Forecasting annual solar energy to a particular region using data measurements with Meteorological station Vantage Pro2 Plus

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Abstract

The amount of sunlight reaching Earth's surface is monitored and accumulated by automatic weather station Vantage Pro2 Plus. Applying the data, sun energy characteristics of different months are monitored and related to the sun position during the seasons. The degree of repeatability is presented for the corresponding days and months in different years. The annual repeatability is estimated on the base of these measurements. The monthly and daily repeatability has been compared with the annual one, as the latter turned out to be significantly better. The high annual repeatability provides an opportunity for sunlight forecast for subsequent years.

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. MC Vantage Pro 2 Plus is a semi-professional type weather station equipped with additional sensors for measuring solar and solar ultraviolet radiation. The sensors record both the intensity of the direct solar radiation, the dose and the ultraviolet index. Seven directly recorded meteorological parameters are accessible to the users by the weather station Vantage Pro 2 Plus. Besides, more than thirty derivative parameters are also supplied. The monitoring had been carried out for the region of Stara Zagora.

Investigation of solar energy falling on the Earth.

It is known that the 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].

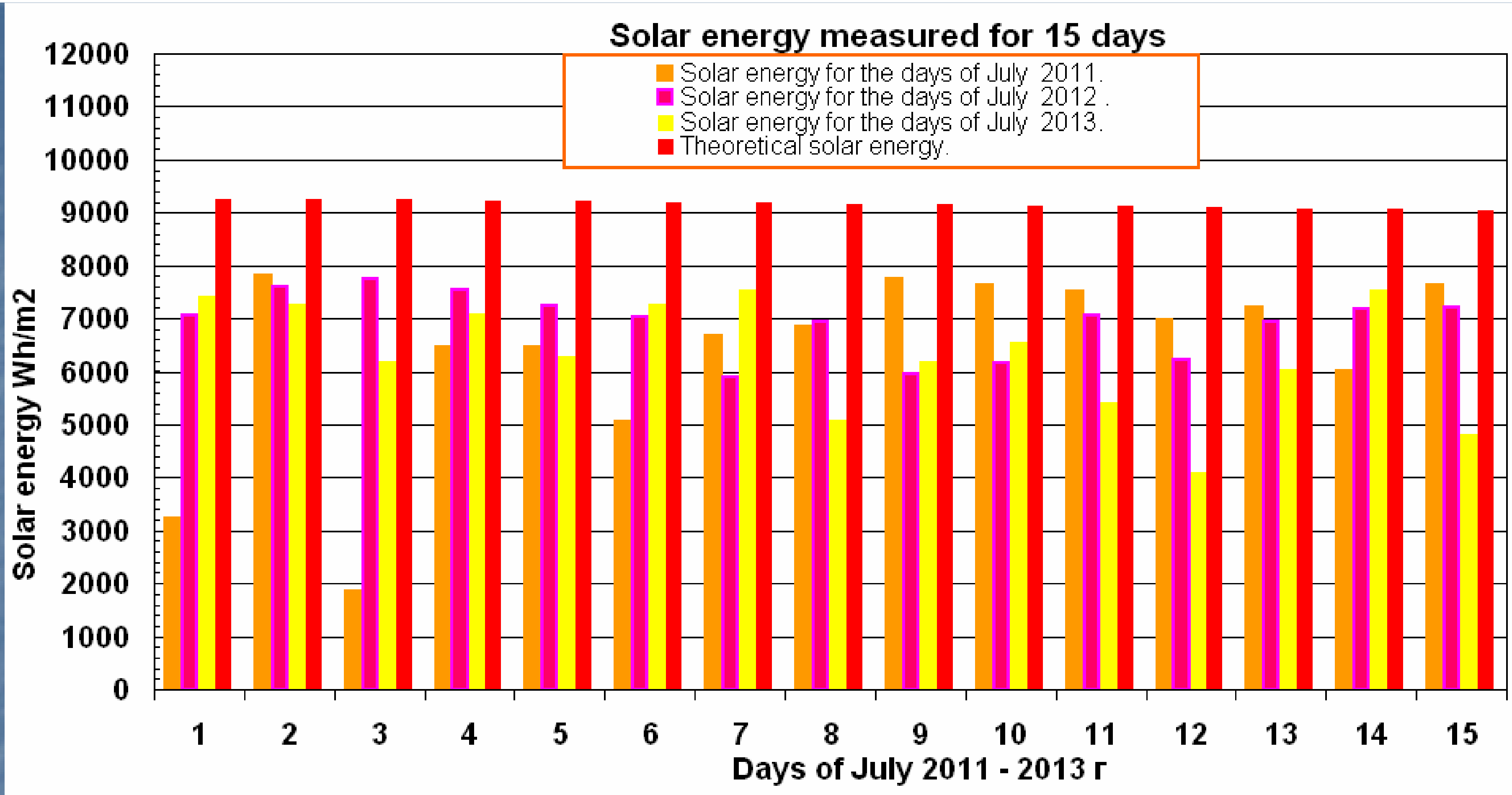

Fig. 1 Solar energy measured for each day.

