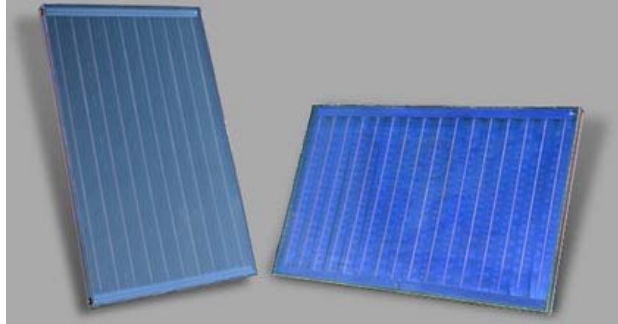


## Solar Combi Systems

Trans-solar Workshop  
Romania, Bucurest

**Ioannis Santzaklis**  
Mechanical Engineer &  
**Dimitrios Chasapis**  
R.E.S. Systems Technology Engineer  
ΚΑΠΕ Τομέας Θερμικών Ηλιακών Συστημάτων

# Solar Thermal Collectors



Flat Plate



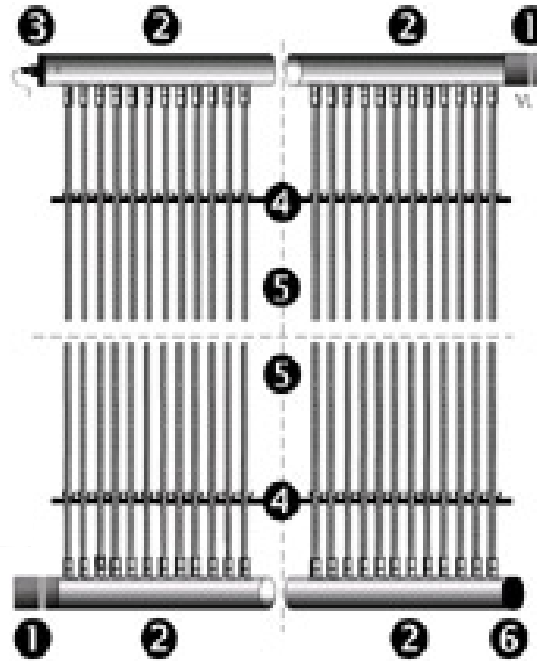
Vacuum Tub

Unglazed

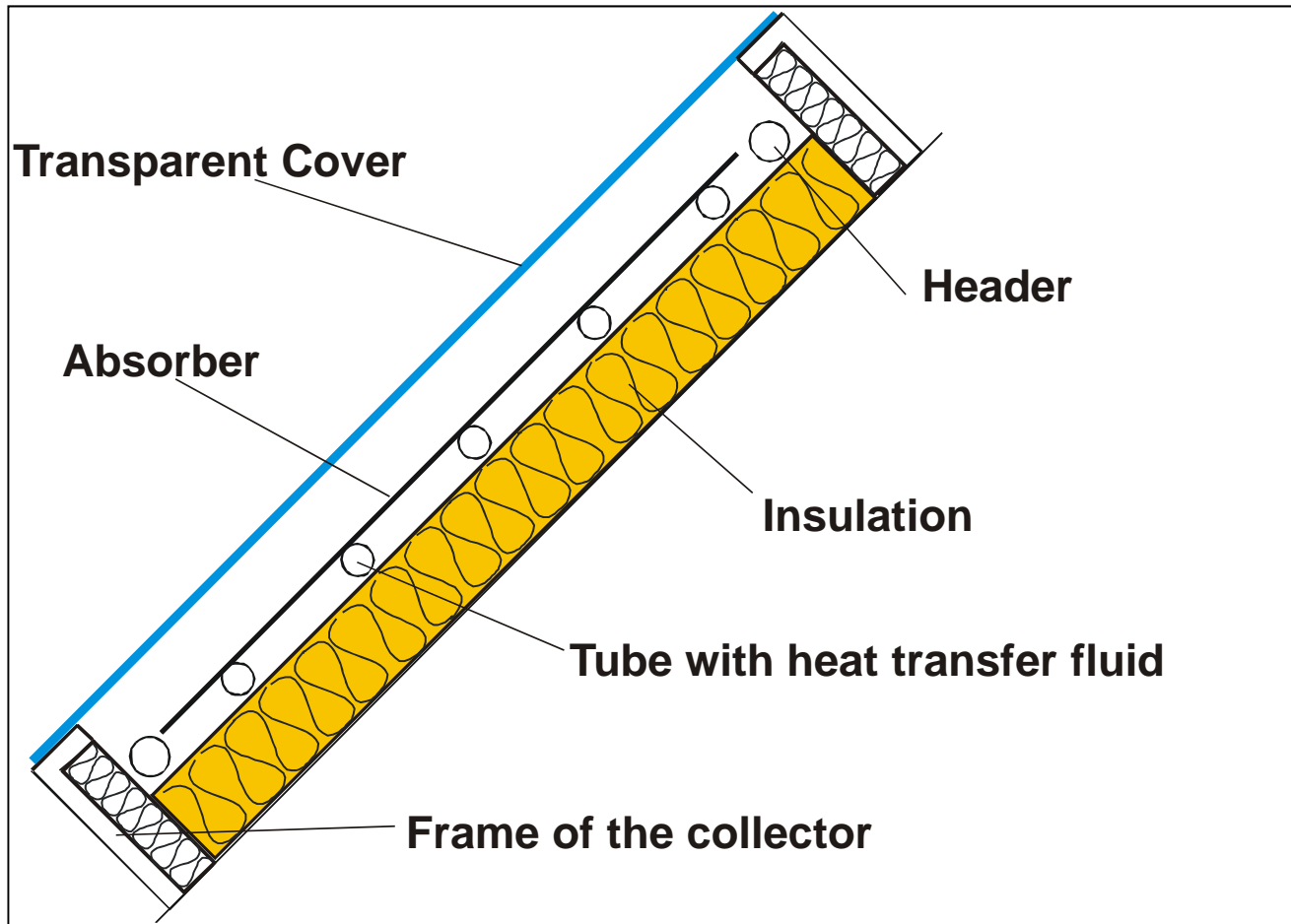


# Plastic Absorber – Unglazed Collector

- 1** Inlet/Outlet
- 2** Header
- 3** Temperature sensor
- 4** Spacer
- 5** Absorber tube
- 6** Cap



# Flat Plate Collector



Section of flat plate collector

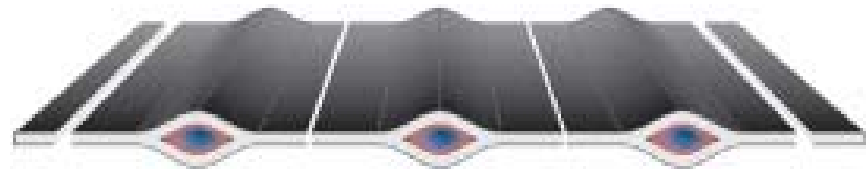
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# Flat Plate Collector

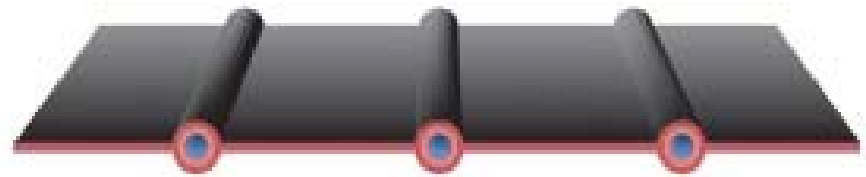
Aluminium Absorber



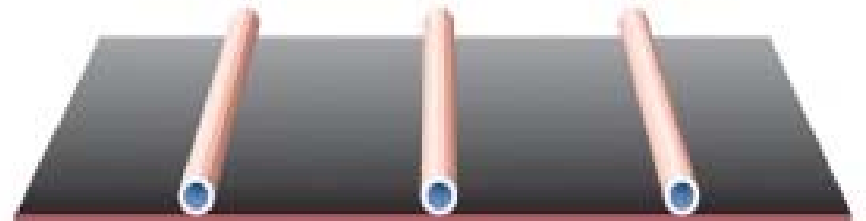
Aluminium absorber with pressed cooper tubes



