

**Energy and Environment**  
**Winter 2020 ENVS 12**  
**Thursday & Thursday 2:25-4:15**  
**X-Hour Wednesday 4:35-5:25**  
**Steele 007**

Professor Elizabeth Wilson  
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Class Canvas site: <https://canvas.dartmouth.edu/courses/37535>  
Multimedia Resources: <https://researchguides.dartmouth.edu/multimedia>

In this class we will explore energy, technology, environmental issues and the evolving political context and response. We will examine the interplays between technological systems and social systems, trying to better understand how technology has played a key role in both creating and mediating environmental impacts. We will use a diverse set of tools and methodologies to examine energy/environmental systems from many different angles and understand how energy systems work, explore the larger impacts of the energy system and examine implications of technology and policy choice. This will allow us to better evaluate the environmental and social implications of different energy options in a changing future. By understanding how these issues interact at the local, state, regional, national and international levels I hope that we will be able to understand the global and local forces shaping energy-environment systems.

By its very nature, this study will be interdisciplinary and multi-scalar. Lectures and discussions will focus on methods from engineering, political science, physics, sociology and economics. This course will cover local energy use and impacts, national policies and the global trends that shape the energy system. We will examine energy use in history, study the present energy/environmental systems and explore the challenges of transforming the energy system.

### **Course Structure and Goals**

This class will be taught using active learning techniques is roughly broken into four parts. Part 1 will help to build a set of basic tools (unit analysis, economic cost calculations, and introduce ‘back of envelope’ calculations) and familiarize you with the system underpinnings (environmental systems, energy units, infrastructure) to explore energy and environmental issues. Part 2 will examine how humans use energy, and Part 3 explore the transformations in the electric sector. Part 4 covers cross-cutting issues like

energy transitions, and energy poverty and development. Each part will cover energy production, use, and policy, associated environmental impacts, and incorporate history, technology, regulation and geopolitical considerations as well as cross-cutting issues.

By the end of this term I hope that you will be able to:

- Understand and use basic energy units and conversion factors and be able to perform basic “back of the envelope” calculations on energy and environmental technologies.
- Understand opportunities and challenges of existing energy infrastructure and emerging technologies.
- Understand the existing regulatory environment and the role of public policy in shaping energy and environmental planning.
- Be able to become a discerning participant/observer within the energy and environmental debate, examining the literature, institutions, and technologies with a critical and informed eye.
- Be familiar with different communication methods: academic paper, policy brief, and video project to address a critical energy issue.

### **Required Texts**

Bradford, Travis, 2018, The Energy System, MIT Press, Boston

Additional required articles and assignments will be made available on the class Canvas site. Please ensure that you can view and contact Kim Wind if you need any help.

### **Grading**

20% Daily questions

30% Three problem sets containing both qualitative and quantitative elements  
(10% each)

40% Final Group Presentation, including video and policy-brief (15% presentation, 15% video project, 10% policy brief)

10% Participation class discussion, back of envelope

### **Daily Questions**

For each of the assigned readings prepare at least two questions or comments. These daily questions or comments should be 3-5 sentences in length and should be posted on Canvas by **noon the day before each class** when daily questions are due, so we can address them in lecture the following day. Note that the questions can only be read by the course instructors. We will share the questions with guest speakers beforehand to help them target their presentations. Questions will be scored 1=poor (your question required very little reflection on the reading); 2=good (it's evident that you read the paper, but you only put a moderate amount of thought into the question); 3=excellent (it's clear that you read the paper carefully and put a lot of effort into reflecting on the reading and formulating a question).

The objectives of these required "daily questions" are:

- to provide practice at critical thinking
- to give us constant feedback on your level of understanding
- to help move classroom focus to issues you find interesting and important
- to increase the likelihood that required reading will be completed in a timely fashion

What types of questions make good questions for discussion?

A question should indicate some depth of thought, and not just be, "why did the author want to study ABC?" A question could be something you don't understand (e.g., "what is smart grid and why should it affect system cybersecurity?", "under cap-and-trade policies how are greenhouse gas emissions measured and how are caps enforced?"), or that seems to contradict something else we've heard (e.g., "how can we reconcile these results with those of Sarah Smith who found opposite results in her analysis?") or something that was not clarified by the paper in question. Comments could for instance, indicate what you think is a novel approach by the author; highlight an important, but underemphasized point; make a linkage with another paper we read previously, etc. Or perhaps you might disagree with the data, methods, interpretation of data, interpretation of results, conclusions, speculation, or extrapolation.

