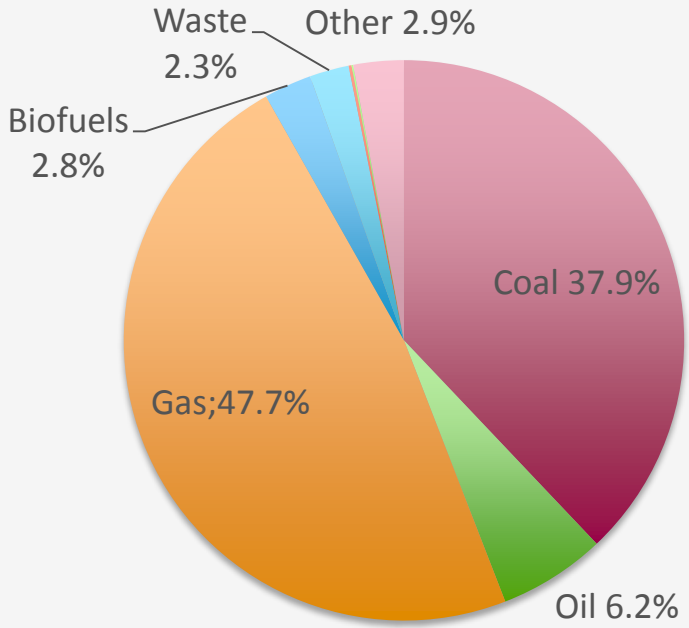
Third Generation PV and Other Ways to Utilize Solar Energy

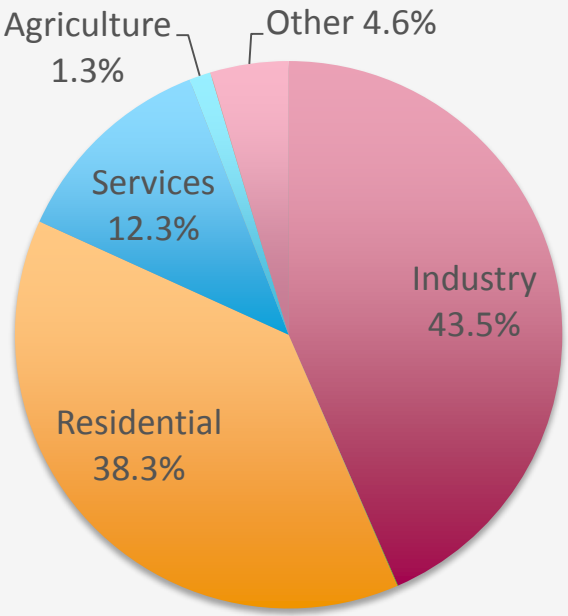
Solar Thermal Energy II - Solar Thermal Heating