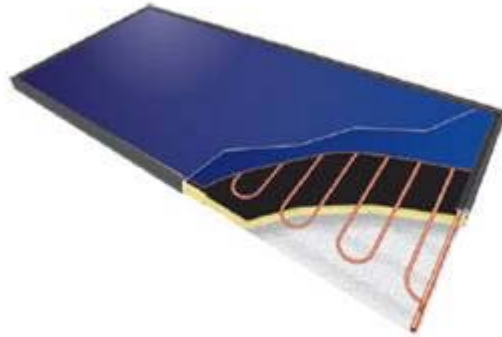
Pressed tubes between 2 metal sheet



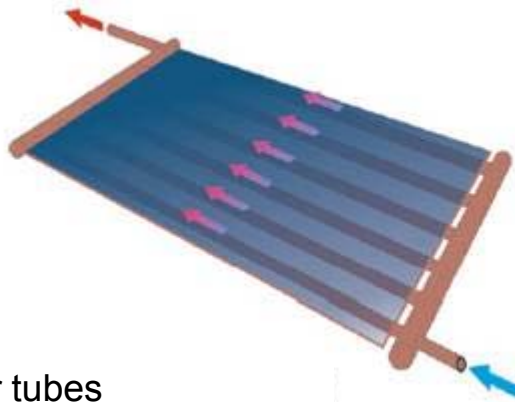
Tubes welded on metal sheet



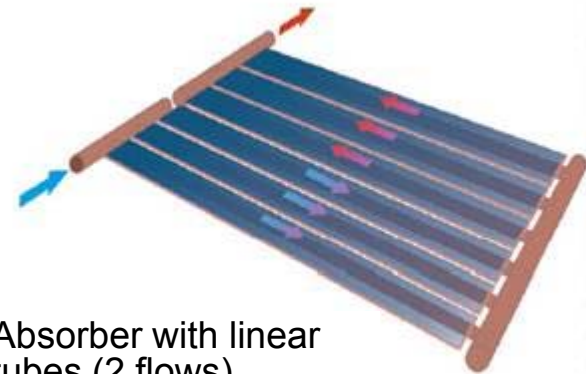
# Flat Plate Collector



Absorber with serpentine tube (All surface cover)

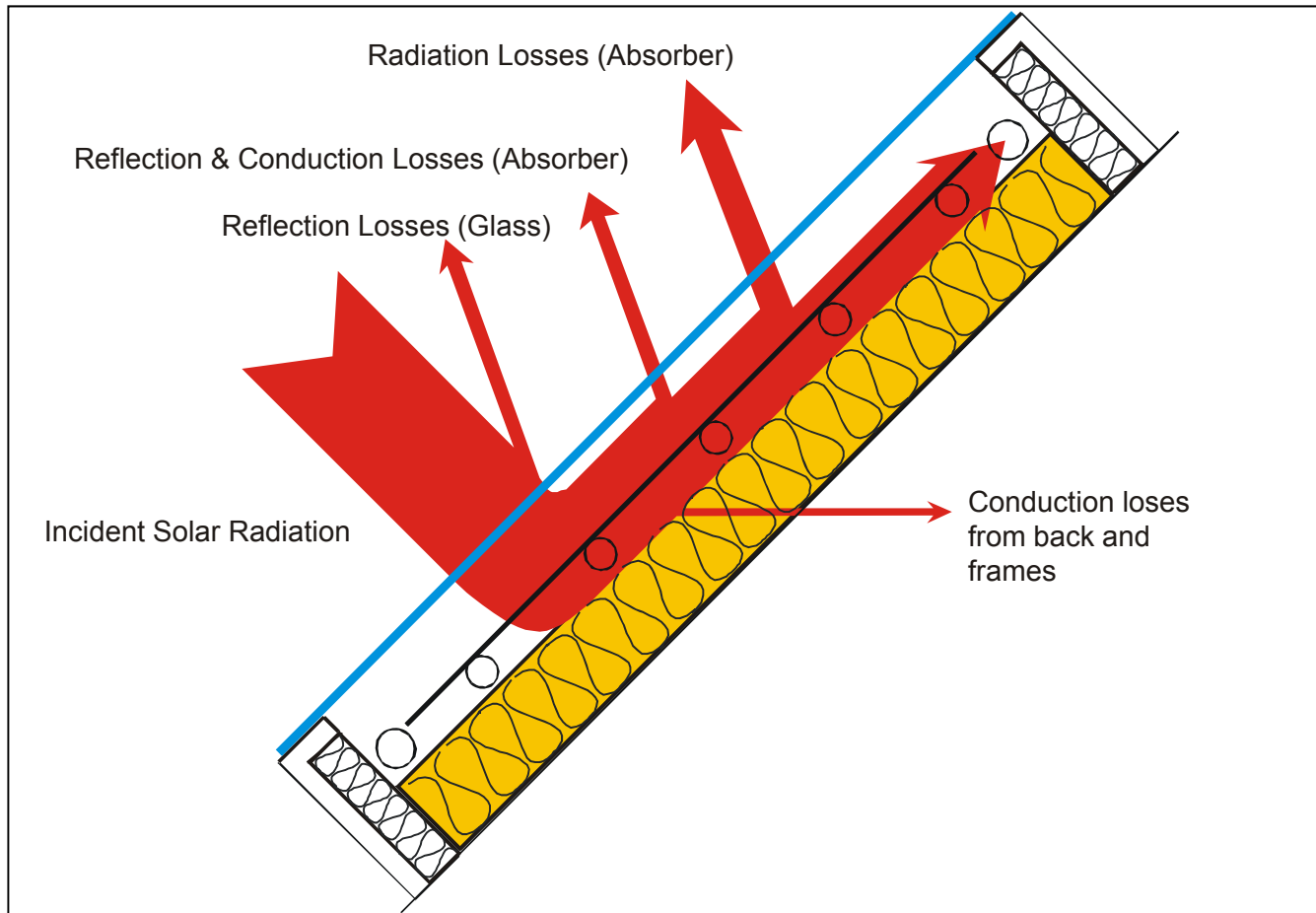


Absorber with linear tubes  
(All surface cover)



