Energy and the Environment

ENVIRON 711 (ENERGY 711)

Duke University—Nicholas School of the Environment
Fall 2016

Monday and Wednesday, 3:05 to 4:20
Gross Hall 103

Instructor
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Office hours: Monday and Wednesday after class until 5:30 (in Gross Hall), or by appointment

Course Description and Objectives

This class provides an introduction to the energy system from an environmental and human health perspective. Our quality of life depends on a secure supply of energy that is also affordable and clean. We will therefore examine how the ways in which we supply and use energy impact the environment and human health, and explore alternatives that mitigate these impacts in the context of tradeoffs with related economic and social objectives. Energy production and consumption have been at the core of our most pressing environmental problems for decades, affecting air and water quality, as well as waste accumulation and land use, and are now recognized as the major drivers of anthropogenic climate change. Rather than focusing on impacts one-by-one, however, we will approach these challenges by discussing how the energy system itself is organized: how we got to where we are today, how the existing system operates, what might be feasible going forward, and how we can leverage the forces driving change for a more sustainable future. In short, anything positive we do to influence the energy system "upstream" will ideally prevent "downstream" impacts (assuming we also pay careful attention to potential unintended consequences), and avoid the need for more traditional "end of pipe" controls or pollution mitigation. An energy *system* perspective is essential to this understanding, and therefore frames the course.

By the end of this course, you will be able to:

- Describe the energy system, including the most significant primary energy resources, the processes that transform these resources into more useful energy carriers, the

technologies that meet demand for energy services, and the drivers of this end-use demand
- Describe the most significant environmental and human health impacts associated with energy supply and use across the energy system
- Identify and evaluate the potential for alternative energy resources, emerging technologies, and additional efficiency measures to mitigate these negative impacts
- Understand how policy and regulation, economics and markets, science and technology, and institutional design and individual behavior affect energy system evolution, and how these "levers" interact to enable and constrain change
- Use back-of-the-envelope calculations to answer fundamental energy questions

Course Format

Class time will consist of background lectures, discussions based on readings and the material presented in class, as well as small group problem solving and other participatory exercises. The course will wrap up with presentations of project work.

Prerequisites

This course does not have formal prerequisites. All students who are interested in learning about energy supply and use from an environmental perspective are welcome.

Coursework and Grading

Your grade will be based on the following:

Quizzes	25%
Team Project	25% (all group members receive the same grade)
Midterm Exam	25%
Final Exam	25%

I will use the following rubric to translate cumulative scores into final grades:

[99 to 100]	A+	[80 to 83)	B-
[93 to 99)	A	[77 to 80)	C+
[90 to 93)	A-	[73 to 77)	C
[87 to 90)	B+	[70 to 73)	C-
[83 to 87)	B	Below 70	F

Quizzes will take place at the start of all regular class sessions beginning Monday, September 12th. Each quiz will consist of four short answer or multiple choice questions, as well as one numeric problem for which you will need a calculator. The questions will cover each day's assigned *reading* material (but not prior lecture topics), and will therefore provide encouragement to keep up with the readings and come prepared to participate in class. You may not use notes, the readings, or other materials. We will have 18 quizzes over the semester, and you may drop your three lowest scores. I will not give make-up quizzes for unexcused absences (see below), and a missed quiz will receive a score of 0.

The ***Exams*** will test your knowledge of and ability to apply the material we discuss in class. Unlike the quizzes, the exams will cover *both* reading and lecture topics. The midterm and final exams will take place in class on the dates noted in the schedule below, and will consist of a mix of quantitative and short-answer written problems (much like the quizzes). Each exam will be closed-book. While you will need a calculator, you may not use a computer (including smartphones and tablets) on the exam. I will not give make-up exams for unexcused absences (see below), and a missed exam will receive a score of 0.

The ***Team Project*** will give you a chance to synthesize and apply what we have learned in class by examining how the trends and issues we discuss throughout the semester might affect the energy and CO_2 projections in Duke Energy's most recent Integrated Resource Plans. Each group will be responsible for a specific focus area, with examples ranging from the future of natural gas and nuclear power, to the Clean Power Plan and other environmental regulation, energy efficiency and the smart grid, residential solar and other forms of distributed generation, and the changing demographic and economic profiles of the region. I will provide further instructions on the project as well as due dates for team formation and specific project milestones early in the semester. Teams will submit a written analysis of their work and present their project findings in class on Monday, November 28. All team members will receive the same project grade. Team size and the number of teams will depend on total course enrollment.

Policy on Absences

If you know of conflicts with the course schedule that will affect a majority of the students, please let me know as soon as possible.

I will not give make-up quizzes and exams, and an unexcused absence will therefore result in a complete loss of credit. I will make exceptions *only* for serious illnesses and personal emergencies, though I reserve the right to use alternative quiz or exam questions.

