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VALORIZATION OF THE SOLAR ENERGY IN THE "CÂMPIA CRIŞURILOR" PLAIN

Tania POPA
University of Oradea, Electrical Engineering and Information Technology Faculty
e-mail: tania_popa@yahoo.com

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Abstract: This paper presents the theoretical and experimental preoccupations of the author concerning the solar potential of the "Câmpia Crişurilor" plain. The measurement results point out that the high potential of the solar energy in the "Câmpia Crişurilor" plain is to be valorized in many activity domains. Thus it is necessary to find the most efficient solar collecting and storage installations and to properly install them.

1. INTRODUCERE

The use of the solar energy has been studied since antiquity, and the limited and decreasing oil and natural gas resources increases the interest for this energy type. Besides that, solar energy is non-pollutant and has many application possibilities. The effective exploitation depends of the geographical zone.

In our country, the plain regions are characterized by maximal values of the solar potential. In this context I have studied the sector situated between the river Mureş at south and river Crasna at north, known as the "Câmpia Crişurilor" Plain. This is the central part of the West Plain, situated between the Mureş Plain at south and the Someş Plain at north. Because it is placed in the temperate zone, under the mostly westward air circulation, the Crişurilor Plain features a high energetic potential that has not been valorized yet.

The factors that determine the high values of the solar energy potential and make their valorization easy and high efficient are the climate and the relief. The relief, by its planarity and uniformity, offers the possibility of maximal and constant collecting of the solar energy throughout the day. As for the climate, it has a direct influence upon the solar energy potential by means of the solar radiation, mainly the direct one, which depends on the sunshine intervals. The solar potential is directly influenced by nebulosity, and frost must also be taken into account.

This high solar potential is the result of the wide sunshine interval and the large values of the global radiation. An indirect role comes to air temperature, nebulosity and relief, and some risky climatic events may have a negative impact upon the valorization of the solar energetic potential.

In order to study the solar energetic potential of the Crişurilor Plain, I gathered and used climatic data that were recorded by the meteorological stations of Chişineu Criş, Salonta, Oradea and Săcuieni. Naturally, they directly influence the solar radiation values, because the sunshine interval and, indirectly, some other climatic parameters (air temperature, nebulosity and frost) do have influences upon the technological operations of solar energy collecting and valorizing.

The global solar radiation consists of a sum of two components: the direct solar radiation and the diffuse solar radiation. It is measured over the surface unit in a precisely determined time interval. The value of the global solar radiation value is conditioned by a series of factors, such as: latitude, solar declination, air transparency, nebulosity, position of clouds relative to the Sun, topographic slope declivity etc. Thus, global solar energy features variations versus time and space, according to the above-mentioned factors.

Because there are few observation points, calculus formulae have been developed in correlation to the existing statistical data that refer to meteorological elements, such as nebulosity and sunshine duration. One of these is the Ångström – Sarinov formula:

$$Q = Q_0 \cdot [1 - n \cdot (1 - k)] \qquad (1)$$

where
Q = total solar radiation in clear sky conditions;
k = altitude-dependent coefficient (k = 0.35);
n = mean monthly nebulosity, expressed in tenths.

The mean value of the solar radiation in the Crişurilor Plain has been calculated according to the measured values at the above-mentioned meteorological stations. The gathered data show that its value exceeds 100 kcal/cm^2/an.

Because this region stretches over less than 2º of latitude, the annual global solar radiation has close values, higher than the ones measured at hill and mountain regions. The lowest global solar radiation is recorded in December, because daytime is shorter, nebulosity is high and fog is quite frequent.

Thus, by generalization, we can state that the global solar radiation value is slightly above 2 kcal/cm^2 over the entire Crişurilor Plain:

- Oradea 2.19 kcal/cm^2;
- Chişineu Criş 2.15 kcal/cm^2;
- Săcuieni 2.23 kcal/cm^2;
- Salonta 2.15 kcal/cm^2.

The greatest monthly mean values of global solar radiation, of about 16 kcal/cm^2, are recorded in July, due to the low nebulosity. Although the maximal value of daylight os achieved in June, the nebulosity in this month is slightly higher, so the global solar radiation is lower in June than in July.

