Large Solar Thermal Energy Systems for Cooling and Heating

S.O.L.I.D. works on Solar THERMAL

• Solar PV (Electricity)

• Solar Heating (Heat)

> 500% higher output per m²!
Technical Solutions by SOLID

- SOLAR YIELD
- HEAT
- STORAGE
- DOMESTIC HOT WATER
- PROCESS HEAT for INDUSTRY
- SOLAR COOLING

System Integration by S.O.L.I.D.

Large solar thermal systems (> 500 m² / 5,000 ft²)

- Project development
- Design & engineering
- Construction
- Operation & maintenance
- Financing (ESCo)
- Research & Development
S.O.L.I.D. Group

Headquarter in Graz, Austria
Subsidiaries in USA & Singapore
Partners in many other countries
300 reference plants around the world

Solar Thermal Collectors

SOLID cooperates with the major collector producers in collector development and realization of projects.
The best is chosen case by case for each specific project site.

Collector field test at Fernheizwerk Graz, Austria: 2500 m², 4 different suppliers
Domestic Hot Water
SOLID Examples

Hyatt Regency, Scottsdale, AZ

Resort and Spa
Hot water preparation
Solar Panels: 283.5 m²
Harvard, Cambridge, MA, USA

University Campus
2 Housing Buildings.
82+16 apartments

50.4 m² / 543 ft² at Broadway
94.5 m² / 1017 ft² at Prescott

Domestic hot water

Solar Process Heat

SOLID Examples
Gatorade (Pepsi Cola) Phoenix, AZ

Preheating production water for the soft drinks before the reverse osmosis plant.

Storage: 38 m³
2008: 893 m²
2010: upgrade to 2600 m²
2012: upgrade to 3700 m²

Next step to integrate Solar Heat in the pasteurization in planning phase today.
Gatorade (Pepsi Cola) Phoenix, AZ

Solar Thermal system:
- 30,000 gal/110 m³ storage
- 20 ft container for pumps and controls
- Expansion tanks

Meat factory Berger, Austria

- 1067 m² HT flat-plate collectors
- Guaranteed solar yield: 400 kWh/(m²*year)
- European funded – Research and best practice demo project
- Commissioned in June 2013
Meat factory Berger, Austria

80 – 90 tons/day of meat and sausage products

Heat for dehumidification of maturation chambers
– 160 m³ daily consumption
– Usage of waste heat @ 40° C
– Solar heating up to 60°

Preheating feed water for steam production (ham cooking)
– 25 m³ daily consumption
– Usage of waste heat @ 40° C
– Solar heating up to 98°

www.tinyurl.com/Berger-GBE-Video
Solar Cooling
Why & How?

Why solar air conditioning?

- The buildings sector accounts for 42% of global electricity consumption (IEA 2007)
- Air-Conditioning (AC) represents the biggest single energy/power consumer in public and commercial sectors
- AC key driver of electric peak power demand growth → negative impact on grid load factor, electricity price and environment
Solar Cooling – the advantage

peak of solar radiation and peak of cooling demand match perfectly

- We can use the same radiation that creates the cooling demand to cover it.
- Avoids electricity peaks and extreme operations on the electric distribution grid.
- Solar Cooling saves the most expensive electricity
- Approx. 75% of the UAE electricity production is spent for Cooling !!!

LiBr Absorption Chiller & LST

Nominal Temperature Levels and Power Requirement at external Interfaces

- WASTE HEAT
  - 30 - 35 °C

- SOLAR YIELD
  - 88-70 °C

- HEAT

- COLD
  - 7-14 °C

Solar Thermal Plant

Li-Br Absorption Chiller

Cooling Tower

Consumption
Target value of > 80% Solar coverage fits well to typical Arabian cooling load profile

A brand new technology?

World Expo 1878 in Paris, A. Mouchot produces ice with solar energy
## Solar Cooling

