INVESTIGATION OF ANNUAL AND MONTHLY VARIATIONS OF THE ACCUMULATED SOLAR ENERGY USING A WEATHER STATION VANTAGE PRO2 PLUS

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Abstract

In a period of four years are measured, collected and compiled database of solar energy. This is performed by using automatic weather station Vantage Pro2 Plus. It is a semi-professional type, and one of its sensors is specifically designed for measuring solar radiation. With these data is tracked the solar energy characteristics in different days, months and years. Also shown is the degree of repeatability in the corresponding months of different years. We calculated the annual repeatability of measurements. Monthly repeatability compares with annual and the latter turned out to be significantly better.

Introduction

The data obtained from the solar radiation sensors of a weather station Vantage Pro 2 Plus are used to measure the amount of sunlight reaching Earth's surface [1]. The collected data from all sensors are integrated and recalculated in order to be obtained results for the solar energy that is absorbed for a certain period of time per unit Earth's surface. The purpose of research is to trace how great is the repeatability during different periods. A high annual repetition provides a good opportunity to forecast energy yields in the coming years. The monitoring had been carried out for the region of Stara Zagora.

Investigation of solar energy falling on the Earth.

It is known that solar radiation depends on many factors and logically the energy amount for the different regions should be quite distinctive. This is due to the fact that only part of the solar energy is reaching the earth's surface. A part of the solar energy falling on the Earth's atmosphere is reflected directly back into space, while another part is absorbed by the stratosphere and troposphere. In total, about 19% of the solar energy does not reach the lower layers of the Earth's surface (Roedel, 1994) [4].

