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)

Solar process heat: 7.2 EJ/a

Source: IEA Technology Roadmap – Solar Heating & Cooling
Existing process heat systems

- **132 plants / 136,500 m² / 95,5 MW**

- 17 plants with 98,700 m²
- 52 plants with 2,250 m²
Industry Sub Sectors

- Mining
- Food
- Textile
- Beverage
- Chemical Industry
- Metal industry
- Agro industry
- Services
- Tabaco
- Others
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

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

- **Shenzhen Qinger Solar Energy Co.**

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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

- 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
Israel – collector development

- New process-heat flat-plate collector developed by TIGI in Israel (honeycomb-structure under the glazing → minimized heat losses)
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

<table>
<thead>
<tr>
<th>Energy</th>
<th>End user costs (net)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>0,11 €/m³</td>
</tr>
<tr>
<td>Gasoil</td>
<td>0,53 €/litre</td>
</tr>
<tr>
<td>Heavy fuel</td>
<td>218 €/ton</td>
</tr>
<tr>
<td>GPL</td>
<td>503 €/ton</td>
</tr>
</tbody>
</table>

Source: TEG, Tunisian ministry of Industry (January 2013)
SHIP in South-America
Chile – large plants in the past

- Chile's advantage in Solar radiation was discovered by Charles Wilson in 1872. The Swedish Engineers built a 5,000 m² solar system to desalt brackish water. It delivered 20,000 liters / day and was in operation till 1912.
Three large solar-thermal applications in the mining-industry

- Minera El Tesoro (2 MW parabolic trough by ABENGOA)
- Constanza Mine (350 kW flat plate collector, 80% solar fraction)
- Minera Gabriela Mistral (39,000 m² flat plate collector, 80% solar fraction).

Other projects in the tendering or pre-study phase
World's largest solar field

➢ Process
  ➢ Copper recovery process
  ➢ Electrolyte constant at 50°C
  ➢ Additionnally cleaning processes

➢ Solar system
  ➢ Sunmark
  ➢ 39,300 m² flat plate collectors
  ➢ 4,300 m³ storage
  ➢ 85-100% solarer fraction
World's largest solar field
SHIP in North-America

USA

Mexico
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

Italy, Switzerland, Germany, Austria
Italy – process steam project InSun

- **Location:** Italy
- **Size:** 1.2 MW (1’800 kg\textsubscript{steam}/hr@10 bar)
- **Sector:** building materials
- **Process:** drying

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Italy– TVP Solar – vacuum-flat plate collectors
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, unconventional tracking.
Germany: solar thermal process heat for the laundry industry - SoProW

- 20 screenings, 10 case studies
  - Representative model laundry with/without efficiency measures for simulation studies
  - Identification of potential integration points and development of systems
  - General process heat system concepts optimization for T*SOL
  - Testing area of solar steam generation with Fresnel-collectors equipped with measurement

Industrial washing machine with hot / cold water and steam connection
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
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

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

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

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

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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)

- 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
Thank you for your attention

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