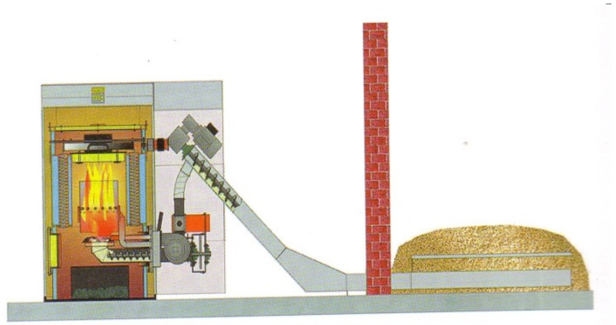
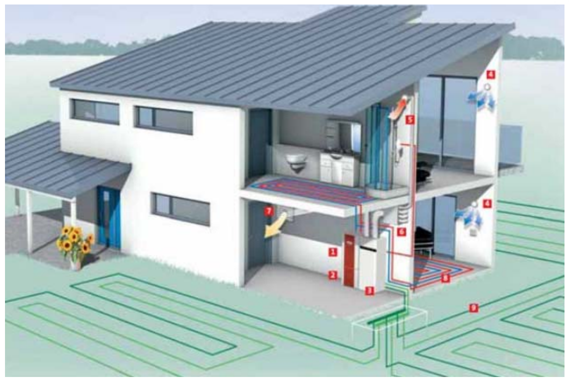
M5

Energy Resources and Renewable Energy Technologies





INTELLIGENT ENERGY EUROPE

UP-RES
Urban Planners with Renewable Energy Skills

Content

1. Introduction
1.1 EPBD – the nZEB

According to the Energy Performance of Building Directive (2010) the energy demand of nearly **z**ero **e**nergy **b**uildings „should be covered to a very significant extent by energy from renewable sources (including energy from renewable sources produced on-site or nearby."

New buildings must fulfil this requirement from 2019 and 2021 (state owned buildings and all buildings, respectively).

The use of "onsite" (= at building) renewable energy in densely built urban environments is constrained: solar over-shading, biomass incineration increasing smog risk, space availability for geothermal energy.

1. Introduction

1.2. Where is the Source of RES

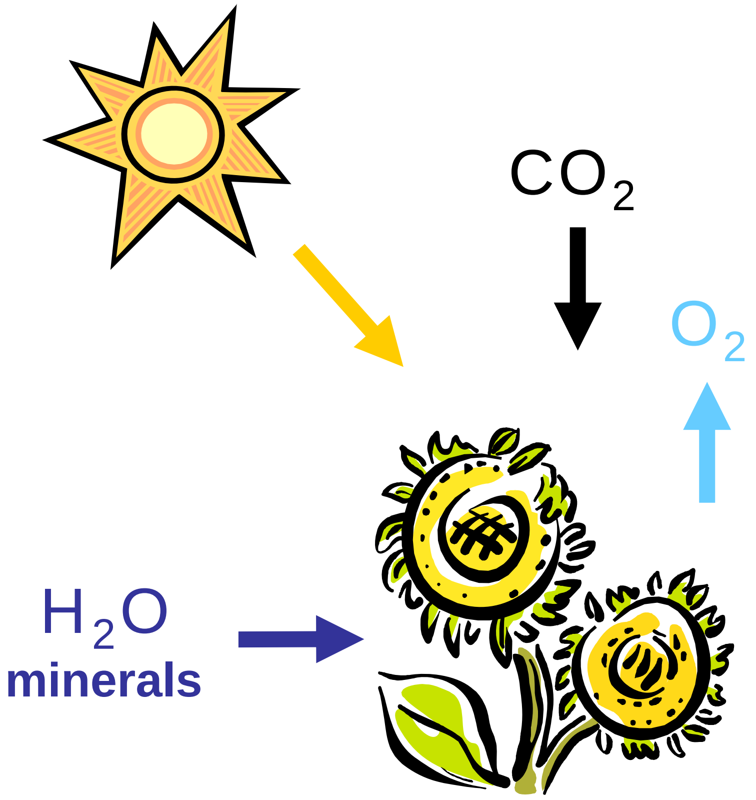
„Nearby" system is interpreted as a „closed" system based on, or supported by, renewable energy which supplies a group of buildings. Its capacity and topology are adjusted to the performance requirements of that group of buildings as a whole.

Nearby systems facilitate better, collective use of solar energy from the group of buildings, easier service of biomass boilers, easier transport and storage of biomass, less risk of air pollution with properly positioned chimneys, more efficient use of geothermal energy, and potential for small-scale CHP.

Off-site systems include district heating and cooling as well as the national grid. The primary energy content expresses whether they are based on, or supported by, renewable sources.

2. Biomass

2.1. Sources



Biomass = transformed solar energy

Organic materials from plants, animals and humans.

Products, by-products and waste from agriculture, forestry, animal husbandry, industrial processes

