New developed solar thermal systems for heating and cooling

Budapest, 16th April 2009

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Overview

- Solar Thermal Systems
- Solar Collectors
- Solar Cooling Technologies
- HIGH COMBI, Best Practice

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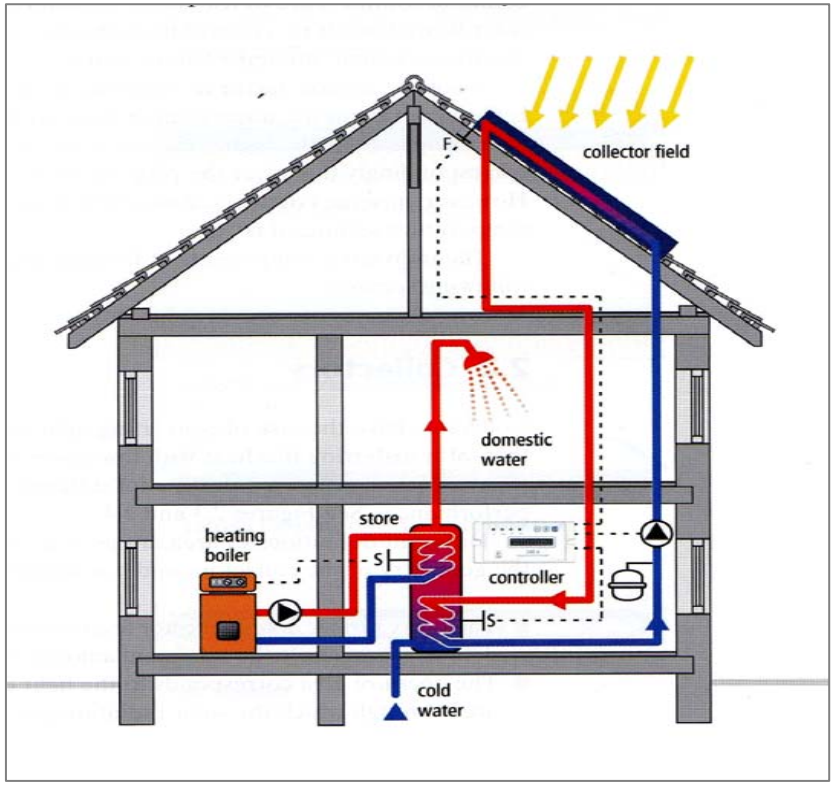
Domestic Hot Water Systems

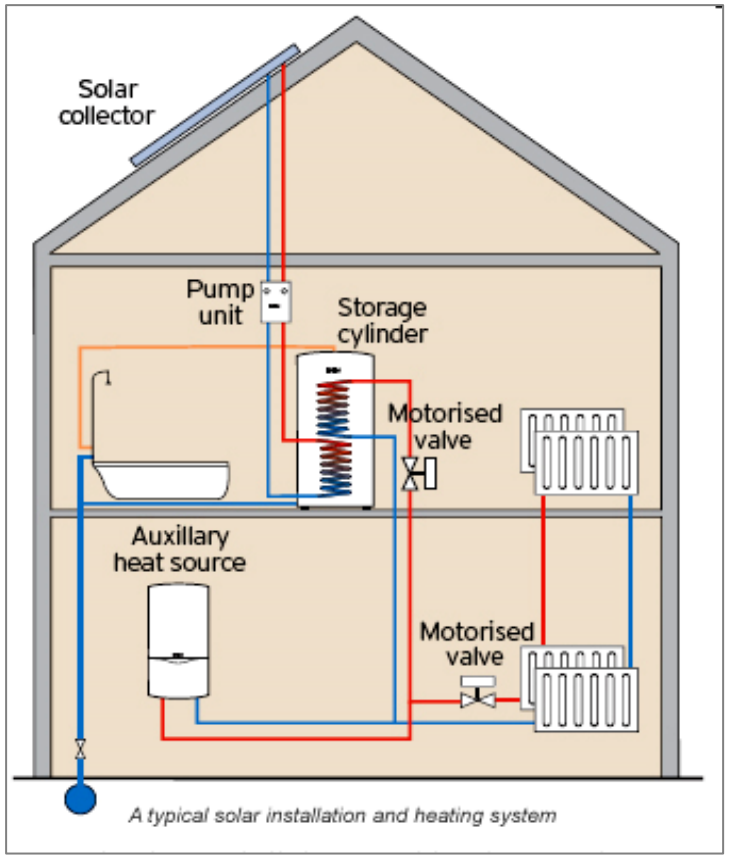
✓ **DHW** × Space Heating × Space Cooling



