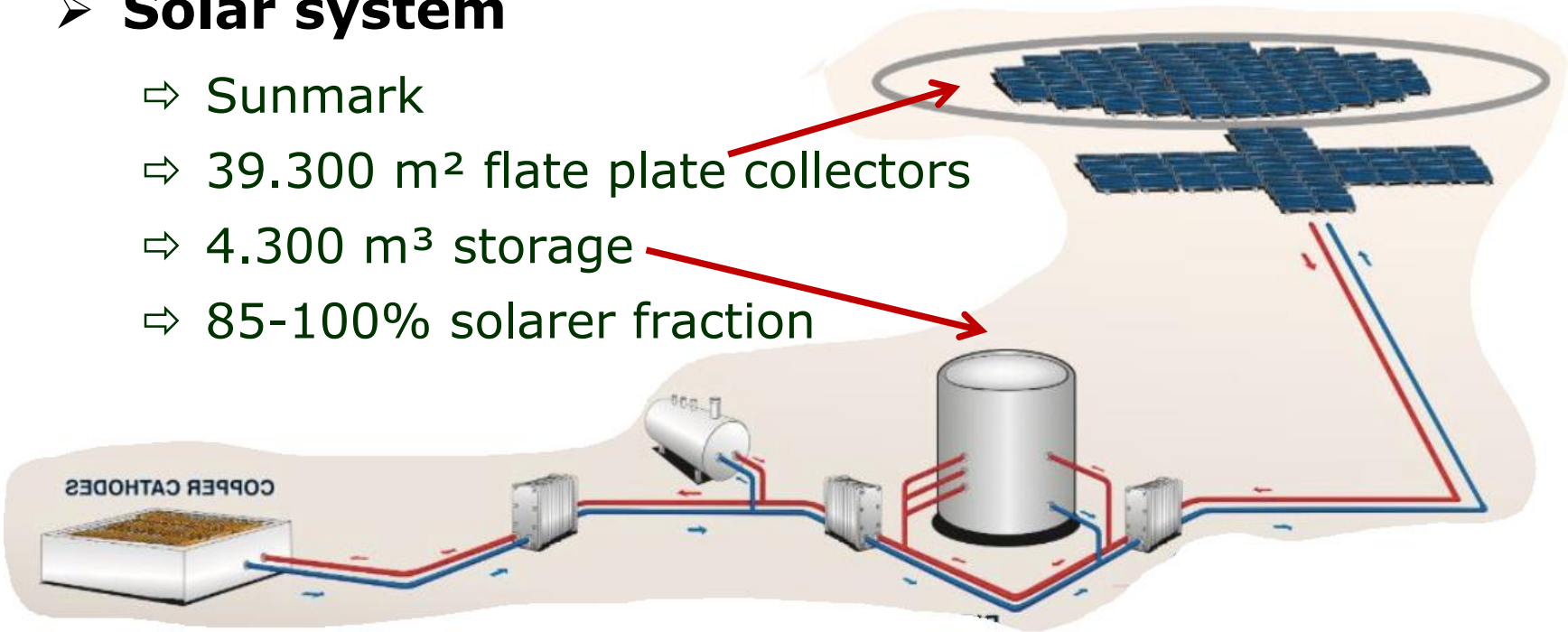
Energy	End user costs (net)
Natural gas	0,11 €/m3
Gasoil	0,53 €/litre
Heavy fuel	218 €/ton
GPL	503 €/ton

Source: STEG, Tunisian ministry of industry (January 2013)

SHIP in South-America

World's largest solar field

- **Process**
  - ⇨ Copper recovery process
  - ⇨ Electrolyte constant at 50°C
  - ⇨ Adittionally cleaning processes
- **Solar system**
  - ⇨ Sunmark
  - ⇨ 39.300 m² flate plate collectors
  - ⇨ 4.300 m³ storage
  - ⇨ 85-100% solarer fraction