The daily measured solar energy for 15 days in July for 3 years is shown in fig. 1. The theoretical values of the solar energy depend on the direct solar radiation and do not vary a lot. They are marked by red bars. 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.

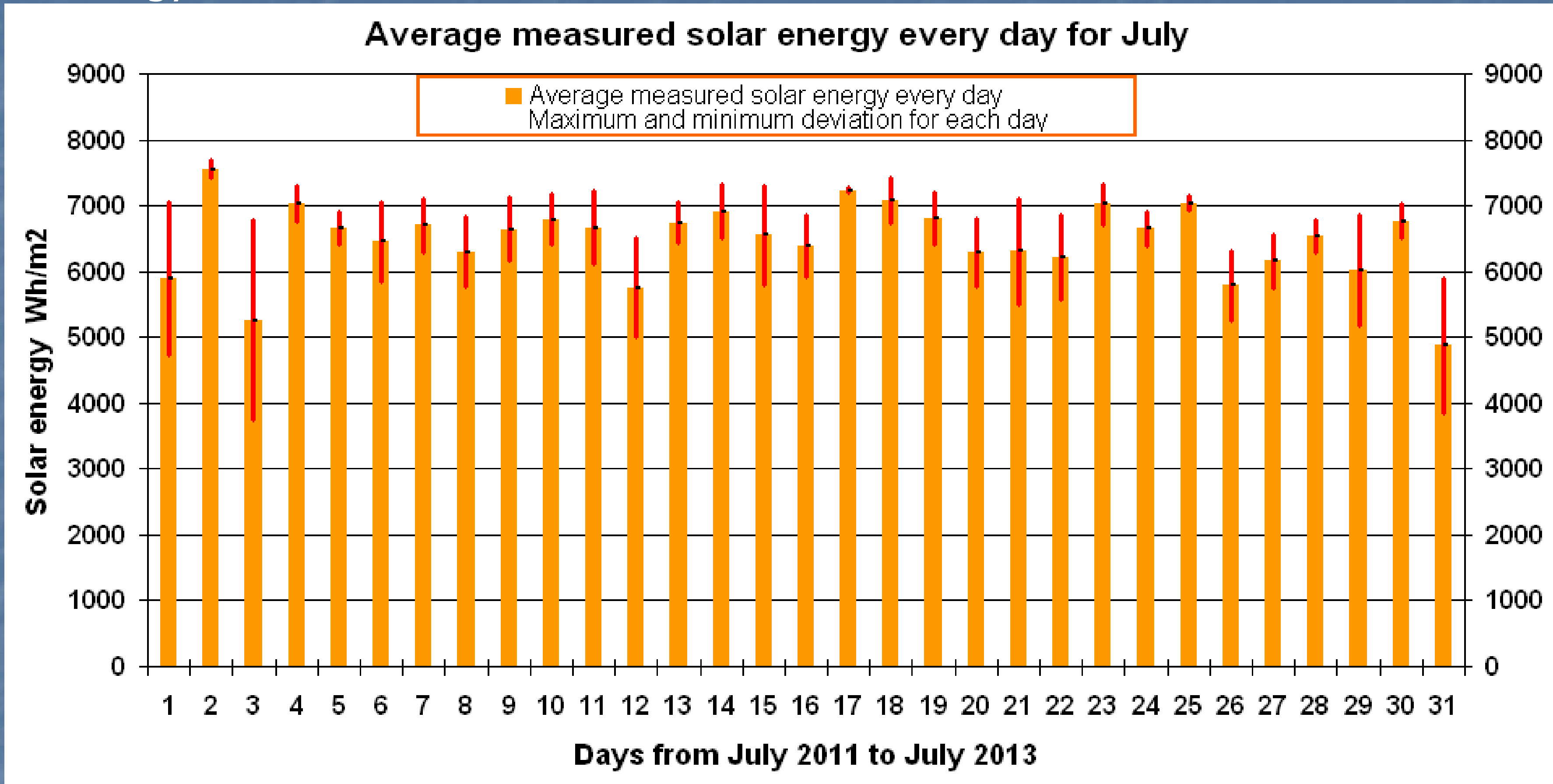

Fig. 2 The average measured solar energy for every day.

