Solar Heating and Cooling

Applications

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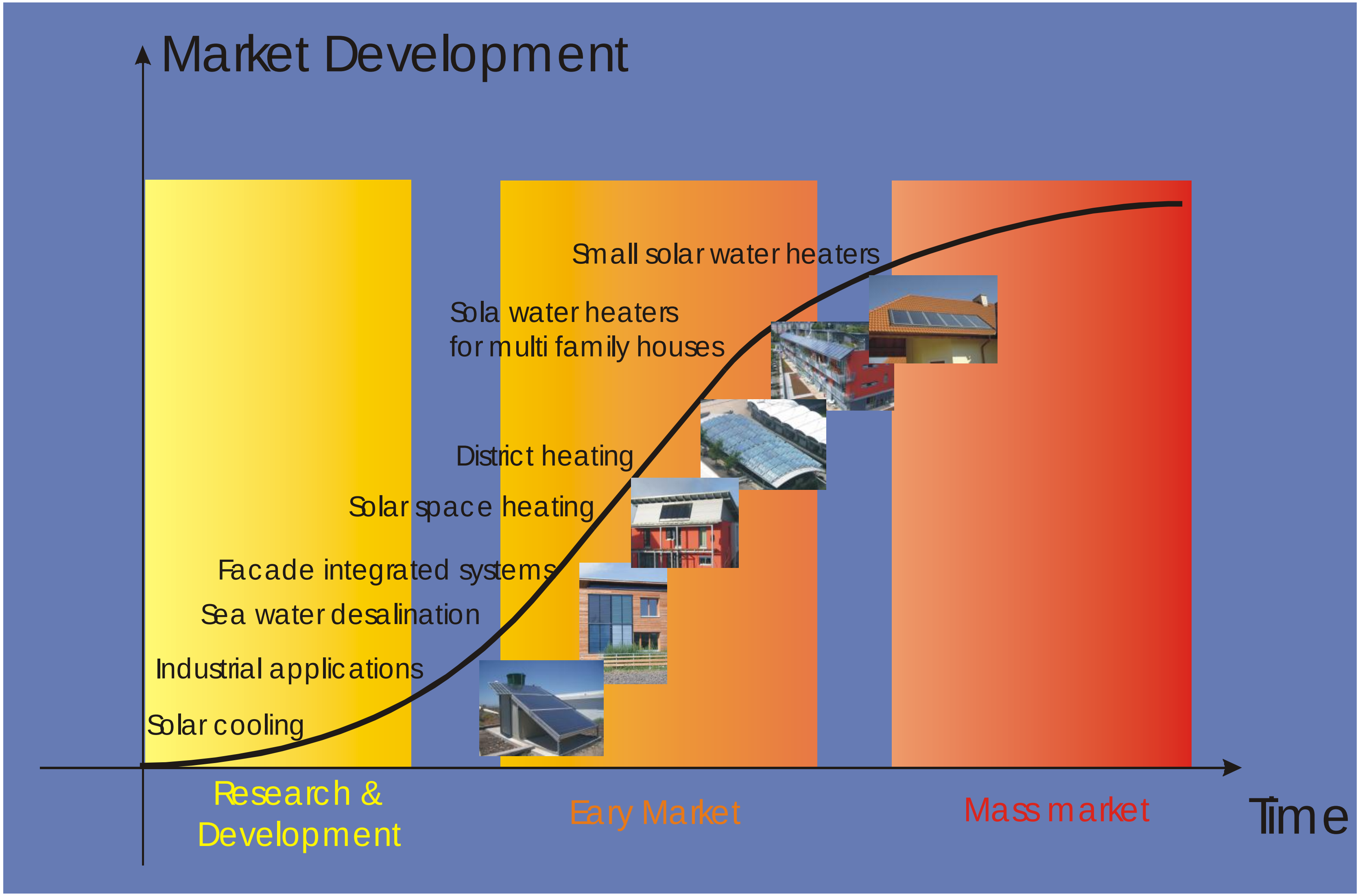
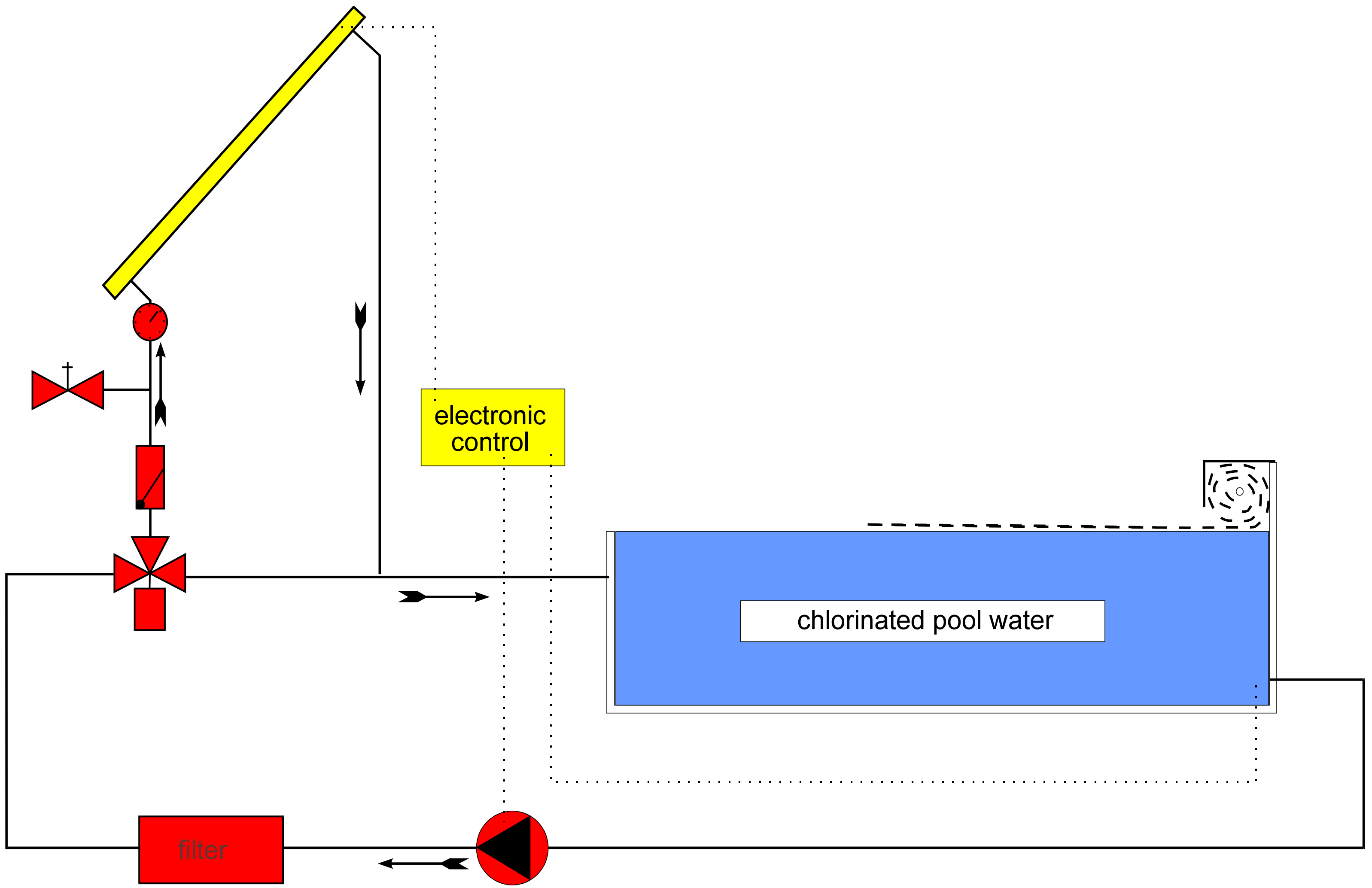
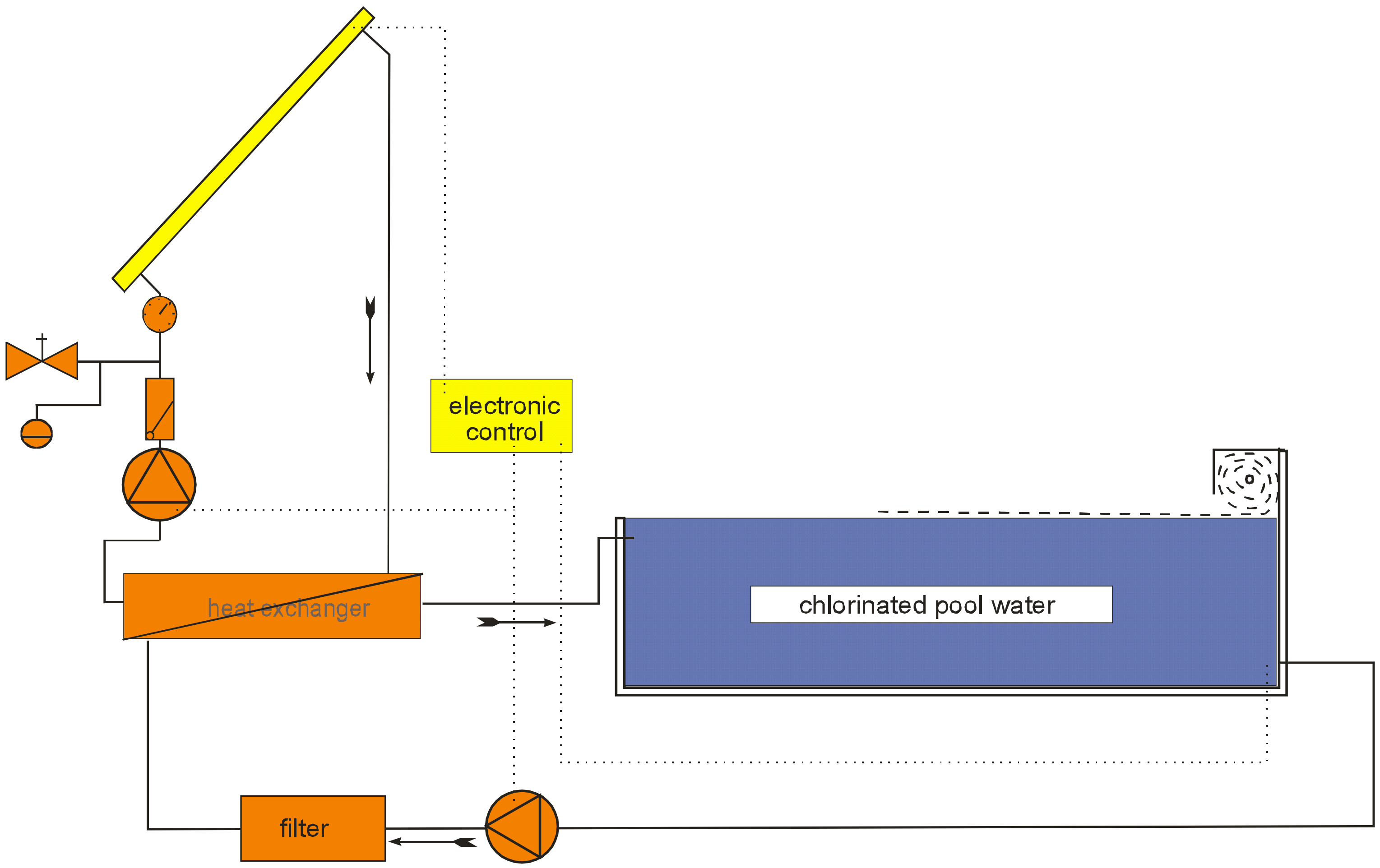
AUSTRIA


Market Development
Small solar water heaters
Sola water heaters
for multi family houses
District heating
Solar space heating
Facade integrated systems
Sea water desalination
Industrial applications
Solar cooling
Research &
Development
Eary Market
Mass market
Time

SWIMMING POOL SYSTEM

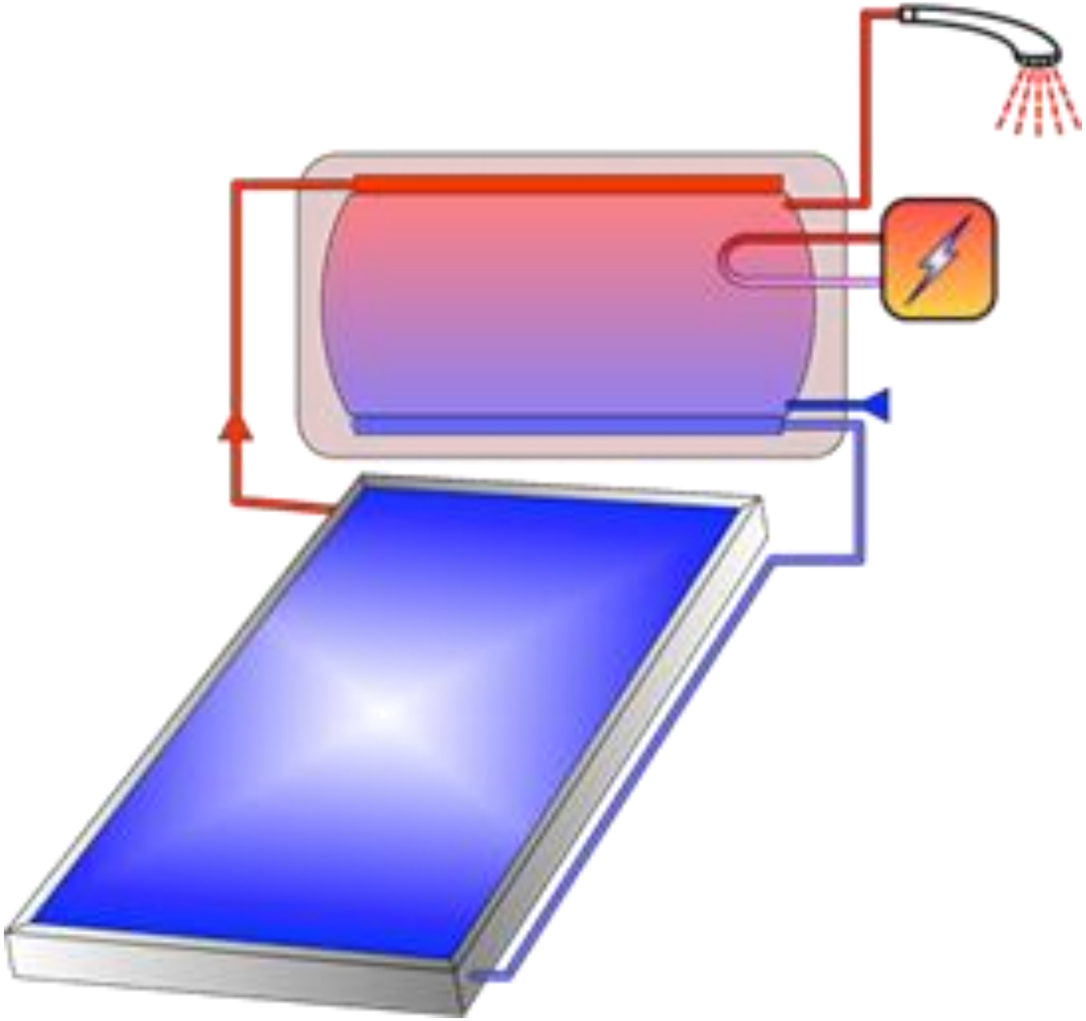


SWIMMING POOL SYSTEM



Plastic absorber for pool water heating

Thermosiphon system for domestic hot water preparation



Source: ESTTP - SRP

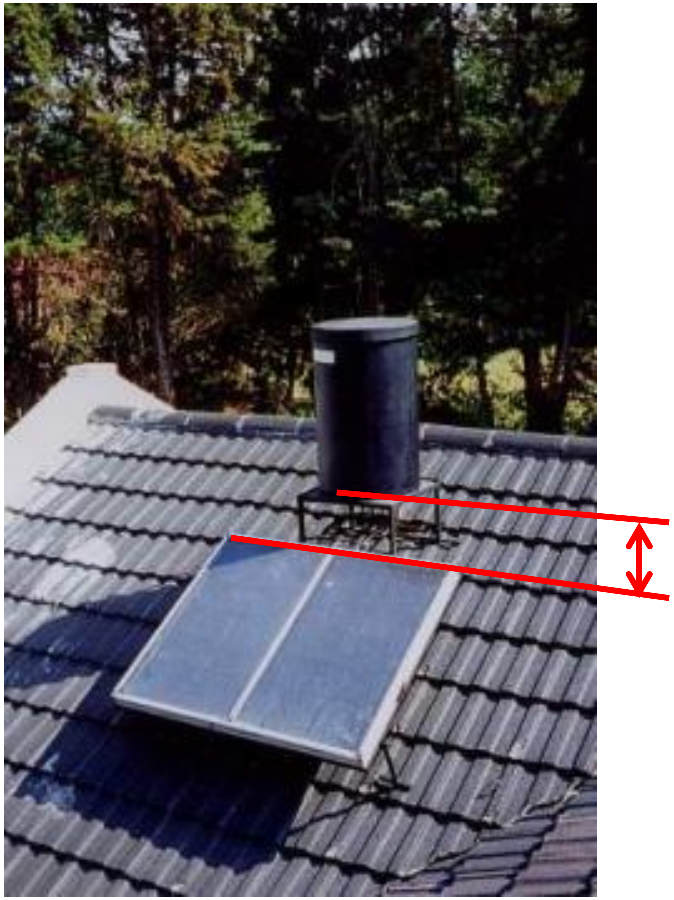
Gravity-driven domestic hot water system

Water conditions suitable for direct systems

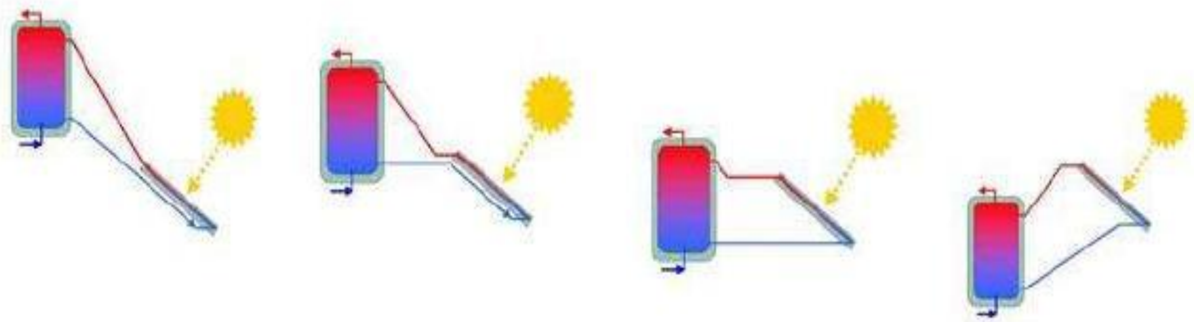
Description	Maximum Recommended Level
Ph	6.5 - 8.5
TDS	600 mg/l
Total Hardness	200 mg/l
Chlorides	300 mg/l
Magnesium	10 mg/l
Calcium	12 mg/l
Sodium	150 mg/l
Iron	1 mg/l

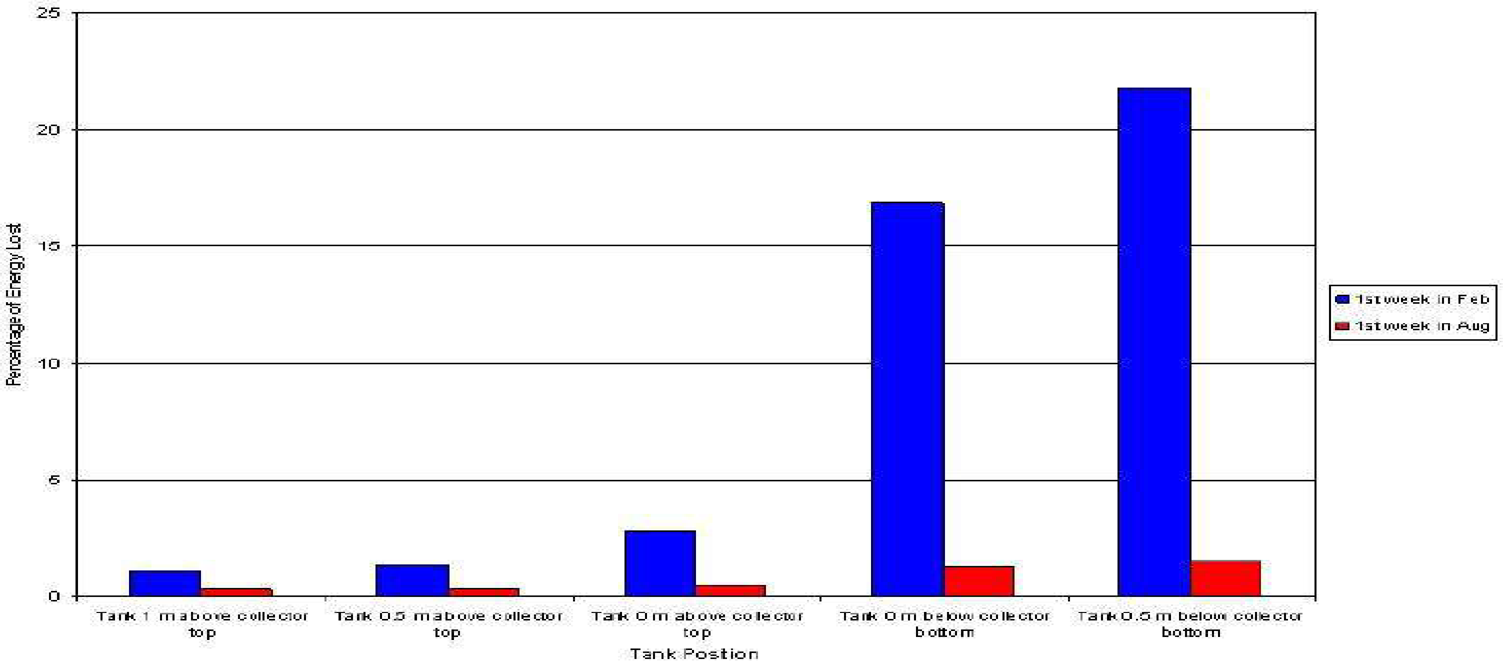
Source: Solar Edwards, Australia

Simple direct thermosiphon systems, Zimbabwe



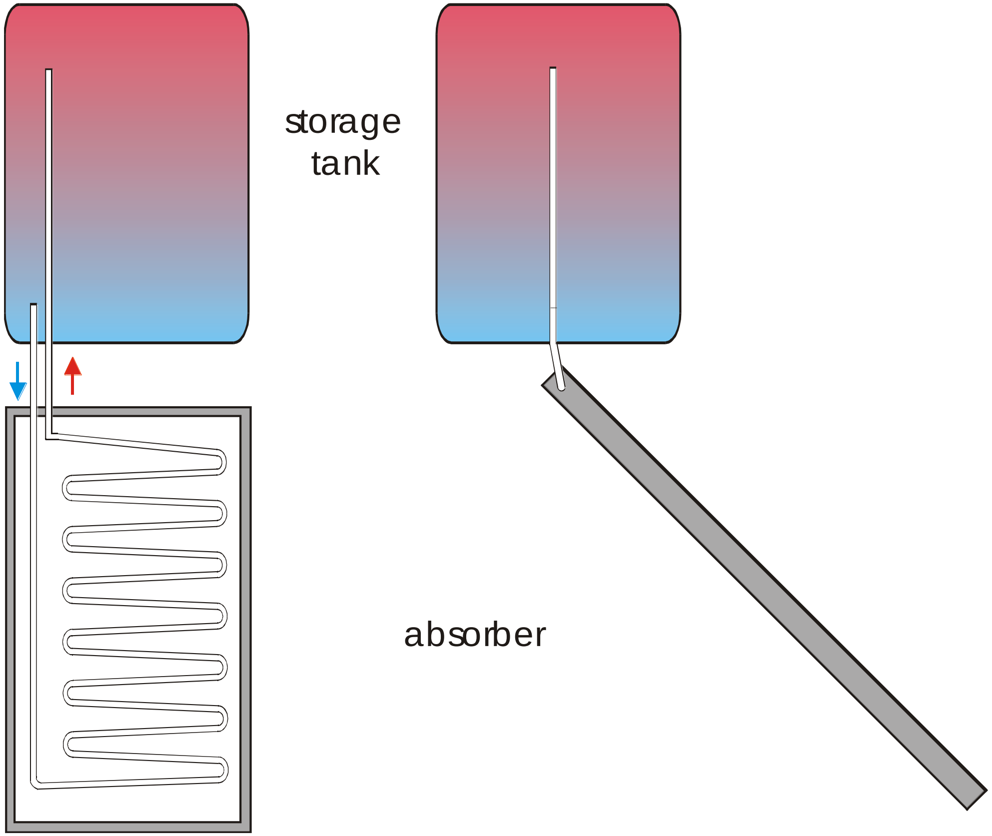
Energy losses due to reverse flow caused by the hot water storage position



