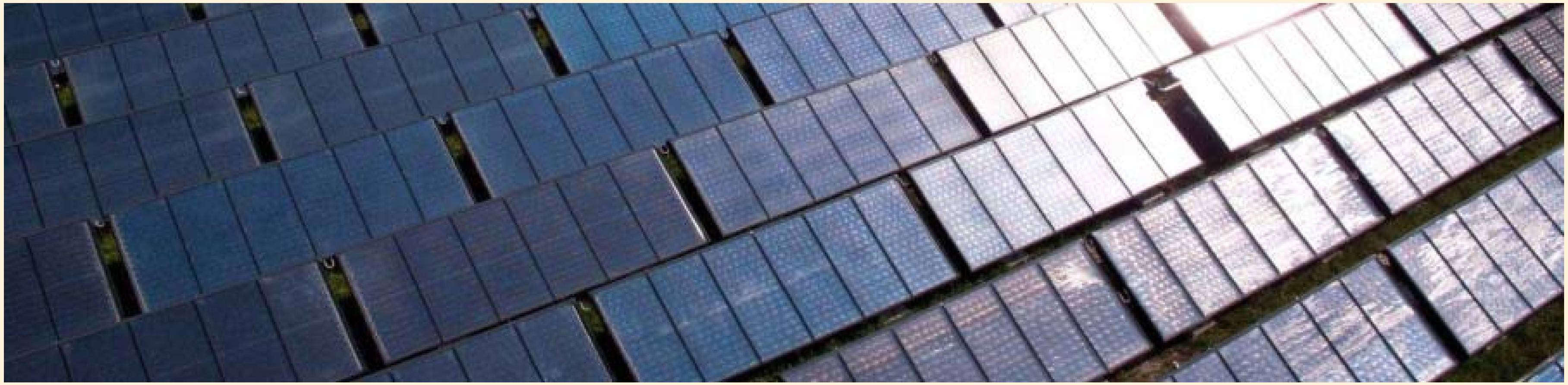
Successful large scale projects on solar cooling - energetic and economic performance

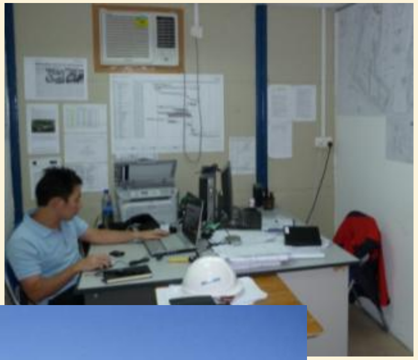
Christian Holter



S.O.L.I.D. Activities

Large solar thermal systems (>500 kW)