In Fig. 2, the daily measured average values of the solar energy in July are shown for 3 years. The daily deviation from the average value is marked by red lines. The dynamic change of the values for the 2nd and 4th days in comparison with the 1st and 3rd days is clearly seen as well as in comparison with the ongoing days.

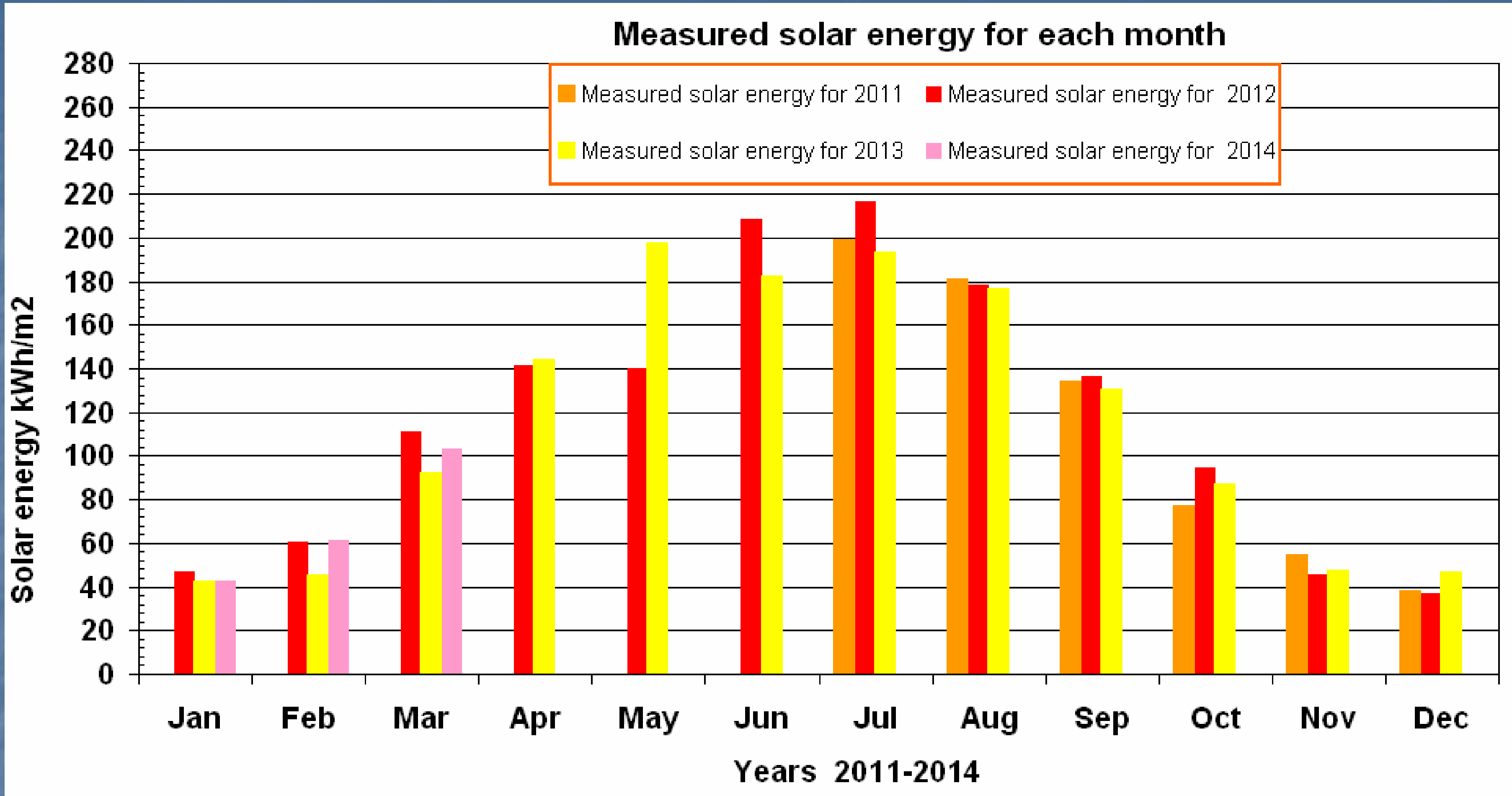

Fig. 3 Solar energy measured for each month from 2011 to 2014.