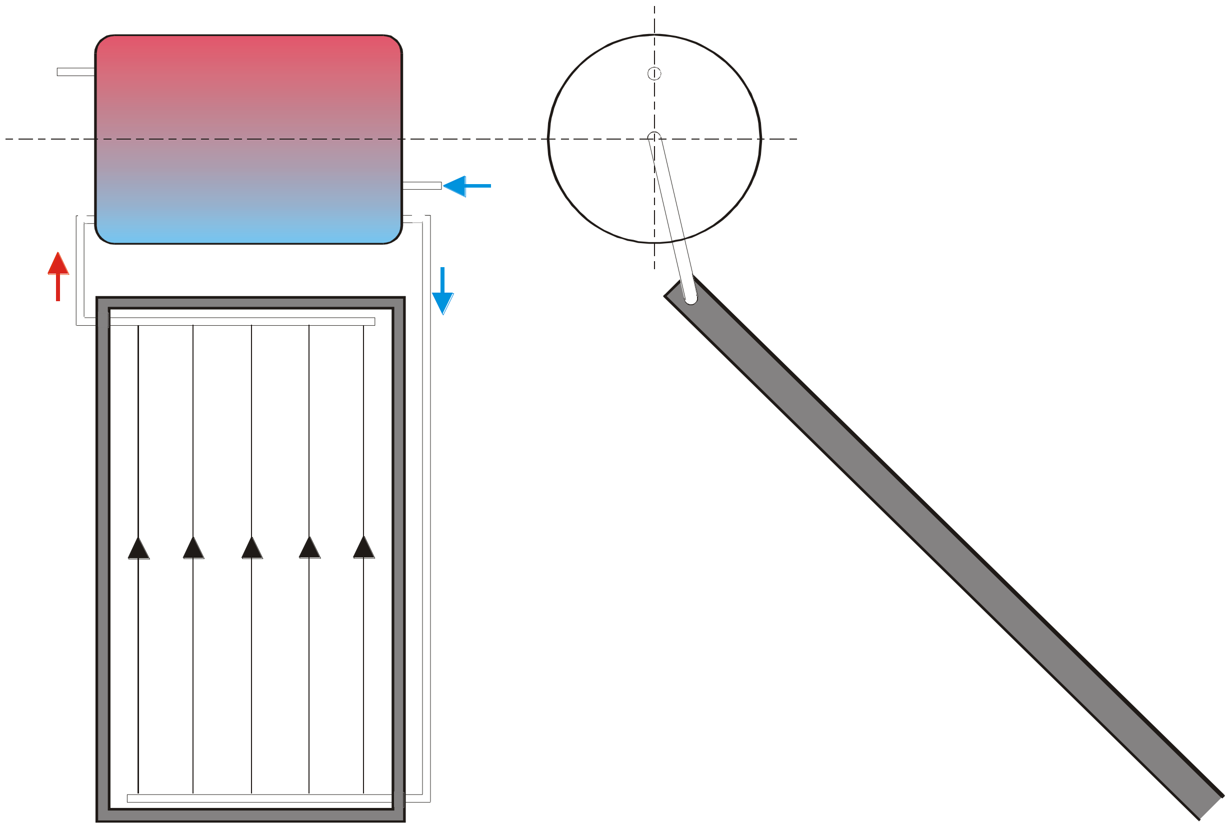


Source: http://www.outilssolaires.com/Glossaire/prin-4installations.htm

Principle of a direct system with vertical storage tank



Principle of a direct system with horizontal storage tank



Gravity driven systems

f_{sol} = 70 – 90%

700 – 1000 kWh/kW_{th}

Further Developments:

- Compactness
- Building integration
- Medium sized systems

Solar Water Heating Systems

Source: Solahart

1 Million Solar Water Heaters Programme, South Africa

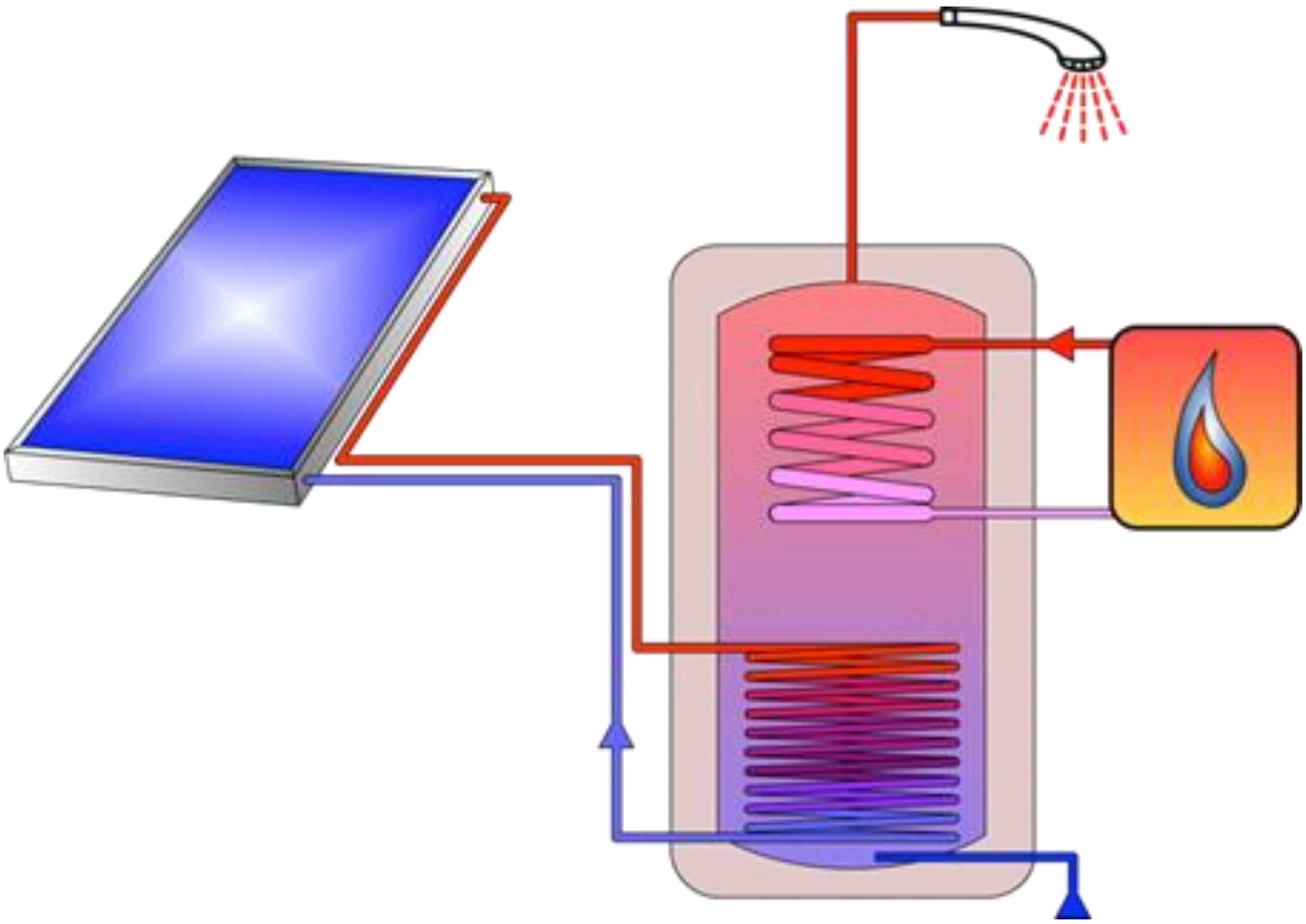
THERMOSYPHON SYSTEM - Namibia

Source: AEE INTEC, Namibia Wildlife Resorts, Sesrim


CHINA

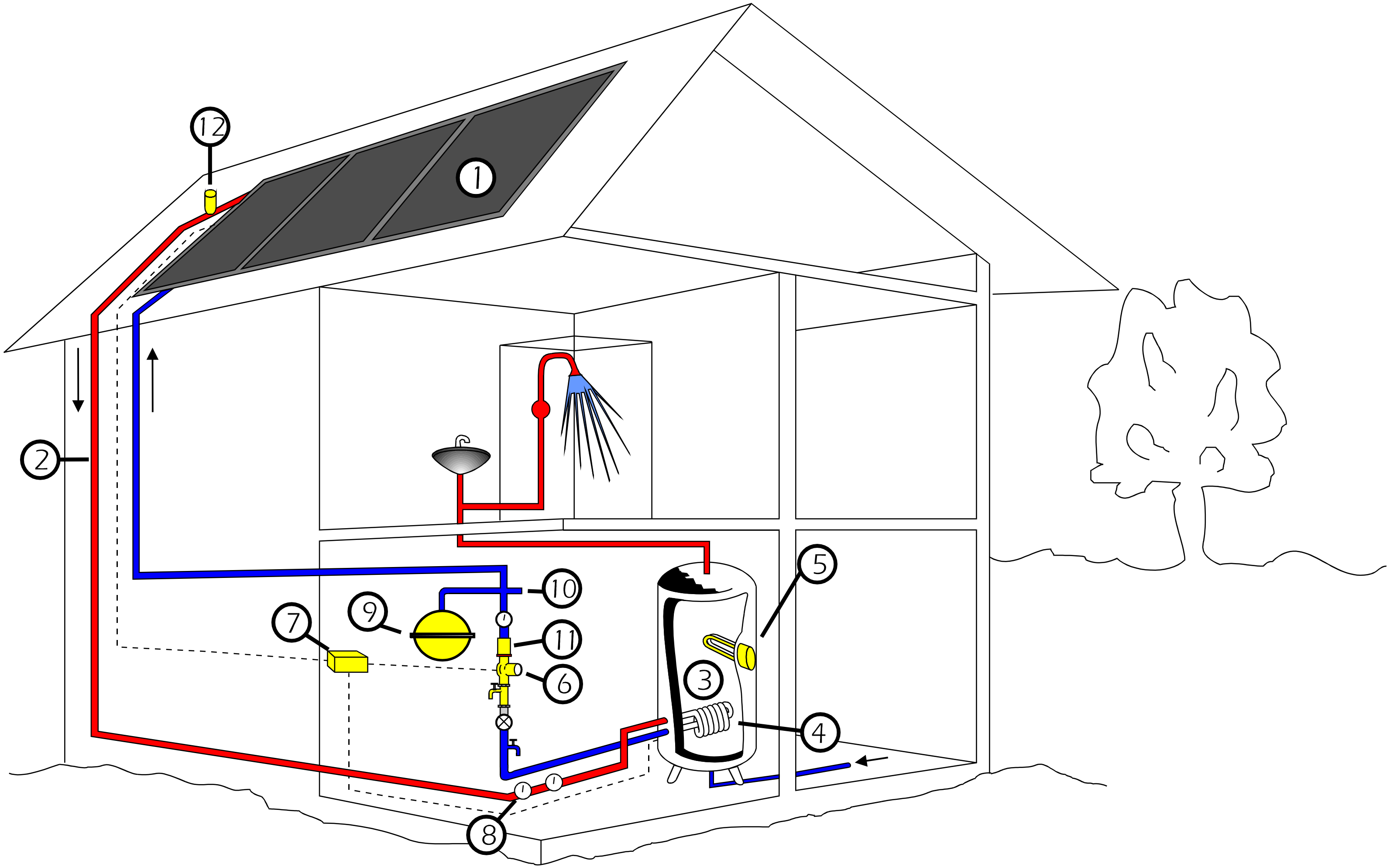
Solar Water Heating Systems

Forced circulated system for domestic hot water preparation

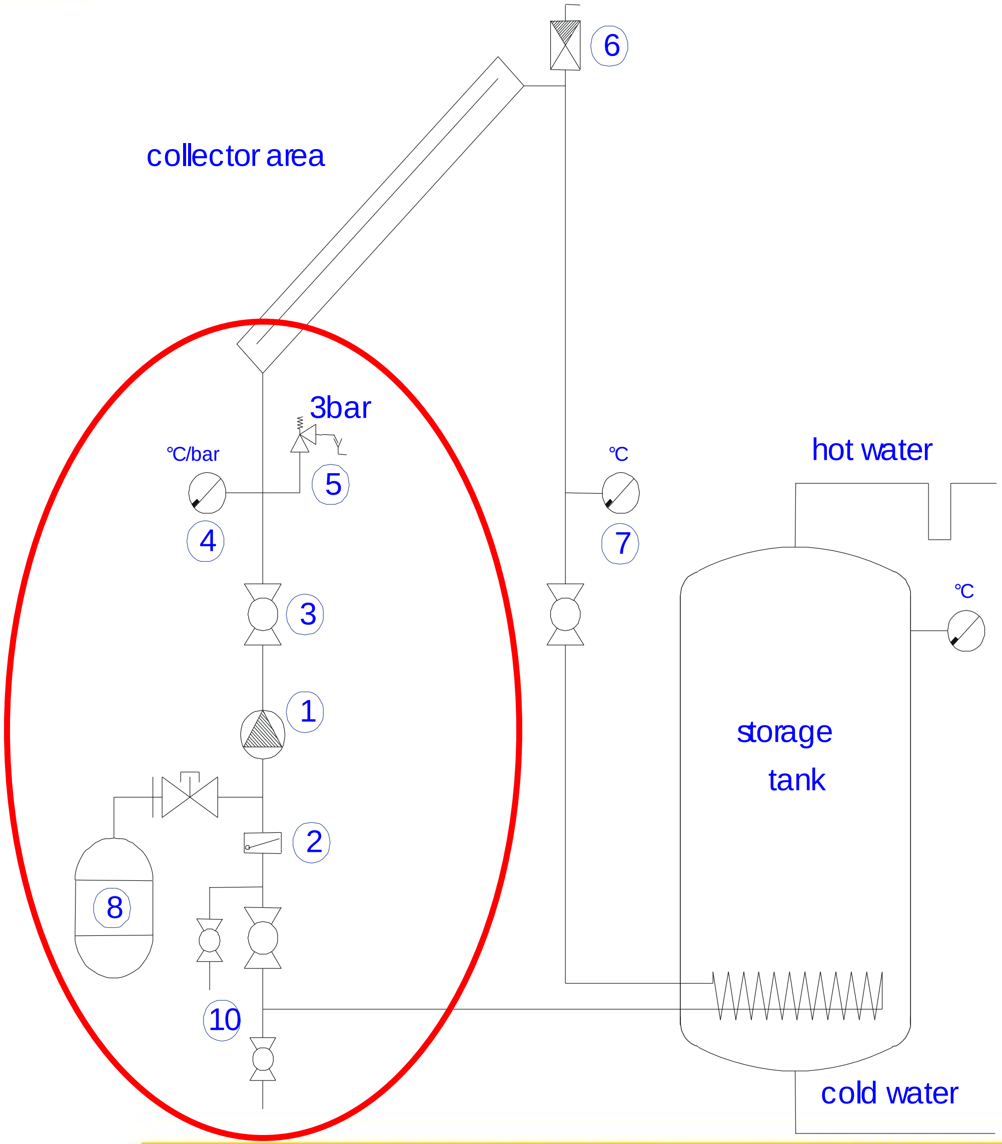


Source: ESTTP - SRP

Domestic Hot Water System with Forced Circulation

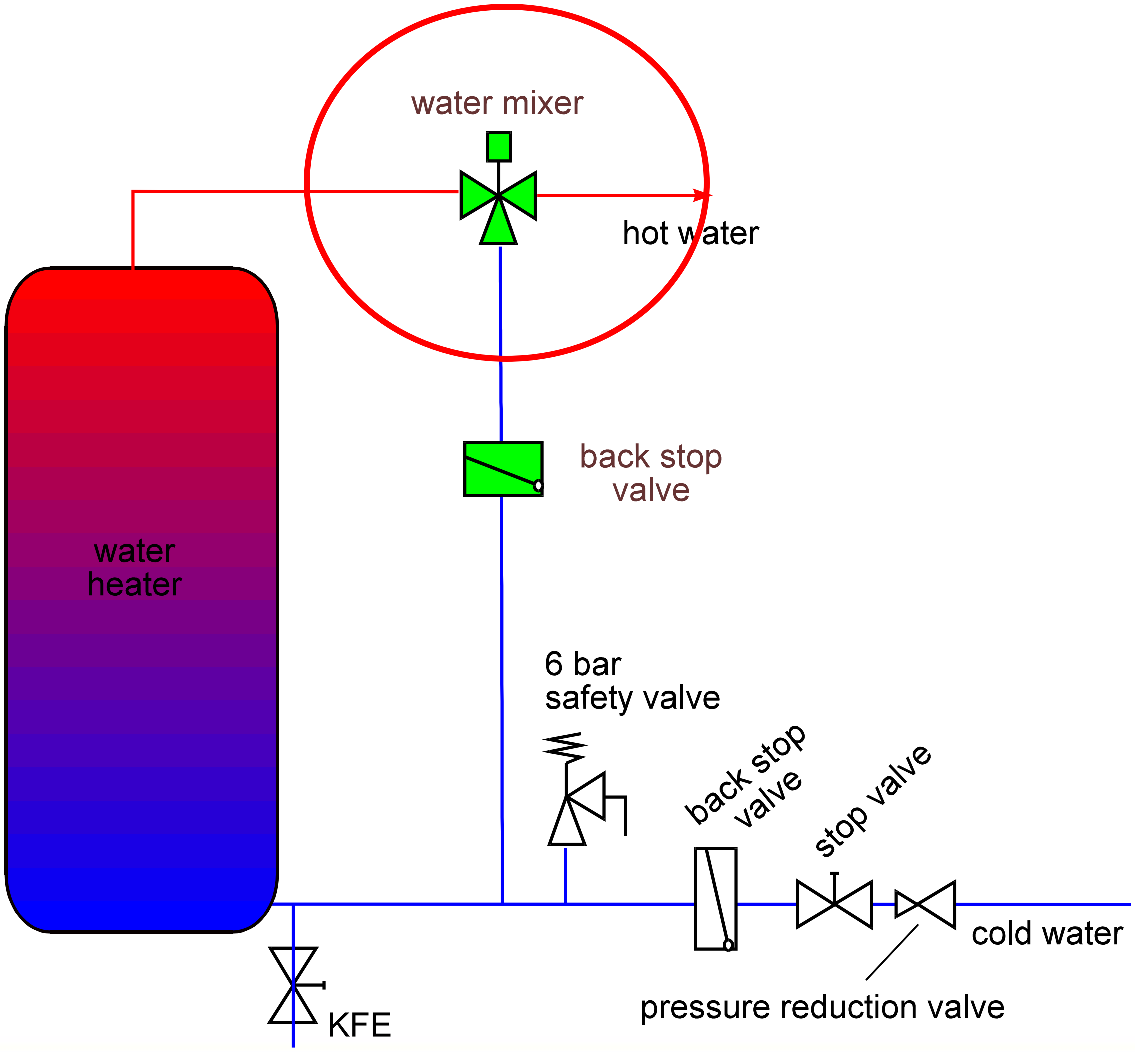


Hydraulic scheme of a hot water system with forced circulation

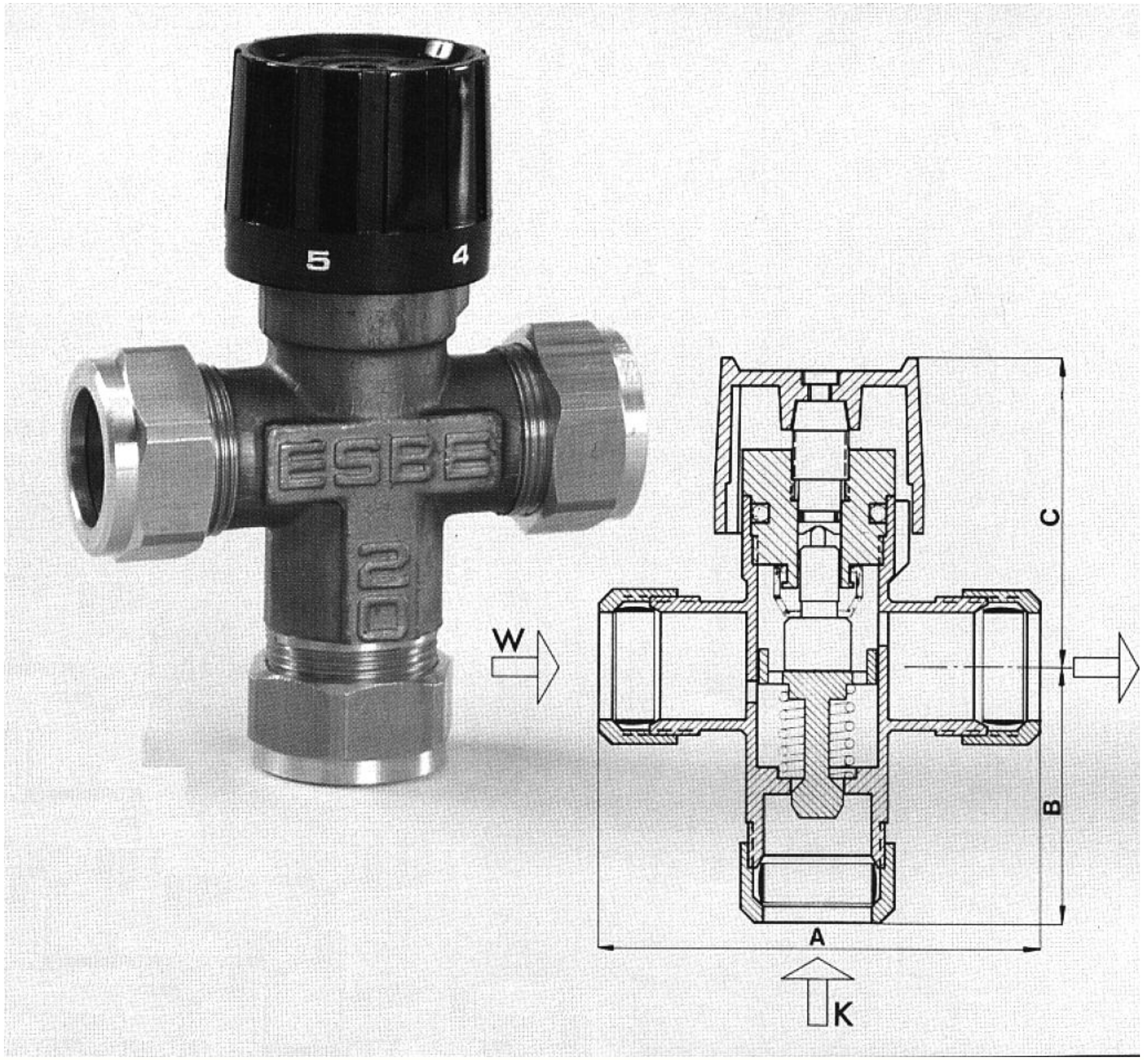


1 circulation pump
2 gravity brake
3 lock valve
4 thermometer and pressure gauge
5 pressure relief valve
6 escape valve
7 thermometer
8 expansion tank
9 fill and empty valve

