

Task 38 - Solar Air-Conditioning and Refrigeration Workshop

SOLAR COOLING ECONOMICS



Orlando – 27/01/2010

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www.tecsol.fr

Overview

Introduction

Market analysis

Market actors

Systems costs

Politics : incentives & lobbying

Cost Reduction potentials

Conclusion

Just for fun..

Look at that :

35,000 HVAC/R professionals



+

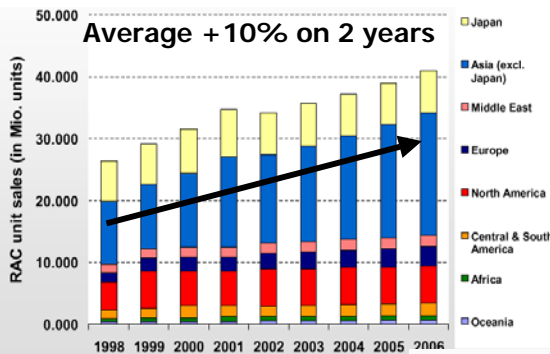


7.7 million ft² free place on the roof for solar !!!

What a huge potential for SOLAR HEATING+COOLING !!



Solar A/C workshop - AHR Expo - 27/01/2010



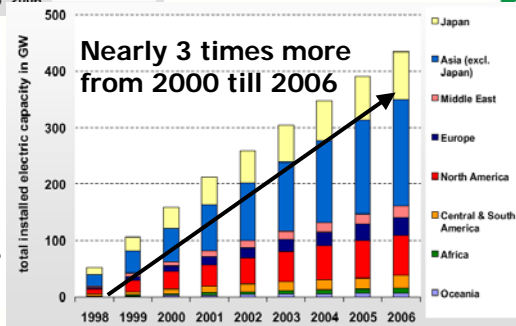
Introduction

← Air conditioning world market

↓ Power consumption increase

IMPORTANT CORRELATION :

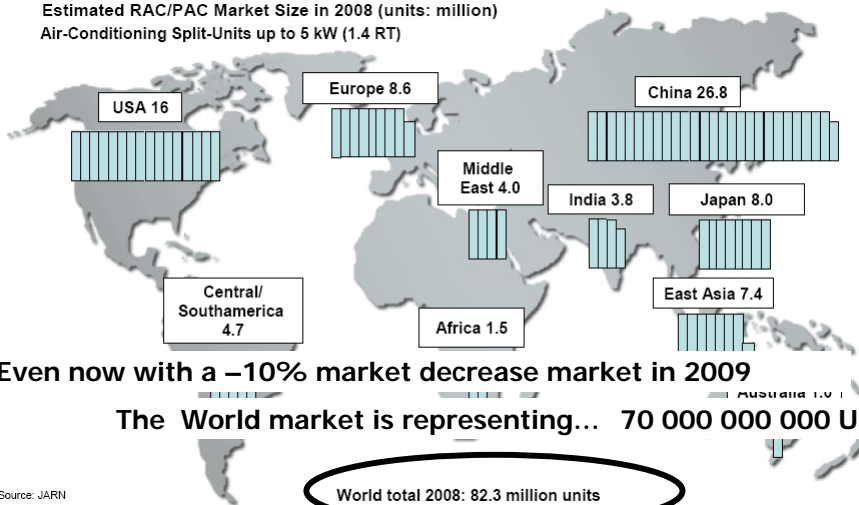
Example : 30 to 40% Summer power consumption in some Southern Chinese big towns due to AC/R devices



Solar A/C workshop - AHR Expo - 27/01/2010

Introduction

Estimated RAC/PAC Market Size in 2008 (units: million)
Air-Conditioning Split-Units up to 5 kW (1.4 RT)