Central Sustem for DHW

Solar Combi Systems

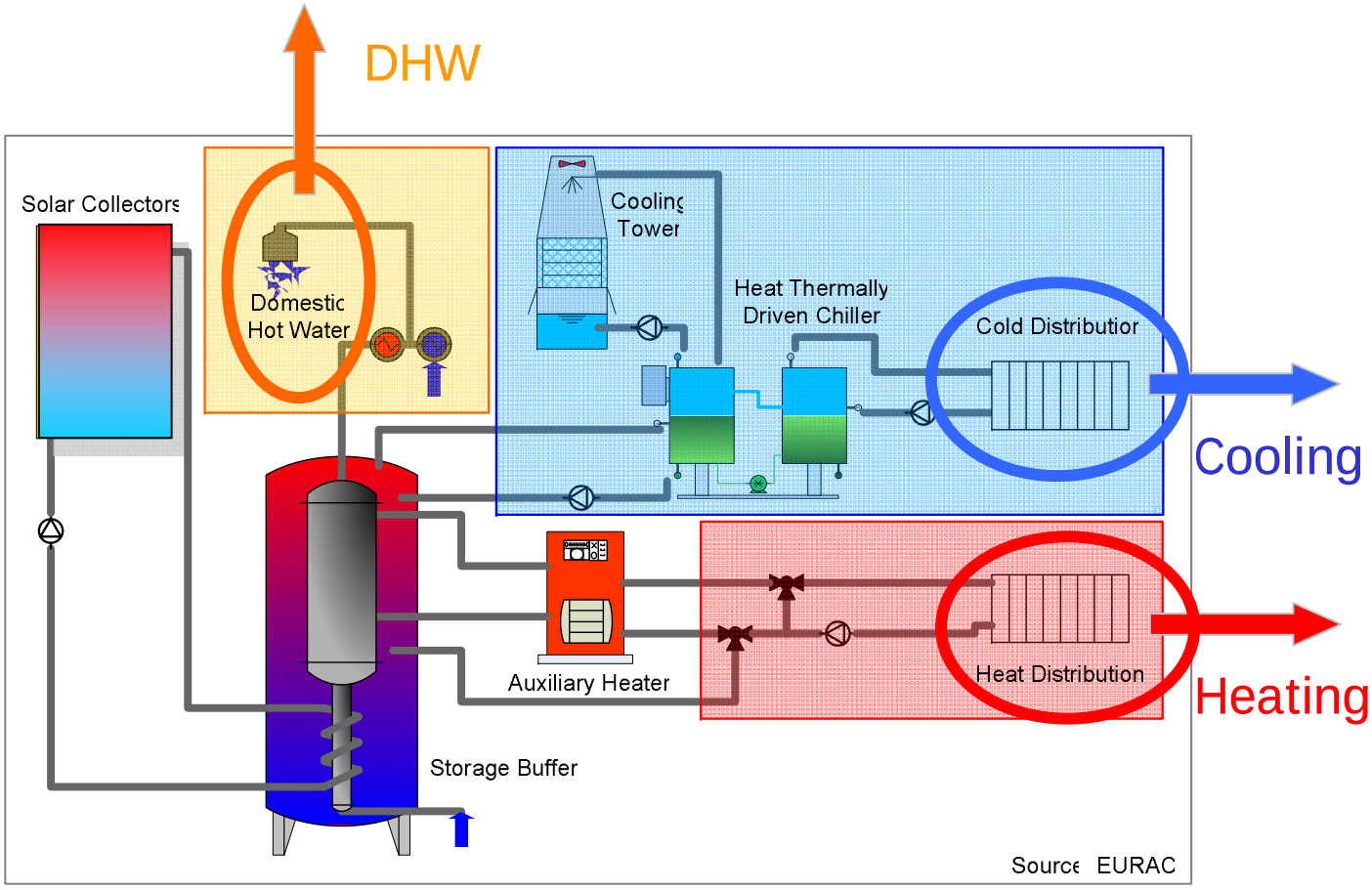
✓ **DHW** ✓ **Space Heating** × Space Cooling



