

## **APPLICATION OF THE PV GENERATORS IN THE CZECH REPUBLIC AND THEIR PERSPECTIVE**

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### **ABSTRACT**

In previous periods, the photovoltaic generator installation numbers were limited by the very high installation costs. Now is great press on the environment protection in order the emission of the classic fossil fuels should be reduce and therefore the higher utilization of the renewable sources is expanding all over the world. The paper deals with the experience of the PV operation and results in the Czech Republic. Next, the research activities of University of West Bohemia (WBU) in Pilsen, Czech Republic on the field of renewable energy sources (RES) are discussed. The utilization of the solar radiation for the electricity production by the photovoltaic generators is one of the production way with high regardful of the environment protection.

### **1. INTRODUCTION**

Now, because of the pressure increasing on the environmental protection and the necessity of the fossil fuels emission reduction (oil, coal and gas), in the Czech Republic, the intensive utilization of the renewable power sources, including the photovoltaic, is growing. In 2002 there was the greatest unit power output in the Czech Republic 20 kWp. In the follows years five 20 kWp units were installed under the project EU PV Enlargement. Now, there is great boom of the new installations due to the support of the redemption prices of electricity from these types of sources. In February 2007 was installed the PV unit with power output of 600 kWp. Therefore it is necessary to make investigation on this field and education process as well to improve next possibilities for spreading of the all solar technologies.

### **2. PROJECT EU „PV ENLARGEMENT”**

The European countries started to pay the great attention to the PV generators in order to fulfill the promise to increase energy efficiency and effectiveness of the photovoltaic systems and that to develop and enlarge the photovoltaic market in Europe. The one of the way how to support it was the 5<sup>th</sup> EU project with the name „PV Enlargement“. The main part of the project was realized between 2003 and 2005, when the new grate PV generators were installed over the EU countries. Further, the long term collecting and evaluation of the data from these generators continue.

#### **2.1 Objectives of the project**

The main role of the project was the great demonstration of the engagement accepted by the European countries to increase energy efficiency and utilization of the photovoltaic systems and the PV market enagement over Europe. The project is concentrated to the three main activities:

1. Demonstration (more then 1 150 kWp) of the very high or the most innovation PV technologies in 10 European countries in order to the public awareness and visualization of PV electricity could be reached.
2. Know-how transformation among the states of EU 25.
3. European exchange of the scientific knowledge in improving possibilities and efficiency of the innovation PV technologies by the interconnected data and power output monitoring.

In the scope of the project, there were 26 PV demonstration systems installed, with the whole capacity more than 1 500 kWp, at technical universities or academies and public authorities in 10 European countries (fig. 1). The systems have very effective or the innovation PV technologies (three amorphous silicon technologies, two with CIS technology, two with CdTe technology and technology of the wireless magnetic PV module power transmission).

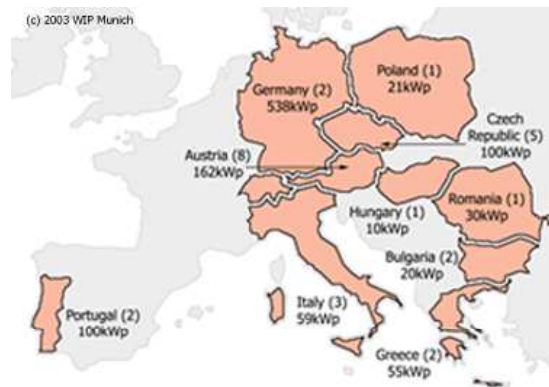


Fig. 1: Map of the countries taking part in PV Enlargement project

## 2.2 Operating of the PV generators

The all installed equipment are operated and monitored by the universities participants. The monitoring and control methods are sufficient for the modern requirements of the standardizations. Next, after the installation and the setting of the PV systems, the scientific data evaluation and consulting of the results with the producers follows to the measured increase of the systems should be achieved. The experience exchange, in the scope of the advanced monitoring, among the universities partners is made. The project has direct influence on the university's generation – the people who will be “tomorrow” responsible for the power industry. More information is on [www.pvenlargement](http://www.pvenlargement) and [www.envi.fel.zcu.cz](http://www.envi.fel.zcu.cz).

This project is the contribution to the objectives of European Union to increase development of the European industry, employment, spreading of the renewable power sources and the power sources diversification. It expands the PV utilization what it is supported in the RES policy and CO<sub>2</sub> reduction. More, the project extends the social and economy compatibility among EU countries and candidates of the joining. Finally, the project PV Enlargement is the platform for the expanding and future EU development.