## **Problem Sets**

The three **problem sets** will cover quantitative and qualitative material covered in the class. You will be asked to calculate basic 'back of the envelope' information on a variety of different subjects as well as provide qualitative synthesis of the different articles and speakers coming to the class. You are encouraged to do individual work supported within a larger study group (i.e. do your own work but use the other course members as resources for help and support) and to discuss the problems and your analyses with your fellow students.

Problem set grading: The **quantitative questions** will be evaluated on your thinking process (outlining your problem, stating your assumptions, showing your work, explaining your thinking process as clearly as possible) as well as the answer obtained. In some cases, there will be a 'correct' response, in others, the value of the problem is your thinking process and the underlying logic of the assumptions that you made while solving the problem. Underlying message: *think*. For the qualitative questions, they aim to examine your comprehension and assimilation of course readings and material. These will be graded on a 5-point scale, with a 5 denoting a well-researched and supported response, 4 a response with most of the logic correct, but with up to two errors in logic or calculation, and a 3 for problems with more than two errors in logic or calculation, but still an overall grasp of some basic concept, and a 0 for problems not set up or calculated correctly. Use references and draw from the readings.

## **Presentation Days: Policy Brief and Video Investigation Project**

During the course, students will develop presentations with their groups on some issue related to the energy and environment. Groups should work together to come up with a topic

that explores in greater detail and in more depth an issue raised in class or one related to the course content that was not covered in class. The purpose of this assignment is for you to explore an issue in greater depth than we have time to cover in lectures and teach your peers and instructors about it. Examples of possible topics include: “Evaluation of Carbon Offset Programs”, “Review/critique of laws and legislation in New England related to renewable energy”, “Review of status of solar energy in New Hampshire”, “Evaluation of ‘eating local’ culture on energy use”, or others of your choice. Each team will be responsible for a 20-minute presentation of your group's Video Investigation Project and policy brief. Be creative! You will have the opportunity to evaluate the participation of your group members for their final grades.

### **Video Investigation Group Project**

The Video Investigation Project is a combination of policy analysis, calculation and presentation skills will require your group (3-4 students) to prepare a short 5-minute video, 10-minute presentation, and 5-page policy brief on an assigned topic. The background and supporting evidence will use the tools you are taught in class. You will be divided into teams that will research and analyze an assigned energy/environmental issue. You are responsible for ensuring that these groups function smoothly, guidelines are provided in the video investigation project materials.

Your group will be responsible for developing the quantitative and qualitative analysis, defining an interesting and relevant angle and evaluation of applicable policies (in consultation with experts in the field, and other universities, the peer-reviewed literature, through other courses, state and private consultations, etc...), data collection, choosing and carrying out the quantitative and policy analyses to write, plan, film, edit and present the final video and policy brief. These will then be posted on the class Facebook site.

The goal of this project is to help your group prepare to communicate complex energy and environmental policy issues to an educated population and provide a supporting policy brief, supported by relevant policy analysis of difficult, yet pertinent questions. In doing so, I hope you reach a more nuanced understanding of the policy tradeoffs. Grading for the group project will be assessed on both an individual and collective basis. The video investigation product (15% of grade) and accompanying policy brief (10% of grade) are culminating parts of this class. Examples, templates and the grading of the elements of the video investigation project are posted on the course Canvas site.

### **Class Participation**

In terms of **class participation**, I expect each student to come to class having read the day's reading and responded to the posted questions on the Canvas Site, responses to the readings due at noon the day before class. The format of the class will be a hybrid. While some lectures remain, the class will mainly be taught as a “flipped class”, where do the readings and answer questions BEFORE class, we use the class time to resolve complex issues and delve deeper into the material.

We will follow all College guidelines regarding accessibility and the **Academic Honor Principle**. If you have a disability, please see **Student Accessibility Services** so that we can make the necessary accommodations.

**Academic Honor Principle:** You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a College academic record; or fabricating or falsifying data, research procedures, or data analysis. (<https://student-affairs.dartmouth.edu/policy/academic-honor-principle>) If it is determined that a student has cheated, he or she may be given an "E" for the course and may face additional sanctions.

**Grading policy** will follow the standard College policy, [https://www.dartmouth.edu/~reg/transcript/grade\\_descriptions.html](https://www.dartmouth.edu/~reg/transcript/grade_descriptions.html)

In order to avoid all possible bias, I ask you to **PLEASE turn in your assignments with your student ID ONLY**. Assignments turned in **late** will lose three points for every day after the due date.

