An Investigation on Undergraduate’s Bio-Energy Engineering Education Program at the Taiwan Technical University

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ABSTRACT

With global warming issues and high dependence on imported energy in Taiwan, the Advisory Office of Ministry of Education (MOE) started a pioneer four-year project to develop the interdisciplinary green technology (GT) education program for undergraduates since 2007. In this paper, the implementation of bio-energy program at the two technical universities (i.e., National Pingtung University of Science and Technology, and Tajen University of Technology) under the funding support of the program was described to focus on the curriculum development. This paper will also address some new approaches and innovative directions to bio-energy education: incorporating basic courses into the bio-energy program, transforming the current bio-energy program into undergraduate degree program, implementing distance learning courses, and combining informal science education into the professional education program. It is thus prospective that the bio-energy education at university level will be in line with the efforts in the directions of comprehensive energy education.

Keywords: Bio-Energy, Curriculum, Engineering Education, Higher Education, Talent Cultivation

INTRODUCTION

Taiwan, situated off the southeast coast of the Asian continent, is known throughout the world for its economic achievements in the past decades. It is a densely populated island (i.e., population density: 640 people/km²; total area: 36,000 km²) with only limited natural resources. In 2010, total domestic energy consumption summed up to 120.3 million kiloliters of oil equivalent (KLOE), in contrast to 45.7 and 83.9 million KLOE in 1990 and 2000, respectively (MOEA, 2010). Meanwhile, the Taiwan’s dependence on imported energy increased from 95.8% in 1990 to 99.4% in 2010. In response to the Kyoto Protocol, the environmental issues such as global warming or greenhouse gas (GHG) emission mitigation are consecutively arousing public concerns. For this reason, the energy strategies and policies for promoting
renewable energy in Taiwan have been active in providing some financial and economic incentives (Tsai & Chou, 2006; Chen et al., 2008).

In Taiwan, the bio-energy has received much attention in recent years because most of renewable energy sources were highly dependent on it, including waste-to-power, biogas and biodiesel (Tsai, 2010). As a result, the Executive Yuan of Taiwan adopted the “Renewable Energy Development Plan” in January 2002. In June 2008, the Taiwan government further approved “Sustainable energy Guidelines.” The Guidelines were intended for attaining a definite goal: cutting annual emission of CO$_2$ to 2008 levels between the years 2016 and 2020, and curtailing annual emission of CO$_2$ to 2000 levels in 2025. Furthermore, the Renewable Energy Development Act promulgated on 8 July 2009 will promote the utilization of renewable energy sources and foster renewable energy industry in Taiwan. To enhance Taiwan’s competitiveness in the industrial development, the Executive Yuan announced green energy industry as one of the six key new industries in 2009. One of the action plans concerning research & development on energy technology is to promote green energy industry towards a clean energy economy by the subsidiary demonstration project, national research plan and professional talent cultivation.

Every country has made the cultivation of human talents in response to the different industrial and economic development stages. In addition to on-job trainings, the education system plays an important role in sustaining industry developments and upgrading professional levels because it is fostering high-quality human resources for the need of industry. In this regard, university education for cultivating professional talents is the key tool of moving society towards sustainability and of boosting green energy industry for competitiveness. Therefore, there have been a number of funds-supporting projects on renewable energy education in Taiwan at the university level in recent years. For example, the interdisciplinary green energy technology education program under the funding support by the Advisory Office of Ministry of Education (MOE, Taiwan) was a four-year project starting from 2007 to 2010, and designing for undergraduates of the College of Engineering. It aims at developing core and professional courses by integrating interdepartmental knowledge. However, there was less literature on analyzing the bio-energy education program at the higher education system (Bhattacharya, 2001; Lozano, 2010; Acikgoz, 2011; Karabulut et al., 2011).

The information on the energy engineering education program at the Taiwan technical university focusing on the bio-energy technology and its talent cultivation was addressed in the present study based on the background about the importance and urgency of bio-energy industry. This paper will also describe some new approaches and innovative directions, including interdisciplinary curriculum suggestion, distance learning implementation, promotion of undergraduate degree program in green energy, and incorporation of informal education system. With these considerations, this paper will bring important information in the development of the professional bio-energy education.

## IMPORTANCE AND URGENCY OF BIO-ENERGY AND BIO-ENERGY EDUCATION IN TAIWAN

According to the data listed in Table 1 (MOEA, 2010), 66.2% (approximately $814.5 \times 10^6$ W in terms of installed capacity) of renewable energy utilization in 2009 were from bio-energy sources, including municipal solid waste (MSW) incinerators, biogas (e.g., sanitary landfill gas) and other utilization utilities of agricultural/industrial wastes (including bagasse, rice husk, waste paper, black liquor, waste tire and waste plastics). In order to achieve the goals of 1,400 $\times 10^6$ W of bio-energy in terms of installed electricity capacity in 2025, it is expected that liquid fuels (i.e., biodiesel and bio-ethanol) and solid biofuels such as woody biomass and agricultural residues will be the main alternative fuels applied to the energy and industrial sec-
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