Week 6.2.2

Arno Smets

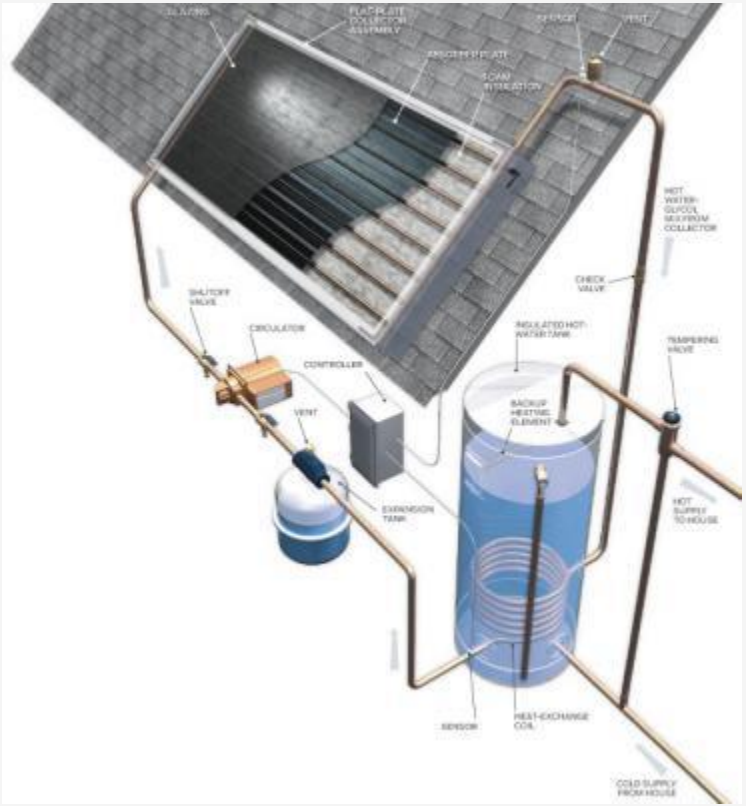
Heat demand



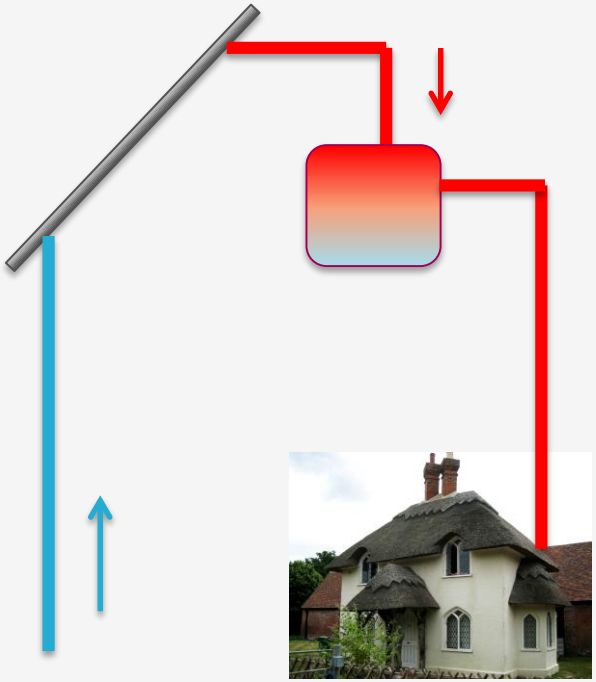


Source: IEA Electricity/Heat in World in 2009

Solar water heating systems



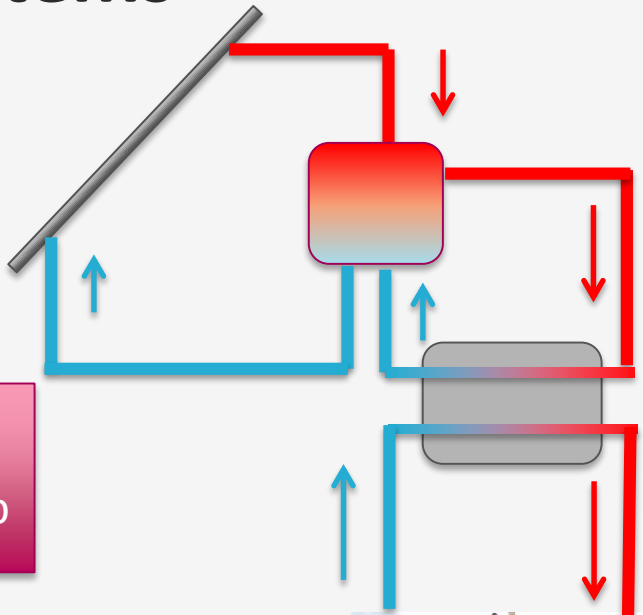
Types of solar water heating systems



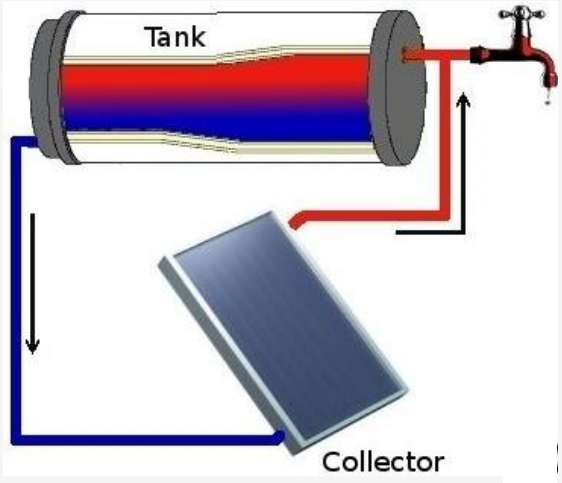
