Status and perspective of solar cooling in Europe

Australian Solar Cooling 2013 Conference,
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Green Chiller – Association for Sorption Cooling e.V.
• Formed in March 2009 as Industry Association (today 10 Companies, 11 Institutes, 1 Association)
• 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 (8 - 200 kW)

• Lobbying of Sorption Cooling Technologies
• Promoting and Developing of the Solar and Thermal Cooling Market on European Level

Green Chiller – Association for Sorption Cooling
World exhibition in Paris – First ice block through solar energy (1878)
<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 collector</td>
<td>Thermal oil, Water</td>
<td>120-250°C</td>
<td>Refrigeration, air-conditioning, slab cooling</td>
</tr>
</tbody>
</table>
Small-scale capacity absorption and adsorption chillers

SorTech (DE)  
8 & 15 kW  
Water / Silica Gel  
Source: SorTech

InvenSor (DE)  
10 & 18 kW  
Water / Zeolithe  
Source: InvenSor

Pink (AT)  
19 kW  
Ammonia / Water  
Source: Pink

Tranter Solarice (DE)  
30 & 50 kW  
Ammonia / Water  
Source: Tranter Solarice

Sakura (JP)  
10.5 – 35 kW  
Water / LiBr  
Source: Sakura

EAW (DE)  
15 & 30 kW  
Water / LiBr  
Source: EAW

Yazaki (JP)  
17.5 & 35 kW  
Water / LiBr  
Source: Yazaki

Thermax (IN)  
35 kW  
Water / LiBr  
Source: CISRO

no claim on completeness
Medium-scale capacity 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 / Zeolite

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: HIJC
Source: AGO

no claim on completeness
Latest developments of resorption and absorption chillers

Makatec (DE)  
5 – 100 kW  
Ammonia / Water

Köhler Industries (DE)  
40 kW & 250 kW  
Ammonia / Water

Fischer Eco Solutions (DE)  
15 kW – 1.2 MW  
Water / Lithium bromide

Source: Makatec
Source: Köhler Industries

Sources: Fischer Eco Group
Latest developments with integrated heat rejection

SolabCool (NE)
5 kW
Water / Silica gel

Mitsubishi Plastics (JP)
10 kW
Water / Zeolite

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

Source: SolabCool
Source: Mitsubishi Plastics
Source: Jiangsu Huineng
Pre-designed pump group

Source: SorTech

Recooler

Source: SorTech

Sub-systems of sorption chiller manufactures
Integrated hydraulic unit including pumps, mixers and valves

Source: InvenSor

Integrated hydraulic unit for comfortable system integration
Recent solar cooling kit suppliers in Europe

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

SOLARTIK, 17.5, 35, 70 and 105 kW

Package System, 17.5, 35, 70, 105, 140 and 210 kW

LB Cooling System, 15 and 30 kW

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

Alaska-Set, 8, 15, 30 and 54 kW

no claim on completeness
Solar / thermal cooling kits (small and medium-scale capacity)

Source: SolarNext
Solar Cooling Kit
Heating, DHW, Cooling

System development
& field test

Latest developments of solar cooling kits / example #1

Solar combi+ system
Commercial development – Velta Italia with EURAC

Solar Collectors ➔ Storage Tank ➔ DHW Tank ➔ Radiant Floor

Dry Cooler ➔ Sorption Chiller ➔ Reversible Compression Heat Pump

Source: EURAC

Latest developments of solar cooling kits / example #2
Worldwide suppliers of costume-made solar cooling systems

(Middle East, North Africa)

(USA)

(Middle East, Spain, USA)

(Europe, USA, Caribbean, Asia)

(Europe, Middle East)

(China, Europe, USA, Middle East)
- Scheffler-Mirror and parabolic trough collectors with LiBr Absorber (SE, DE, new TR)

Latest system supplier from India (2010)
Hitachi Plant Technologies Develops a Solar Activated Air Conditioning System
Use of a high-efficiency solar energy collector developed by Hitachi Plant Technologies reduces consumption of fossil fuels and carbon dioxide emissions

• Planned turn-over of 44 million EUR till 2015

Latest system supplier from Japan (2011)
- Refrigerants (HCFC and HFC) with global warming potential (GWP)
- Leakage rate approx. 5 – 15 % per year!
• About > 1,000 systems installed worldwide (2012)

Small, but steadily growing market

Source: TECSOL / Solem Consulting
135 large-scale installations (blue column)
166 small/medium-scale installations (red column)
Market share of solar driven sorption chillers (2009)

Absorption 71%

Adsorption 13%

DEC Solid 14%

DEC Liquid 2%

Sources: EURAC, Tecsol
ca. 34% Solar Cooling
ca. 8% District Heating
ca. 44% CHPC
ca. 14% Waste Heat

Sales numbers of Green Chiller manufacturer (2006-2011)
Cost development of solar cooling Kits (2007-2012)

Cost reduction of 45-55% within last 5 years!
Solar collectors cost share at low cooling capacity at about 45% and at larger cooling capacity about 65%!

Specific total costs of thermal and solar cooling kits (2011)
Figure 9: Costs of solar heating and cooling (USD/MWhth)


Note: Costs of solar cooling: USD/MWh_{cooling}
Figure 16: Roadmap vision for solar cooling (Exajoule/yr)

- $1.5 \times 10^{18} \text{ J/a} = 416.7 \text{ TWh/a Solar Cooling by 2050}$
- Systems could enter the market between 2015 and 2020

IEA Technology Roadmap SHC – Market potential by 2050

Solar Cooling nearly 17% of total energy use for cooling!

• Total cooling demand in 2050 will reach 733 TWh/a in the EU
• At least 50% of the cooling demand could be covered by renewable energy by 2050 (about 370 TWh/a)
• 50% of this cooling demand could be met by solar thermal cooling alone (RDP-scenario, 185 TWh/a)!
• Total collector area of 3,880 million m² (8 m² per EU inhabitant)!

Öko-Institut study 2012 – Contribution of renewable cooling in the EU
• About 1,000 solar cooling systems installed worldwide (2012)

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

• Standardized Solar Cooling Kits available to bring down the costs

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

• Incentive schemes available, e.g. in Germany (KfW) up to 50% repayment bonus of net investment costs!

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

Conclusion
Thank you.

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www.greenchiller.eu