Large Solar Thermal Energy Systems for Cooling and Heating

SOLID
solarinstallation+design

IEA Committee on Energy Research and Technology

EXPERTS' GROUP ON R&D
PRIORITY-SETTING AND EVALUATION

Renewable energies overview

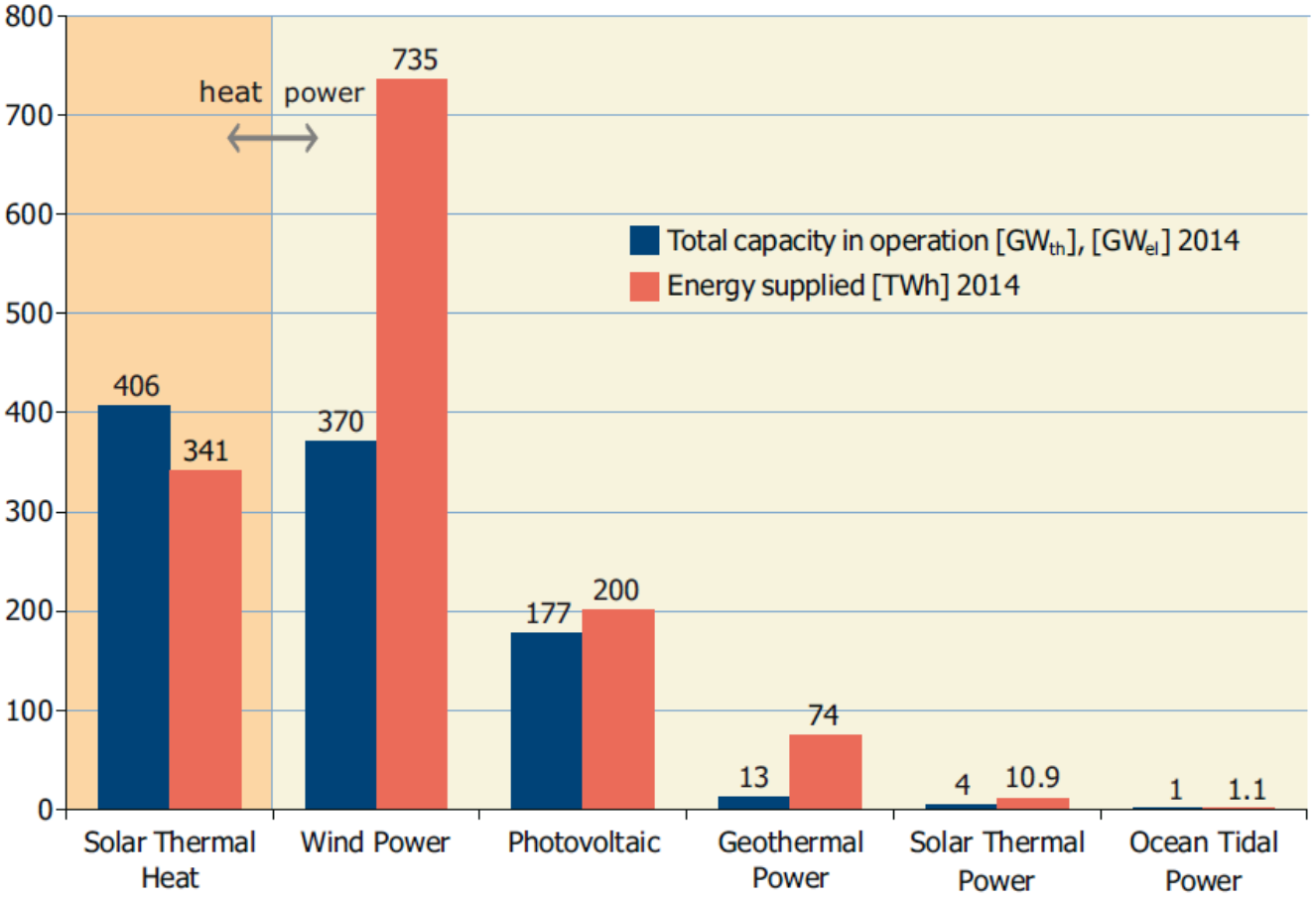

Figure 3: Global capacity in operation [GW_{el}], [GW_{th}] 2014 and annual energy yields [TWh_{el}], [TWh_{th}]
(Sources: AEE INTEC, Global Wind Energy Council (GWEC), European PV Industry Association (EPIA), REN21 - Global Status Reports 2014 and 2015)

Weiss/Mauthner 2015

Global Solar Potential

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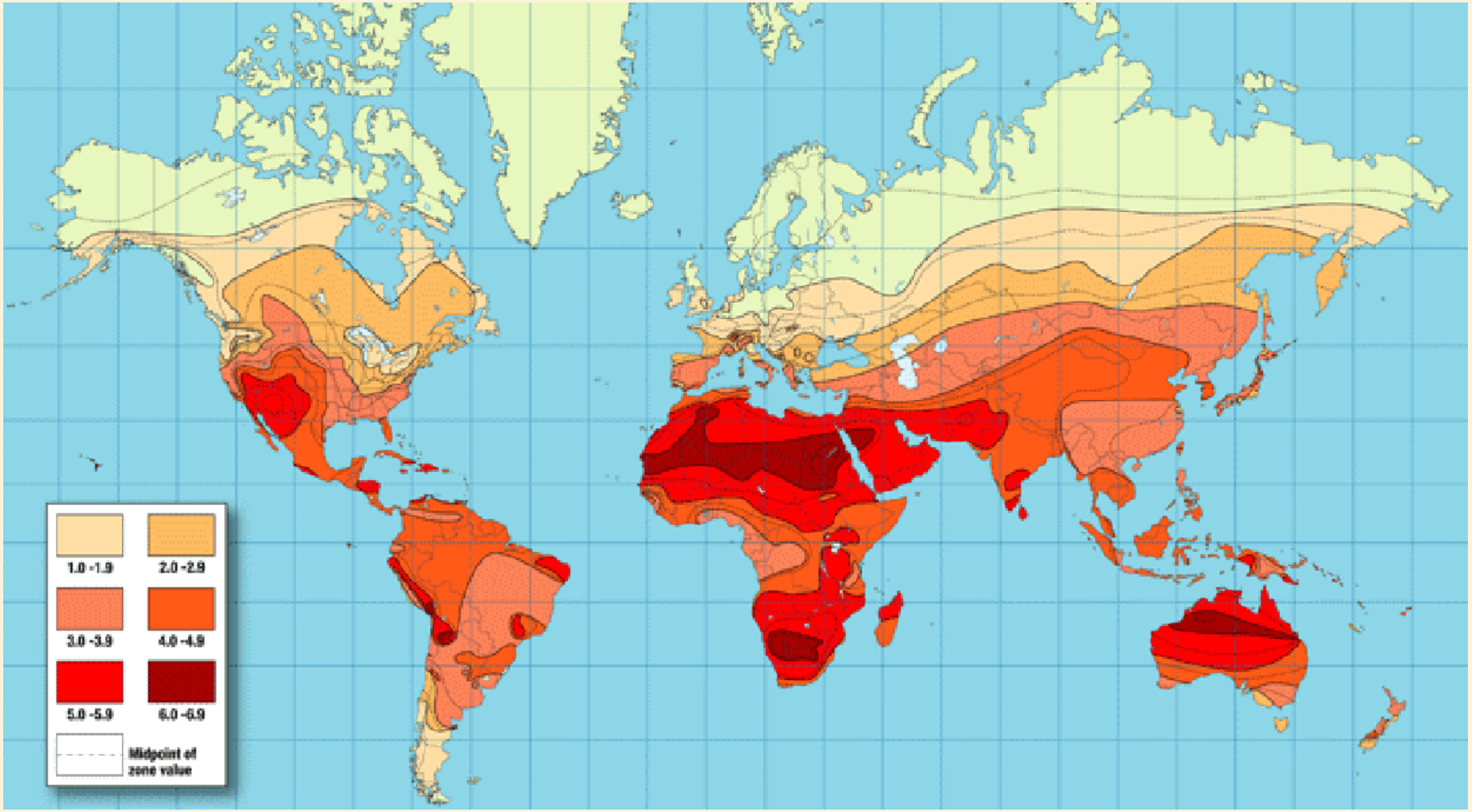


Who is SOLID ?