Solid and liquid fuels, biogas

EU: 84% heat, 15% power generation, 1% vehicles

Biomass

2. Biomass
2.2. Pellet



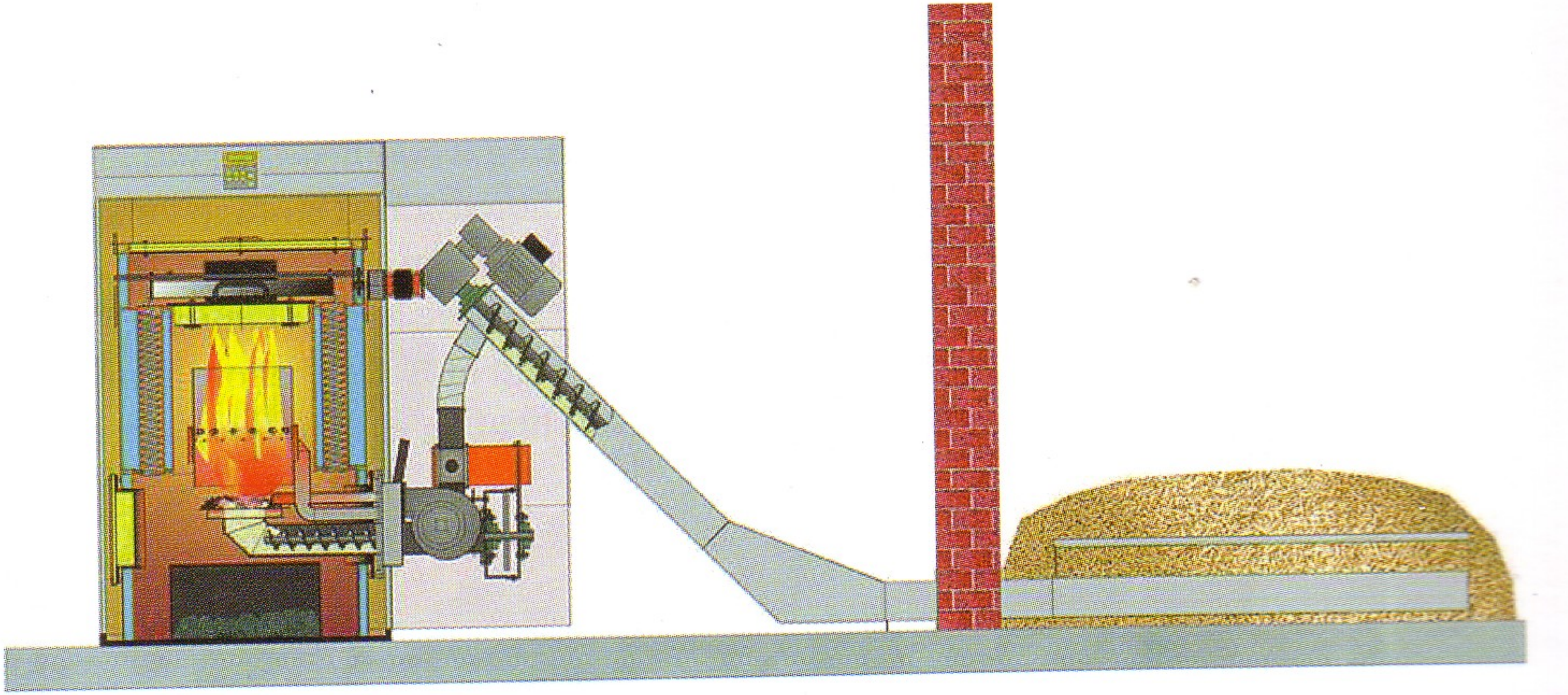
Granulated spin and sawdust

D=5-10mm, L=10-25mm

Clean, easy to transport and feed

2. Biomass

2.3. Feeding Pellets to Boiler



2. Biomass
2.4. Wood Gasifying Boilers

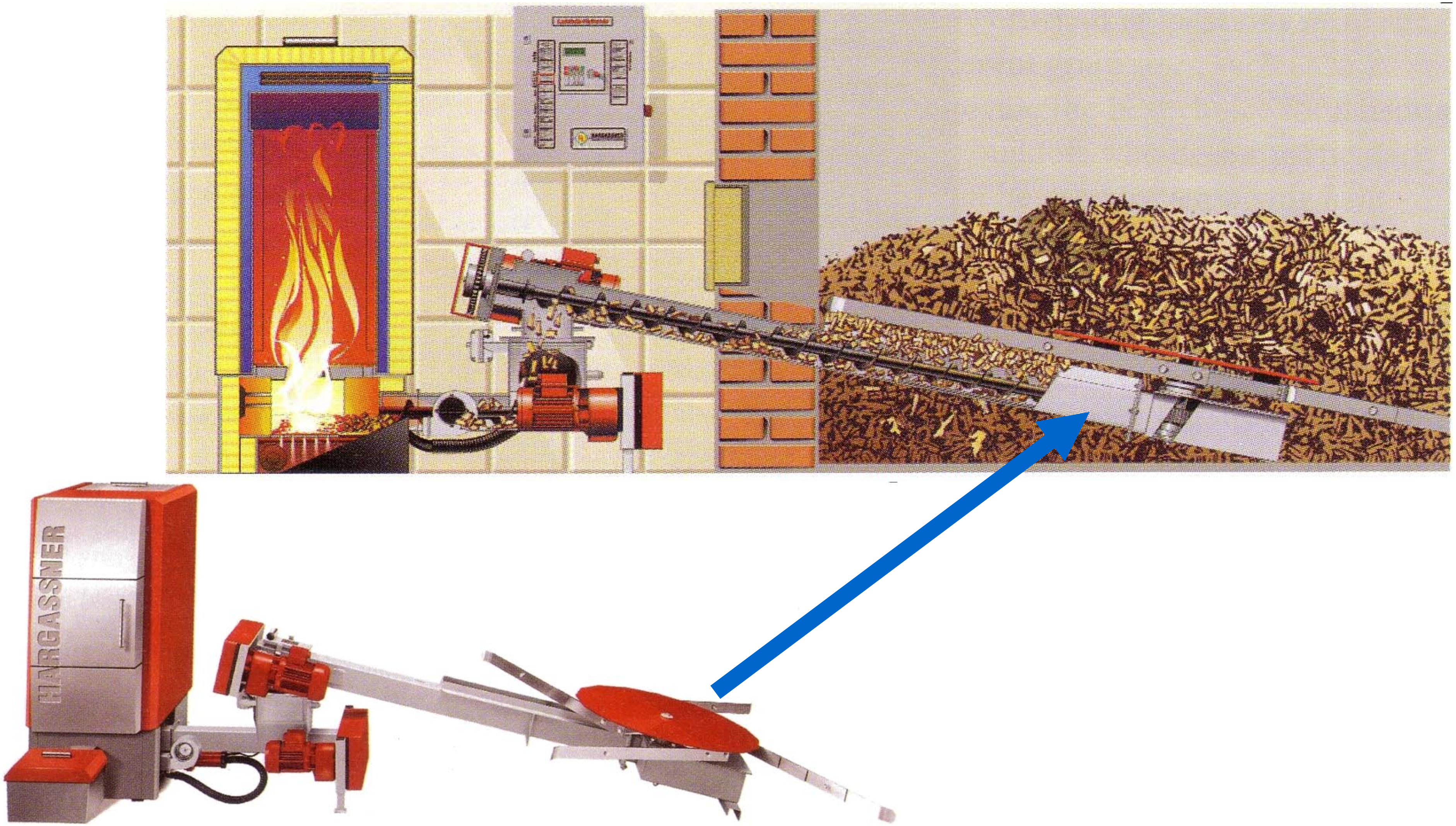
Main elements

Primary chamber:
- low temperature fire
- gas generation
- exhaust fan

Secondary chamber
- high temperature fire
- heat exchanger
- chimney

2. Biomass

2.5. Wood-chip Boiler

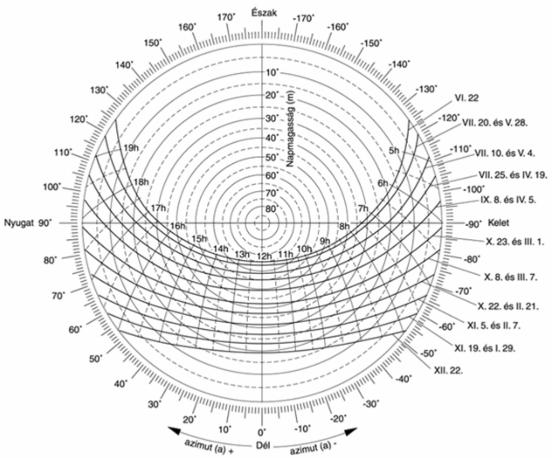


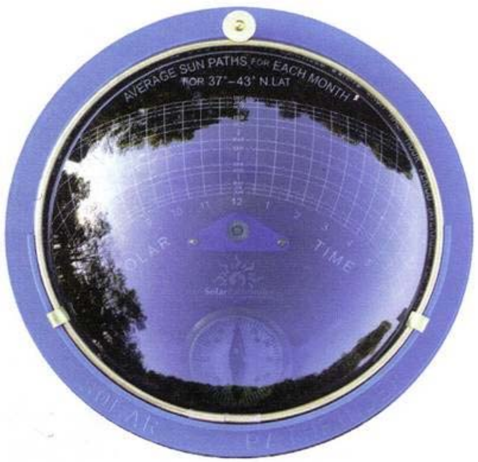
3. Solar Access

The access of solar radiation to solar thermal collectors or PV arrays is often obstructed in densely built urban areas, particularly for low-rise buildings

On tall buildings the ratio of ‘energy collecting area’ to ‘useful floor area’ is small

A group of buildings may be supplied from collectors or PV arrays on nearby unobstructed roofs or open spaces.

