



Learning from Global Practices



STAKEHOLDER CONSULTATION WORKSHOP
“POLICY DEVELOPMENT TO SUPPORT SOLAR COOLING IN
THAILAND AS DEMONSTRATION PROJECT in Southeast Asia



Sustainable
Solutions
for the
Environment



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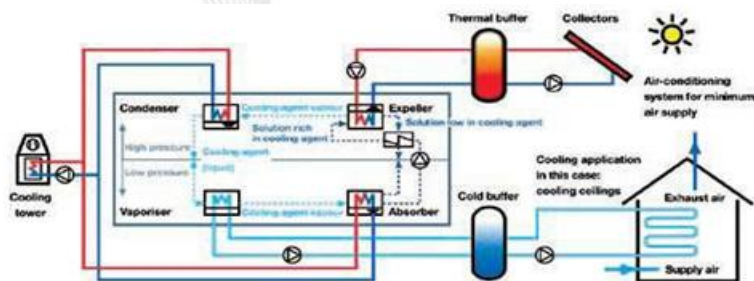


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Date: 22nd October 2013



EXAMPLE OF CLOSED SOLAR THERMAL COOLING SYSTEM

Closed systems keep the refrigerant in the system. Two main types exist:

- Absorption - use liquid refrigerants: lithium bromide-water or ammonia-water pair
- Adsorption – use solid refrigerants: water-silica gel and Water-Zeolite

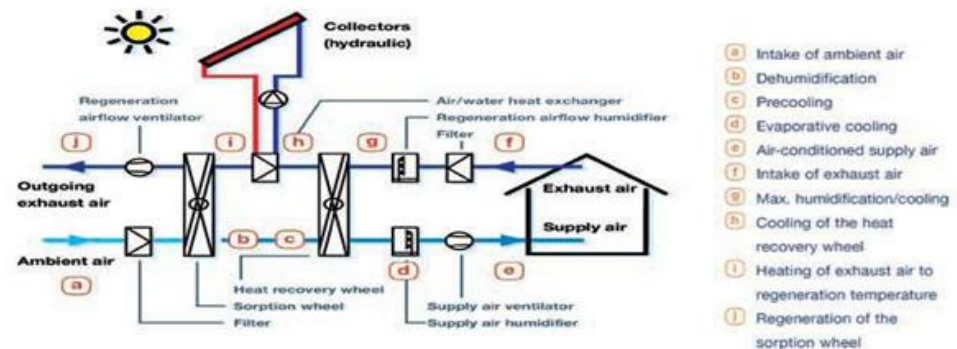
Technology	Absorption H ₂ O/LiBr			Absorption NH ₃ / H ₂ O
Types	Single effect	Double effect	Triple effect	Single effect
Heat	75- 95°C	140 – 180°C Steam	steam	85- 240°C
Chilled water	> 6°C	> 6°C	> 6°C	- 20°C - > 0°C
Cooling water	27- 35°C	27- 35°C	27- 35°C	25 – 45°C
COP	0,6-0,8	> 1 (1,4)	> 1,4 (1,8)	0,5 – 0,6
Power rates	> 15 kW	> 150 kW	> 500 kW	> 10 kW
Manufacturers	EAW (Germany, Yazaki (Japan)	Broad (China), Thermax (India), LG (Korea), Hitach (Japan), Carrier (USA)	Kawasaki (Japan, Hitachi (Japan)	SolarNext (Germany), Pink (Austria), Robur (Italy),

Types	Adsorption water /Zeolith /Silica Gel			
	HTC High temperature chillers	LTC Low temperature chillers		ADR-Z
Heat temperature	85°C	72°C	55- 95°C	68°C
Chilled water	14°C	15°C	6- 20°C	15°C
Cooling water	27°C	27°C	22- 37°C	27°C
COP	0,52	0,6	0,6	0,52
Power rates	18 kW	10 kW	8/ 25 kW	> 110 kW
Manufacturers	Invensor (Germany)	Invensor (Germany)	Sortech (Germany), SolarNext (Germany)	Mayekawa (Japan)

