Standard fixed PV panels and Ridge concentrator annual energy [kWh] gain measurement and comparison

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Introduction

During last years we have designed several photovoltaic solar systems at the Czech University of Life Sciences Prague. There are fixed and tracking ridge concentrator systems. We have tested parameters of the photovoltaic systems, especially the amount of produced energy. The results of our testing are presented.

EXPERIMENTAL ARRANGEMENT

Fig. 1 shows the location of CULS in Praha/Prague the Czech Republic. The isoareas of the average annual solar energy incident in the Czech Republic on the PV panel area with the slope corresponding with the latitude are shown as well. In these power plants, the PV panels based on the crystalline silicon have been used. The PV system in Prague is described below in details.

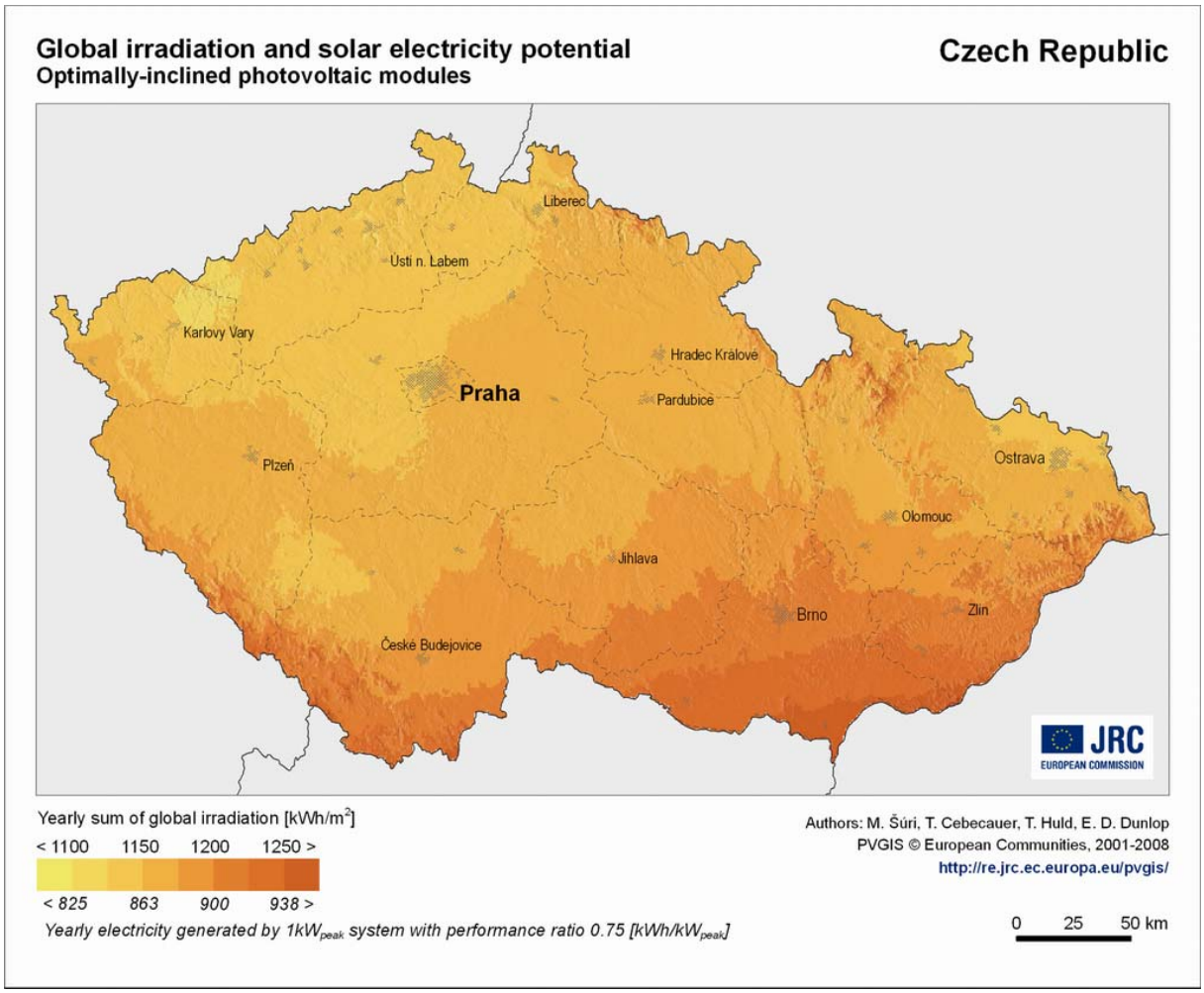

Fig. 1.Isoareas of the average annual solar energy incident in the Czech Republic

The PV system in Prague has following construction. There are two parts of the experimental PV system and they have been built so that one set of twelve mono-Si PV panels of Trina Solar company with the rated output P_{max} = 170 W_p and with the efficiency of the photovoltaic energy conversion η = 15 % have been installed on a fixed stand which is oriented to the south. The stand has a fixed inclination of 35°. The SMA SB 4000TL inverter was used.