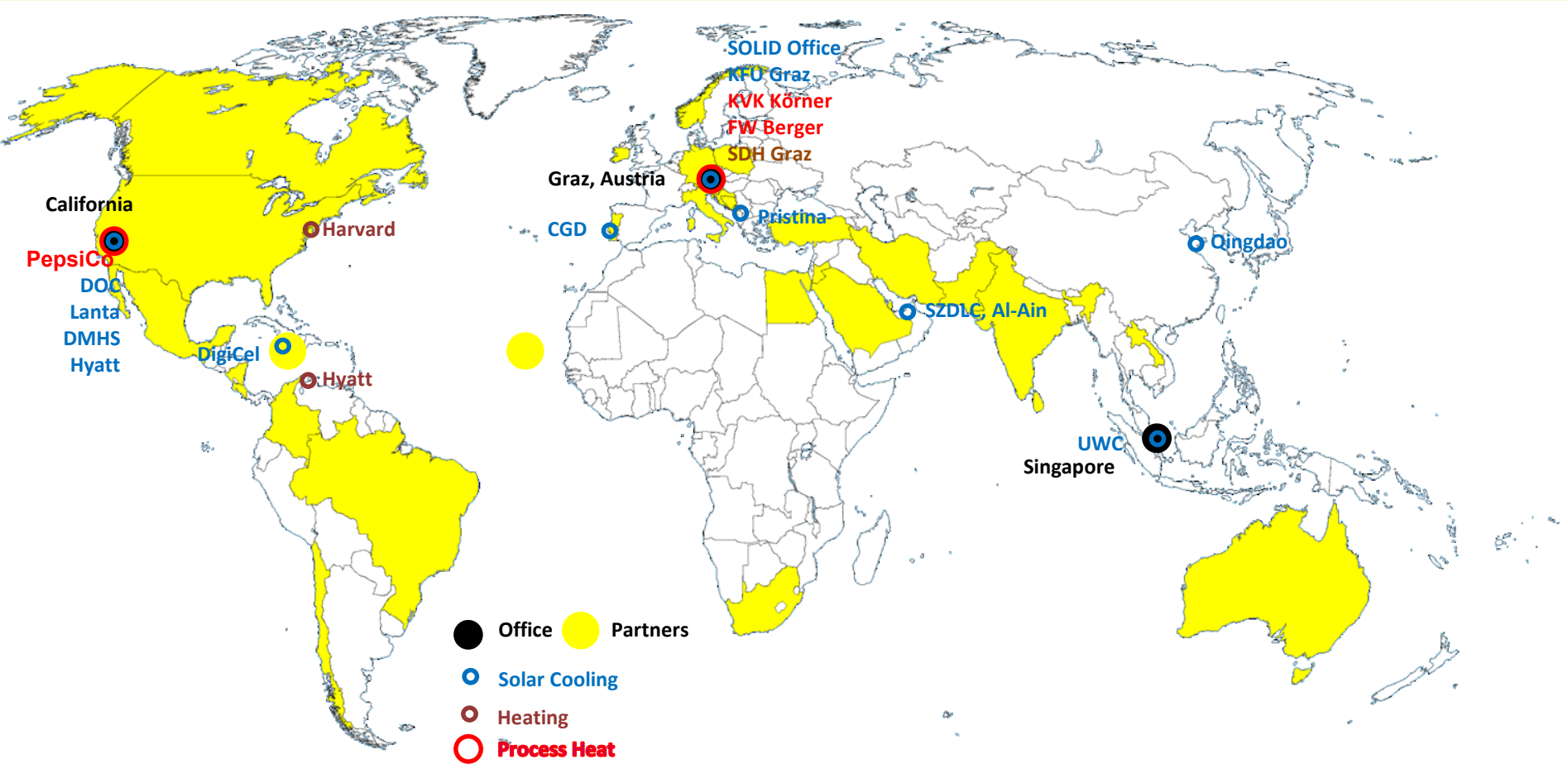
S.O.L.I.D. Group

Headquarter in Graz, Austria

Subsidiaries in USA & Singapore

Partners in many other countries

300 reference plants around the world



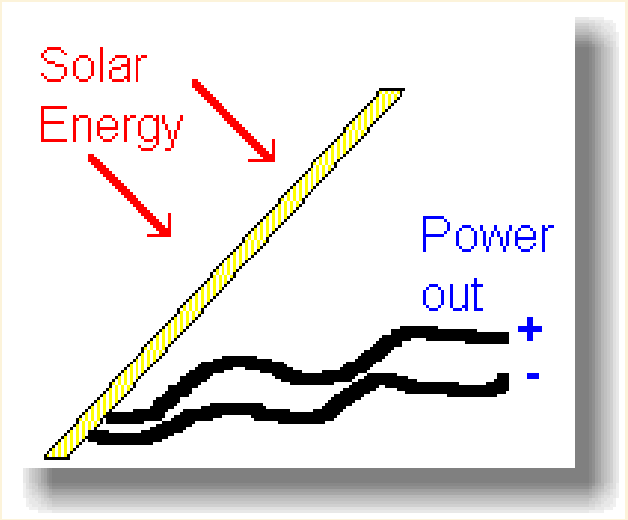
System Integration by S.O.L.I.D.

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

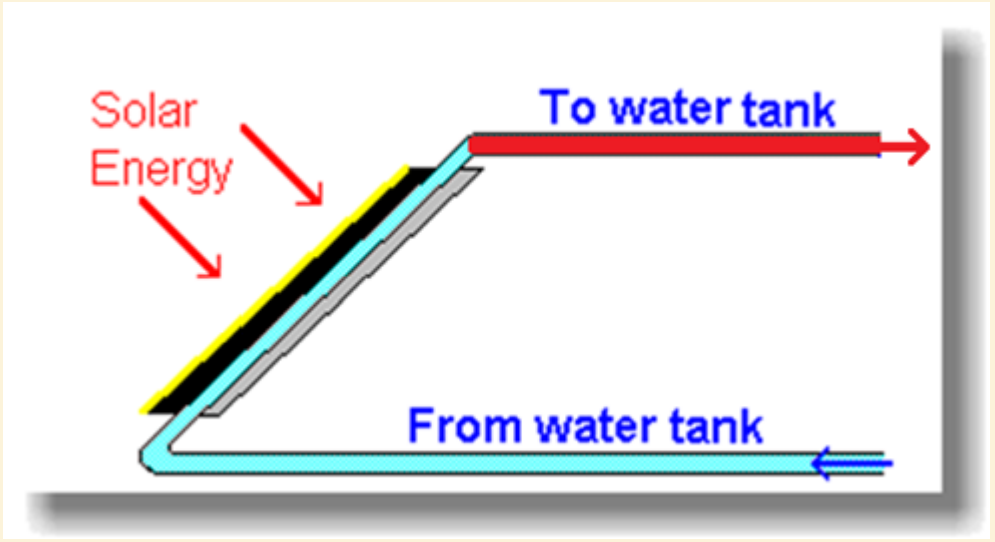
- Project development
- Design & engineering
- Construction
- Operation & maintenance
- Financing (ESCo)
- Research & Development

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

- Solar PV (Electricity)