Even now with a -10% market decrease market in 2009

The World market is representing... 70 000 000 000 US\$

Source: JARN

Source: Uli Jakob, SOLARNEXT 2009

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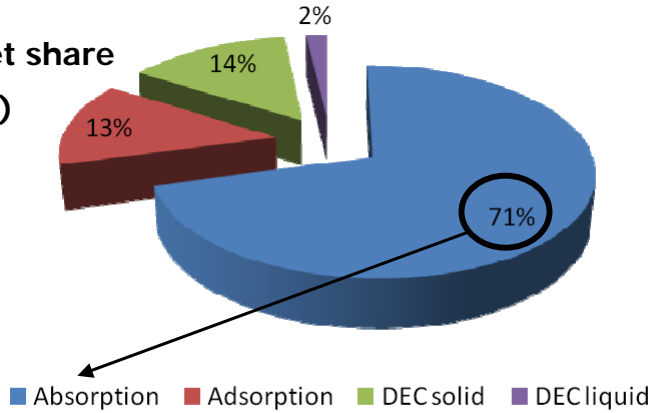
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Market share
(2009)



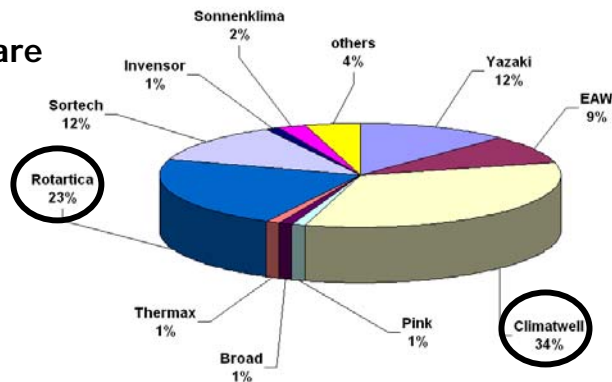
- Percentage of use of different technologies for thermally driven chillers within 113 large scale systems.

Ab/Adsorption representing nearly 85%...

Source : EURAC, Sparber & Napolitano, 2009

Market analysis

Market share
(volume)

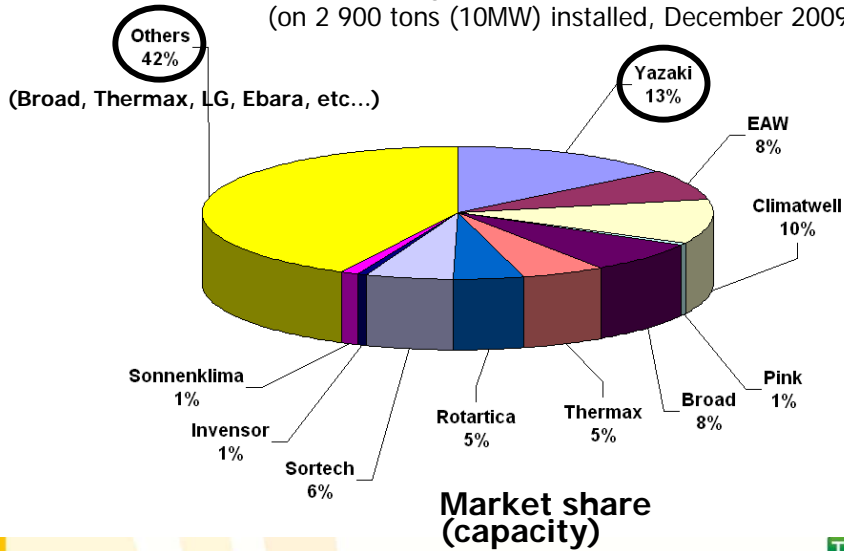


Solar cooling sorption chiller « market » share
(on 450 installations, December 2009)

