Where does Solar Cooling stand today?

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Introduction
Heat sources for thermal cooling

Solar

Source: Tsinghua

District Heating


Cogeneration Units,
Biomass,
Process Heat etc.

Source: EC-Power

Source: GE Jenbacher
## Introduction

### Collector technologies – Application for solar cooling

<table>
<thead>
<tr>
<th>Solar thermal collector</th>
<th>Heat transfer medium</th>
<th>Collector temperature</th>
<th>Application for cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air collector</td>
<td>Air</td>
<td>40-60°C</td>
<td>Air-conditioning</td>
</tr>
<tr>
<td>Flat plate collector</td>
<td>Water, Water-Glycol</td>
<td>70-90°C</td>
<td>Air-conditioning, slab cooling</td>
</tr>
<tr>
<td>Evacuated tube collector</td>
<td>Water, Water-Glycol</td>
<td>90-120°C</td>
<td>Air-conditioning, slab cooling</td>
</tr>
<tr>
<td>Parabolic trough / Fresnel</td>
<td>Thermal oil, Water</td>
<td>120-250°C</td>
<td>Refrigeration, air-conditioning, slab cooling</td>
</tr>
</tbody>
</table>
### Chiller technologies

#### Many low power systems available

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>kW Rating</th>
<th>Refrigerant</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>SorTech (DE)</td>
<td>8 &amp; 15 kW</td>
<td>Water / Silica Gel</td>
<td>SorTech (DE)</td>
</tr>
<tr>
<td>InvenSor (DE)</td>
<td>10 &amp; 18 kW</td>
<td>Water / Zeolithe</td>
<td>InvenSor (DE)</td>
</tr>
<tr>
<td>Pink (AT)</td>
<td>14 &amp; 19 kW</td>
<td>Ammonia / Water</td>
<td>Pink (AT)</td>
</tr>
<tr>
<td>Tranter Solarice (DE)</td>
<td>30 &amp; 50 kW</td>
<td>Ammonia / Water</td>
<td>Tranter Solarice (DE)</td>
</tr>
<tr>
<td>Sakura (JP)</td>
<td>10.5 – 35 kW</td>
<td>Water / LiBr</td>
<td>Sakura (JP)</td>
</tr>
<tr>
<td>EAW (DE)</td>
<td>15 &amp; 30 kW</td>
<td>Water / LiBr</td>
<td>EAW (DE)</td>
</tr>
<tr>
<td>Yazaki (JP)</td>
<td>17.5 &amp; 35 kW</td>
<td>Water / LiBr</td>
<td>Yazaki (JP)</td>
</tr>
<tr>
<td>Thermax (IN)</td>
<td>35 kW</td>
<td>Water / LiBr</td>
<td>Thermax (IN)</td>
</tr>
</tbody>
</table>

No claim on completeness.
Chiller technologies
Medium-scale absorption and adsorption chillers

**EAW (DE)**
50 – 200 kW
Water / LiBr

**Yazaki (JP)**
70 – 175 kW
Water / LiBr

**Thermax (IN)**
70 – 352 kW
Water / LiBr

**Mayekawa (JP)**
105 – 430 kW
Water / Zeolithe

**HIJC (US, former Nishiyodo)**
220 – 350 kW
Water / Silica gel

**AGO (DE)**
50 – 500 kW
Ammonia / Water

Source: EAW
Source: Yazaki
Source: Thermax
Source: Mayekawa
Source: GBU
Source: AGO

No claim on completeness.
Chiller technologies
Focus last years - integration of heat rejection

Jiangsu Huineng (CN)
11 – 350 kW
Water / LiBr

Mitsubishi Plastics (JP)
10 kW
Water / Zeolithe

Source: Jiangsu Huineng
Source: Mitsubishi Plastics
Standardized systems
Solar cooling kits

SolarNext
chillii® Cooling Kit ISC18

Schüco
LB15 System Package
Standardized systems
System controller with visualisation (Modbus TCP / VPN)
Standardized systems
Sub-systems of sorption chiller manufactures

Pre-designed pump group

Recooler

Source: SorTech
Standardized systems
Recent solar cooling kit supplier

- coolySun,
  8, 15, 30, 54, 83, 150 and 200 kW

- Kingspan Climate System,
  10 and 20 kW

- SOLARTIK,
  17.5, 35, 70 and 105 kW

- LB Cooling System,
  15 and 30 kW

- chillii® Cooling Kit,
  8, 10, 14, 15, 17.5, 18, 19, 30, 35, 50, 70, 105 and 175 kW

- Alaska-Set,
  8, 15, 30 and 54 kW
Costume-made systems
Supplier of costume-made solar cooling systems

(Middle East, North Africa)

(Europe, North Africa, Middle East)

(USA)

(Middle East, Spain, USA)

(Europe, USA, Caribbean, Asia)

(Europe, Middle East)

(China, Europe, USA, Middle East)
Latest developments
New system supplier from India (2010)

- Scheffler-Mirror with LiBr Absorber (SE, DE, new TR)
Latest developments
New system supplier from Japan (2011)

• Planned turn-over of 44 million EUR till 2015
Where does Solar Cooling stand today?