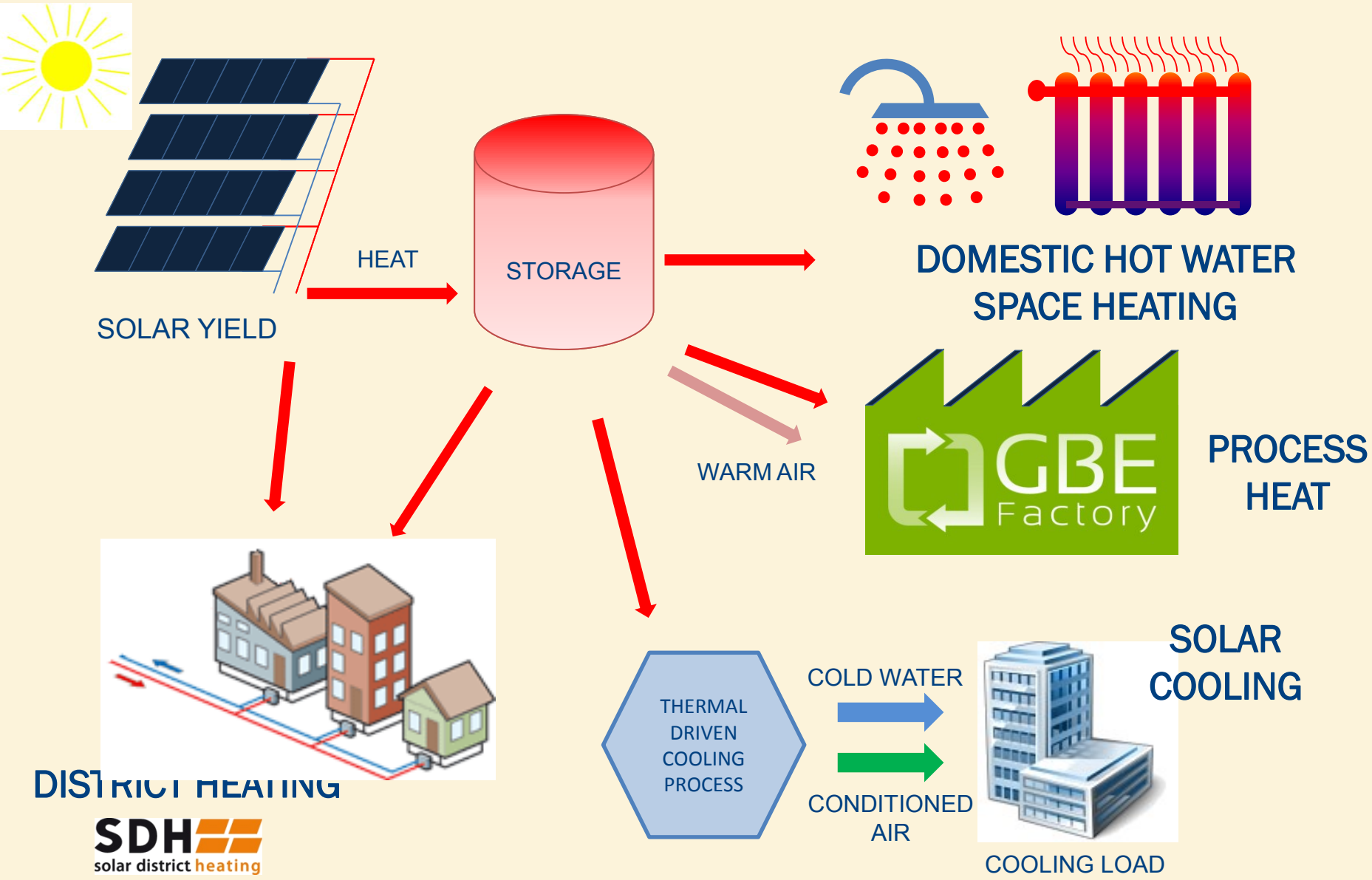


- Solar Heating (Heat)



Peak capacity 500 % higher
Annual energy harvest 300% higher

Technical solutions by SOLID



Large Scale
Solar Thermal today

Solar Thermal Collectors

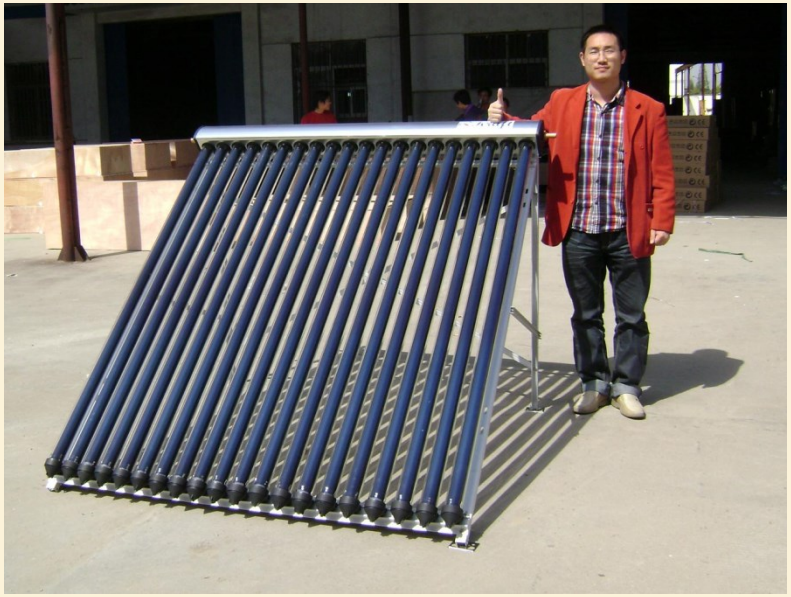
SOLID cooperates with the major collector producers in collector development and realization of projects.

The best is chosen case by case for each specific project site.

Collector field test at Fernheizwerk Graz, Austria: 2750 m², 5 different suppliers

Non - Concentrating Collectors

Vacuum Tube



Changzhou Yongre Solar

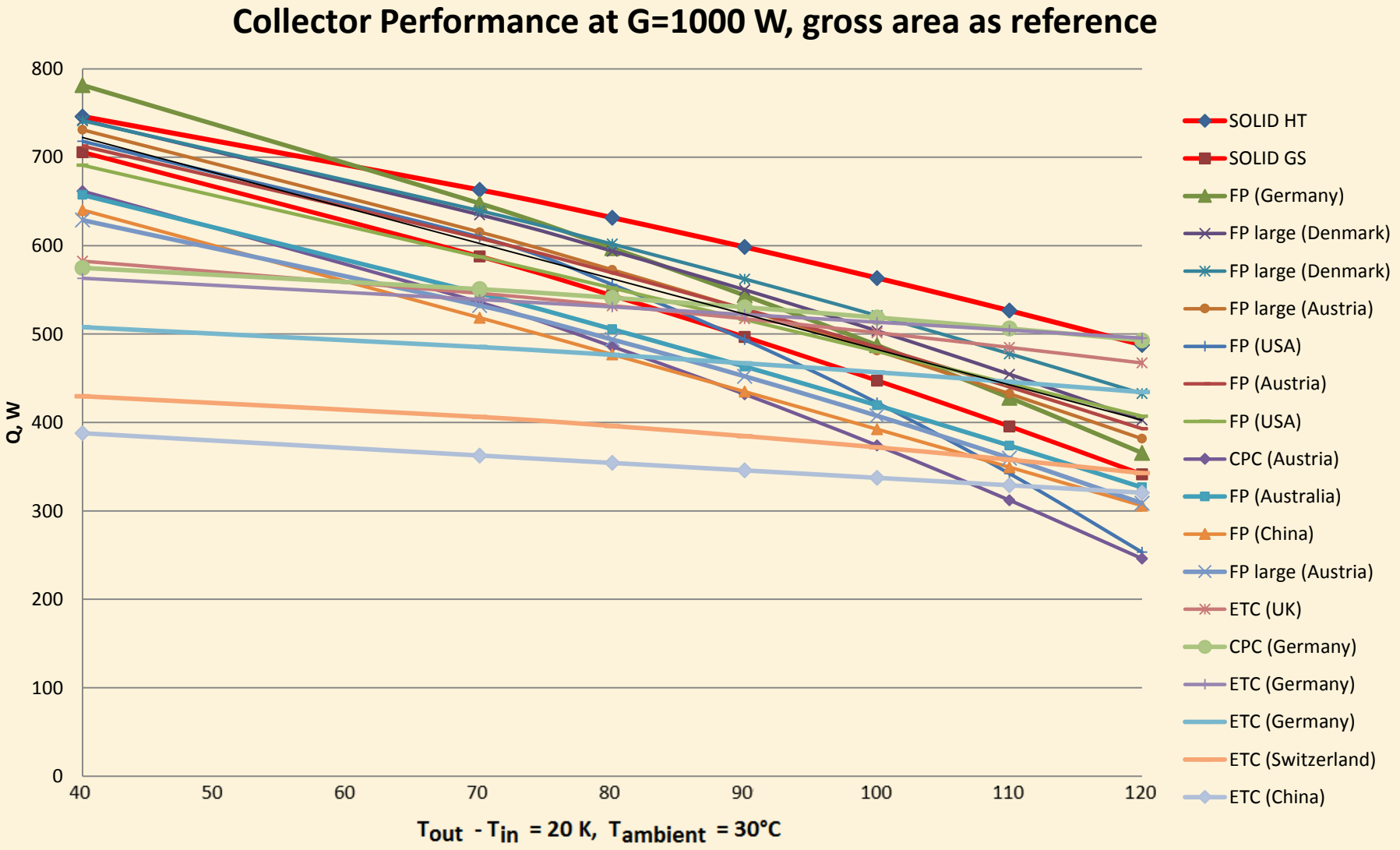
- Less absorber area
- Vacuum insulation
- Building integration difficult