Fig. 2. Photograph of the tracking ridge concentrator and a part of the fixed PV system

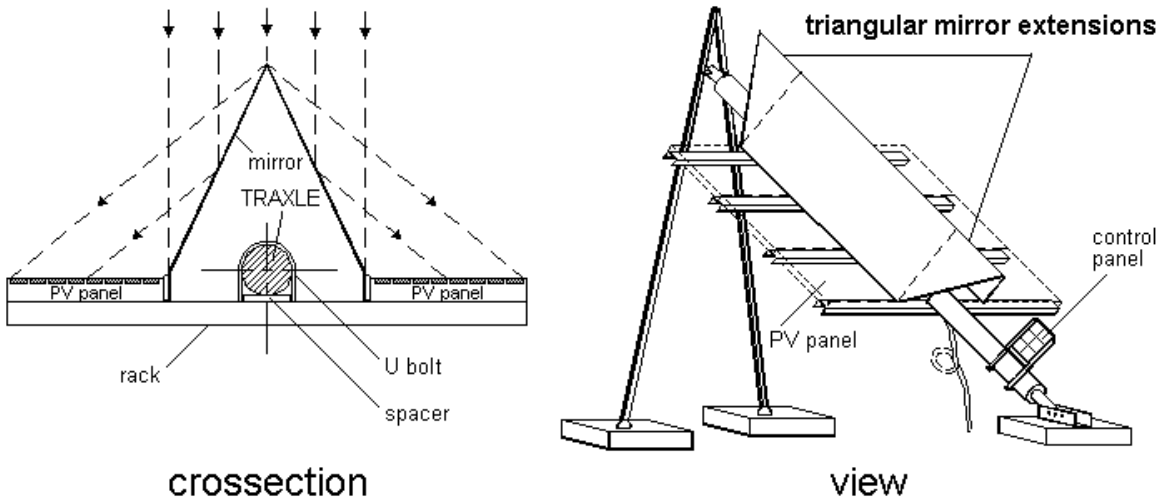

Fig. 3 Scheme of a PV system with ridge radiation concentrator

The tracking ridge concentrator system was the 2nd experimental set. The system combines single axis Sun tracker TRAXLE™ with additional mirrors. The internal ridge of mirrors (Fig. 3) acts as a moderate radiation concentrator with concentration ratio $c = 1.6 \div 1.7$. In uniaxial trackers with polar axis, the mirror should be extended beyond the photovoltaic panels (Fig. 3). This provides homogeneous illumination between seasons, when the angle between the horizontal plane and the

plane of the Sun's movement over the sky changes. Fig. 3 gives front and cross-sectional schematics of such a system. The vertex angle contained by the mirrors must be chosen so that the reflected radiation impinges on the mirror uniformly over the entire panel area as depicted. The PV system with a ridge radiation concentrator, installed and tested at CULS Prague, shows Fig.2. A new ridge radiation concentrator installed on a tracking stand could enhance PV panels energy production by as much as 65% compared to a configuration in which the same panels are mounted to fixed stands.