Source : IEA Task 38, Sparber & Mugnier, data estimations 2009

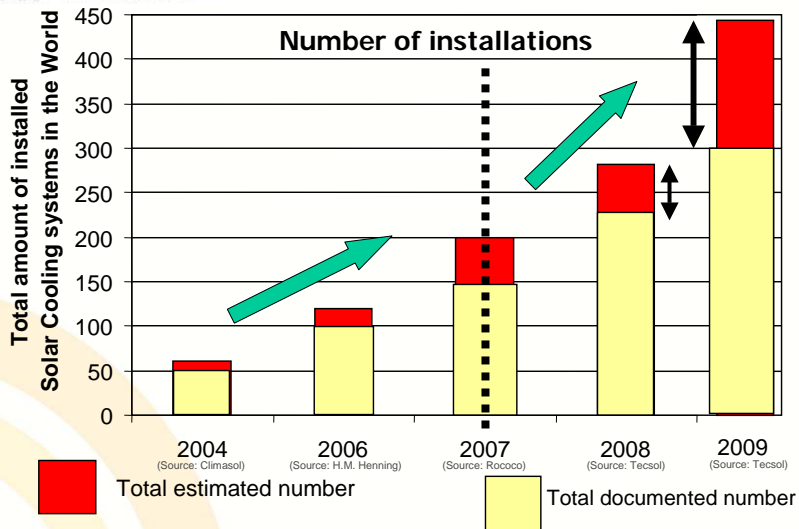
Market analysis

Solar cooling sorption chiller « market » share
(on 2 900 tons (10MW) installed, December 2009)



Source : IEA Task 38, Sparber & Mugnier, data 2009

Market analysis



Source : IEA Task 38, EURAC, Sparber & Mugnier, data 2009

About 100 new installations in 2009 ! (+50%)

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Europe: leader on small/medium chillers adapted to solar energy



~3.28 ft



SorTech AG
(2.5 tons)



ROBUR
caring for the environment

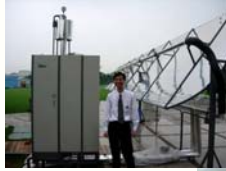


Only 1 company
present at AHR 2010 !!

Manufacturers out of Europe...



 BROAD AIR CONDITIONING
远大空调有限公司



Nishyodo (70-500 kW)

Maekawa (50-350 kW)

(Japan)



Thermax
(India)



YAZAKI (Japan)



SWAC-10 (China)
8.5 kW

上海交通大学
Shanghai Jiao Tong University



Dunham Bush

(Russia)

300 kW



Employment & turnovers on solar cooling (installation+R&D)

Employment :

* **Chiller manufacturers** (Europe) : 150 employees working at
80% for solar cooling => 120 people

* **R&D centers** : nearly 100 full time persons on the topic

Germany : FhG ISE, ILK, FH Stuttgart, Oldenburg

Austria : AIT, AEE Intec, TU Graz, ZAE Bayern

France : INES, CNRS

Italy : POLIMI, UNIFI, UNIPA

Spain : Univ. Madrid, ..

Portugal : INETI

Greece : CRES

Turnover :
(only installations)

nearly 50 MUS\$ since 2005 (40 M€)

about 15.5 MUS\$ in 2009 (12 M€)

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System costs : chillers

Some indicative costs for chillers

(for Europe, incl. transport+start up, 2009)

➤ Absorption

- 5-7 kW LiBr chiller : \approx 15 600 US\$ (12 000€)
 - 10 kW LiBr chiller : 32 000 US\$ (25 000 €)
- (including delivery, installation, control system and start up)
- 35 kW LiBr chiller : 32 000 US\$ (25 000€)
 - 105 kW LiBr chiller : 48 000 US\$ (40 000 €)

➤ Adsorption

- 70 kW : 78 000 US\$ (60 000€)
- 8 kW silicagel chiller : 13 000 US\$ (10 000 €)

Increasing market share : the Solar cooling kits

Small-scale
cooling
capacity range
up to 8.5 tons
(30 kW)

- Schüco International, Germany
- Sol-ution, Austria,
- SolarNext, Germany
- Gasokol, Austria
- Startec, Austria
- Sun Power Systems, France
- SOLBEO, France
- Kingspan/Thermomax, Ireland

Solar cooling kits generally include : solar thermal collectors, hot water storage, pump-set, chiller, re-cooler, cold water storage and system control



System costs : solar cooling kits

Specific costs of Solar cooling kits in Europe (*) :