A typical solar installation and heating system

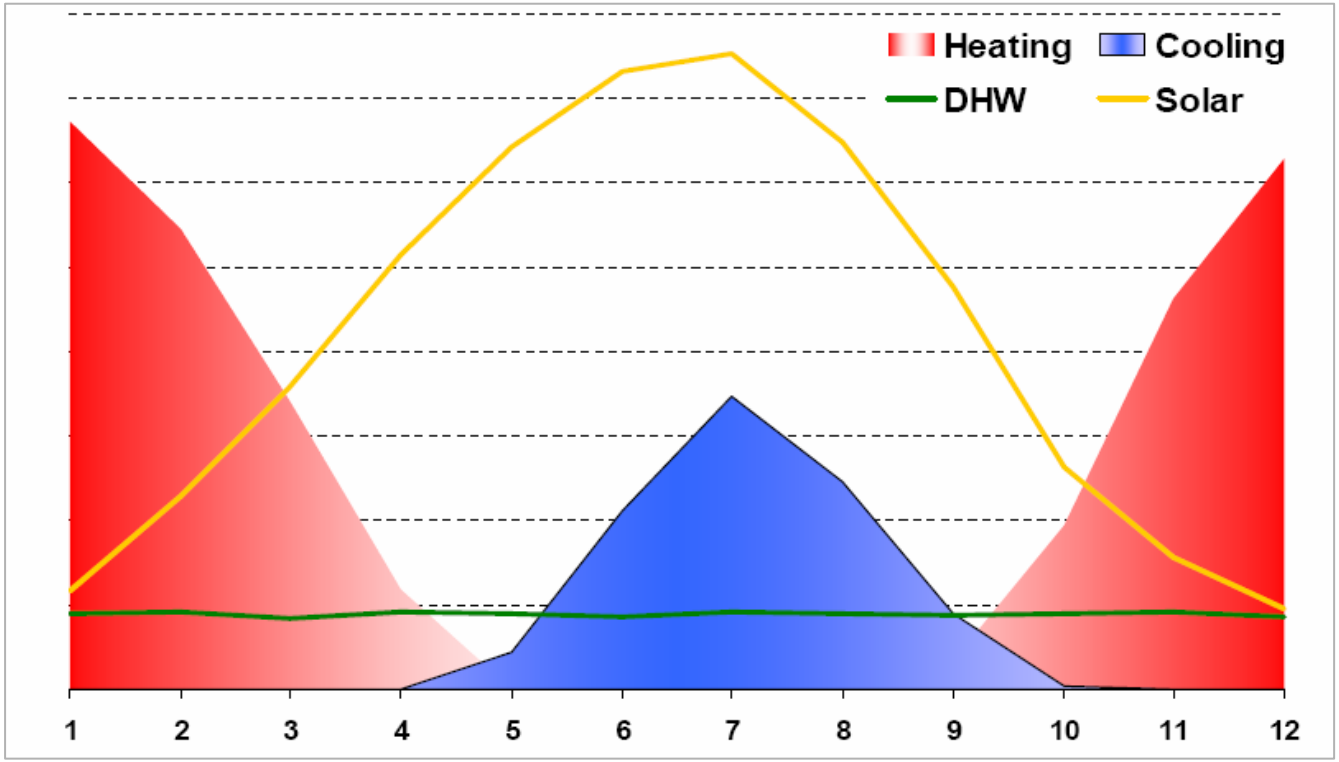
Solar Combi plus Systems

✓ DHW ✓ Space Heating ✓ Space Cooling



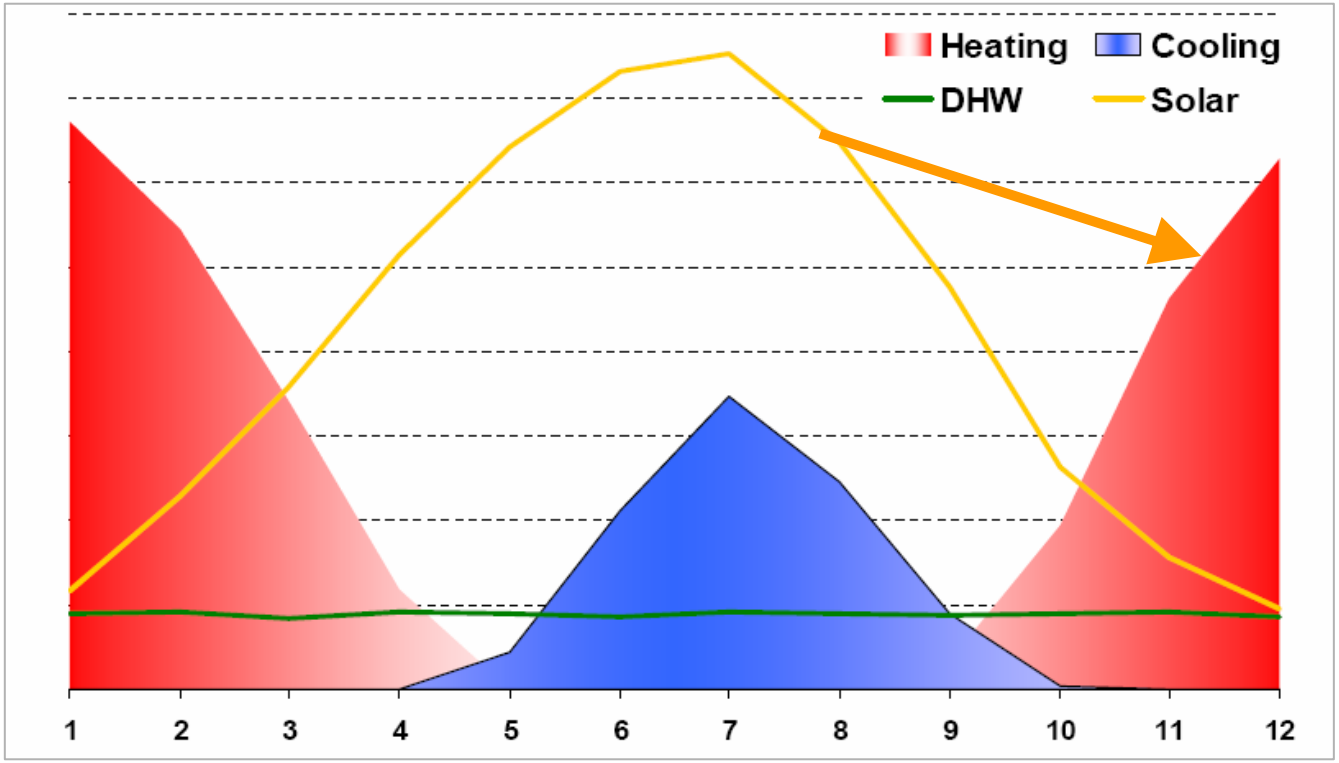
Loads vs Solar Radiation

- ✓ Coincidence of solar gains and cooling loads
- ✓ Reduction of electric peak loads
- ✓ Better utilization of solar energy throughout the year
- × Mismatch of Solar Radiation and Heating Load



Energy Storage

- ✓ Exploit Better Solar Energy
- ✓ Raise Solar Fraction
- × Increase initial cost
- × Extra space required



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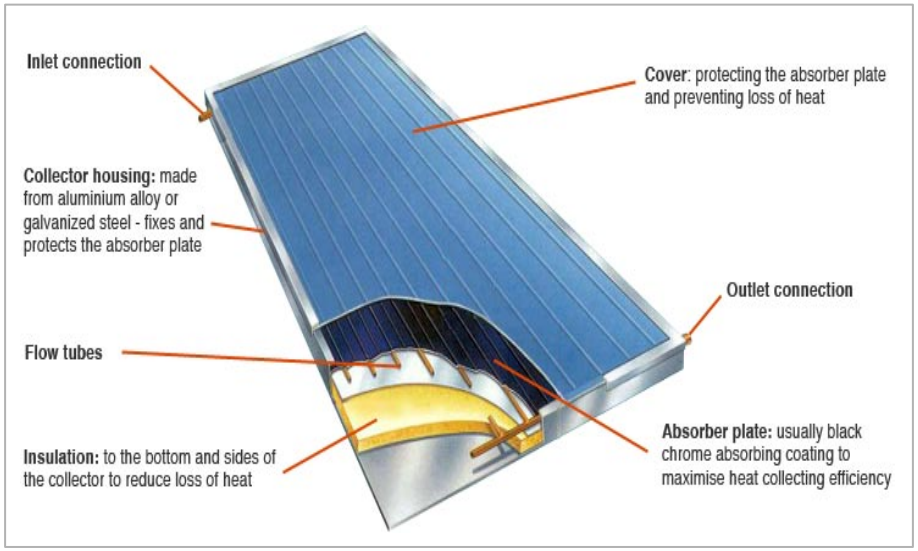
Flat Plate Collectors

Properties

- Middle cost: more expensive than unglazed, but cheaper than vacuum
- Higher operation temperature
- Thermal insulation on back & edges
- Fragile, heavier: 20-32 kg/m^2
- Absorber: black paint or spectral-selective coating
- Spectral-selective coating: conversion of short-wave solar radiation into heat (light absorption capacity) is optimized
- Absorption rate: 90-95%, emission rate 5-15%

