



## **Developments of a General Education Course to Broaden the Knowledge of College Students in Renewable Energy and Sustainability**

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## **Abstract**

With continued advances, technology has become an indispensable part of our personal and social life, with its significant benefits. On the downside, technology increases our dependency on limited sources of energy and threatens our world with climate change and environmental pollution. Technology affects every individual's life, regardless of nationality, gender, race, or occupation. This fact is closely related to the purpose of general education, which is a requirement for college students in our modern education system. General education aims to not only place students into a major specialization based on their interests, but it also aims to help students gain universal skills and knowledge in many diverse areas to meet life's wide-ranging challenges intelligently and creatively.

Today, industry and business needs graduates from all majors across the board that holds the profound knowledge of energy, technology, the environment, and sustainability. Industry and business need students who can not only understand the complex relationship between these topics, but also can analyze and evaluate problems as well as able to offer the best possible solutions to such problems.

The purpose of this paper is to report in detail on the development of a course on renewable energy and sustainability, titled "Renewable Energy and Sustainability," and to provide an assessment plan for the course. The proposed course is designed as general education course. This course does not have a prerequisite and is open to students from all majors as a general education elective. The course uses a combination of lectures, reading discussions, case studies, and demonstrations. Class content includes an extensive review of various renewable energy resources, as well as an analysis of the economic, social, and environmental effects of renewable energy systems. It also analyzes the effects of politics and government regulation of renewable energy.

## **Introduction**

For more than a century, human beings have relied on fossil fuel as a primary energy source. However, these conventional energy resources are under harsh criticism over issues such as global warming, public health, air pollution, waste disposal, and ecological damage<sup>4</sup>. Because of the increase in energy demand, the depletion of fossil fuel resources, and the cleaner nature of renewable energy compared to fossil fuel resources, renewable energy has gained massive attention during the last twenty years. Due to these concerns, the U.S. government is attempting to replace conventional energy resources with renewable energy resources. The production of renewable energy production is experiencing rapid growth, thanks to supportive policies and attractive incentives provided by the U.S. government. With government and private initiatives, renewable energy generation has increased 49.6% from 2000 to 2013<sup>7</sup>. As shown in Figure 1, a share of renewable energy has increased from 9.2% to 14% in the same period<sup>3</sup>.

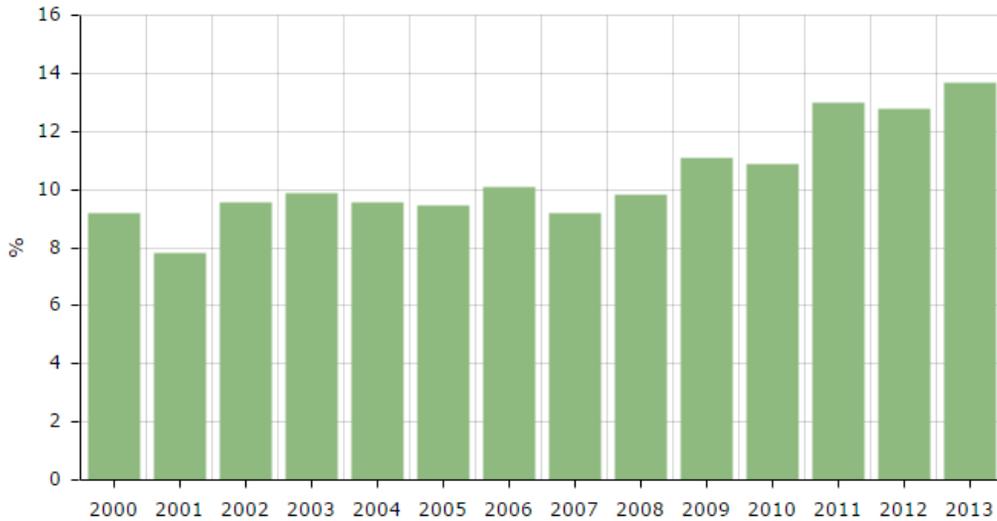


Figure 1. The Share of renewables in electricity production from 2000 to 2013.

