Duke | NICHOLAS SCHOOL of the ENVIRONMENT

Energy and Environment Syllabus

ENVIRON/ENERGY 711
Fall 2023

Monday and Wednesday, 8:30 to 9:45
LSRC B101 (Love Auditorium)

Instructor

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Course Description and Learning Objectives

Our quality of life depends on a secure and plentiful supply of energy that is also affordable and clean. Driven largely by the need to make deep reductions in greenhouse gas emissions, the ways in which we supply and use energy are entering a time of transition unseen since the modern energy system emerged in the late 1800s. New energy technologies and resources, business models and regulatory needs are emerging that promise to transform both the global economy and our daily lives, and this is the most exciting time to study and work in the energy industry in several generations. Energy also promises something for everyone, whether you are an engineer or data nerd, an economist or policy wonk, a financier or serial entrepreneur, a geophysicist or environmental scientist, an historian or cultural anthropologist.

This class provides an introduction to the energy system from an environmental perspective. We will examine how the ways in which we supply and use energy affect the natural environment and human health and explore alternatives that mitigate these impacts. Energy production and consumption have been at the core of our most pressing environmental concerns for decades, affecting air and water quality, shaping land use, and generating the

largest share of anthropogenic greenhouse gas emissions worldwide. 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 an ideal world, energy system changes will prevent subsequent environmental impacts without compromising other important societal goals. We will see that reality is not this simple and strive to be honest brokers when evaluating both conventional and emerging energy options. 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
- Identify the most significant environmental and human health impacts associated with energy supply and use across the energy system
- Critically evaluate the potential for alternative energy resources, emerging technologies, and additional efficiency measures to mitigate these negative impacts, without compromising affordability or security
- Explain 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
- Employ 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.

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.

Respect for Diversity and Honest Analysis

Energy supply and use are inseparable from our daily lives and lifestyle choices. Hence, many of the topics we will cover have a political and even personal subtext, and some of you may arrive with strong opinions about the past, present, and future of energy and all that it affects. My goal is to help you reason through the complexities of how we might balance conflicting societal goals that require more than technical problem solving or idealistic visions of how

cultural change occurs. I also understand the temptation to see the issues we will encounter this semester in either-or terms (e.g., "fossil fuels are always bad", "renewable energy is always better"). While I will respect the individual conclusions you reach, I ask that you *lead with evidence and analysis rather than opinion* and I will try to model this behavior in class. In short, let's strive to be honest brokers and respect differences in personal and cultural preferences. The fact that we come from many different places and backgrounds is an asset, and I will draw on the range of your experiences as a valued resource.

Beyond that, I teach because I like spending time with students. If you all looked, felt, and thought like me teaching would not be nearly as interesting, and I would not learn nearly as much as I continue to learn after many years in the classroom. I enjoy getting to know you as individuals and will do whatever I can to create a comfortable environment in which we can all be challenged and learn together.

Coursework and Grading

Your grade will be based on the following:

Reading Quizzes	10%
Team Project	15% (all group members receive the same grade)
Exam 1	25%
Exam 2	25%
Exam 3	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

The ***Reading Quizzes*** are associated with our online text, *Energy 101* (see below) and will provide encouragement to keep up with the readings and come prepared to participate in class. Each *Energy 101* chapter contains a short quiz, which you must complete prior to the start of class on the day the chapter is assigned. Note that several class sessions make use of material from two chapters, and you will therefore need to complete the quizzes for both chapters on these days. I have assigned 26 chapters from *Energy 101*, and you therefore have 26 quizzes to complete. You may drop your three lowest scores. I will not give make-up quizzes for unexcused absences (see policy below), and starting with Class 4 (Monday, 11 September) a quiz not completed before the start of class will receive a score of 0. You may not collaborate on the quizzes (though feel free to read to each other!).

The three ***Exams*** will test your ability to apply the material we discuss in class in the weeks prior to each exam. Unlike the quizzes, the exams will cover *both* reading and lecture topics. The exams will take place in class on the dates noted below, and you will have the full 75 minutes to complete your work. Each exam will be closed book and notes and consist of a mix of quantitative and short answer written problems. 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 policy below), and a missed exam will receive a score of 0. We will not have a cumulative final exam.

EXAM	COVERAGE	DATE (in class)
1	Classes 1 through 7	Wednesday, 27 September
2	Classes 8 through 15	Monday, 30 October
3	Classes 16 through 23	Wednesday, 29 November

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, energy storage, and nuclear power, to environmental regulation, energy efficiency, 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 early in the semester. Teams will submit a written analysis of their work no later than Friday, 01 December. All team members will receive the same project grade. Team size and the number of teams will depend on final 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 exam questions.

If you are sick and cannot complete assigned work, please contact me. If your illness will affect multiple classes and you are a Nicholas School MEM or MF, you should also notify Cynthia Peters, Nicholas School Assistant Dean Student Services, at petersca@duke.edu or 919-613-8071.