The tracking ridge concentrator was adapted for 12 photovoltaic panels (per 170 W_p) Trina Solar (equal to a fixed system). The SMA SB 4000TL inverter was used.

RESULTS

The systematic measurement and the comparison of the produced amount of electric energy in the above mentioned photovoltaic power systems with fixed and ridge concentrator stands is given in Fig. 4. The calculation of the energy in kWh/kW_p is shown as well. This finding is in agreement with the annual values expected in the Czech Republic.

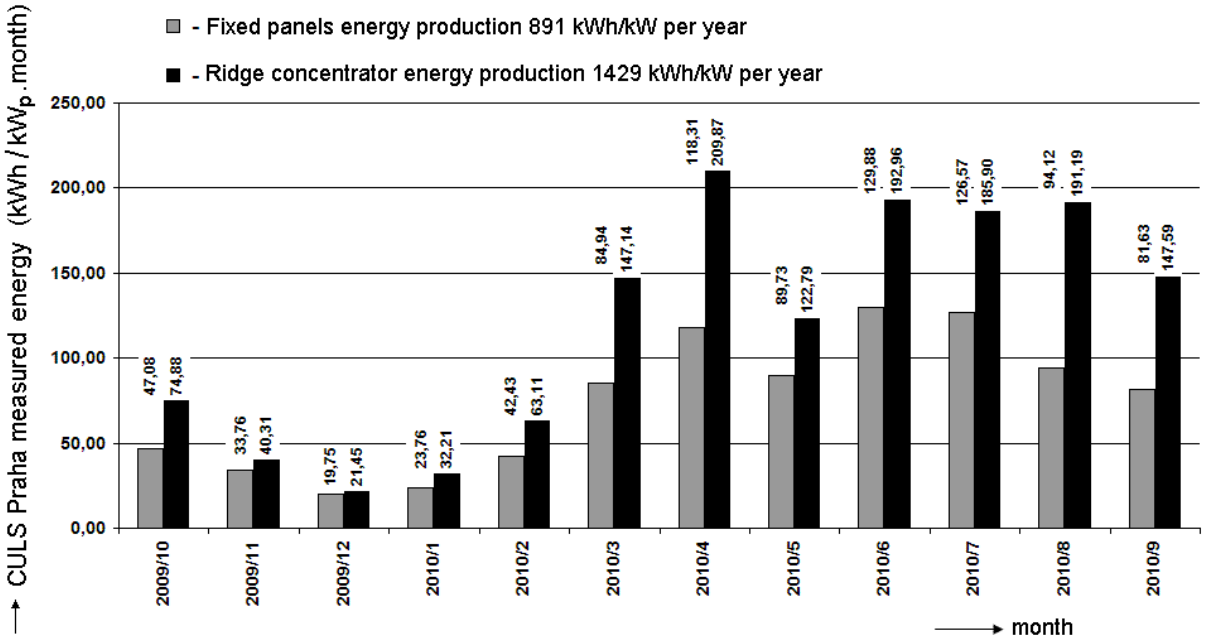

Fig. 4. Comparison of energy [kWh] production of standard fixed and tracking ridge concentrator system

Fig. 4 shows the energy [kWh] production comparison of the PV systems at the Czech University of Life Sciences Prague with fixed and Ridge concentrator stand. During this annual monitoring period the amount of produced electric energy was W = 891 kWh/kW/year in the system with fixed inclination and W = 1.429 kWh/kW/year in the system with tracking ridge concentrator. The fixed stand values correspond to the value expected in Prague at the 50° of north latitude (see Fig. 1).