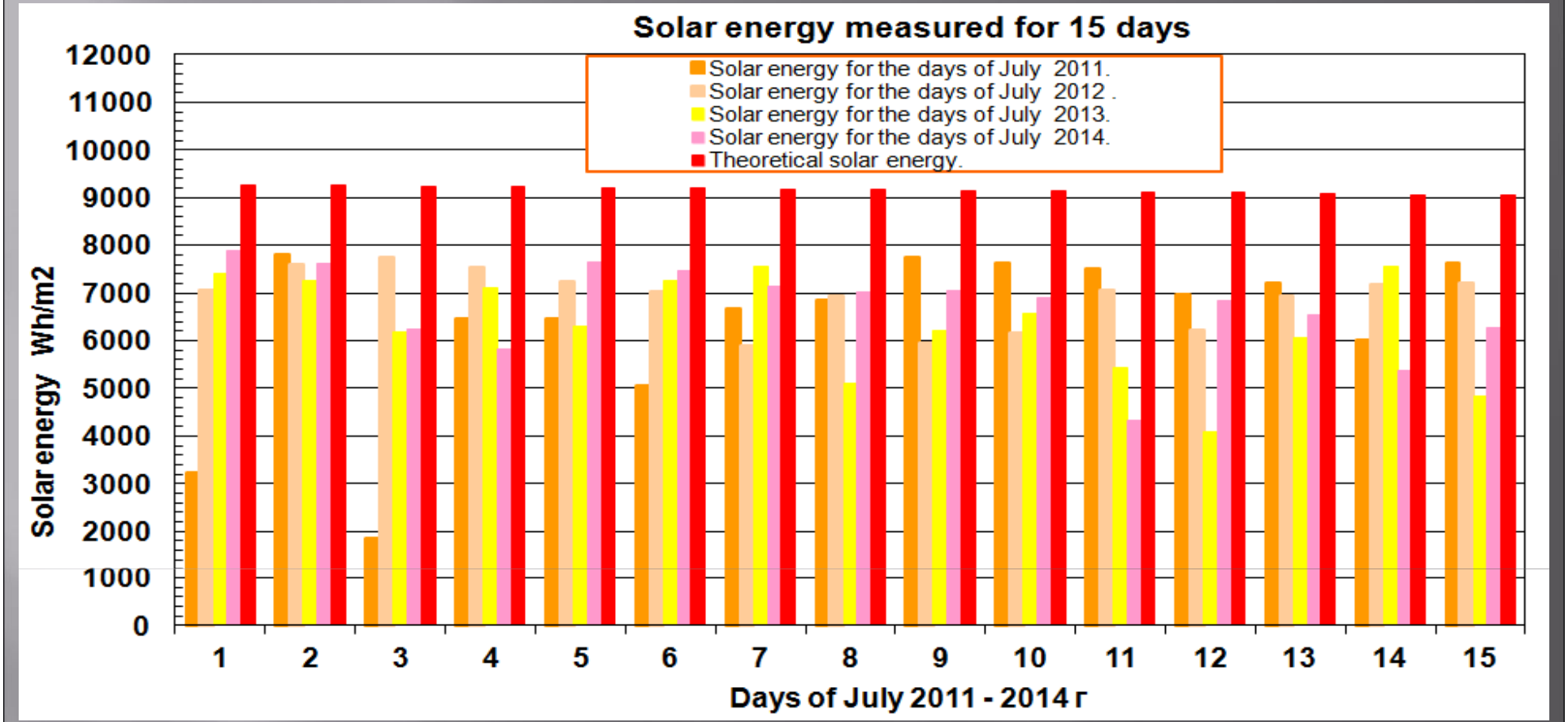

Fig. 1 Solar energy measured for each day.

The daily measurements of solar energy for 15 days in July for 4 years is shown in fig. 1. The theoretical values of the solar energy dependent on the direct solar radiation are marked by red bars and did not varied a lot, The measured solar energy, however, significantly varies in the different days as it is seen from the graph. For example, the values are almost the same for the 2nd and 4th days, while for the 1st and 3rd days the values are changed from 2000 to 7500 wh/m2. Although the sun position is not significantly changed, the measured values differ due to actual atmosphere composition in the different days.

The atmosphere permeability is significantly affected by clouds, moisture, dust and other contaminants that absorb the solar energy.