Assignment	Due Date
Problem set 1	January 16
Video Treatment Plan	January 23
Problem set 2	February 4
Video project draft, interview footage completed and review	February 20
Problem set 3	February 20
Policy brief due	February 27
Final presentations and videos	March 3 and 5

**Student Standards of Conduct Code:** The College seeks an environment that promotes academic achievement and integrity, that is protective of free inquiry, and that serves the educational mission of the University. Similarly, the College seeks a community that is free from violence, threats, and intimidation; that is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the College; and that does not threaten the physical or mental health or safety of members of the College community. To review the Standards of Conduct Code, please see: <https://student-affairs.dartmouth.edu/policy/standards-conduct>

**Use of Personal Electronic Devices in the Classroom:** Using personal electronic devices in the classroom setting can hinder instruction and learning, not only for the student using the device but also for other students in the class.

**Appropriate Student Use of Class Notes and Course Materials:** Taking notes is a means of recording information but more importantly of personally absorbing and integrating the educational experience. However, broadly disseminating class notes beyond the classroom community or accepting compensation for taking and distributing classroom notes undermines instructor interests in their intellectual work product while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community.

**Student Mental Health and Stress Management:** As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. Dartmouth College services are available to assist you with addressing these and other concerns you may be experiencing. You can learn more about the broad range of confidential mental health services available on campus via <https://students.dartmouth.edu/health-service/counseling/about/clinical-services/counseling/>.

**Equity, Diversity, Equal Opportunity, and Affirmative Action:** The College will provide equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identity, or gender expression. For more information, please consult <https://student-affairs.dartmouth.edu/policy/nondiscrimination-equal-opportunity-and-affirmative-action>

**Academic Freedom and Responsibility:** Academic freedom is a cornerstone of the University. Within the scope and content of the course as defined by the instructor, it includes the freedom to discuss relevant matters in the classroom. Along with this freedom comes responsibility. Students are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled. Reports of concerns about academic freedom are taken seriously, and there are individuals and offices available for help. Contact the instructor, the Department Chair, your adviser, the associate dean of the college, or the Provost.

**Contacting Us:** We respond to emails during normal business hours, M-F, 9-5.

## Class Structure

1	Tuesday	7-Jan	Intro and Video Investigation Project
	Thursday	9-Jan	UNITS and IIES Intro
2		14-Jan	Histories of Environmental and Energy Pollution & Library Resources
		16-Jan	Energy, Air Quality and Climate Change
3		21-Jan	Economics and Laws around Energy Transitions
		23-Jan	Principles for Environmental Management
4		28-Jan	Principles of Energy and Environmental Economics and Finance
		30-Jan	Energy Demand in Industry and Buildings and Efficiency
5		4-Feb	VIP Group Workday
		6-Feb	Health Impacts of Air Quality
6		11-Feb	Legacy Energy System
		13-Feb	Electric System Transformations: Carbon Free Energy and Renewables
7		18-Feb	The Dartmouth Campus Energy System
		20-Feb	Energy System Transformations in North America
8		25-Feb	Energy in Developing Countries
		27-Feb	Energy Transitions Practitioner Panel
9		3-Mar	Student presentations and Videos
		5-Mar	Student presentations and Videos
10			Wrap Up and Evaluations

## Reading List

### Week 1

#### Tuesday January 7: Introduction

- Overview of syllabus
- How to do the Homework Assignments
- Hand out Problem set 1
- Group Mingle Activity
  
- Reading: Bradford, Chapter 1
- National Academies, 2009, America's Energy Future, Context and Challenges, pages 9-79
  
- ADDITIONAL READING: Koomey, Johnathan G.; Chris Calwell; Skip Laitner; Jane Thornton; Richard Brown; Joseph Eto; Carrie Webber, and Cathy Cullicott.

2002. Sorry Wrong Number: The Use and Misuse of Numerical Facts in Analysis and Media Reporting of Energy Issues. Annual Review of Energy and the Environment 27:119-58.

