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Energy and Sustainability - An introductory level undergraduate course at the intersection of science and society

Abstract

This paper will present the curricular objectives and design of an undergraduate course, Energy and Sustainability. This course is designed to support an introductory level understanding of the science of energy and to contextualize these scientific principles to investigate society's reliance on fossil fuels. An objective of this course is to establish a basic understanding of what energy is, why we need energy, and the significance of access to sources of energy to sustainable development. By intentionally connecting scientific principles to issues of societal interest, this course also aims to support the objectives of liberal education as suggested by the Association of American Colleges and Universities (AACU): "Liberal Education is an approach to learning that empowers individuals and prepares them to deal with complexity, diversity, and change. A liberal education helps students develop a sense of social responsibility, as well as strong and transferable intellectual and practical skills such as communication, analytical and problem-solving skills, and a demonstrated ability to apply knowledge and skills in real-world settings."

The learning outcomes of this course are listed below:

- Demonstrate a foundational understanding of the physics of energy
- Demonstrate an understanding of chemical energy and why fossil fuels drive our economies
- Evaluate the environmental and health impacts of energy use
- Evaluate the pros and cons of alternate and renewable energy sources and their role in transitioning from a fossil fuel based society
- Use evidence-based, and quantitative arguments to debate pros and cons of current energy-related controversies

To support these outcomes, the course provides a basic understanding of the physics of energy and the chemistry of fossil fuels and focuses on why society has relied on fossil fuels for economic and human development. The course then raises the consequences that society now faces by its dependence on fossil fuels, and the complex challenges we face in increasing the percent contribution from non-fossil fuel based energy sources.

The course also includes a project that allows students to investigate a current energy related issue. This allows students to apply a scientific approach to investigate the problem and appreciate the interplay between science and society. Students are often passionate and actively support positions that they believe are "right". However, often students do not have a complete picture or do not have the background (particularly in the natural sciences) to question why they think the way they do, what informs their thinking, and what evidence may support their thinking. An aim of the project is to get students to objectively understand the issues and

possible solutions and to be able to support their understanding by data and evidence. The project is also designed to encourage students to recognize arguments made by “sides” they may not agree with, and to recognize that some of these arguments may in fact be valid and supported by evidence as well. As part of this project, students are encouraged to recognize that when deciding a “path” forward for many complex socially relevant issues, both pros and cons must be recognized and weighed. Examples of projects used in the past includes students debating the pros and cons of hydraulic fracturing in increasing the use of natural gas in the U.S. to reduce emissions of greenhouse gases, and evaluating the pros and cons of using rooftop photovoltaic panels to support the electrical energy needs of New York City.

The paper will present ways in which the basic science is intentionally connected to societally related energy issues, including the challenges in transitioning out of fossil fuels, as well as looking at the global disparities in access to energy and how these disparities impact human and economic development. The course includes quantitative reasoning problems to help students grapple with energy units and energy-related numbers used in the media, and the paper will provide examples of activities that help students contextualize these numbers. The paper will also discuss two different projects that have been implemented in this course. Student learning is assessed in different ways, and the paper will present results on students’ understanding of relevant concepts and application of those concepts. The paper will present students’ perceptions of the approach used in this course and what they feel they have learned through the course. Finally, the paper will also summarize how courses like these, which connect disciplinary based content with current socially relevant issues, may be a way to support liberal education.