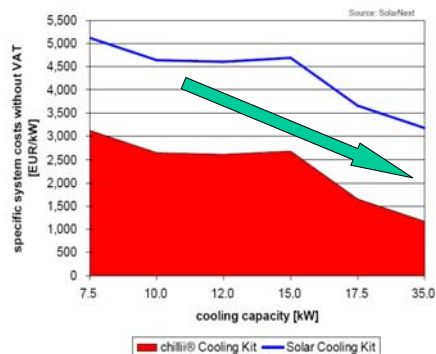
- 22 800 to 36 500 US\$/ton in 2007 (5 000 to 8 000 €/kW)
- 20 500 US\$/ton in 2008 (4 500 €/kW)
- future : 13 700 US\$/ton in 2012 (3 000 €/kW)

* Solar cooling kits generally include :

- solar thermal collectors,
- hot water storage,
- pump-set,
- chiller,
- re-cooler,
- cold water storage

system control.

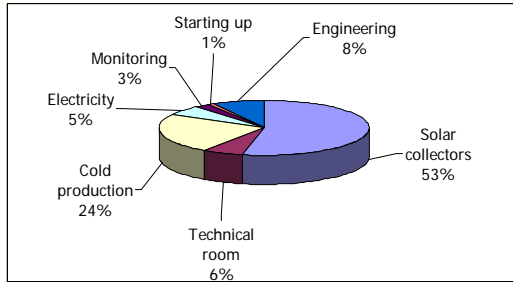
The specific costs are without cold distribution and installation costs.



System costs : example #1

Solar cooling installation – 10 tons abs. – France - 2009

	\$ (w/o tax)
Solar collectors	130 000
Technical room	15 080
Cold production	57 200
Electricity	13 000
Monitoring	6 500
Starting up	1 950
Engineering	19 500
TOTAL	243 230
	\$/ton 24 323



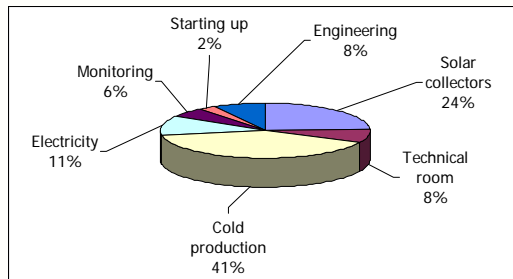
Source : TECSOL



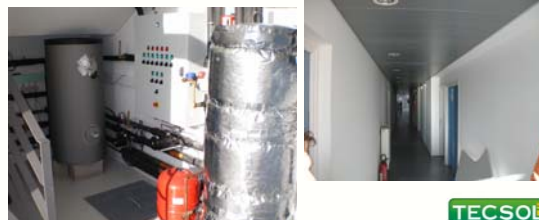
System costs : example #2

Solar cooling installation – 2 tons ads. – France - 2008

	\$ (w/o tax)
Solar collectors	19 500
Technical room	6 500
Cold production	32 500
Electricity	9 100
Monitoring	4 550
Starting up	1 950
Engineering	6 500
TOTAL	80 600
	\$/ton 40 300



Source : TECSOL



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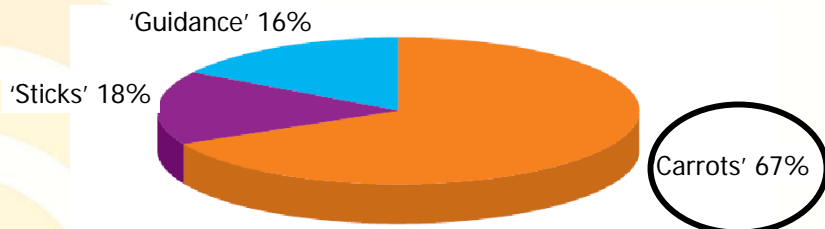
Incentive schemes for solar cooling

A famous trilogy (Vedung et al. , 1998) :

