

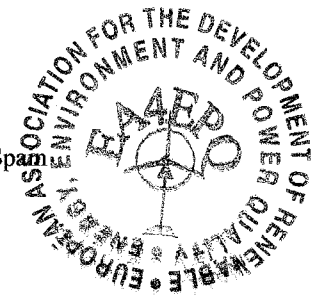
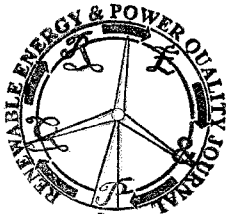
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Simulation and Modeling of Systems in Engineering Education for the Sustainability. The Renewable Energy Case

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Abstract. In this paper we discuss about the use of computer simulations for sustainable systems. We propose laboratory practices for those subjects taught in the Engineering degrees that use systems or plants in their laboratories. The proposal is to use renewable energy systems for those laboratories. The interest in simulation of this kind of systems is focused to forecast their behavior in order to control and actuate over them wasting the less natural resources as possible. In this paper, the use of a didactic material for laboratory practices is explained. This pedagogical resource is published in a web platform (<http://model.upc.edu>) where the student can find laboratory practices, the instructor explanations and the software to develop new dynamical models. We have the strong belief that undergraduate students must receive an Education for the Sustainability independently of their career together and transversally with the basic and specifically concepts of the own subject.

Key words

Mathematical Models, Sustainability, Renewable Energy, Simulation, Education.

1. Introduction

In the last years society has become aware of that the pattern of current development affects our Planet in a noxious way. The wrong and excessive use of the natural resources, the group of substantial changes in the environment (deforestation, natural disasters, climatic, pollution, lack of water...) has generated the environmental problem that all the countries of the world are living, especially the industrialized ones. Particularly, in the Mediterranean region the climate change effect will be the decrease of water supply, causing a higher health risk and a decrease of hydroelectric energy generation. In order to not increase the use of nuclear energy generation neither the primary energy production coming from burning fossil fuels, there is the necessity of shifting to the generation of renewable energy to help meet increased energy needs. Education and Training play an important role in the sustainable production of renewable energy (solar, wind, tides, geothermal, biomass...) as well as in a rational use of this energy (consumption reduction, effective energy transport, efficient grid system...).

The United Nations Decade of Education for Sustainable Development, declared from January 2005 to December 2014, demands a concerted effort to expand environmental education around the world. High schools are places where students and teachers share knowledge, learn skills, and shape values. Rarely, industrial technology is at the focus of the classic case studies used in environmental engineering ethics courses and textbooks. That makes sometimes difficult exciting and motivating technical engineering students to study and discuss these cases.

Besides, in our modern society, distance education has become a viable solution for students who require more flexible, accessible, and adaptive teaching systems, without spatial and temporal restrictions [1], [2]. In the past, the interaction methods for distance education were limited to the telephone, postal mail, or fax. Today's new information technologies provide alternative tools for improving teacher-student interaction, two of which can be pointed to as the most capable and reliable for distance education. These tools are hypermedia systems as a new way of arranging information and wide-area communication networks (i.e., the Internet) for information support [3]. Although these tools are sufficient for constructing support systems for subjects without a strong practical component, teaching of systems' modeling or other subjects with strong experimental content requires a new element. This new element must allow students to apply the knowledge acquired in a way that goes beyond the traditional laboratory with the presence of students, which requires the presence of students as well as an instructor. If the laboratory environment is to be transferred to distance education, the element required to put simulation and modeling concepts into practice is the virtual laboratory [4][5][6].

This article describes the experience in the Automatic Control Dept at the Technical University of Catalonia (UPC) in teaching "Simulation and Modeling" of renewable energy systems subjects that use dynamic and interactive simulations in a stand-alone or Web-based