Flat Plate

SOLID

- More absorber area
- Standard insulation
- Building/roof integration possible

Collector comparison

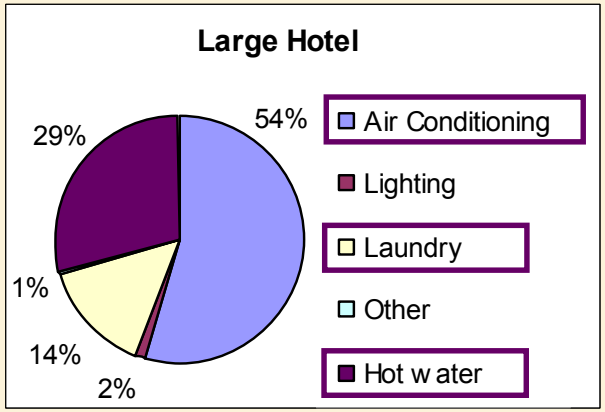


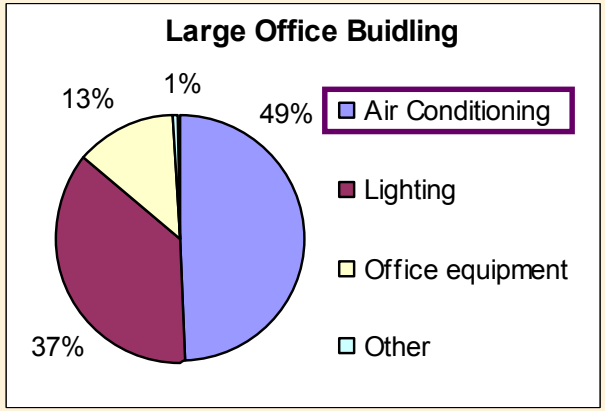
Solar Cooling

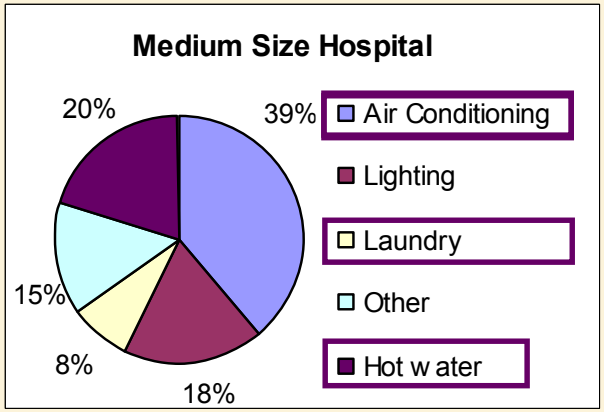
Why & How ?

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





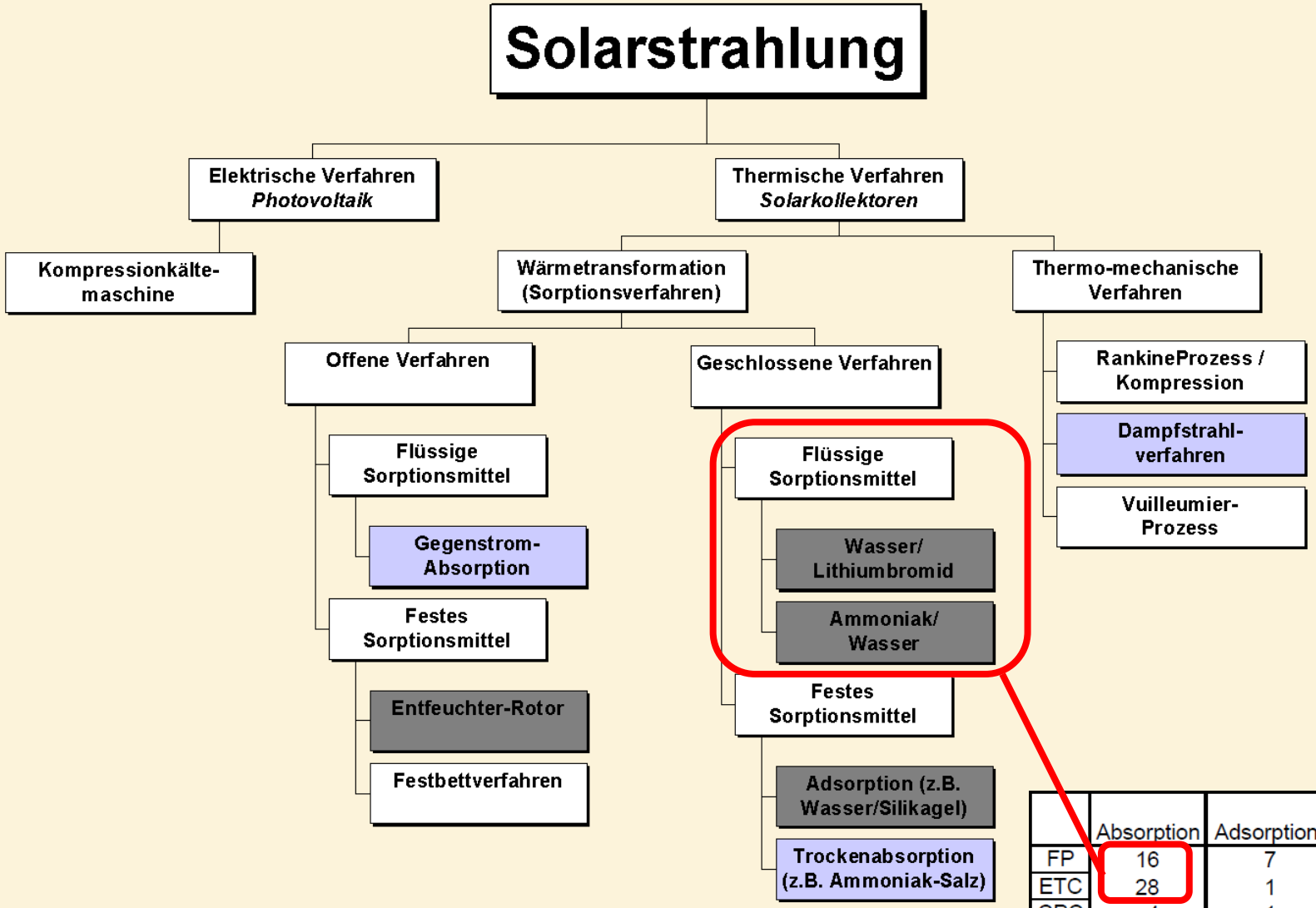


Solar Cooling – the advantage

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.
- Buildings profit from shading by collectors
- Avoids electricity peaks and extreme operations on the electric distribution grid.
- Solar Cooling saves the most expensive electricity
- Rich nations in desert climate use approx. 75% of all electricity production for Cooling !

