1. Introduction

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Over the last few decades, the applications of photovoltaic systems have grown rapidly and are paving the road for solar energy to become a contender for alternative energy source as a mature and major energy source for Europe and the world. In 2012 photovoltaics were the top new source of electricity generation in the European Union [1]. The capacity of the systems installed during that year alone was sufficient to cover the annual power supply for over 21 million European households. Each year, these PV installations save more than 36 million tons of CO_2. It is thus argued that the reduction of EU's current fossil-fuel combustion rate can be assisted greatly by introducing coherent, comprehensive and coordinated energy education policies. The applications of photovoltaic systems can also contribute to the achievement of sustainable development in rural areas and developing countries, as they offer many community and social services, such as lighting of communal buildings, water pumping, refrigeration for health centres, preservation of agricultural products, food, medicines and vaccines.

Photovoltaic technology will continue to prove their ability to compete in the energy sector as a mainstream power generation source and their benefits to society will play a key role in addressing energy challenges. Even in the most pessimistic scenario taken into account, photovoltaics will continue to increase their share of energy mix in Europe and globally, and become a reliable source of clean, safe, affordable, decentralised and renewable energy for all.

It has been suggested that education, research and development, and commercial exploitation focused on solar energy systems are key priorities of the energy policy, to promote the solar energy applications for sustainable development [2]. There is an urgent need to promote solar energy systems successfully; this can be done only by appropriately educating the people whoever involved in design, sizing, installation and maintenance. Furthermore, the provision of suitable, advanced and updated educational material is the key for the successful organization of educational and training activities.

Within the European Erasmus+ program, a group of particular EU universities was offered the opportunity to develop educational materials on the subject of photovoltaics - open educational resources (OER). These OERs include development of educational texts and documentation to support various educational activities, such as: undergraduate and postgraduate courses, training of engineers and economists working in sectors of energy, executives in public administration and related services (regional or national), energy specialists, planners, building engineers and scientists.

Moreover, the group developed these OERs that includes modern technologies, recent educational theories, a new online library and a new module on photovoltaic systems. The OERs cover the conversion of solar energy to electricity, from the basic characteristics of solar radiation up to the most recently available technology, design and installation practices, in a manner sufficiently comprehensive for this rapidly emerging field. The OERs contain more material than could be covered in one semester university-level engineering course. This enables the educator and the trainee to focus on particular topics that are of specific relevance to their interests. An extensive bibliography at the end of each chapter will propose a more detailed exploration of topics that may be of interest to the users.

The first four chapters describe the issues of solar geometry, to provide the reader with all the knowledge necessary to allow decisions regarding the optimal placement of photovoltaic panels at a particular area. In chapters 5 – 7, the photovoltaic effect and operating mode of photovoltaic panels are analyzed in a simple, understandable manner. In addition, research and development of semiconductor materials gives new types of photovoltaic cells with high energy efficiency, are effectively described. The challenges in the grid-connected and stand-alone systems with their applications are described in chapters 8-11.

The continuous and efficient operation of a photovoltaic installation depends on two critical issues, namely the maintenance and the repair of potential damage. For this reason, all the necessary knowledge to address the aforementioned issue were described in chapter 12 and 13.

The economic viability is a key element in any study regarding photovoltaic installations. Therefore, a method of economic analysis is included in the OERs, while economic indicators are given for common photovoltaic investments. The proposed method is the life cycle cost analysis, a method commonly used for energy-related investments described in chapter 14.

Given that the photovoltaic system is a unit that converts solar radiation into electricity, some indicators characterize its efficiency, while they also serve as comparative figures between different types of photovoltaic systems. The OERs present these indications in a chapter, alongside with the characteristic curves of PV cells. Furthermore, the group describes the environmental impact of photovoltaics and presents information regarding their marketing and promotion. Finally, advanced and specialized topics on photovoltaics are included.

We hope that these OERs will help the reader to understand fully the entire scope of photovoltaic systems and, in the long run, to contribute to the reduction of the planet's pollution that will eventually lead to societal well being.

References

[1] European Photovoltaic Industry Association, '*Global Market Outlook for Photovoltaics 2013 – 2017', 2013.*

[2] Axaopoulos P., K. Moutsopoulos, and M. Theodoridis, "Engineering education using remote laboratory through the Internet". European Journal of Engineering Education, Vol. 37, Issue 1, pp. 39-48, 2012.