MONITORING ON THE FALLING AND ACCUMULATED SOLAR ENERGY ON THE EARTH'S SURFACE AND FORECASTING FOR A PERIOD OF ONE YEAR WITH THE HELP OF AUTOMATIC WEATHER STATION.

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Abstract

The amount of solar energy is measured in continuous mode every 15 minutes. For this purpose we use data obtained from sensors of solar radiation of meteorological station Vantage Pro 2 Plus. It is a semi-professional type, and one of its sensors is specifically designed for measuring solar radiation. The collected data from the sensor 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.

Introduction

In the period of 6 years data for solar energy are measured and collected using the weather station Vantage Pro 2 Plus [1]. During the 6 year time frame the data was captured every 15 minutes for total of more than 210 000 data points. The raw data was recorded by the solar radiation sensors of the station which was after that converted to solar energy absorbed over a given period of time per unit area. Quantitative accumulation of solar energy has been processed and aggregated in daily, monthly and annually periods. The results obtained are shown in graphic form. From the graphs shown the degree of repeatability during different periods.

Investigation of solar energy falling on the Earth.

As is well-known the solar radiation depends on many factors. Given that we can say that the solar energy which is directly related to the solar radiation would be different for the different places on the earth surface. This is based on the fact that only part of the solar energy is able to reach the earth surface. Some of the solar radiation is reflected right back into the space, some is absorbed by the stratosphere and troposphere. Overall, around 19% of the solar radiation does not reach the lower layers of the atmosphere (Roedel. 1994) [4].