HOT WATER MIXING VALVE



DOMESTIC HOT WATER-MIXING VALVE



Safety Valve

Savety valve

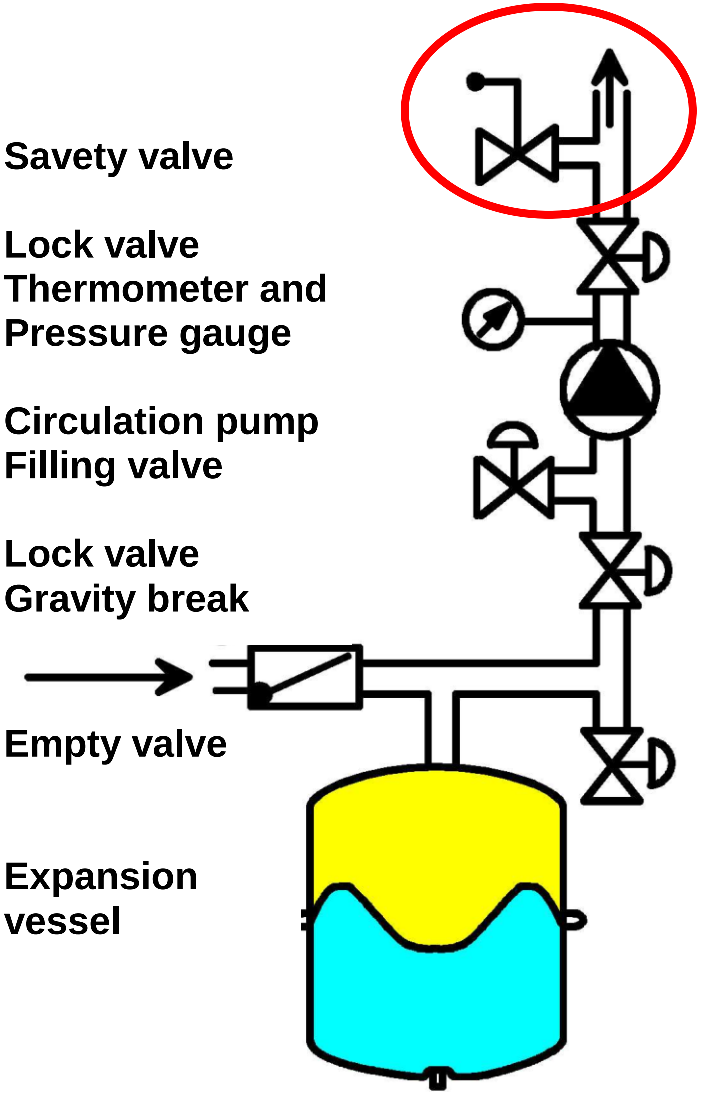
Lock valve
Thermometer and Pressure gauge

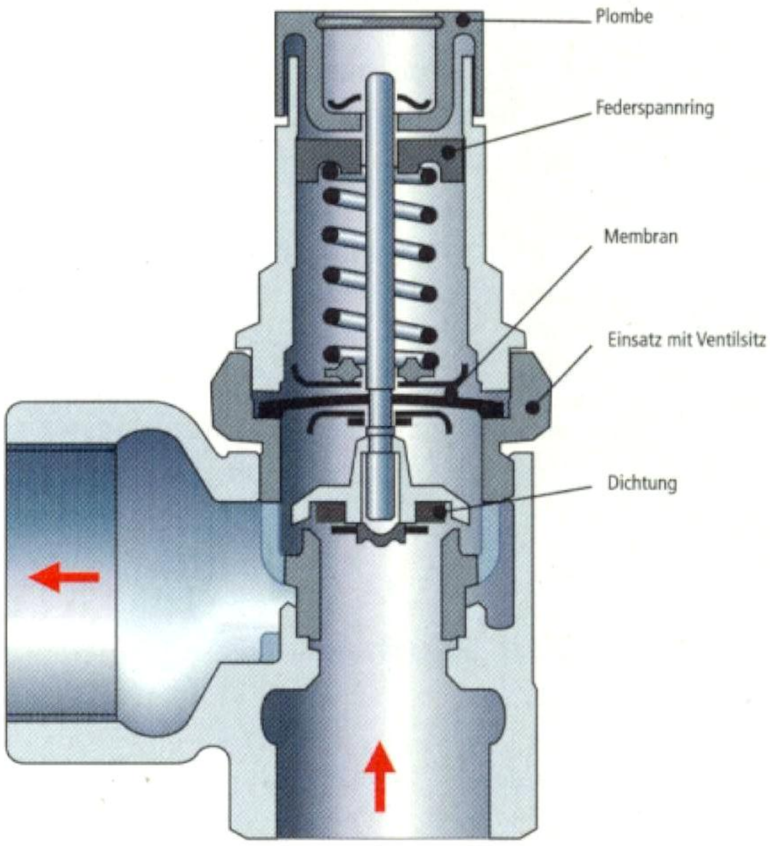
Circulation pump
Filling valve

Lock valve
Gravity break

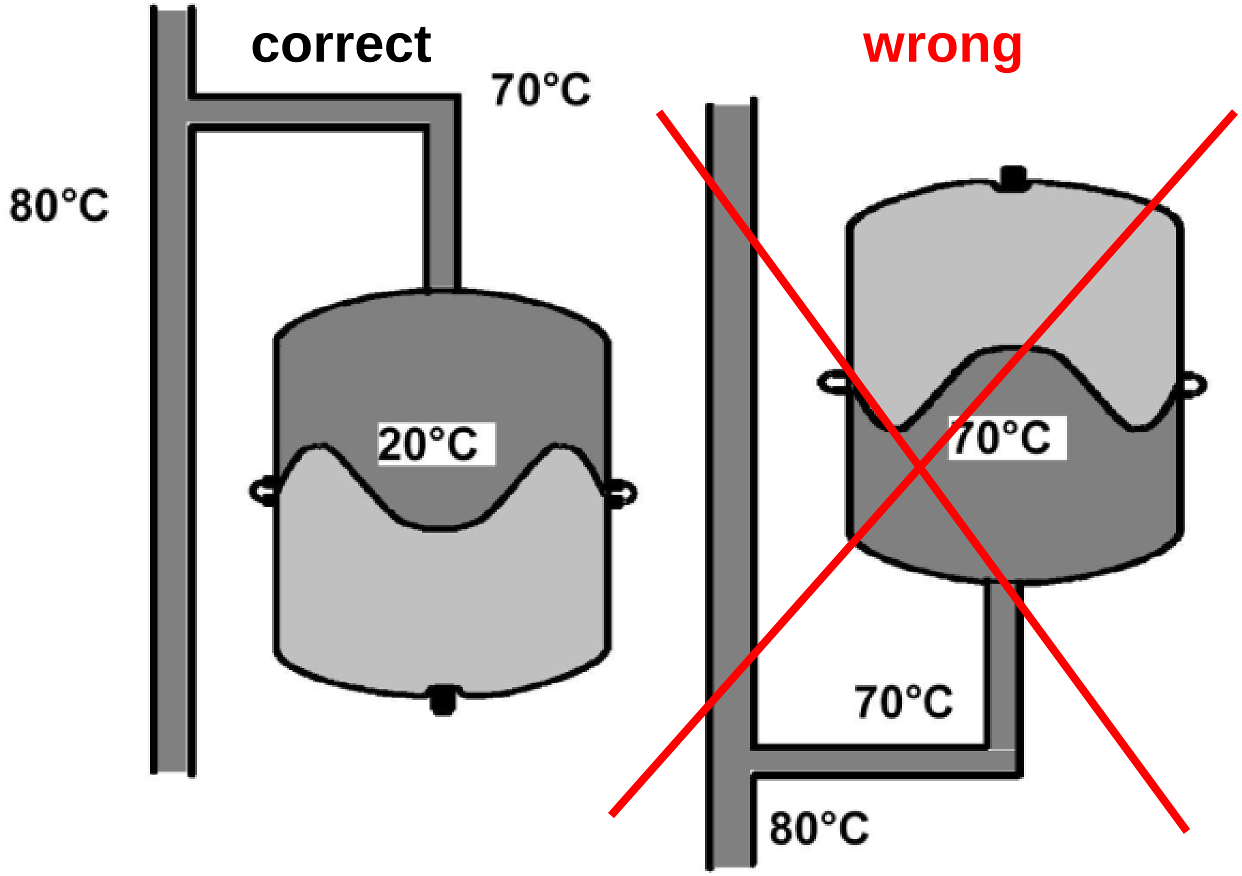
Empty valve

Expansion vessel





EXPANSION VESSEL

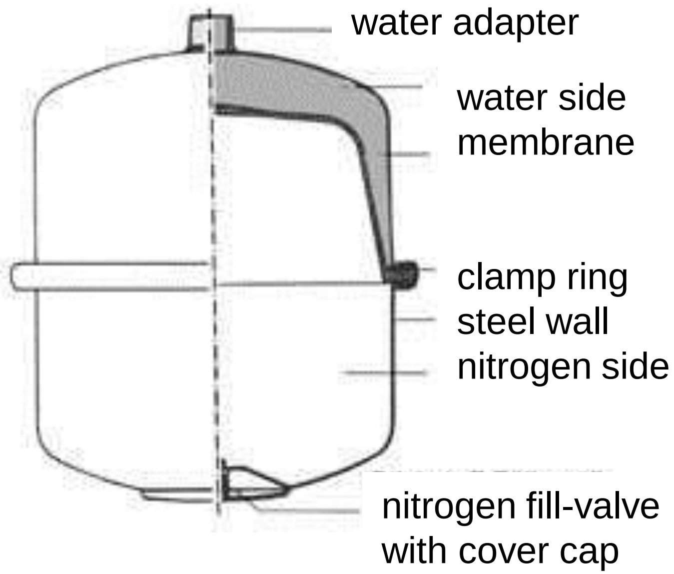


Mode of operation

- In order to keep the increase in pressure in all cases of operation **at least 20% below the responding pressure** of the security valve the expansion vessel has to contain

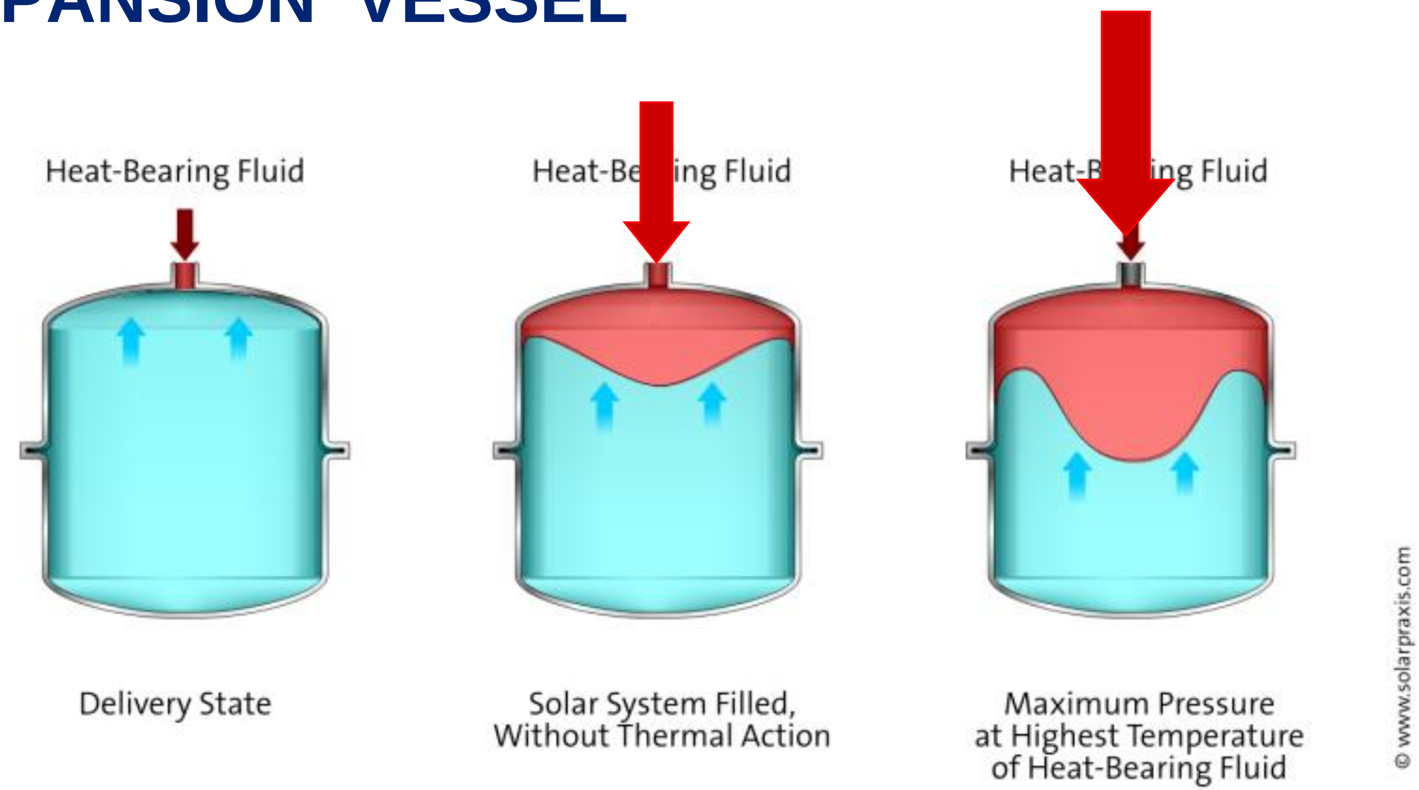
1. the expansion volume of the heat transfer fluid
2. the overall vapour volume (VD) at the state of stagnation

General - MEV



- Adjustment of the Nitrogen-pre-pressure prior to the installation
- Annual check of the pressure
- Hanging installation with not insulted copper pipe
- Installation before the pump and after the non-return valve
- Membrane has to be resistant against glycol (anti-freeze fluid)

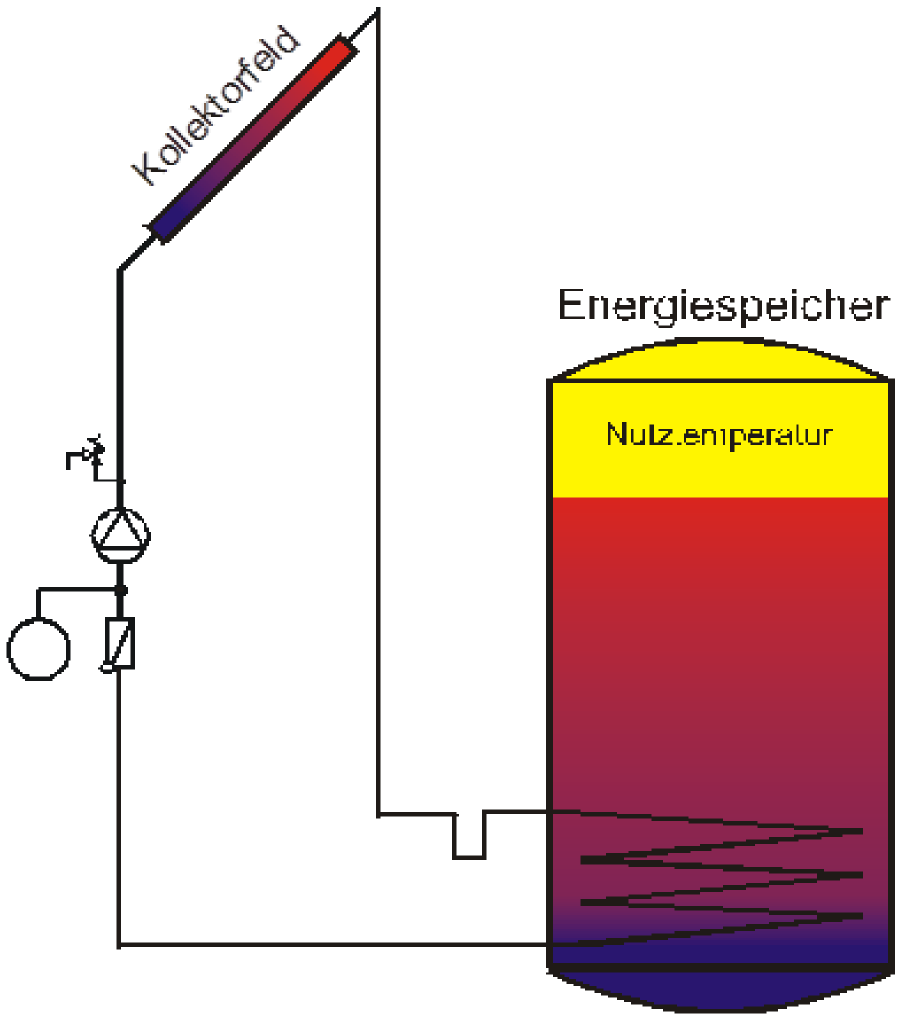
EXPANSION VESSEL



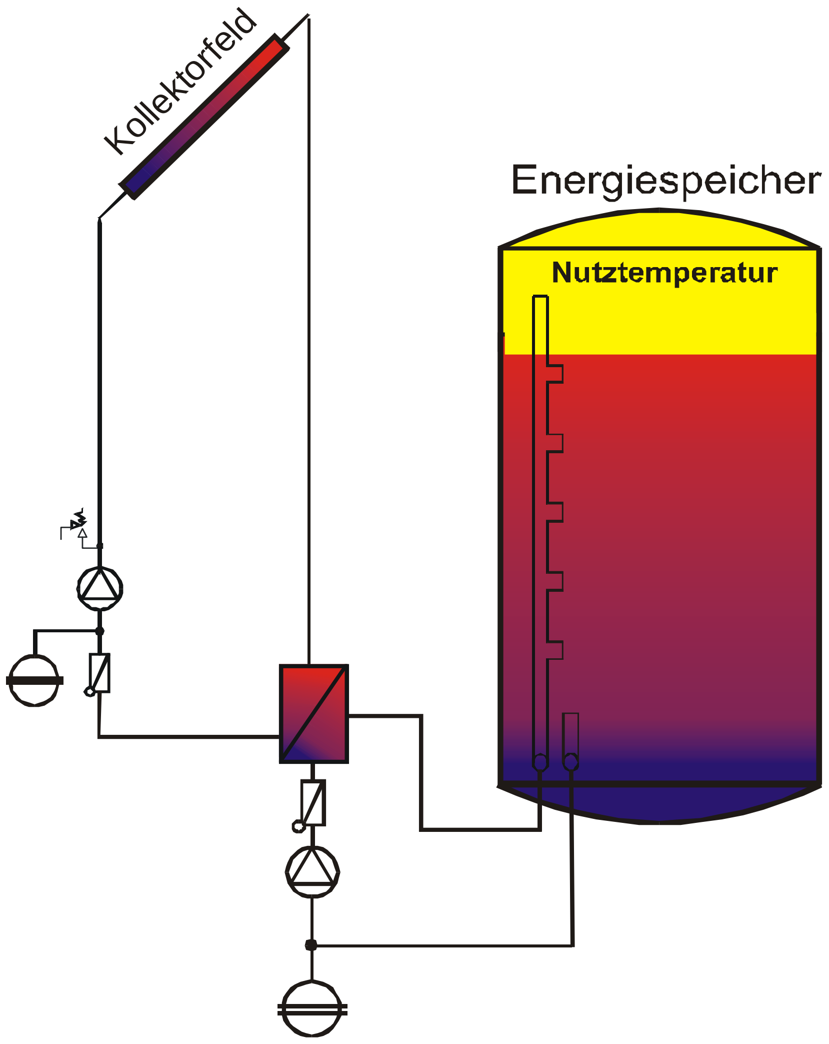
1) Delivery state
2) Normal working condition
3) Max. pressure (3 – 6 bar)