Fluid loop

Direct or open loop

Indirect or closed loop

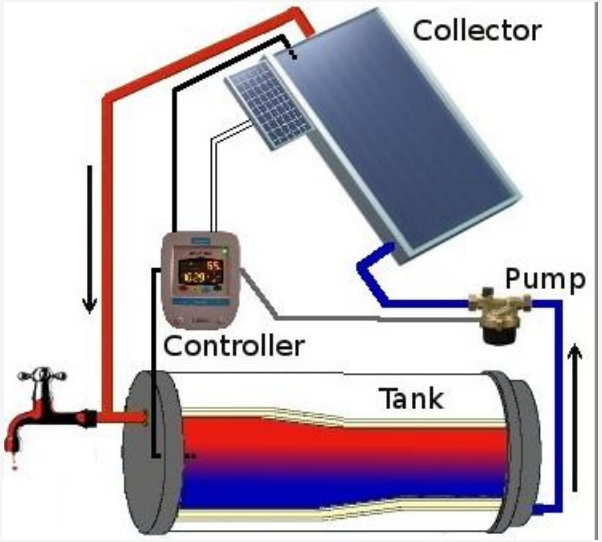


Types of solar water heating systems

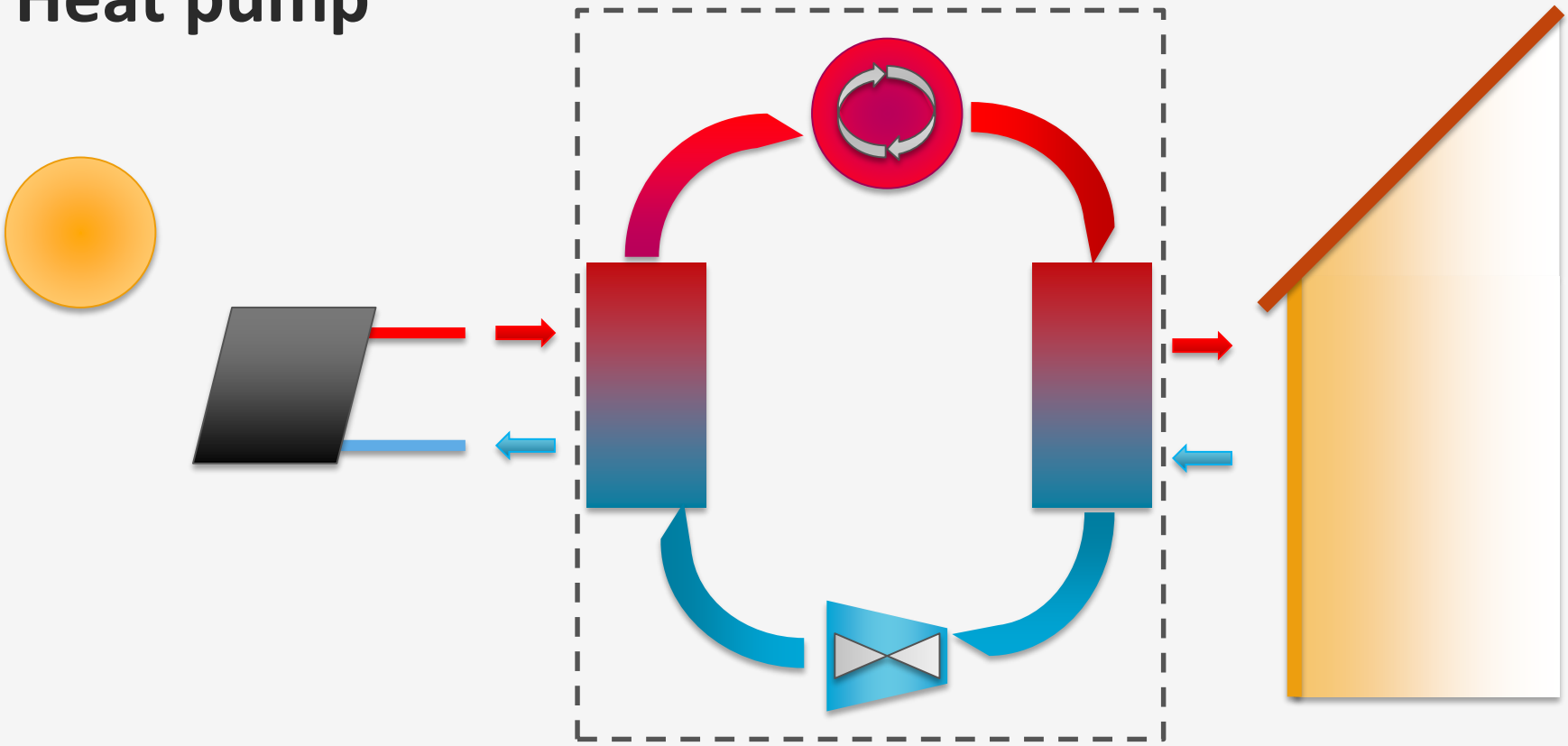


Fluid movement

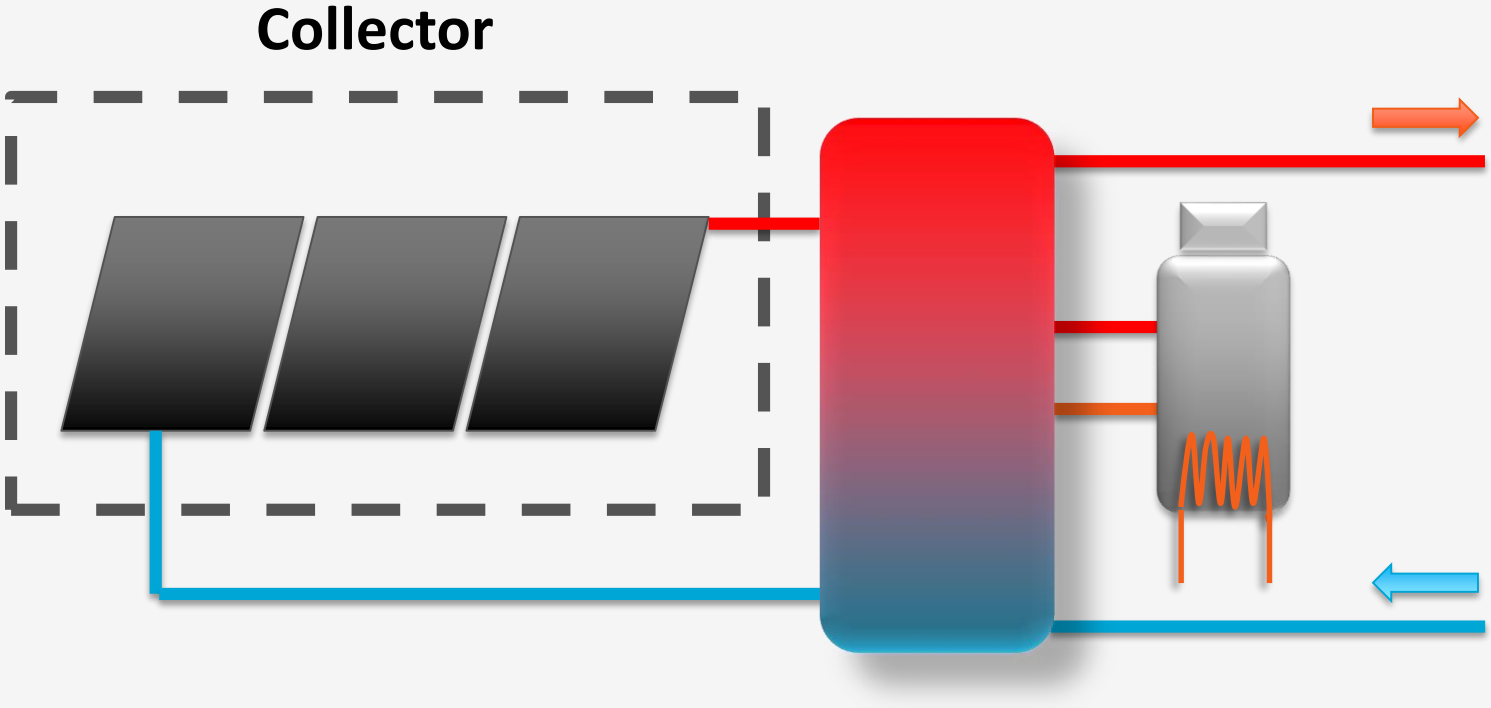
- Passive systems
- Active systems



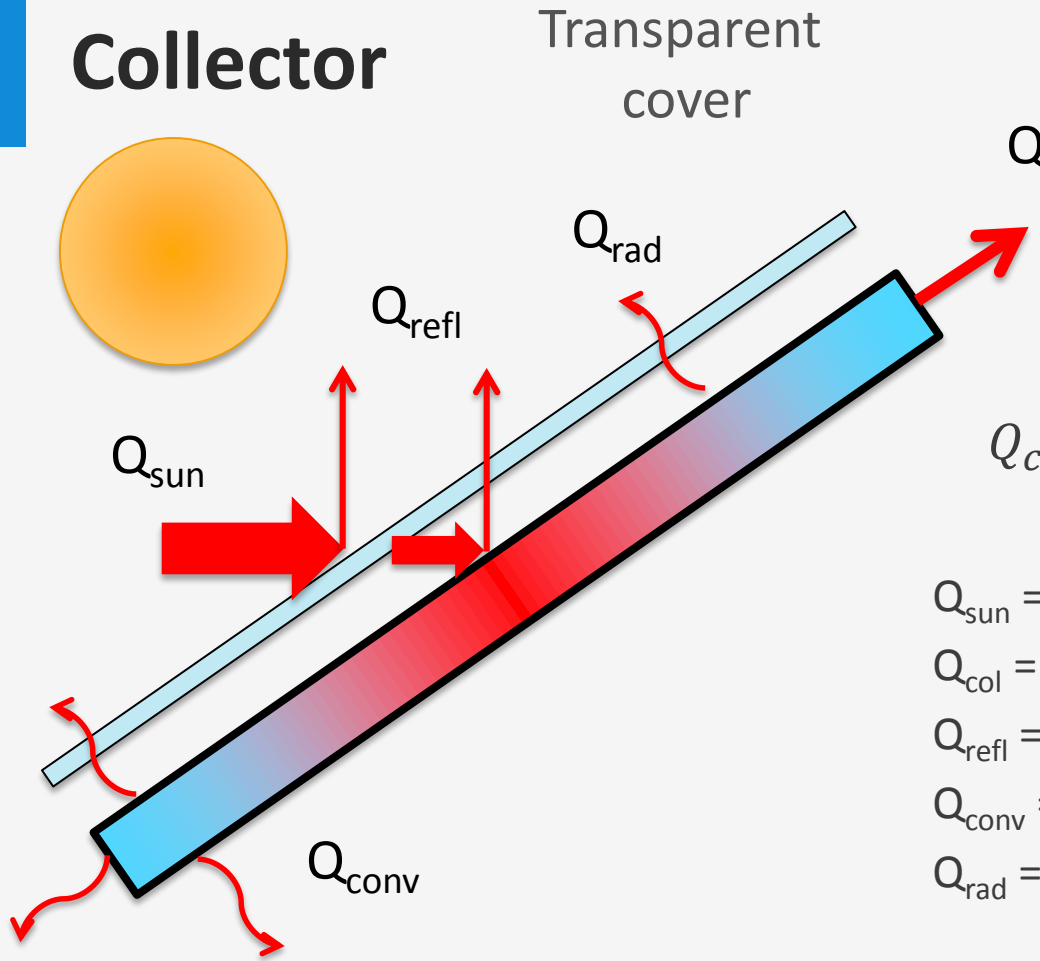