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 sunlight change is well followed. The sunlight 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.

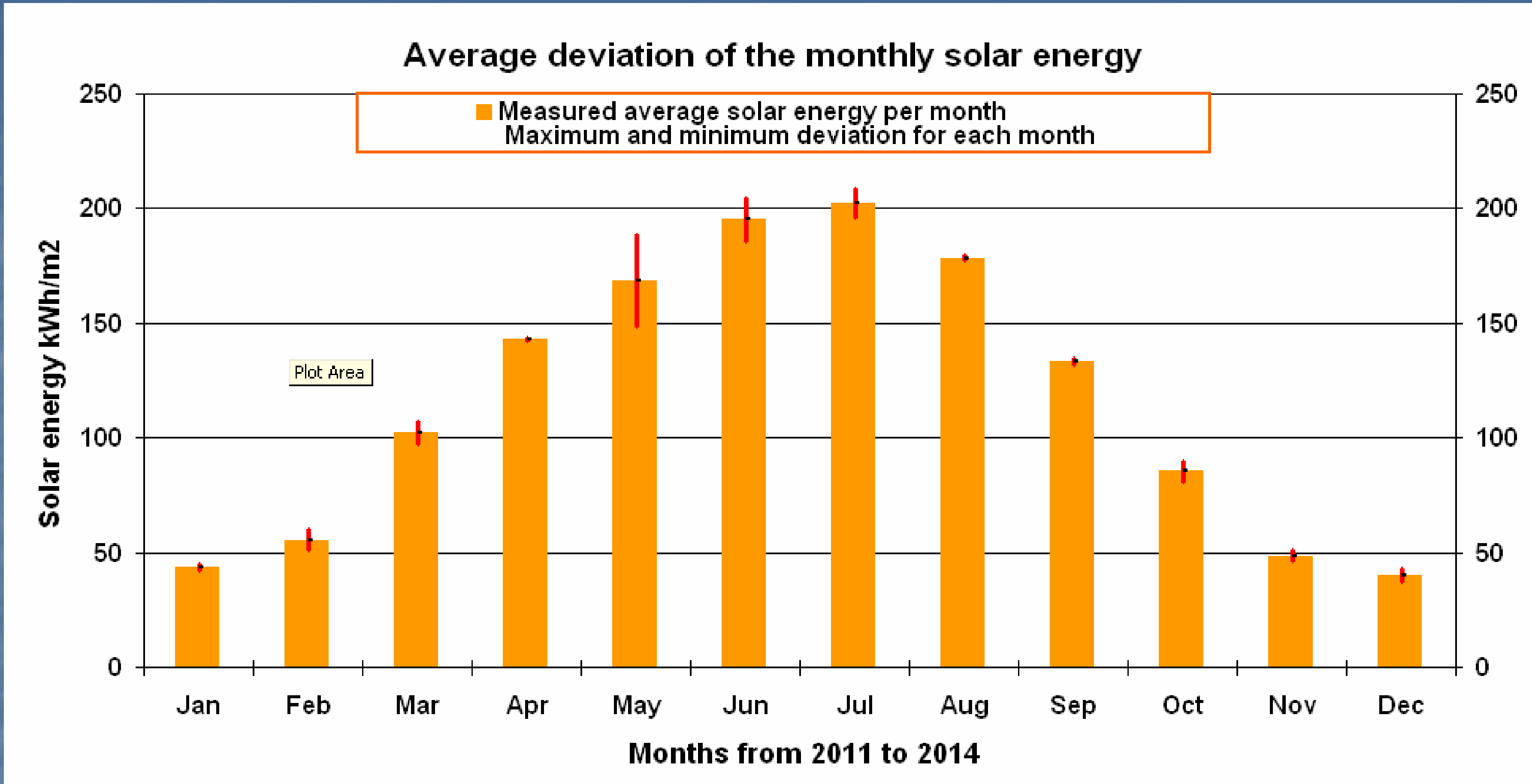

Fig. 4 Average measured solar energy for each month.

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.

