Techno-economic assessment
on solar thermal systems for space heating

By Dr.-Ing. Paris A. Fokaides*

Solar thermal systems for space heating constitute a recent development in the sector of Renewable Energy sources, which has been rendered possible due to the significant advancement in the efficiency of solar collectors. Several households in the Mediterranean Region have opted for space heating using solar energy. In the present document, reference is made on the main components of a solar thermal system for space heating, and a general techno-economic assessment of such systems is made, based on Mediterranean Region data. Point of reference for the techno-economic assessment will be a residence of 200 square meters in area, a typical construction for Cyprus data.

System description

A complete closed loop solar system consists of:

• Solar collectors

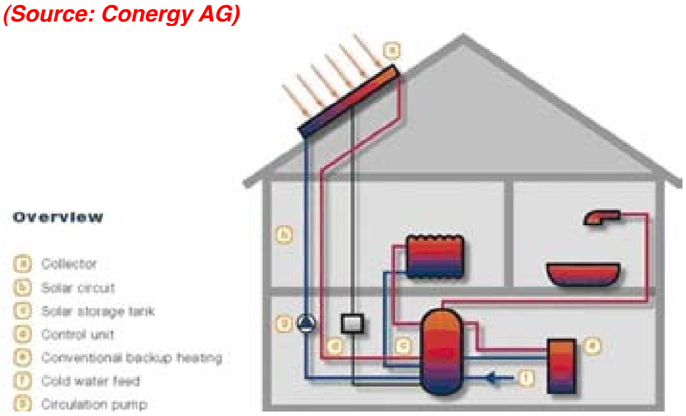
• A solar storage tank – heat exchanger

• An energy management system

• Control and regulation systems for the proper function of the system

• Other ancillary systems (pump, hydraulic network, expansion valves, etc.)

Figure 1: Operation principle of a solar thermal system ***(Source: Conergy AG)***



The basic concept of the system function is based on heating, supported by the solar radiation of a fluid, i.e. the thermal medium (typically a water-glycol mixture), which flows through the solar collectors, and on the transfer of its thermal energy to a storage tank. Within the storage tank, the energy of the thermal medium is transferred in the water used for space heating, which runs through the heating elements of the residence, i.e. built-in units or floor heating systems. The function of the entire system is regulated via the use of a central energy management system which is connected to thermocouples and valves, which are placed at vital points of the system (solar collector outlet, solar storage tank). The thermal medium circulation within the system is supported by a pump. An energy backup system is also deemed to be essential, for instance, for the purpose of heating oil or LPG.

With regard to the individual components of the system, the selection of solar collectors is of great significance. The types of solar collectors that are generally used are flat plate collectors, collectors with selective surface coating and evacuated tube collectors. For systems of the scale of the presented scenario, all three types of solar collectors are appropriate.

The latter selections are distinguished by their purchase price and efficiency. The specific value of the produced energy per surface to the cost of purchasing [kW / m² / €] indicates selective surface coating and evacuated tube collectors to be the optimal solutions. Evacuated tube collectors are more efficient than selective surface coating in terms of collector temperatures greater than 60°C, whereas selective surface coating outweighs lower temperatures. This practically means that selective surface coating achieves better performance in December, January, and February.

Table 1

	η [40 °C]	η [60 °C]	η [80 °C]
Flat plate	60%	38%	15%
Selective surface coating	66%	52%	39%
Evacuated tube	63%	61%	57%

Table 1: Efficiency of solar collectors as a function of temperature (Source: Thermal Solar Systems in Buildings, E. Mathioulakis, Presentation at Geroskipou Municipality Conference in Cyprus, November 2008)

Installation constitutes a significant parameter in relation to collectors. Due to solar geometry, collectors in the northern hemisphere must be south-oriented and their gradient is to be defined according to latitude.

The appropriate gradients for the Mediterranean region would be 30°-50°. Furthermore, the distance between arrays and the spot of installation must be taken into account so as to avoid any artificial shadowing of the collectors.

As far as connection configuration is concerned, this