Experience with teaching photovoltaics using PV*SOL at FEKT BUT

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Abstract

*The principles of photovoltaic power plants are taught in several courses guaranteed by the Department of Electrical Technology of the FEKT BUT. These courses have been expanded to include the course Designing Photovoltaic Power Plants, which allows a deeper understanding of the design of photovoltaic power plants using the PV*SOL design and simulation tool. This subject is gaining popularity among students and we are seeing an annual increase in interest.*

Keywords: teaching, photovoltaic, PV*SOL

INTRODUCTION TO TEACHING OF PHOTOVOLTAIC AT THE FEKT BUT

The Faculty of Electrical Engineering and Communication Technologies (FEKT) at Brno University of Technology (BUT) offers courses dealing with photovoltaics and renewable energy sources. Here are a few of them:

Alternative Energy Sources (MPC-AZE): This subject focuses on various alternative energy production methods, including photovoltaics. Students become familiar with principles and technologies used in the field of renewable energy.

Small Hydropower Plants (BR53): This subject deals with electricity generation from water energy, which is another form of renewable energy and there is also some introduction to photovoltaic.

Renewable Energy Sources (MPC-OZE): This subject focuses on renewable energy production methods, focused on photovoltaics. Students become familiar with principles of photovoltaic and learn basic work with design system PV*SOL.

Design of Photovoltaic Power Plants (XPC-PFV): This elective subject allows students to gain practical experience in assembling rooftop photovoltaic systems. It is part of both bachelor's and master's programs. In this course students will learn advanced usage of design system and simulation tool PV*SOL for photovoltaic power plants, covering project creation, simulations, and energy audits.

In addition to teaching in the exercises of these courses, PV*SOL is used as a design and simulation system for solving bachelor's and master's theses

At the beginning of September 2023, the Institute of Electrical Engineering of the Faculty of Electrical Engineering and Communication Technologies (UETE FEKT started the operation of the photovoltaic and electromobility polygon, which would serve as a practical teaching laboratory for students to install photovoltaic roof systems and electric vehicle charging stations. The Faculty of Electrical Engineering and Telecommunication Technology offers students of courses focusing on renewable energy sources the opportunity to gain professional practice in assembling rooftop photovoltaic systems. So far, theoretical teaching has been supplemented only by computer simulations in PV*SOL. The creation of the laboratory would thus enable students not only to test their theoretical knowledge in practice.

Figure 1: Photovoltaic polygon - overall view

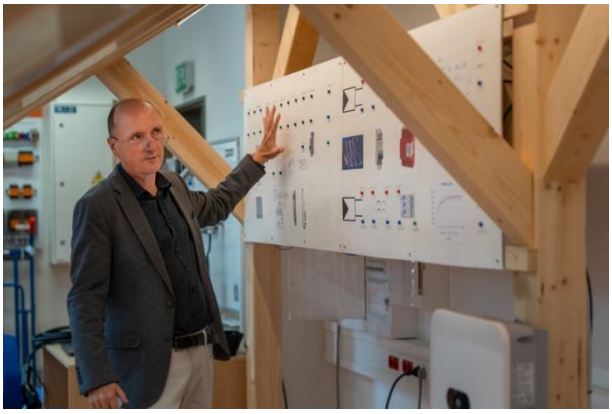

Figure 2: Photovoltaic polygon - close-up of the wiring part

INTRODUCTION TO PV*SOL PREMIUM

PV*SOL® premium is the world's most widely used program for the simulation of photovoltaic systems. PV*SOL® premium is intuitive and ideal for practical exercises. With the 3D visualization, complex shading situations can be easily modelled and the effects of shading on the yield can be precisely calculated for each module at any time. The integrated financial analysis allows students to examine the economic impact of different system designs. The simulation results provide an excellent opportunity to monitor the occurrence of maxima, minima, regularities and deviations.

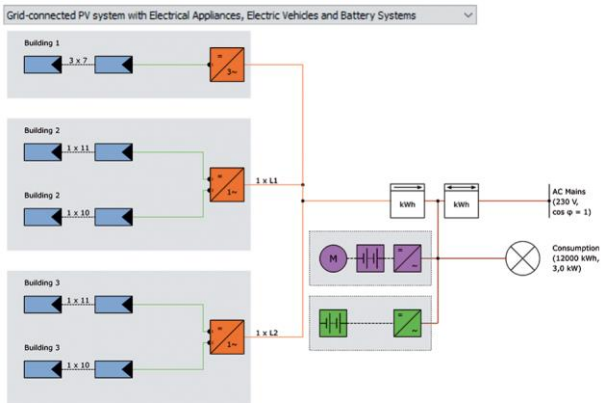

Figure 3: Example of Grid-Connected PV system with Eclectical Appliances, Electic Vehicles and Battery System designed and simulated in PV*SOL.

