PHYS 009, Spring 2019

SU: Energy and the Environment

Lecture: MWF, 13:10-14:00.
Lafayette Hall L403

Instructor
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Course Description: This course will focus on answering one central question: how sustainable is our use of energy? To answer, we will cover many important aspects of energy: what it is, how it is produced and consumed, and ways in which it impacts society and the environment. Readings and weekly assignments will prepare you for informed daily conversations on the theme of energy sustainability. We will develop a quantitative physical understanding of many issues and problems involved with the generation, storage, transport, and usage of various forms of energy in our technological society and their broader economic, ecological, and social impacts. Topics include fossil fuels, hydropower, nuclear, solar, and wind energy, and issues related to energy conservation in everyday life. We will also consider the effects of waste products associated with energy generation and usage on e.g. global warming, ozone depletion, and pollution of the atmosphere. Individual impact will be a central theme of the course, but the question of energy sustainability will be considered from the perspective of the local and global community at time-scales ranging from a few years to many generations. **This course meets the UVM General Education requirement in sustainability.**

Prerequisite(s): High-school level algebra

Credits: 3

Text: *Energy and the Environment*, 3rd Edition
Author: R. A. Ristinen and J. J. Kraushaar; **ISBN-13:** 978-1-118-85463-1
Note: This text must be purchased as an e-book through the Perusall web interface using the course code: WHITE-66QXV

Materials: Pocket calculator with trigonometric functions, scientific notation and exponential functions.

Online Communication Resources:

All students must have reliable access to the University of Vermont Blackboard course website. (bb.uvm.edu) This access requires internet connection, which is free of charge for all UVM students while on campus. You will need your UVM net ID and password to log into the Blackboard

system. All supplementary course materials, course updates and announcements will be made via the Blackboard system. **It is the student responsibility to check his/her UVM email and Blackboard course website for updates at least once a day!**

Reading & Discussion:

You are required to complete the assigned readings prior to each days class meeting. Assignments will be listed on Blackboard, and must be completed by 11:00 AM on each M,W,F that the class meets. Through the Perusall interface, you will read the e-book and participate in an online discussion of the material. You may highlight portions of the text and annotate with comments that your discussion group and I can read and respond to. Your comments and responses to other comments are graded: 3 points for a good comment, 2 points for an adequate comment, and 1 point for a poor comment. Good comments provide insight, analysis, or express a good question or point of confusion. Adequate comments may provide some basic level of information etc. Poor comments add little value to the discussion. Each reading assignment will be graded based on the average of your top five comment scores, unless otherwise noted. Shorter assignments may require fewer comments. You may create new comments for up to 24 hours after the deadline, but the points awarded will decrease linearly to 0 over the late annotation period. You may also reply to the comments of others for up to 48 hours after the deadline for full credit. This is to promote discussion of points raised near the end of the deadline period. However, you may not earn more credit after the deadline than you received before the deadline. So the total number of points earned after the deadline cannot be greater than the total earned before. As a general piece of advice, it is relatively easy to earn full credit for the Reading & Discussion portion of your grade, provided that you are actively participating in the discussion. If you spend time trying to reach the minimum number of comments, you will likely find it more difficult.

Personal Energy Report: Each student will turn in a final report, worth 35% of the total course grade. The report will summarize a two-month project of tracking and analyzing personal energy use. You will record, plot, and analyze the different ways that you consume energy, including electricity, heating, transportation, food consumption, etc. The final Personal Energy Report will present the accumulated data in a scientific manor, including analysis of the sources, costs, benefits, and byproducts of the energy use. In the report, students will identify local and global impacts of their own energy consumption, and address the sustainability of the various uses and sources of energy. **Due on Mon. March 25**.

Final Project:

Working in groups of 3, you will prepare a detailed analysis of a contemporary energy issue. The students in this class represent a wide variety of academic disciplines, and each can offer a unique perspective and contribution towards solving some of today's greatest energy challenges. Your final project should address an energy-themed question of your choice (I have many suggestions), and should explore that question in great detail. Analyze the economic, ethical, and scientific underpinnings of your topic, present the factual information in a clear way, explore some potential solution or hypothetical outcome. Your group should approach the topic with both detailed analysis and creative problem solving. The results of your project will be presented in a 25 minute presentation at the end of the semester. Many of the groups will present during our scheduled final exam, Monday May 6th, 13:30 - 16:15 in Lafayette L403. Others will present during the final days of class. Your grade will be based on a combination of my own evaluation (50%), and the combined evaluation of all other students in the course (50%). You will also be required to attend the presentations of other groups to participate in the evaluation, and your individual grade on the project may be

reduced by as much as 20% if you fail to attend and evaluate the presentations of other groups.