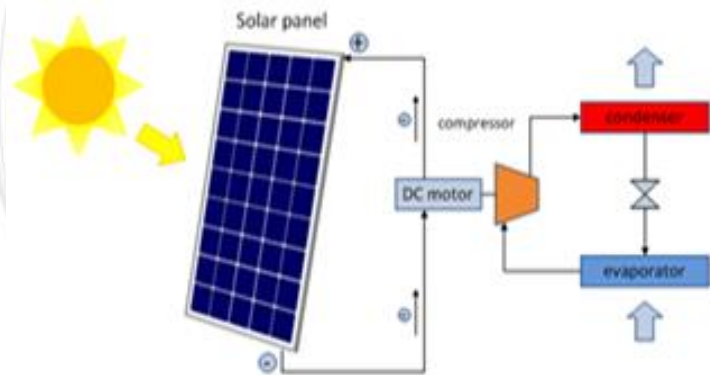
Three main temperature parameters for the chillers: heat, cooling water and chilled water

Open systems do not keep the refrigerant in the system:

- Use water as the refrigerant in direct contact with air
- Use a solid rotating wheel for continuous removal of the moisture from air thus the name “Desiccative Evaporative Cooling” (DEC)
- Common desiccants are solid like silica gel or lithium chloride



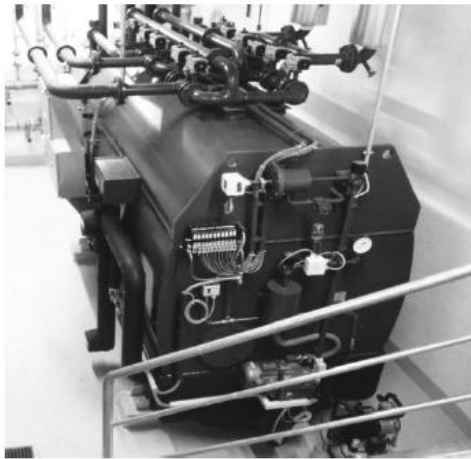
EXAMPLE OF OPEN SOLAR THERMAL COOLING SYSTEM



SOLAR PV BASED COOLING SYSTEM

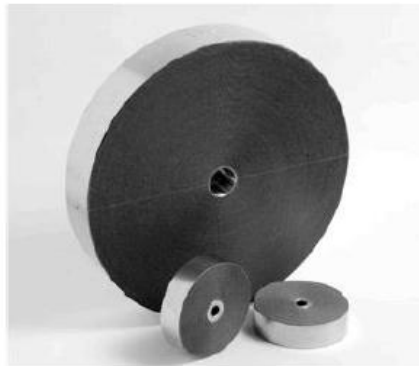
Technology	Fixed sorption	Liquid sorption
Refrigerant/sorbent	Water/silica gel Water/lithium chloride (in a cellulose matrix)	Water/calcium chloride Water/lithium chloride
Power rates	20-350 kW	> 5 kW
COP	0.5 - > 1	> 1
Flow rates	> 5000 m ³ /h	> 1000 m ³ /h
Heat temperature	50-95°C	50 - 70°C
Manufacturers	Klingenburg (Germany), Munters (Sweden), Robathem (Germany), Siegle & Eppler (Germany)	Menerga (Germany), Kathabar (USA), Ficom (Australia), LDCS Technology (Germany), Ail research (USA), AEX - American Energy Exchange (USA)

Solar cooling technologies



A
b
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Adsorption



Dessicant wheel



Absorption

Solar cooling technologies



Festo, Germany. Evacuated tubes, adsorption, 1050 kW.



CGD, Portugal. Large flat plates, absorption, 545 kW.



Inditex, Spain. Flat plates, absorption, 150 kW.