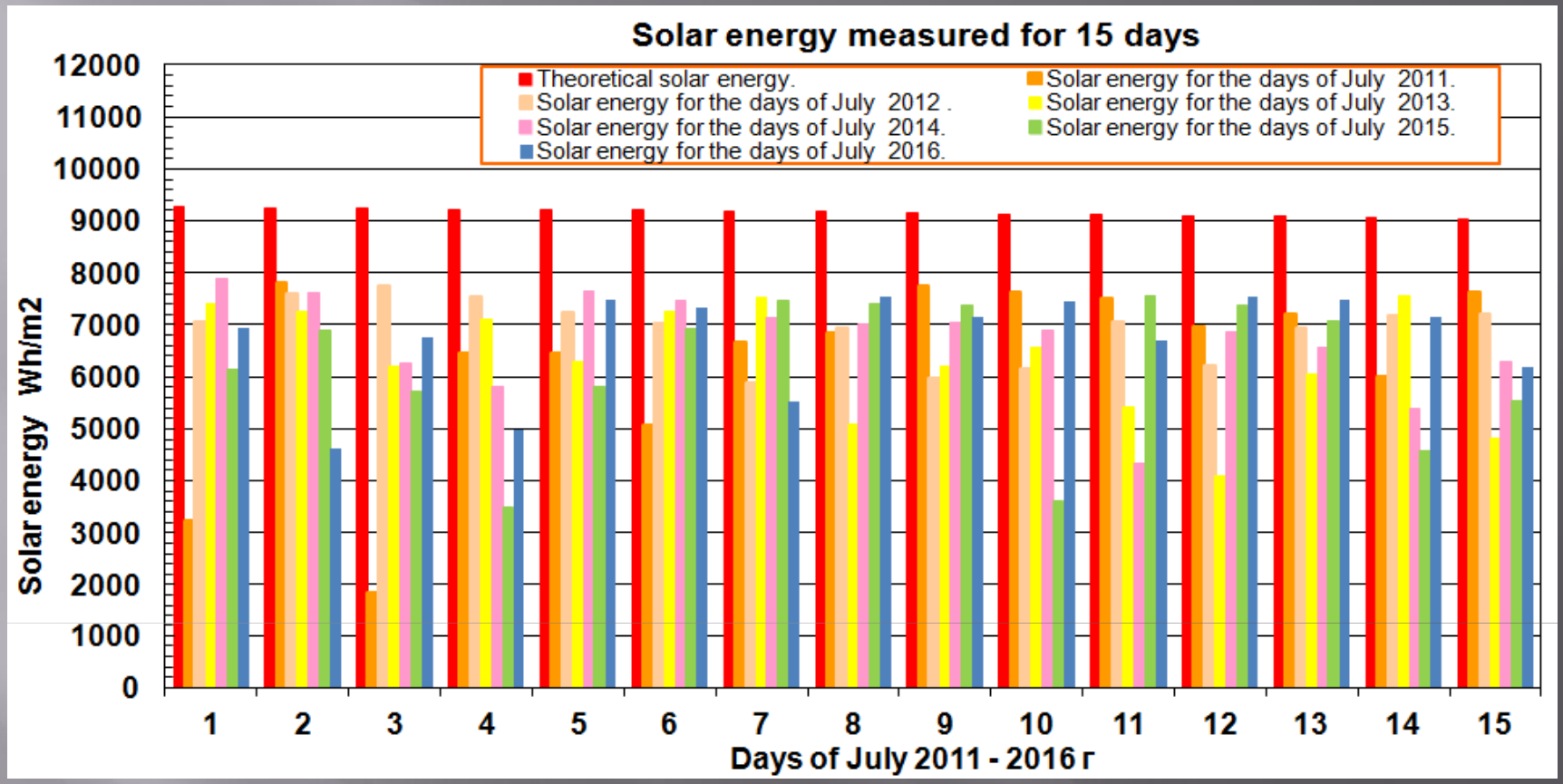

Fig. 1 Solar energy measured for each day.

The different The daily measurements of solar energy for 15 days in July for 6 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 7th and 13th 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.

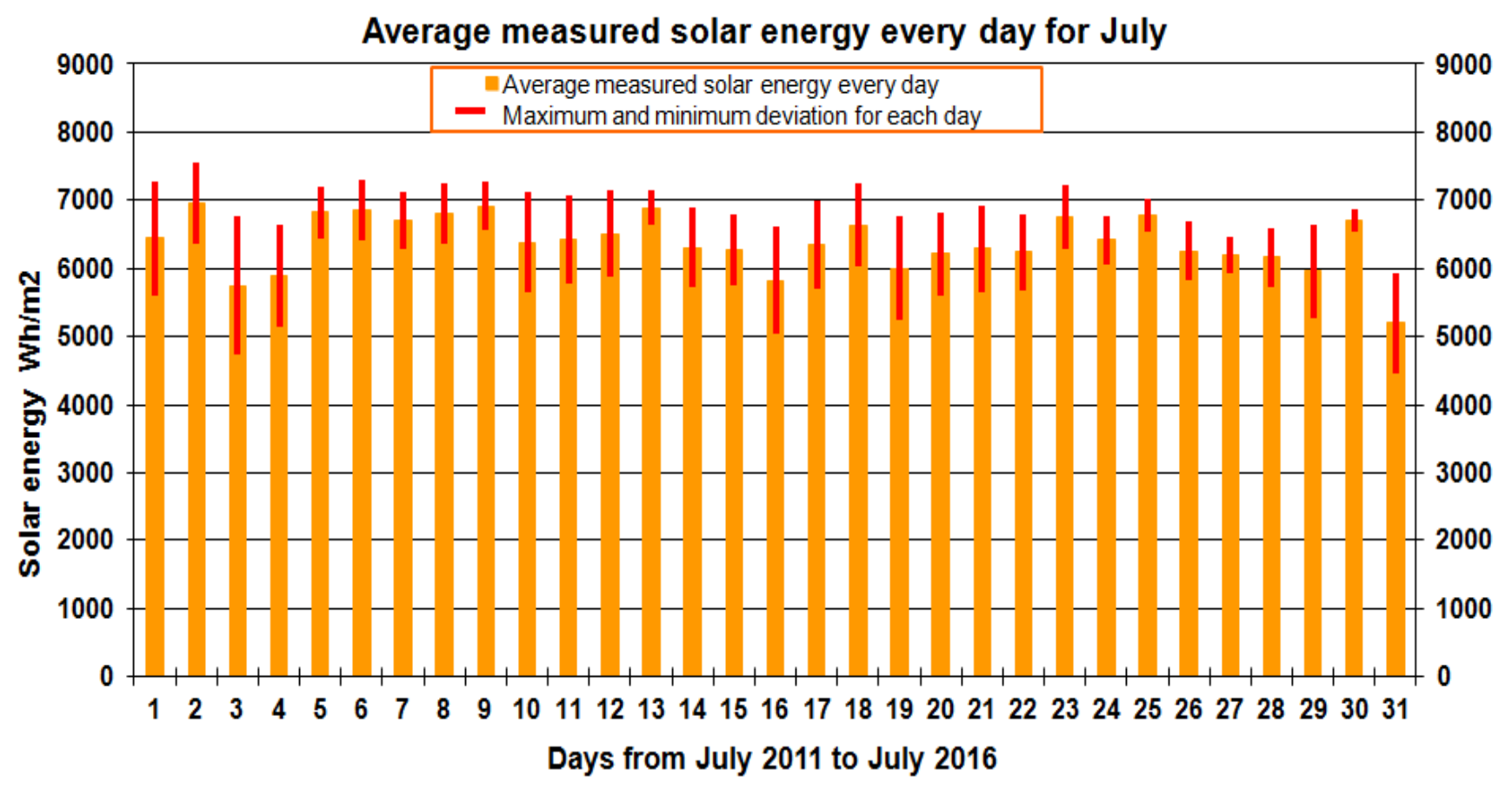

Fig. 2 The average measured solar energy for every day for July.