<http://www.annualreviews.org/doi/abs/10.1146/annurev.energy.27.122001.083458>

Thursday January 9: Methods for the Madness 1: Unit Analysis and Energy Opportunities

Guest: Dr. Amanda Graham IIES

Readings:

- Bradford, Chapter 2 p. 37-79
- Kakalios, James. 2017. The Physics of Everyday Things. Broadway Books, New York. Pp. 20-36.
- Energy Conversions (MIT Energy Club Fact Sheet), [http://www.mitenergyclub.org/assets/2008/11/15/Units\\_ConvFactors.MIT\\_EnergyClub\\_Factsheet.v8.pdf](http://www.mitenergyclub.org/assets/2008/11/15/Units_ConvFactors.MIT_EnergyClub_Factsheet.v8.pdf)

## Week 2

Tuesday January 14: Histories of Environmental and Energy Pollution and Library Resources

Guests: Librarians Karen Sluzenski and Amelia Looby on Library resources for Energy and Environmental Policy

Readings:

- Tarr, Joel A. 1996. The Search for the Ultimate Sink: Urban Pollution in Historical Perspective. Akron, Ohio, Chapter 1
- Holdren, John P. 1990 Energy in Transition, Scientific American. 263(3):157-164

Thursday January 16: Energy, Air Quality and Climate Change

Class Lead by Chris Callahan, Ph.D. candidate in EEES

- IPCC Fifth Assessment Report, Synthesis, [http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-TS\\_FGDall.pdf](http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-TS_FGDall.pdf)
- Climate Central, Global Weirdness, pages 1-63, pages 197-200
- IPCC Fourth Assessment Report, Summary for Policy makers at [http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4\\_syr\\_spm.pdf](http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf), pages 1-26 (stop at 4. Adaptation and mitigation options)



- Shindell, D., Faluvegi, G., Seltzer, K. et al. Quantified, localized health benefits of accelerated carbon dioxide emissions reductions. *Nature Clim Change* 8, 291–295 (2018) doi:10.1038/s41558-018-0108-y
- PROBLEM SET 1 DUE IN CLASS

### Week 3

Tuesday January 21: Economics and Laws around Energy Transitions

Guest speaker via Zoom: Alexandra Klass, University of Minnesota, Law Professor

- Mayer, Jane, 2017, *Dark Money*, Chapter 8, 243-278
- Richard Heede, 2017, Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854–2010
- *Massachusetts v. Exxon Focus on factual background.*  
<https://www.mass.gov/files/documents/2019/10/24/Complaint%20-%20Comm.%20v.%20Exxon%20Mobil%20Corporation%20-%2010-24-19.pdf>
- Other Complaints: <http://climatecasechart.com/case-category/actions-seeking-money-damages-for-losses/>
- Read San Mateo for range of Legal claims.
- VIP: Groups and Topics Decided

Thursday January 23: Principles for Energy and Environmental Management

- Rosenbaum, Walter. A, 2018, Chapter 2: Making Policy: The Process, In *Environmental Politics and Policy*, 11<sup>th</sup> Edition, CQ Press. Washington DC
- Rosenbaum, Walter. A, 2018, Chapter 3: Making Policy: Institutions and Politics, In *Environmental Politics and Policy*, 11<sup>th</sup> Edition, CQ Press. Washington DC
- Kraft, Michael E., and Norman Vig. 2018, *Environmental Policy Over Four Decades*. In *Environmental Policy: New Directions for the Twenty-first Century*, 10th edition, edited by Kraft, Michael E. and Norman Vig, pp. 1-26,. CQ Press, Washington D.C.
- VIP: [Treatment Plan](#) DUE

### Week 4

Tuesday January 28: Principles of Energy and Environmental Economics and Finance

- Chapter 13 in Rubin, Edward S. 2001. *Introduction to Engineering and the Environment*. McGraw Hill, Boston.

- Pacala, S., and R. Socolow. 2004. Stabilization Wedges: Solving the Climate Problems for the Next 50 Years with Current Technologies. *Science* 305:968-972.
- Bradford, Chapter 3 p 83-118
- Davies Chapter 2: Economic Rationale section
- OTA, 1993, Industrial Energy Efficiency, page 123, box B4

Thursday January 30: Energy Demand in Industry and Buildings and Efficiency

Guest Speaker: Dr. Stephen Doig, IIES Research Director

- Bradford, 2018, Chapter 17 p 869-921
- Nadel, Steven. 2002. Appliance and Equipment Efficiency Standards. *Annual Review of Energy and the Environment* 27:159-92.
- Lazar, J, Regulatory Assistance Project, 2011 Electricity Regulation in the US, pages 77-86, Energy Efficiency programs, <http://www.raponline.org/document/download/id/645>
- PROBLEM SET 2 DUE IN CLASS—Remember, turn in with ID numbers ONLY.
- PROBLEM SET 3 AVAILABLE ON CANVAS

## Week 5

Tuesday February 4: VIP Group Workday

Thursday February 6: Health Impacts of Air Quality

Guest: Dr. Laura Paulin, DHMC and Geisel School of Medicine

- Rosenbaum, Walter. A, 2018, Chapter 6 command and control in Action: Air and Water Pollution Regulation, In *Environmental Politics and Policy*, 11<sup>th</sup> Edition, CQ Press. Washington DC
- Additional Readings TBD.