UWC, Singapore. Large flat plates, absorption, 1575 kW.

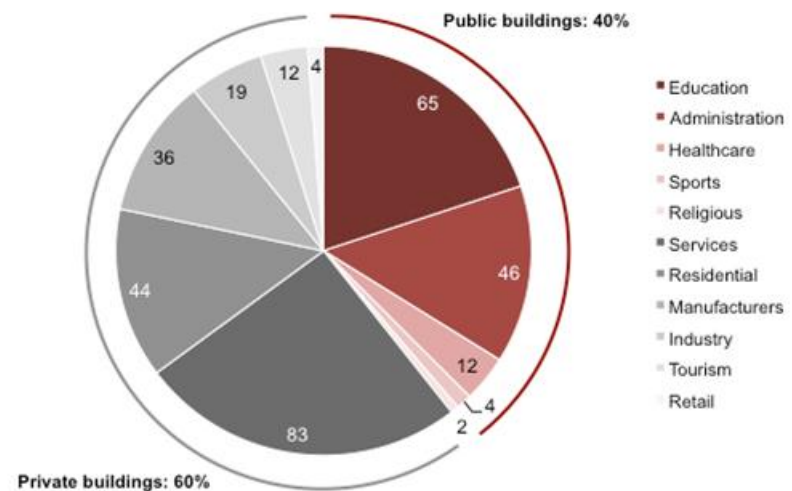
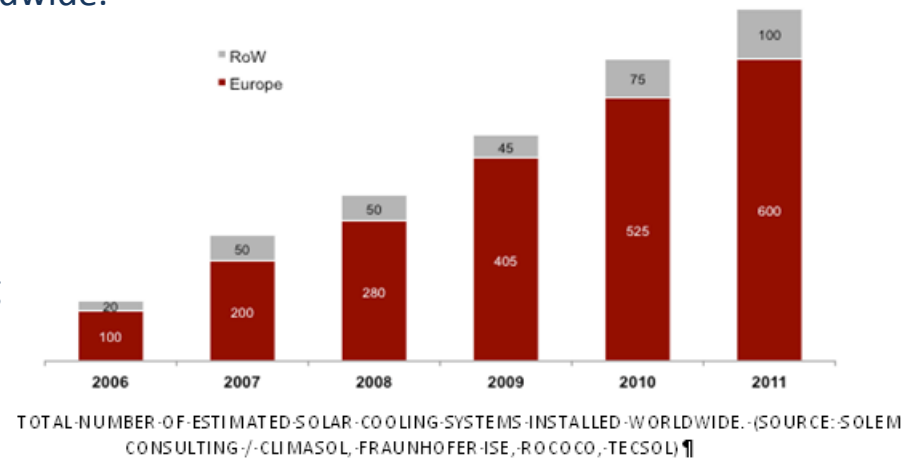


Stadium, Qatar. Linear Fresnel, absorption 2-effect, 750 kW.