However, this continued growth has brought about the problem of a serious shortage of skilled professionals. The type of workforce in demand not only includes engineers and technicians, but it also includes policy analysts, teachers, researchers, lawyers, regulatory experts, power marketers, finance managers, environmental scientists, and many others. In short, there is a high need for a workforce from diverse backgrounds and with different levels of renewable energy-related skills and knowledge<sup>4</sup>.

The problem is twofold: First, training for engineers and technicians needs to change drastically. Jennings (2009) stated:

*“These people are not the electrical engineers of yesterday, with a slightly different training. They are a new breed who understand the new technologies and the appropriate roles for them in the society of the future. They require a broader training in social, economic and environmental issues than the current professionals who design and operate today’s conventional power supply systems. (p. 436)”*

Second, the renewable energy industry needs a non-technical workforce that has basic technical knowledge in addition to knowledge of the social, economic, and environmental aspects of renewable energy.

In 21<sup>st</sup> century, basic knowledge of renewable energy is crucial, even if students do not plan to work in a field related to renewable energy. Such knowledge promotes greater public awareness of the technologies of renewable energy and develops consumer confidence in such technologies.

As a result of their surveys and inquiries, Jennings and Lund identified the following needs for renewable energy:

- Retraining professionals who wish to move into the renewable energy industry;
- Retraining technicians and tradespeople who wish to work in this field;

- Initial training of scientists and engineers to design and develop new renewable energy systems;
- Training in renewable energy technology and policy for financiers, investors, and policy analysts;
- Short, in-service professional development courses on aspects of renewable energy technology and policy;
- Lessons and resources for schools on energy issues; and
- Contemporary information about renewable energy technology for the general public. (p. 436)

Courses related to renewable energy are becoming an essential part of engineering and engineering technology program curricula<sup>8</sup>. Most of these courses focus only on the technical side of renewable energy technology, and/or require prior knowledge of engineering. Thus, non-engineering students do not enroll in such courses, as they either do not meet prerequisite requirements or fear being unsuccessful in a class filled primarily with engineering students.

### **Goals and Objectives**

The main goal of the course is to introduce undergraduate students the essential principles and fundamental concepts of renewable energy necessary to build professionals from diverse fields of study as literate in renewable energy.

Upon satisfactory completion of the course, students will be able to do the following:

1. Explain the basic principles of energy science and mechanics.
2. Describe how electricity works to transfer energy from an energy source to homes and businesses.
3. Analyze various energy sources and evaluate their advantages and disadvantages.
4. Calculate energy use, cost, and rate of depletion of energy sources under varying scenarios.
5. Obtain an essential understanding of the political, economic, environmental, and social issues related to energy production and consumption in the contemporary world.
6. Discuss U.S. and global trends on energy and sustainability related to policies, ethics, economics, politics, environment, and society.
7. Identify and locate the appropriate types of information for review, evaluate the information, and use the information effectively, ethically, and legally.

### **Description**

Topics for the course include the following:

- The history of energy use;
- Energy science and mechanics;
- Electricity;
- Sources of renewable energy and use of energy;
- Energy conservation and efficiency;

- Environmental impacts of energy use;
- Health effects of energy use;
- The economics of energy use;
- Policies of renewable energy;
- Future technologies for renewable energy; and
- Evaluating the development, energy security, environment ethics, and conflicts between energy, food security, and the environment.

## **Methodology**

This course emphasizes critical and creative thinking by requiring students to draw connections between contemporary environmental issues and energy generation policies/energy consumption behaviors. These analytical skills are reinforced through course readings, completing writing exercises, class discussion, and course assignments that require students to evaluate and analyze energy technology systems in the context of engineering, political, social, economic, and environmental goals.

Course materials will include primary sources such as research reports and policy assessments, which expose students to different types of challenging texts. Course pedagogy will emphasize critical reading skills, such as breaking down the development of an argument or analysis, identifying supporting ideas and evidence, and evaluating the effectiveness of an argument or analysis. In addition to critical reading skills, the assessment will include a combination of writing assignments, such as short reading reactions and summaries, issue analysis, and research papers. Some class meetings will be organized around the small group and large group discussion activities.

