SESSION 3: Introductory Energy Education: Energy 101 and General Education

Chaired by **Dan Kammen**, Ph.D., Director of Renewable and Appropriate Energy Laboratory, Class of '35 Distinguished Chair in Energy at the University of California, Berkeley

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Integrating Energy Literacy with Bioenergy into the Classroom

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Abstract
Energy Literacy is an understanding of the nature and role of energy in the world and daily lives accompanied by the ability to apply the understanding to answer questions and solve problems. It looks at energy through the lens of natural science as well as social science, and is intended to be used as a guide for anyone involved in formal and informal energy education, standards development, curriculum design, assessment development, and educator trainings. This presentation presents a method for educators and administrators to apply the Energy Literacy Framework in the classroom through the specific example of bioenergy.

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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.

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An Energy Course and Free Online Textbook for University Students

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Abstract

Energy is a difficult topic that spans a wide number of disciplines. My team has put together a single course on energy that spans the entire energy sector. This course is intended for a non-technical audience (for example business students) rather than those in a STEM discipline where this sort of education has usually been focused. In an effort to support this class, the team further developed an encyclopedia that can be used as a textbook for this class. Various interactive data visualizations have been developed to help people understand the energy sector. With over 900 pages of content this hyperlinked resource allows users to explore the extensive and expansive topics related to energy. These efforts have won several awards for teaching and outreach. The encyclopedia can be found at energyeducation.ca.

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Game Design for Energy Literacy

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Abstract

Teaching energy literacy can be as fascinating as it is challenging. The nature of the subject is one of constant flux, and its full understanding practically demands an interdisciplinary, hands-on approach. But all teachers encounter topics that challenge their classes' creative foundations.

They could be anything: the business models of utilities, the nuances of cap-and-trade, or the inner workings of NERC might be topics that are, to borrow imagery from Vox's David Roberts, shrouded in a "force field of boringness." Yet these topics have the potential to provide the greatest opportunity for engaging the oldest of teaching techniques, games.

The teaching power of games has long been recognized. From the classroom of a Montessori school to the publications of university researchers, facilitators can trace a clear link from "play" to the uncommon understanding of complex issues in children and adults alike. Games include a wide spectrum, from rules-heavy simulations meant to teach specific processes, to collections of made-up rules meant to pass the time. And while each of these can be powerful in its own right, games all along the spectrum have a place in classrooms at any level.

The New World (Middle Passage), a game developed by game designer Brenda Romero, illustrates the power of a simple set of rules and pieces to communicate a social impact that lectures, discussions, or readings simply cannot. The game's objective is not to win, nor even to finish; the impact plays out instead in the players' reactions. Even the more energy-applicable simulation, the World Climate Game by Climate Interactive, can be played to similar effect. Players attempting to negotiate an international climate deal to limit warming to acceptable levels quickly discover the near impossibility of success without driving countries into economic depression, yet are still forced to grapple ethically with the consequences of failure.

Games provide a method that allows students to create, through play, their own deeper understanding of complex issues beyond the memorization of acronyms or cursory understanding of processes. The Middle Passage is more than just a piece of commerce history drawn on a blackboard; its inhumanity and loss are the key conclusions to be communicated across generations. Climate negotiations are not just a numbers game; the infinite variation between countries' needs, motivations, and powers contains the real lesson. The all-encompassing, all-affecting energy sector is no less apt of a subject, and effective methods of teaching the "boring" topics often provide the glue between its political, economic, scientific, and environmental manifestations.

In this talk we will explore the potential for our students to create their own informative experiences, and therefore deeper understanding, through games. We will lay out the steps to creating our own games and briefly look at an example, reinforcing participants' tools and creativity to take back to their own students.

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Health, Sustainability, and the Oil Patch

Abstract