The global solar radiation during the warm period of the year (April ÷ September) is approximately 80% of the total annual value – such as 81.05 kcal/cm^2/an recorded at Chişineu Criş station. The global solar radiation during the cold period of the year (October ÷ March) is influenced by the oceanic air circulation, the temperature inversions that cause nebulosity and the above-mentioned factors. Over the entire Crişurilor Plain, the mean values of global solar radiation are less than 2/3 of the annual mean values. The lowest values are recorded in December (short daylight time, high nebulosity), slightly above 2 kcal/cm^2:

- Oradea 2,19 kcal/cm^2;
- Chişineu Criş 2,15 kcal/cm^2;
- Săcuieni 2,23 kcal/cm^2;
- Salonta 2,15 kcal/cm^2.

Starting with the month of March, the global solar radiation values increase rapidly and go beyond 8 kcal/cm^2.

The sunshine duration was analyzed according to the data recorded at the four above-mentioned meteorological stations. It varies over the year according to daytime duration, nebulosity and other occasional factors, such as fog, smoke, dust in the air etc. The greatest sunshine duration is recorded in the months of June, July and August, of above 40% of the annual value. As in the case of global solar radiation, July features the longest sunshine durations:

- Oradea 295,1 ore;
- Chişineu Criş 303,2 ore;
- Săcuieni 300,8 ore;

which means an average of 10 hours/day.

December features the shortest sunshine durations:

- Oradea 53,5 ore;
- Chişineu Criş 55,5 ore;
- Săcuieni 53,8 ore;

which means less than 2 hours/day.

Tab.1. *Annual mean sunshine duration (in hours) in the Crişurilor Plain, during 1990 ÷ 2005.*

Year	Oradea	Chişineu-Criş	Săcuieni
1990	2262.8	2437.6	2239.1
1991	1934.9	2040.1	1944.0
1992	2150.0	2292.7	2169.0
1993	2131.8	2236.8	2136.0
1994	2288.2	2311.9	2225.3
1995	2102.3	2185.9	2117.2
1996	1924.7	2102.0	1973.1
1997	2163.3	2365.2	2155.9
1998	1978.0	2207.9	2016.9
1999	2102.0	2142.0	2164.1
2000	2373.2	2622.7	2455.3
2001	2037.5	2166.9	2097.0
2002	2062.0	2270.1	2200.7
2003	2103.0	2253.0	2230.0
2004	2128.5	2275.1	2205.4
2005	2111.1	2239.5	2143.6

The annual value of the sunshine duration (tab.1) rarely went under 2000 hours/year. During the period under study, year 1991 was the rainiest, so the lower daylight duration were recorded:

- Oradea 1934,9 ore;
- Chişineu Criş 2040,1 ore;
- Săcuieni 1944,0 ore.

The year 2000 was the sunniest, so the longest daylight durations were recorded then:

- Oradea 2373,2 ore;
- Chişineu Criş 2622,7 ore;
- Săcuieni 2455,3 ore.

In order to make a study concerning the valorization of the solar potential, it is useful to know the average number of sunny days. During an average of 7 month/year, the sunny days are at least 26; in the months of June, July, August and September there was only one cloudy day. In the months of the cold year period, there are less than 20 sunny days, and the least number, 15, was recorded in December.

The mean temperature is greater than 10ºC over the entire Crişurilor Plain.

2. SOLAR ENERGY COLLECTING INSTALLATIONS

Solar installations can be successfully used to prepare household hot water, pool heating or as an alternative energy source to the classical heating systems.

2.1. Solar panels

The solar panels can be placed anywhere in our country. Their main functional element is of a cylindrical glass collecting tube, which is the same for all solar panels.

The solar panels consist of: collecting tube, outer glass tube, inner glass tube, fixing aluminum sheet, air-tight packing, metallic cap, condensing space, copper tube, vaporization space, vacuum space, centering clamp, heat-protective inferior sheath.

The purpose of solar panels is to convert the solar energy into heat and to transmit it to a water heat exchanger.

There is no optimal mounting angle, because the sun position varies throughout the day and season. Thus the recommended mounting position of the solar panel is at a vertical angle of 30º ÷ 70º.

The solar panel comes mounted on a rectangular metallic frame, which is to be placed by the owner in the chosen location. These panels can be placed directly on inclined roofs, on the horizontal roofs by means of adequate supports or even on the building façade walls. The solar preparatory system with atmospheric accumulator is shown in fig.1, and the pressurized one, without accumulation, is shown in fig.2.