Applications

- DHW Preparation
- Space heating
- Solar air conditioning

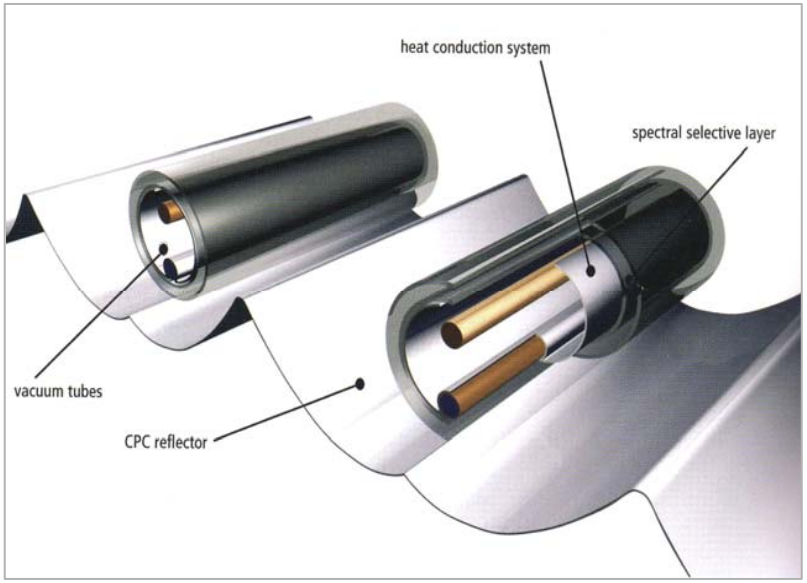


Source: Wagner & Co ESTIF

Vacuum Collectors

Properties

- High cost
- Minimal convection thermal losses (tube pressure < 10^{-5} bar)
- Low radiation losses
- High efficiency, even with low radiation
- Low weight
- Average annual efficiency 45-50% (with 1000kWh/m^2 irradiation, the energy yield is 450-500kWh/m^{2}a
- Stagnation temperature: 200-350^{0}C



Applications

- Solar air conditioning
- Industrial applications (steam generation)

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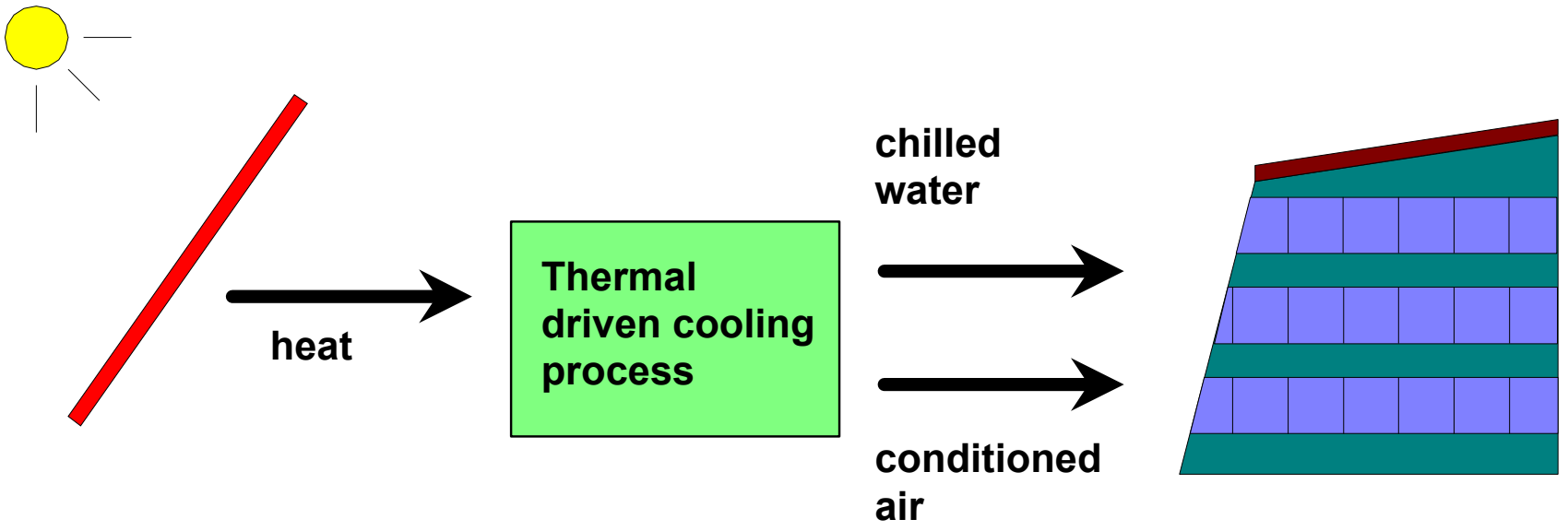
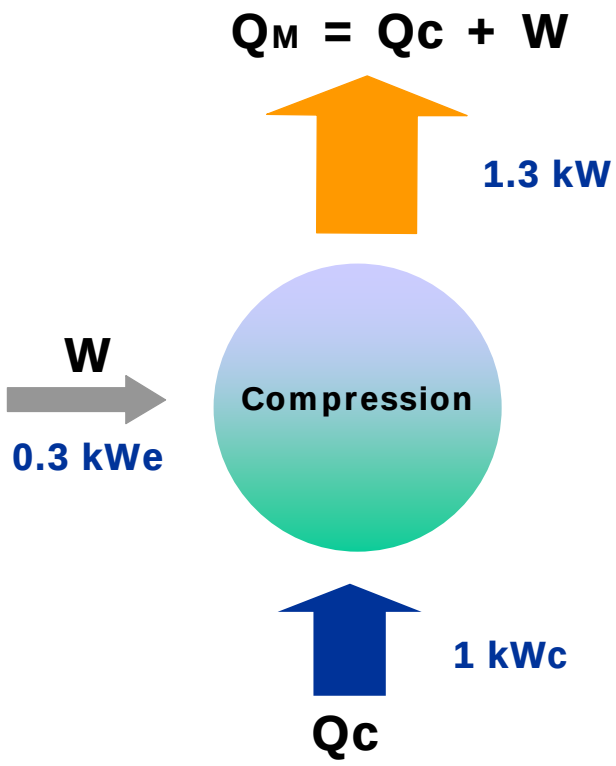
Basic Concept

