Education on Solar Potential Estimation at EUC "Energy-Nature-Balkan", TU-Varna

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Abstract - **The current energy tendencies in Renewable Energy Sources (RES) are setting new problems in order their optimal exploitation. Solar energy is one of the renewables with practically inexhaustible source, the Sun energy. At present time the technologies converting solar energy into electricity are rising very rapidly, the production of silicon has been enlarged during the past few years and the price of photovoltaic cells is reducing continuously, so the solar education of Bulgarian students must be up-to-date and more efficiently.**

Keywords – **Renewable Energy Sources, Photovoltaics, Solar Cells**

I. INTRODUCTION

The practical education at TU-Varna concerning RES has been concentrated during the years mostly on solar and wind energy exploitation. The bachelor and master degree programs of education are intended for students who wish to specialize in the field of RES. One of the most important efforts of the academic staff is focused to solar potential evaluation at particular sites of Bulgaria.

Methodology of education

The education on solar potential estimation is divided into three parts : 1. Theoretical estimation of the potential – Solar estimation procedures, Satellite sources and others, 2. Solar radiation parameters measurement with laboratory equipment, optimal angle of inclination obtaining and 3. Long period meteorological and solar parameters measurement and data acquisition.

II. THEORETICAL ESTIMATION OF SOLAR POTENTIAL

This is a very important part of planning and preliminary estimation of a site [1]. Several solar maps are known and the students are introduced to them in order to have information about the relation between geographic conditions of our country and solar potential at different places. On fig.1 may be seen one of the lasts solar maps of Bulgaria which shows the average yearly energy per square meter, [kWh/m^2] measured on horizontal surface and on optimally-inclined surface [2].

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Fig.1, Average solar radiation on horizontal surface and optimal angle

The other map, fig.2 is an issue of the European Commission and also shows the yearly sum of global irradiation on optimally-inclined photovoltaic (PV) modules. The information of both maps is used for comparison with the laboratory data measured.

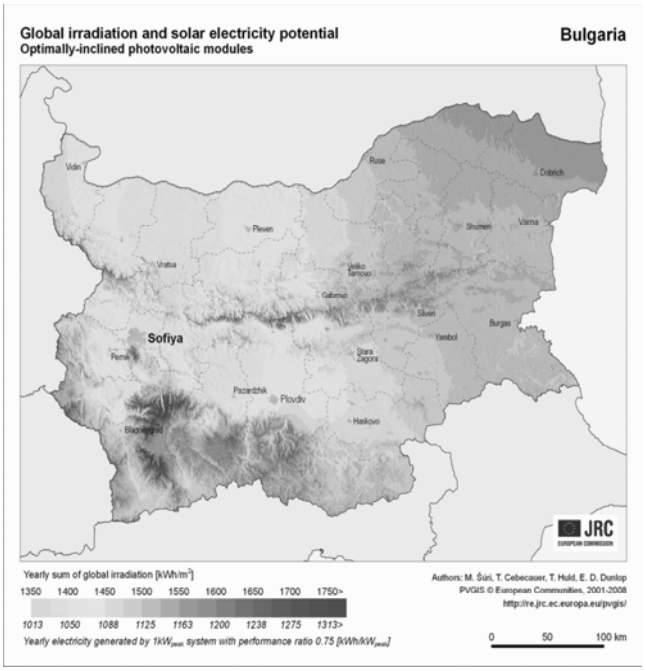

Fig.2, Yearly sum of global irradiation for Bulgaria, European Commission, 2008

Some other sources can be used in order to find important parameters during the years for the site analyzed. Very useful is the official Web site of NASA [3], containing a lot of satellite and radar data. The NASA data base helps also for statistical evaluation of collected information and a has lot of meteorological parameters measured during the years in order to analyze how the climate changes are related with the site conditions. Very important information especially about the photovoltaic systems contains the Web site of PVGIS, there are a lot of opportunities to calculate optimal angles, PV output and others.

II. SOLAR RADIATION PARAMETERS MEASUREMENT WITH LABORATORY EQUIPMENT

This part of education is necessary to give the students practical skills using different solar measurement facilities, pyranometers and others. The laboratory of EUC "Energy-Nature-Balkan" has at disposal some types of solar parameters measurement devices, fig.3 :

- Kipp & Zonen pyranometer, type CM11B, (Second Standard) calibrated and equpped with AMPBOX amplifier,
- Solar meter TES 1333R with RS232 interface,
- Silicon cells, produced by the EUC.