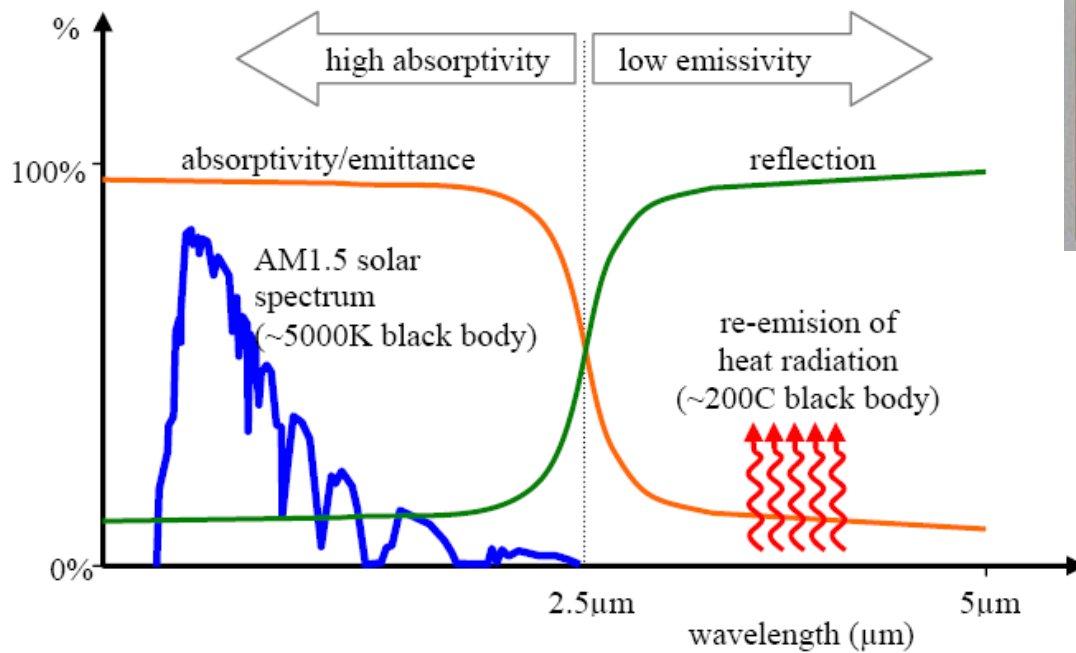
Absorber with linear tubes (2 flows)