In Fig. 2, the daily measured average values of the solar energy in July are shown for 6 years. The daily deviation from the average value is marked by red lines. The dynamic change in values in the first, third and thirty-first days compared to the twenty-seventh and thirtieth days is significantly greater. Here even more clearly shows the changed dynamics due to changes in the atmosphere.

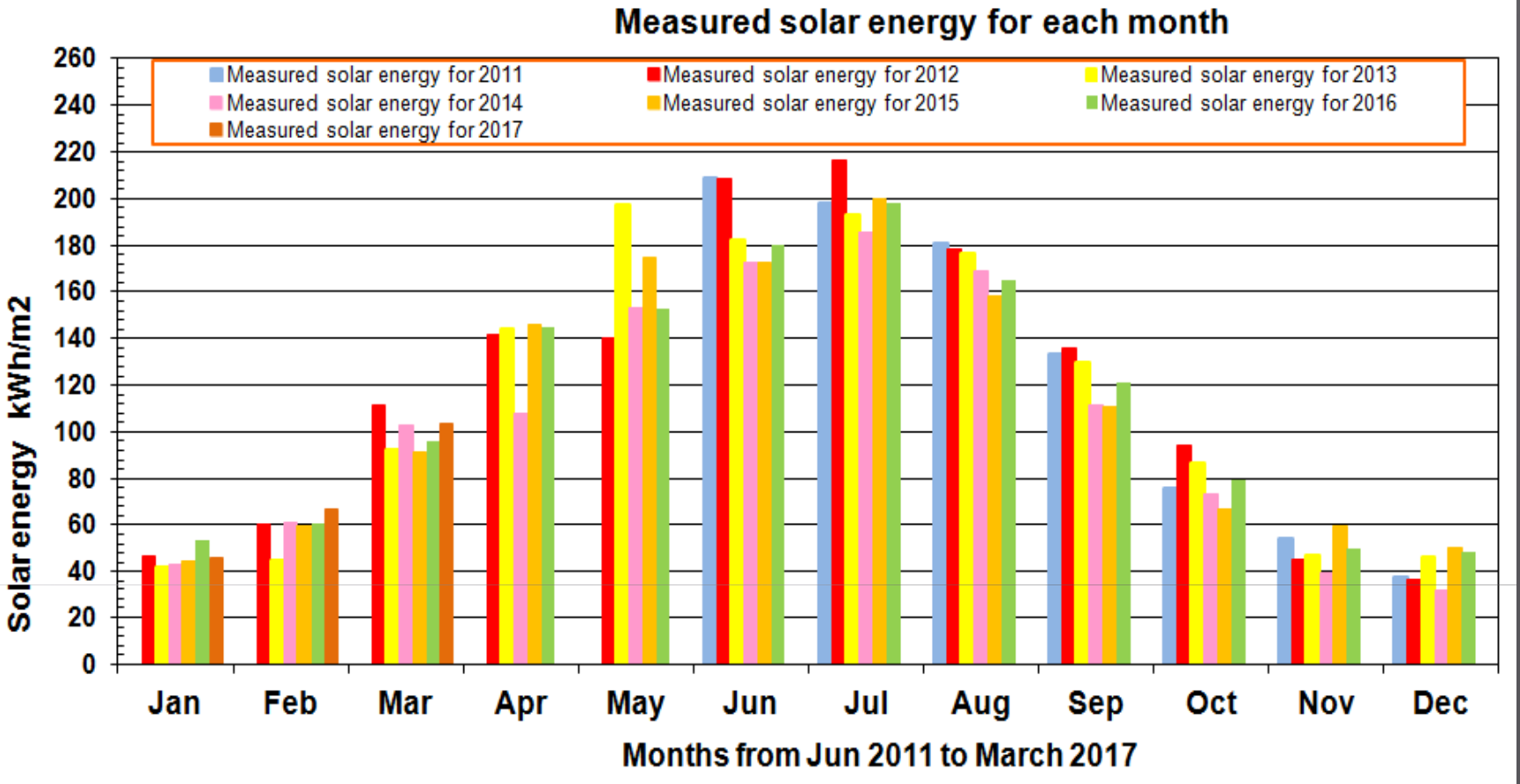

Fig. 3 Solar energy measured for each month from 2011 to 2017.