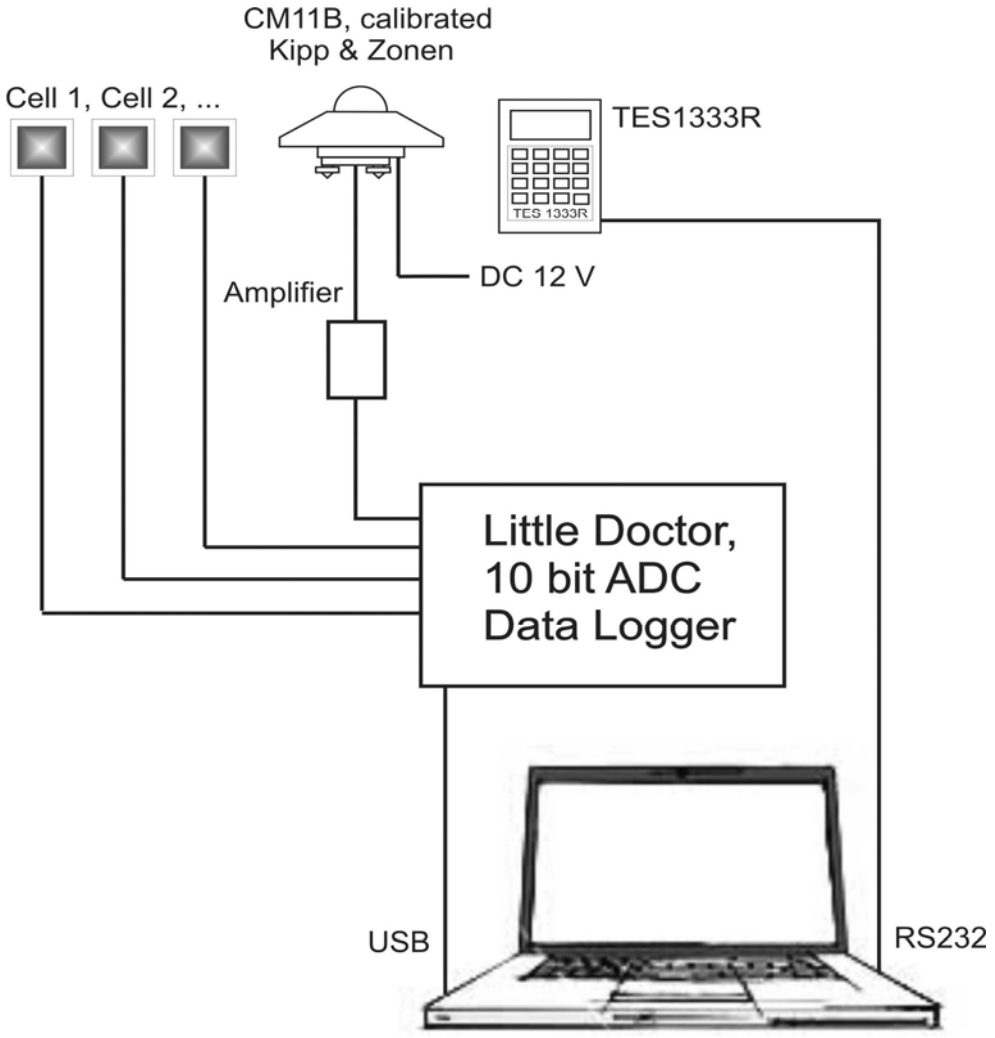

Fig.3 Laboratory equipment for solar cells calibration

The Secondary Standard pyranometer CM11B is used in order to calibrate other solar meters. The experiments have been realized via 10-bit Data Logger, "Little Doctor" and the data collected can be easy compared, different exercises can be performed with PV cells as solar meters.

On fig.4 some results of comparison between experiments data are given. The solar radiation density or "flux" is also known as irradiance, measured in W/m^2. The other instrument TES1333R is ISO9001 certified and it can be used as an independant control device.