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



S.O.L.I.D. Group

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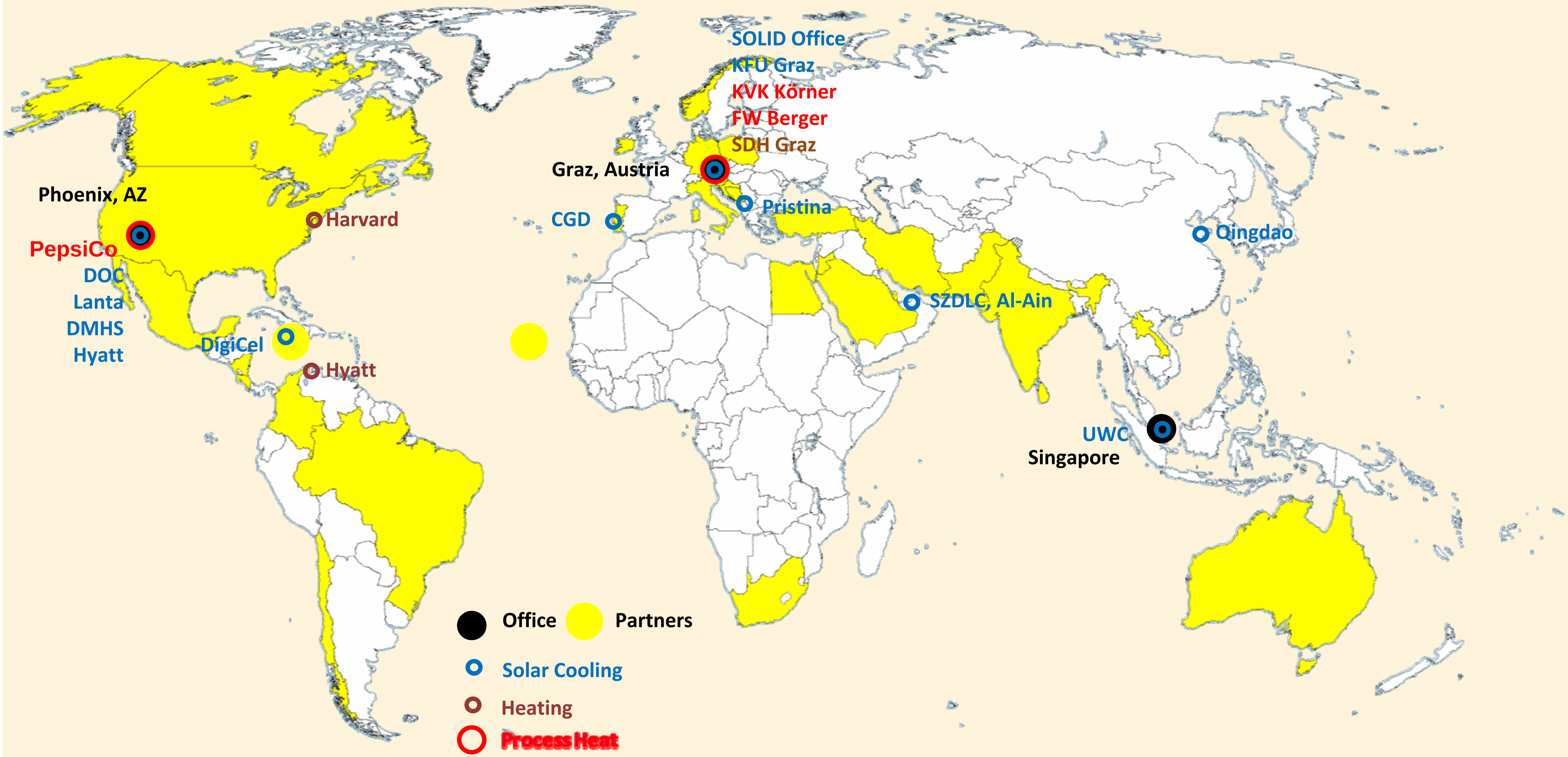
Headquarter in Graz, Austria

Subsidiaries in USA & Singapore

Partners in many other countries

Recent reference plants around the world



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Solar Cooling

Applications

Solar cooling references

Location/Project	Cooling Machine	Constr.	Cooling Power	Collector Area
EAR Tower, Pristina, Kosovo	LiBr-Chiller	2002/3	90 kW	226 m^2
Wine Cooling , Leutschach, Austria	Ammonia	2003	10 kW	100 m^2
Graz – office, test Plant	Ammonia	2003	2 kW	8 m^2
Stadtwerke, Crailsheim, Austria	LiBr-Chiller	2004	15 kW	500 m^2
Renewable Energy House, Brussels, Belgium	LiBr-Chiller	2005/7	35 kW	60 m^2
Desert Outdoor Center, Phoenix, USA	LiBr-Chiller	2006	70 kW	126 m^2
Olympic Village, Qingdao, China	LiBr-Chiller	2006	512 kW	638 m^2
Estellas Restaurant, Tampa, USA	LiBr-Chiller	2007	70 kW	210 m^2
CGD Office Building, Lisbon, Portugal	LiBr-Chiller	2008	545 kW	1579 m^2
Warehouse, Lanta, Phoenix, USA	LiBr-Chiller	2008	130 kW	504 m^2
Service Center Municipality, Gleisdorf, Austria	LiBr Chiller & DEC	2008	35 kW	260 m^2
New Office, Graz, Austria	Li Br Chiller	2008	17.5 kW	58 m^2
Metro MAN, Istanbul, Turkey	LiBr Chiller	2009	Study	
Sheikh Zayed Desert Learning Center, UAE	LiBr Chiller	2010/12	400 kW	1108 m^2
United World College, Singapore	LiBr Chiller	2010/11	1470 kW	3900 m^2
DigiCel, Kingston, Jamaica	LiBr Chiller	2012	600 kW	982 m^2
Desert Mountain High School, Scottsdale, USA	LiBr Chiller	2013/14	1750 kW	5000 m^2
University Graz, Chemistry building, Design & Consultancy	LiBr Chiller	2014	105 kW	636 m^2