In Fig. 3, solar energy values are measured and presented for different months in different colors over a period of 6 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.

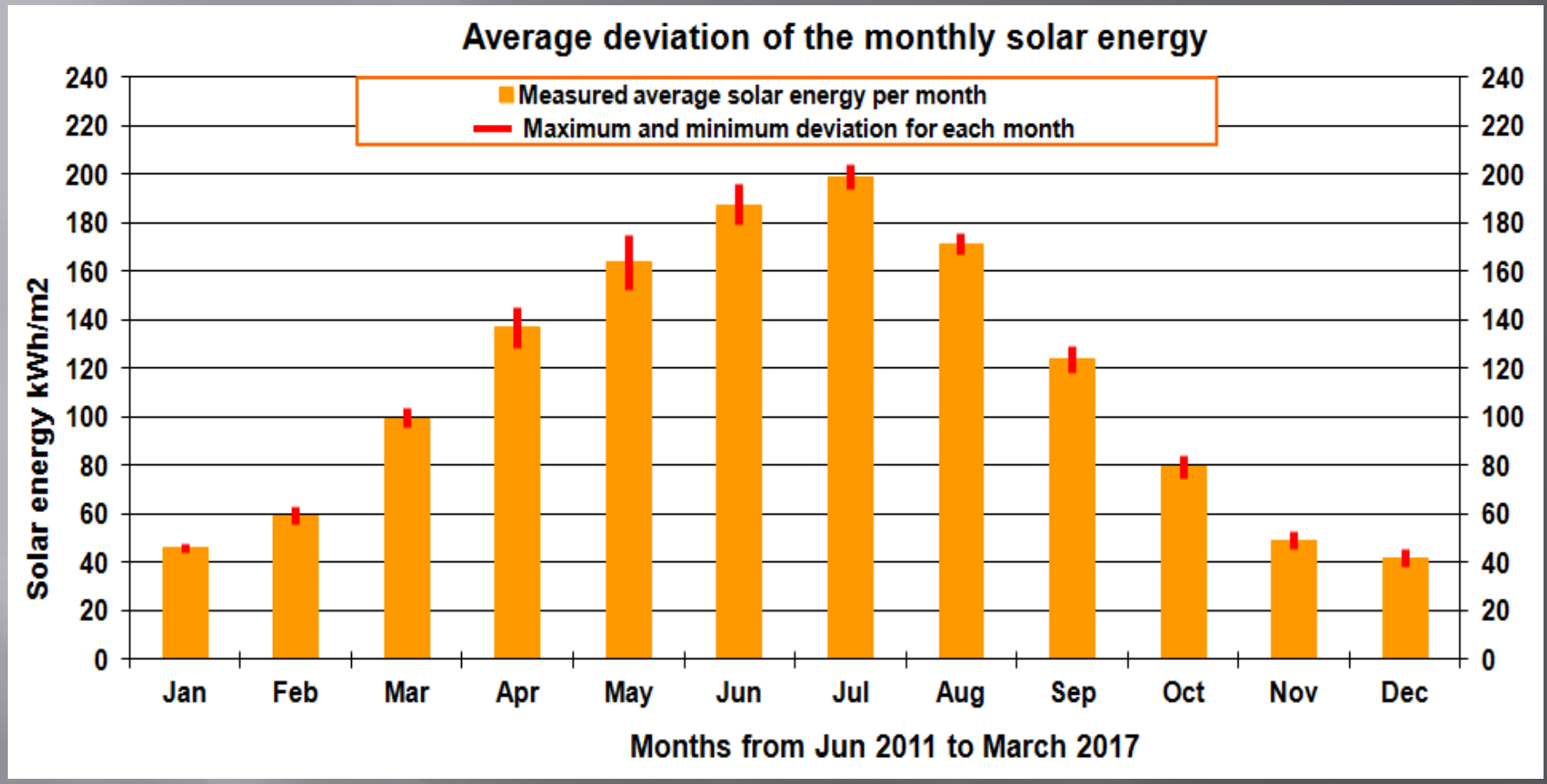

Fig. 4 Average measured solar energy for each month.