# Flat plate Collector– Losses



Thermal losses from flat plate collector

# Selective surface



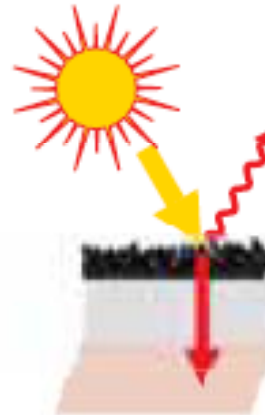


# Selective surface



Black laquer

$\alpha = 95\%$   
 $\epsilon > 80\%$



Black chrome

$\alpha = 95\%$   
 $\epsilon = 12\%$



TiNOX

$\alpha = 95\%$   
 $\epsilon = 5\%$

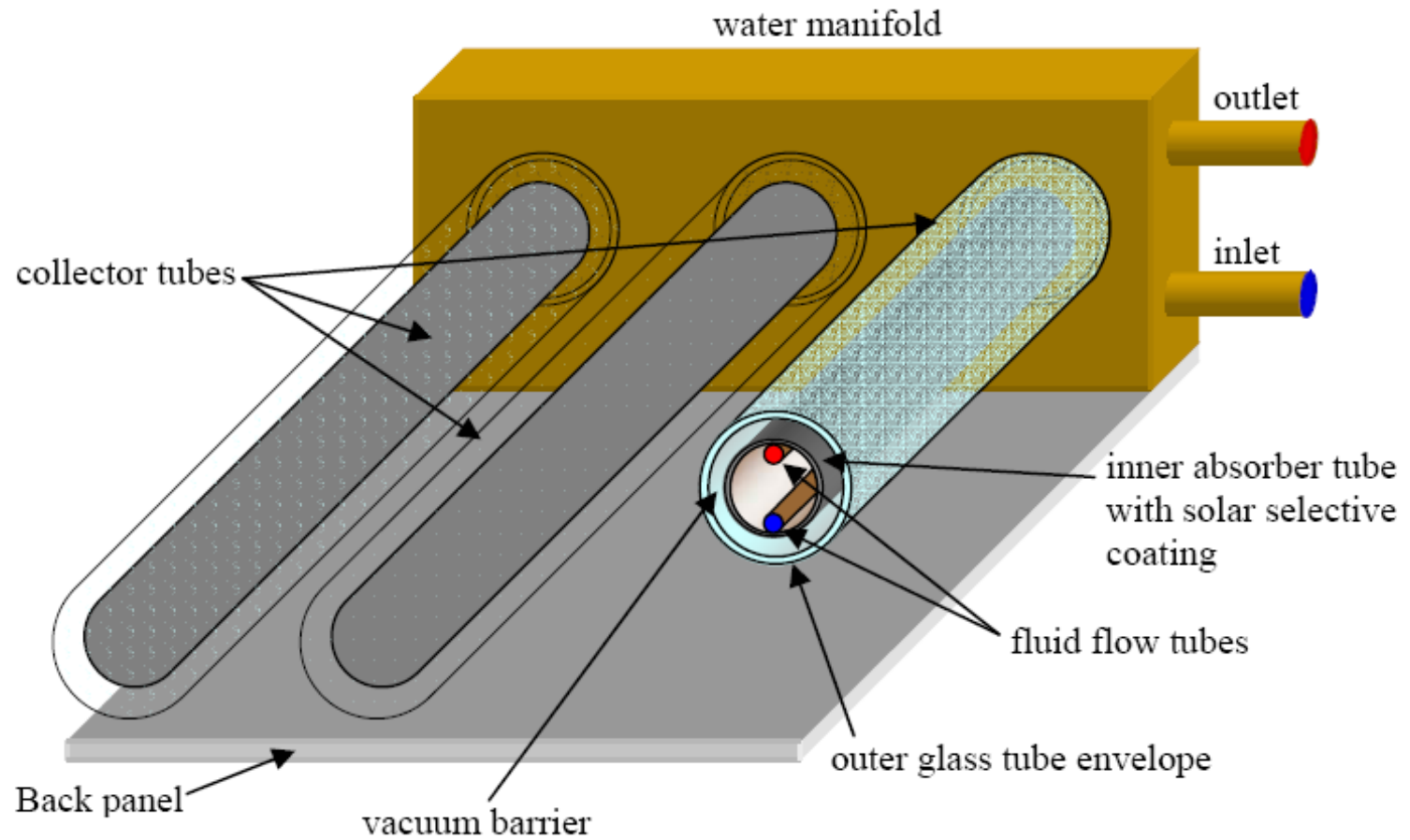


Selective coating

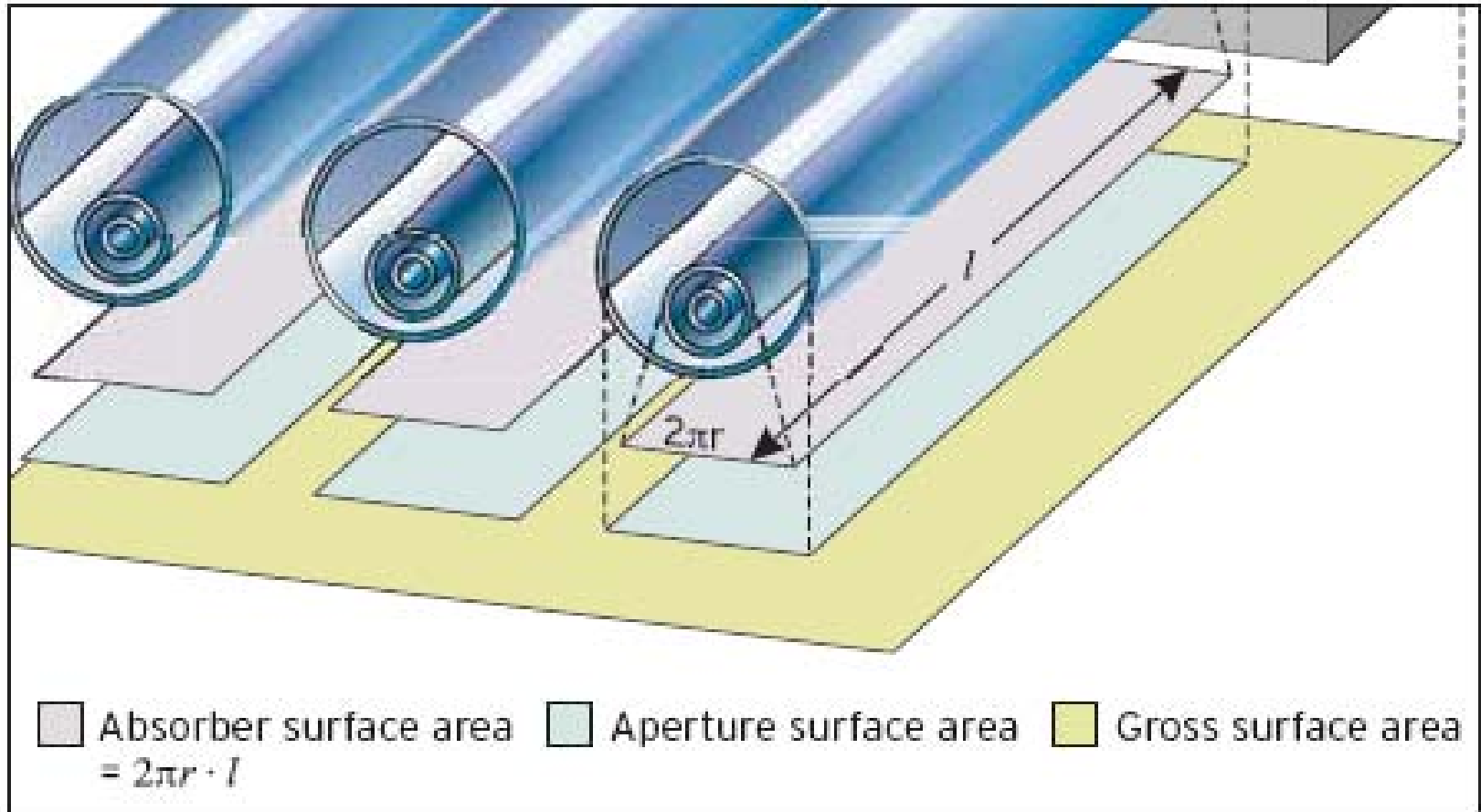
$\alpha = 95\%$   
 $\epsilon = 5\%$

Source:Vaillant

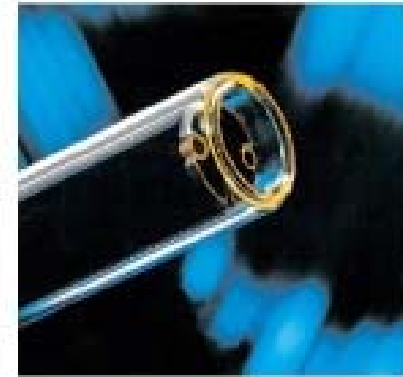
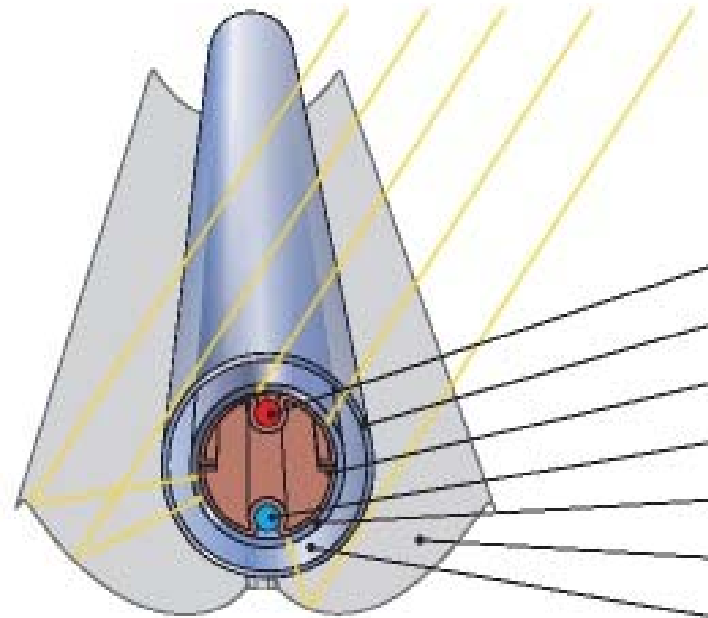
# Vacuum tube collector



# Vacuum tube collectors



# Concentrated Parabolic Collector - CPC



- Inlet
- External glass tube
- Heat transfer sheet
- Outlet
- Internal glass with absorber
- Reflector
- Vacuum chamber

# Solar collector characteristics

Collector Type	Price	Performance (kWh/m <sup>2</sup> /year)	Typical use
Unglazed	Low	300	Pool heating
Flat plate (Black paint)	Mid	650	Pool heating, DHW
Flat plate (Selective absorber)	Mid	700	DHW, Space heating, Air conditioning
Vacuum tubes collector	Hi	850	Space heating, Air conditioning

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# Solar Key Mark

Way to guarantee the collector efficiency

- Randomly choose of the collector (Produce line or stored)
- Pass all the tests according to EN 12975/12976
- ISO certified production line
- Yearly inspection of the production line.
- Reinspection of the product every 2 years.



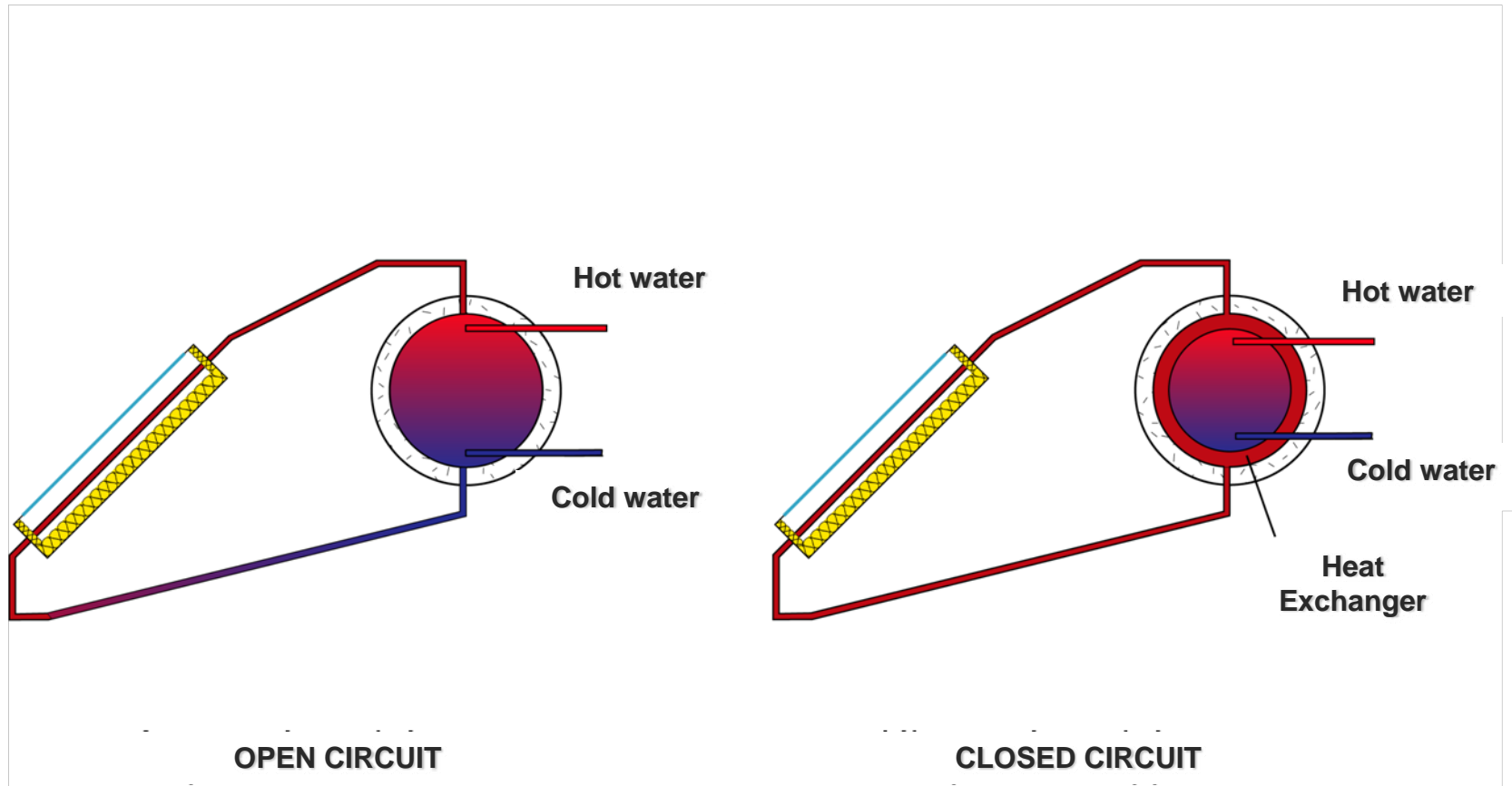
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# Domestic hot water heating