EXPANSION VESSEL

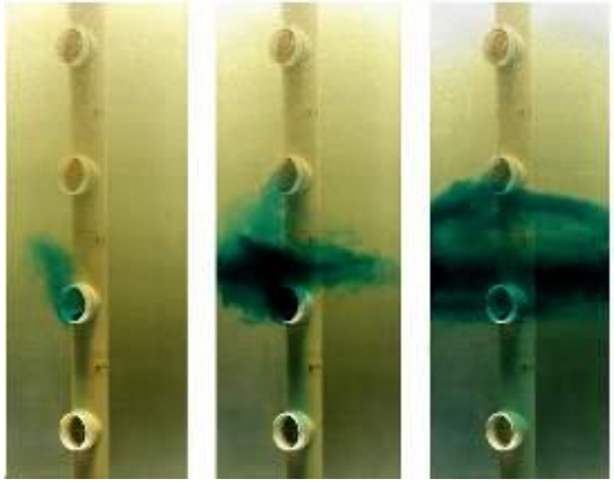
Hydraulic scheme of a high flow system

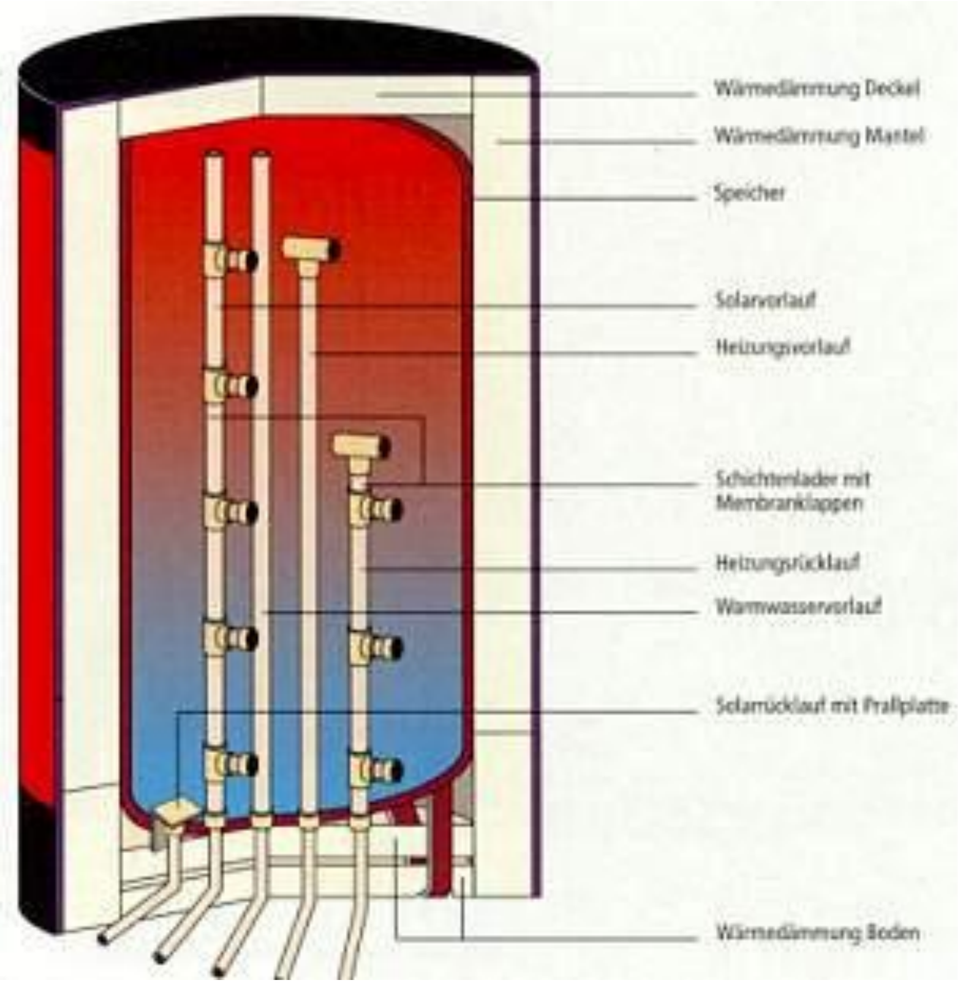


Hydraulic scheme of a low flow system with stratified charging of the heat store



Stratified charging of the heat store





Source: SOLVIS

Small-scale Systems for Hot Water Preparation

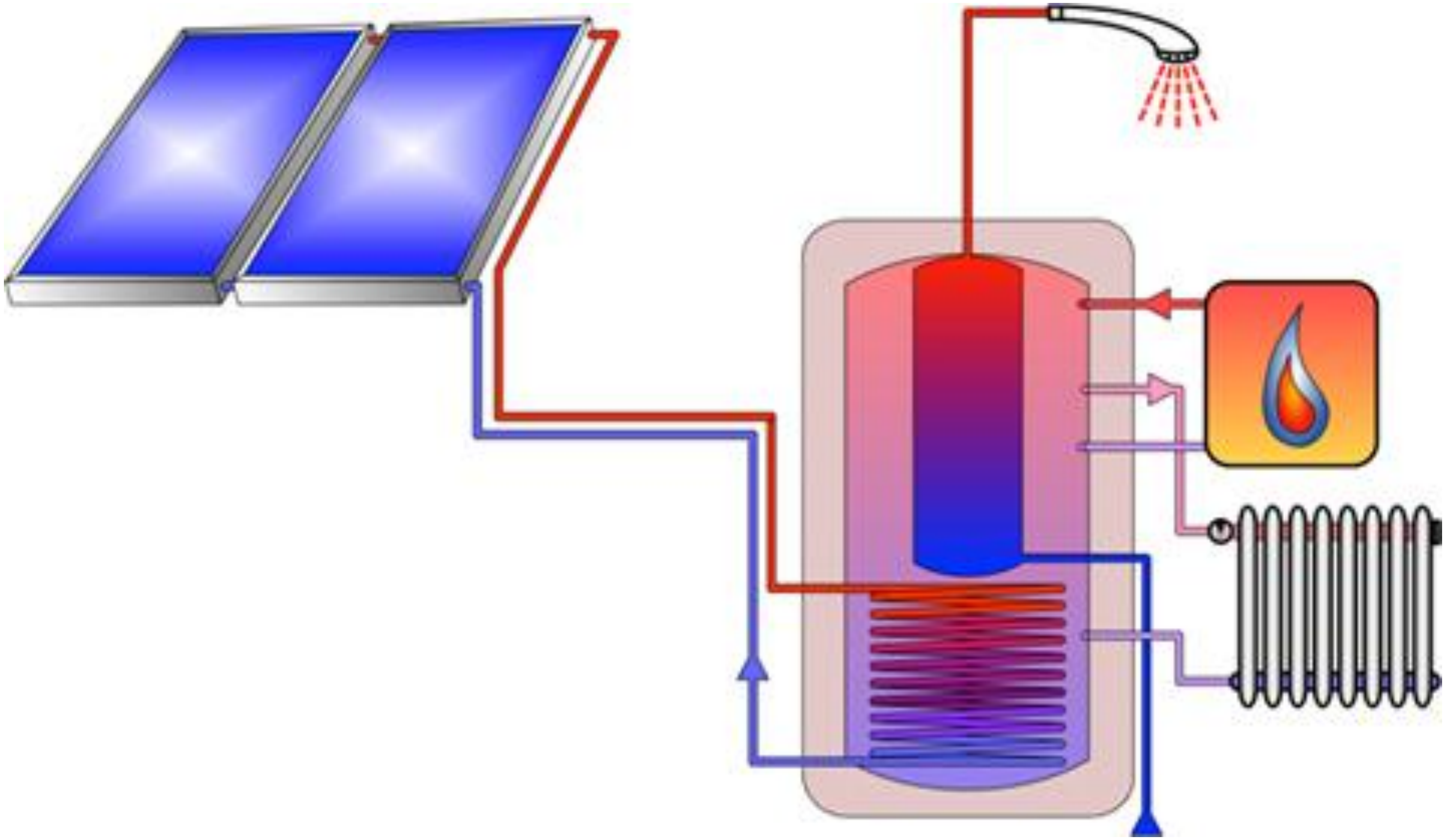
f_{sol} = 50 – 70%

500 – 650 kWh/kW_{th}

Further Developments:

- Compactness
- Kit Systems

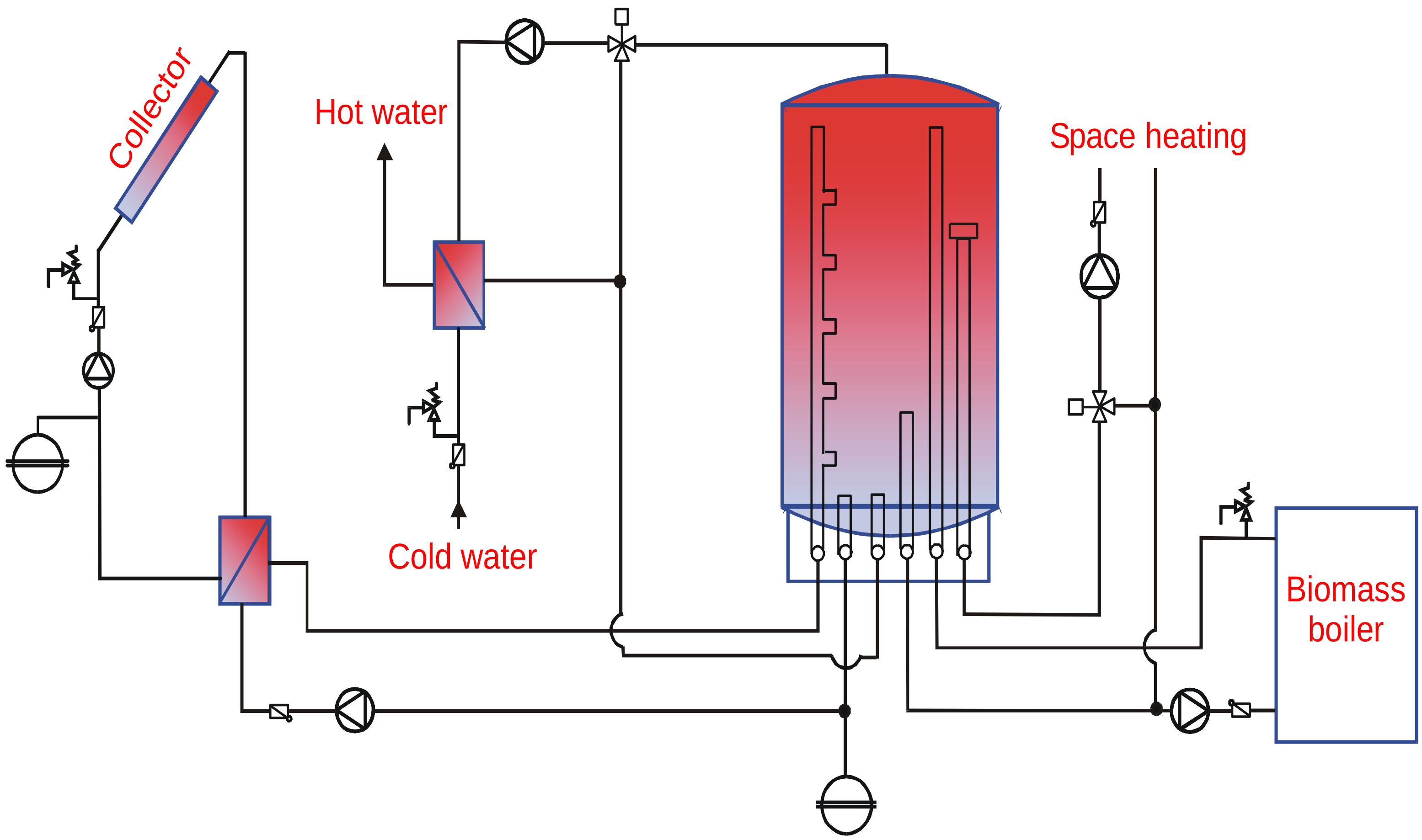
Solar thermal combi-system for domestic hot water preparation and space heating



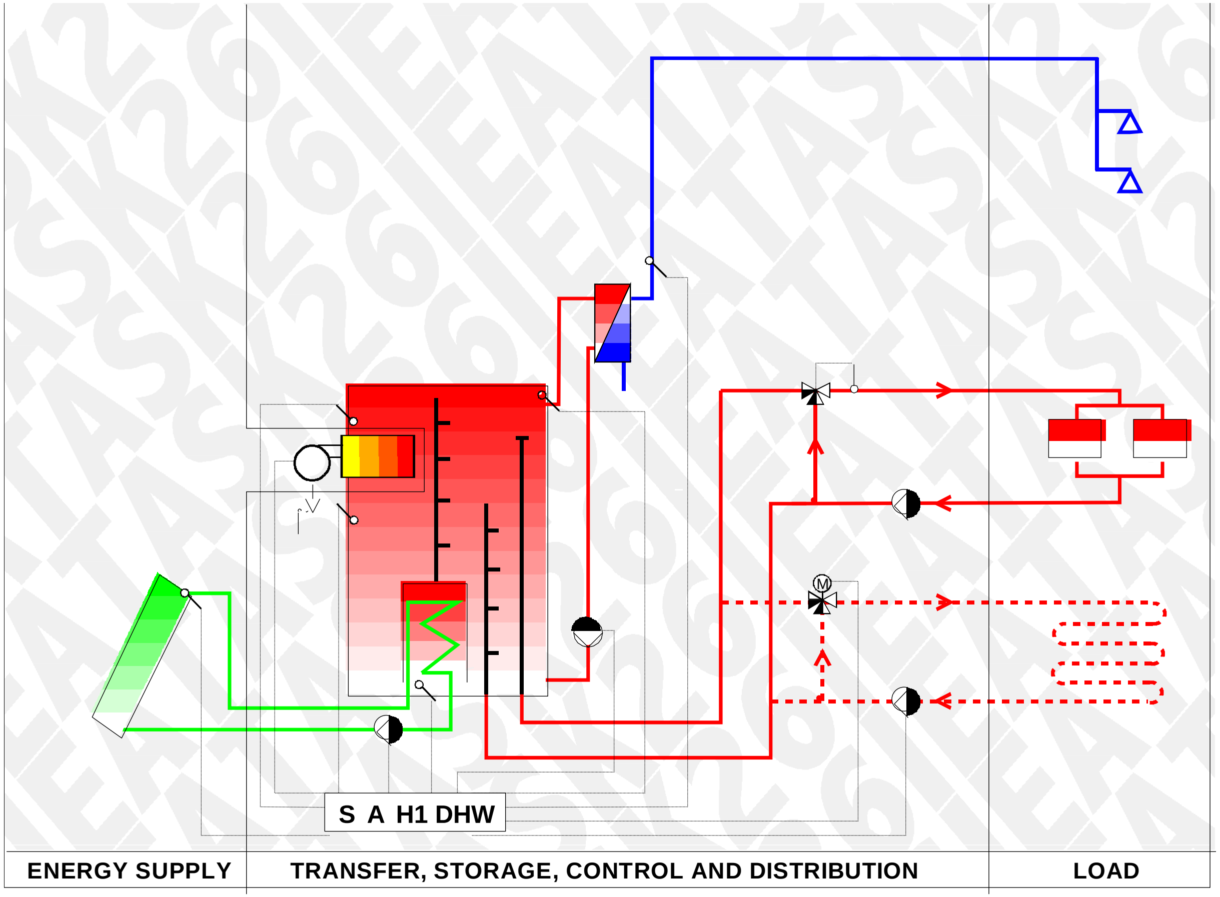
Source: ESTTP - SRP

Source: Wolf GmbH

Hydraulic scheme of a solar combi-system for a single family house

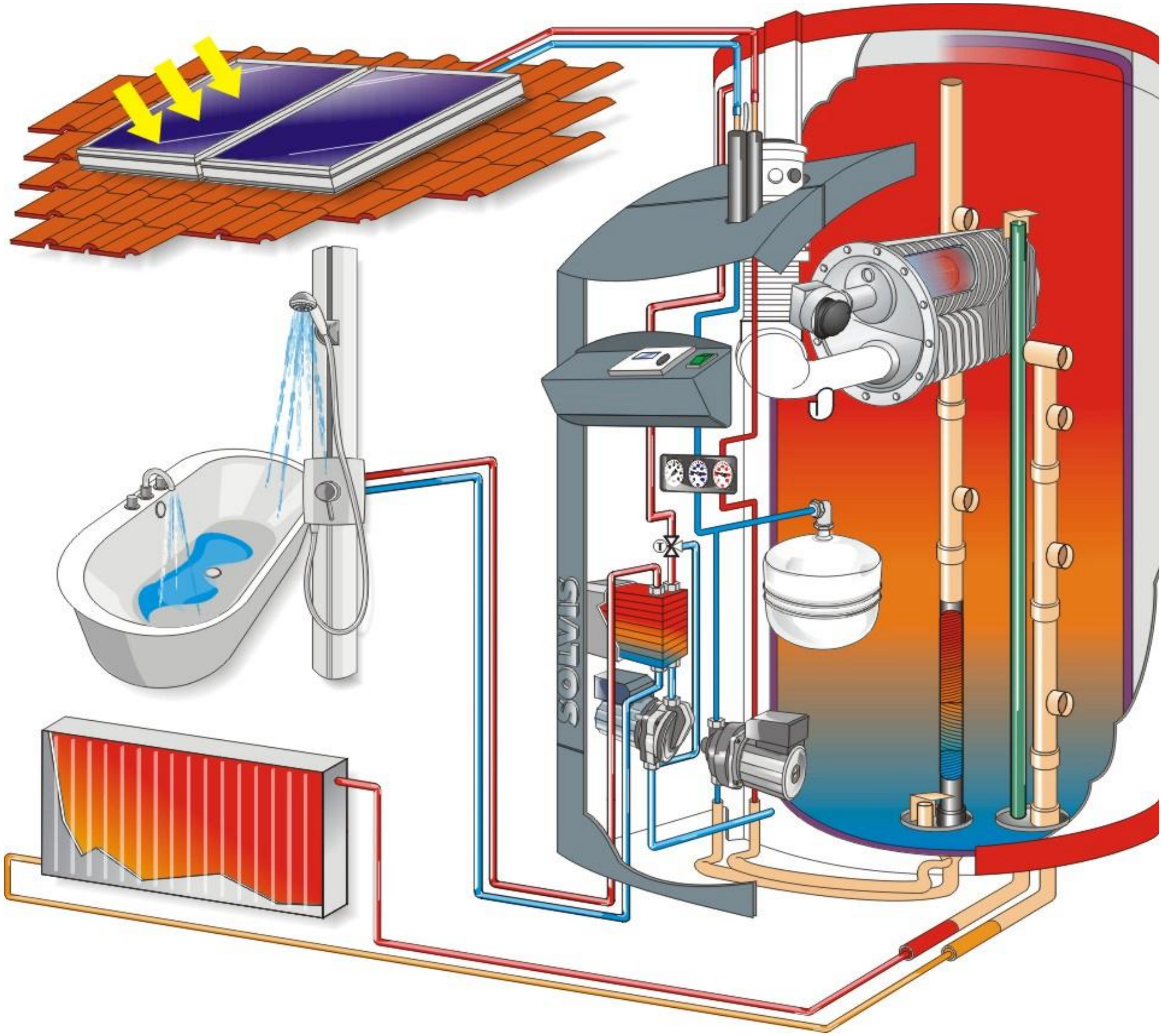


Advanced Solar Combi System



Source: Solarfocus

Advanced Solar Combi System



Solar Combi Systems for SFH

f_{sol} = 20 – 50%

450 – 550 kWh/kW_{th}

100% Solar Heated Houses
Multi family house Switzerland

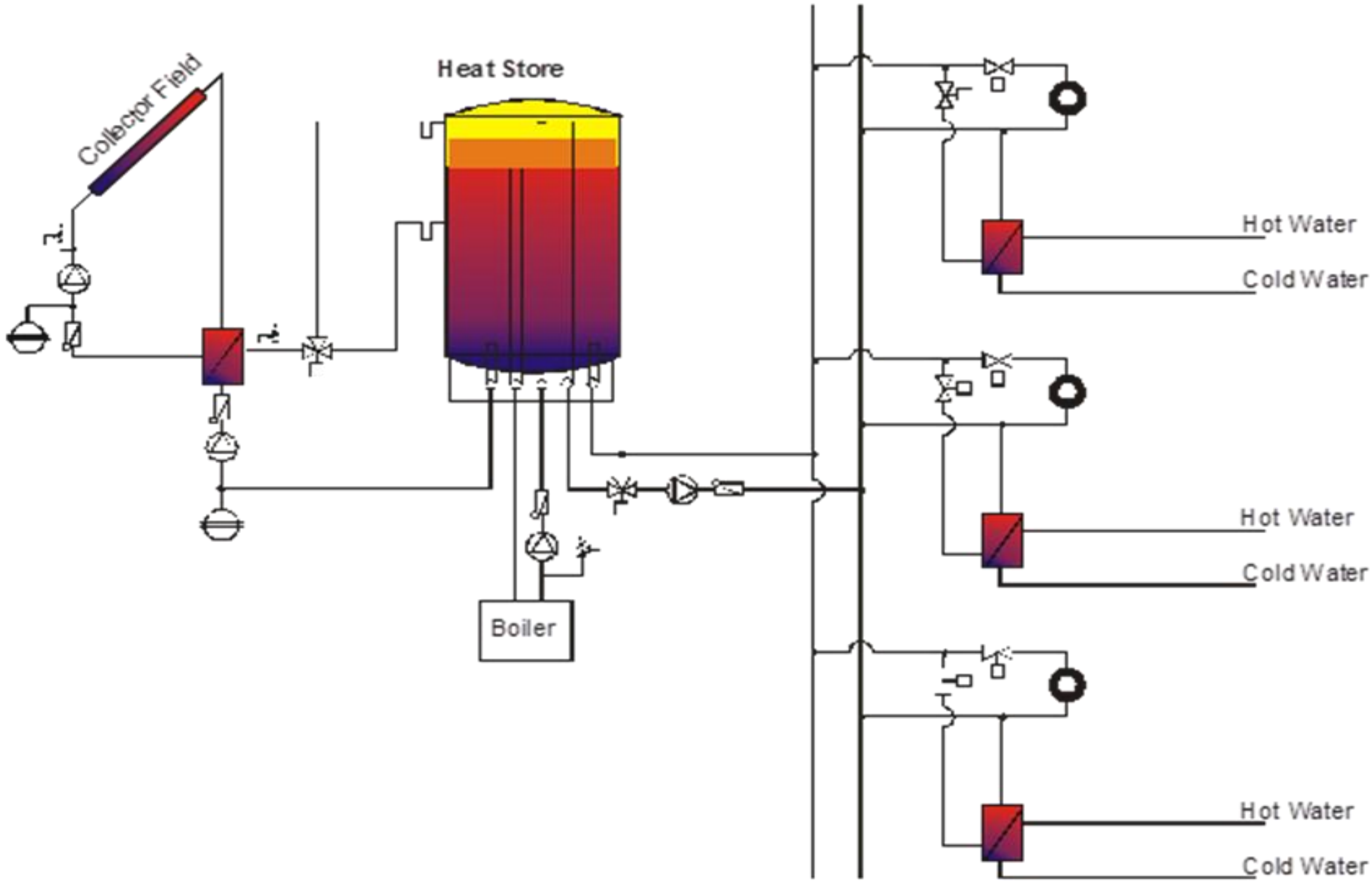
Solar thermal systems for the Hotel Sector

Solar thermal systems can be applied in hotels for:

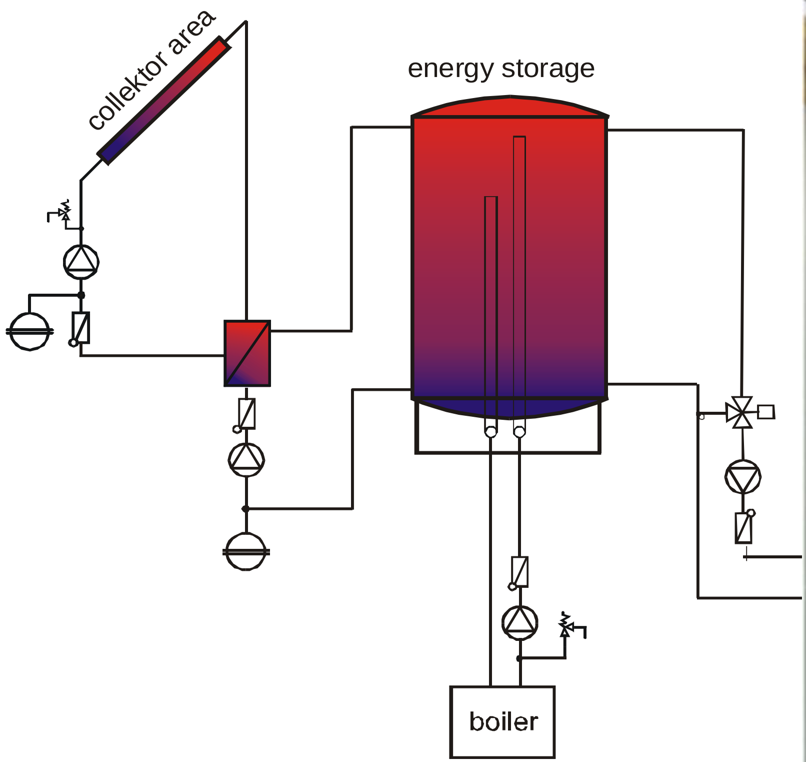
- Pool heating
- Hot water preparation for showers
- Hot water for kitchen and laundries
- Air conditioning and cooling
- Space heating

Solar thermal systems for the Hotel Sector

Hydraulic scheme for a hotel application



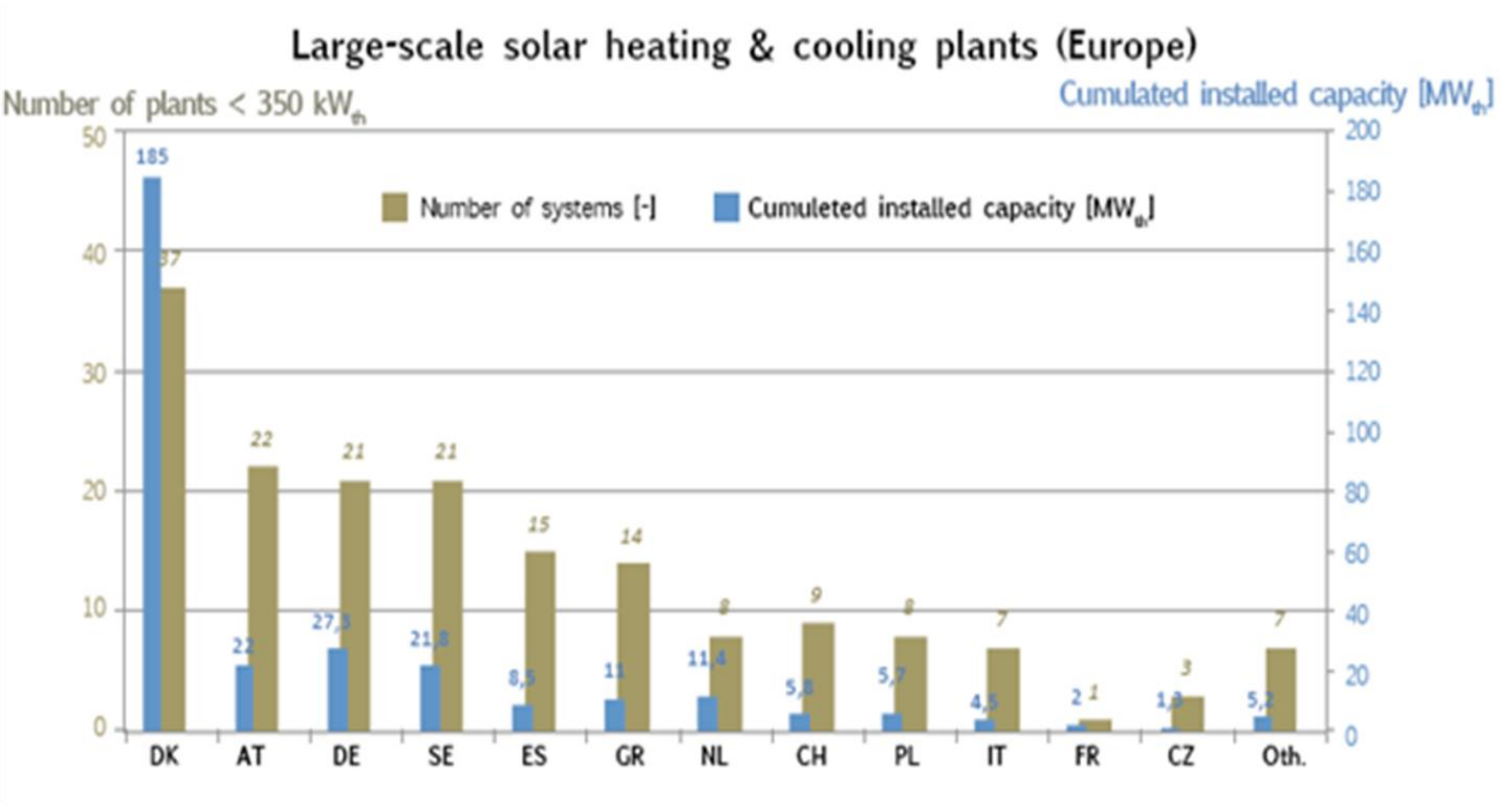
System with medium-term storage Gneis-Moos, A



Solar Assisted District Heating

Large-scale Systems in Europe

>350 kW_{th} / >500 m² (Status October 2012)



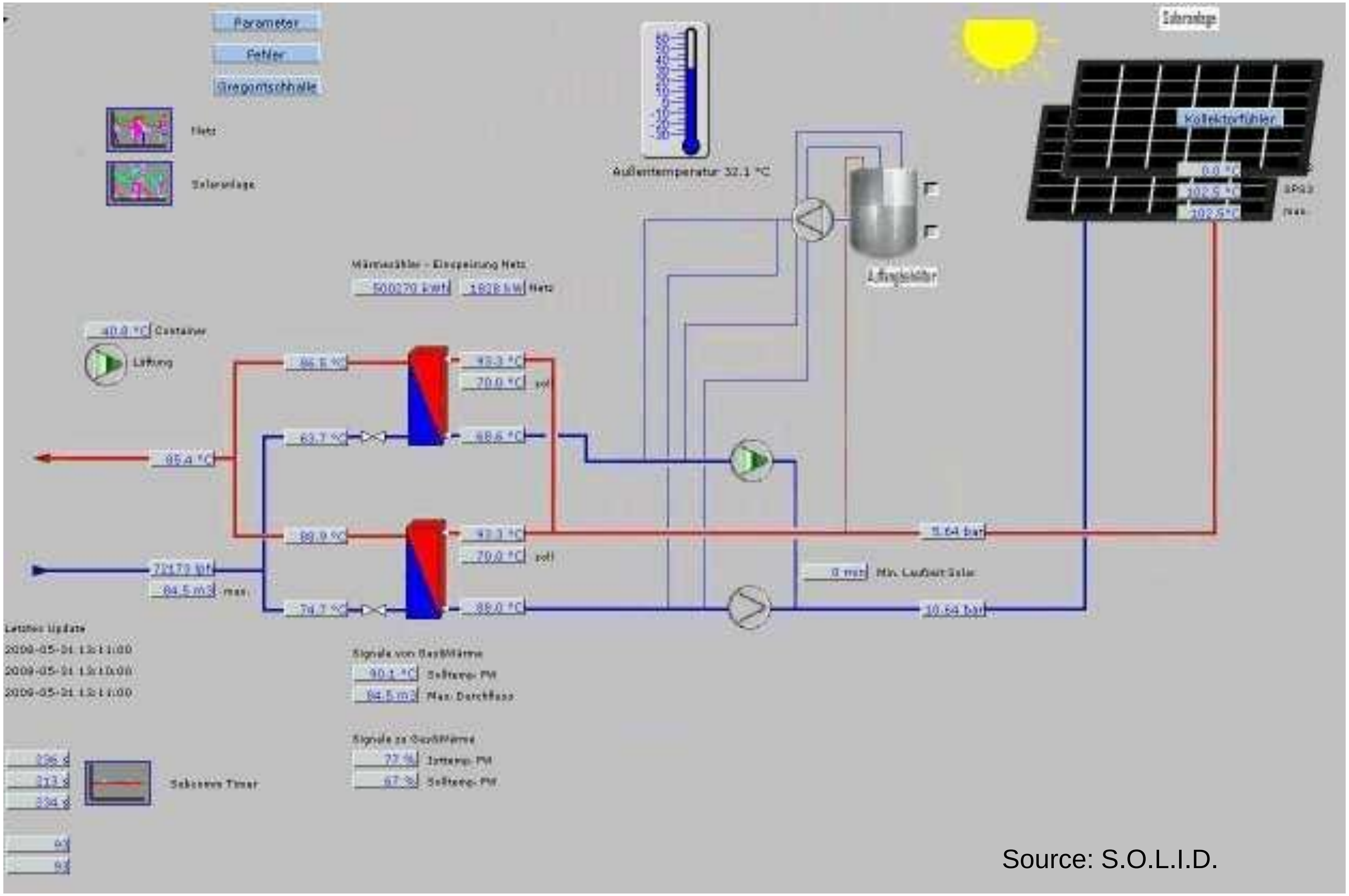
Source: *Jan-Olof Dalenbäck - Chalmers University of Technology*

District Heating – 1 MW_{th}, Graz, Austria

Source: S.O.L.I.D.

District Heating – 3,5 MW_{th}, AEVG, Graz, Austria

District Heating – 1 MW_{th}, Graz

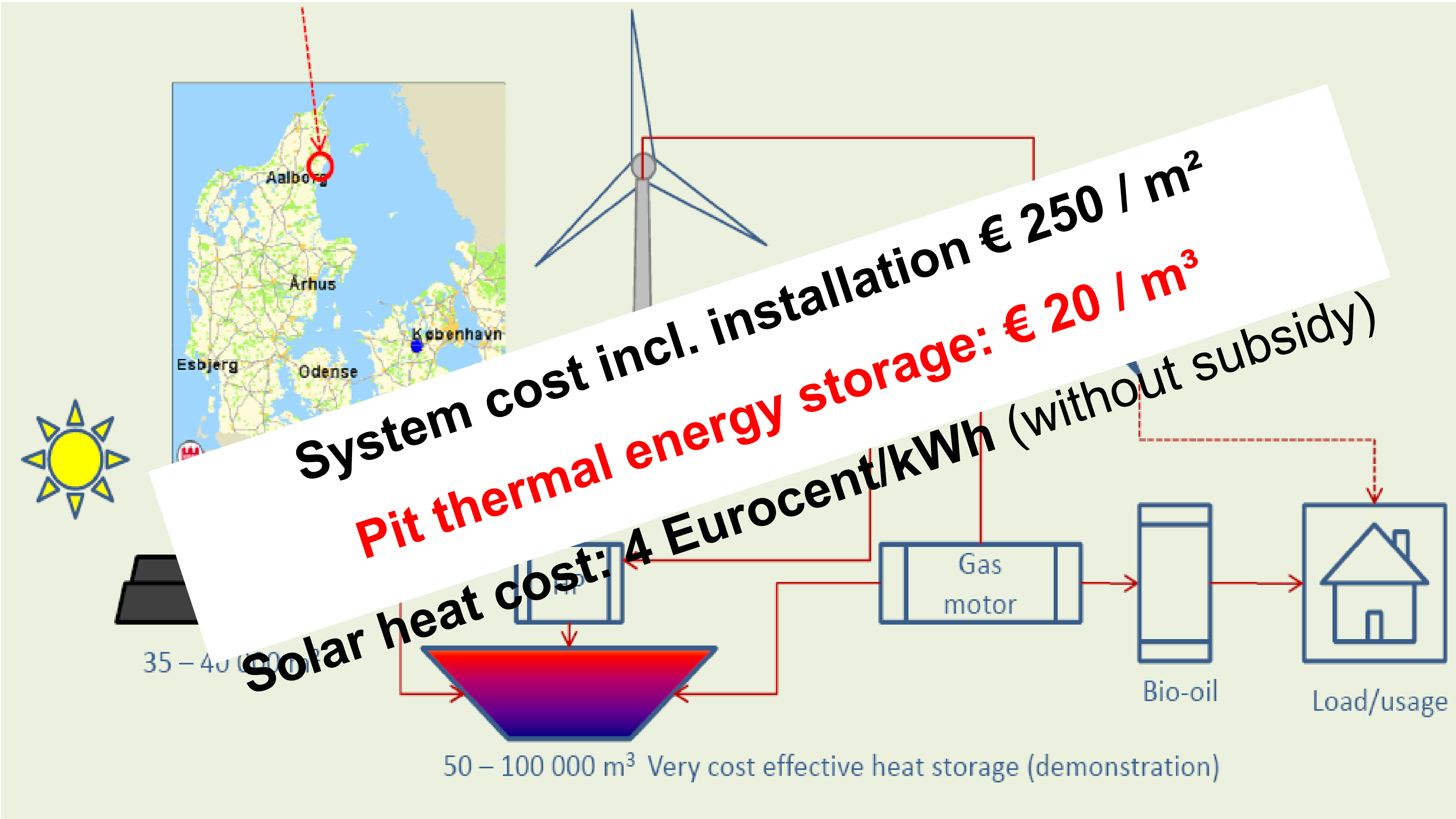


Source: S.O.L.I.D.

Hilleroed Solar District Heating, DK

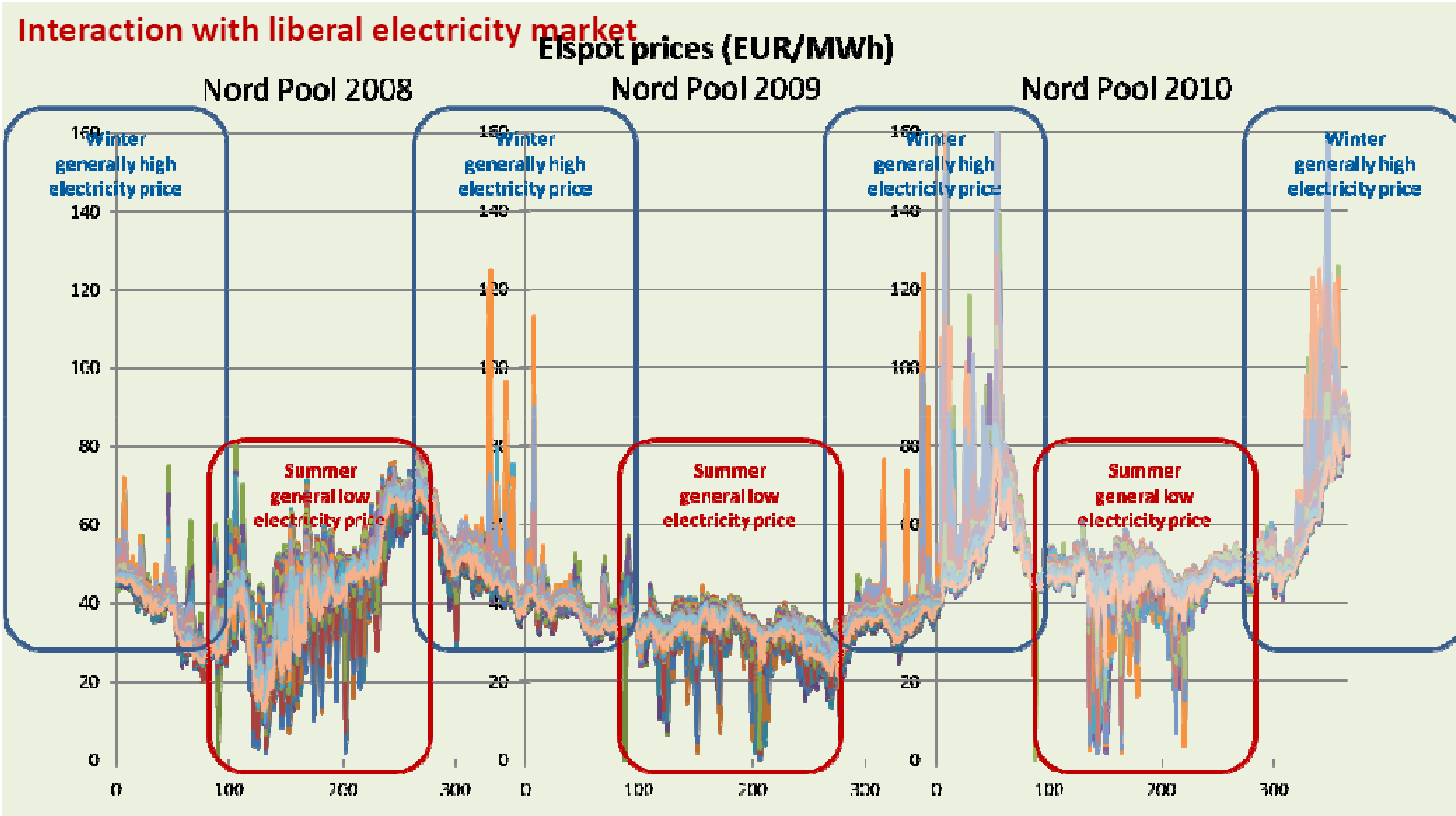
Source: http://www.altomsolvarme.dk/solvarmecenter/fotostore.htm

Smart District Heating Systems
Integration of heat and electrical grids



Source: Jan-Erik Nielsen, PlanEnergi, Cost source: SDH, Report „success factors in district heating, Dec 2010

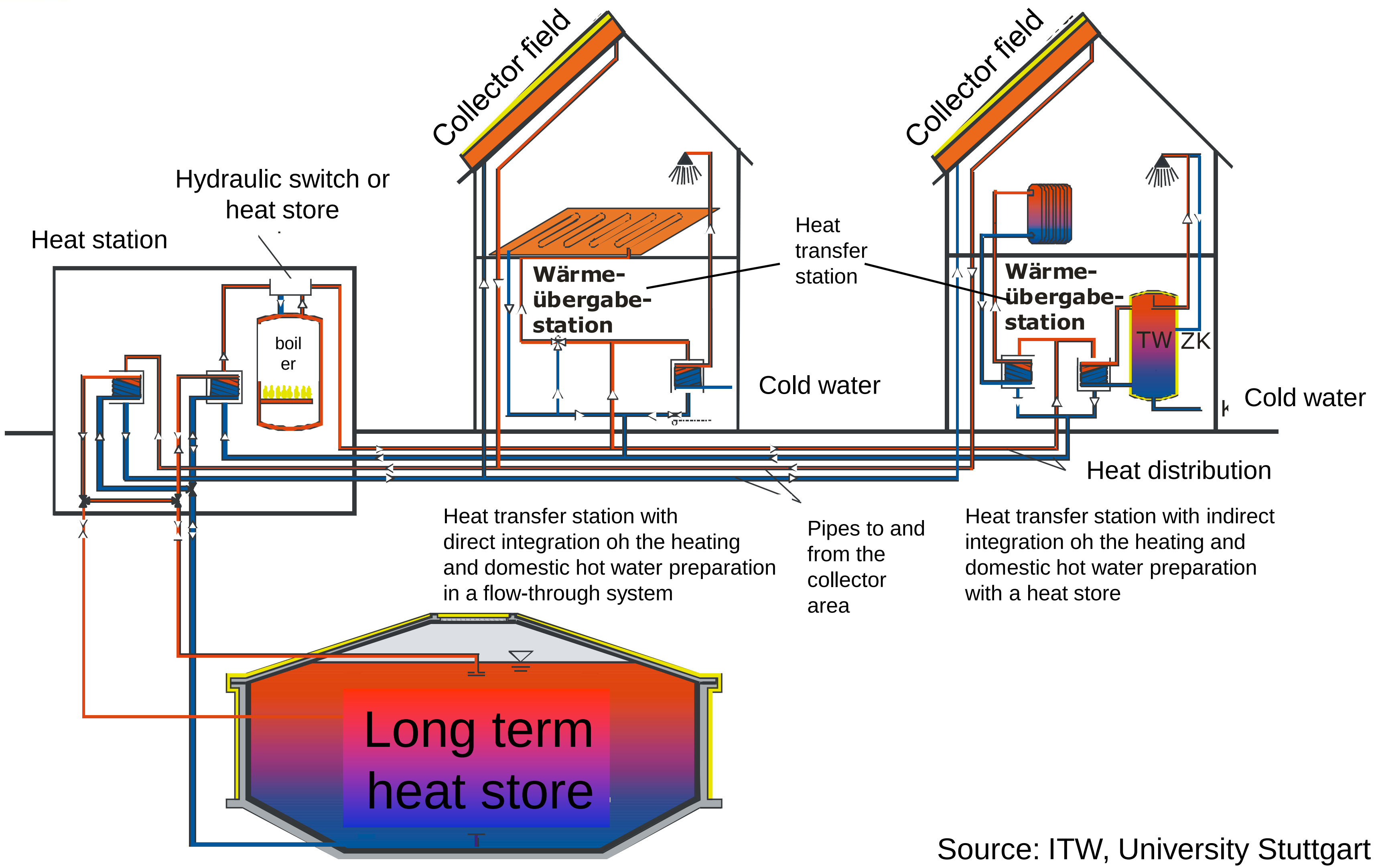
Electricity prices during the summer and winter period in Denmark



Local District Heating – Hamburg, Germany

Source: ITW, University Stuttgart

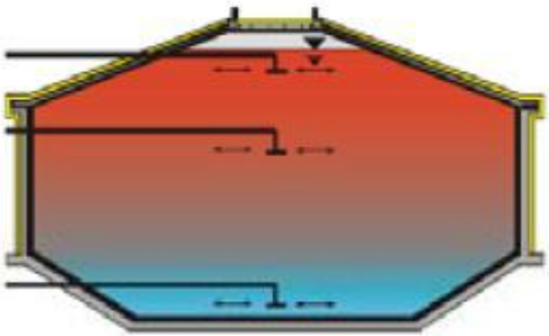
Local District Heating with Seasonal Storage



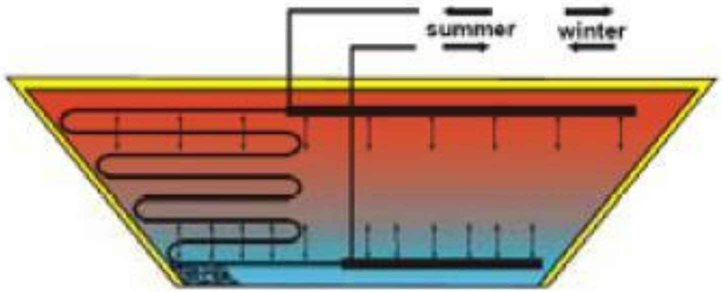
Source: ITW, University Stuttgart

Different types of seasonal storages (Source: ITW, Stuttgart University)