Heat pump



System components



Collector



$$Q_{col} = Q_{sun} - Q_{refl} - Q_{rad} - Q_{conv}$$

Q_{sun} = incident energy from the sun

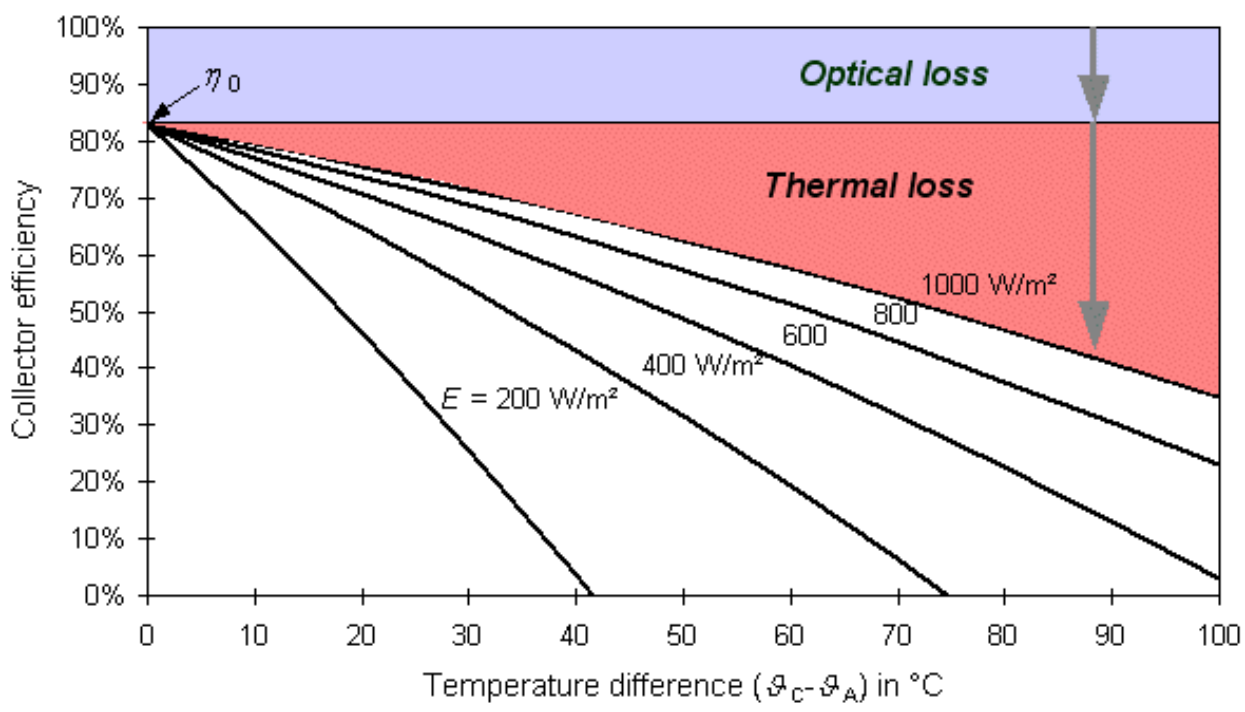
Q_{col} = heat output of the collector

Q_{refl} = reflection losses

Q_{conv} = convection losses

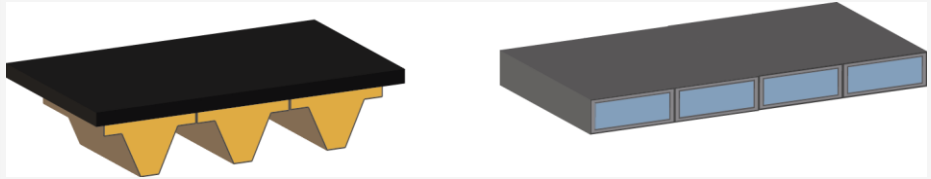