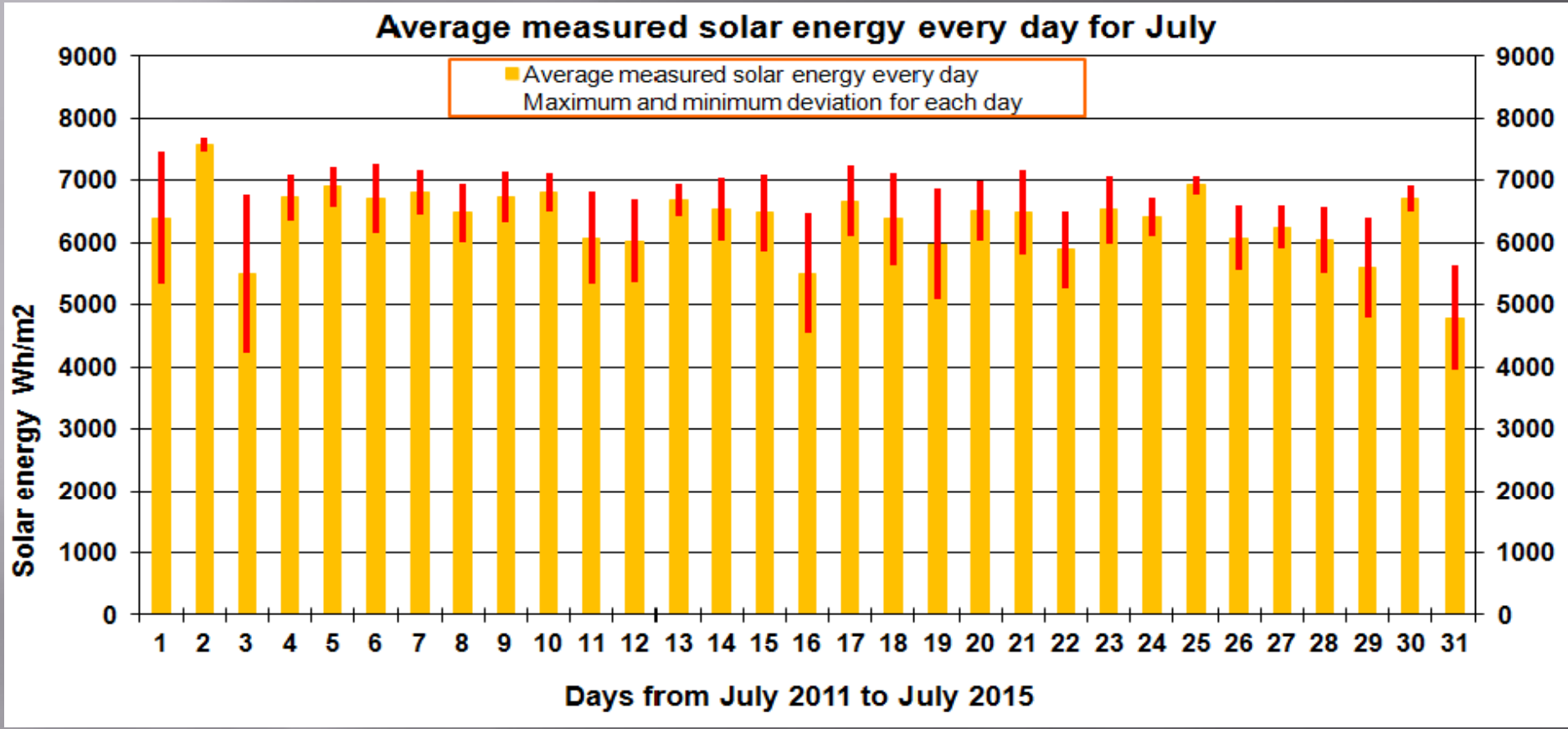

Fig. 2 The average measured solar energy for every day for July.

In fig. 2, the daily measured average values of the solar energy in July are shown for 4 years. The daily deviation from the average value is marked by red lines. The dynamic change of the values of the second and fourth days in comparison with the first and third day were significantly greater. Here even more clearly shows the changed dynamics due to changes in the atmosphere.