## *DHW heating system*

# Thermal solar systems

## Thermosifonic

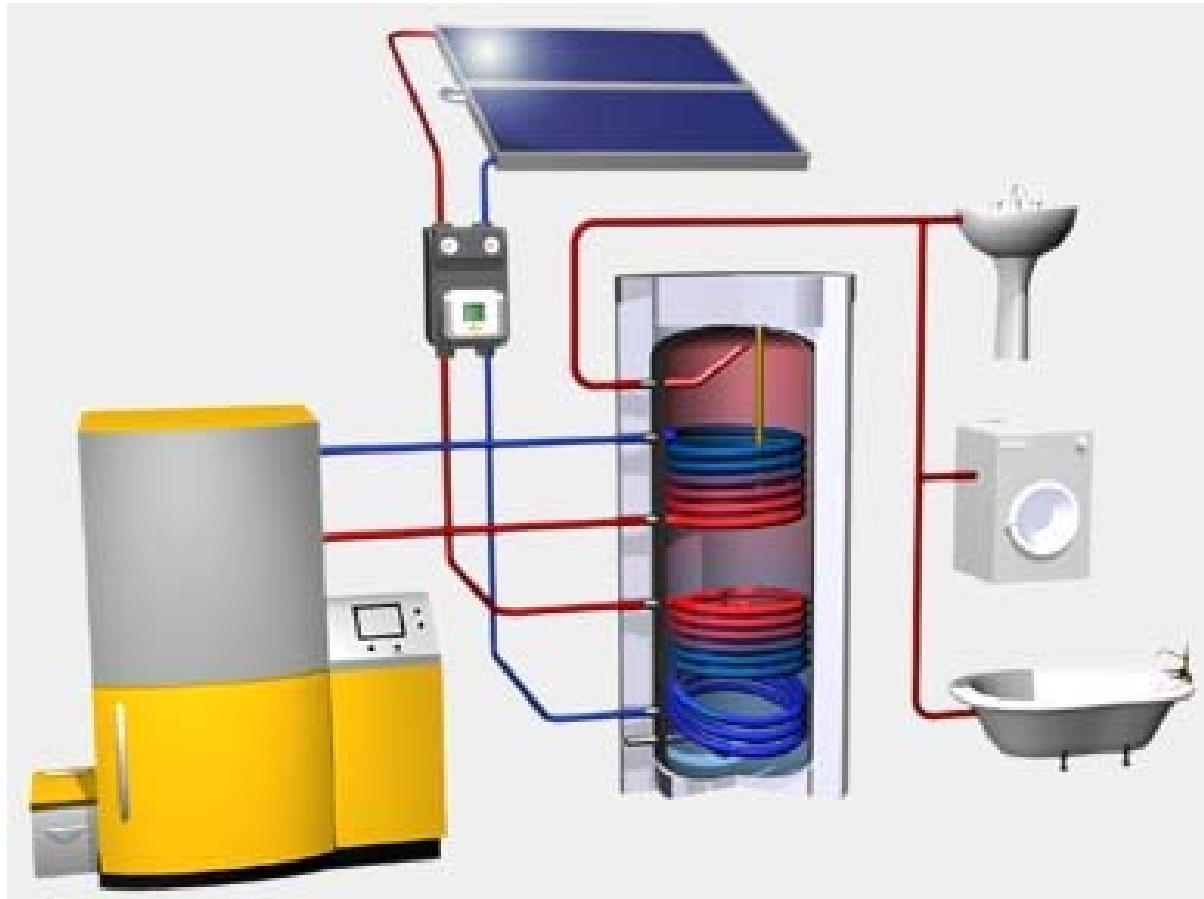


Source: Target/DGS



# Thermal Soar Systems

## Forced circulation



Source: IfaS

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## Combi Systems

- *Operational ways, characteristics and examples.*

# "Combi" Systems

General description

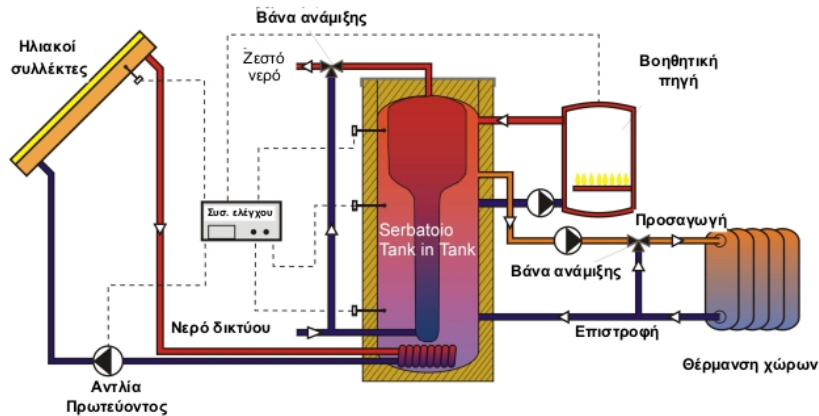


"Solar combisystems" or "combi": Solar thermal systems used for DHW and space heating.

10 basic variations  
(International Energy Agency  
-IEA, Solar Combisystems,  
Solar Heating & Cooling  
Programme, Task 26).

# "Combi" Systems

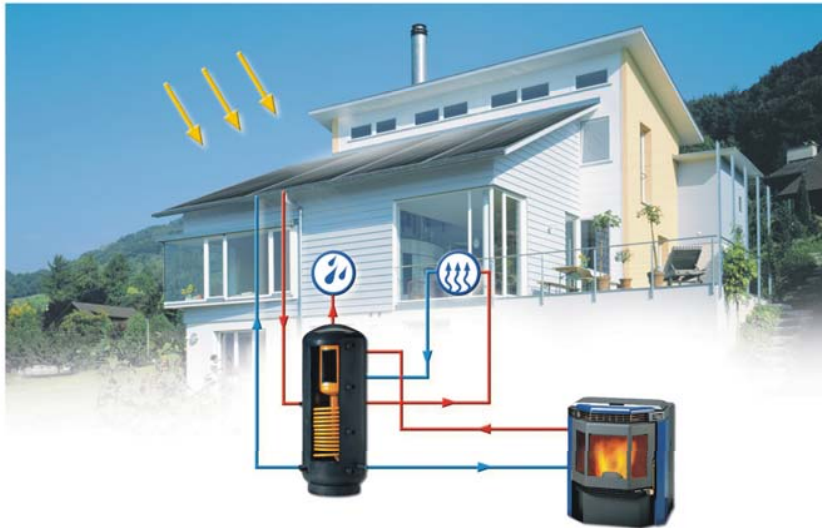
## Properties



- High energy savings:
  - Introduction Solar technology in space heating
- Cost comparable with central solar systems.
- Possibility to combine with solar air condition units.