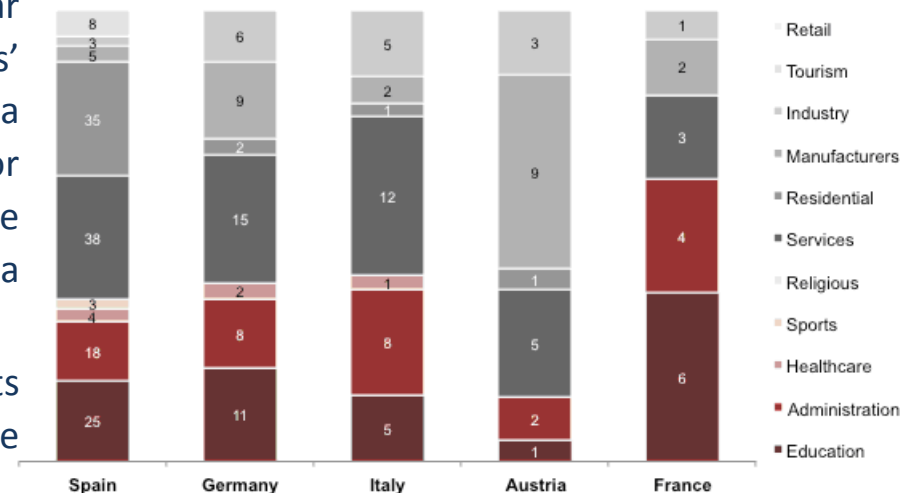


Ökopark Hartberg, Austria. Flat plates, dessication, 30 kW.

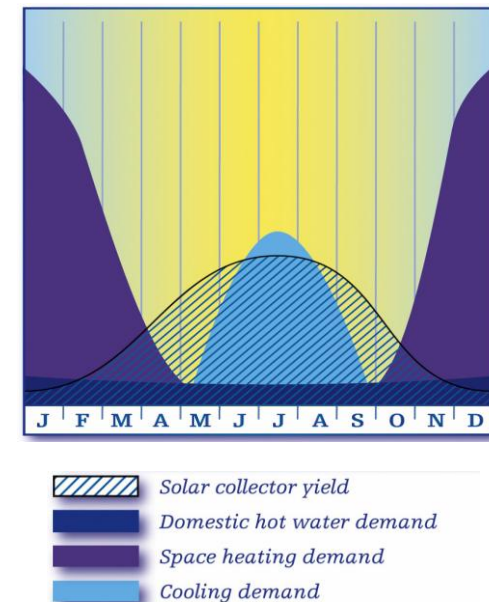
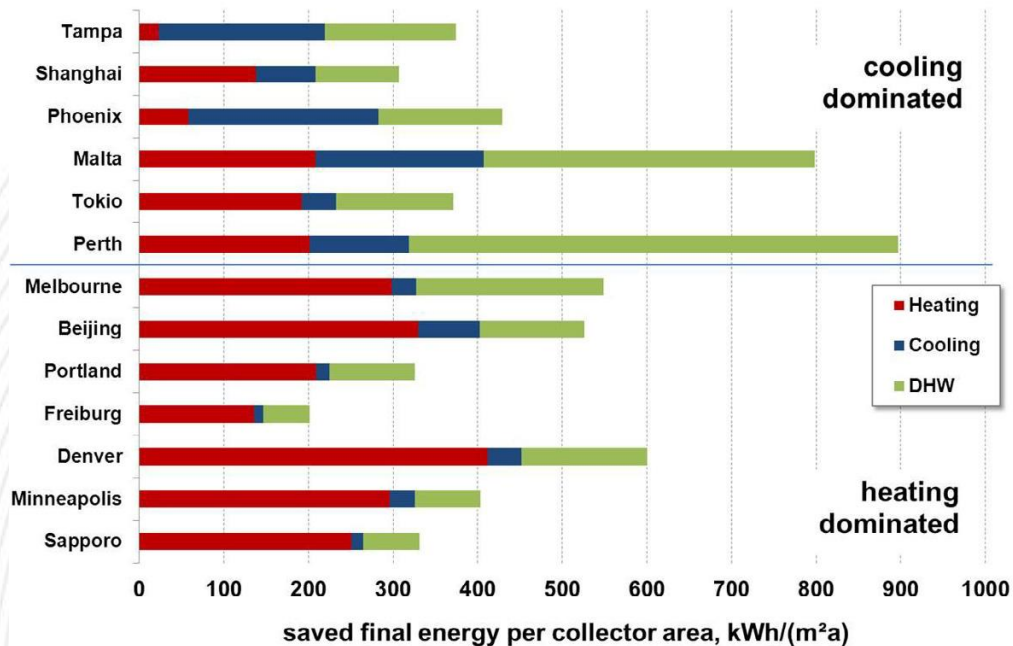
- Around 327 known solar thermal cooling systems are installed in 32 countries around the world with more than 90% being installed in Europe and 80% in: Spain (139 systems), Germany (53), Italy (34), Austria (21) and France (16). A total of 700 is believed to be installed worldwide.
- Public buildings represent approx 40% of the total. About 50% of these were made on schools, universities and others linked to educational activities.
- Over 10% of the total (36) were installed on the premises of manufacturers/providers of solar cooling products and services to develop and showcase the systems. Majority of the remaining private systems were installed in services buildings and private residences.