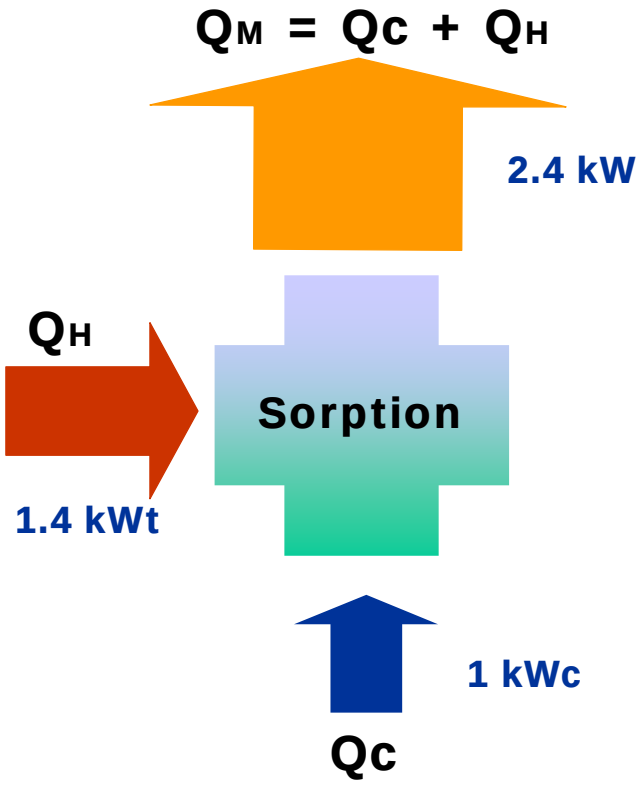


Principle of Operation

Conventional Chiller



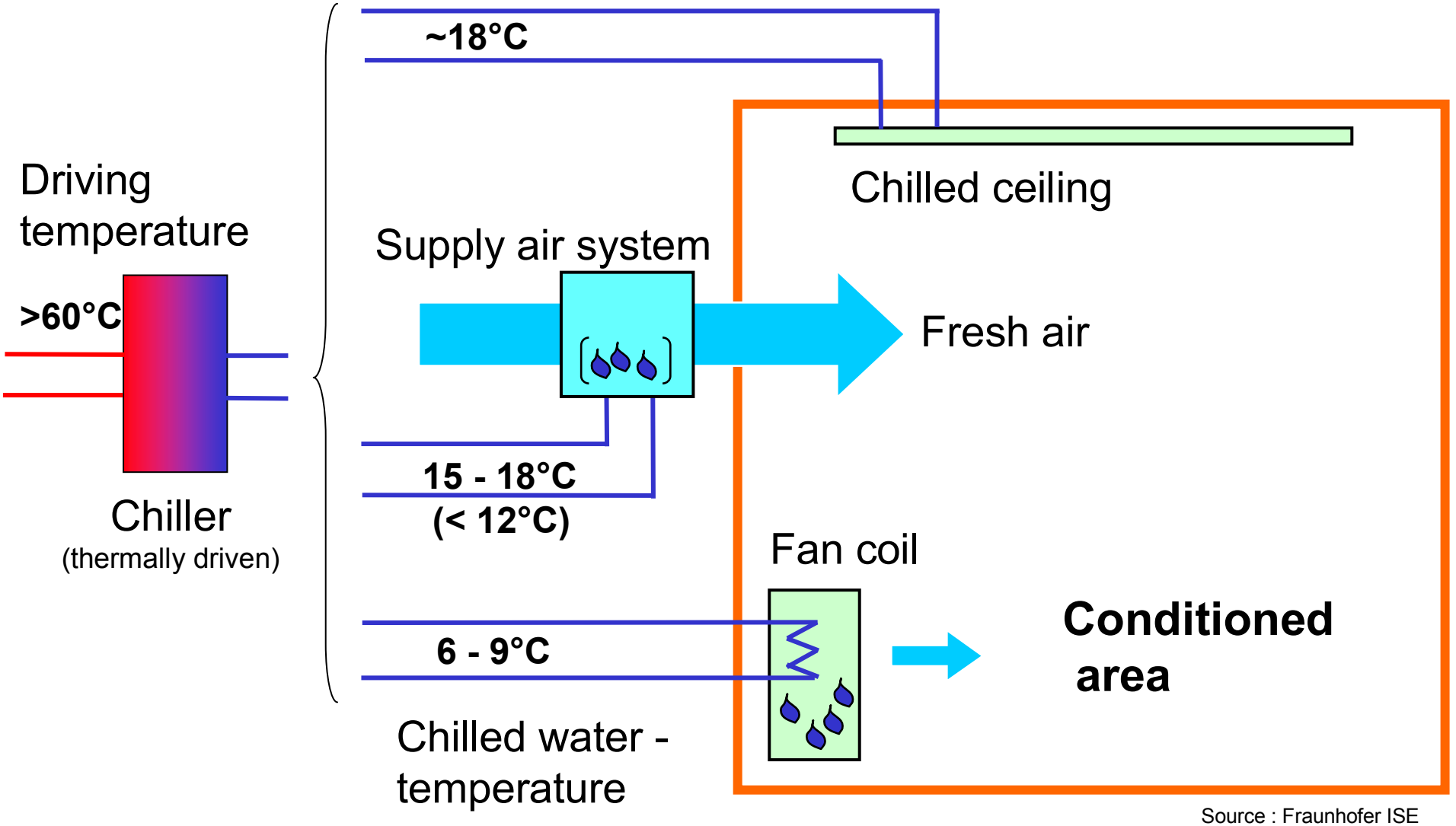
Sorption Chiller



Cooling Technologies

Method	Closed cycle		Open cycle	
Refrigereant cycle	Closed refrigerant cycle		Refrigerant (water) is in contact to the atmosphere	
Principle	Chilled water		Dehumidification of air and evaporative cooling	
Phase of sorbent	solid	liquid	solid	liquid
				
