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THE APPLICATION OF SUN COLLECTORS IN HUNGARY AND EUROPE

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***Abstract*:**

The article shows the non-exhaustive theoretical bases of the thermal utilization of solar energy. Based on statistical data it gives an overview of the spread of sun collectors in Hungary. It gives the reasons responsible for the current situation and proposes possible solutions.

1 SOLAR RADIATION

Sun collectors transform the radiation energy represented by the short wave (λ= 4 μm) beams emitted from the Sun into heat energy. This heat energy may be utilized for terrestrial life. This article only covers the "sun radiation – sun collector – utilization of heat energy" relationships.

Figure 1 shows the proportion of solar radiation reaching the Earth's surface and the losses of the radiation.

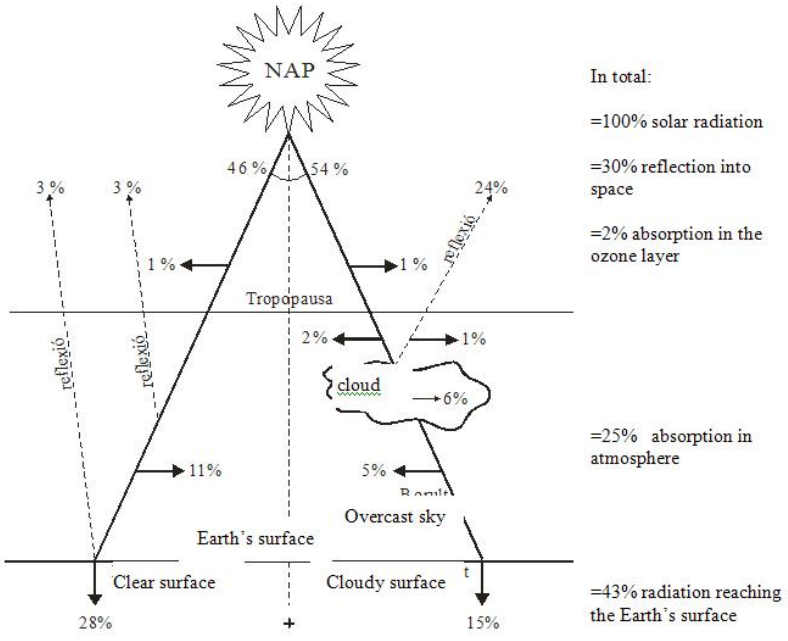

Figure 1: The balance of solar radiation

This figure builds on the assumption that 54% of the Earth's surface opposite the Sun is covered by clouds, while 46% is clear (free of clouds).

A large amount of the radiation leaving the Sun cannot be used on the Earth – for heat production. These must be considered as losses. These losses (Figure 1) and their relative value:

- reflection into space 30 %
- absorption by the ozone layer 2 %
- absorption in the atmosphere 25 %

With these values the total radiation loss amounts to 57% of the radiation of the Sun. This means that 43% of the Solar radiation may be utilized on the Earth's surface. These losses occur in the airspace between the lower border of the thermosphere (at a height of ~ 80 km) and the Earth's surface. It is assumed that the losses of solar radiation above the height of 80 km (the lower part of the thermosphere) are negligibly small compared with the total loss. At the lower border of the thermosphere the relative energy of the – loss free – solar radiation, when the Earth is at its mean distance from the Sun, is determined at 1345 W/m^2 ± 3 % by the specialist literature. This value is called Solar constant (N).

This means that the relative energy current represented by the unobstructed part of the radiation coming from the Sun is called I_d=1345 W/m^2 x 0.43 = 582.2 W/m^2, energy current represented by direct radiation (I_d). If we place a surface (e.g. a sun collector) smaller than the Earth's surface irradiated by the Sun in the irradiated area of the Earth's surface, then the solar radiation reaching this surface is shown in Figure 2.