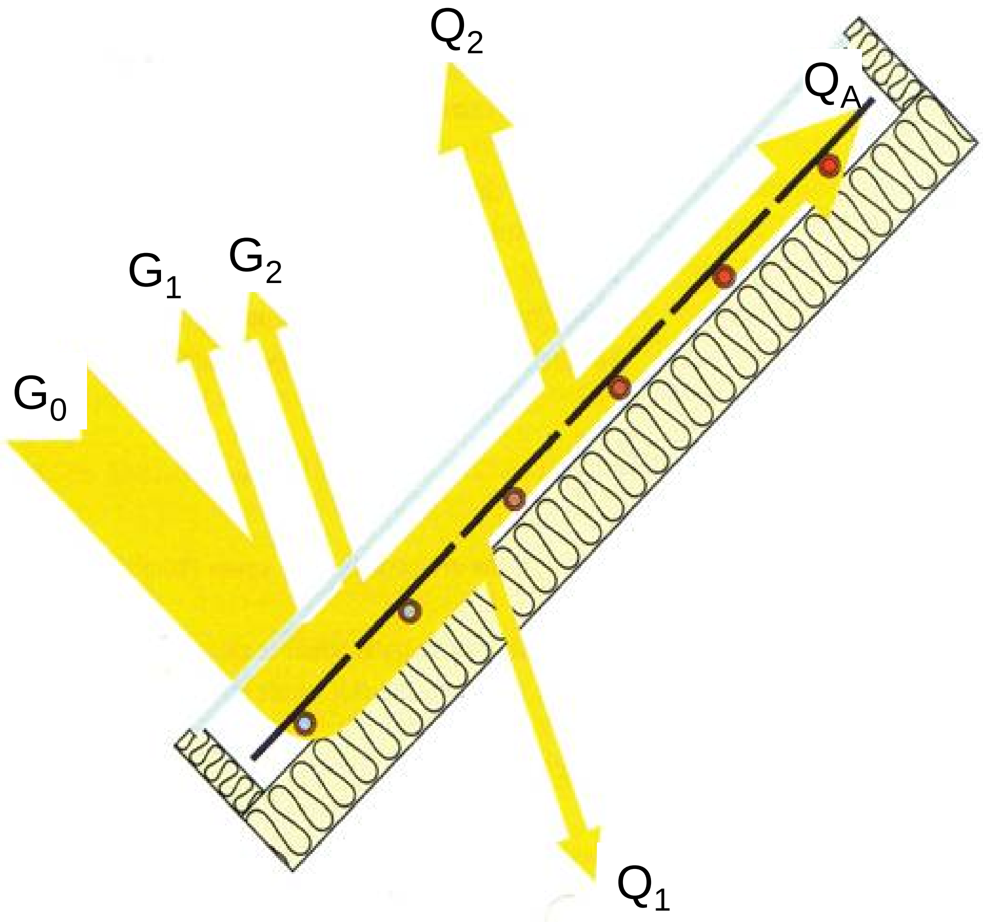




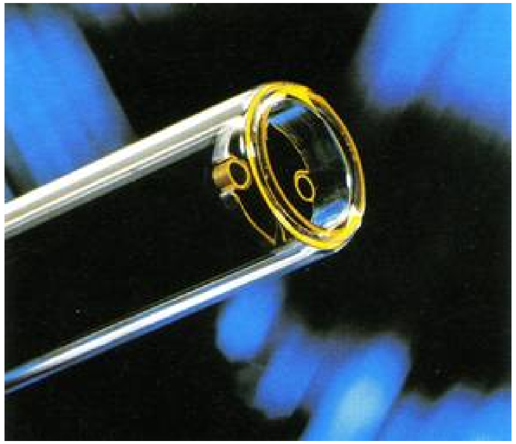
4. Solar Thermal

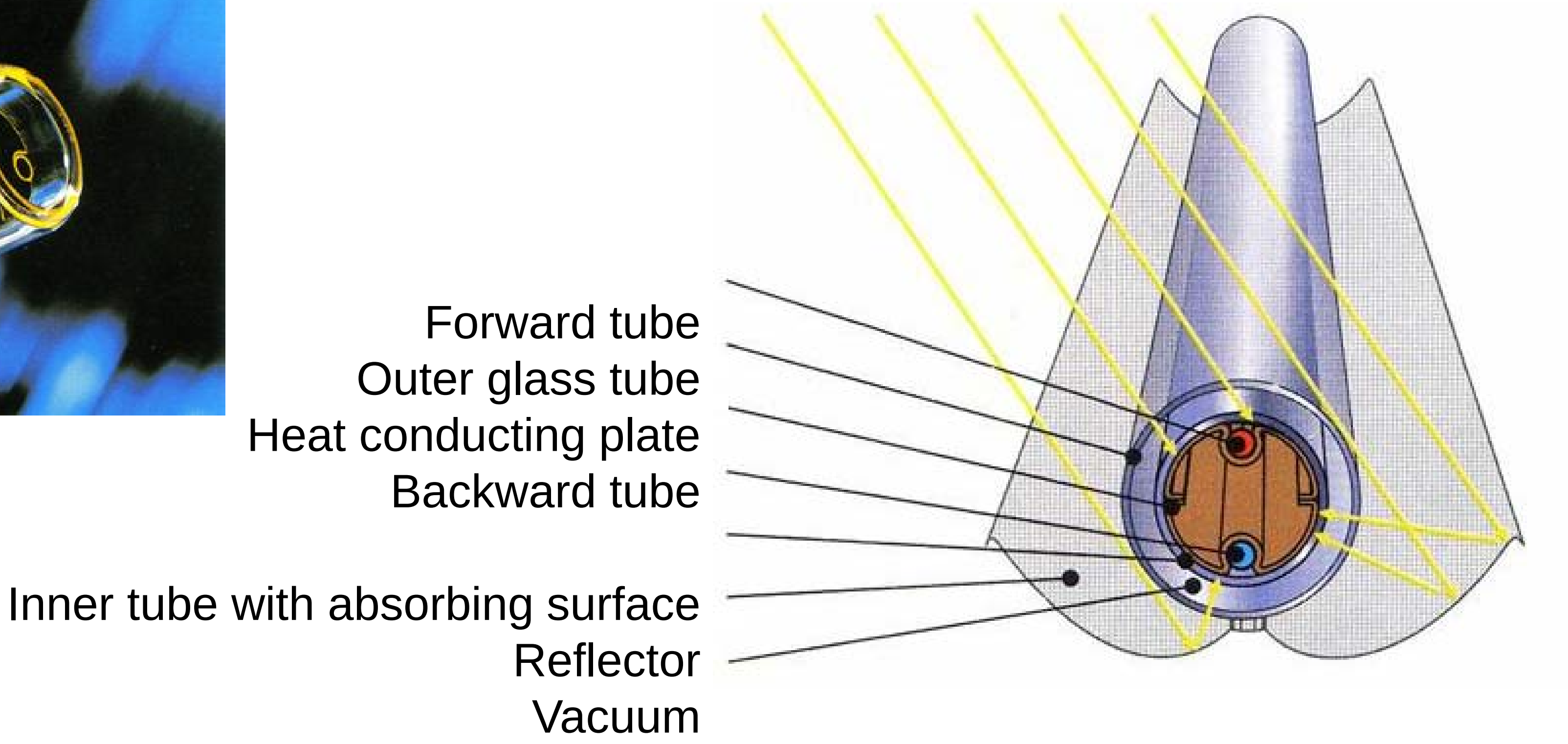
4.1. Flat Plate Collectors

- G_0: incident radiation
- G_1: reflected radiation from the glazing
- G_2: reflected radiation from the absorber
- Q_1: heat loss through the thermal insulation
- Q_2: heat loss of the absorber
- Q_A: heat output from the collector