With PV*SOL® premium system designers and operators can design their solar systems according to the latest findings, simulate accurate yield calculations under site-specific conditions and thus also perform accurate financial calculations, taking government subsidies into account.

Figure 4: Students also learn how to work with Photo plan, integrated into the PV*SOL environment for a realistic representation of future photovoltaic systems.

The product database provides extensive and constantly updated data sets. The components are maintained online by the respective manufacturer (number of data records PV*SOL 2023 are rounded):

- PV-Modules:18,000
- Inverters: 4,500
- Electric vehicles: 70
- Batteries: 700
- Battery systems: 1,000
- Power Optimizer: 23

Additional features

- Realistic configuration with power optimizers
- Multiple PV arrays connected to one MPP
- Simulation of bifacial PV modules S
- election of different electric vehicle groups
- Free addition of safety devices to the circuit diagram

Program languages: Čeština, Deutsch, English, Español, Français, Italiano, Polski, Português, Turkce

Figure 5: Students use 3d models of buildings and surroundings to accurately simulate the effects of shadows and other spatial factors.

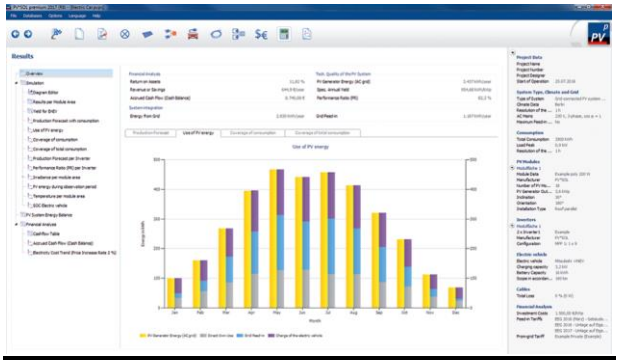

Figure 6: The output is then very detailed outputs of possible energy yields, Energy Flow graph, Production forecast, Financial analysis, Cash flows, economic returns.

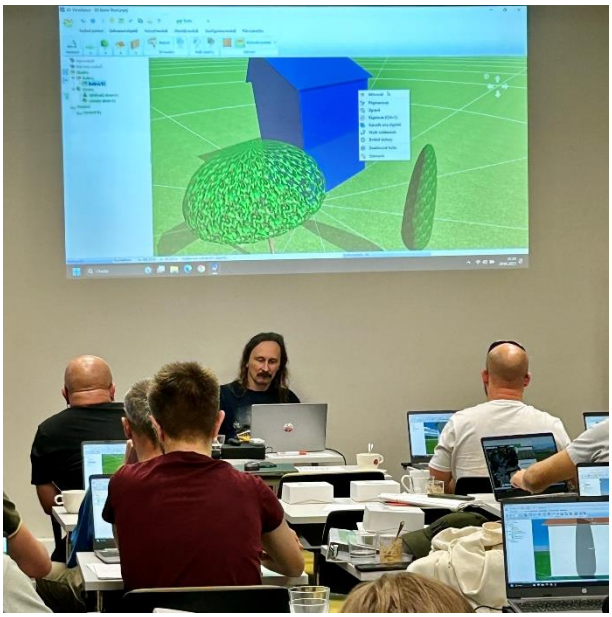

Figure 7: PV*SOL training is also offered to non-faculty students in professional courses, in cooperation with the Czech Photovoltaic Association.

CONCLUSION

Students are interested in learning PV*SOL and this is the reason why students like to enroll in courses containing work with this designing and simulation software. During the time of using the PV*SOL design system, 47 full-time students and 21 students of the combined form of study have taken course Renewable Energy Sources. Additionally 69 foreign students have taken the English language version of this course. The course Designing Photovoltaic Power Plants was taken by 127 students of different study programs at the Faculty of Electrical Engineering of the BUT. The design system PV*SOL was also used to solve bachelor and master theses in more than 15 successfully defended theses.

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