Readings

We will use the online textbook *Energy 101: Energy Technology and Policy* by Michael Webber and Yeal Glazer from the University of Texas at Austin. You may purchase a six-month subscription to the book for $75.00 at https://www.energy101.com/duke-environ-energy-711/. You will need your own subscription to complete the online quizzes associated with each assigned chapter.

The schedule below lists reading assignments, which must be completed prior to each day's class along with the chapter quizzes. 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 web browsing while we are together. These activities are more obvious than you might think, and I will not hesitate to cold call anyone who appears to be using their device for anything other than notetaking or researching the occasional discussion question. I will ask everyone to turn off and store all phones, laptops, and other devices during class if I feel that electronic media are becoming too much of a distraction.

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 and arrive having completed the readings. I also expect you to have an open mind, think critically, and use what we learn to make your own judgments.

In addition, if you have suggestions on how to improve the course, please let me know. Feedback received midstream is often 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 am here to help you learn. I will do my best to understand and appreciate the diversity in your backgrounds, interests, and analytical strengths, and I have tried to design the course to accommodate these differences while providing opportunities to help you develop in new areas. Again, I appreciate feedback. I am available during my office hours if you have questions

about the class (or life in general) 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 (https://integrity.duke.edu/new.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."

You will need to attest to the Duke Community Standard with each assignment and exam submission.

The Nicholas School Honor Code (https://nicholas.duke.edu/about/policies/nicholas-school-honor-code) describes implementation of the Duke Community Standard and its terms govern violations related to this class.

Use of AI (e.g., ChatGPT)

All work you submit for this class must be your own. The world of generative artificial intelligence (AI), most prominently ChatGPT, however, has complicated what "your own" involves. Just as use of a calculator to solve math problems is not only acceptable but expected, AI is quickly finding its way into everyday use through online search applications and word processing software. The line between acceptable and unacceptable use is therefore blurry. At minimum, copying results from ChatGPT or a similar application verbatim into an assignment or exam is plagiarism and a violation of the Duke Community Standard and Nicholas School Honor Code subject to punishment for academic misconduct. Use of AI as a starting point (i.e., the equivalent of a Google search) on assignments is fine, though your submitted work must reflect significant original thought and effort on your part. Think of AI as one of your classmates: any use of a peer that is improper (e.g., copying from another's work, having a buddy complete an assignment for you) is also an improper use of AI apps.

Zoom

This is an in-person class. That said, Covid remains with us, and colds, the flu, and other seasonal illnesses will likely make the rounds. I will open a Zoom link only for those who are genuinely ill and cannot attend class in person. If you are sick, please let me know as soon as you can, and I will send you meeting information. Unfortunately, our classroom is not configured for hybrid class sessions. You will be able to see me and view my slides online but will not be able to see or hear others in the room.

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 will provide updates to the schedule in class and via email.

CLASS	DATE	TOPIC(S)	READING (*Energy 101* Chapter)
1	28-Aug Mon	Introductions; Energy as a system; Importance of energy	1, 2
2	30-Aug Wed	What is energy; Quantifying energy	3
--	4-Sep Mon	**Labor Day** (no class)	--
3	6-Sep Wed	Types of energy resources and end uses	4, 5
4	11-Sep Mon	Coal (briefly); Oil and gas exploration and production	7, 8
5	13-Sep Wed	Oil and gas refining and distribution	9
6	18-Sep Mon	Oil and gas economics, unconventional resources	10
7	20-Sep Wed	Electrical energy	18
8	25-Sep Mon	Electricity generation	19
9	27-Sep Wed	**Exam 1** (classes 1 through 7)	--
10	2-Oct Mon	Electric power grid operations	20
11	4-Oct Wed	Electricity markets	21
12	9-Oct Mon	Environmental impacts of energy: Air quality	28
13	11-Oct Wed	Environmental impacts of energy: Water	32
--	16-Oct Mon	**Fall break** (no class)	--
14	18-Oct Wed	Energy and climate change	30, 31

CLASS	DATE	TOPIC(S)	READING (*Energy 101* Chapter)
15	23-Oct Mon	Energy and environment policy	25, 26
16	25-Oct Wed	Carbon capture, use, and storage; Geothermal energy	15
17	30-Oct Mon	**Exam 2** (classes 8 through 15)	--
18	1-Nov Wed	Nuclear power	17
19	6-Nov Mon	Solar energy	14
20	8-Nov Wed	Wind energy	13
21	13-Nov Mon	Energy storage	--
22	15-Nov Wed	Transportation and energy	22
23	20-Nov Mon	Alternative transportation fuels and vehicles	23
--	22-Nov Wed	**Thanksgiving break** (no class)	--
24	27-Nov Mon	Built environment and energy	24
25	29-Nov Wed	**Exam 3** (classes 16 to 23)	--
--	1-Dec Fri	Project write-ups due	--