Solar Cooling – the advantage

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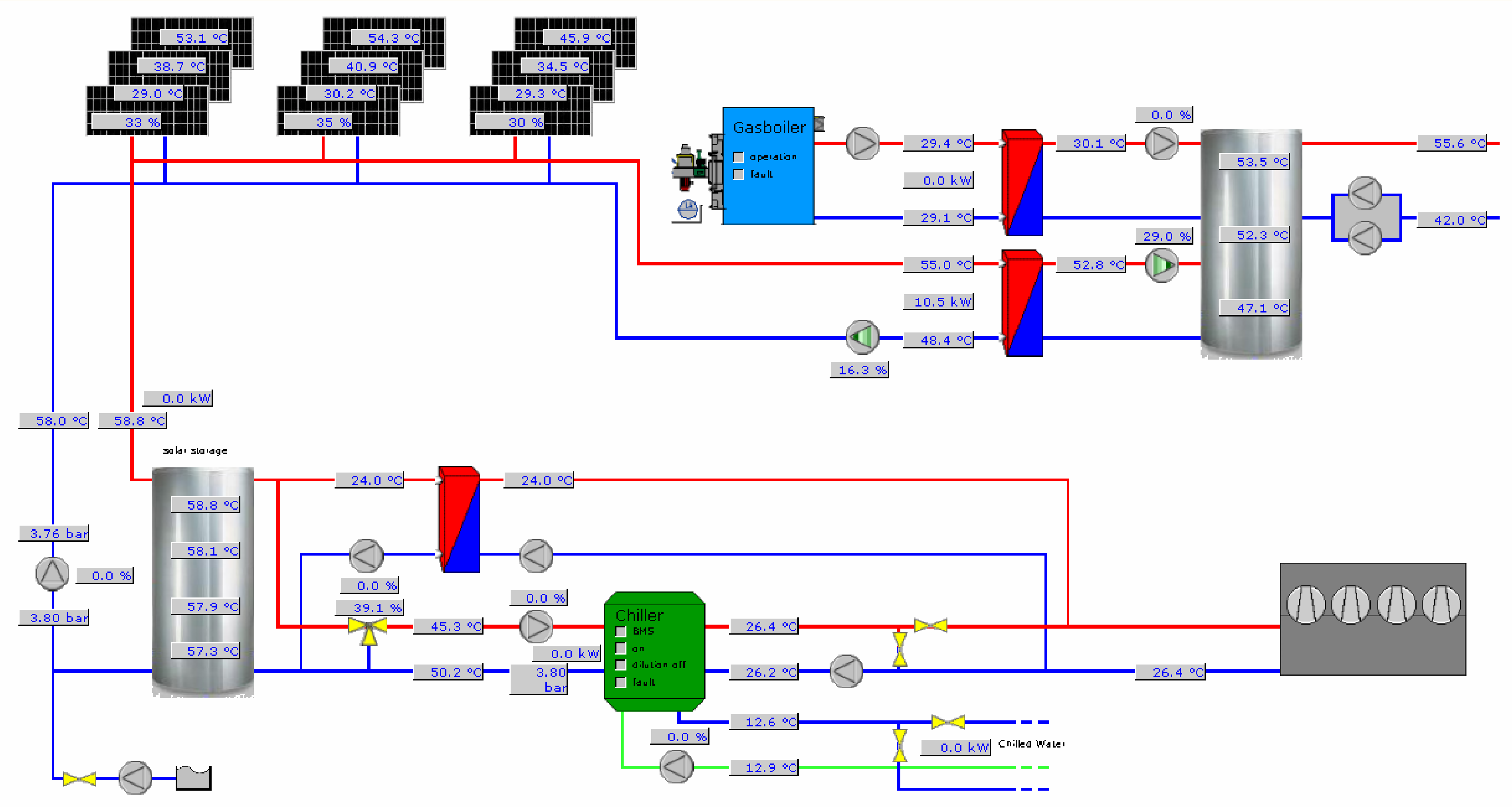
peak of solar radiation and

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!