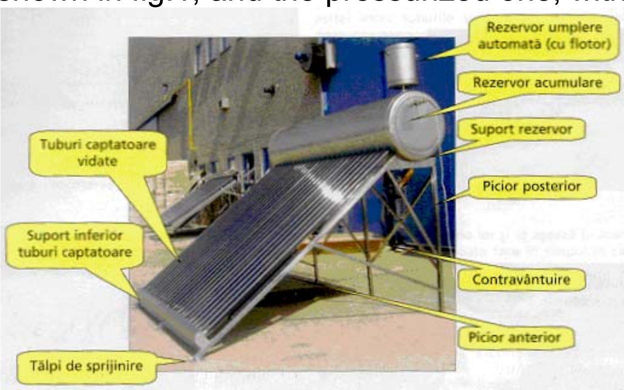

Fig.1. *Solar preparatory system with atmospheric accumulator.*

Fig.2. *Pressured solar preparatory system without accumulation.*

This kind of solar panel can be installed in various ways: installation with discharge in a bivalent boiler, without overheating protection, which may be used in the cold months (fig.3), or installation with discharge into a bivalent boiler with overheating protections, which may not be used in the cold months (fig.4)

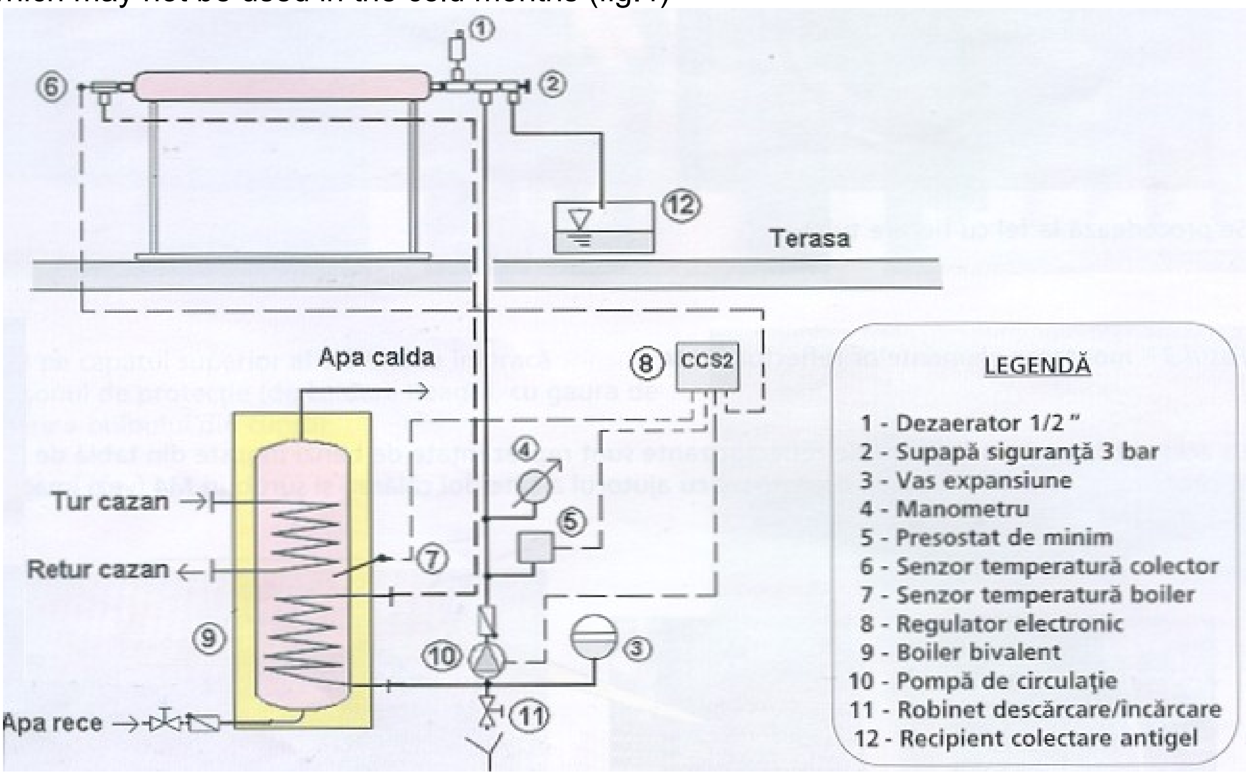

Fig.3. *Installation with discharge intro a bivalent boiler, without overheating protection.*