## Week 6

Tuesday February 11: Legacy Energy System

- Bradford Chapter 4 and 5
- Lazar, J, Regulatory Assistance Project, 2011 Electricity Regulation in the US, pages 1-19, <http://www.raponline.org/document/download/id/645>
- Lazar, J, Regulatory Assistance Project, 2011 Electricity Regulation in the US, pages 20-63 and 69-76, 91-97 <http://www.raponline.org/document/download/id/645>

- Davies et al Chapter 5 on the Electric System

Look at: <http://www.eia.doe.gov/emeu/international/petroleu.html>

Thursday February 13: Electric System Transformations: Carbon Free Energy and Renewables

Class Presentations: Team up and Present on Key topics

- Bradford Chapters 8, 9,10,11
- Additional Readings: Davies et al.: Chapter 9 on Electrifying Transportation
- Watch: <http://www.bbc.co.uk/learningzone/clips/vehicles-and-air-pollution/6010.html>

## Week 7

Tuesday February 18: The Dartmouth Campus Energy System

Guest Speaker Rosi Kerr and students from ENGS 89/90

- Bradford Chapter 12
- Rubin, Edward S. 2001. Introduction to Engineering and the Environment. McGraw Hill, Boston. P. 162-234
- Additional Resources: Davies et al. 2014 Chapter 4 on the Electric System
- Morgan, M. Granger; Jay Apt, and Lester B. Lave. 2005. The U.S. Electric Power Sector and Climate Change Mitigation. Pew Center on Global Climate Change.

Thursday February 20: Energy Transitions in North America

Guest Speaker: Prof. Alberto LaMadrid, Lehigh University, visiting at MIT

- Bradford Chapters 6, 7
- Davies et al Chapter 7 on transportation
- Greene, David L. and Plotkin Steven. 2011 Reducing GHG from US Transportation, Pew Center on Global Climate Change, <http://www.pewclimate.org/publications/reducing-ghg-emissions-from-transportation>
- VIP: Video and Policy Drafts Due
- PROBLEM SET #3 Due

## Week 8

Tuesday February 25: Energy in Developing Countries

Guest Speaker: Stephen Doig, Research Director IIES

- Watch Rose Mutiso's TED talk: [https://www.ted.com/speakers/rose\\_m\\_mutiso](https://www.ted.com/speakers/rose_m_mutiso)
- Practical Action, 2011 Energy Poverty the Hidden Crisis
- UNDP, Energy Poverty: How to make modern energy access universal?, Excerpt, WEO 2015, [https://www.undp.org/content/undp/en/home/librarypage/environment-energy/sustainable\\_energy/energy\\_poverty\\_howtomakemodernenergyaccessuniversal.html](https://www.undp.org/content/undp/en/home/librarypage/environment-energy/sustainable_energy/energy_poverty_howtomakemodernenergyaccessuniversal.html)
- Norad, Gender and Development
- Guruswamy, Lakshman, Energy Poverty, 2011 Annual Review of Environment and Resources, <http://www.annualreviews.org/doi/pdf/10.1146/annurev-environ-040610-090118>
- Watch Hans Rosling on Health and Wealth and Development, [www.youtube.com/watch?v=meR5Z1UAswY](http://www.youtube.com/watch?v=meR5Z1UAswY)
- Watch this video on a lighting project in the Philippines, <http://www.bbc.co.uk/news/world-asia-pacific-14967535>

Thursday February 27: Practitioner Panel for Energy Transitions

Guest Professional Panel: Julia Griffin, Hanover Town Manager; April Salas, Director, Revers Center, Tuck School of Business.

## **Week 9**

Tuesday March 3: Student Presentations 1! VIDEO and Policy Brief

Thursday March 5: Student Presentations 2! VIDEO and Policy Brief

## **Week 10**

## **Exam Week**