Latest developments

New system supplier from Japan (2012)
Latest developments
Small-scale Solar Cooling Kit supplier from China (2012)

Source: Jiangsu Huineng
Solar Cooling Kit
Heating, DHW, Cooling

System development & field test

Solar collection
Hydraulics
System integration

Chiller
Heat rejection
Hydraulics

Tests, optimisation, evaluation

Source: Fraunhofer ISE
Latest developments
Solar cooling kit example #2

Solar combi+ system
Commercial development – Velta Italia with EURAC

Source: EURAC
Costs and market development

Specific total costs of thermal and solar cooling kits (2011)

Cost reduction of 20% within 2 years (2009-2011)!
Solar cooling installation – 10 RT (35 kW) Absorption in France (2009)

<table>
<thead>
<tr>
<th>COST ITEM</th>
<th>$ (w/o tax)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar collectors</td>
<td>130 000</td>
</tr>
<tr>
<td>Technical room</td>
<td>15 080</td>
</tr>
<tr>
<td>Cold production</td>
<td>57 200</td>
</tr>
<tr>
<td>Electricity</td>
<td>13 000</td>
</tr>
<tr>
<td>Monitoring</td>
<td>6 500</td>
</tr>
<tr>
<td>Starting up</td>
<td>1 950</td>
</tr>
<tr>
<td>Engineering</td>
<td>19 500</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>243 230</strong></td>
</tr>
</tbody>
</table>

$/ton = 24 323

Sources: Tecsol

about 5,500 EUR/kW
Costs and market development

Documented solar cooling installations (2009)

135 large-scale installations (blue column)
166 small/medium-scale installations (red column)

Source: Sparber, IEA-SHC Task 38
Economics

Economics of solar cooling systems

**Investment and O&M cost**

**Solar cooling:**
- higher investment cost upfront
- lower O&M cost lifetime
- ROI depends on fossil fuel cost

**Absorption chiller**

**Vapour compression chiller**

- ROI residential sector: 12-18 years
- ROI commercial / industry: 7-15 years

Electricity and oil price increase

**Time [a]**
Design tools
Check-list method (IEA-SHC Task 38)

Source: Tecsol
Design tools

Example simulation software (Polysun)

Source: Velasolaris
R&D / Networks / Associations
EU research projects related to solar cooling

- HIGH-COMBI (2007-2011, FP6)
- SOLAR COMBI+ (2007-2010, Intelligent Energy Europe)
- SAHC (2007-2010, Intelligent Energy Europe)
- KeepCool II (2007-2010, Intelligent Energy Europe)
- MEDISCO (2006-2009, FP6)
- REACT (2006-2008, FP6)
- ROCOCO (2005-2008, FP6)
- CLIMASOL (2003-2005, ALTENER)
- SACE (2002-2003, FP5)
R&D / Networks / Associations
International Energy Agency (IEA)

R&D / Networks / Associations
Green Chiller – Association for sorption cooling

- Formed in March 2009 as German industry association (today 10 companies, 10 institutes)
- Located in Berlin, Germany
- Representing around 60% of all European manufacturers of thermally driven sorption chillers in the small and medium-scale cooling capacity range
- **Lobbying of sorption cooling technologies** in general but especially in the politics (small and medium cooling capacity range)
- Promoting and developing of the solar and thermal cooling market on European level
R&D / Networks / Associations
Green Chiller – Website

www.greenchiller.eu
R&D / Networks / Associations
ausSCIG – Australian Solar Cooling Interest Group

- Formed in January 2008 as Australian interest group
- Located at CISRO in Newcastle, Australia
- At present over 200 members
- Working groups:
  1. Technology Roadmap and Barrier Assessment;
  2. **Standard Development**;
  3. Demonstration, Funding and Research and
  4. Education, Training and Communication
- ausSCIG Chairmann Dr. Stephen White
  and ausSCIG Secretary Daniel Rowe
R&D / Networks / Associations
ausSCIG – Website

www.ausscig.org
Conclusion / Outlook

• Several new small-scale and medium-scale Absorption and Adsorption chillers were developed worldwide in the last few years

• Standardized Solar Cooing Kits available to bring down the costs

• Standards/Norms needed (CEN, DIN, etc.) to develop the markets

• Solar heat is particularly of interest if a solar thermal system is used for other heat needs, too (e.g. heating, DHW)

• Solar cooling position paper prepared in Task 38 "Solar Air-Conditioning and Refrigeration" of the IEA Solar Heating and Cooling Programme (www.iea-shc.org)
Thank you for your attention!

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