UWC Tampines, Singapore



Concept for 100% Hot water & 30-80% cooling

UWC Tampines, Singapore

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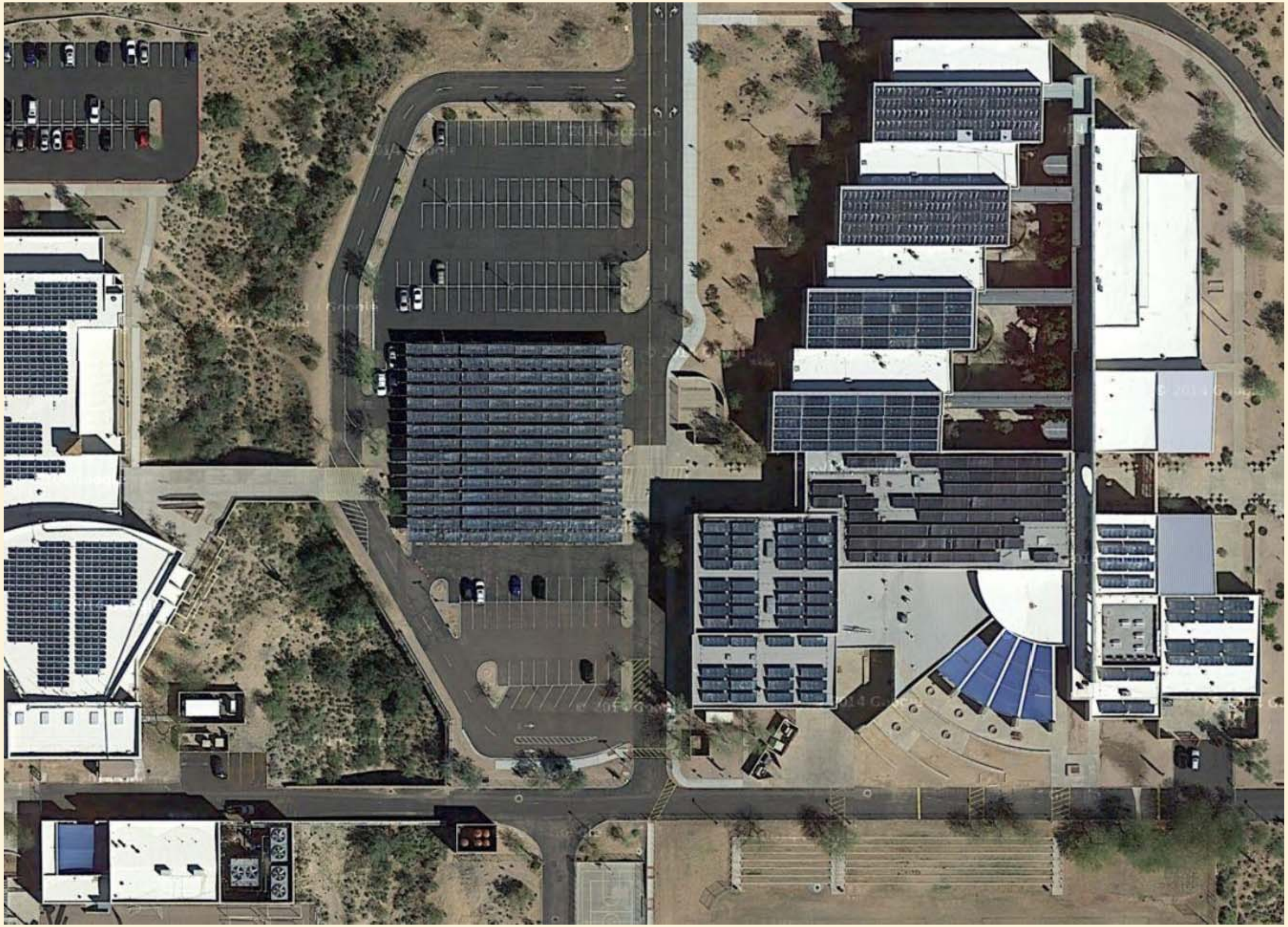
Desert Mountain High School, USA



Google Maps, March 8th 2014

Desert Mountain High School, USA

Solar Panels: 4.885 m² → 3.4 MW

Cooling Capacity: 500 tons / 1750 kW

In operation since June 2014

World's most powerful Solar Cooling System

Desert Mountain High School, USA

	Forecast	Actual
Solar Heat	3.876 MWh	3.660 MWh 5% Collectors added in Nov.2014
Chilled Water	2.713 MWh	2.201 MWh Weekend load not as per design/contract until July 2015

Desert Mountain High School, USA

<u>Results after 15 months of operation:</u>

- Chiller $COP_{thermal}$ 0,7 – 0,75
- Peak Hour up to $COP_{electric}$ 42 (kW/kW)/ 0,08 kW/ton
- Full day up to $COPs_{electric}$ 25-30 (kW/KW)/ 0,12 kW/ton

(on days when full load has been used)

<u>How to achieve these results?</u>

- Learn how to run Chillers and Cooling towers within <u>and beyond</u> manufacturers specs !
- Develop intelligent control strategies adapted to Solar Thermal heat input profile, starting and stopping heat supply every day.

Learnigs at DMHS & UWC

- Run chiller and Solar on maximum Delta T
  - Smaller Pipes
  - Less Heat Losses
  - Less Electricity for pumping
  - Small loss of Capacity but worth the investment

- Use High Performance Collectors
  - Significant Performance Increase from normal Flate Plate to double glazed flat plate
  - Through Limitation of Area Flat Plate Collectors Gross Area outperforms Tubes.