If you are sick, you will need to complete the Short-Term Illness Notification Form (STINF) at: http://trinity.duke.edu/undergraduate/academic-policies/illness. The website provides instructions, but note the following text: "Definition of Incapacitation: An incapacitating illness or injury is one in which you are hospitalized, under medical care for a short-term condition, or otherwise sufficiently debilitated as to be unable to perform basic academic tasks. Colds, headaches, or other such mild complaints that result in your feeling less than 100% are not considered incapacitating, and you should not use the STINF in such instances. Appropriate uses of the STINF might include such conditions as influenza, migraine, sinus infection, and strep throat." In the event of something even more serious, of course, I will make every effort to accommodate your situation.

Readings

We have one textbook: *Energy 101: Energy Technology and Policy*, an eBook by Dr. Michael Webber from the University of Texas at Austin. The text is available is three different formats:

- An IOS version available through Apple's App Store
- An Android version available through Google Play
- A web (i.e. browser) version from the University of Texas Press, available at http://utpress.utexas.edu/index.php/webene

The schedule below lists reading assignments, which must be completed prior to each day's class. I may assign additional readings based on your interest in particular topics.

Sakai

If you are registered for the class, you will have complete access to our Sakai website. All course materials except the text are available on Sakai.

Classroom Etiquette

Please arrive on time and refrain from checking email and social media, texting, and websurfing while we are together. These activities are more obvious that you might think, and I will not hesitate to cold call anyone who appears to be using their laptop for anything other than notetaking or researching the occasional discussion question. If I feel that electronic media are becoming too much of a distraction, I will ask you to turn off and store all phones and laptops during class.

My Expectations of You

This is your course. At minimum, I expect you to attend class and be an active participant, which, in turn, requires that you prepare for each class in advance, having completed the readings. I also expect you to have an open mind, but to think critically and use what we learn in making your own judgments.

In addition, if you have suggestions on how to improve the course, please let me know. Feedback received midstream can be more useful (to you and me) than end-of-term evaluations, and I am happy to make reasonable changes if a majority concurs.

What You Can Expect from Me

I'm here to help you learn. I understand and appreciate the diversity in your backgrounds, interests, and analytical strengths, and have tried to design the course to accommodate these differences while providing opportunities to help you develop in new areas. Again, feedback is appreciated. I'm available during my office hours if you have questions about the class (or anything related), and am happy to find mutually-agreeable times outside of these windows to meet. Just let me know what works best for you.

Nicholas School Honor Code and the Duke Community Standard

All activities of Nicholas School students, including those of you in this course, are governed by the Duke Community Standard (http://integrity.duke.edu/standard.html), which states:

"Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and nonacademic endeavors, and to protect and promote a culture of integrity. To uphold the Duke Community Standard:

- I will not lie, cheat, or steal in my academic endeavors;
- I will conduct myself honorably in all my endeavors; and
- I will act if the Standard is compromised."

Topic and Reading Schedule

This schedule below is subject to change, and I may modify it as we go along if extra time is needed (or desired!) for particular topics. I'll provide updates to the schedule in class and via email.

CLASS	DATE	TOPIC	READING (Webber Chapter)
1	29-Aug	Introduction; Energy system; Importance of energy	1
2	31-Aug	What is energy; Quantifying energy	3, 4
3	5-Sep	Types of energy resources and end uses	2, 5
4	7-Sep	Introduction to hydrocarbons, Coal	6, 7
5	12-Sep	Overview of natural gas and petroleum	8, 9
6	14-Sep	Petroleum refining, distribution, and markets	8, 9
7	19-Sep	Unconventional hydrocarbon resources	10
8	21-Sep	Introduction to electric power generation	4, 19
9	26-Sep	Electricity demand and system operation	18, 20
10	28-Sep	Electric power markets and pricing	21
11	3-Oct	Electricity wrap-up	21
12	5-Oct	Midterm Exam	--
	10-Oct	*Fall Break (no class)*	--
13	12-Oct	Environmental impacts: Air and Water	28, 30

CLASS	DATE	TOPIC	READING (Webber Chapter)
14	17-Oct	Climate change and energy	29
15	19-Oct	Energy and environmental policy	25, 26
16	24-Oct	Nuclear power	17
17	26-Oct	Wind power	13
18	31-Oct	Solar energy	14
19	2-Nov	*Duke University Energy Conference (no class)*	--
	7-Nov	Wind and solar wrap-up	13, 14
20	9-Nov	Other renewable energy, energy storage	12, 15
21	14-Nov	Bioenergy	16
22	16-Nov	Transportation and energy	22, 23
23	21-Nov	Built environment and energy	24
	23-Nov	*Thanksgiving Break (no class)*	--
24	28-Nov	Project presentations	--
25	30-Nov	Final Exam	--