Q_{rad} = radiation losses

Collector efficiency

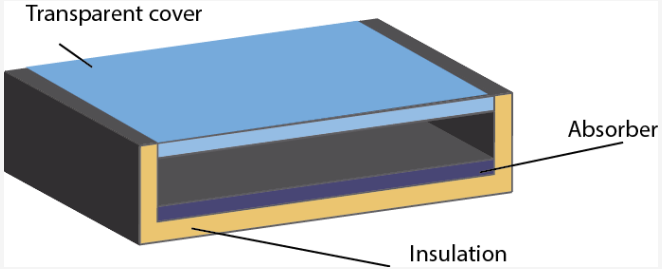


Collector

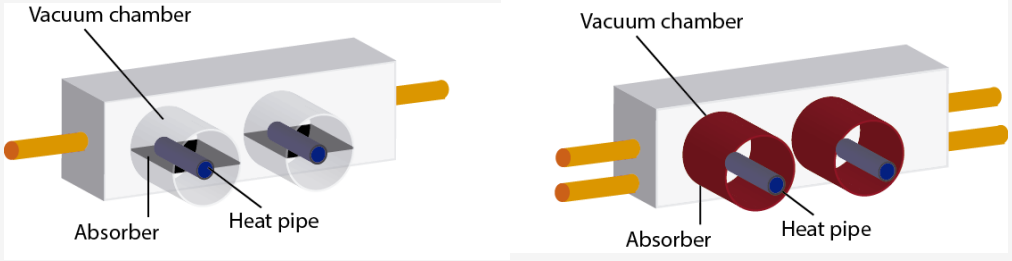
Uncovered



Covered

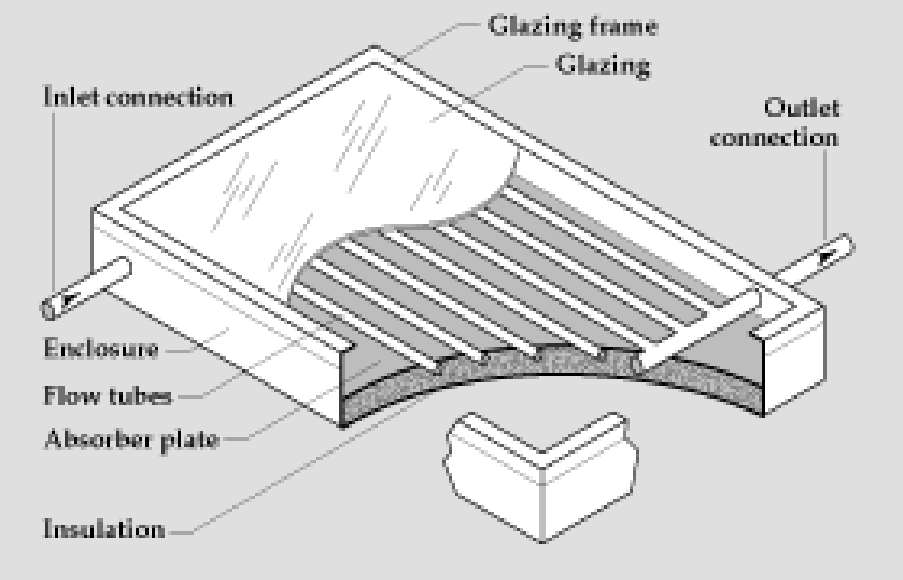


Vacuum

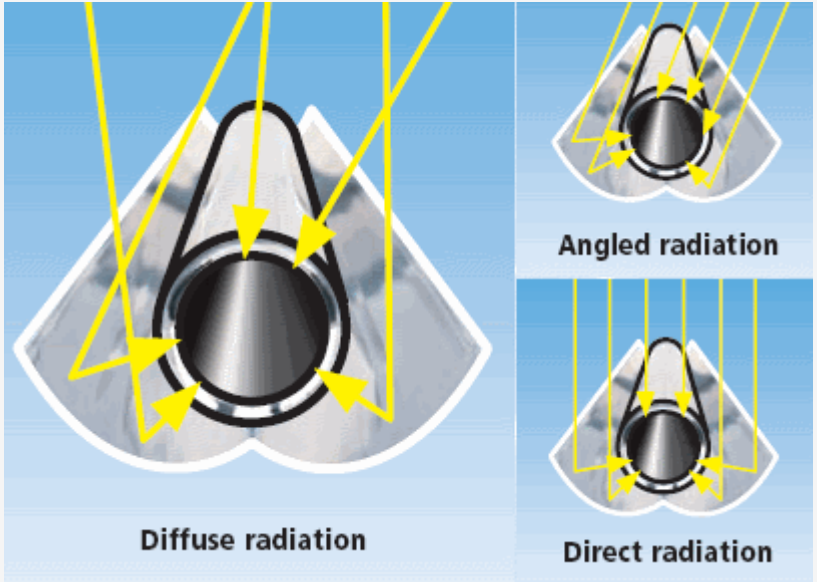


Collector

Flat-plate collector