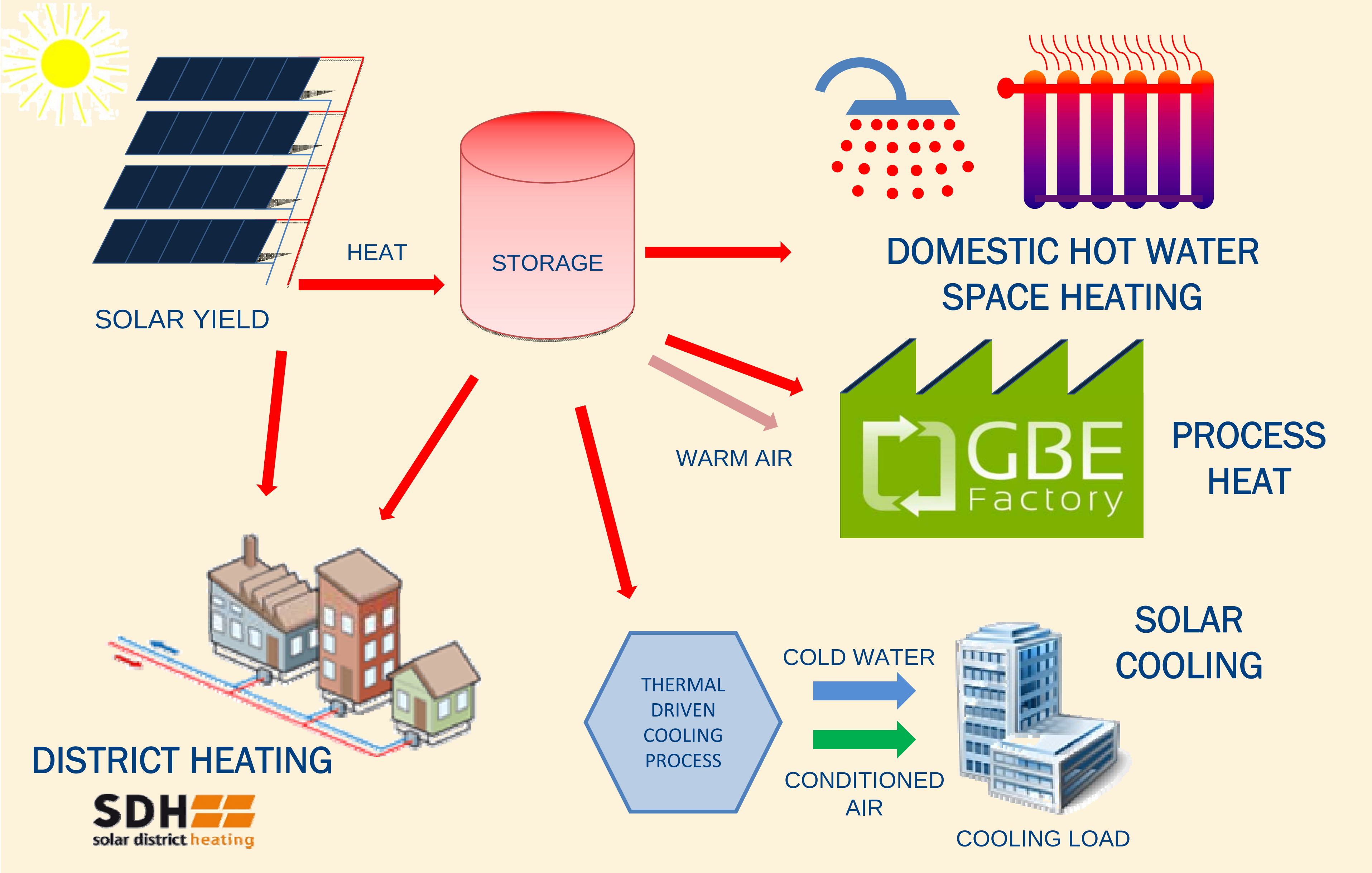
- Adapt Chiller to best set points
  - Chiller is designed for a nominal work point- but pressure, internal flow rates, setpoints shall be adapted to real needs of system

- Storage Tank
  - In fact not a storage tank

Learnigs at DMHS & UWC

- Interface existing control system
    - Ongoing efficiency measures impacted solar chilled water supply
- Combined Systems are real winners
    - UWC: 100% Solar Hot water- Boiler still not connected to gas. Oversized Solar System for DHW avoids all the standby losses and benefits for cooling
    - Supplementary integration of Waste Heat supports economics
- Real & Full Cost comparison
    - Capacity Costs to be considered
    - Equipment Replacement effect
- Regions with high electricity costs and/or variable Tarifs attract solar cooling

Technical Solutions by SOLID



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