4. Solar thermal
4.2. Vacuum Tube Collector

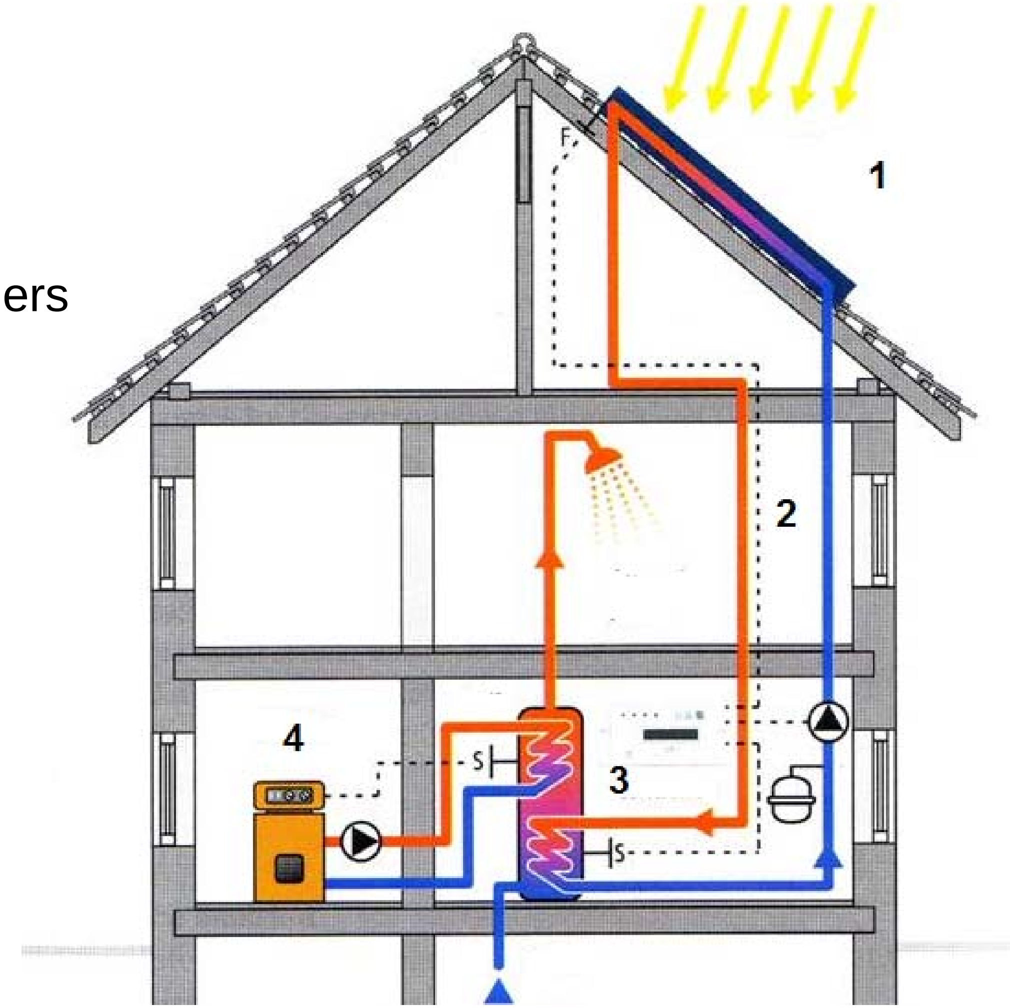




4. Solar Thermal

4.3. Solar Thermal at the Individual Building Scale

1 Collector array
2 Solar loop
3 Storage tank with heat exchangers
4 Boiler



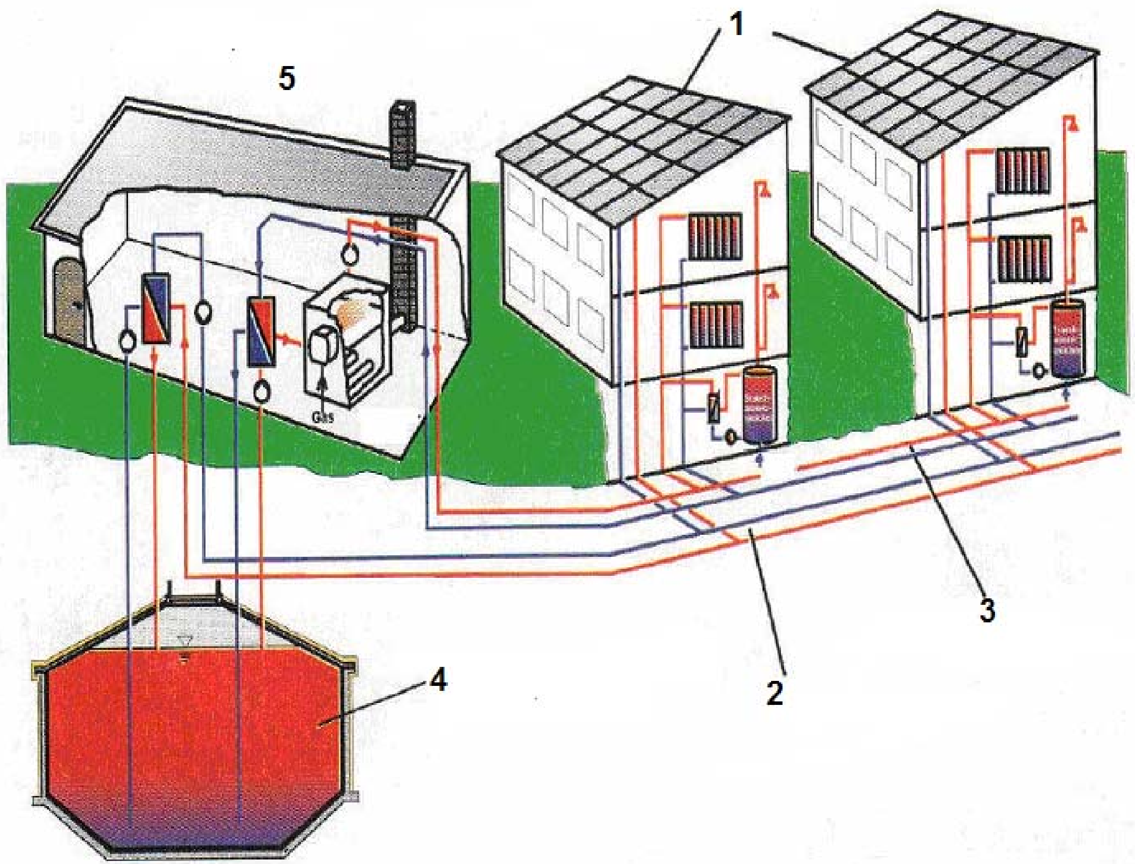
4. Solar thermal

4.4. Solar Thermal at the Neighbourhood Scale

‘Nearby’ or district heating supported by active solar thermal system and seasonal heat storage

Example:
the Friedrichshafen project

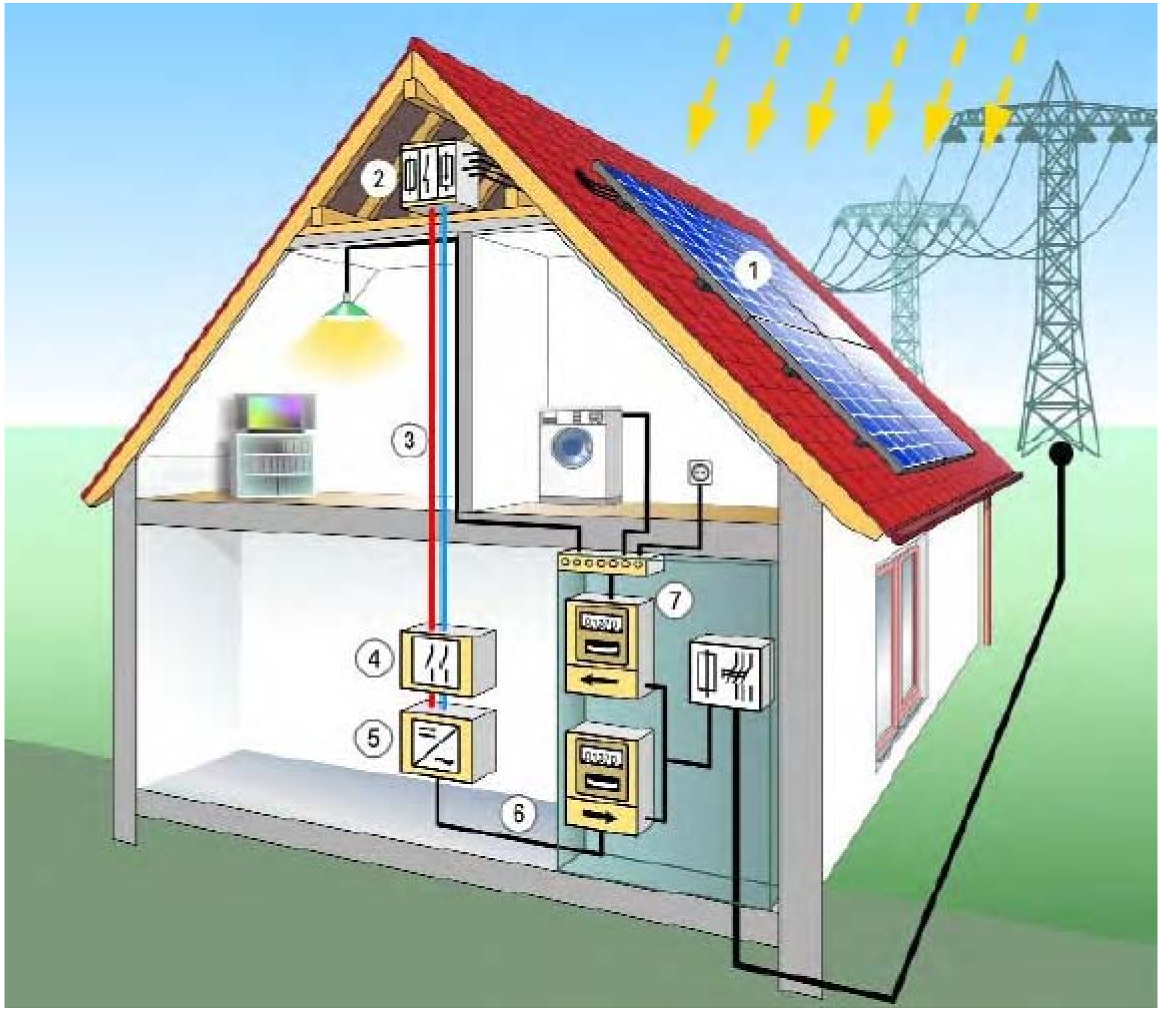
1 Collector array 5600 m²
2 Collector network
3 Heating network
4 Seasonal storage 12000 m³
5 Heating plant