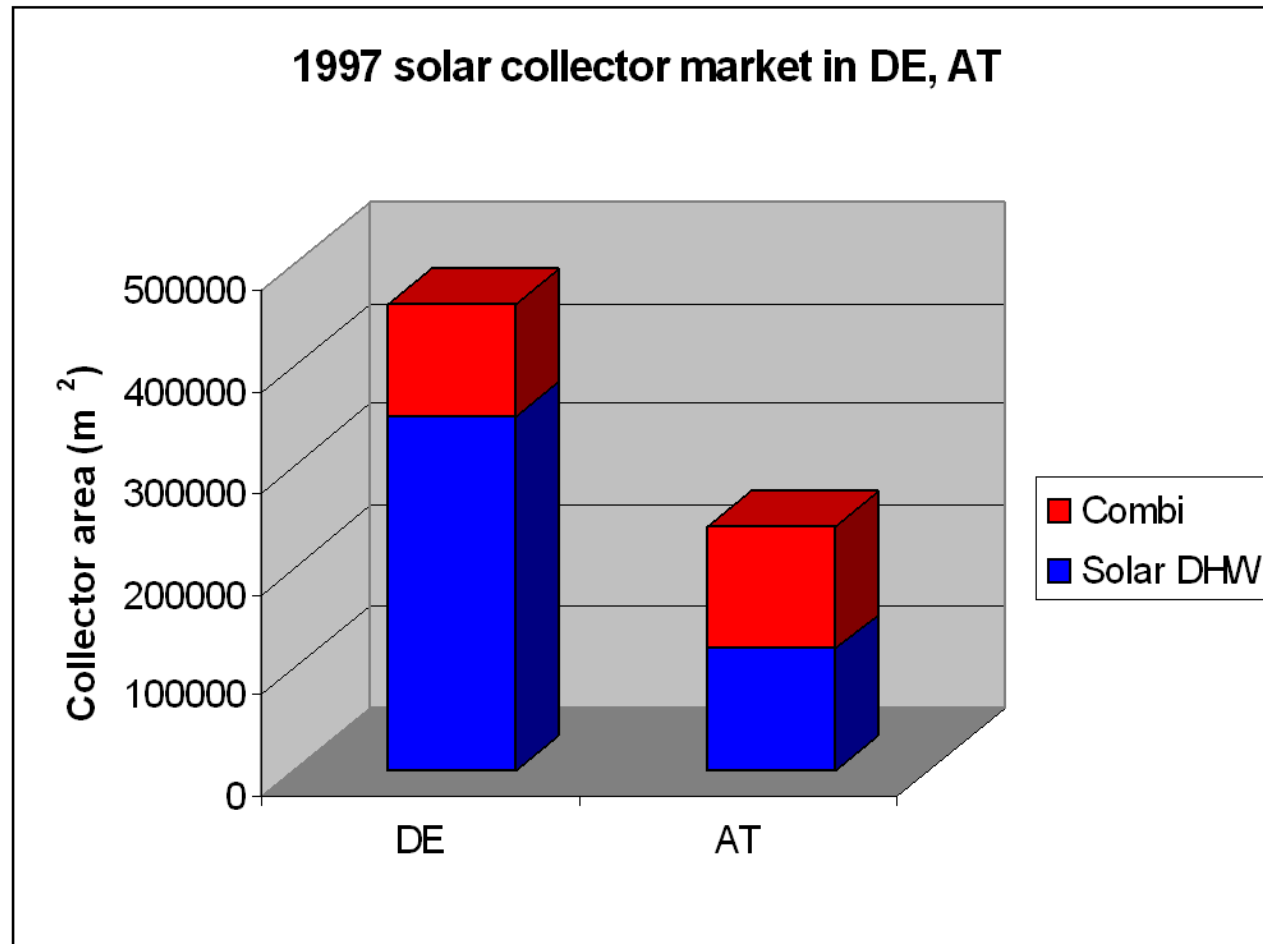
# "Combi" systems

## Advantages



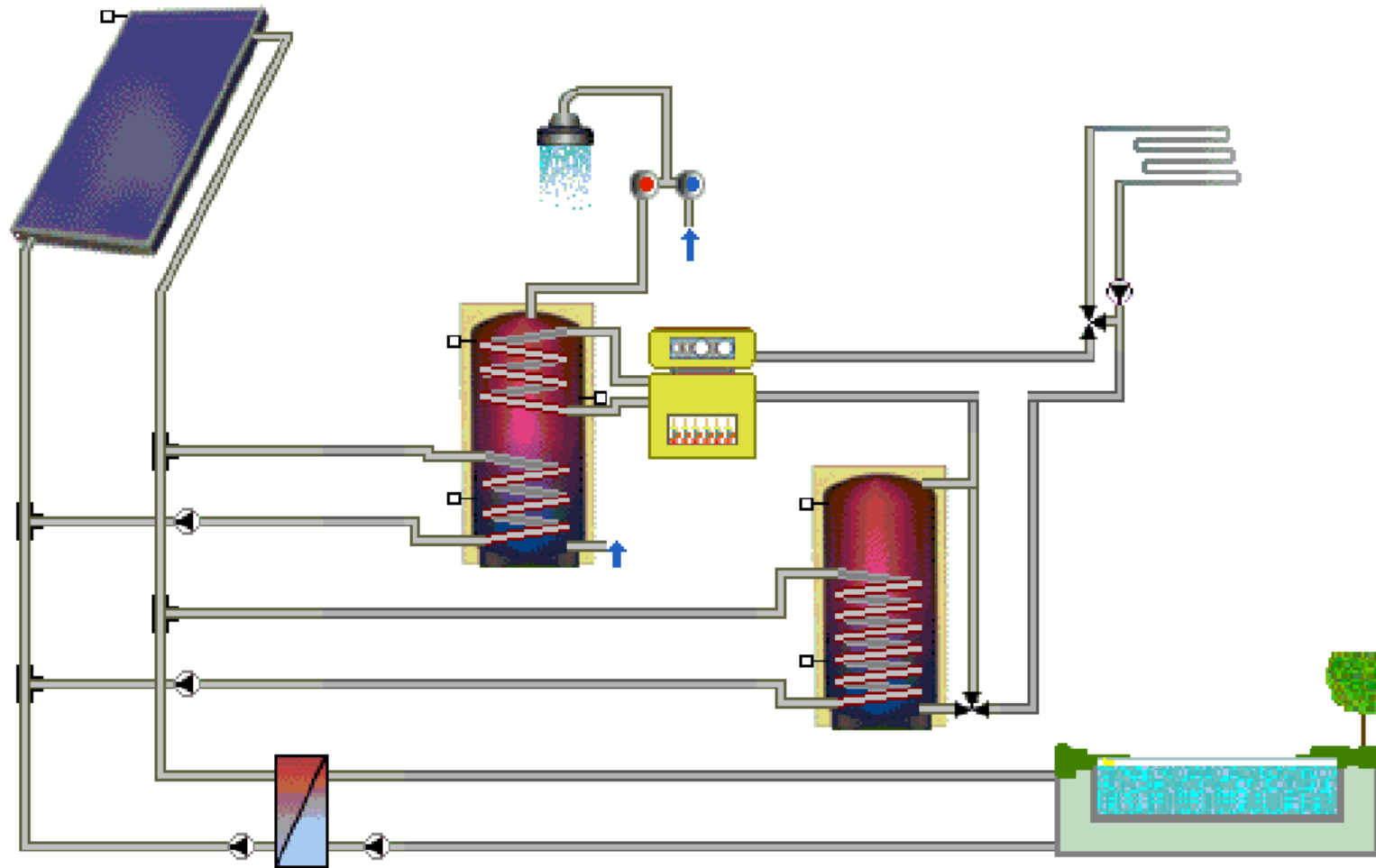
- Use at:
  - Homes
  - Hotels, Hospitals e.t.c.
  - Industry
- Already penetrated in European market
- Ability to cover high thermal load:
  - 30-50% only from sun
  - 100% (Combine with biomass)