Course Grades:

Each student will receive a grade based on the grades of the Reading & Discussion, Personal Energy Report, and Final Project. The individual components will be scaled and converted to letter grades according to:

Reading & Discussion	30%
Personal Energy Report	35%
Final Project	35%

A	=	90 - 100%
B	=	80 - 89.9%
C	=	70 - 79.9%
D	=	60 - 69.9%
F	=	59.9% or below

Within each letter grade, the + and - will indicate above and below the corresponding 7% and 3%. For example, grades above 77% but below 80% will receive a C+.

All grades will be posted on Blackboard to ensure privacy. It is each student's responsibility to verify the accuracy of the postings regularly. **Report any discrepancies promptly.**

Academic Dishonesty Disclosure:

Academic dishonesty **will not be tolerated.** Perceived failures to abide by the standards of academic integrity will be prosecuted as set forth in the University of Vermont Code of Academic Integrity. The code states the four standards of academic integrity; that students may not plagiarize, fabricate, collude, or cheat.

Disability Services

In keeping with University policy, any student with a documented disability interested in utilizing accommodations should contact ACCESS, the office of Disability Services on campus. ACCESS works with students and faculty in an interactive process to explore reasonable and appropriate accommodations, which are communicated to faculty in an accommodation letter. All students are strongly encouraged to meet with their faculty to discuss the accommodations they plan to use in each course. A student's accommodation letter lists those accommodations that will not be implemented until the student meets with their faculty to create a plan. Contact ACCESS: A170 Living/Learning Center; 802-656-7753; access@uvm.edu; or www.uvm.edu/access.

Course Outline

1. Fundamentals of Energy - Introducing some basic physics and facts about energy consumption to prepare for our evidence-based physics approach to energy sustainability.

2. Fossil Fuels - Analysis of our finite resources, the Hubbert curve, geology, fossil fuel production techniques will define what is possibly the most important economic, technological, and social problem of the 21st century.

3. Heat Engines - We bring in some more basic physics, including the laws of thermodynamics to reinforce our understanding of the fundamental limits of energy generation and storage.

4. Solar Energy - The passive, active, and direct conversion of solar energy into useful forms provides perhaps the most promising energy solution and brings fascinating physical and socio-economic perspectives. Incident solar energy is uniformly distributed throughout the world, and is

therefore difficult to centralize. Is it the most democratic energy source?

5. Alternative Energy Sources - The physical principles and broader impacts of wind, hydro, biomass, geothermal, tidal energy are introduced. While each of these energy sources are economically sound at certain levels, they all have physical limitations, as well as distinct impacts on lifestyles and life-cycles. We will further discuss the challenges related to power distribution, specifically related to adding alternative sources to the grid and smart-grid alternatives.

6. Nuclear Energy - The basic physics of nuclear energy will motivate our discussion of the advantages, costs, and risks associated with it. We will introduce the familiar nuclear fission technology, and discuss the prospects of future thorium/molten-salt based fission reactors as well as the physics and current progress in nuclear fusion. With the first firing of the Wendelstein 7-x Stellarator in Dec. 2015, and scheduled firing of the ITER Tokamak in 2020, fusion is an exciting, promising, and currently relevant topic in physics.

7. Energy Conservation - One of the most direct ways an individual can positively impact energy sustainability is through energy conservation. Conservation measures for homes, industries, heating, appliances, and recycling will be introduced.

8. Transportation Issues - Transportation in planes, trains and automobiles (among other modes) constitutes a significant portion of the energy sector. We will analyze how we move now and how we will likely move in the future across local and global distances.

9. Pollution - Energy production and consumption produces unwanted byproducts. No source, including the renewables, are guiltless in this respect. The physical processes and limits to mitigating these pollutants will be discussed in the context of their social and environmental impacts.

10. Global Effects - The greenhouse effect (an incontrovertible physical process) is a topic of much recent public debate. We will reinforce the physics behind the process and the direct consequence of global warming. Reinforcing the thermodynamic concepts introduced in chapter 3, we will calculate to a high degree of accuracy the temperature of all planets in the solar system. By changing the infrared absorption coefficient of the Earth's atmosphere, we will see how the average temperature of the Earth will change accordingly, independent of weather and politics. This quantitative understanding will form an evidenced-based approach for our discussion of the ecological, economic, and social consequences of global warming.