Carrot : financial incentive

~~**Stick** : rules, compulsory requirements~~

Guidance : information, training, marketing



12 countries of OECD with repartition of incentive schemes

Overview of some major incentive programs

Country	Grant level	Perf. Expect.	Requirements	Nb installations	Grant volume	Program duration
France	50 to 70%	145 MBTU/ft ² .y	Monitoring on 2 years Delayed payment CO ₂ Pelec >5	15 to 30	5.2 M\$	3 years (2010-2012)
Austria Niederösterreich	30%		Monitoring			
Italy Lombardia	40% to 50% max (FSCO's)		Monitoring GSR contract Delayed payment		9 M\$	
Italy Sicily	up to 80% (public build. only)	Min perf. (tep/keuro) (tCo ₂ /keuro)	Monitoring Innovative project		26 M\$ (incl. BIPV, hydro biomass)	1 year
Germany (BMU/DBU)	up to 50%	Strict selection: -quality -performances	Monitoring Innovative project > 1000 ft ² coll.	Limited		
Germany (MAP ; BAFA)	26\$/ft ²		<430 ft ² coll.			
India (Ausaid with Australia support) Australia NSW (Energy Saving Scheme)				2 installations	1 M\$	

Sources : **TECSOL, SOLEM, SUNDAY, SOLARNEXT, UNIPA**

Focus on the French Emergence program

- Wish of both French Government and Solar cooling professionals to build a High Quality Solar Heating and Cooling Demo Projects Incentive Scheme
- Based on Selection criteria and public fundings (invest+monitor.)
- Highly supported by ENERPLAN (Solar Professionnal Association)
- Audit of existing solar cooling installations (20 in France since 1990) ongoing
- Operational program starting in 2010 and for 2,5 years (June 2012)

Focus on the French Emergence program

Step 1 : efficient preselection tools : questionnaire + check list
Step 2 : study and final selection tool (~6500 US\$ granted at 50%)
Step 3 : investment grant attribution + follow up (monitoring)

- Open to systems with sorption chillers / DEC
- Products available on the French market (local distr. + O&M)
- Nominal solar cooling power range : 1.5 to 60 tons
- Reversible systems permitting to do Heating & Cooling (all year long valorisation)

No geographical limitations on the projects (balance between heating and cooling changing between areas)

Objective : 15 to 30 financed installations on 3 years
(3 to 6 installations in 2010 – 5 à 10/year afterwards)

Focus on the French Emergence program

Minimum annual performance level to reach

- Minimum solar yield : Estimated value (feasibility study) calculated from the useful solar thermal production for heating and for cooling :
- Heating : useful kWh out of the storage tank and without back up.
- Cooling : useful cooling kWh produced at evaporator divided by a ratio of 0,6 for absorption chillers and 0,4 on adsorption chillers (COP average value). Possibility to extend to double sorption chillers with value of 1.

Thermal useful energy (all over in France) : **145 MBTU/ft².year**

Focus on the French Emergence program

Minimum electric annual efficiency

- Calculated value of efficiency on a full year monitoring and equal to the ratio between useful solar energy kWh (thermal energy out of the solar tank in winter and out of the evaporator of the chiller in summer) + overall yearly electric consumption of the auxiliaries used in the solar system (except the distribution pump and the back ups).
- **Minimum electric overall efficiency of the system : 5**
(corresponding to an average yearly value for high efficiency actual heat pumps).
- Minimum value to reach in an average 2 full year monitoring campaigns (heating + cooling)
- Threshold value evolving during the Program duration and permitting to increase the installation productivity & quality + enhancing the important benefit of valorising the solar cooling installation in heating mode.