5. PV

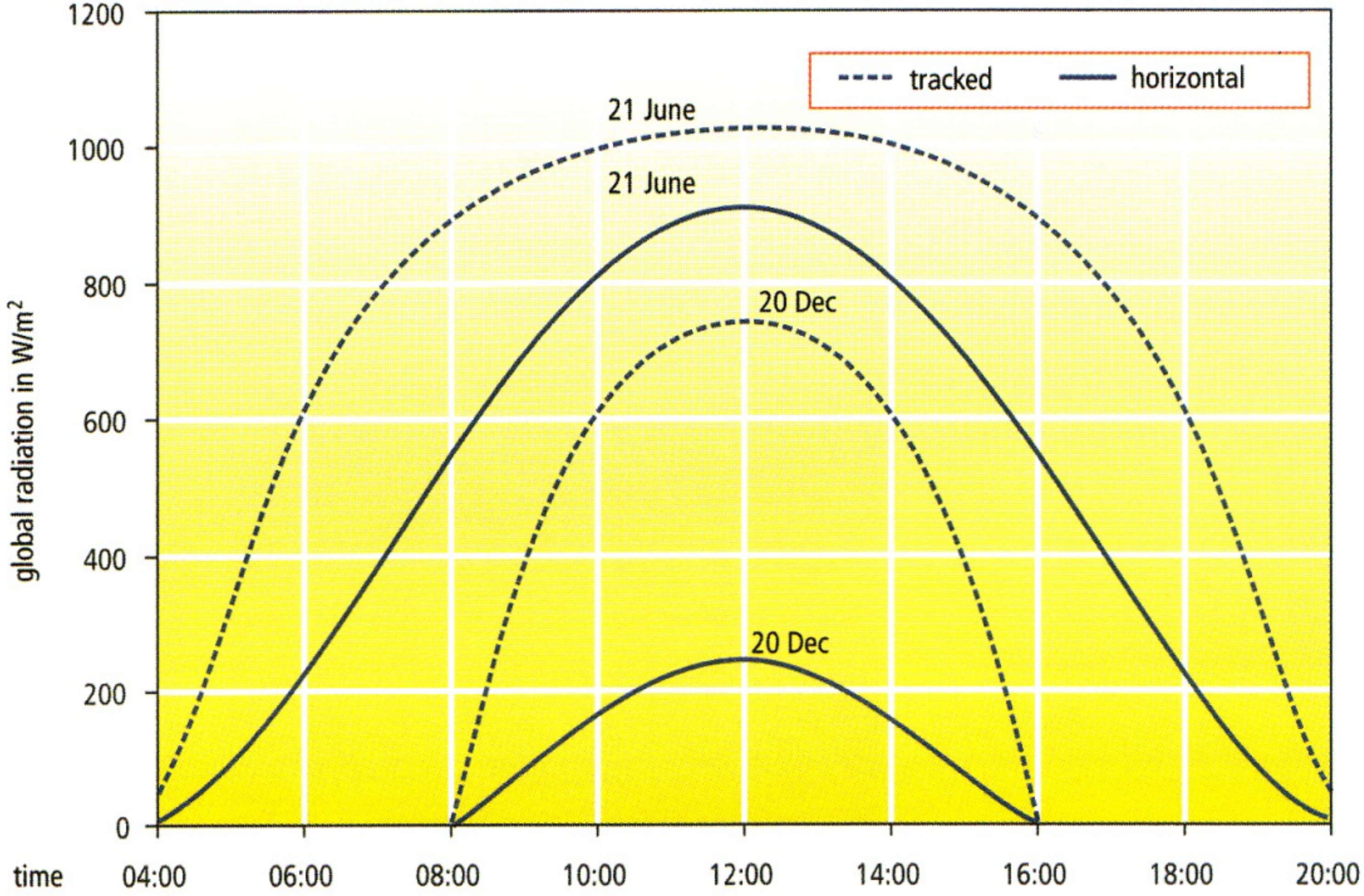
5.1. PV System

1. PV array
2. Junction box
3. Direct current cabling
4. DC isolator switch
5. Inverter
6. AC cabling
7. Supply and feed meter



5. PV

5.2. Effect of Sun-tracking



5. PV

5.3. Sun-tracked PV Arrays

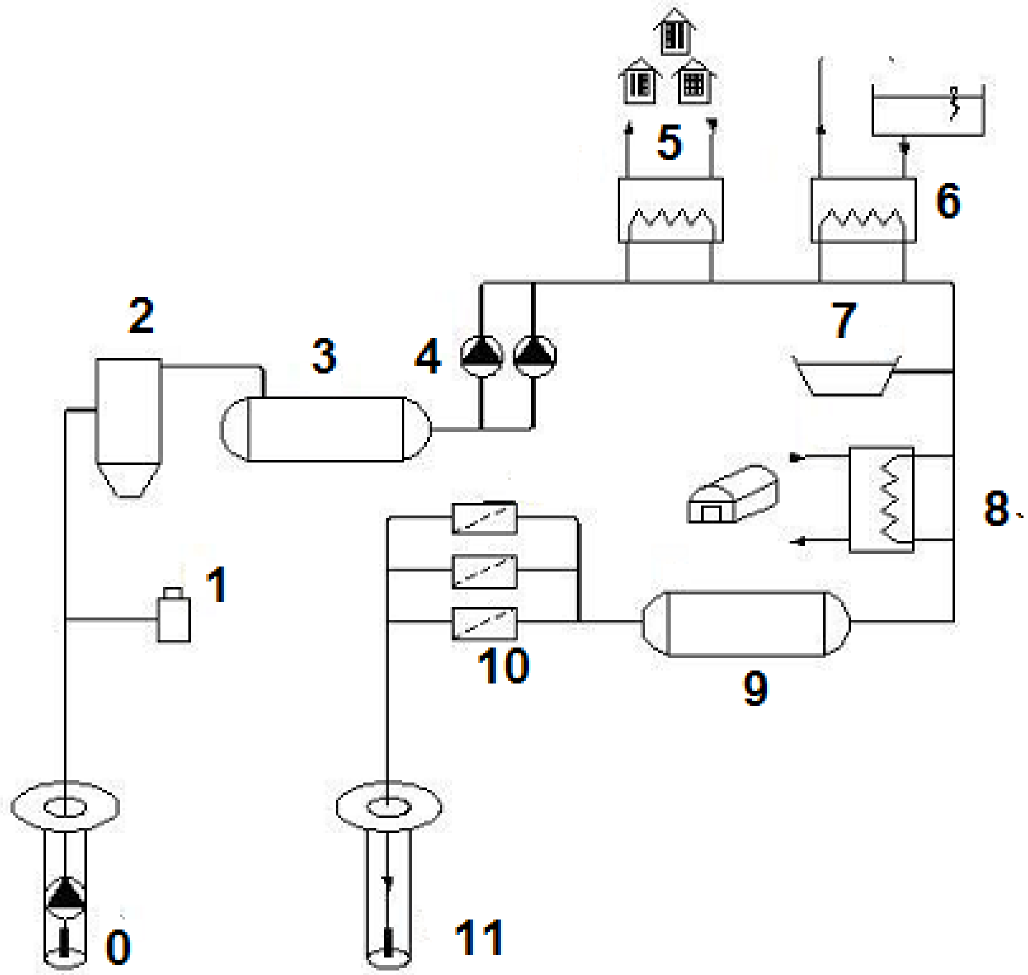
PV arrays on individual buildings should be fixed at near optimal orientation and tilt.

In open areas the orientation and tilt can continuously follow the Sun’s path.

The yearly energy production is much higher with Sun tracking system.

6. Thermal water

Thermal water utilisation
0 source
1 chemical treatment
2 hydrocyclon
3 storage tank
4 pumps
5 heat exchanger for heating
6 heat exchanger for hot water
7 balneologic utilisation
8 soil heating in greenhouses
9 storage tank
10 filters
11 return well to the soil