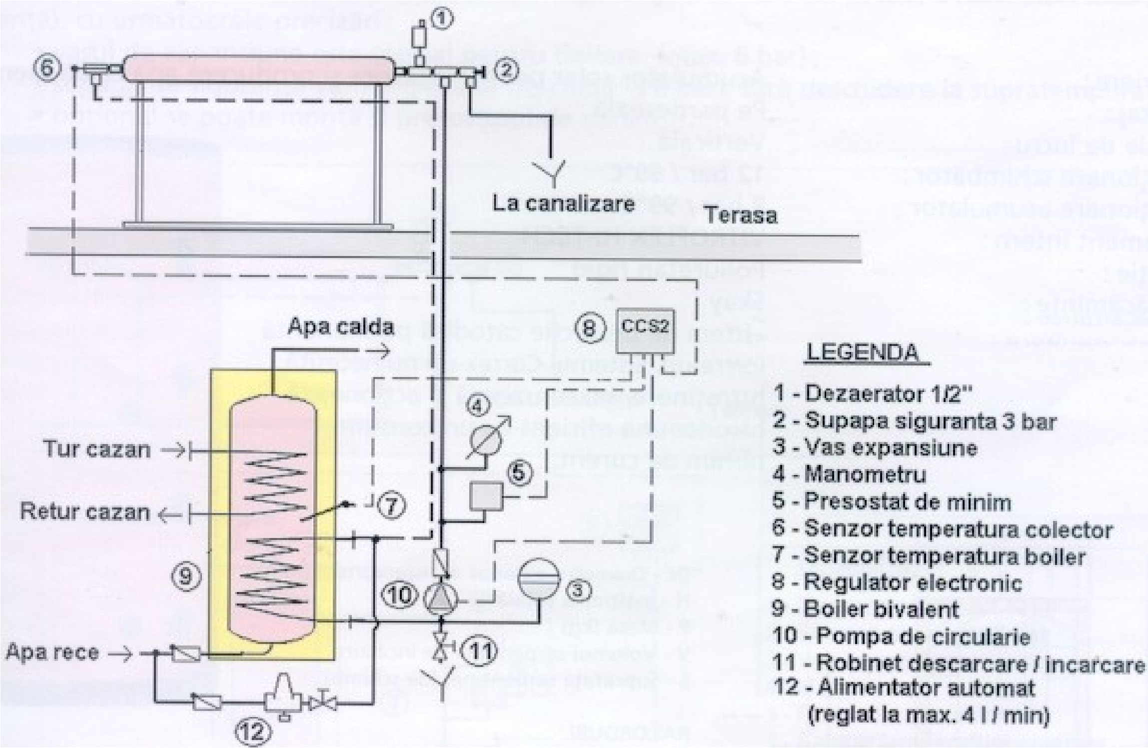

Fig.4. *Installation with discharge intro a bivalent boiler, with overheating protection*

3. STORAGE OF THE SOLAR ENERGY

The solar installations have the following thermal storage categories:

- protection storage;
- load peak storage;
- basic storage;
- storage for optimal solar energy valorization with independent functioning throughout 48 +8 = 56 ore
- seasonal storage.

In order to describe the heat storage installation, the following characteristics must be known:

- the required thermal level;
- the thermal properties of the accumulator block;
- the heat transfer;
- the required thermal insulation level.

When setting the ensured thermal level, the sum of total heat losses must be taken into account, which is expressed as follows:

$$t_{eliberat} = t_{colectat} - \sum_{j} \Delta t_j \qquad (2)$$

where *j* includes all the intermediate steps of solar energy transformation into heat.

According to the required thermal level and the consumer installed power, the solar installation type is established by choosing the constructive solution and dimensioning the storage installation. All these can be done by means of the following criteria:

- *the required thermal level*;
- *heat injection mode*: direct mixing; indirect mixing, with heat exchanger;
- *heat extraction mode*: direct; indirect;
- *physical state of the storage media*: pressurized gas; liquids; solids;
- *used thermal property type*: sensible heat; latent heat; reaction heat.

4. CONCLUSIONS

The high solar potential of the Crişurilor Plain implies that this energy source is to be used in various activity fields. Thus it becomes necessary that the adequate and most efficient collecting and storage solar installations be studied, selected and properly placed.

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