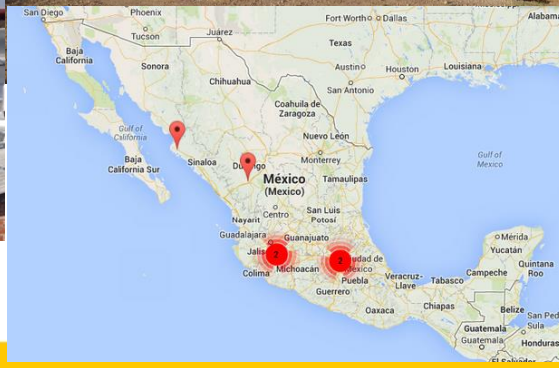
World's largest solar field

SHIP in North-America

Mexico – parabolic trough collectors

➢**6 installations from „Inventive Power“**

- **Buenavista Greenhouse**
- **La Doñita Dairy**
- **Lácteos Covbars Dairy**
- **Nutrición Marina (Food Pellets)**
- **Matatlan Dairy**
- **El Indio Dairy**



USA: Prestage Food

➢ Process

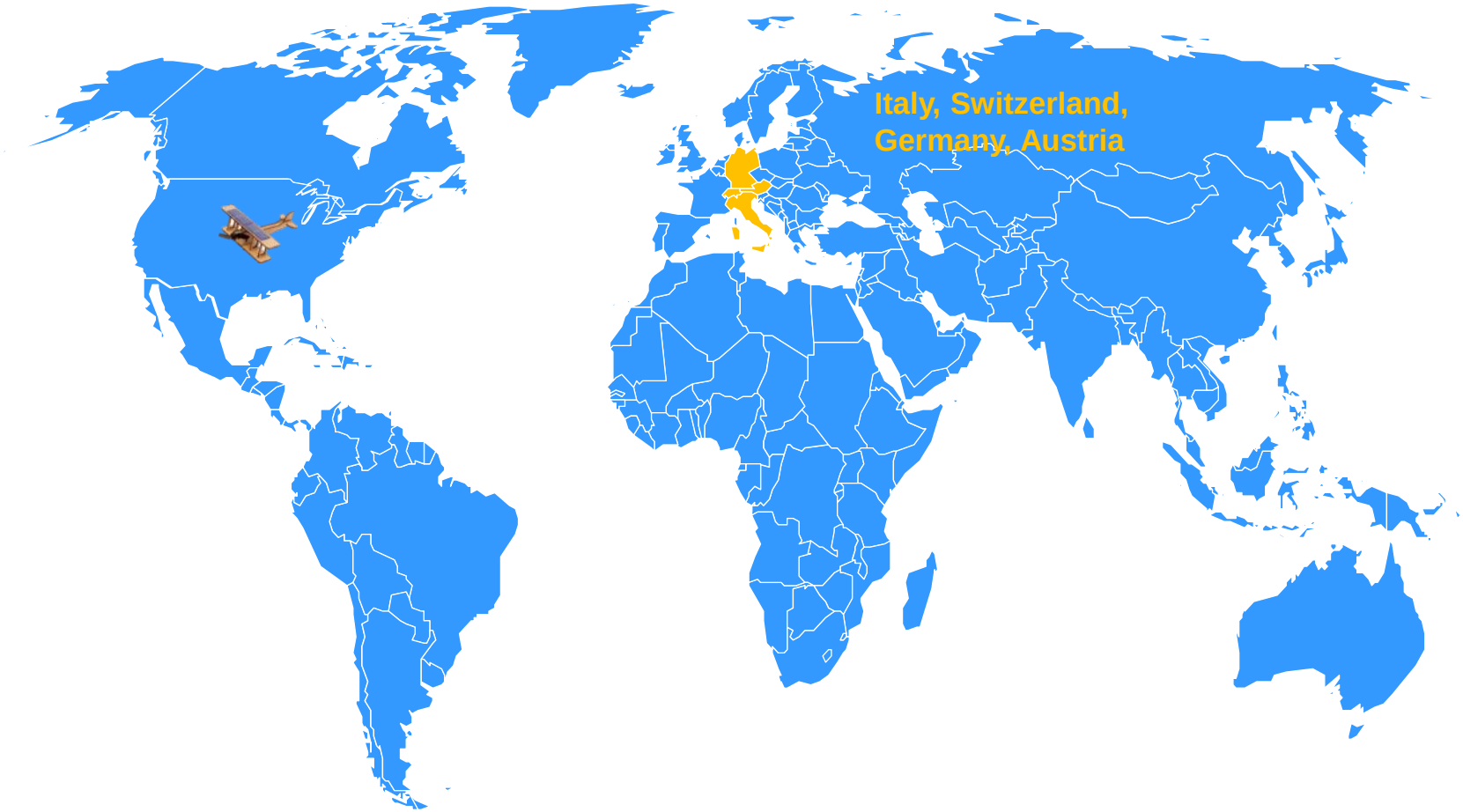
- ⇨ Poultry-processing plant in North Carolina, USA
- ⇨ ESCO: FLS Energy
- ⇨ 568 m³ hot water each day (60 °C)
- ⇨ Cleaning processes