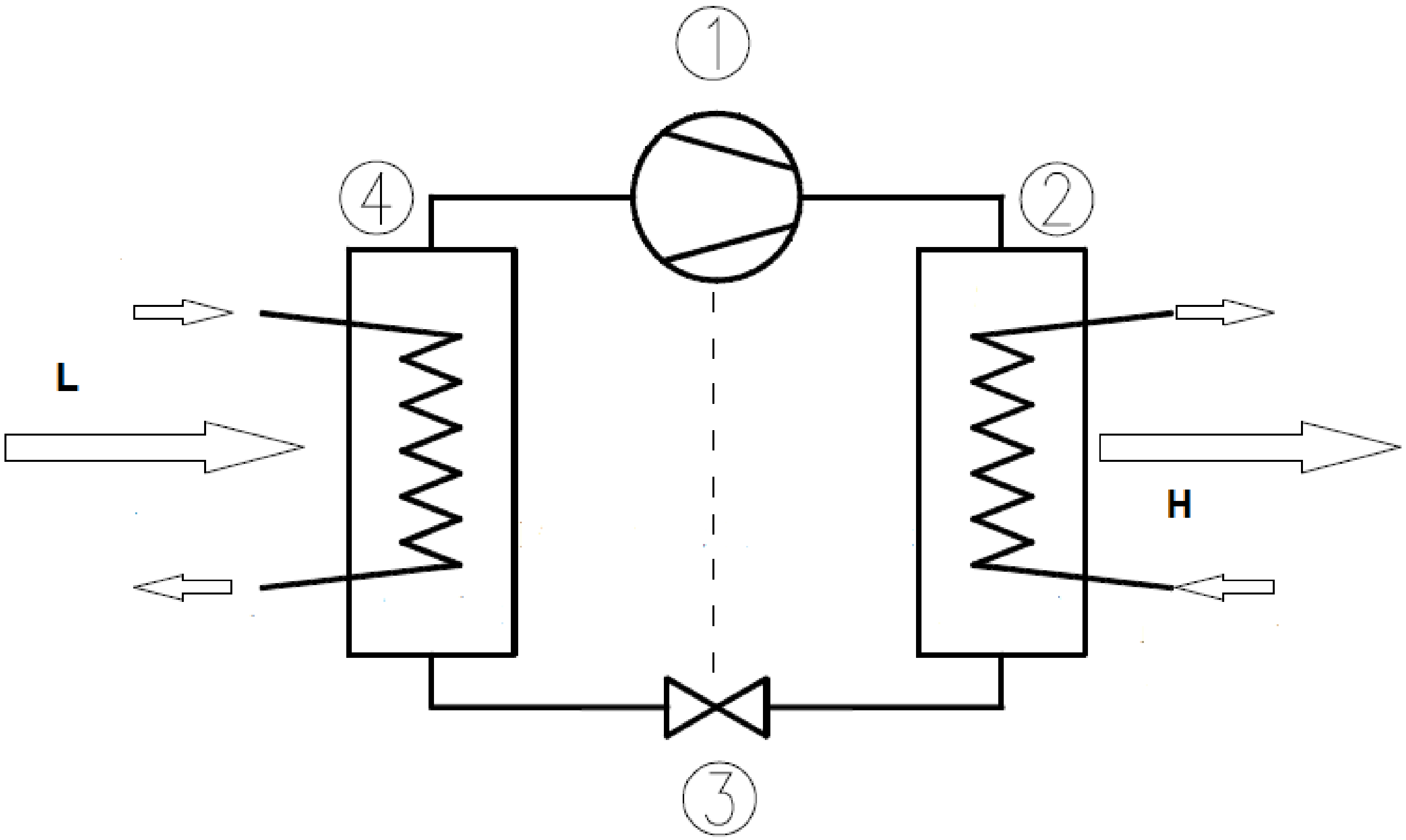


The cascade system is adjusted to the required energy carrier temperatures of different consumers: favourable use of exergy

7. Heat pump

7.1. Heat Pump with Compressor

L: low temperature, low pressure, heat extraction
H: high temperature, high pressure, heat output
1 Compressor
2 Condenser
3 Expansion valvel
4 Evaporator



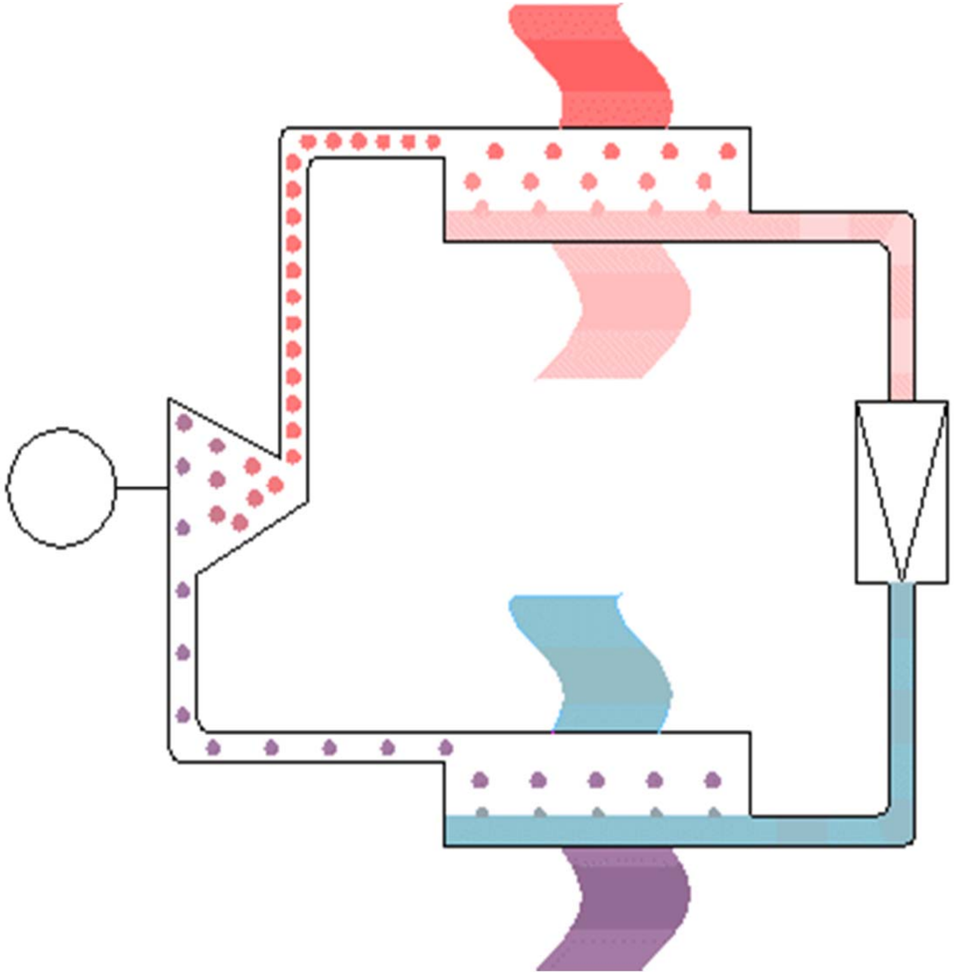
7. Heat pump

7.2. How the Heat Pump Works

The heat pump is based on the phenomenon that the temperature of liquid-vapour phase change depends on the pressure.

At low temperature, evaporation extracts heat, at high temperature condensation releases heat.

Pressure is provided by the compressor, driven typically with an electric engine. The COP expresses the ratio of thermal and electric energy