The tracking ridge concentrator annual energy production is by 60% higher (1.429/891 = 1.6) compared to reference standard fixed system. A comparison of the fixed and ridge concentrator power PV system at sunny day is shown on Fig. 5.

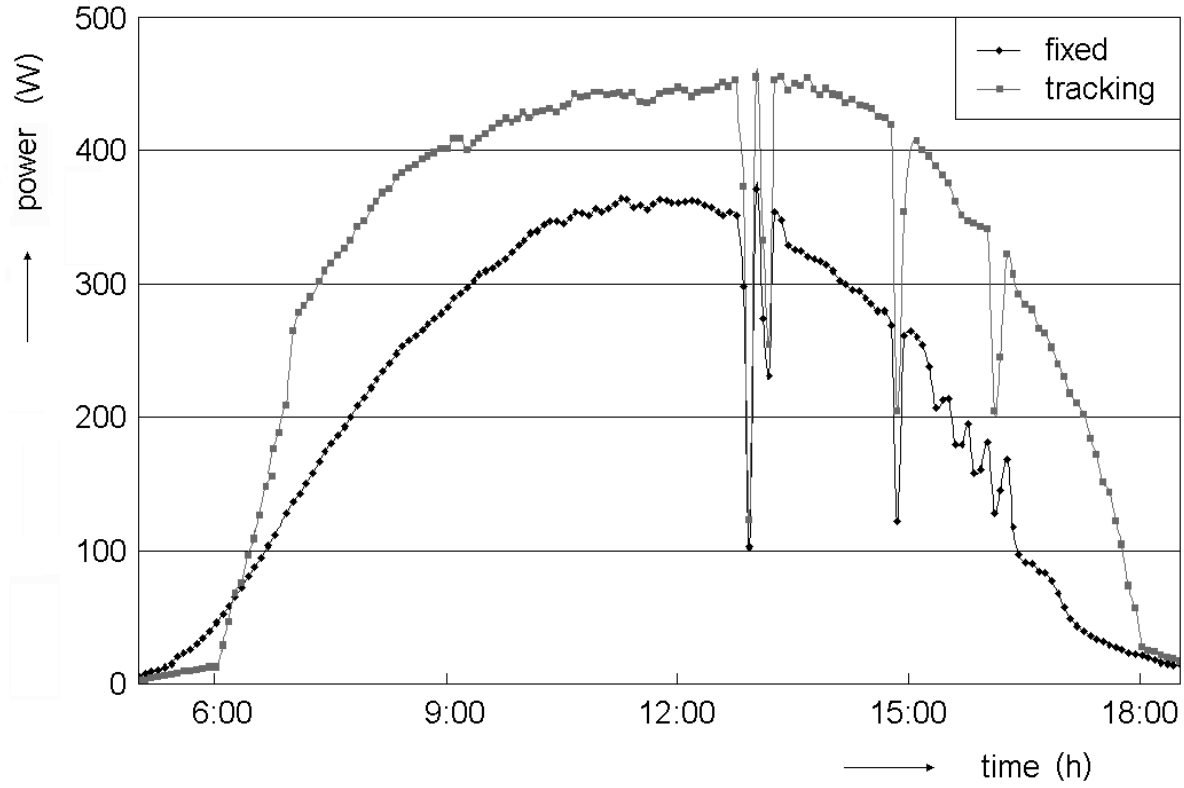

Fig. 5. Comparison of power [kW] of standard fixed and tracking ridge concentrator system (Sept. 21st)

CONCLUSION

Our endeavor was aimed to the construction and realization of tracking ridge concentrator photovoltaic power systems and a comparison with the fixed inclination PV panels from the point of view of the amount of produced electric energy during one year. The photovoltaic systems were installed in the Czech Republic, the obtained values correspond to the assumption.

From the measured and evaluated data it can be seen that tracking ridge concentrator can enhance the amount of produced electric energy by +60%.

ACKNOWLEDGEMENT

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