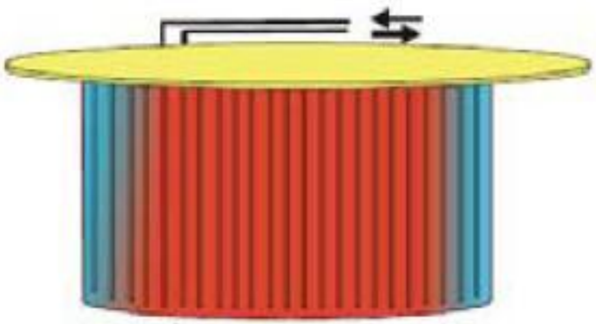
Hot-water thermal energy store



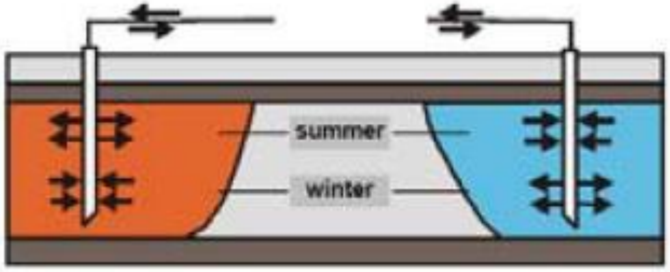
Gravel-water thermal energy store



Borehole thermal energy store



Aquifer thermal energy store



Large-scale district heating plants with seasonal storage

Plant, location Year in operation	**Collector Area** [m²]	**Capacity** [MW_{th}]	**Solar yield** [GWh/a]	**Heat store type**	**Load** [GWh/a]
Crailsheim, 2005	7,300	5.1	2.1	BTES / HP	4.1
Neckarsulm, 1997	5,670	4.0	1.5	BTES / HP	3.0
Friedrichshafen, 1996	4,050	2.8	1.4	CWT	3.0
Hamburg, 1996	3,000	2.1	0.8	CWT	1.6
Munich, 2007	2,900	2.0	1.1	CWT / HP	2.3
Augsburg, 1998	2,000	1.4	0.7	BTES	1.0

Legend: BTES: Borehole Thermal Energy Storage; HP: Heat Pump; CWT=Concrete Water Tank

Source: Dalenbäck, 2010

Canada - Drake Landing Solar Community

Drake Landing Solar Community Canada

Location: Okotoks, Alberta, Canada

Number of homes: 52

Collector area: 2,293 m^2 (1.6 MWth)

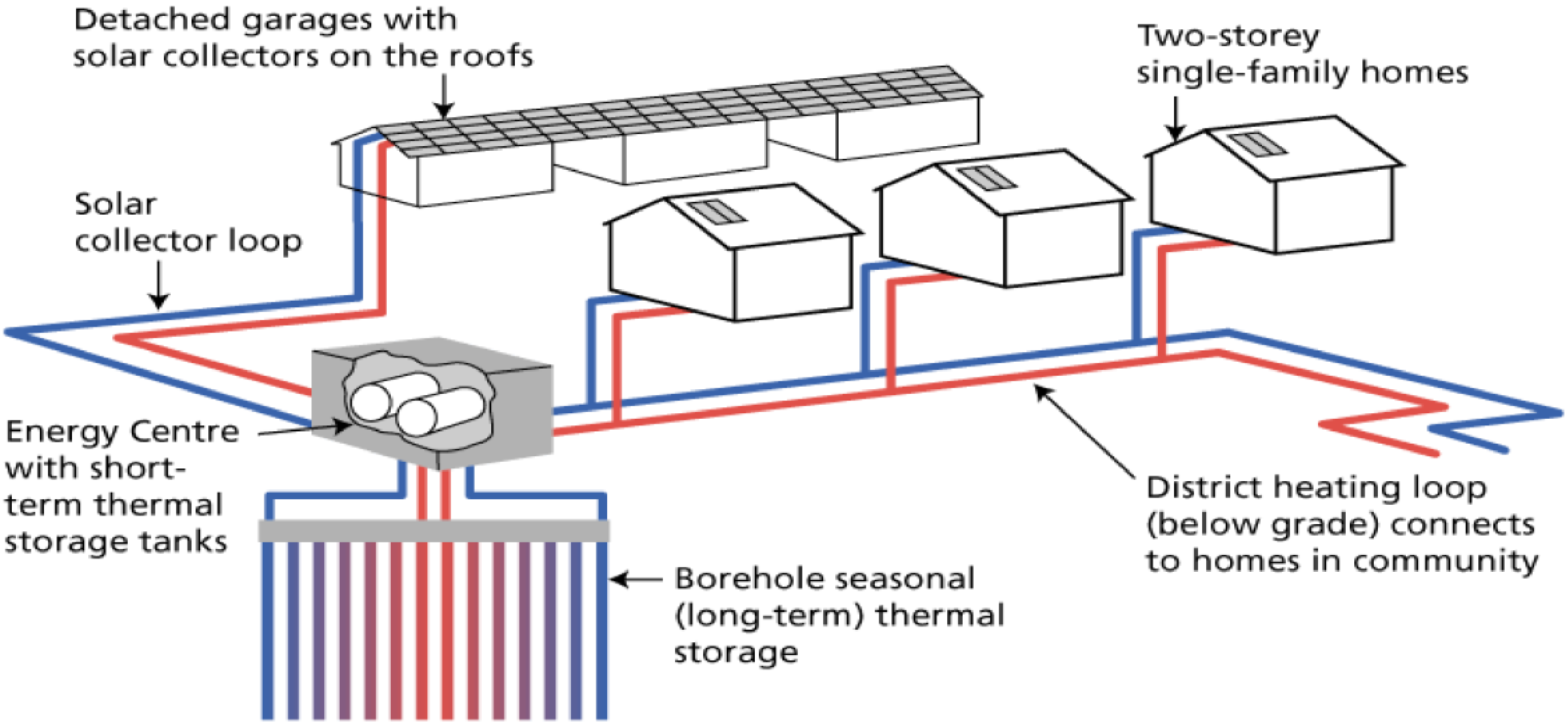
Addition independent solar domestic hot water systems for each home

Short-term storage tank: 2 x 120 m^3 steel tanks

Borehole thermal energy storage: 34,000 m^3 earth, 144 boreholes

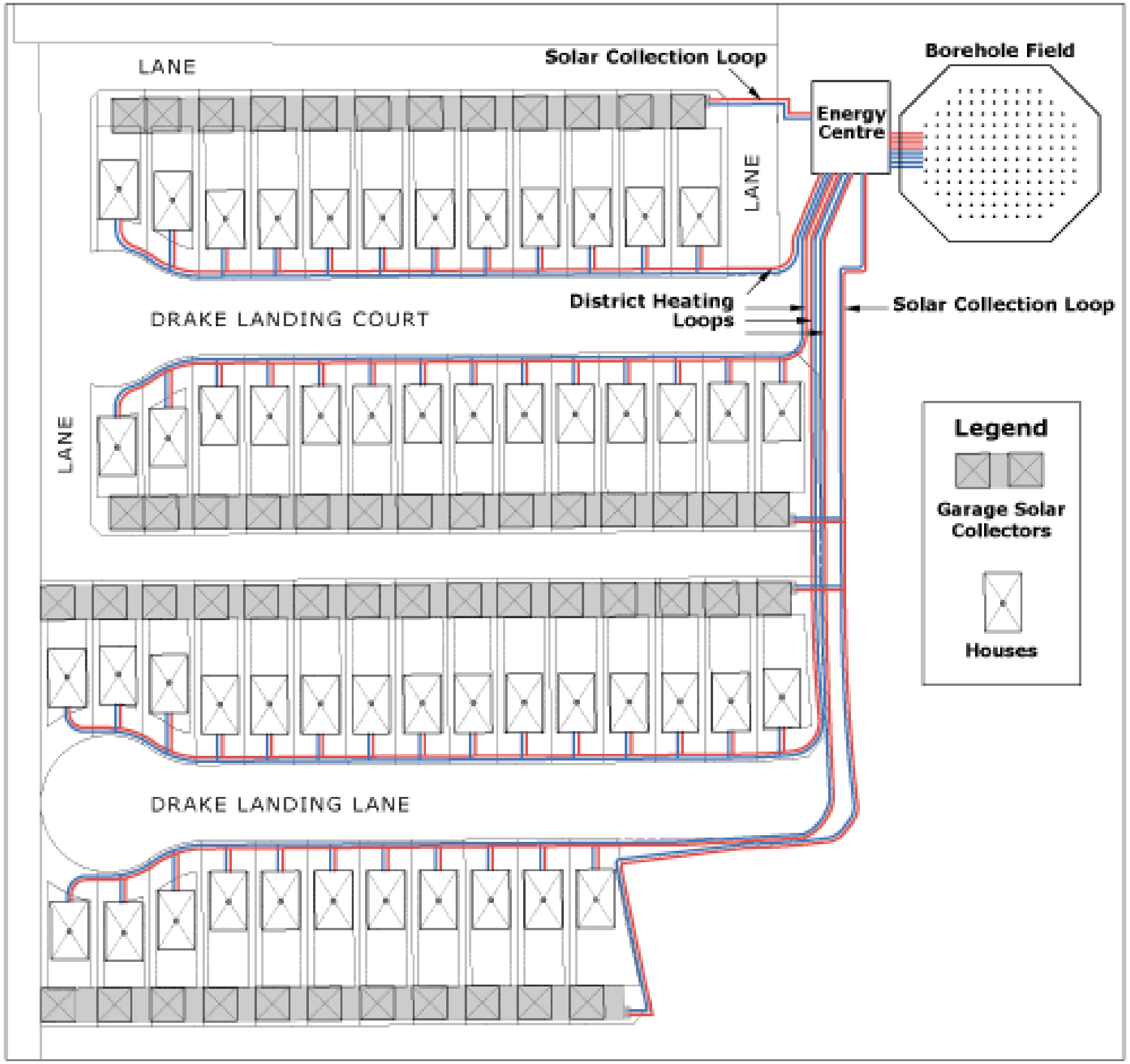
Commissioning: July 2007

Solar Seasonal Storage and District Heating

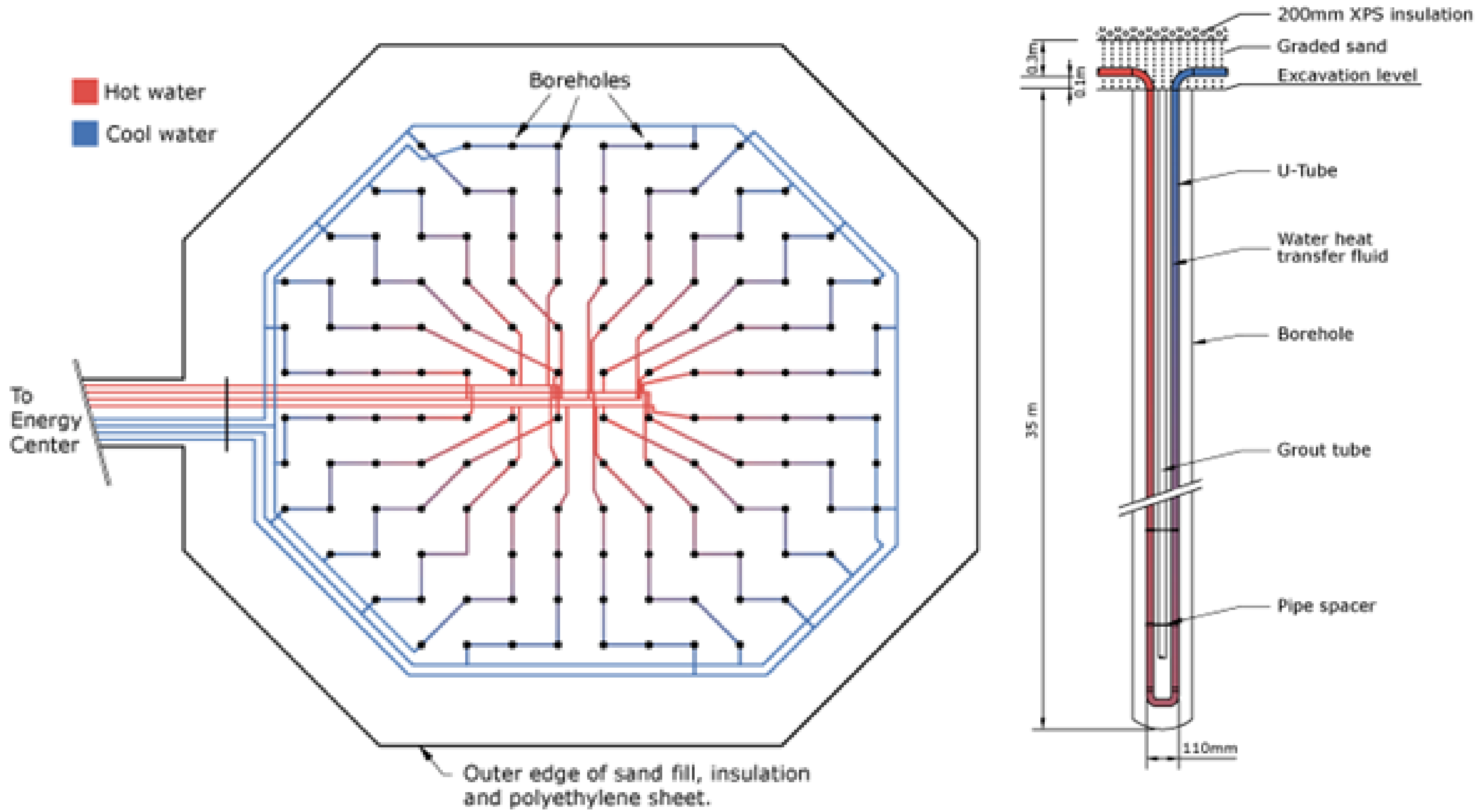


Source: CanmetENERGY, Ottawa

Drake Landing Solar Community Site Plan



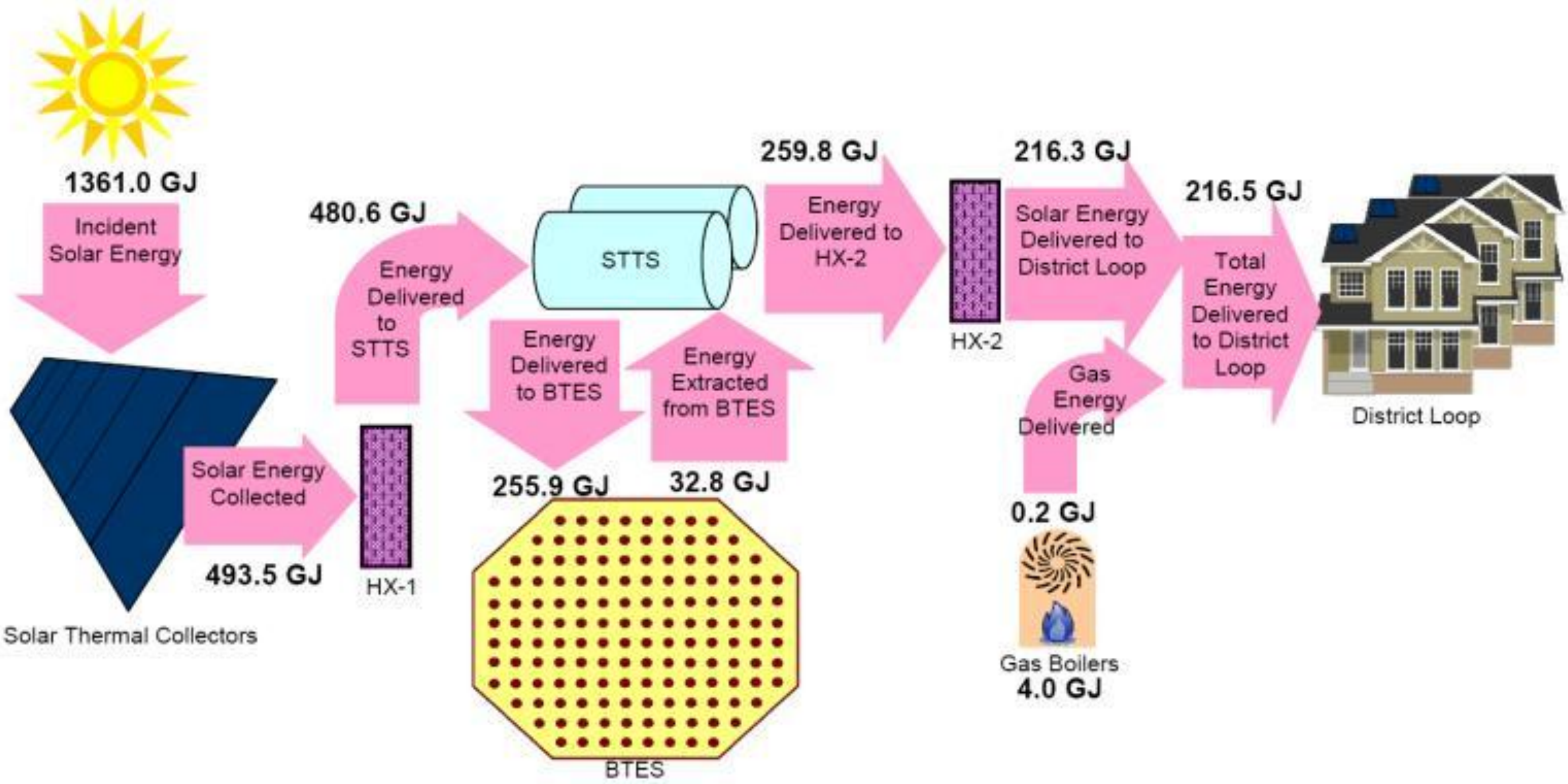
Aerial view of Borehole Thermal Energy Storage (BTES)



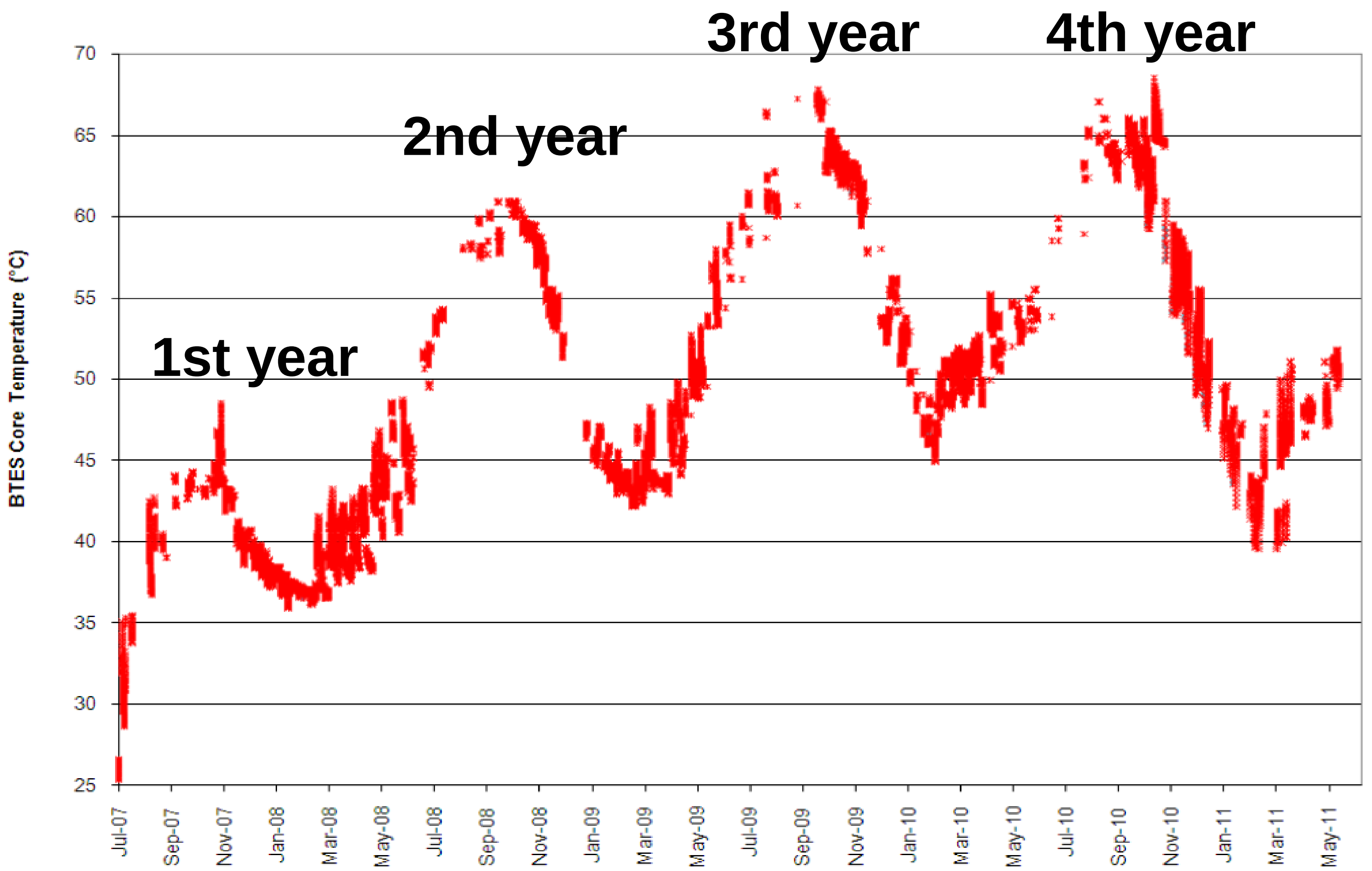
AEE INTEC

System energy diagram (Source: SAIC Canada)