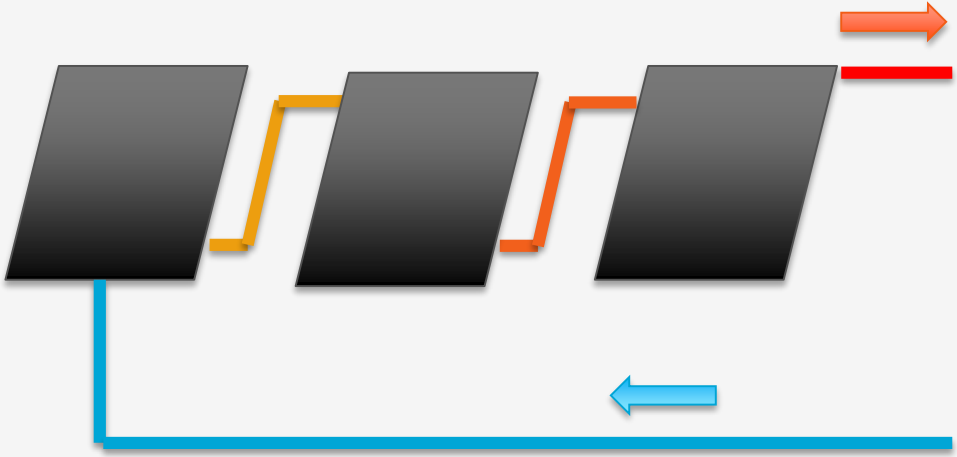


Concentrating collector

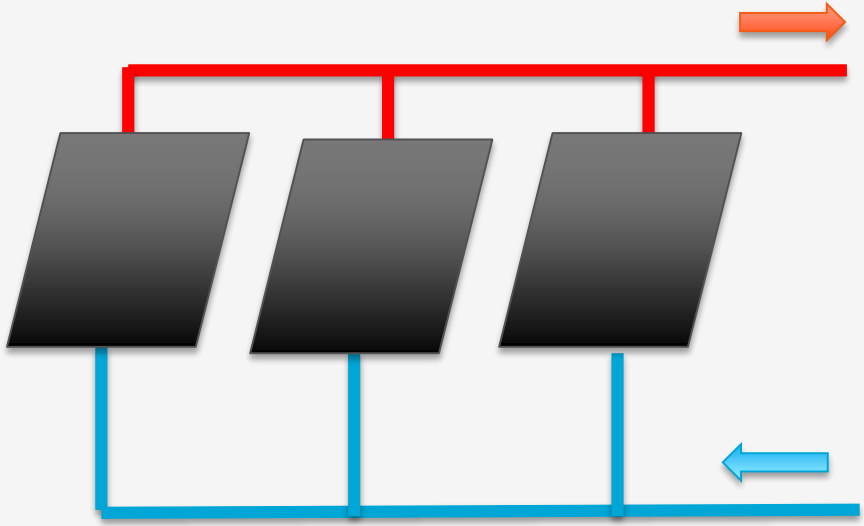


Solar system arrays

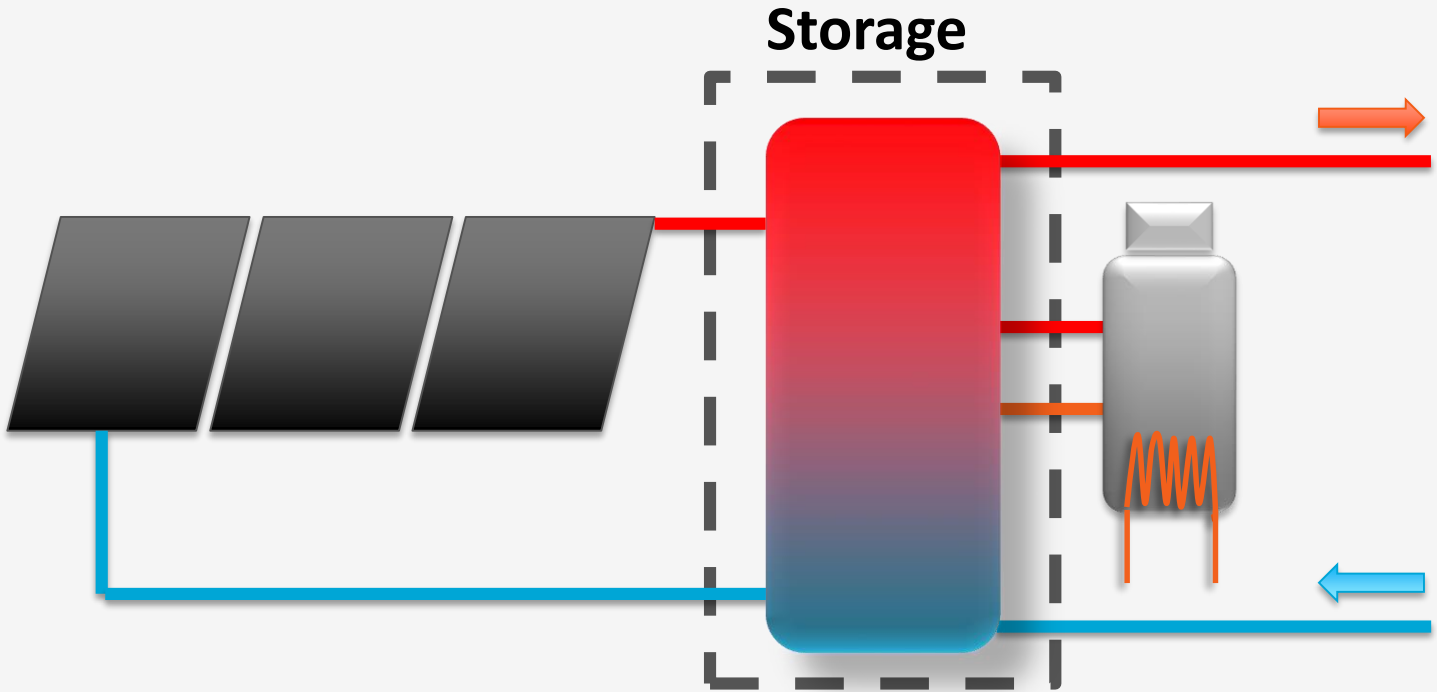
Series connected



Parallel connected



System components



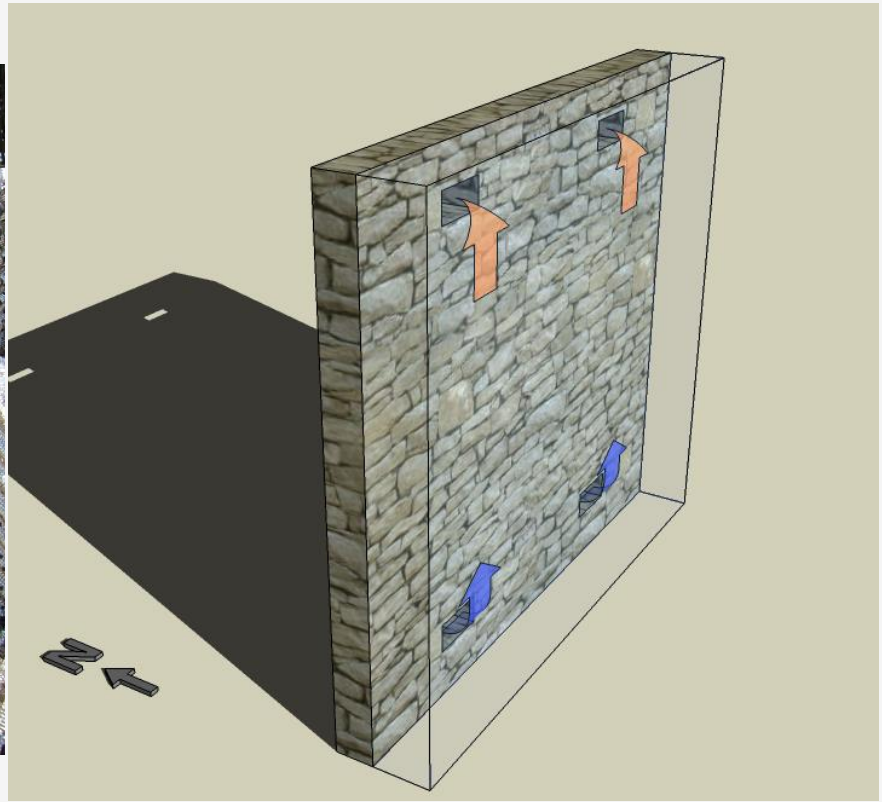
Energy storage

Energy storage: Water