In the Czech Republic the 6 universities have been taking part, including University of West Bohemia, where, in the project scope under the support of the state environment fund, the photovoltaic power station with 20 kWp power output was implemented (fig. 2) to the operation on 12. 03. 2004. In 2004, there were already 5 installations each with power output 20 kWp and the next year the PV generator of 40 kWp appeared. Except these bigger equipment, a few dozens smaller equipment (mainly on 200 Wp) were put to the operation under the project “Sun to schools”, which started in 2000.



Fig. 2: PV generator of the WBU in Pilsen

### 3. RES RESEARCH OF THE WBU IN PILSEN

At the University of West Bohemia in Pilsen, the problematic of RES, including PV technologies, is developed by the workers of electric power and ecology department (DEE) of electrical engineering faculty. Besides, above mentioned the solar power station, the new RES mini-park was realized on the faculty's roof during the new campus construction. The mini-park consists of:

- Small photovoltaic system with different color types of PV modules, accumulators and invertors
- Wind power station of 10 kW
- Thermal solar system with various collector types
- Heat pump air – water
- Control system and monitoring system
- Meteorology station

This RES complex serves for the scientific research, students education, mainly in study programs “Technical ecology” and “Power engineering and as the information source for laic public.

#### Research of the air pollution influence on the PV

Except above mentioned project 5 RP EU “PV Enlarge-ment”, the workers of DEE have shared on the solution of Environment Ministry research project – “Research of pollution influence on the photovoltaic power output decreasing and influence of the PV position in the cities and regions over the Czech Republic. The responsible organization was company SOLARTEC ltd. Rožnov pod Radhoštěm, which was in previous years' only one firm producing photovoltaic cells in the Czech Republic. Some of the results which were obtained at WBU are presented on pictures in this paper.

In the scope of the project, there were placed three couples of the PV panels with the different angles – 35, 45 and 60 degrees situated to the south on the university roof (fig. 3).



Fig. 3: PV modules with the different angles

First member of the couple was cleaned and the other one no, in the week intervals. The research took for 18 months. For the whole time Solartec company made the continual collection of the data from all the places where the PV cells have been situated, including WBU.

In fig. 4, 5, 6 there is noticeable influence of the angle on the power output duration and therefore on the total daily production (fig. 7). The influence of the cleaned modules on the daily production is very low (blue-grey curves) but the influence of the angle on the power output is very high, as it can be seen from the sunny day as the 18. 7. 2005 was. The difference between the production of the module with the angle 35 (blue) and 60 degrees (red) is approximately 20 %. The difference between 35 and 45 degrees angels is about 10 %.