In Fig. 4, the measured average solar energy per month in a period of 6 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 December during the summer month of August. This is due to the fact that these seasons are with more stable dynamics of the atmosphere. The largest deviation in the transition months of May and June.

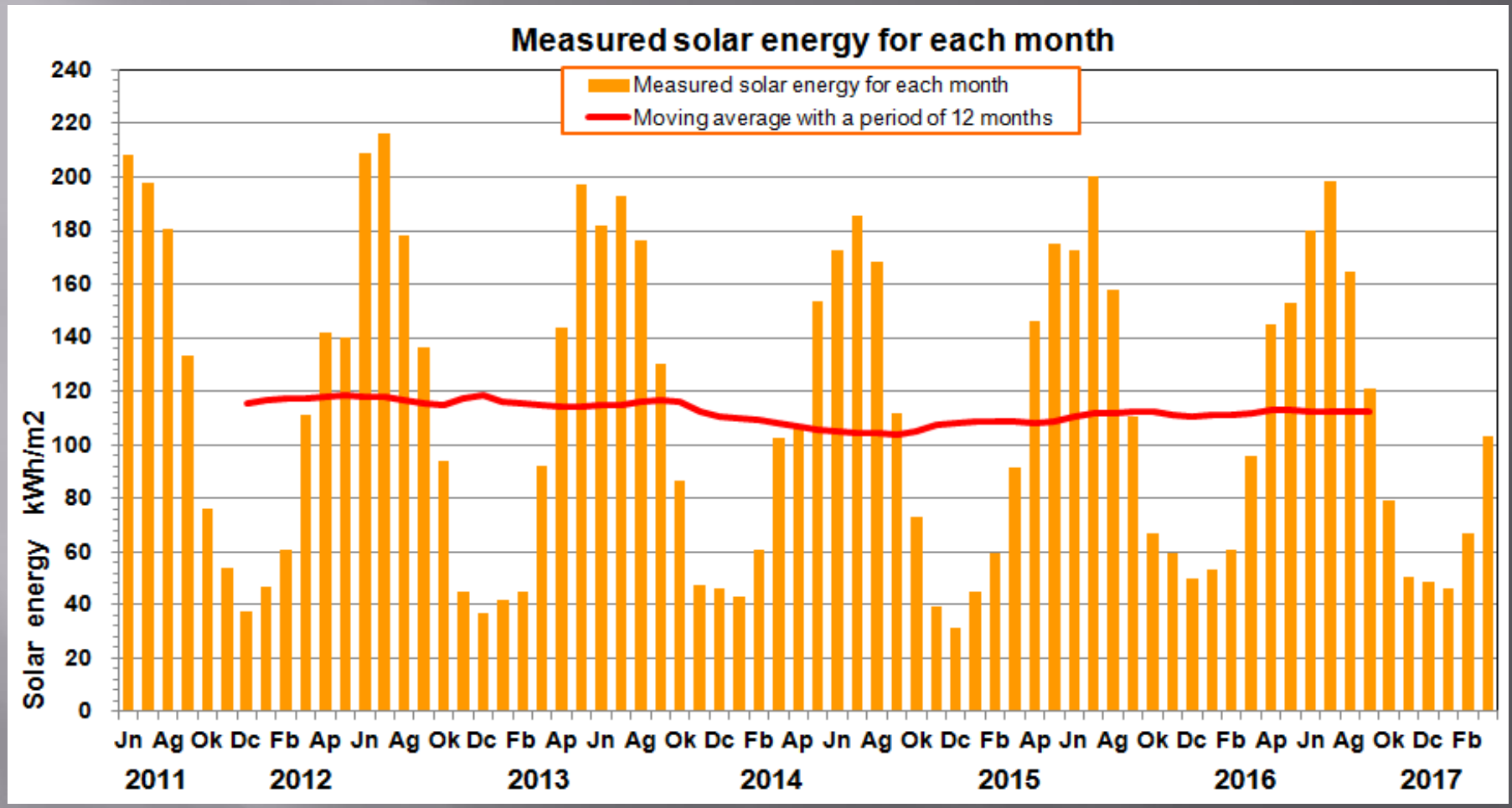

Fig . 5 Centered moving average with a period of 12 months for 6 years.

In fig. 5, a centered moving average value of solar energy for 12 months is presented for a period of about 6 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 sunshine deviations for the corres ponding months are less than the daily sunshine 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 results obtained we can state that the expected energy from the photovoltaic converter for an annual period can be calculated and predicted with relatively good accuracy.

References

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