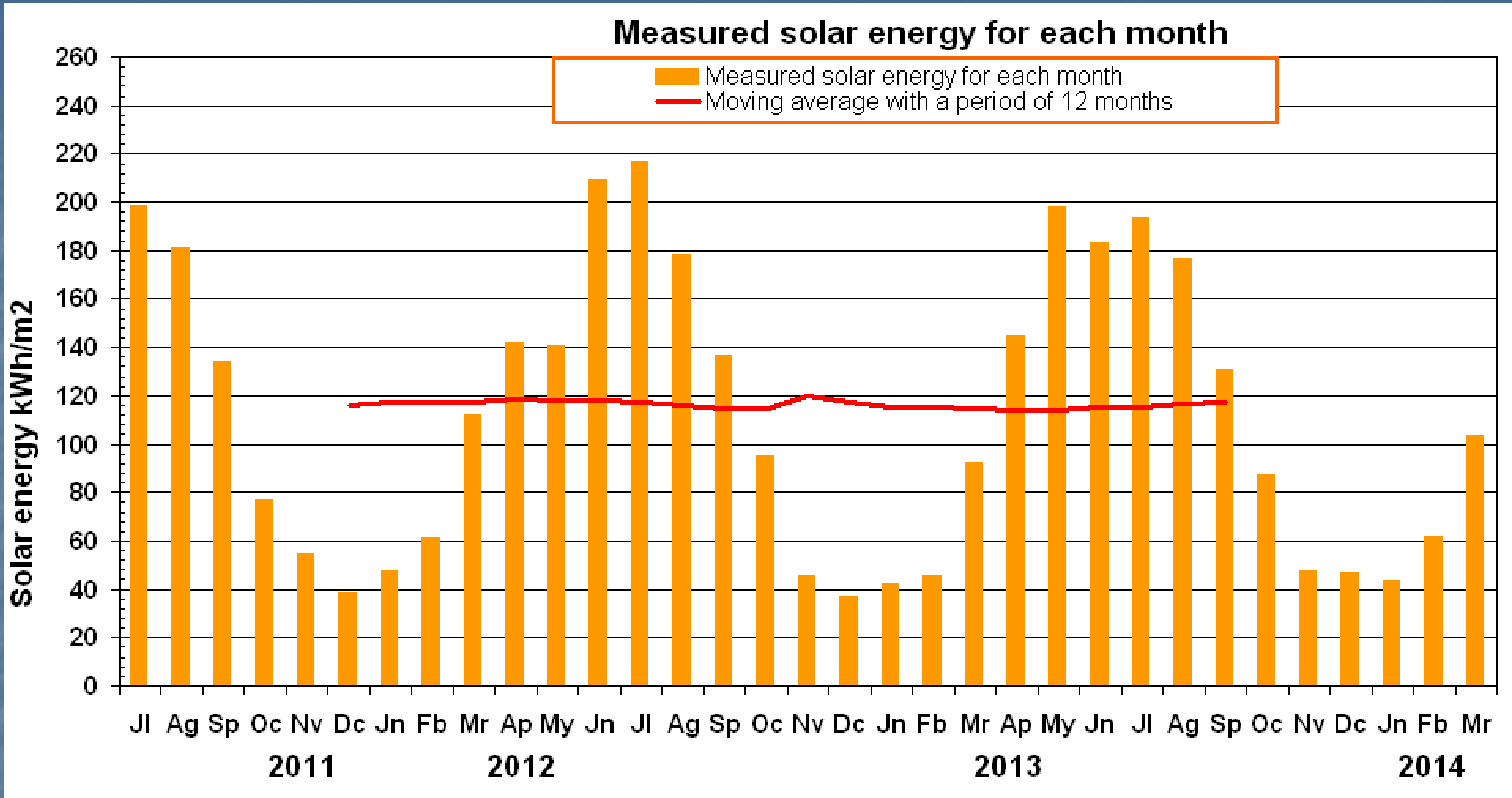

Fig . 5 Moving average with a period of 12 months for three years.

In Fig. 5 a moving average solar radiation for 12 months is presented for a period of about 3 years. As it is seen its value is substantially constant, i.e. the annual deviation is less than monthly one.

Conclusion

The research presented so far proved that the sunshine deviations for the corres - ponding months are less than the daily sunshine deviations, while the annual sunshine deviations are less than the monthly. Consequently, the calculated deviation of the corresponding values is smaller in 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.

References

1. D a v I s I n s t r u m e n t s C o r p. Vantage Pro2 Plus. Referen. Guide.

2. J. M e e u s, Astronomische Algorithmen, Johann Ambrosius BarthVerlag, Leipzig-Berlin-Heidelberg, 1993

3. L e a n, J.L., Solar irradiance and climate forcing in the near future, Geophzs. Res. Lett. 28, pp. 4119-4122, 2001.

4. R o e d e l, W. Physik unserer Umwelt, 2. Aufl., Springer-Verlag Berlin Heidelberg, S.48, 1994.

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