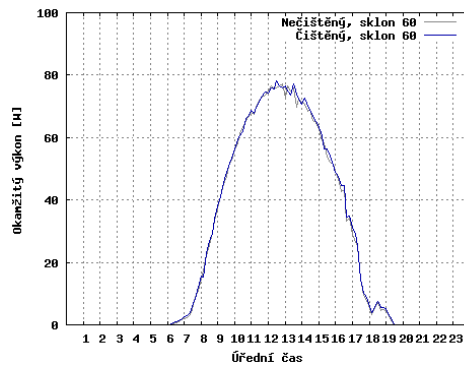


Fig. 4: Power output on 18. 7. 2005 with 60°

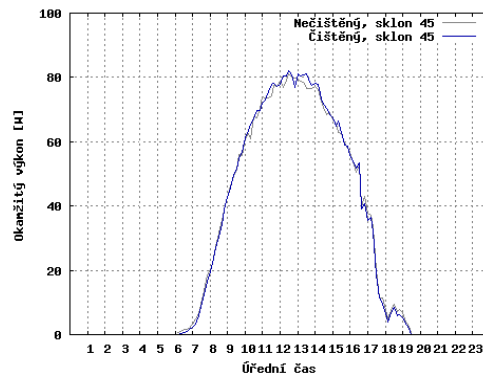


Fig. 5: Power output on 18. 7. 2005 with 45°

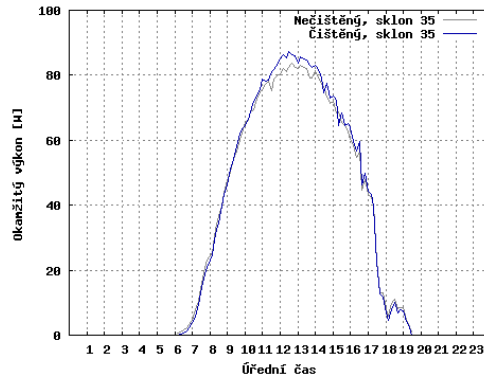


Fig. 6: Power output on 18. 7. 2005 with 30°

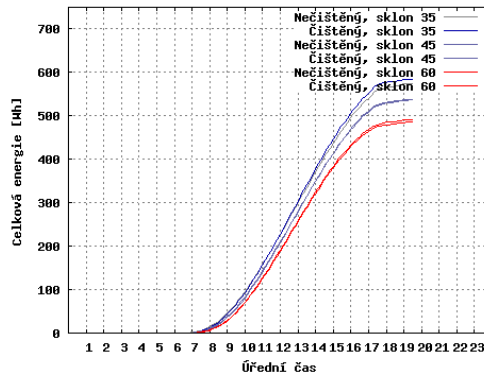


Fig. 7: Daily production on 18. 7. 2005

In fig. 8, 9, 10, the influence of the year's season on the whole daily production is presented. The sunny days of spring, summer, and autumn in Pilsen city location are shown. The great influence of the PV module's angle on the whole production in the different year seasons and the low influence of the pollution can be seen. The average difference between the cleaned and no cleaned module during the project whole time was for the all research installation 1.4 %.

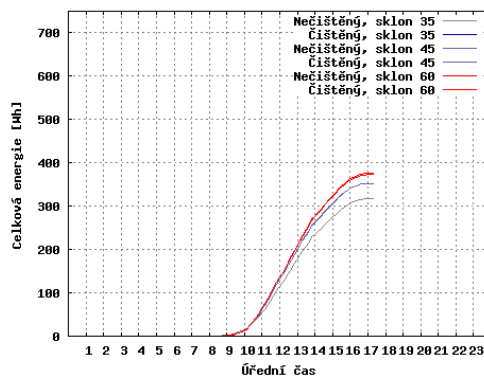


Fig. 8: Daily production on 23. 2. 2005

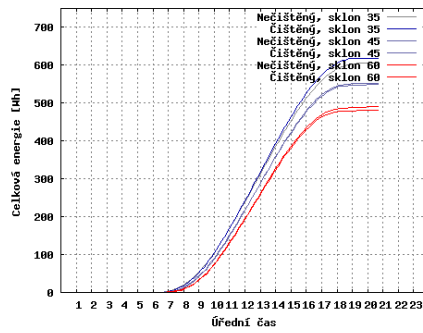


Fig. 9: Daily production on 23. 6. 2005

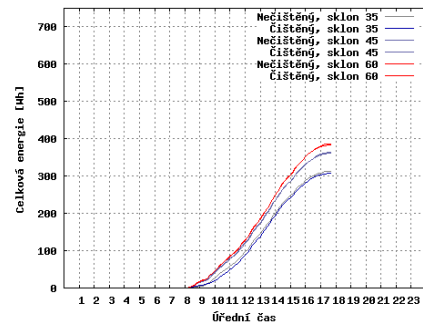


Fig. 10: Power output on 23. 10. 2005

#### 4. CONCLUSION

At present, there is in the Czech Republic a great interest about the photovoltaic electricity production due to the new Czech law n. 180/2005 “About the support of electricity production from RES”, possibility to have a foundation of Ministry of environmental protection and the purchase prices.

Many companies offer the whole installation in the prices of 4.5 – 5.7 for the installed kWp. The market competition has influence on the price decreasing and the increasing production of the PV cells as well. There are much PV equipment of the bigger power outputs under the design and realization. The PV power plant with power output 25.8 kWp which is integrated to the facade has even Ministry of environment protection (fig. 11).



Fig. 11: PV generator of the Ministry

In February the greatest PV power plants with 600 kWp was put the in operation at Bušanovice village – south region of the Czech Republic (fig. 12).



Fig. 12: Bušanovice PV generator

The installed cost was  $3.1 \times 10^6$  € and the foundation was  $1 \times 10^6$  €. The area of the PV modules is  $6\,170\text{ m}^2$ . It is the greatest solar power plan in middle Europe. Till the end of 2007, its output is going to be doubled. The purchase price of 1 kWh from the PV generators in CR is 0.48 €/kWh. The total capacity of the PV generators in CR is 1 MWp, but the intensive grow due to foundation, conditions and state support can be expected.

## 5. ACKNOWLEDGMENTS

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