➢ Solar system

- ⇨ In operation since 2012
- ⇨ 7.804 m² flate plate collectors
- ⇨ 852 m³ storage (10 x 85 m³)
- ⇨ Solar fraction of hot water demand: 50%

Bildquellen: FLS Energy

SHIP in Europe



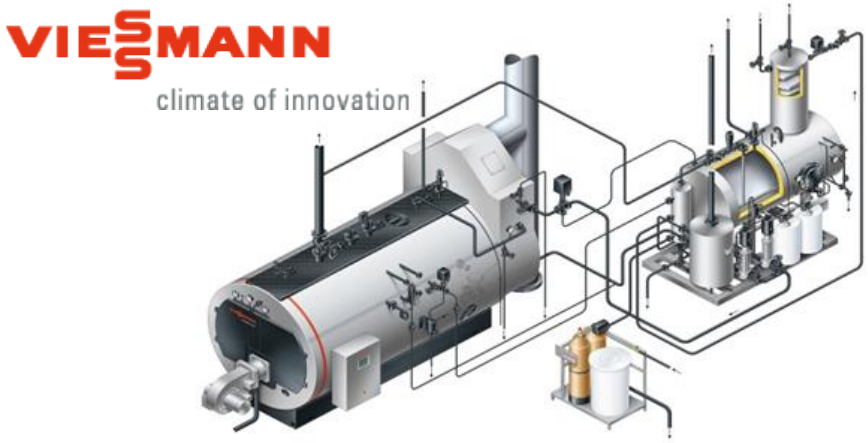
Swiss– milk processing in the focus

- **LESA (Lateria Engiadinaisa SA) in Bever**
  - ⇨ 115m², heat contracting
  - ⇨ 1700 altitude, high snow load
- **Emmi Group (Fromagerie Tête de Moine) in Saignelégier**
  - ⇨ 627m², low temperatures to -20°C
- **Cremo SA in Fribourg**
  - ⇨ 585m²
  - ⇨ Assembled towards the south, unconventiolal tracking.

Germany- SolSteam

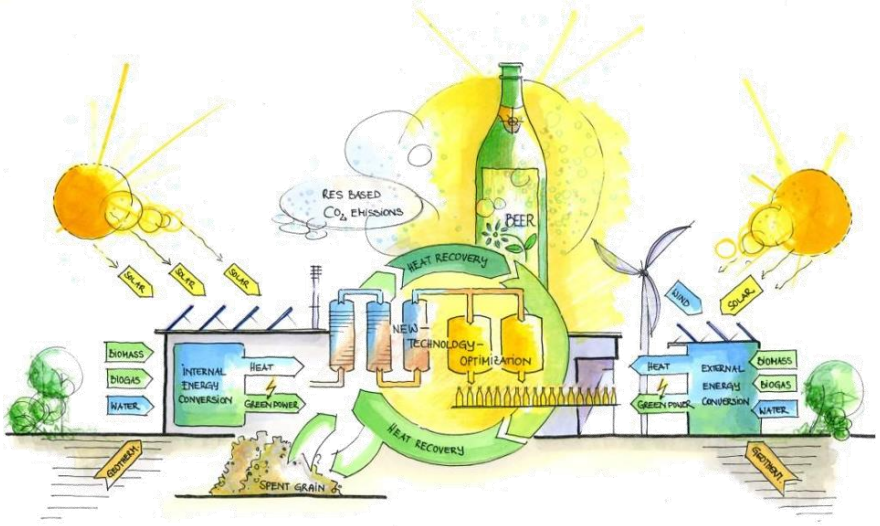
- **Integrated system concept based on proven components**
- **Secure steam supply to the processes in the usual quality**
- **Fuel saving by solar steam generation**
- **Sharing of peripheral components**