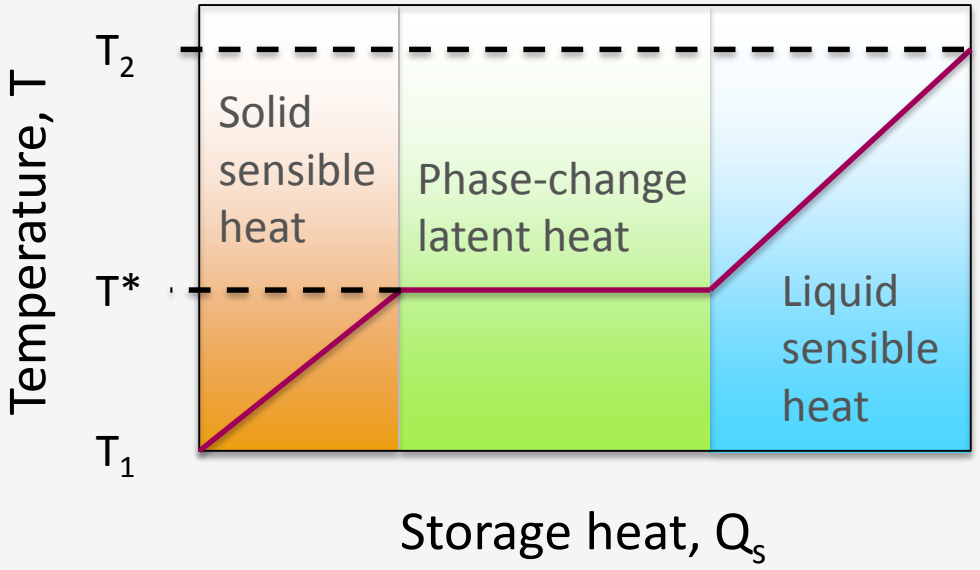
$$Q_s = V\rho C_p \Delta T$$

$$Q_{loss} = UA\Delta T$$

Energy storage: Solids

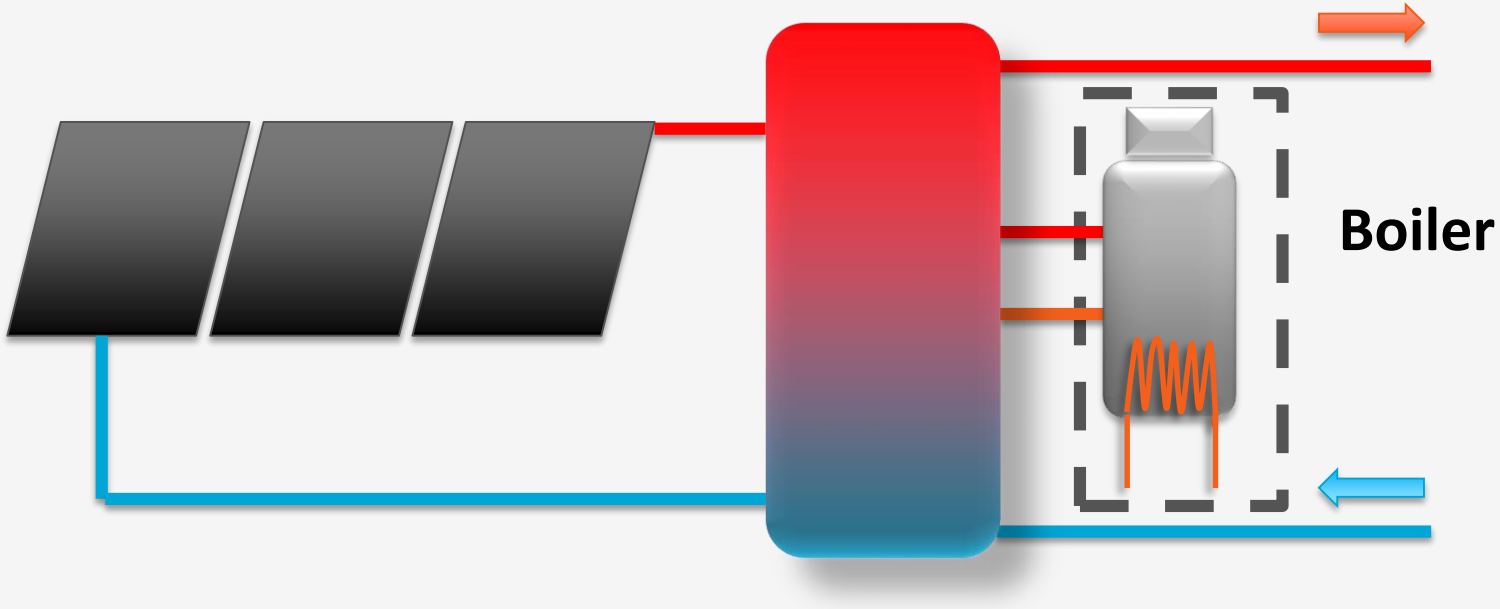


Energy storage: Phase change

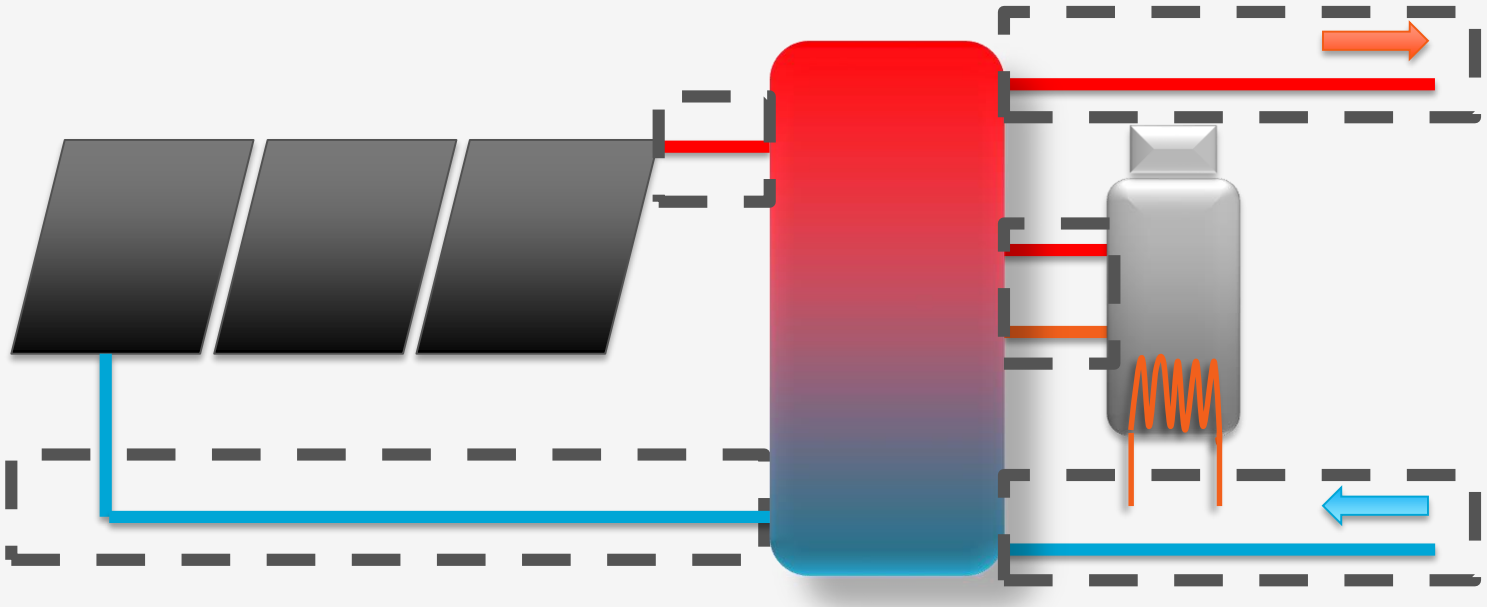


$$Q_s = m[C_s(T^* - T_1) + \lambda + C_l(T_2 - T^*)]$$

System components