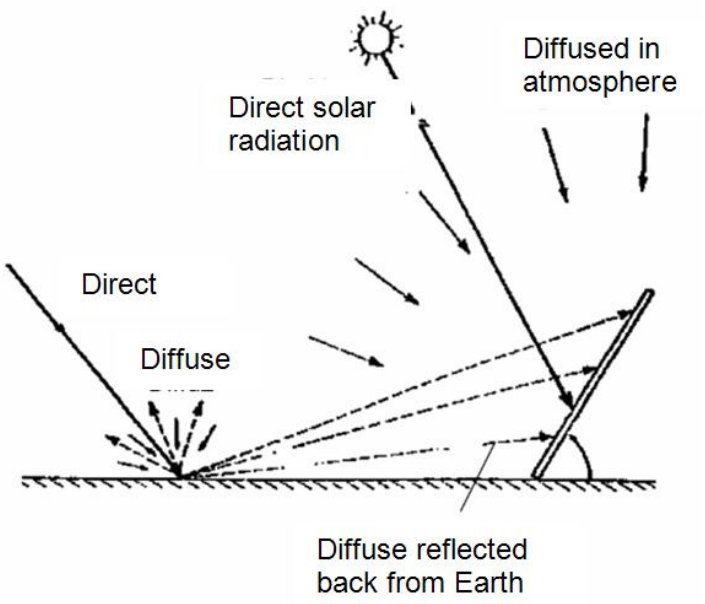

Figure 2: Solar radiation reaching the sun collector

Part of the previously described losses (diffusion) may become utilized on the surface of the sun collector. With these the solar radiation reaching the sun collector is:

- direct: I_d
- diffuse I_{dif}
  - diffused by the atmosphere: I_{da}
  - diffused by the Earth's surface I_{dE}

Total radiation reaching the surface of the sun collector (I_{total}):

$$I_{total} = I_d + I_{dif} = I_d + I_{da} + I_{dE} \qquad (W/m^2)$$

2. HUNGARY'S POTENTIAL FROM DIRECT SOLAR RADIATION

In Hungary the total hours of daylight is 1850-2200 hours/year. The area of the country is (rounded) 93000 km^2, which is $93 \cdot 10^9$ m^2. The energy reaching Hungary's surface by direct solar radiation (I_d):

$E_{dir.sol\ rad.} = 93 \cdot 10^9 x 582.2\ W/m^2\ h = 54.1 TWh$ where h is the hours of daylight.

Naturally, this amount would be only generated if the total area of the country was covered by sun collectors.

If we further examine the energy only coming from direct radiation, more considerable determinations may be made.

Assuming that 1 m^2 sun collector is installed in every 1 km^2 area of the country (total 93000 m^2), altogether $E = 54.1 \cdot 10^3$ kWh energy becomes utilized. This sun collector output ($54.1 \cdot 10^3$ kW) equals the total output of heating equipment operated by fossil fuels installed in about 2500 – average – houses.

3. THE ACTUAL SITUATION OF THE THERMAL UTILIZATION OF SOLAR RADIATION IN HUNGARY AND EUROPE

The following statistical data from 2008 were published by the ESTIF (European Solar Thermal Industry Federation) in May 2009. The statistics refer to glazed collectors, which may be flat plate or vacuum tube. In the statistics the amount of heat energy produced by 1m^2 sun collector is 0.7 kWh. Diagram 1 shows the newly installed sun collector capacity in EU27+Switzerland.