# Advanced market "Combi"



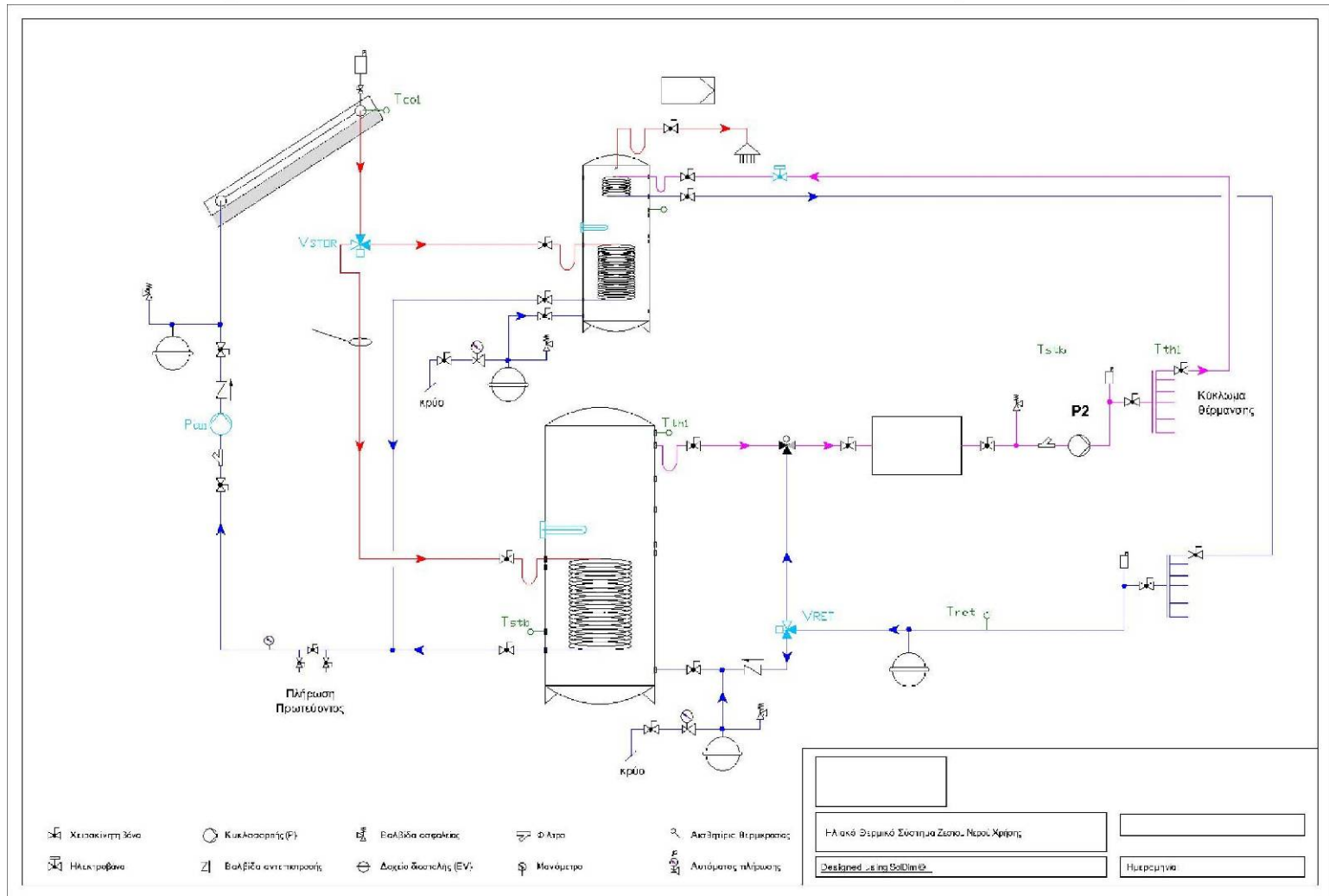
# Combi Systems

Schematic diagram of a combi system for space heating, DHW and pool heating.