Industrial Solar Fresnel-Kollektor



Viessmann Dampfkessel mit Peripherie

Introduction to SolarBrew



Solar Brew: Solar Brewing the Future

EU FP7 (2012 – 2015)

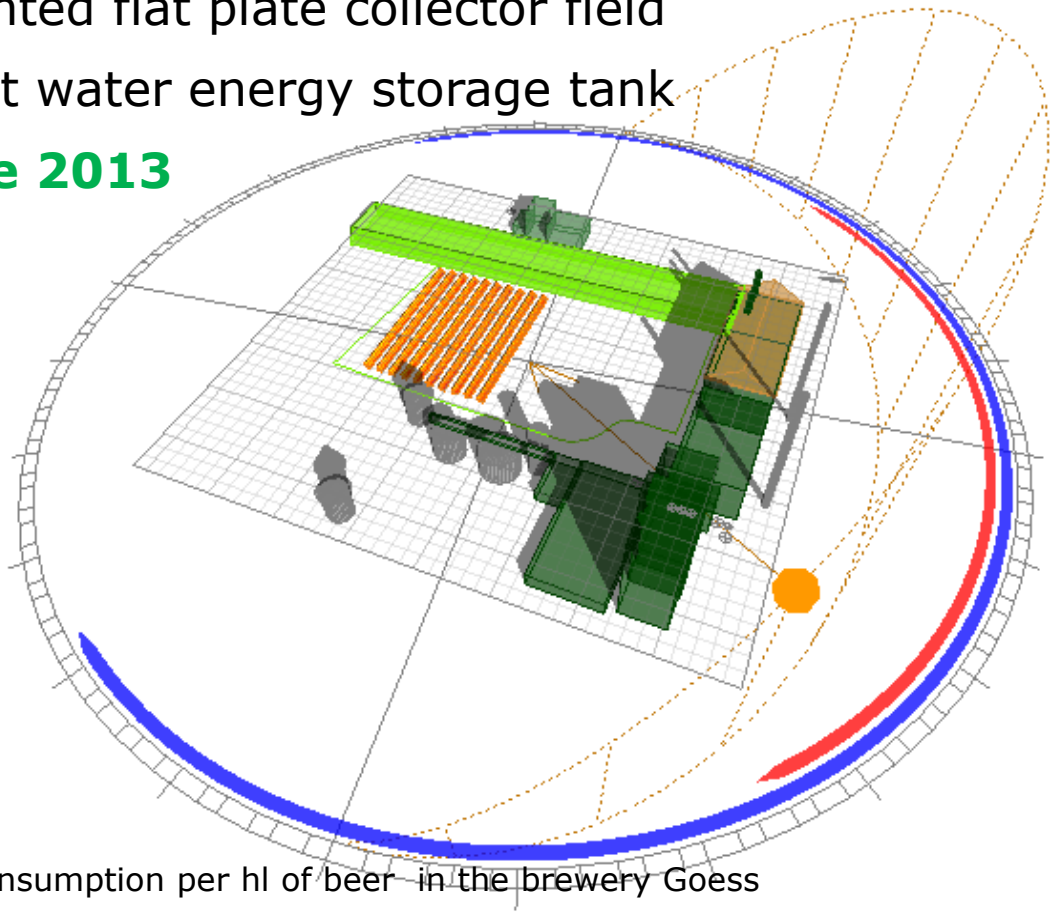
Projekt Nr. 295660

- **PROJECT CONSORTIUM**
- **AEE INTEC (coordinator)**
- **HEINEKEN Supply Chain B.V.**
- **GEA Brewery Systems GmbH**
  - process engineering
- **Sunmark A/S**
  - solar engineering