Typical material pairs	water - silica gel	water - lithium bromide ammonia - water	water - silica gel, water - lithium chloride	water - calcium chloride, water - lithium chloride
Market available technology	Adsorption chiller	Absorption chiller	Desiccant cooling	Close to market introduction
Typical cooling capacity (kW cold)	50 – 430 kW	15 kW – 5 MW	20 kW – 350 kW (per module)	
Typical COP	0.5 – 0.7	0.6 – 0.75 (single effect)	0.5 – >1	> 1
Driving temperature	60 – 90 °C	80 – 110 °C	45 – 95 °C	45 – 70 °C
Solar collectors	Vacuum tubes, flat plate collectors	Vacuum tubes	Flat plate collectors, solar air collectors	Flat plate collectors, solar air collectors

Closed Cycle Systems

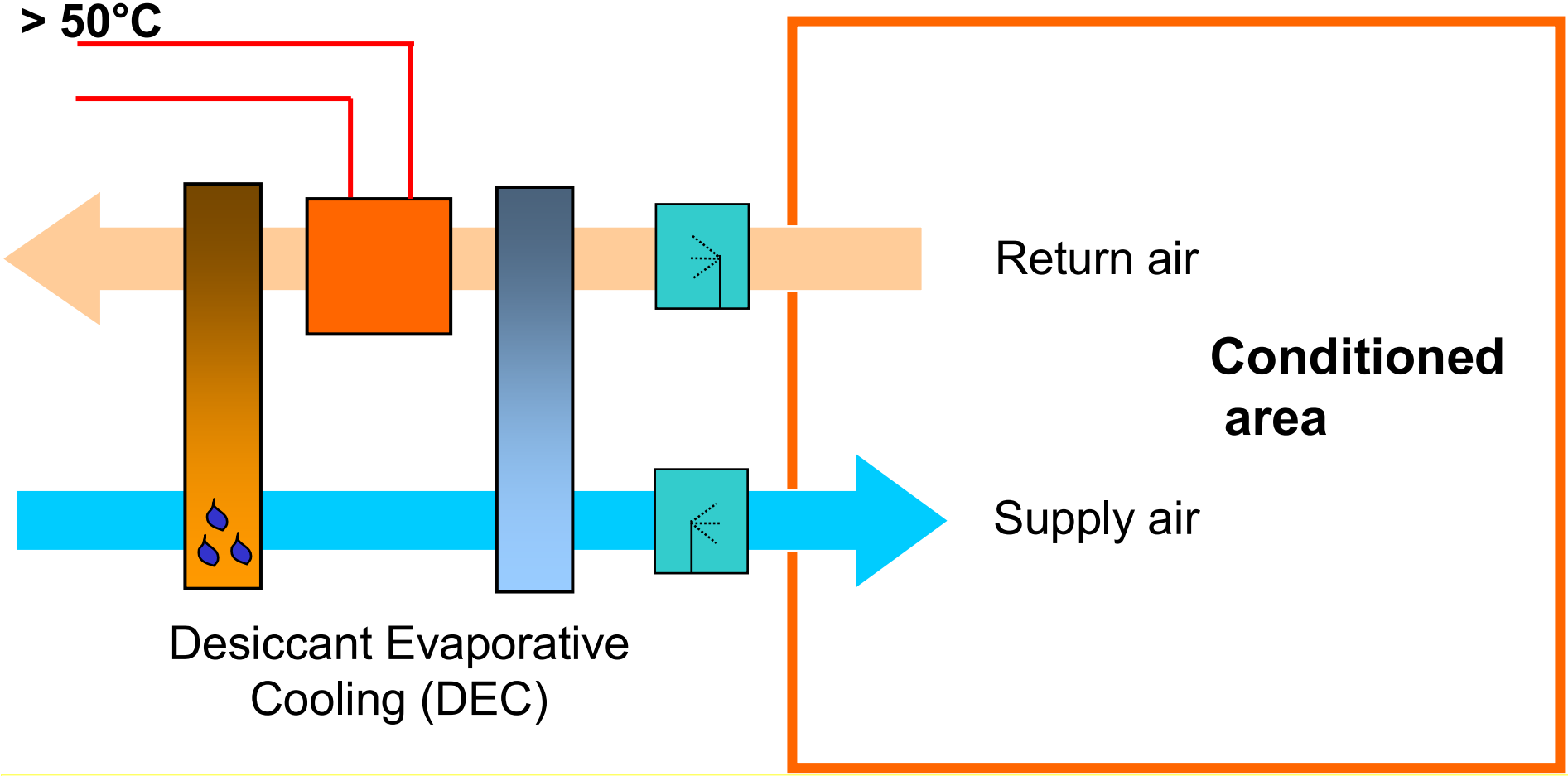


Source : Fraunhofer ISE

Open Cycle Systems

Driving temperature

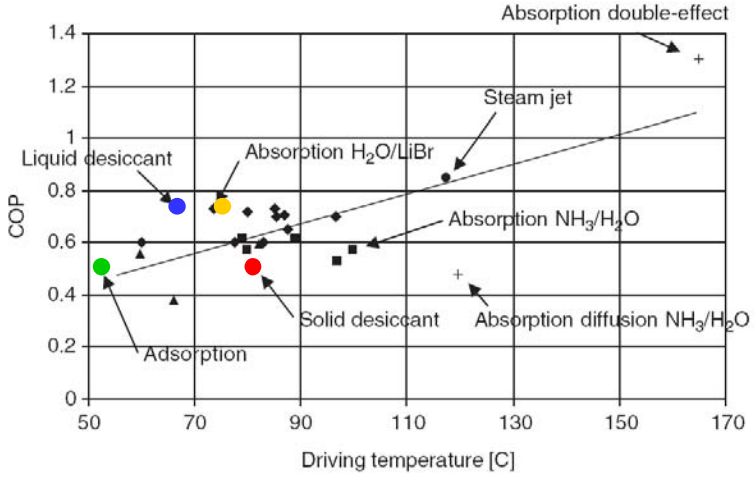
> 50°C



Desiccant Evaporative Cooling (DEC)