NEW ENERGY

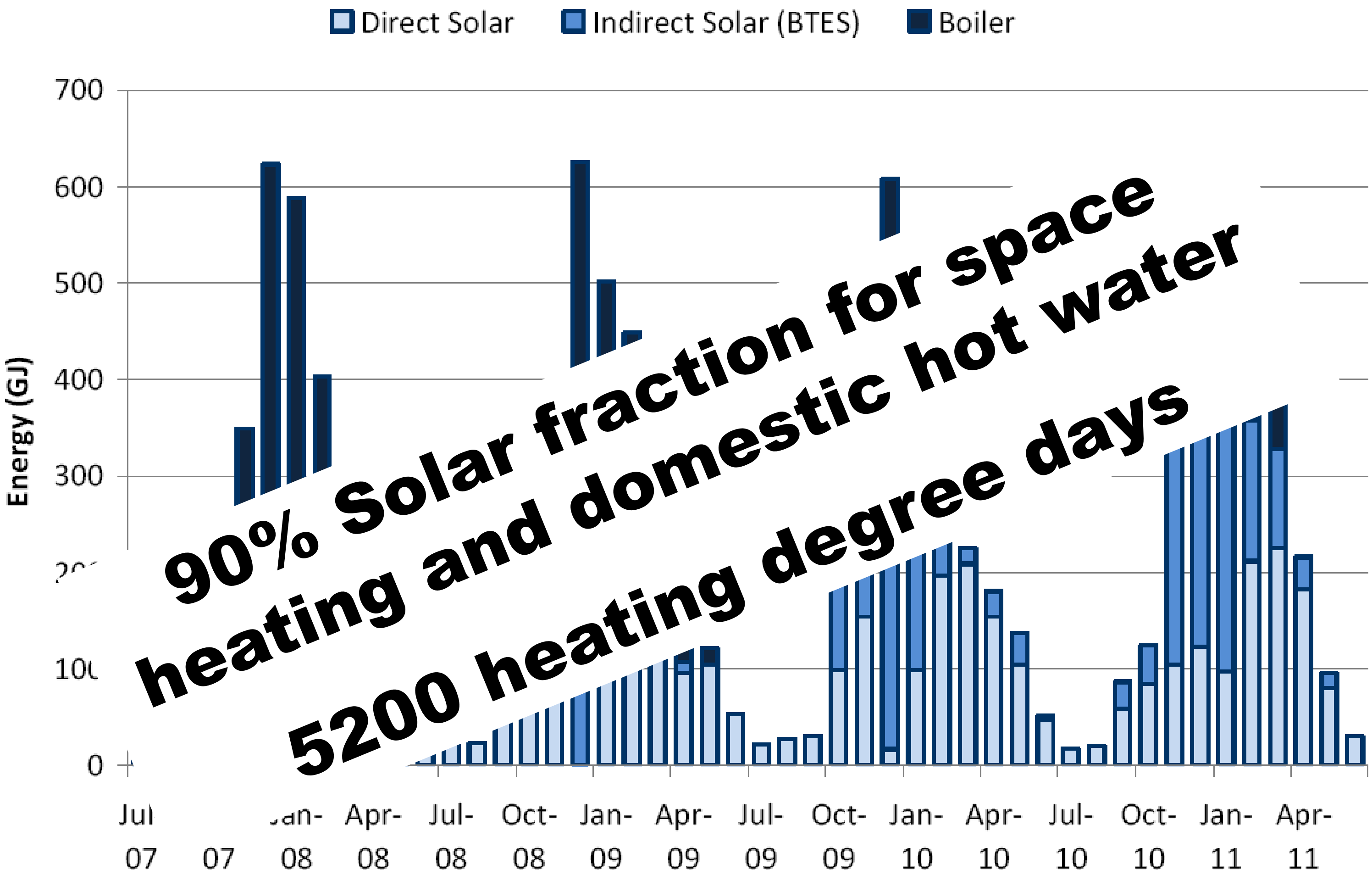


BTES Core temperature
July 2007 – May 2011



Source: CanmetENERGY, Ottawa

Energy Supplied to the Distribution Loop July 2007 – Apr. 2011



Source: CanmetENERGY, Ottawa

Biggest System Worldwide, Saudi Arabia

36.000 m² / 25 MW_{th}

Biggest System Worldwide, Saudi Arabia

36.000 m² / 25 MW_{th}

Biggest System Worldwide, Saudi Arabia

36.000 m² / 25 MW_{th}

Biggest System Worldwide, Saudi Arabia

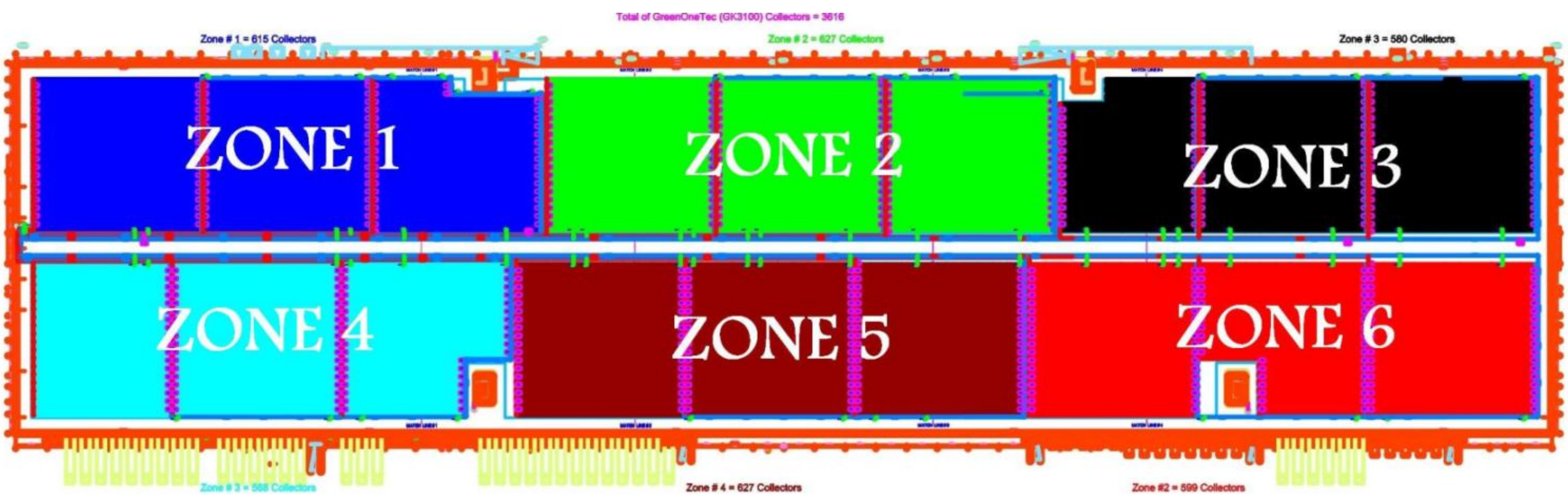
36.000 m² / 25 MW_{th}

Pipes and Heat Exchangers

Given Requirements

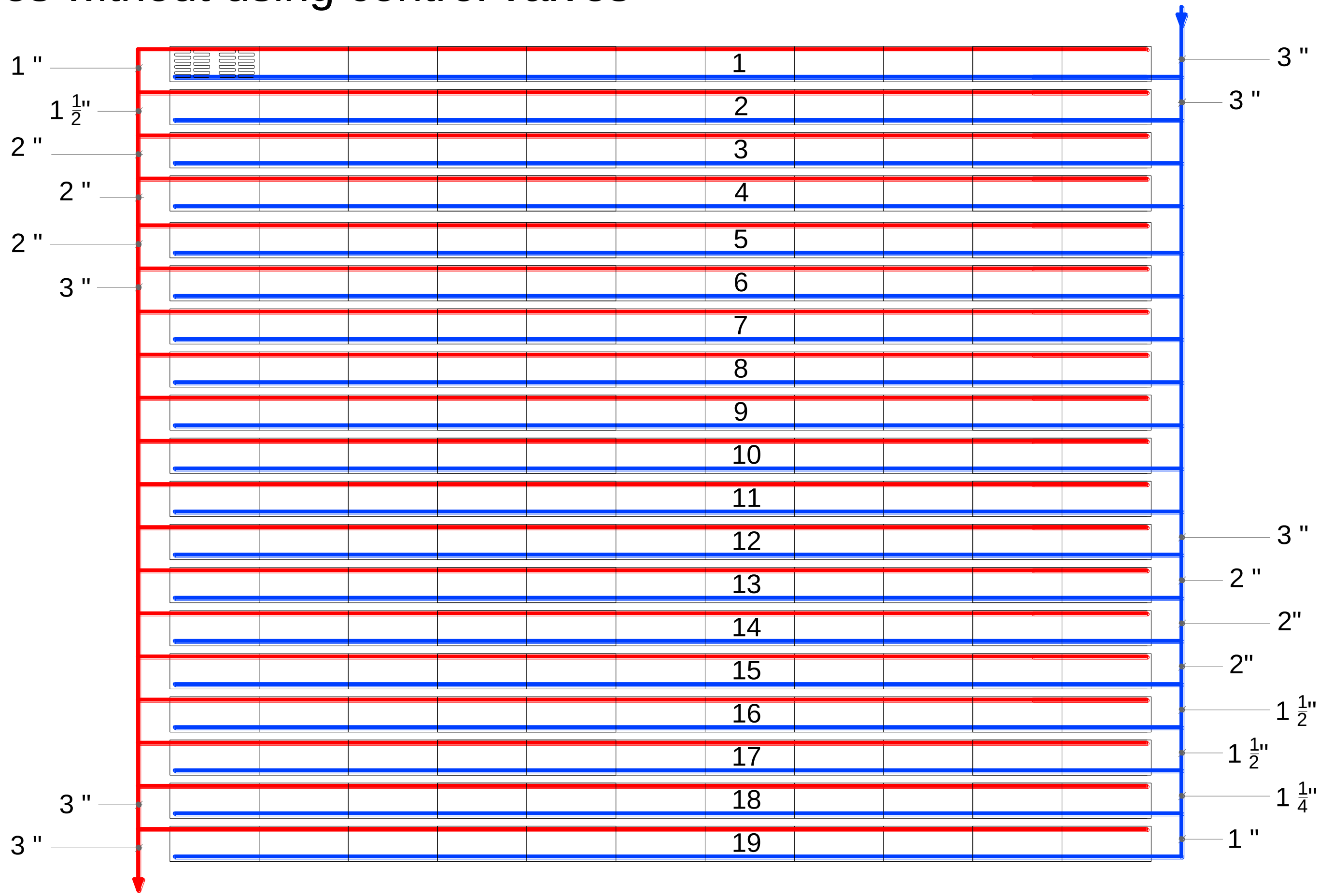
Geometry and position of the Collector Array:

- 36.000 m² subdivided into 6 zones, each ~6.000 m²
- Each zone subdivided into 3 clusters, each ~2.000m²
- Each cluster subdivided into 19 rows, each 90 – 110 m²

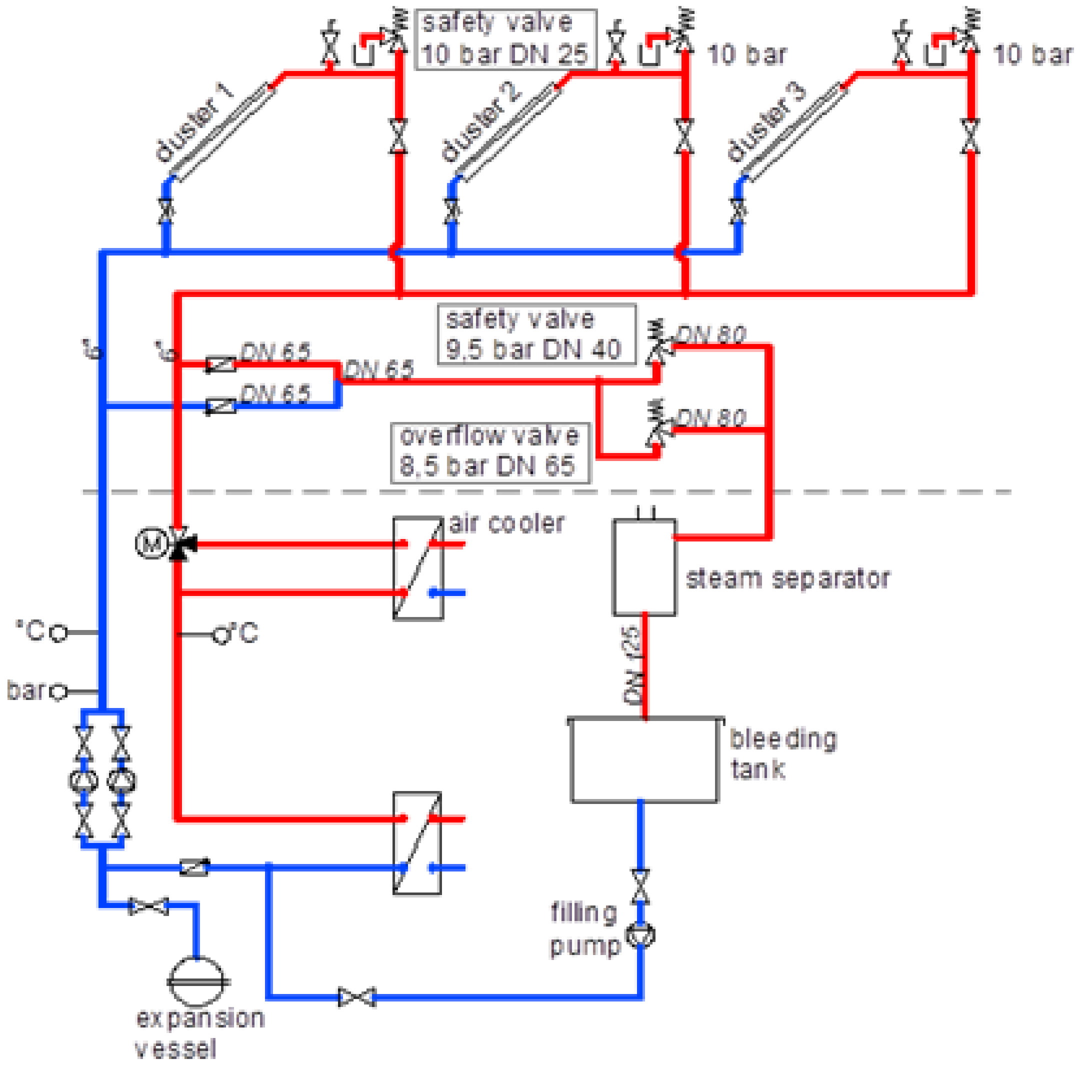


Hydraulic connection in a regular Cluster

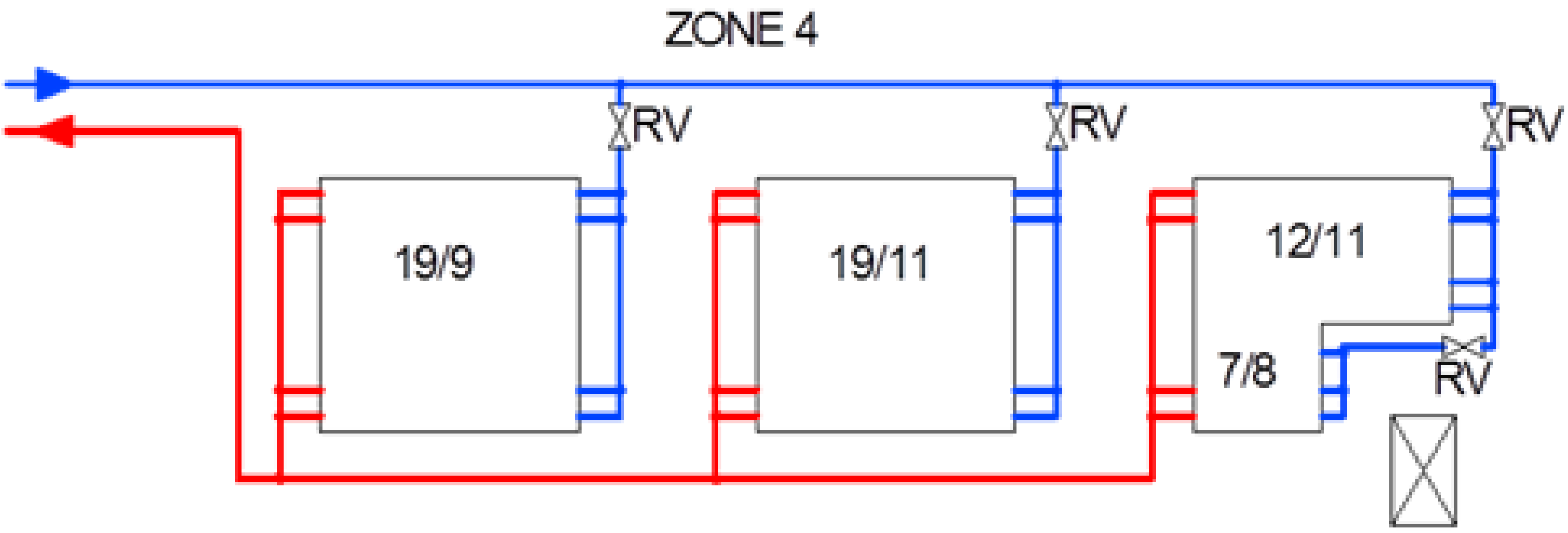
- Equal flow distribution in the rows of a cluster can be reached by stepwise changing the pipe dimensions of the higher-ranking header pipes without using control valves



Hydraulic scheme of one zone

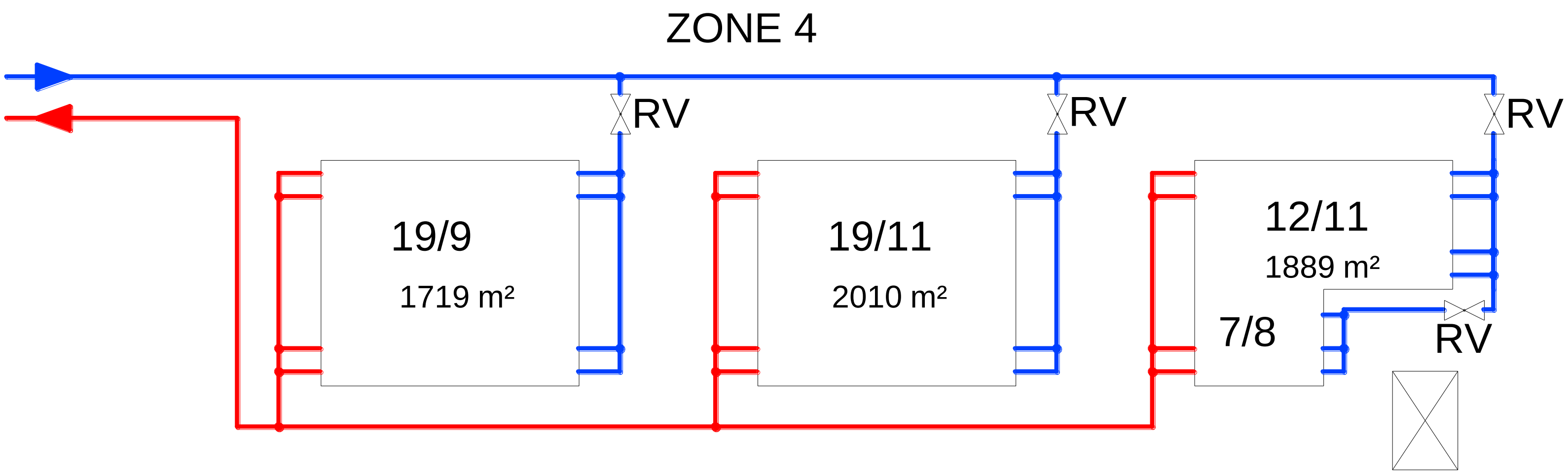


Hydraulic scheme of one zone



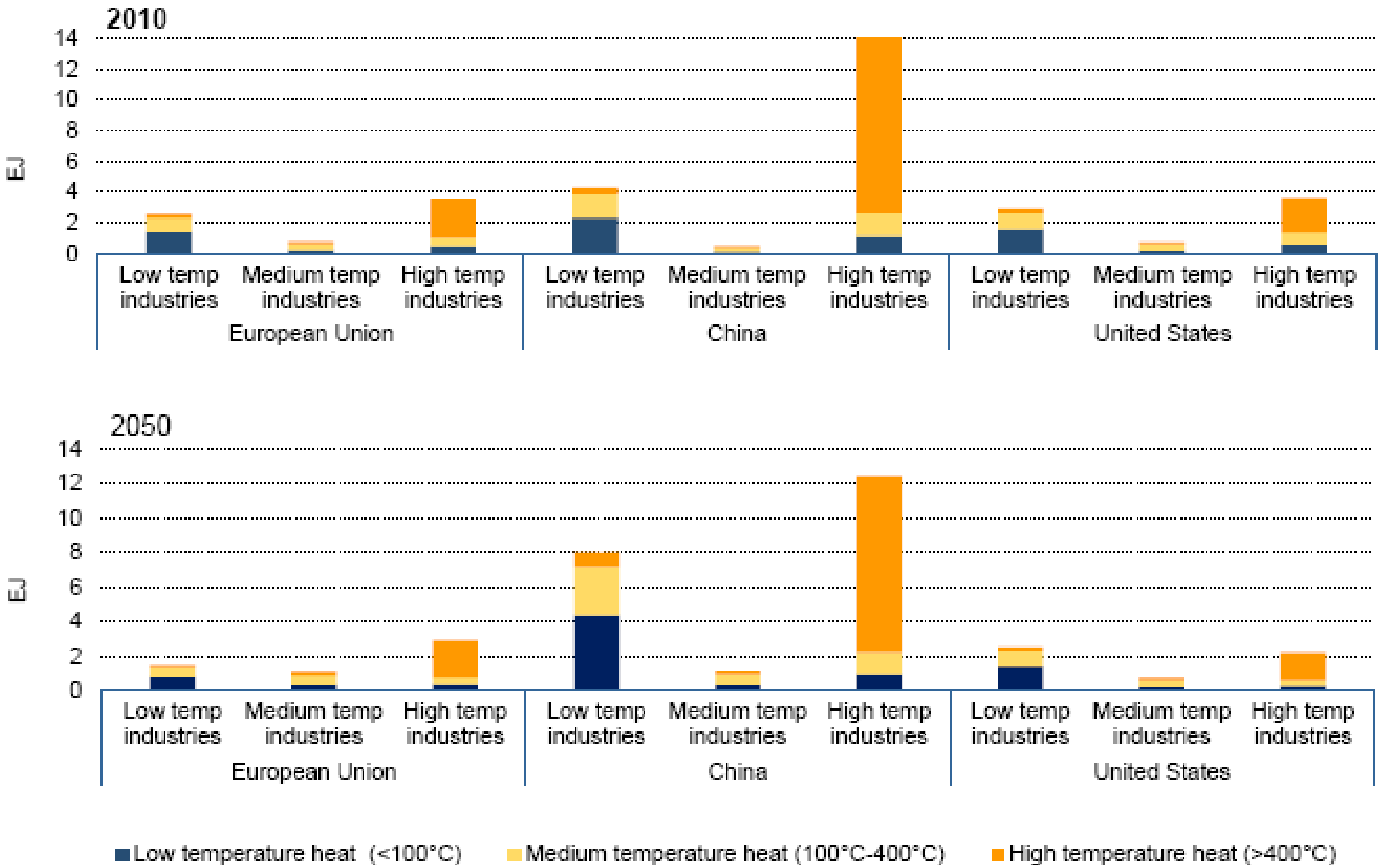
Hydraulic connection in a Zone

- Each row is connected according to the Tichelmann principle
- Each cluster is connected according to the Tichelmann principle with stepwise changing pipe dimensions
- Only four regulating valves are needed for a zone consisting of three different clusters



