
Beyond electricity: Opportunities for CSH for heat & steam generation in industry

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Sectors
Heat for Industrial Processes

- Heat related Final Energy Consumption (FEC) in industry [1] comparable to Transport or Building sectors.
  Distribution: Energy-Intensive (EI) sectors 54%, Non-EI 46%

Suitable Solar Thermal technologies
Heat for Industrial Processes

- Solar collector technology vs. required process temperature

<table>
<thead>
<tr>
<th>Solar collector technologies</th>
<th>50°C</th>
<th>100°C</th>
<th>150°C</th>
<th>200°C</th>
<th>250°C</th>
<th>400°C</th>
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</thead>
<tbody>
<tr>
<td>Resid.</td>
<td>DHW, Heating</td>
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<td>Water</td>
<td>MED, MD, HD</td>
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<tr>
<td>Industry</td>
<td>Food &amp; Beverages, Paper, Fabricated metal</td>
<td>Rubber &amp; Plastic</td>
<td>Machinery, Textiles</td>
<td>Chemical</td>
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<tr>
<td>Power</td>
<td>Stationary</td>
<td>Tracking</td>
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<tr>
<td>Solar collector technologies</td>
<td>Flat Plate</td>
<td>Evacuated / CPC</td>
<td>Small Parabolic Trough / Linear Fresnel</td>
<td>Large Parabolic Trough / Linear Fresnel</td>
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</tbody>
</table>
Dilemma: less resistance to integration at supply level vs. lower temperatures in integration at process level
Temperature levels
Heat for Industrial Processes

Heat requirements in industry occur at different temperature levels in different sectors [2]:

~ 50% HT; ~ 50% MT + LT

Existing projects
Market penetration

- SHIP systems database [3]: 213 projects listed, 129 MWth installed capacity (0.18 million m²) → < 1% installed solar thermal capacity

- Mostly small/medium size systems (<500 m²)
- Largest capacity in large systems (>1000 m²)
- Stationary technologies dominate in nr. systems and capacity

- Recent survey [6] points out > 500 SHIP systems with total installed capacity > 280 MWth (0.4 million m²)


Existing projects

Examples tracking

- Tracking technologies

**Services MTN Johanesburg, S.Africa**
Linear Fresnel
Aperture: 396 m²
Application/End Use: Air conditioning
Oper. Temp.: 180°C
Commissioning: 2014

© Industrial Solar [5]

**Dairy El Indio, Mexico**
Parabolic Trough
Aperture: 132 m²
Application: Make-up water pre-heating
Oper. Temp.: 95°C
Commissioning: 2012

© Inventive Power S.A. de C.V. [6]
Existing projects

New applications

- Tracking technologies

Miraah Solar EOR Pilot Project, Amal, Oman
Parabolic Trough in greenhouse
Status: Delivered first steam (Pilot), construction ongoing
Pilot: 6 ton steam / day
Full-scale: 1.0 GWth, 6.0 ktons steam/day, 3 km² (1.9 aper)

Sundrop Farms Project, Port Augusta, Australia
Central Receiver, 51 505 m² aperture
Solar driven cogeneration: (1.7 GWh + 20 GWhth)/year

Growing tomatoes in the Australian desert with sunlight and seawater

[7,8] © Petroleum Development Oman / Glasspoint

Challenges
Learning curve and technology costs

- The successful story of PV [9]

[9] adapted from Navigant Consulting; EUPD PV module prices (since 2006), Graph: ISE 2014
Challenges

Current technology costs

- Current cost range and NG benchmarking


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Conclusions
Prospects and Challenges

- **Prospects**
  - Heat supply to industry stands worldwide for a very large market
  - There is political pressure and drive towards industrial decarbonisation
  - Available Solar Thermal technologies suit 50% of these heat requirements (LT, MT)
  - CSP companies acknowledge this market and are already moving towards it

- **Challenges**
  - Point-focus technologies addressing HT processes
  - Balance of Plant concepts and integration on steam networks
  - Lighter hydraulic costs and requirements
  - Centralized storage and heat supply systems
  - Hybridized concepts towards full decarbonisation
  - Connection to electric grid and district heating networks
  - Shift investment assessment from Payback to NPV approach → third-party financing
Thank you for your attention!

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