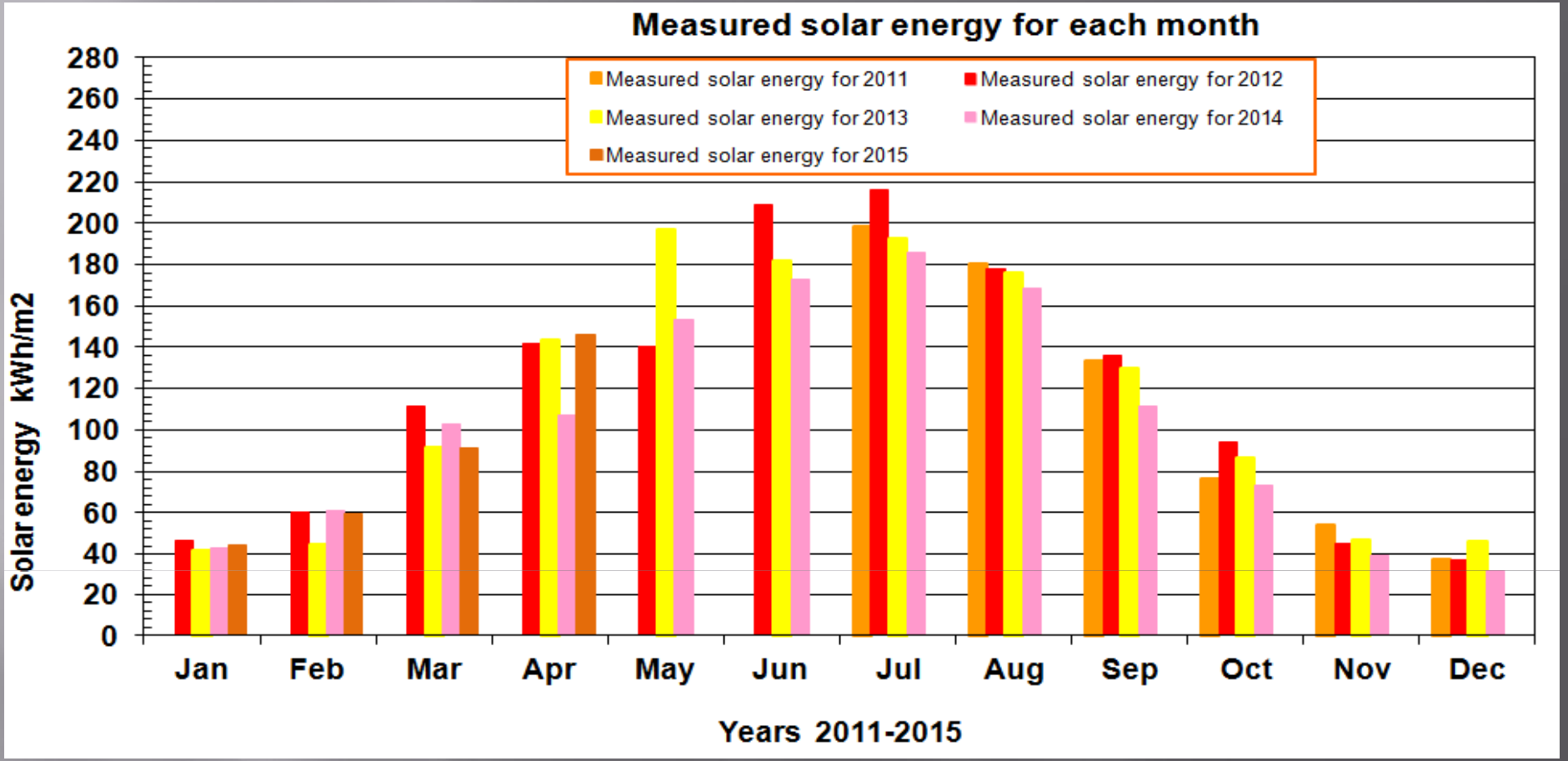

Fig. 3 Solar energy measured for each month from 2011 to 2015.

In fig.3, the solar energy values are measured and presented for the different months in a period of 4 years. The seasonal nature in the solar energy change is well followed. The solar energy is maximum in June and July and a minimum in January and December. It is worth to indicate that the dynamic change of the values for the corresponding months during the years is much less than the dynamic change of the values for the corresponding days as shown in fig 2.