Focus on the French Emergence program

Budget frame

45 500 \$/TOE (≈ 0.06 \$/MBTU produced in 20 years operation)

Amount of incentive calculated on the total yearly useful energy

+ Separated financing agreement for the monitoring including:

- Monitoring material at 100% financing
- Monitoring work (compulsory during the 2 first years) with a *minima* **3 energy measurements** (heating, cooling and parasitic electric) + inform the client if dysfunctioning **within 1 week**

Grant level :

- Monitoring material, **100%** covered limited to **13 000 US\$** (can do both control and monitoring)
- Monitoring work, **50%** for the 2 first years limited to **19 500 US\$**



Focus on the French Emergence program

Example : a real case commissioned in September 2009

247 000 \$

Type of building: University office building				
Place : Bordeaux, France				
Solar collector area	963 ft ²	(90 m ²)	Investment (w/o tax)	247 650 USD (=190500€)
Nominal chiller capacity	10 tons	(35 kW)	Investment (with tax)	24 765 USD (=19500€)
Cold energy production (Summer)	51 724 MBTU	(15 000 kWh)	Investment per ft ² (w/o tax)	257 USD (=2117€/m ²)
Heating energy production (Winter)	68 966 MBTU	(20 000 kWh)		
Equivalent heating energy (Summer)	86 207 MBTU	(=15 000 kWh/0,6)		
TOTAL equivalent (useful heat) :	155 172 MBTU	(=3,9 TOE)		
Minimum production requirement (145 MBTU/ft ² .year) (450 kWh/m ² .year)	139 635 MBTU	(=3,5 TOE)		

Grant in USD/TOE :	45 500	(=35 000 €/TOE)	Emergence' grant level (% on invest.)	72%
Total Grant level due to Emergence Program	177 450 USD	(=135 430€)		
Investissement résiduel avec aide Emergence :	70 200 USD	(=55 000€)		
Net annual savings :	5 801 USD	(50% from cooling & 50% from heating)		
Net Payback time	12 years			
Temps de retour hors aide :	43 years			

Final investment for the customer : **70 200 US\$**

Net payback time ≈ 12 years

Payback time without grants ≈ 43 years

Hypothesis :

- Avoided cold energy Gas heat pump (COP=1.5) : 2 US\$/therm
- Avoided heat energy Gas heat network : 2 US\$/therm
- O&M : 1% invest./year
- Amortisation :
 - Gas heat pump replacement (39 000 US\$) on 10 years
 - Solar system replacement on 30 years



Task 38
Solar Air-Conditioning
and Refrigeration

Examples of complementary lobbying actions



VERBAND FÜR SORPTIONSKÄLTE E.V.

Green Chiller – Verband für Sorptionskälte e.V.

Formed in March 2009 as an association in **GERMANY**

(7 Companies, 2 Institutes)



ausSCIG
AUSTRALIAN SOLAR COOLING INTEREST GROUP
www.ausSCIG.org

ausSCIG : an Australian Industry Interest Group

to develop the Solar Cooling Industry in **AUSTRALIA**
(Residential and Commercial Building Sectors)



ENERPLAN : French Solar Association

Promoter in partnership with ADEME (French Energy Agency)
of the Emergence program in **FRANCE**



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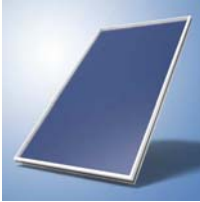
Cost Reduction potentials

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Cost Reduction Potential of Solar Cooling Kits

- **Solar Plant (Collectors and Storage):**
max. 10% Cost Reduction Potential in the next 2-3 years
- **Small-Scale Sorption Chillers:**
max. 20% Cost Reduction Potential till 2011, from 2011 up to 50% if Serial Production is started (Production Capacity larger than 500 Units)
- **Recooler:**
Cost Reduction Potential between 40-50%
- **Control:**
min. 60% Cost Reduction Potential, Increasing of the System Performance
- **Installation:**
10-30% Cost Reduction Potential through Standardized Solar Cooling Kits

How do reduce costs ?



Source : Schüco

Flat plate collectors + drainback

Compact packages solutions



Source : Climgazpro



Source : Broad

And above all...

Large scale production

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Conclusion

- Emerging technology with big potential... even if quite small market at the moment
- Large cost reduction perspectives (big investments + larger volumes required)
- From technology companies toward sales companies & powerful lobbies
- Important incentive programs in Europe to create a success story for solar cooling..

Thanks for your attention !
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