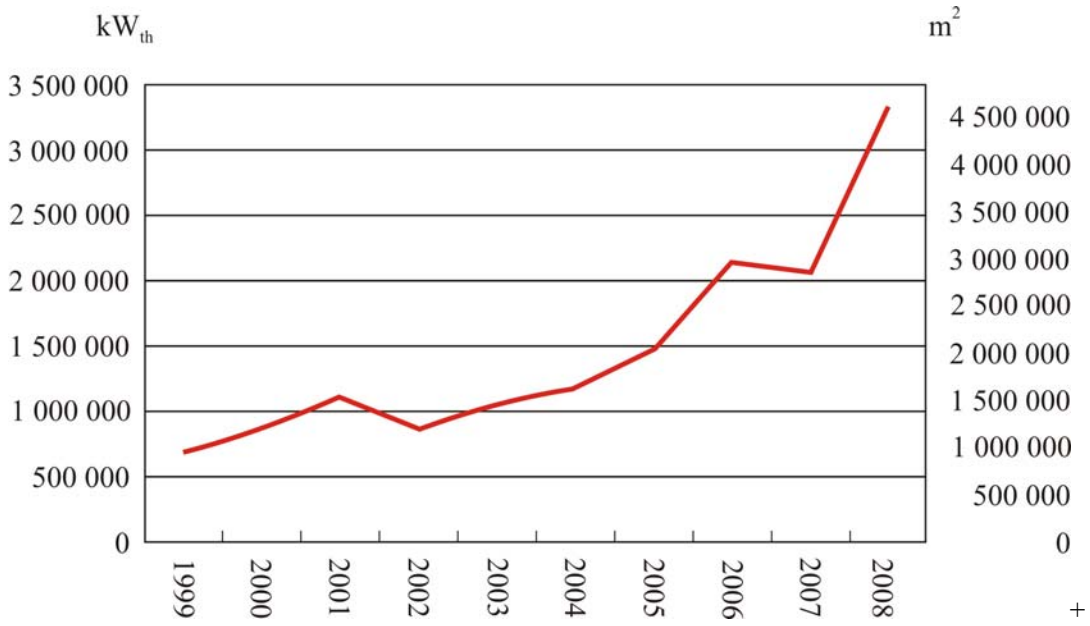

Diagram 1: Newly installed sun collector capacity in EU27+Switzerland

In 2008 in the area of EU27+Switzerland altogether 27,261,289 m^2 sun collectors were in use, whish are capable of producing 19,082,903 kWh i.e. 19.1 MWh energy. In sun collector operation Germany is leading Europe with a total of area of 11,090,000 m^2 sun collectors.

In order to examine the situation in Hungary we must choose such European countries that are very similar to or comparable with Hungary in area, the size of the population and geographical location.

These are the countries:

- Austria
- Switzerland
- Slovakia
- Hungary

Table 1 shows the total area of sun collectors operating in the four Central-European countries mentioned above, while Table 2 shows the total area for 1000 inhabitants.

Table 1: The area of installed sun collectors.

Operating		Installed					Growth
	2008	2006	2007	2008			2008/2007
	Total collector m^2	**Total collector m^2**	**Total collector m^2**	**Total collector m^2**	**Flat plate collector m^2**	**Vacuum tube collector m^2**	**Total collectors %**
AT (Austria)	3,240,330	292,669	281,000	347,703	343,617	4,086	24 %
CH (Switzerland)	593,980	51,863	65,432	85,000	81,500	3,500	30 %
HU (Hungary)	25,250	1,000	8,000	11,000	8,500	2,500	38 %
SK (Slovakia)	95,250	8,500	9,000	13,500	12,000	1,500	50 %

Table 2: The relative area of installed sun collectors per 1000 inhabitants.

Country	**Population**	**Installed collectors** $\frac{m^2}{1000fő}$	**Sunshine hours/year**
Austria	8,037,400	403	1,850-2,250
Switzerland	7,376,000	80.5	1,850-2,250
Slovakia	5,381,200	17.7	1,850-2,250
Hungary	10,121,000	2.5	1,850-2,250

Tables 1 and 2, but especially Table 2 shows Hungary's situation. In summary, it may be concluded that this result is the consequence of:

- failed government and energy policy,
- uninterested social atmosphere,
- insufficient utilization of European Union funds – for this purpose.

What is the way out?

The increase in energy prices – in the near future – will force Hungary to

- create a new philosophy in energy policy,
- create a new system of subsidies which will subsidize the user and not the sun collector producers,
- persuade the inhabitants in a planned way,

- make a system of subsidies which will subsidize the thermal integration of solar energy with the posterior heat insulation of buildings

by introducing immediate measures.

Works consulted:

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