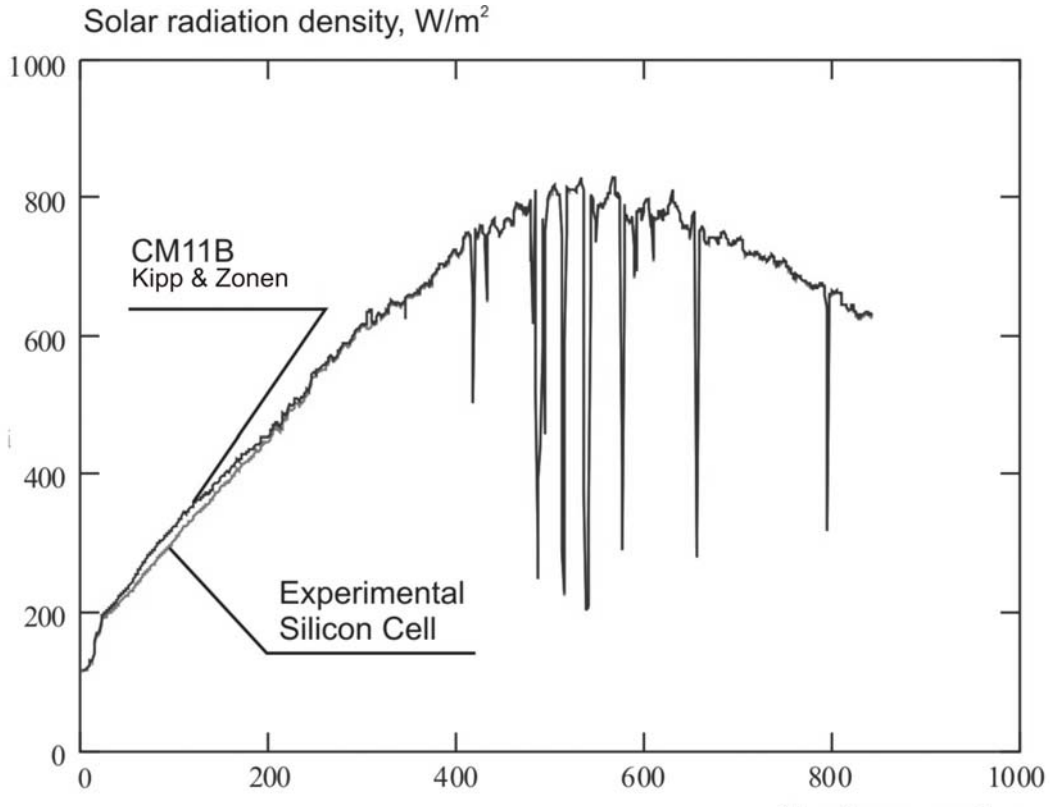

Fig.4 Comparison between solar irradiance measurement with Kipp & Zonen CM11B and an experimental PV cell measurement performed in October, 2008

III. Long Period Meteorological and Solar Parameters Measurement, Data Acquisition

This is the most important part of practical education, connected with data acquisition for a long period of time. The aim is solar irradiance data collection for a whole year at a site of interest. The equipment may be seen on fig.5. The parameters measured are ambient temperature, atmospheric pressure and the irradiance. For time interval of 7 minutes the data logger may collect data maximum for 3 months on internal flash memory. There is a battery provided to ensure independent power for a couple of days in case of interruption of main power supply. The data logger system is equipped with PYR-S pyranometer, electronic thermometer and sensor for atmospheric pressure measurement. With the equipment a data base may be created and the comparison between theoretical and experimental data performed.

IV. Conclusion

The experimental equipment of EUC with the theoretical background is able to give the students of TU-Varna education in order to prepare engineering staff to meet the challenges of our time when the energy consumption has to be reduced, new RES technologies to be implemented and to answer the requirements of EC the buildings of the future to be with independent power supply. Another part of education for the future has to be concentrated on creation of low cost silicon solar meters ready to measure with acceptable precision and intended for solar potential estimation. For the future within a project with Bulgarian National Scientific Fund an extension of existing laboratory equipment of Technical University of Varna, connected with Solar and Wind data acquisition is provided. This equipment will highly increase the opportunities for a modern students RES education.

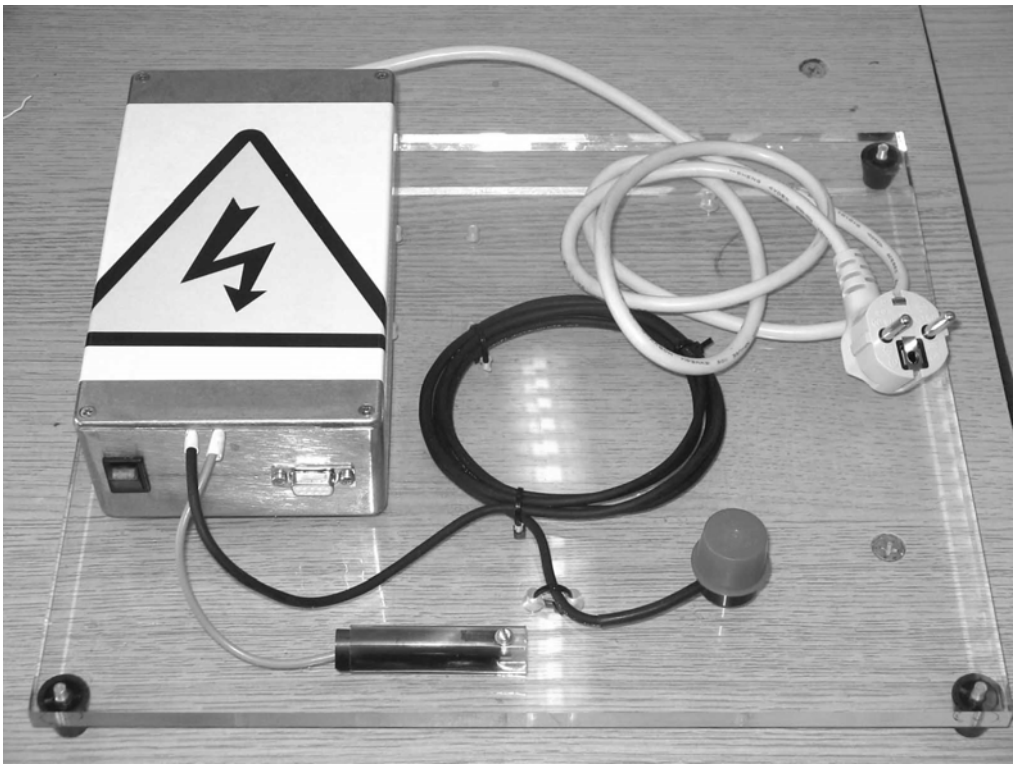

Fig.5 Data acquisition system with flash memory and battery for emergency power supply, RS232 interface

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