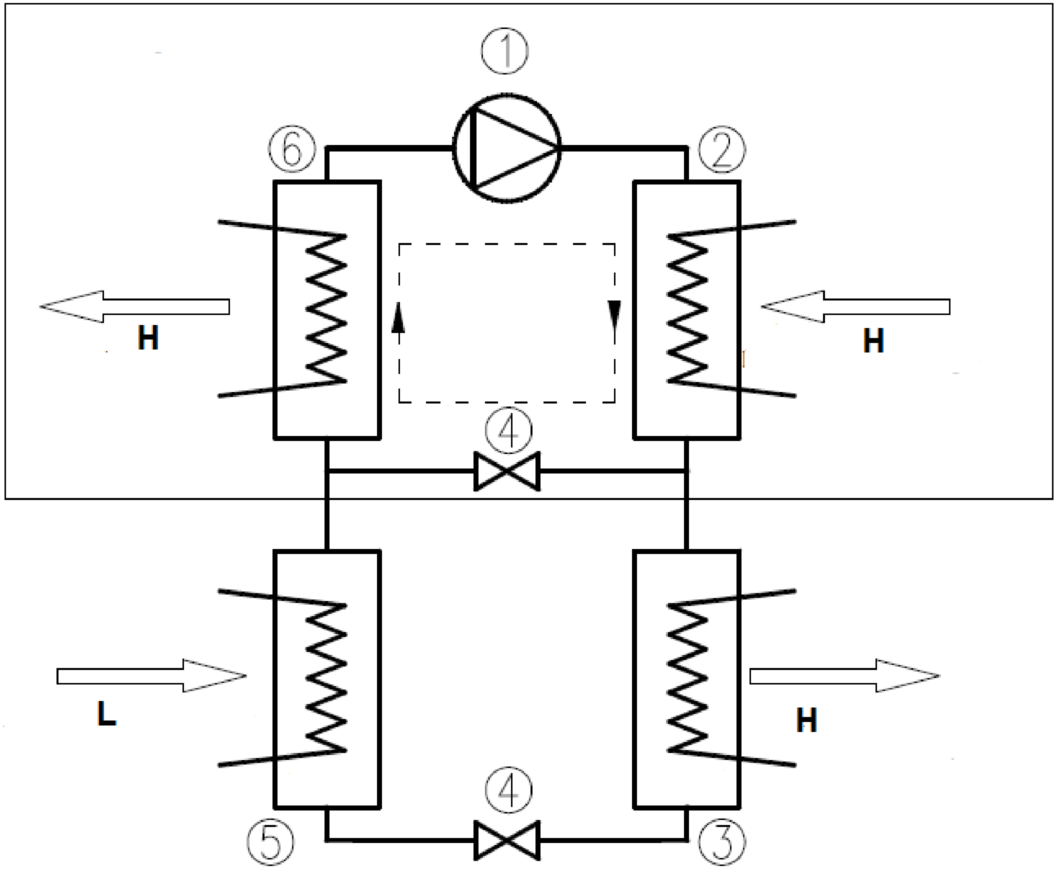


7. Heat pump

7.3. Heat Pump with Absorption

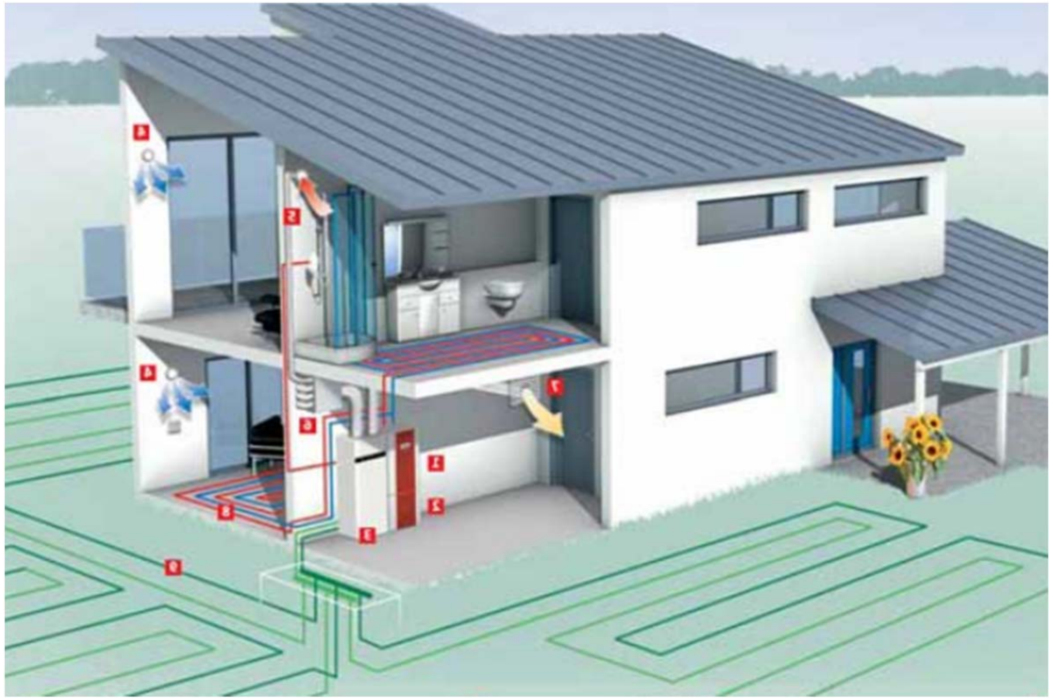
The liquid – vapour phase change temperature depends on the concentration of a solution. The concentration is changed by the evaporation of the solvent with heat input (solar, gas engine)
L - low temperature heat exchange
H – high temperature heat exchange

1. Solvent pump
2. Solvent evaporator
3. Condenser
4. Expansion valve
5. Evaporator
6. Absorber



7. Geothermal energy
7.1. Source: buried coil

The source of a heat pump can be air (outdoor or exhaust), natural water, waste water, or sludge; nevertheless the most typical is heat from the soil.

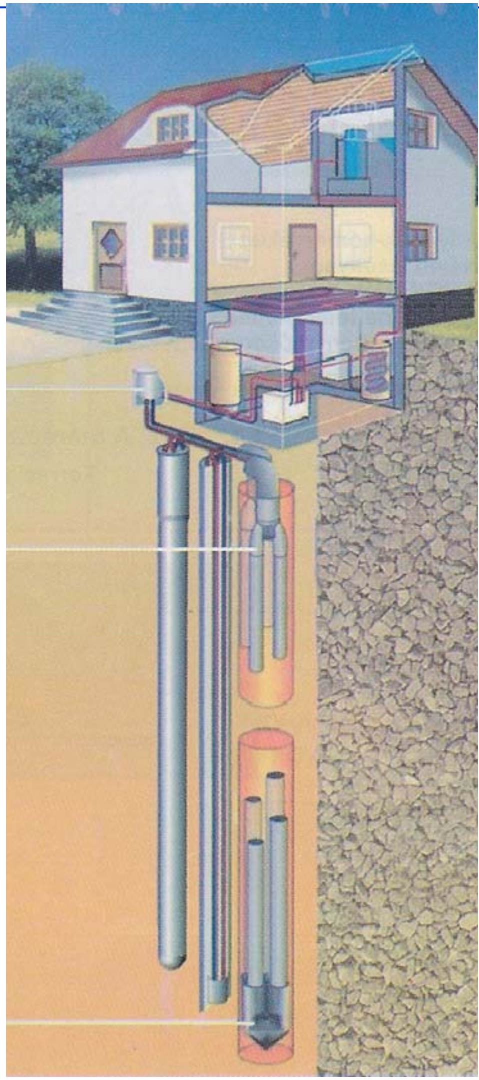


The heat is extracted using a coil laid in a horizontal plane at a depth of 2-5 m

The higher the temperature of the source the better the COP is.

7. Geothermal energy

7.2. Source: bore hole



Heat is extracted from the soil via bore holes which are 30 – 100 m deep. The water circulates in U form or coaxial tubes.

Deeper bore holes means higher source temperature and better COP.

In periods with lower cooling load it is not necessary to reverse the heat pump for cooling regime: simple circulation of the energy carrier in bore holes provides a modest cooling. At the same time the stored heat of the soil is recovered.

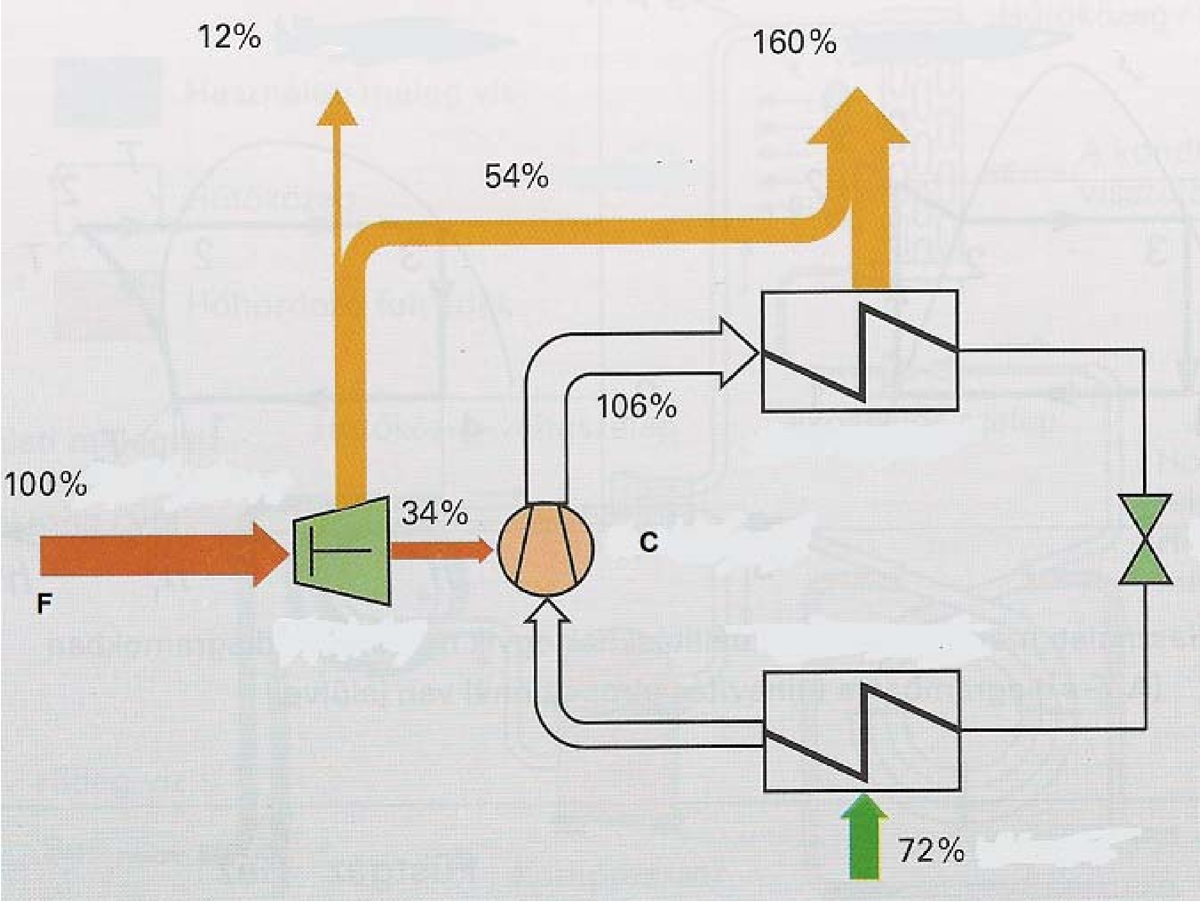
8. Combined systems

8.1. Gas Engine and Heat Pump

The compressor can be driven by a gas engine. Heat is then provided partly by the heat pump, partly by the heat output of the engine.