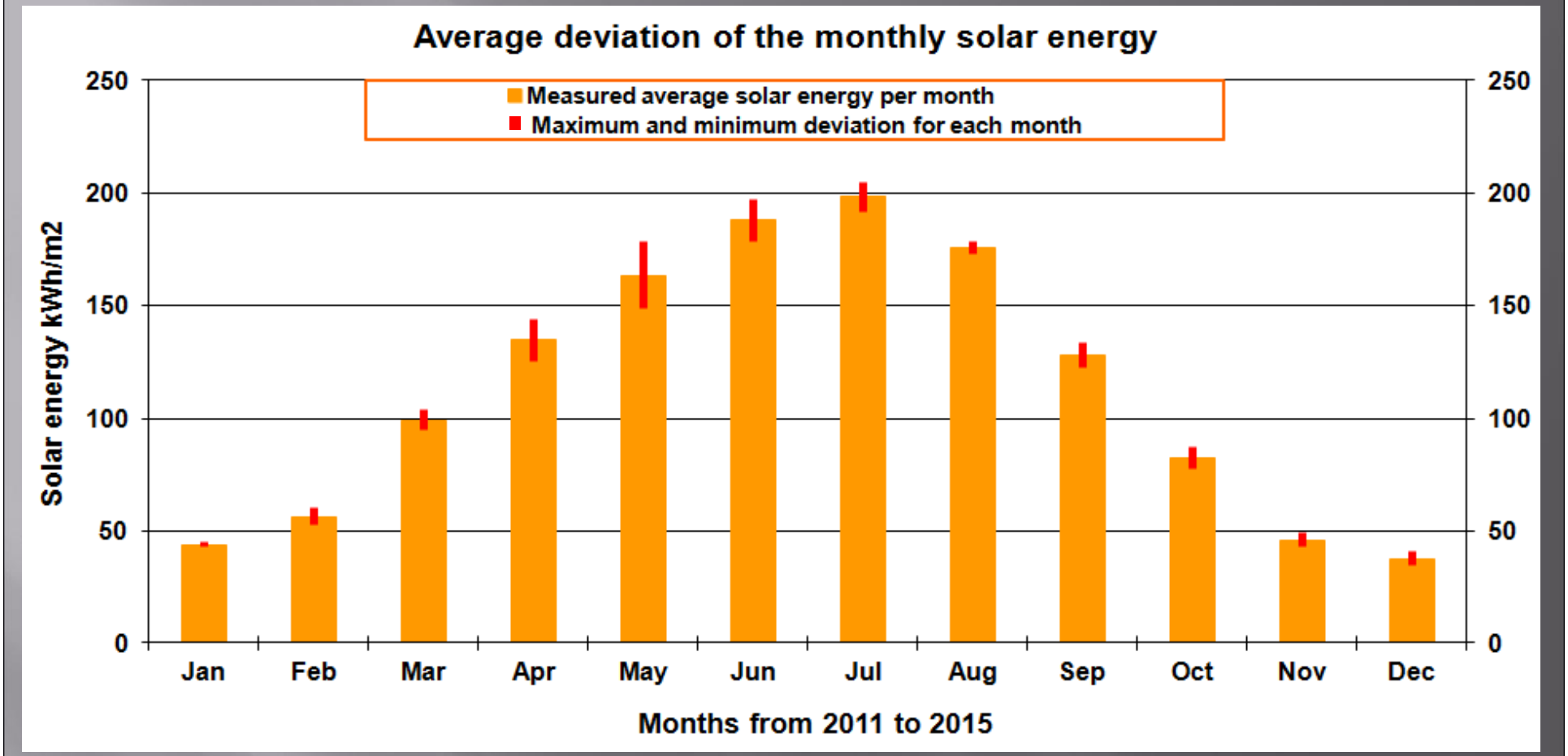

Fig. 4 Average measured solar energy for each month.

In fig. 4, the measured average solar energy per month in a period of 4 years is presented. The deviation from the average value for each month is given with red lines. It is well seen the smaller monthly deviation in comparison with the daily one. The figure shows that the smaller the deviations are during on the winter month January and during the summer month of August. This is due to the fact that these seasons are with more stable dynamic of the atmosphere.