- The **Austrian** market is composed mainly by installations on the manufacturers' premises, while **France** has a higher incidence of installations in public buildings, particularly education. The remaining markets show more balanced deployments, where **Spain** is arguably the most relevant benchmark, with a substantial number of systems both on public and private buildings, with the latter accounting for 60% of the total.
- Solar irradiation has surely played a role on **Spain's** solar cooling market development by reducing the systems' payback period. The approved IDAE (Instituto para la Diversificación y Ahorro de la Energía) subventions for the 2005-2010 period were also key, as suggested by the fact that the 2008 reduction in subventions resulted in a slowdown of new systems.
- The development of the **German and Austrian** markets suggests that different thermal applications require tailored policy frameworks.
- Almost all systems were installed based on up-front direct incentives (up to 37% or more of the system cost, with a cap). The exceptional cases exist and are mostly the result of Corporate Social Responsibility (CSR) practices, with a notable example from Metro Properties. A single example uses an ESCO model.
- The **United Kingdom** launched in March 2011 the **Renewable Heat Incentive (RHI)**, which seeks to increase the share of renewable heat from 1% to 12% of total heat generation by 2020
- The **Dutch 2011 Renewable Energy Stimulating (SDE+)** scheme introduced price competition by awarding renewable energy feed-in premium from the same budget including solar thermal heat since 2012.



- Solar cooling in Europe has a seasonal usage and it was envisaged to cover the surplus heat generated by large solar fields designed to provide space heat in winter. The typical pattern in Europe being more or less pronounced in winter and summer according to the different regions in Europe is shown below as well as a comparison of a hotel in several locations with different climates.



- Solar collector area in the range of about 3m²/kW of cold and 10m² per 1000 m³/h of air volume flow in desiccant systems. Primary energy savings potential is in the range of 30–60%. The cost analysis of systems indicates a pay-back period of 6 years (best locations with high solar irradiation) to over 20 years and is based on the prevalent local energy prices.

Lessons learned

- Thailand must adopt/develop a **handbook** for Solar thermal cooling design and installation (SHC task 25).
- **“Making cold from heat seems to be a magical technology that appeals to many end-users”** (SHC task 38)
- Following the European experience **the early phase of market deployment** should take into consideration:
 - Gathering experience on a broad scale and analyzing and **documenting best practices** is critical in order to **identify best solutions** and **develop solid guidelines** and **technical standards**.
 - A high **visibility of good references** is important in order to **raise the awareness** of the technology.
 - **Demonstration installations** with a **reduced financial risk** due to financial support are needed to allow for the increased effort for design, planning, and installation in an early market implementation status.
 - **Demonstration installations** are an opportunity for all involved **professionals to learn about the technology and their specific requirements and potentials and limits**.
- Thailand should **identify the consumers paying the highest prices for cooling** and that **have also heating needs (including hot water)** to be the first candidates to have solar thermal cooling systems. A **priority** should be given to those **consumers that have already thermal chillers installed**.
- **No major breakthroughs are expected** and the **target is cost reduction** since that has been identified as crucial (ROCOCO). **Offer without demand is not sustainable and demand has to exist** in order for prices and technologies to improve. The **current state of the art is good enough for deployment** and **cost reduction will follow naturally**. The example with PV in the last decade is an example for us all.