Source : Fraunhofer ISE

Comparison



Efficiency – Operational temperature, 2007

Open systems

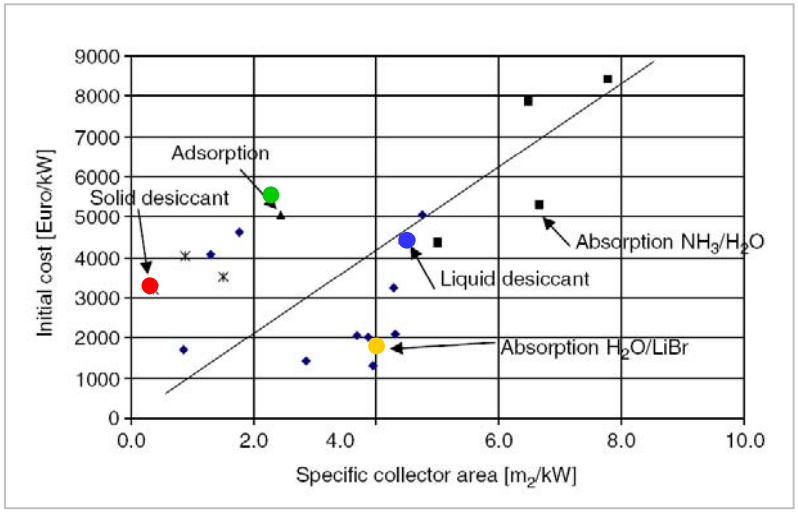
Liquid DEC: T = 60C, COP = 0.7

Solid DEC: T = 80C, COP = 0.5

Closed systems

Absorption: T = 75C, COP = 0.7

Adsorption: T = 55C, COP = 0.5



Initial cost – Collector area needed, 2007.

Open systems

Liquid DEC: 4500 €/kW, 5 m^2/kW

Solid DEC: 3500 €/kW, 0.5 m^2/kW

Closed systems

Absorption: 2000 €/kW, 4 m^2/kW

Adsorption: 5500 €/kW, 2.5 m^2/kW

Source : CA Balaras, G Grossman, HM Henning, *Solar Air-Conditioning in Europe - an overview*, Renewable Energy & Sustainable Energy Reviews, 11, 2007, 299-314

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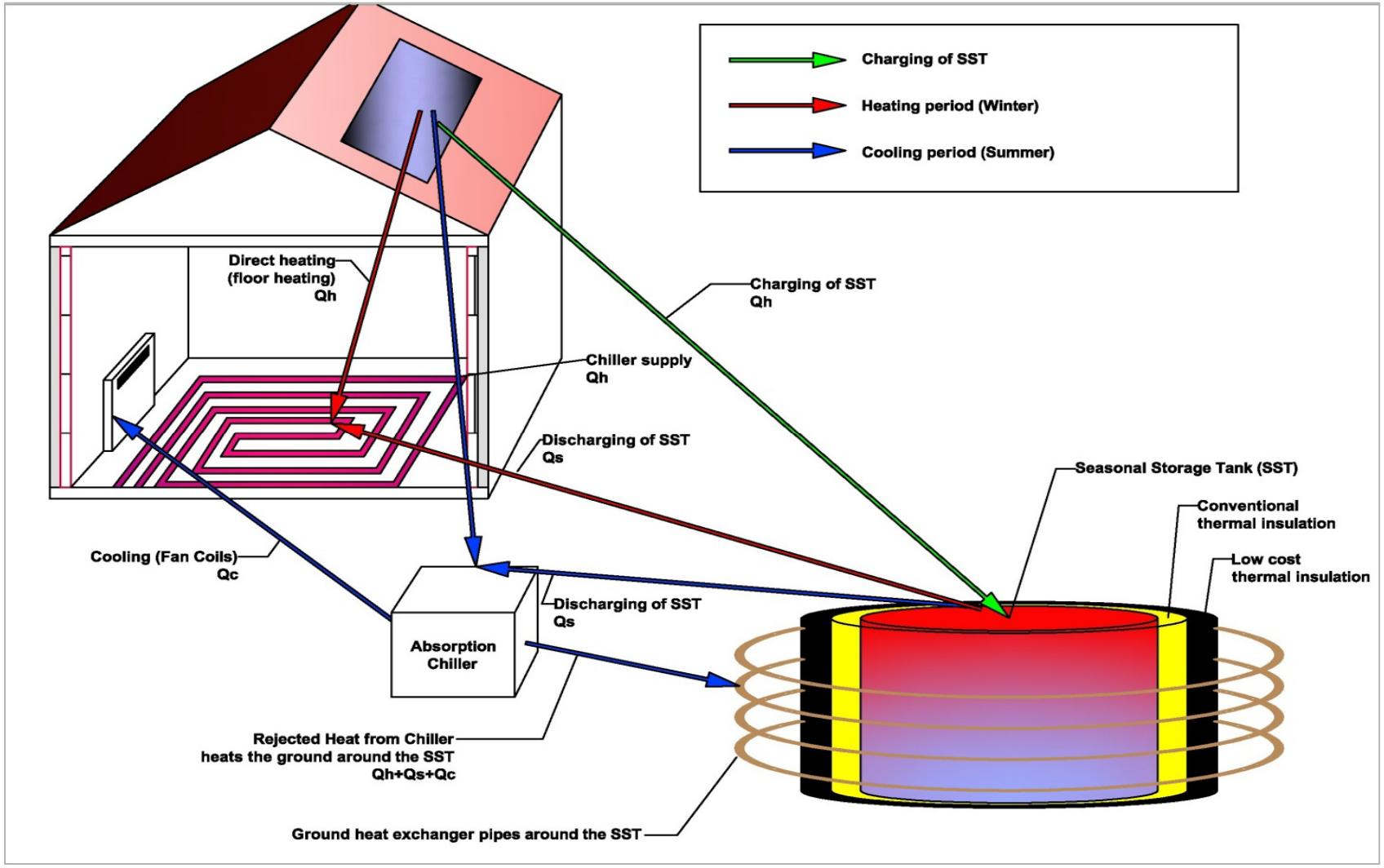
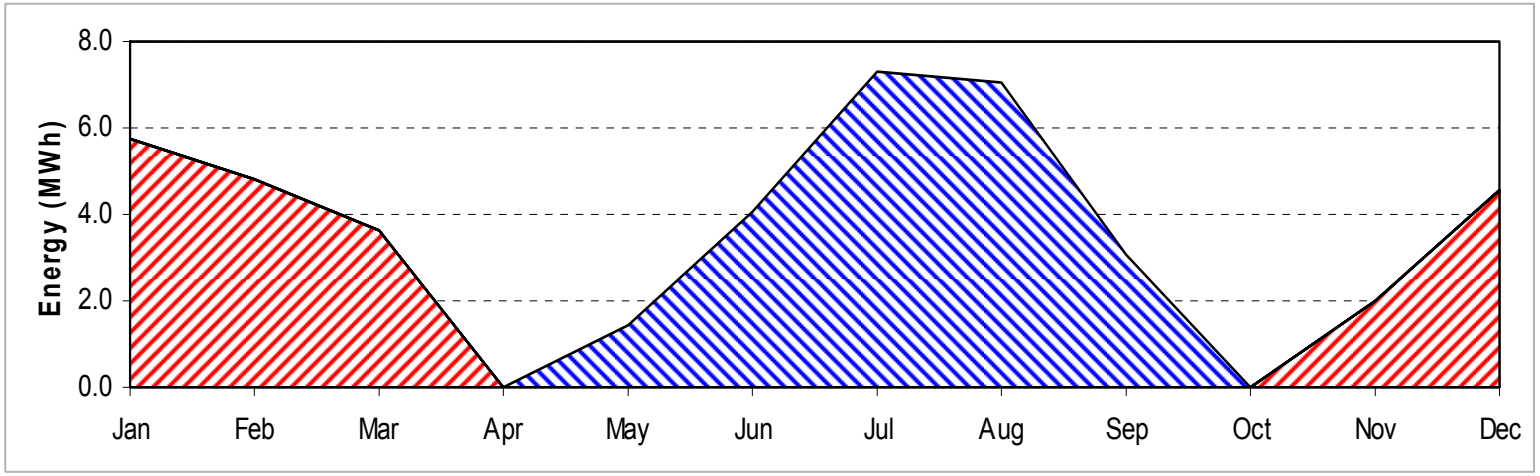
The Greek plant, **HIGH COMBI** *Concept*