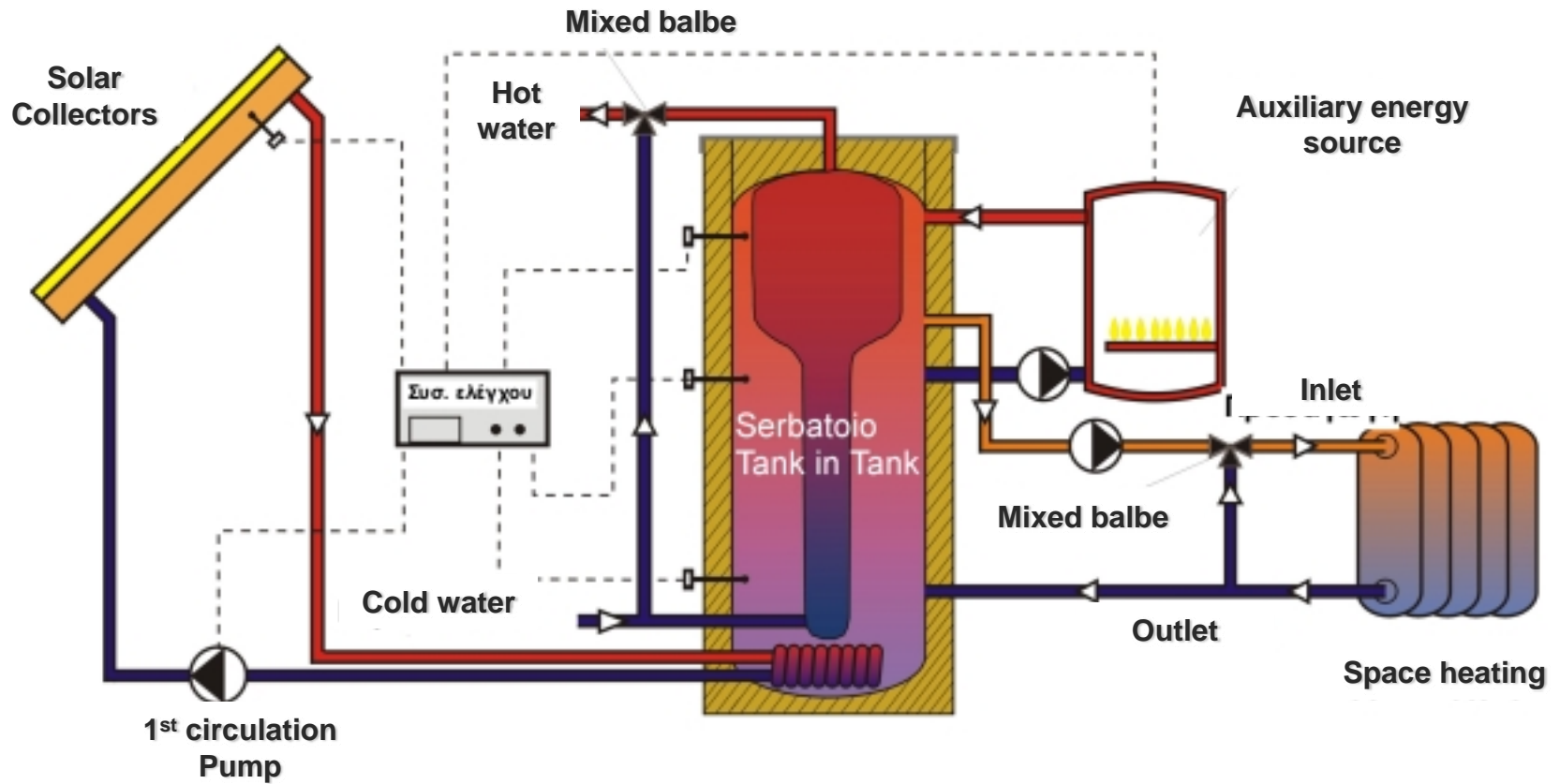
# Combi System

## Schematic diagram of a combi system for DHW and space heating





# Combi Systems – tank in tank



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# "Combi" systems

## Dimensioning

- Domestic Consumption (at 45°C):
  - Low Consumption: 20 - 30 l /person/day
  - Mid Consumption: 30 - 50 l /person/day
  - High Consumption : 50 - 70 l /person/day
  - Washing Machine: 20-40 l / washing
  - Dishwasher: 20 l / washing
  - Example house with 4 persons total  
 $4 \times 40 = 160$  l /day
- Storage tank for DHW = 0,7 - 1,5 x water requirement  
120-240lt storage tank
- Daily energetic load:
  - $E = m \times c_p \times (\Delta T) \Rightarrow$
  - $E = 160 \text{ l} \times 1,16 \text{ Wh/ (l K)} \times (45-15)\text{K} \Rightarrow$
  - $E = 5.6 \text{ kWh}$
- Add energy required for space heating (about 70kWh/100m<sup>2</sup>)\* coverage factor
  - $E = 70 \times 0.4 + 5.6 = 33.6 \text{ kWh}$
- Collector output: 1kWh/m<sup>2</sup> so  $33.6/1 = 33.6 \text{ m}^2$  collector area
- Space Heating Storage 40lt/m<sup>2</sup> collector = 1350lt

# The installation of "SOLLET" project at C.R.E.S



Heated Offices,  
60m<sup>2</sup>

Storage tank, 500lt

Collector area,  
13.5m<sup>2</sup>



Biomass burner,  
35kW



# European project SOLLET (2): Germany, House, Dormagen

## Solar Collectors



- Heating area 400m<sup>2</sup>
- Pellets burner 10 KW with heat exchanger air/water
- Fire place 10 KW with air/water heat exchanger
- 105 m<sup>2</sup> collector area.
- Water tank 3000 l
- Auxiliary heating system with natural gas.



Backup fire  
place

---

## European project SOLLET (3): Germany, House, Cologne



- Heating area 140m<sup>2</sup>
- Pellets burner 10 KW with heat exchanger air/water
- 28 m<sup>2</sup> collector area
- Water tank 1000 l



Pellet Burner



Solar collectors

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## Combi : Home (FR)



Source: IEA Task 26

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## Combi : Apartments (AT)



Source: GSWB



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## Combi : Apartments – Solar village (GR)






# Ready Made Systems



Καυστήρας Pellet



<p>Ηλιακοί συλλέκτες</p> 	<p>Υδραυλικό κιτ</p> 	<p>Δοχείο διαστολής</p> 
	<p>Θερμαντήρας</p> 	<p>Παρελκόμενα</p>  <p>Αυτοματισμός</p> 

Source: Buderus

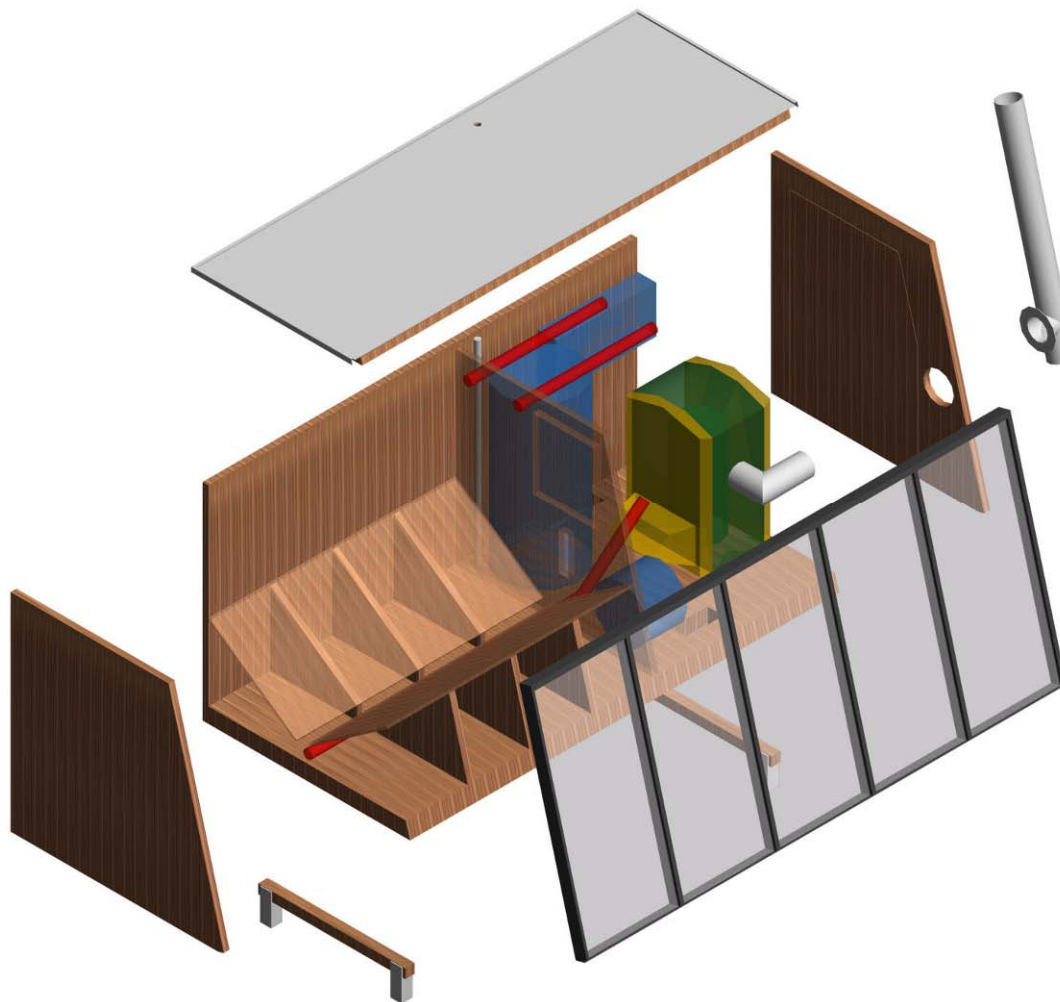
# Compact Systems: Plug n' play

*Dimensions (LxWxH)  
10,5m x 2,5m x 2,6m  
24 m<sup>2</sup> collector area  
30-150 kW pellet burner*



---

# Compact systems: Plug n' play



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## General Observations

- Solar heating systems can be combined with conventional space heating systems – Integration with already installed systems.
- Combination with solar chillers to cover cooling loads (Use of excess energy).
- Cost:  $\approx 400\text{€}/\text{m}^2$
- Collector area: 28% of the heated area for 40% load coverage (ex. 28m<sup>2</sup> flat plate collectors for 100m<sup>2</sup> house).
- Hot water Storage Volume: 10x heated area (1000lt tank for 100m<sup>2</sup> house)
- Must give emphasis at planning.  
ex. Dimensioning of expansion tank of solar circuit. (stagnation temperatures).