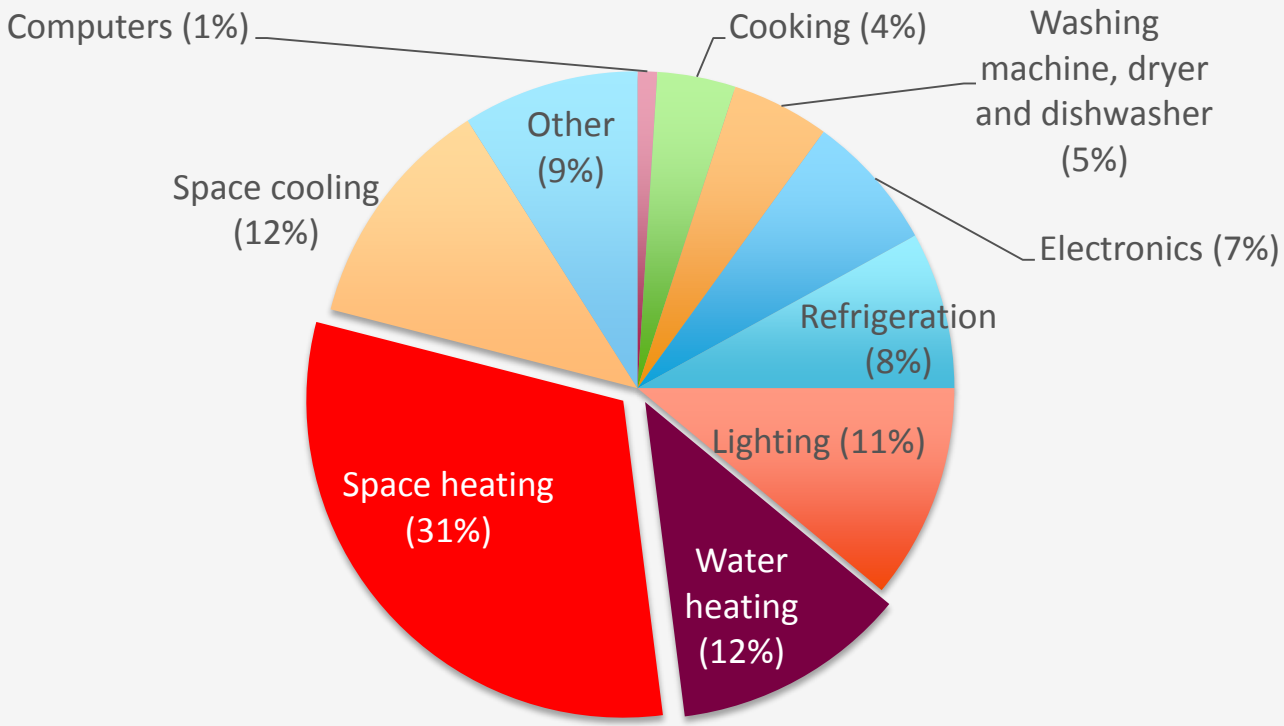


System components



Collector circuit

Household energy demand



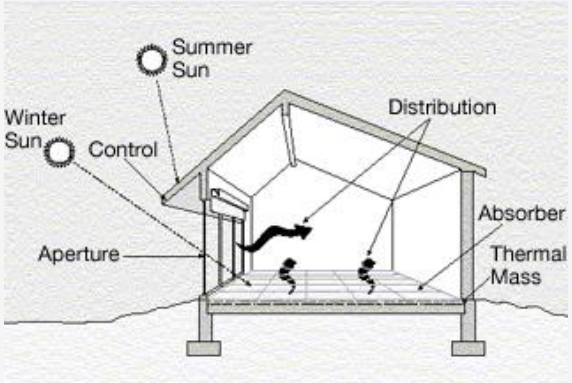
Source: IEA Electricity/Heat in World in 2009

Solar cooling

Solar absorption cooling

Solar dessicant cooling

Combined solar heating and cooling



Solar-mechanical cooling