Different Solar Cooling methods



	Absorption	Adsorption	DEC solid	DEC liquid
FP	16	7	3	2
ETC	28	1	0	0
CPC	4	1	3	0
AIR	0	0	3	0

http://www.iea-shc.org/publications/task.aspx?Task=38, 2011

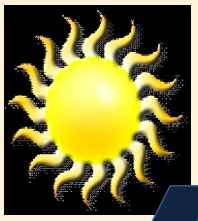
LiBr Absorption Chiller & LST

Nominal Temperature Levels and Power Requirement at external Interfaces

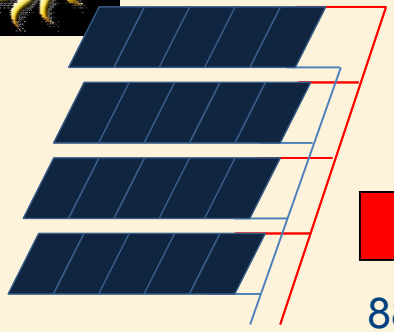
WASTE HEAT

30 - 35° C

Cooling Tower



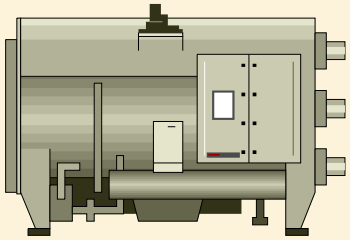
Solar Thermal Plant



SOLAR YIELD

HEAT

88-70 ° C



Li-Br Absorption Chiller

COLD

7-14 ° C

Consumption

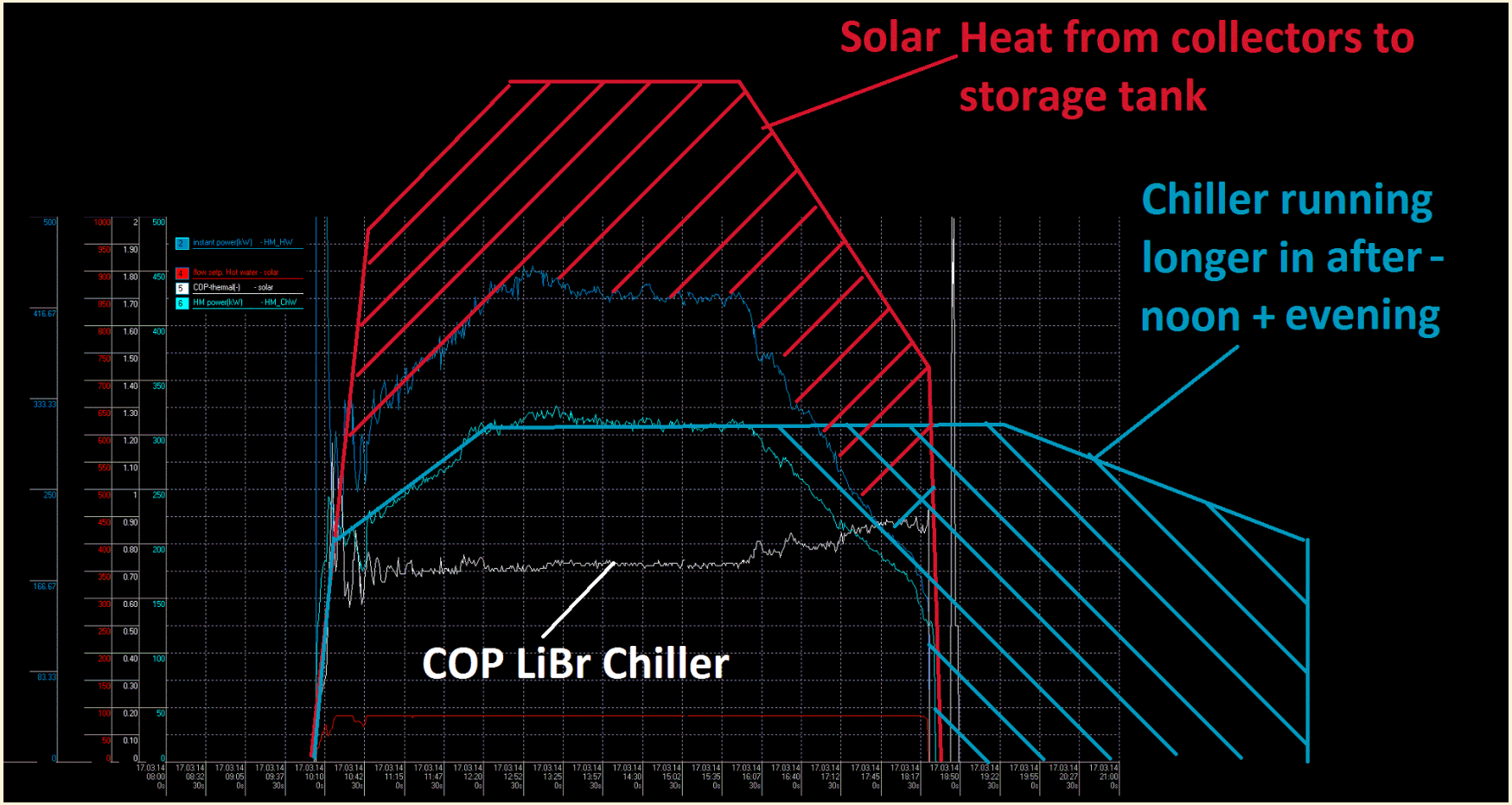
Solar supply per day

Original Graph Al Ain project:

Direct delivery of Solar Heat to Chiller (no storage)

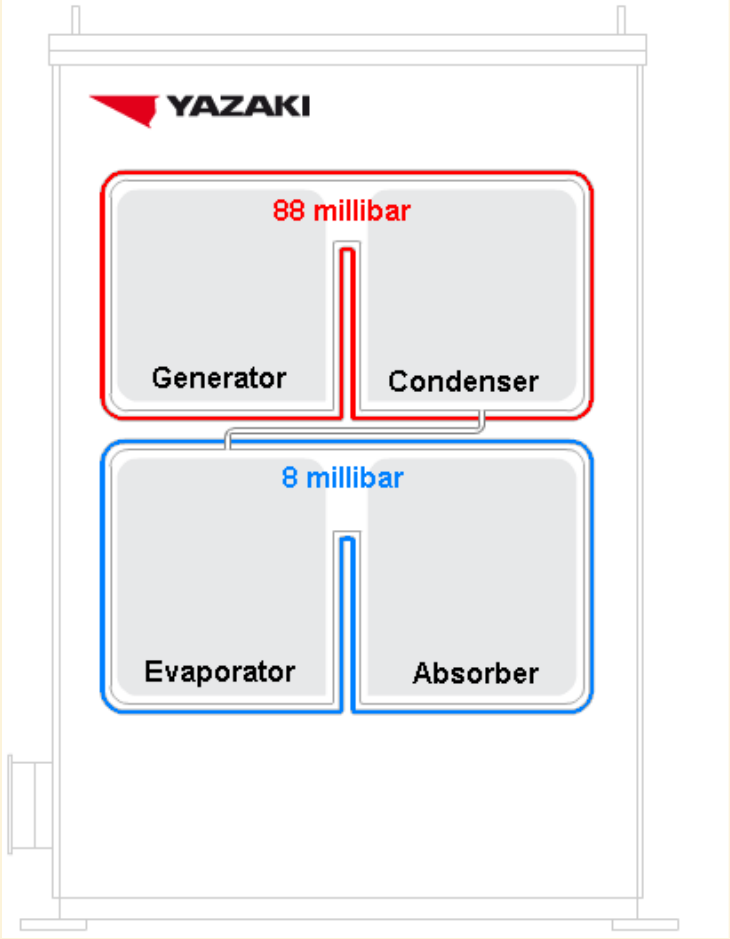
Manual sketch:

More collectors --- heat delivery to Chiller and Storage

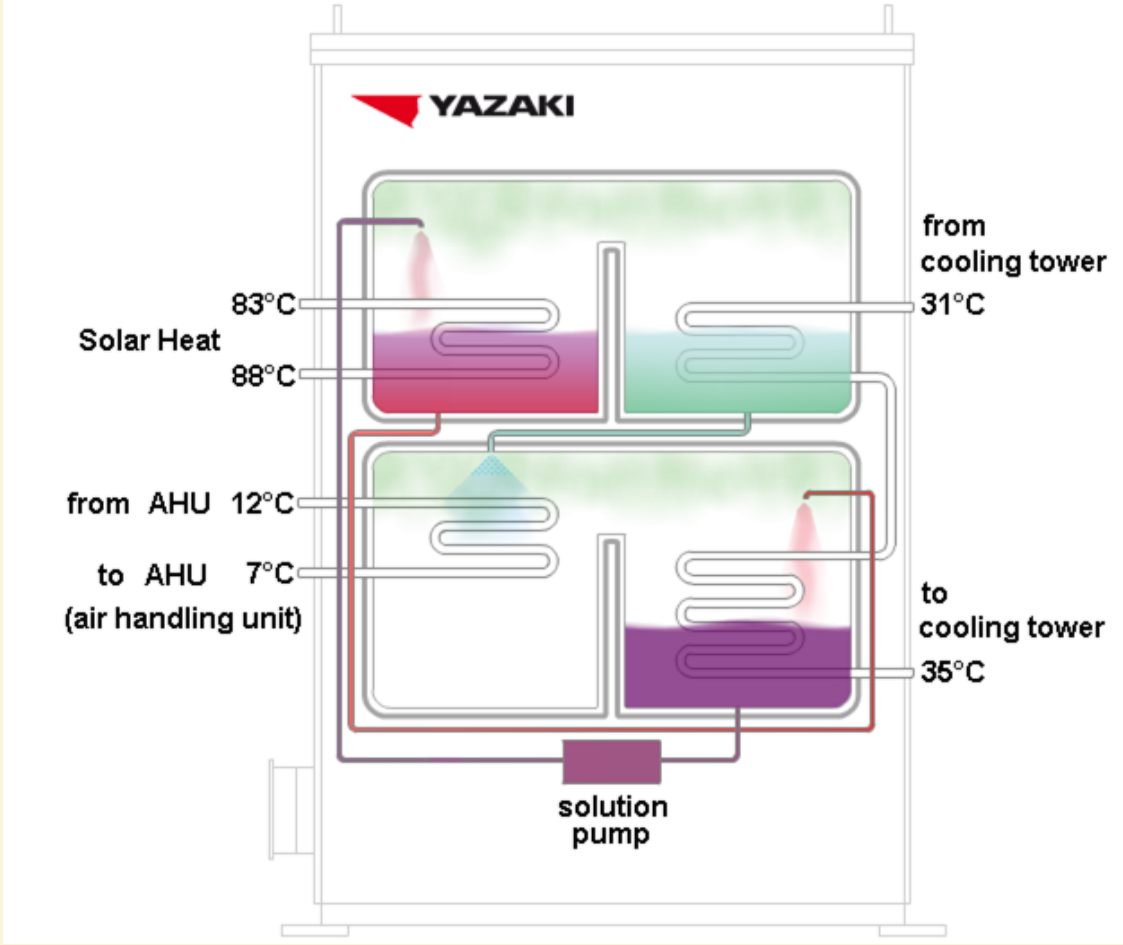


LiBr Absorption Chiller

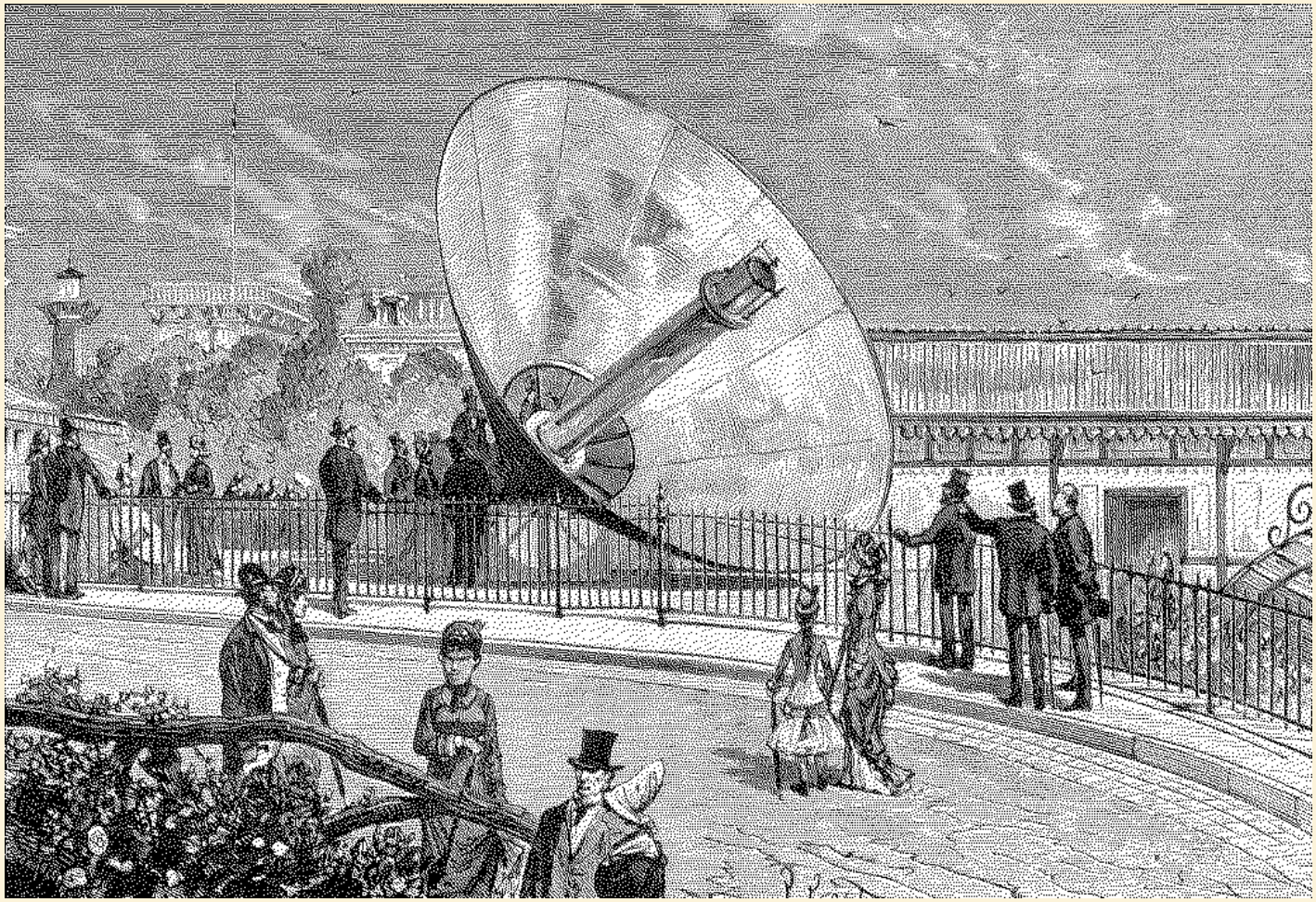
2 chambers at different pressure levels



Flows and temperatures



A brand new technology ?



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

Long lasting technology

Long lifetime of absorption chillers. No moving parts.
This one is > 75 years old !

Solar Cooling

SOLID Examples

Solar cooling references

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

EAR Tower Pristina, Kosovo

2 LiBr absorption machines, total capacity of 70 kW / 20 tons

Solar Panels: 226 m^2

4 m^3 storage tank

Operating since Feb. 2003

14^{th} operating season, 0% unforeseen down time

Sheik Zayed Desert Learning Center (UAE/Al Ain)

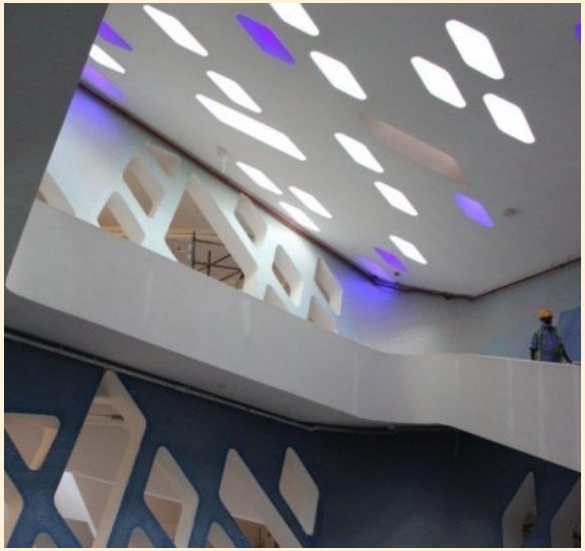
Solar Cooling via concrete core activation of a desert museum

Cooling power: 400 kW

Collector area: 1108 m^2

Expected Solar yield: 825 $kWh/m^2/year$

Commissioning: 2012



Sheik Zayed Desert Learning Center (UAE/Al Ain)