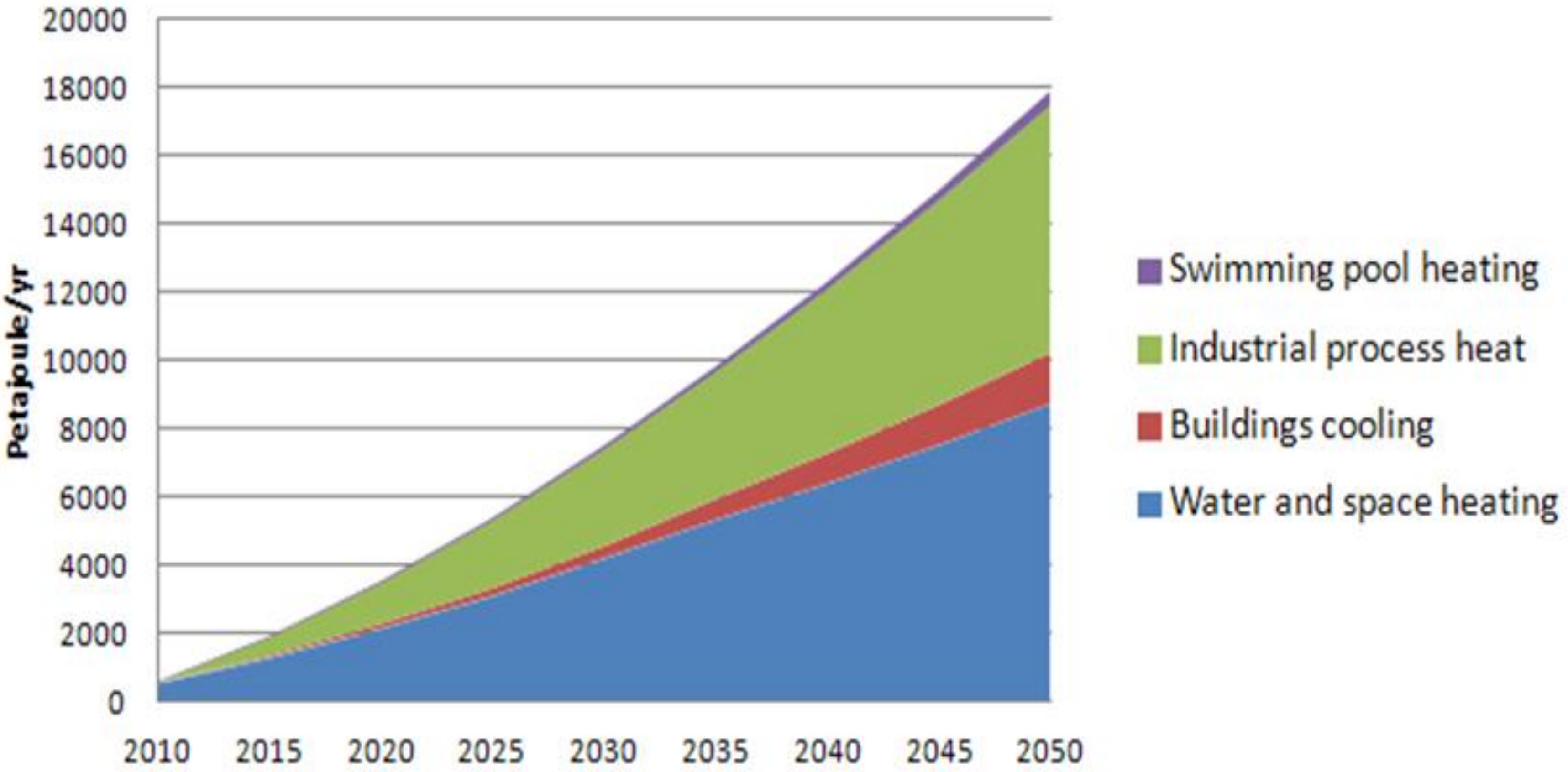
Solar Heat for Industrial Processes

Industrial Heat Demand



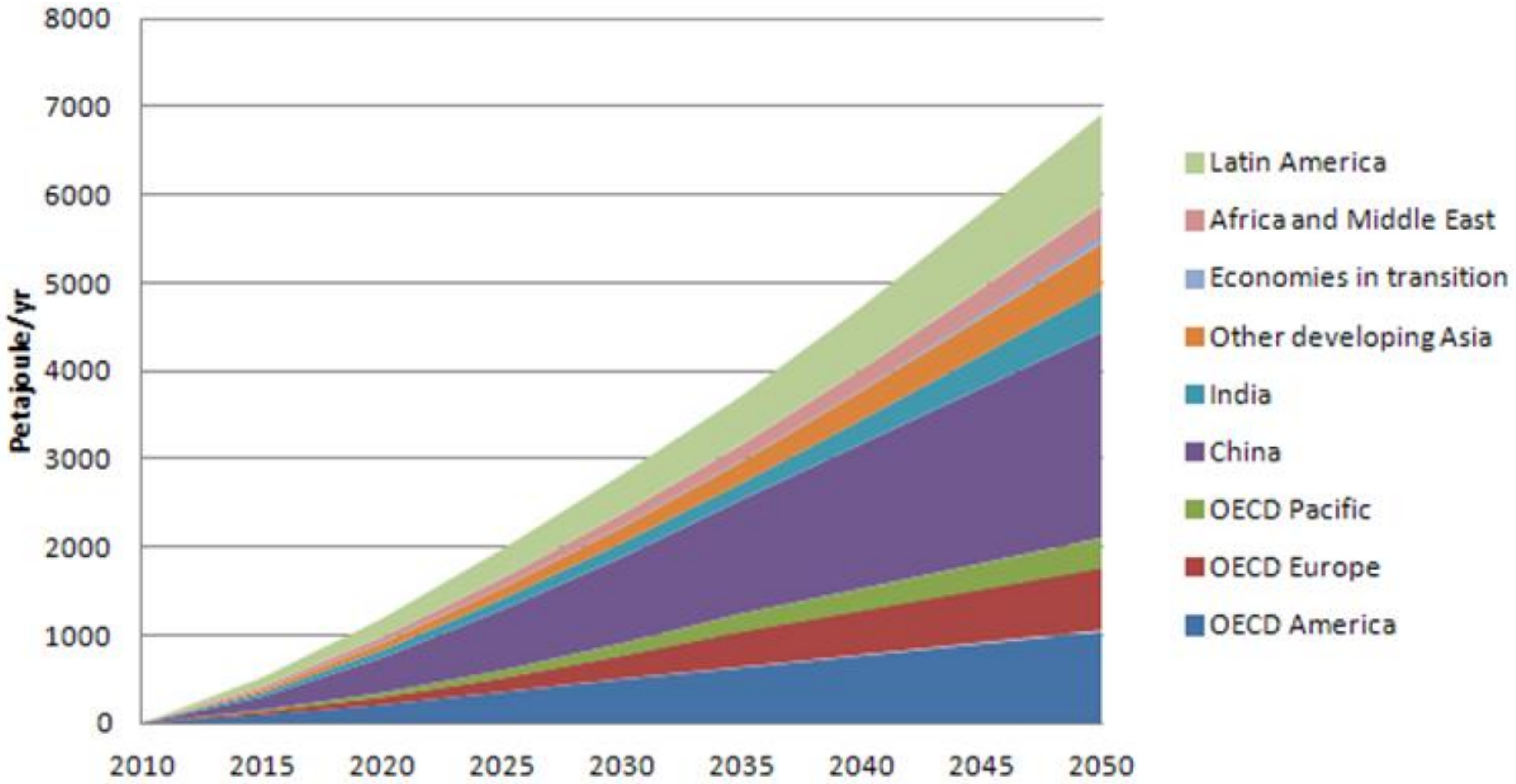
Source: IEA ETP 2012

Potential of Industrial Process Heat



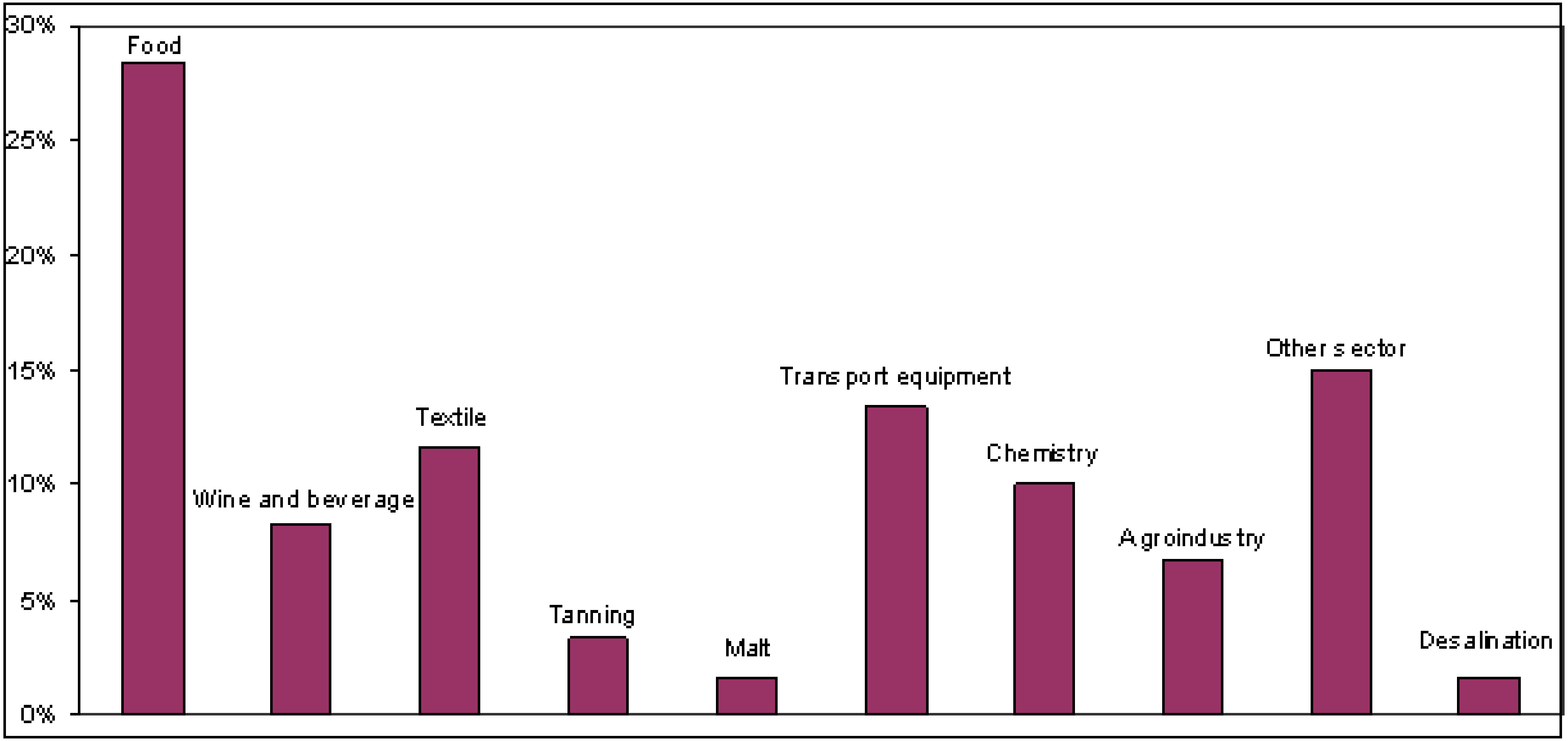
(Source: IEA SHC Roadmap, 2012)

Potential of Industrial Process Heat



(Source: IEA SHC Roadmap, 2012)

Distribution of the documented solar thermal plants in different industrial sectors

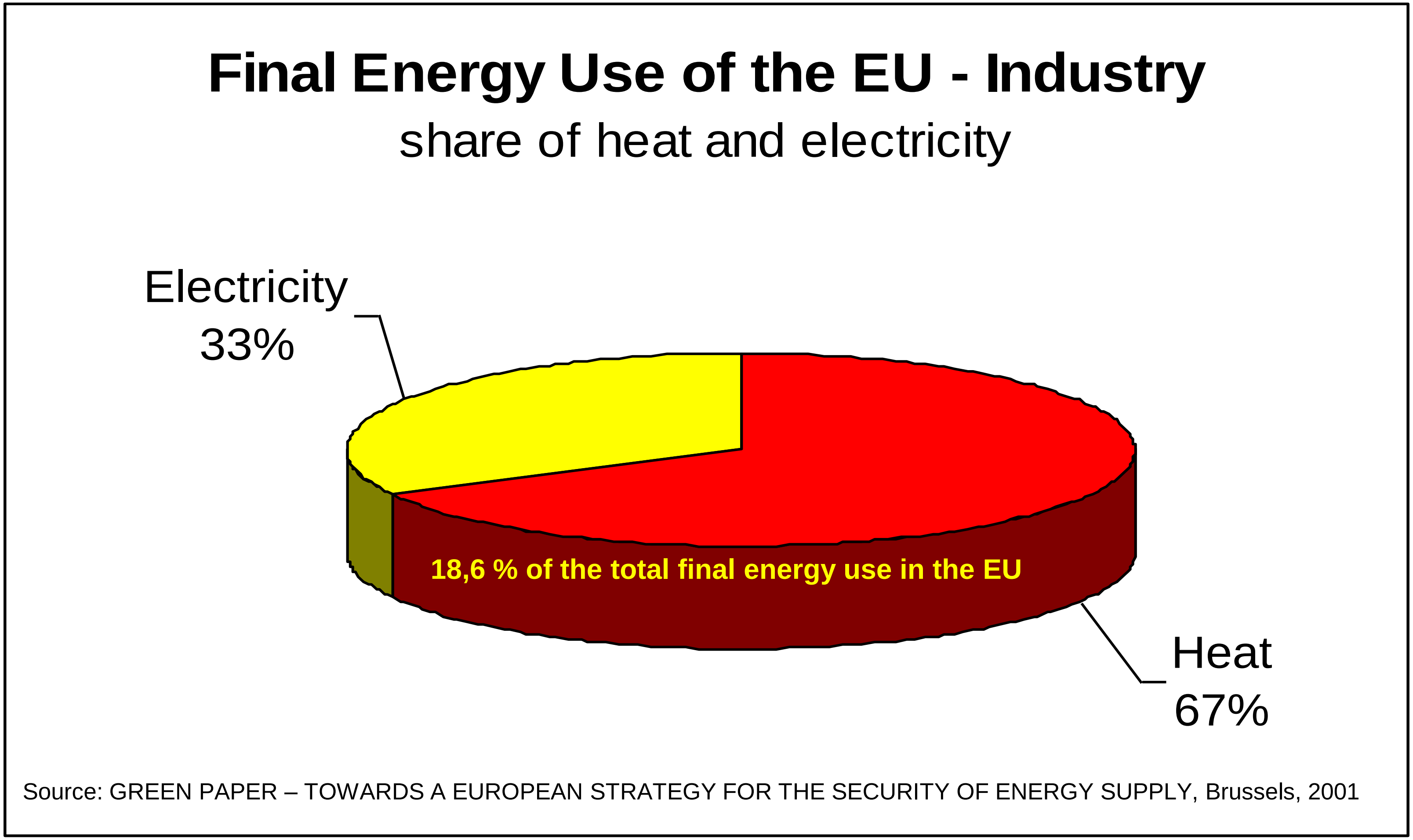


(Source: IEA SHC Task 33)

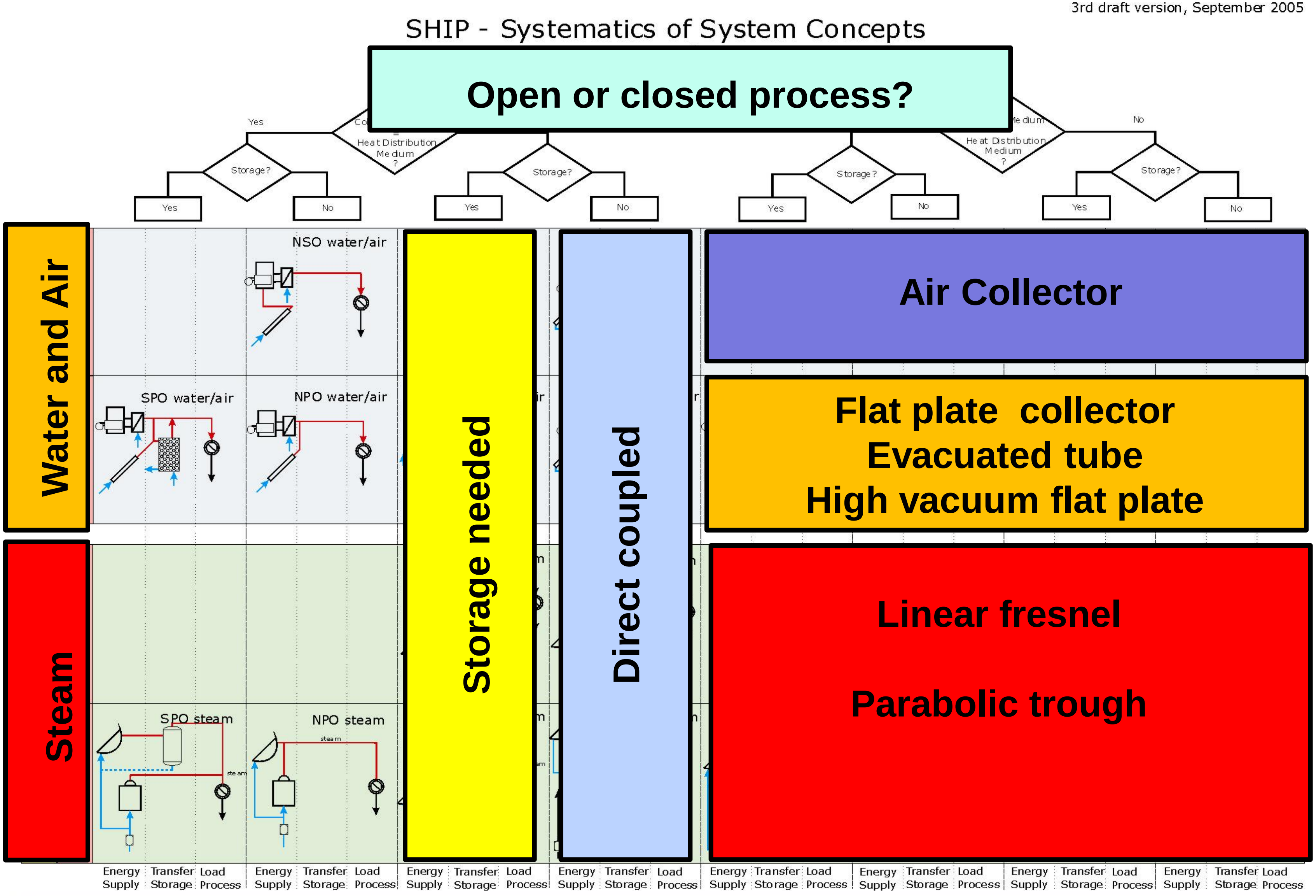
Industrial sectors and processes with the greatest potential for solar thermal uses

Industrial sector	Process	Temperature level [°C]
Food and beverages	drying washing pasteurising boiling sterilising heat treatment	30 - 90 40 – 80 80 – 110 95 – 105 140 – 150 40 – 60
Textile industry	washing bleaching dyeing	40 –80 60 – 100 100 – 160
Chemical industry	boiling distilling various chemical processes	95 – 105 110 – 300 120 - 180
Copper mining industry	leaching	50 - 70
All sectors	pre-heating of boiler feed water heating of production halls	30 – 100 30 – 80

INDUSTRIAL APPLICATIONS



Generic Solar Heat Integration Concepts



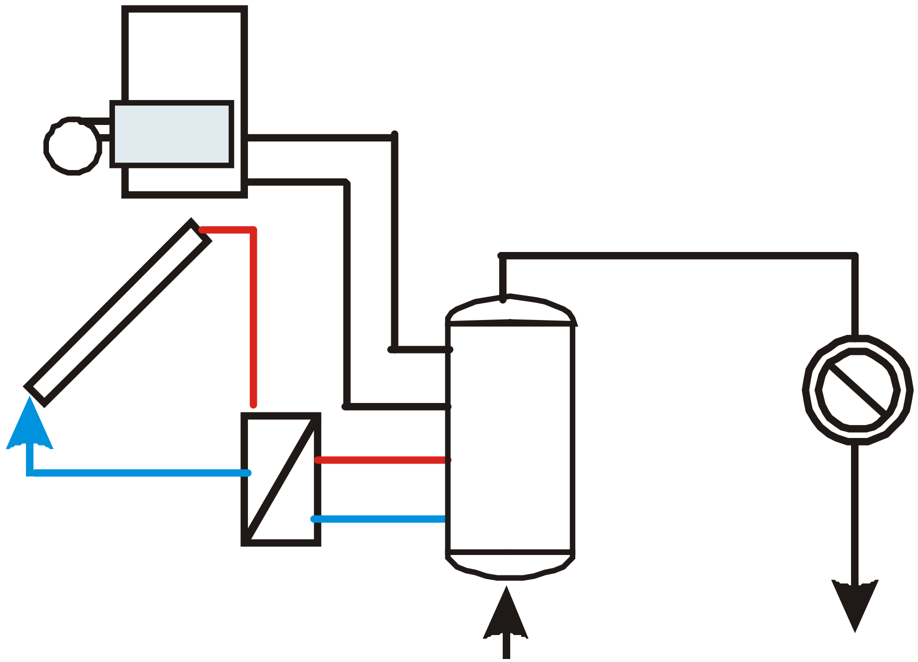
SHORT TERM POTENTIAL FOR PROCESS HEAT

	Low Temperature Heat	Solar thermal	Mill.	5% Market Penetration	
	[PJ]	[PJ]	[m²]	[m²]	[MW_{th}]
Spain	110	17	13,6	680.000	476
Portugal	25	4	3,2	160.000	112
Austria	85	5	4,3	215.000	151
Total	**220**	**26**	**21,1**	**1.055.000**	**739**

Space Heating of Factory Buildings

Solar heated production hall and office building DOMA, Austria

Washing processes with open hot water loop - generic system concept



AEE INTEC

Washing Processes

NEW ENERGY

Parking service Castellbisbal SA, container washing, Barcelona, Spain. Installed capacity: 357 kWth. Source: Aiguasol Engineering, Spain.

Tyras dairy, Trikala, Greece

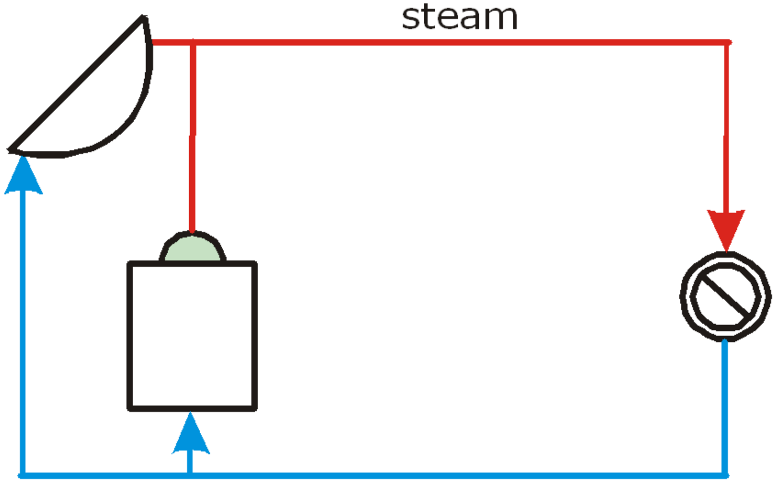
Solar Heat for Copper Mining in Cyprus - 0.5MWth

Solar Leaching Field Pilot Implemented in 3 months

Source: Millennium Energy Industries

Distilling and chemical processes

Steam production via a flashing process - generic system concept



El NASR Pharmaceutical Chemicals, Egypt. Installed capacity: 1,33 MWth

Source: Fichtner Solar GmbH. Germany