SOLCO project (2007 – 2009)

Barriers	Remedial actions
<u>Awareness and know-how</u> - Lack of awareness in potential users (hotels, hospitals, and others) - Most of the technical actors are not familiar with Solar Cooling technologies - Most engineers are not completely educated in this technology; -Lack of packaged solutions - Installation and O&M need specific knowhow;	<u>Information – dissemination</u> -Develop a strong campaign of the solar cooling technology to create broad awareness - Develop guidelines and training courses for solar cooling
<u>Demonstration:</u> - A rather limited number of systems is in operation worldwide and only a few of them are monitored	<u>Demonstration</u> -Real data about the performance of monitored plants is absolutely crucial.
<u>Cost</u> - High investment cost limitations - Currently Sorption technologies are, still, more expensive in comparison to conventional chillers; - The use of sorption chillers requires in most cases the existence of wet cooling towers - maintenance is more expensive and most users prefer to avoid them	<u>Cost:</u> -Existing installations show a high cost reduction <u>Quality, O&M</u> -Improvement of performance (increasing the COP in chillers and the efficiency of solar collectors) - Standardisation and proven operation and maintenance concepts are necessary;

SOLCO project (2007 – 2009)

Barriers	Remedial actions
<u>Market availability</u> - Although there is an important increase in the size of this market, it is still limited	<u>Training</u> - Specific training courses for professionals (installers) and inclusion of solar cooling technologies into standard education for engineers is a must; development of advanced modeling and simulation tools for designers and installers is also absolutely necessary;
<u>Policy and incentives</u> - Tax exemptions and other financial incentives for solar thermal systems are limited and clearly not sufficient to promote the technology; - A roadmap for solar-assisted cooling systems is missing; these installations are often forgotten in current financial incentive schemes for solar thermal plants.	<u>Policy</u> - Introduction of legislation that requires to keep statistics on energy demand for cooling purposes; - Inclusion of solar cooling into financial incentive schemes and subsidies for solar thermal - Subsidies to support the implementation of solar cooling technologies to ensure their effective penetration into the cooling market; - Establishment of an accreditation process based on specific training together with a good track record of successful installations and client references.

- The cost of the systems is a main issue and perceived as being one of the hardest barriers to remove. Prices for total systems range from 2000 € to 5000 € per kWcold and may be even higher in some particular cases. This large range is due to different sizes of systems and technologies.

- Under promising conditions even payback times of ten years and less can be obtained, however for a payback time of five years or less only under very special conditions requiring a high price of the conventional energy used (example: electricity)“

Concept	unit	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Solar cooling capacity	kW	70	105	133	164	214	263	329	462
Solar collector surface	m2	210	315	400	493	642	789	987	1 386
Investment solar cooling plant	€	362 089	463 136	531 062	612 962	727 269	835 605	994 003	1 268 039
Relative increase in solar cooling plant	%	311%	362%	417%	436%	511%	568%	591%	745%
Specific costs (solar collector)	€/m2(sc)	1 724	1 470	1 328	1 243	1 133	1 059	1 007	915
Specific costs (building surface)	€/m2(bui)	113	145	166	191	227	261	310	396
Specific costs (solar cooling-capacity)	€/kW	5 173	4 411	3 983	3 730	3 398	3 177	3 021	2 745

- The situation of Solar cooling in Thailand versus Europe is exemplified on the right with a simple roadmap showing major milestones according to the global practices and based on the results of the European market and of major Programs to support the development of Solar cooling

Roadmap Milestones

	Roadmap Milestones	Thai	EU
Awareness	Demonstration plants	✓	✓
	Monitoring of demonstration plants		✓
	Guidelines for installation		✓
	Feasibility/Sector Market Assessment		✓
	Standard for solar cooling		
	Dedicated solar cooling policy with incentives		✓
	Pilot projects with monitoring		✓
	Open market		✓
	Removal of incentives		
	National players		✓

ขอบคุณครับ

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Thank You...