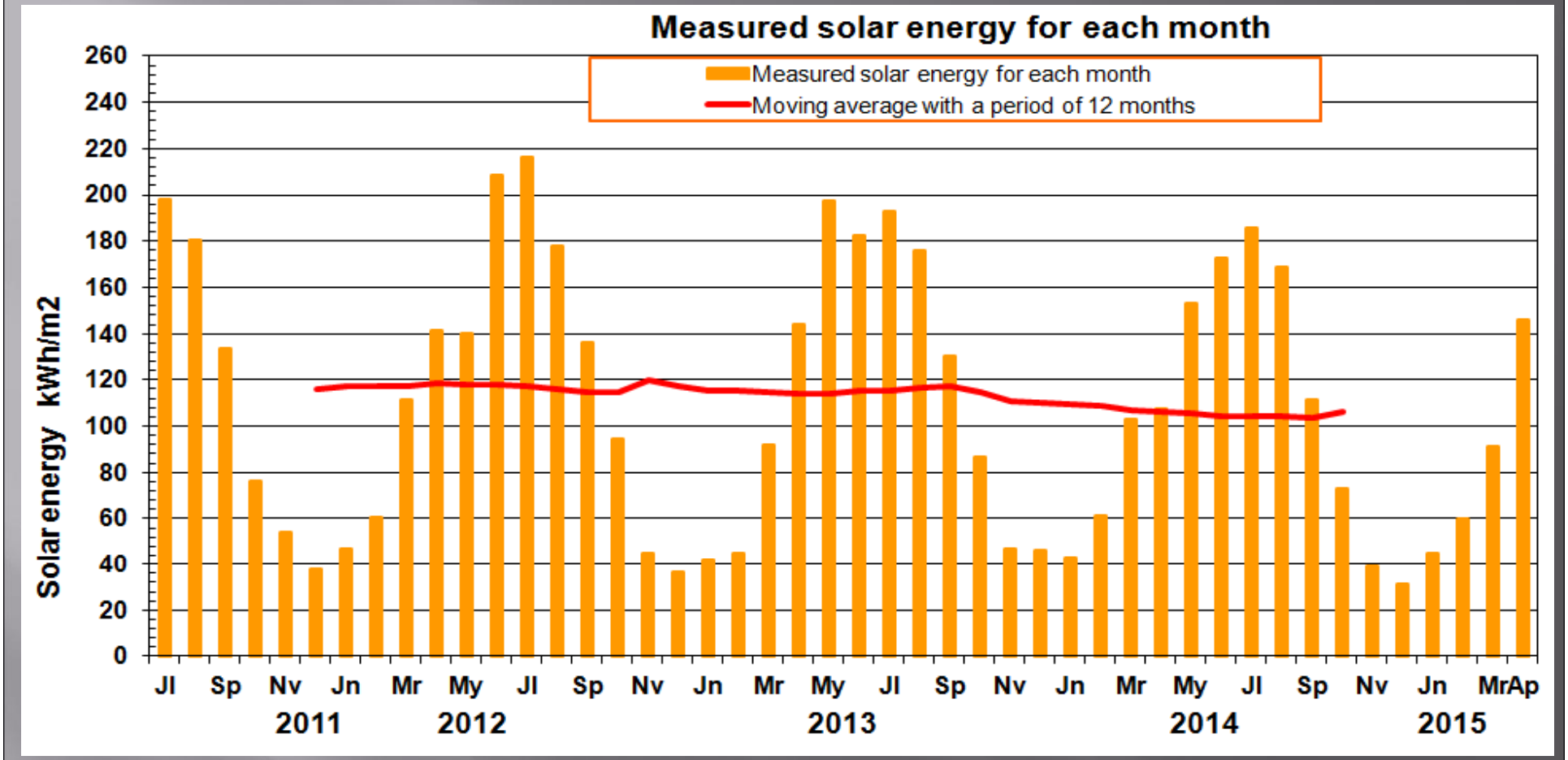

Fig . 5 Moving average with a period of 12 months for three years.

In fig. 5,a moving average value of solar energy for 12 months is presented for a period of about 4 years. It is shown in the chart with a red line. Monthly values of solar energy are shown with orange bars. As it is seen the value of moving average is substantially constant, i.e. the annual deviation is less than monthly one.

Conclusion

The research presented so far proved that the solar energy deviations for the corres - ponding months are less than the daily deviations, while the annual solar energy deviations are less than the monthly. Consequently, the calculated deviation of the corresponding values is smaller at a longer period of monitoring. From the obtained results we could state that it could be calculated and forecasted with a relative accuracy the expected energy from photovoltaic transformer for an annual period.

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