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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

World‘s most powerful Solar Cooling System until 2013

UWC Tampines, Singapore

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UWC Tampines, Singapore

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Desert Mountain High School, USA

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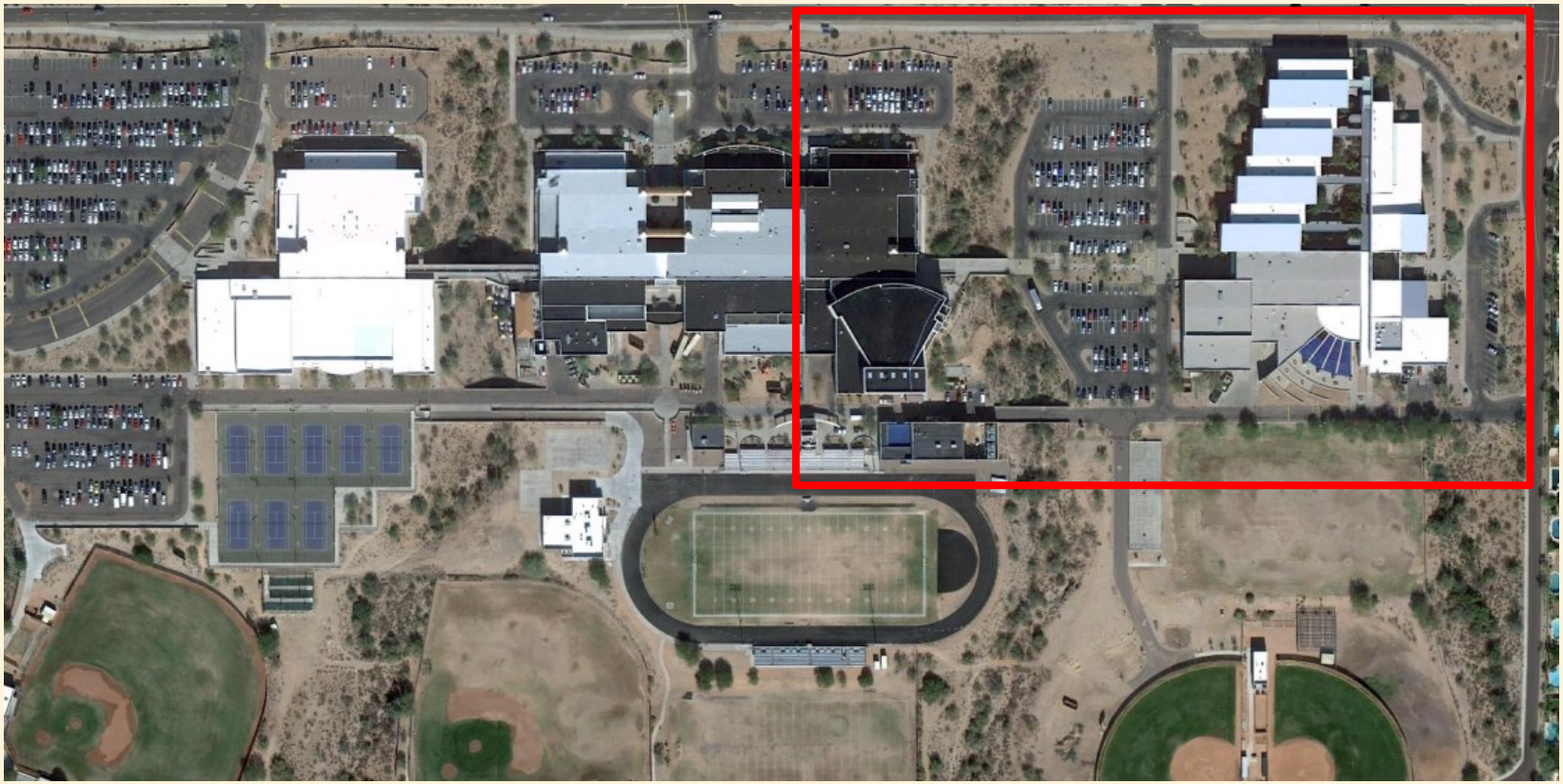
Scottsdale, Arizona, USA
Solar Cooling for Middle School and High school

20% larger than SOLID's Singapore project



Desert Mountain High School, USA

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Desert Mountain High School, USA

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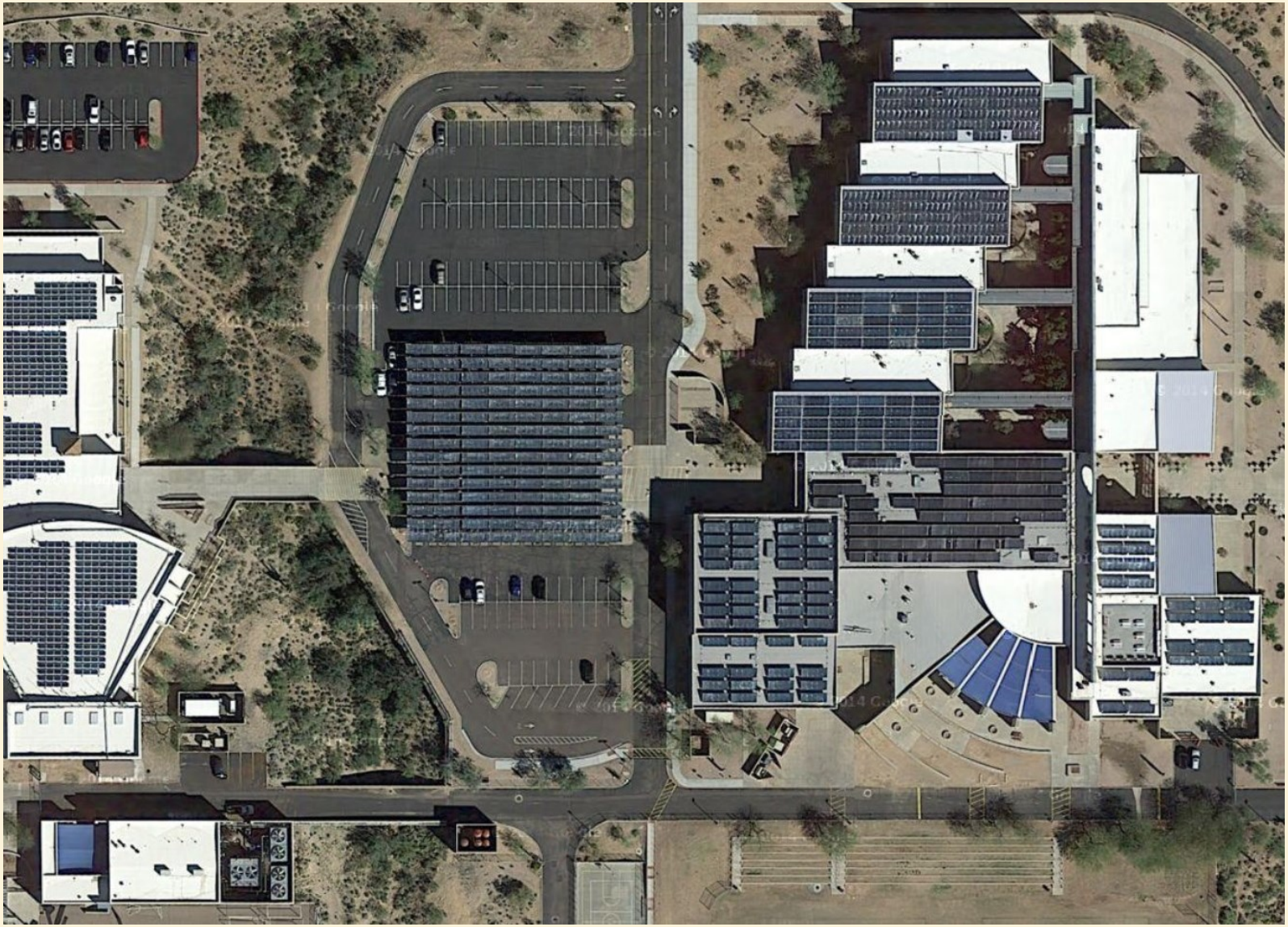

Google Maps, March 8th 2014

Desert Mountain High School, USA

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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

