Solar Heat for Industrial Applications

Current state of play

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IEA – Solar Heating and Cooling Programme
Global Capacity in Operation 2015
Total installed capacity of unglazed and glazed water collectors in operation in the 10 leading countries by the end of 2014.
Distribution by application
for the total installed water collector capacity
by economic region in operation by the end of 2014
Turnover

The worldwide turnover of the solar thermal industry in 2014 is estimated at € 21 billion (US$ 24 billion)
Large-Scale District Heating and Cooling Applications in Europe by 2015

Positive developments

Source: Jan-Olof Dalenbäck, Chalmers University of Technology, DK
Large-Scale District Heating and Cooling Applications in Europe by the end of 2014

Source: Jan-Olof Dalenbäck, Chalmers University of Technology, DK
Vojens Solar District Heating Plant, DK

Collector Capacity: $37 \text{ MW}_\text{th} \ (52,491 \text{ m}^2)$

203,000 m³ Seasonal pit heat storage.

(Source: ARCON-SUNMARK)
District Heating System, Saudi Arabia
36,000 m² / 25 MW_{th}
District Heating System, Saudi Arabia
36,000 m² / 25 MW_{th}
Pipes and Heat Exchangers
SHIP Potential
Industrial heat demand by temperature level and industrial sector

Source: ECOHEATCOOL
Temperature levels of processes

- Parabolic trough collector
- CPC collector
- Vacuum tube collector
- Flat plate collector

Industry sectors:
- Food industry:
  - Cooking
  - Cleaning and washing
  - Evaporation and distillation
  - Pasteurisation
- Textile industry:
  - Washing
  - Dyeing
  - Drying
  - Bleaching
- Surface treatment:
  - Cleaning
  - Finishing
  - Surface treatment
- Chemical industry:
  - Destillation
  - Extraction
  - Cooking
- All sectors:
  - Preheating of processes
  - Heating of industry halls

Process temperature:
- 100°C
- 200°C
- 300°C
Industrial Heat Demand

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).
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
SHIP Installed Systems and LCOH
Global Solar Process Heat Applications

Source: Task 49/IV SHIP Database
Database of solar process heat applications

World Map of Solar Thermal Plants
191 projects

http://ship-plants.info/

Source: AEE INTEC and PSE
## Levelized Cost of Heat

### Levelized Cost of Heat $LCOH_{ST}$ ready installed

(Northern / Central European climate)

<table>
<thead>
<tr>
<th>Storage Type</th>
<th>Storage Size</th>
<th>LCOH [€-ct/kWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHW-SFH</td>
<td>5-10 m²</td>
<td>3-6</td>
</tr>
<tr>
<td>CS-SFH</td>
<td>12-24 m²</td>
<td>6-9</td>
</tr>
<tr>
<td>CS-MFH</td>
<td>30-300 m²</td>
<td>9-12</td>
</tr>
<tr>
<td>SBH (roof)</td>
<td>500-5,000 m²</td>
<td>12-15</td>
</tr>
<tr>
<td>SBH (roof)</td>
<td>1,000-10,000 m²</td>
<td>15-18</td>
</tr>
<tr>
<td>SDH (ground)</td>
<td>5,000-20,000 m²</td>
<td>18-21</td>
</tr>
<tr>
<td>SDH (ground)</td>
<td>20,000-200,000 m²</td>
<td>21-24</td>
</tr>
</tbody>
</table>

Source: Task 53, Franz Mauthner, AEE INTEC
Process Heat Collectors
Flat Plate Collectors

< 85 °C
Advanced Evacuated Tube Collectors

< 80 - 180 °C
High Vacuum Flat Plate Collectors

< 80 -180 °C
Parabolic Trough Collector

www.smirro.de

www.nep-solar.com

Source: Elimar Frank - SPF
Linear Concentrating Fresnel Collectors

< 120 - 250 °C
Space Heating of Factory Buildings
Space heating - air collectors

Source: SolaWall, Canada
Air collectors

Transpired solar collector cavity

Source: SolaWall, Canada
Air based Drying System

Coffee drying, Coopeldos, Costa Rica

Installed capacity: 595 kWth (850 m² Air collector)

Air based Drying System
Prestage Food, North Carolina, USA

- Poultry processor in NC, USA
- Energy contractor: FLS Energy owner of system
- Demand of 568 [m³/d] of hot water (>60 °C) for cleaning of equipment
- System in operation since 2012
  - 7.804 m² flat plate collectors
  - 852 m³ storage tanks (10 x 85 [m³])
  - Covers 50% of hot water demand

Source: FLS Energy
Prestage Food, North Carolina, USA
Heineken Brewery- Göss Austria

Integration in mashing process (50–75°C)
System in operation since 2013
- 1.375 m² flate plate collectors
Heineken Brewery- Göss Austria

Source: AEE INTEC
Heineken Brewery- Göss Austria

➢ Göss – construction of collector field

Source: AEE INTEC
Integration into the mashing process
Integration into the mashing process
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
Copper Mine “Gabriela Mistral”, Chile
26MWth (39,300 m²)

Source: ARCON-SUNMARK
Copper Mine “Gabriela Mistral”, Chile
26MW\textsubscript{th} (39,300 m\textsuperscript{2})

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

- **System**
  - 39.300 m\textsuperscript{2} Flat plate collector
  - 4.300 m\textsuperscript{3} Storage
  - **85-100% Solar fraction**

Source: SUNMARK and IEA SHC Task 49
Copper Mine “Gabriela Mistral”, Chile
26MWth (39,300 m²)

Flow and return temperatures:
primary side: 85 / 55 °C
secondary side – supplying the mine - at 80 / 60 °C

Annual solar yield: 1,272 kWh/m²

Source: SUNMARK
Copper Mine “Gabriela Mistral”, Chile
26MWth (39,300 m²)

Source: SUNMARK
Thank you for your Attention