Course materials will include scientific reports from governmental and private agencies, case studies, white papers, and passages from renewable energy related textbooks, which include a reasonable amount of quantitative data in the form of formulas, graphs, tables. Through examples in the class, students will come to understand such mathematical models and draw inferences from them. These competencies will be fortified through reflection papers, class discussion, and student presentations that require students to represent mathematical information symbolically, visually, numerically, and verbally. Through in-class studies and assignments, student will be given raw data about a specific problem and asked to effectively use arithmetic, algebraic, geometric, logical, and/or statistical methods to model and solve real-world problems. Since students in the course will come from a variety of majors and will hold different skills in reading course materials, assignments will be kept in a level that is both challenging and achievable for each student.

Several case study assignments will be included in the course content to meet this objective. The case studies are designed to require the use of interdisciplinary approaches to understand and solve complex energy-related issues. Examples of case studies incorporated in the course include the following:

- Energy use and global warming;
- Renewable energy and sustainable development;
- Energy and pollution; and

- Renewable energy and environmental issues.

For example, students read case studies about renewable energy and environmental issues for a specific state, and then pursue sustainable energy projects that provide economic gain while also ensuring that local communities and ecosystems aren't harmed, but may even benefit from their initiatives.

Assessment measures for both the course objectives and general education will be derived from writing assignments that include reflection and reaction papers, formal essays, and research papers, as well as from class discussion and participation.

### **Content of the Course**

The content of this course was prepared based on the model curriculum developed by the U.S. Department of Energy (DOE), the Association of Public Land-grant Universities (APLU)<sup>6</sup>, and its partners. Content for the course is as follows:

#### Chapter 1: Introduction to Energy

- Relationship between energy and natural laws.
- Physical processes on Earth and how energy flows through the Earth's system.
- Relationship between energy flow through the Earth system and biological processes.

#### Chapter 2: Energy Basics

- Energy is a physical quantity that follows the precise, natural laws of energy basics.

#### Chapter 3: Energy Sources

- Physical processes on Earth are the result of energy flow through the Earth's system.

#### Chapter 4: Energy Technology and Practice

- Various sources of energy are used to power human activities and energy transfer from source to destination.
- Renewable energy sources and uses.
- Survey of renewable energy conversion processes.
- Renewable energy conversion efficiency and rate considerations.
- Conversion case study.

#### Chapter 5: Energy Policy and Decision Making

- How economic, political, environmental, and social factors affect energy decisions.
- Factors affecting the amount of energy used by human society.
- Energy choices and its effect on the quality of life of individuals and societies.

## Chapter 6: Renewable Energy and the Public

- Conceptual approaches.
- Case studies of public beliefs and responses<sup>2</sup>.

## Chapter 7: Renewable Energy and Environment

- Case Study: Types of Renewable Energy Resources and Sustainable Design
- Case Study: Renewable Energy as a Solution for Climate Change
- Case Study: Conventional and Renewable Energy Law and the Environment

## Student Projects

As a course, “Renewable Energy and Sustainability” aims to give undergraduates an opportunity to make direct contributions to improving energy management and sustainability at their campus and in their local communities.

Course projects are centered on renewable energy, building efficiency, and transportation. Specific project options include the following:

- Assessment of wind power options for selected town, industrial, or educational campuses.
- Study of given companies` fleets to assess the feasibility of increasing vehicle efficiency and switching to alternatives.
- Investigation of green building technologies for given industrial or educational campuses.
- Investigation of renewable energy options for given schools in the region.

Groups consisting of three students will conduct studies that help solve energy-related problems or improve current systems in the region. Students will advance their knowledge through lectures and readings, and will apply that knowledge in their projects. Students will be asked to report on their project design process, including fine-tuning research questions, data collection, and data analysis. In the final presentation, students will share their project and their findings with the class. Throughout their projects, each group will be required to work closely with experts and local stakeholders related to their topics.

Since students will work on a project that deals with real-world problems, it helps students to understand the multidisciplinary nature of renewable energy, leading them to learn and use energy-related vocabulary, which helps them vigorously address real-world problems. Each group will submit a project proposal, a short written and oral progress report each week, one peer critique, a final report, and a public presentation as part of the project.

## Conclusion

“Renewable Energy and Sustainability” is a course designed for students from all majors; there is no prerequisite. The main purpose of this class is to create students literate in renewable energy, students who have a basic understanding of the technical, economic, social, and environmental aspects of renewable energy. This is achieved by elucidating and analyzing the

constraints and choices of renewable energy sources and the uses of renewable energy through reading and discussion materials.

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