Desert Mountain High School, USA

SOLID solarinstallation+design

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 

Solar Cooling

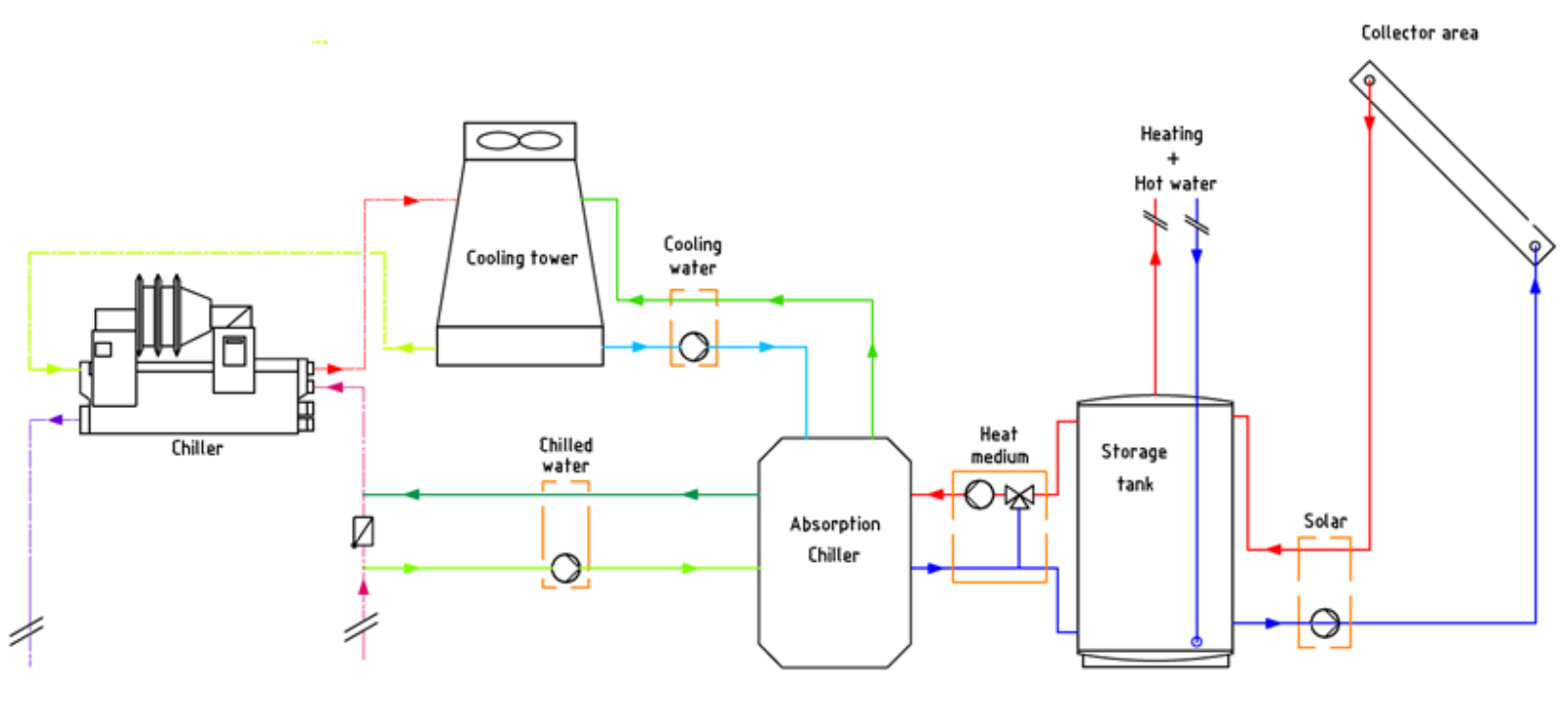
SOLID Things to come…

Study: MODON School, KSA

MODON Prototype School – Living Communities, KSA

Solar Cooling and Heating planned by MENABEX/SOLID .

Study: MODON School, KSA



Efficiency comparison:

MODON AC system report (2).pdf - Adobe Reader

	Description	Chilled Water		DX- Refrigerant system			
		Water cooled	Air cooled	VRV /VRF	Split Units	Package Units	Window Type
2	Operation Cost Electricity Kw/ton approx.	0.7- 0.8	1.7- 2	1.4-1.6	2.1-2.5	2- 2.3	2.1- 2.5

SOLID
Solar Cooling

proven 0,14 kW/RT

Study: MODON School, KSA

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 $RT_{cooling}$

Study: MODON Living Communitites

Red circles: 2 Modon Schools

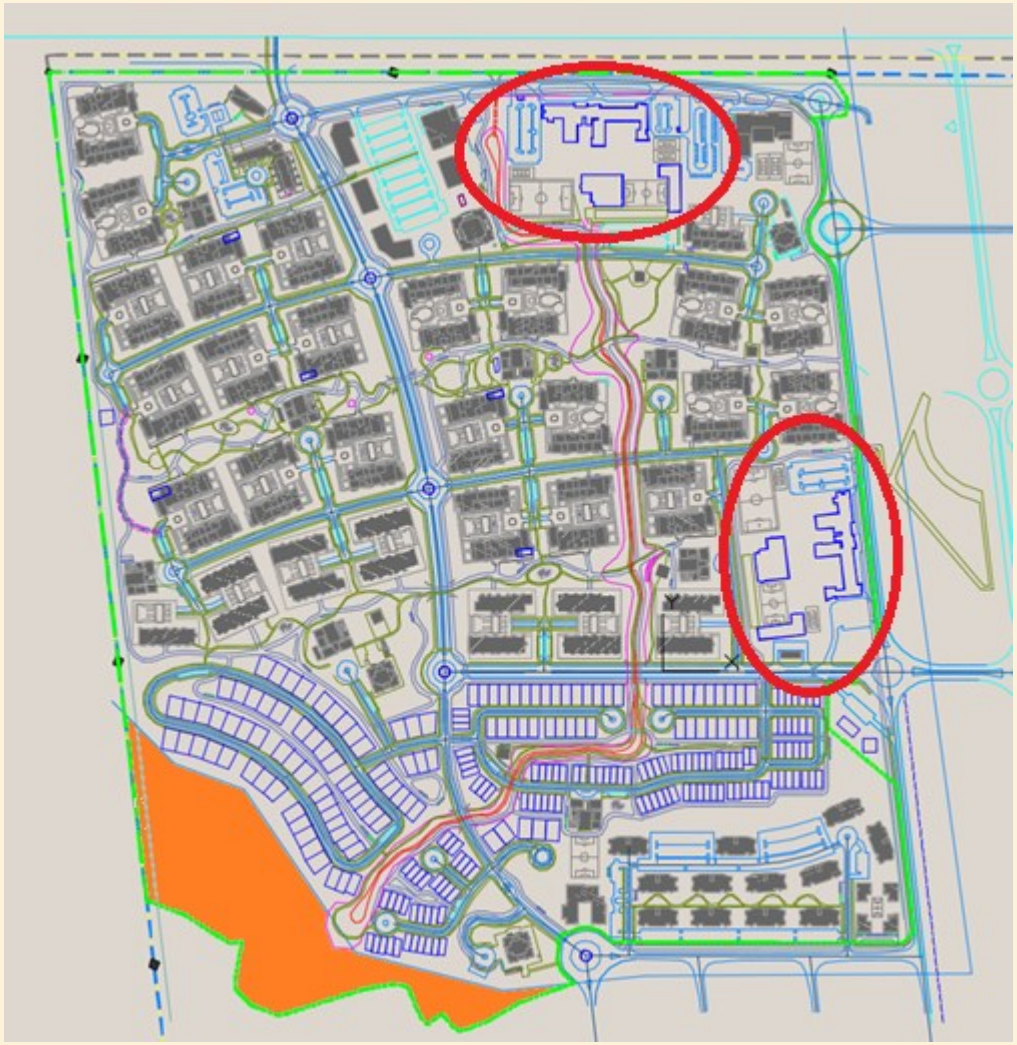
Orange area: 76,000 m² hilly land
Collector area: 50,000 m²

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

Grid based solutions will allow renewable energy supply to a large number of buildings without rooftop collectors.



Keep Cool – Use the sun !

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