The Greek plant, ***End User Data***

CRES Offices, Athens

Building Data	
Area	545 m^2
Heating Load (max)	51 KW
Heating Energy Demand	22 MWh
Cooling Load (max)	45 KW
Cooling Energy Demand	18 MWh
DHW Demand	-
Heating / Cooling Distribution System	Fan Coils



Building Energy Demands, Heating / Cooling

The Greek plant, ***Solar System***

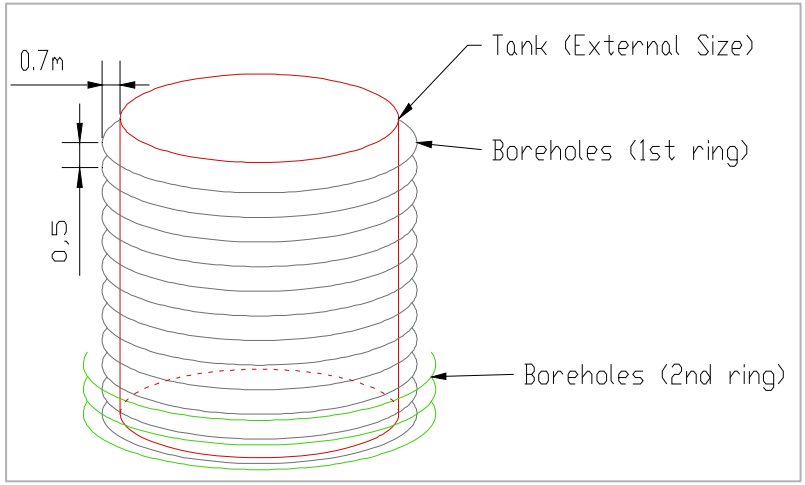
Energy System Data		
	Type	Unit
Collectors	Flat Plate	120 m^2
Primary Circuit Fluid	Mixture of propylene glycol and water	30 %
Chiller	Absorption	35 kW
Heat Rejection	GHE & Cooling Tower	
Storage	Buried Cylindrical Tank	180 m^3
Heating supply/ return Temperature	Fan Coils	45 / 40 ^oC
Cooling supply/ return Temperature	Fan Coils	7 / 12 ^oC
Back up System	Heat Pump	50 KW

Estimated Solar Fraction ~ 95%

The Greek plant, ***Storage System***

Innovative Seasonal Storage

	Type	Unit
Storage	Cylinder	180 m^3
Position	Underground (T_{ground} ~ 15°C)	1 *m*
Restrictions	High Water Level	8 *m*
Structure	Steel & Concrete	
Insulation	Polyurethane & Chipped Tyres	0,4 $W/(m^2 K)$
Heat Rejection	Horizontal Ground Heat Exchangers	402 m *(1st loop)* 463 m *(2nd loop)*
Ground	Clay/ Silt , dry	0,5 *W/(m K)*



Information

www.highcombi.eu

- Further information
- Progress
- Contacts
- Deliverables / Reports
- News

Thank you for your attention!

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