The latter enables the heat pump to run at a lower temperature drop, which results in a better COP

F: fuel
C: compressor



8. Combined systems

8.2. Biomass and Solar

1 Boiler

2 Pellet

3 Collector array

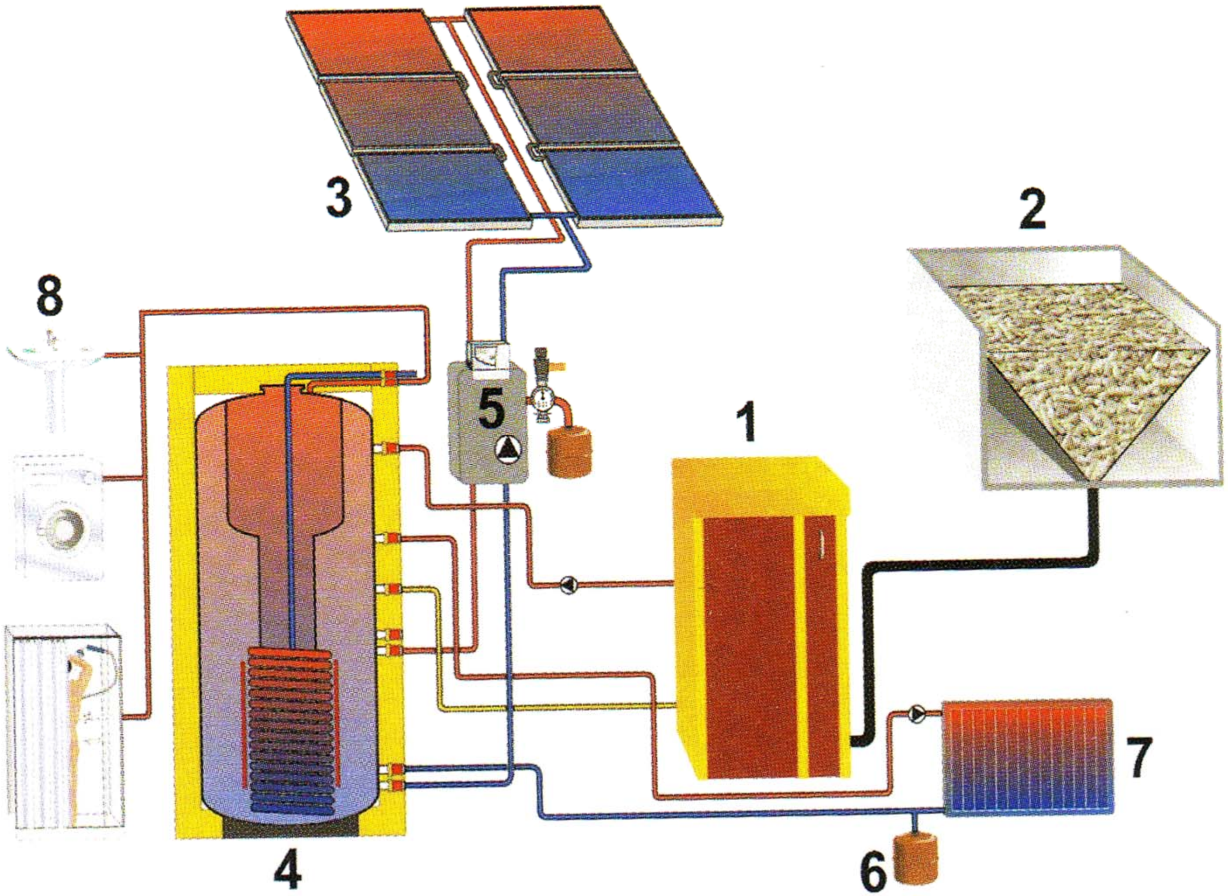
4 Heat exchanger in storage tank

5 Circulation pump and automatic control

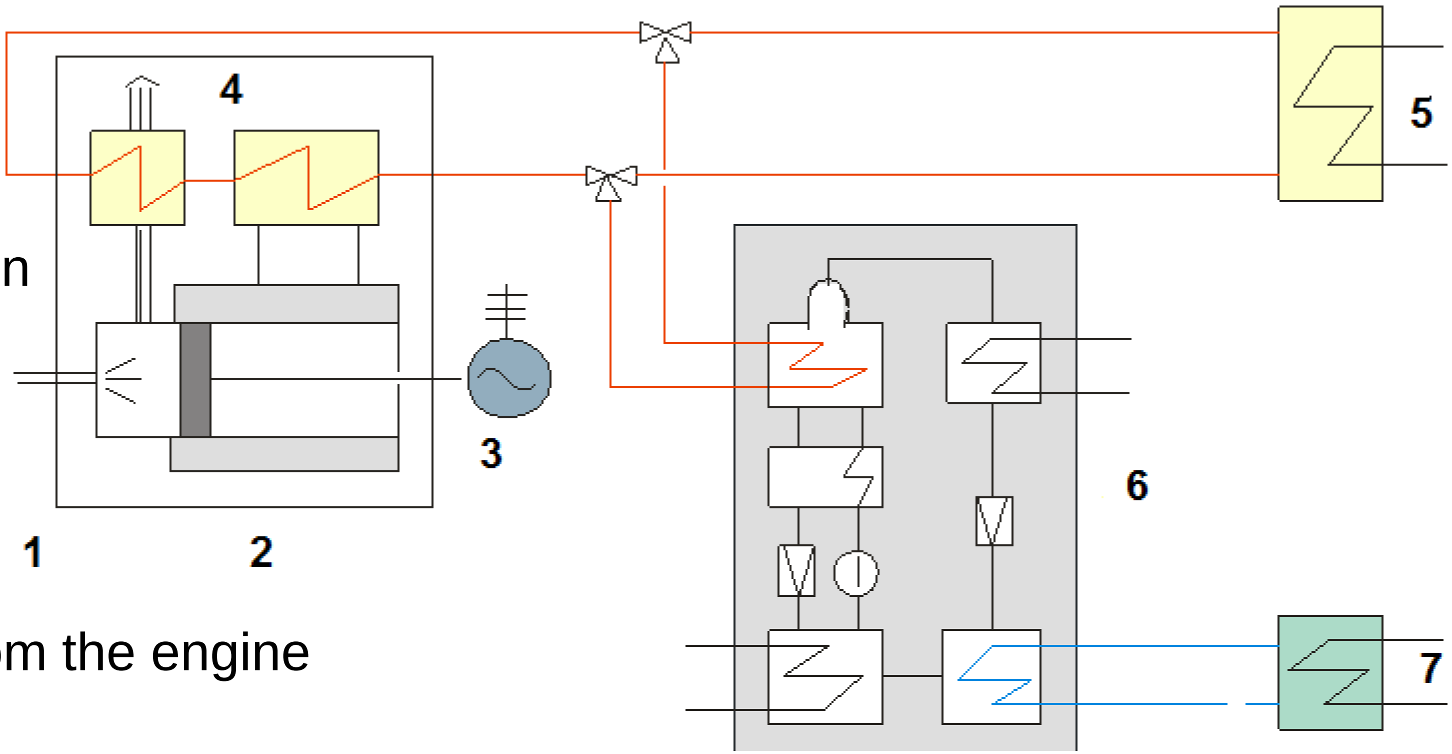
6 Expansion tank

7 Heat output

8 Hot water taps



Micro CHP/ trigeneration



1 Fuel combustion

2 Engine

3 Generator

4 Heat extract from the engine

5 Heating and hot water

6 Sorption cooling

7 Space cooling

The UP-RES Consortium

Contact institutions for this module: **Debrecen University**

- **Finland : Aalto University School of science and technology**
  www.aalto.fi/en/school/technology/
- **Spain : SaAS Sabaté associats Arquitectura i Sostenibilitat**
  www.saas.cat
- **United Kingdom: BRE Building Research Establishment Ltd.**
  www.bre.co.uk
- **Germany :**

  AGFW - German Association for Heating, Cooling, CHP
  www.agfw.de

  UA - Universität Augsburg www.uni-augsburg.de/en

  TUM - Technische Universität München http://portal.mytum.de
- **Hungary : UD University Debrecen**

  www.unideb.hu/portal/en