State of the project

BREWERY GOESS

- Solar assisted mashing process
- 1.500m² ground mounted flat plate collector field
- 200m³ pressurized hot water energy storage tank
- **Commissioned: June 2013**



4.6 million pints of beer
per year brewed with the power from the sun*

* assuming 60 MJ thermal energy consumption per hl of beer in the brewery Goess

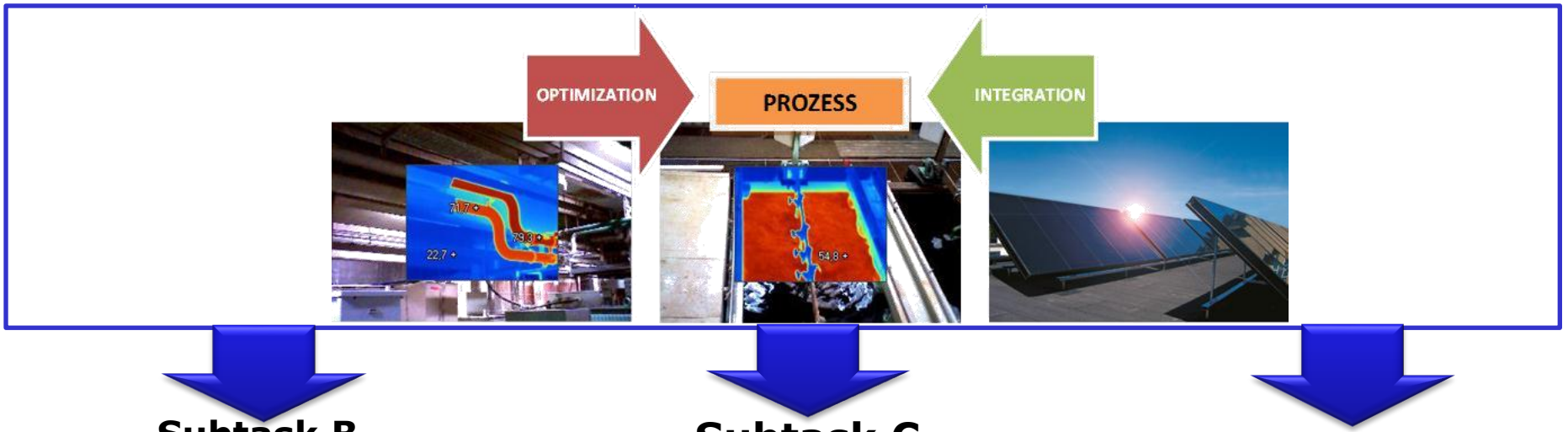
State of the project

BREWERY GOESS

- Construction of the 1,500m² solar thermal collector field

Austria - IEA SHC Task 49 / IV

- **Task leader: AEE INTEC (Christoph Brunner)**
- **Duration: 4 years (start 2012)**
- **Joint Task with SolarPaces**



Subtask B
Process optimization
Process integration
Process intensification
(Bettina Muster – AEE INTEC)

Subtask C
Case studies
Integrations-equipment
Dissemination
(Werner Platzer – Fraunhofer ISE)

Subtask A
Process heat - collectors
(Pedro Horta – Uni Evora)

Research and Development Needs

- **Need of new technology and engineering concepts on the process side for**
  - ⇨ Increased energy efficiency
  - ⇨ Lower process temperatures
- **Standardized optimization and integration approach (branch concepts)**
- **Overcome of barriers space availability and static conditions**
- **Development, implementation and dissemination of case studies in various industry sectors, process integrations and locations (climate zones)**
- **Development of process heat collector technologies and their integration (hot water, direct steam, thermal oil,…)**
- **Training and awareness-raising**
- **Overcome of relative high costs - long term investments (business models)**

Thank you for your attention

Christoph Brunner

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