### SOLID Examples

<table>
<thead>
<tr>
<th>Location/Project</th>
<th>Cooling Machine</th>
<th>Constr. Year</th>
<th>Cooling Power</th>
<th>Collector Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAR Tower, Pristina, Kosovo</td>
<td>LiBr-Chiller</td>
<td>2002/3</td>
<td>90 kW</td>
<td>226 m²</td>
</tr>
<tr>
<td>Wine Cooling, Leutschach, Austria</td>
<td>Ammonia</td>
<td>2003</td>
<td>10 kW</td>
<td>100 m²</td>
</tr>
<tr>
<td>Graz - office, test Plant</td>
<td>Ammonia</td>
<td>2003</td>
<td>2 kW</td>
<td>8 m²</td>
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<tr>
<td>Stadtwerke, Crailsheim, Austria</td>
<td>LiBr-Chiller</td>
<td>2004</td>
<td>15 kW</td>
<td>500 m²</td>
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<tr>
<td>Renewable Energy House, Brussels, Belgium</td>
<td>LiBr-Chiller</td>
<td>2005/7</td>
<td>35 kW</td>
<td>60 m²</td>
</tr>
<tr>
<td>Desert Outdoor Center, Phoenix, USA</td>
<td>LiBr-Chiller</td>
<td>2006</td>
<td>70 kW</td>
<td>126 m²</td>
</tr>
<tr>
<td>Olympio Village, Qingdao, China</td>
<td>LiBr-Chiller</td>
<td>2006</td>
<td>512 kW</td>
<td>638 m²</td>
</tr>
<tr>
<td>Estrella Restaurant, Tampa, USA</td>
<td>LiBr-Chiller</td>
<td>2007</td>
<td>70 kW</td>
<td>210 m²</td>
</tr>
<tr>
<td>CID Office Building, Lisbon, Portugal</td>
<td>LiBr-Chiller</td>
<td>2008</td>
<td>545 kW</td>
<td>1579 m²</td>
</tr>
<tr>
<td>Warehouse, Lanta, Phoenix, USA</td>
<td>LiBr-Chiller</td>
<td>2008</td>
<td>130 kW</td>
<td>504 m²</td>
</tr>
<tr>
<td>Service Center Municipality, Gleisdorf, Austria</td>
<td>LiBr Chiller &amp; DEC</td>
<td>2008</td>
<td>35 kW</td>
<td>260 m²</td>
</tr>
<tr>
<td>New Office, Graz, Austria</td>
<td>U Br Chiller</td>
<td>2008</td>
<td>17.5 kW</td>
<td>58 m²</td>
</tr>
<tr>
<td>Metro MAN, Istanbul, Turkey</td>
<td>LiBr Chiller</td>
<td>2009</td>
<td>Study</td>
<td></td>
</tr>
<tr>
<td>Sheikh Zayed Desert Learning Center, UAE</td>
<td>LiBr Chiller</td>
<td>2010/12</td>
<td>400 kW</td>
<td>1108 m²</td>
</tr>
<tr>
<td>United World College, Singapore</td>
<td>LiBr Chiller</td>
<td>2010/11</td>
<td>1470 kW</td>
<td>3900 m²</td>
</tr>
<tr>
<td>DigICel, Kingston, Jamaica</td>
<td>LiBr Chiller</td>
<td>2012</td>
<td>600 kW</td>
<td>982 m²</td>
</tr>
<tr>
<td>Desert Mountain High School, Scottsdale, USA</td>
<td>LiBr Chiller</td>
<td>2013/14</td>
<td>1750 kW</td>
<td>4865 m²</td>
</tr>
<tr>
<td>University Graz, Chemistry building, Design &amp; Consultancy</td>
<td>LiBr Chiller</td>
<td>2014</td>
<td>105 kW</td>
<td>636 m²</td>
</tr>
</tbody>
</table>
**EAR Tower Pristina, Kosovo**

- 2 LiBr absorption machines, total capacity of 70 kW / 20 tons
- Solar Panels: 226 m²
- 4 m³ storage tank
- Operating since Feb. 2003

**14th operating season, 0% unforeseen down time**

**Sheik Zayed Desert Learning Center (UAE/Al Ain)**

- Solar Cooling via concrete core activation of a desert museum
- Cooling power: 400 kW
  - Collector area: 1108 m²
  - Expected Solar yield: 825 kWh/m²/year
- Commissioning: 2012
UWC Tampines, Singapore

Solar Cooling & Hot Water for School Campus

Solar Panels: 3900 m² / 2.73 MW

LiBr absorption chiller: 1470 kW

Operation started: 2011

Enlargement actually under discussion

World's most powerful Solar Cooling System until 2013
UWC Tampines, Singapore

Desert Mountain High School, USA

Scottsdale, Arizona, USA
Solar Cooling for Middle School and High school

20% larger than SOLID’s Singapore project
Desert Mountain High School, USA

Solar Panels: 4,865 m² → 3.4 MW
Cooling load: 500 tons /1750 kW
In operation since 2014

World's most powerful Solar Cooling System

Results after one full year of operation:

- Chiller COP_{thermal} = 0.75
- Peak Hour COP_{electric} = 42 (0.08 kW/RT)
- Annual COPs_{electric} = 25 (0.14 kW/RT)

How to achieve these results?

- Learn how to run Chillers and Cooling towers within and beyond manufacturers specs!
- Develop intelligent control strategies adapted to Solar Thermal heat input profile, starting and stopping heat supply every day.
- Benefit from desert climate 🌞 ☀️
MODON Prototype School – Living Communities, KSA
Solar Cooling and Heating planned by MENABEX/SOLID.

Efficiency comparison:

<table>
<thead>
<tr>
<th>Description</th>
<th>Chilled Water (0.14 kW/RT)</th>
<th>DX. Refrigerant system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water cooled</td>
<td>Air cooled</td>
</tr>
<tr>
<td>Operation Cost</td>
<td>0.7-0.8</td>
<td>1.7-2</td>
</tr>
</tbody>
</table>

SOLID
Solar Cooling
proven 0.14 kW/RT
Complete package of Solar technologies

Solar Electricity by Austrian KPV
Nominal Capacity 786 kW_{electricity}

Solar COOLING and Hot Water by SOLID
Nominal Capacity 1800 kW_{heating}
Nominal Capacity 260 RT_{cooling}

Sample numbers Cooling:
Marked area: 76,000 m² hilly land
Collector area: 50,000 m²
Equal to 5,000 RT cooling capacity during sunny peak hours
Best support for district cooling
10 times the size of world's biggest Solar Cooling project today