



UNDERSTANDING ENERGY

Course Syllabus
CEE 107A/207A/EARTHSYS 103

Lectures: 80 min, MWF

Workshop (for students enrolled for 5 units): 80 min once/week

Check <https://explorecourses.stanford.edu/> for details on timing, location and updated syllabus

<p>Instructors: Diana Gragg, Avery McEvoy, Kirsten Stasio, and Jane Woodward Contact for Instructors and TAs: Piazza forum (either private or public) preferred; main contact is Diana at moongdes@stanford.edu</p>
<p>Teaching Assistants: TBA Office Hours: see Canvas</p>
<p>Course Websites: Canvas: https://canvas.stanford.edu/ Course info: https://energy.stanford.edu/understanding-energy Youtube channel: https://www.youtube.com/user/EnergyResourcesVideo</p>

Energy is a fundamental driver of human development and opportunity. At the same time, our energy system has significant consequences for our society, political system, economy, and environment. In taking this course, students will not only understand the fundamentals of each energy resource -- including significance and potential, conversion processes and technologies, drivers and barriers, policy and regulatory environment, and social, economic, and environmental impacts -- students will also be able to put this in the context of the broader energy system and think critically about how and why society has chosen particular energy resources. Students who take this course will:

- (1) **Develop a greater awareness** about the energy flows and systems that allow us to turn on the lights, have cold drinks, and take hot showers.
- (2) **Think in terms of energy systems** and grasp the complex interactions between energy resources and end uses, including the technological, scientific, policy, and economic considerations, and the private, social, and natural capital impacts along the entire energy resource life cycle.
- (3) **Apply this knowledge** to...
 - o think critically about the role of energy resources within our broader society.
 - o analyze policies and regulations and their social impacts,
 - o estimate, calculate, and synthesize energy information.
 - o communicate about energy use and environmental impacts in meaningful ways.
 - o make informed energy decisions, from voting to consumption.
 - o be a change agent and innovate solutions that improve our energy use patterns.
- (4) **Have fun** and remember the class as a great and challenging learning experience.

Who Should Take This Course?

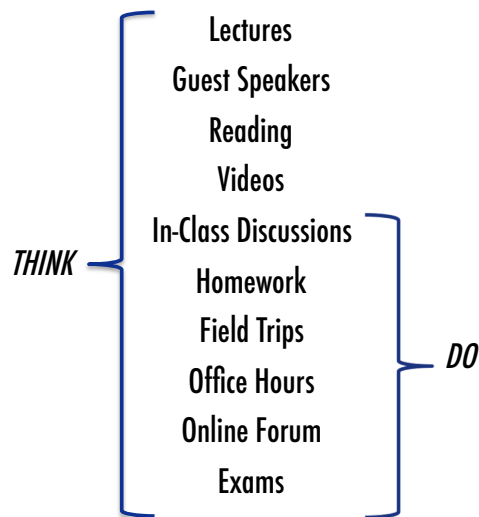
Anyone with an interest in energy or environmental issues! There are no prerequisites for this course except a basic grasp of algebra. Students with and without a technical background are encouraged to enroll. More than half of the course content focuses on how society makes decisions about, and is impacted by, energy resources (including policy and regulatory decision-making; environmental, health and safety considerations; and economics), and the remainder of the course covers the technical and engineering aspects of energy resources (technology innovation, resource formation and potential, conversion processes, and system dynamics). The teaching team and your peers will be available to provide assistance on some of the more challenging aspects of the course via the online forum (Piazza) and the almost daily office hours.

Course Overview

This course, which is taught in the fall and spring, provides students with an in-depth understanding of each energy resource – from fossil fuels to renewable energy.

The **4-unit** course consists of lectures three times per week with accompanying reading and video assignments to be completed prior to each lecture. Students will have an opportunity to apply this knowledge and problem solve during in-class discussions, eight homework sets, the midterm and final exams, one on-campus field trip during lecture time, and two off-campus field trips with accompanying write-ups.

Understanding Energy's Ways of Thinking & Doing



For **5 units**, students will additionally attend [Workshop](#) - a weekly 80-minute interactive discussion section that takes a deep dive into cross-cutting topics complementary to the *Understanding Energy* lectures (see more about Workshop later in the syllabus). The Workshop will be graded on attendance, participation, and a short (800-900 word) paper due at the end of the quarter.

The 3-unit option requires instructor approval – please contact Diana Gragg.

Course Resources

Information about the course is posted on **Canvas** (<https://canvas.stanford.edu/>), including the syllabus, readings and videos, calendar, homework, policies, math review sheets, and grades.

Readings and Videos for each lecture are available under the **Modules** tab and also on the **first slide of each lecture**, along with questions to think about during the readings or to prepare for in-class discussions. **The required readings and videos should be completed before the corresponding lecture** – we will discuss the readings and other questions during lecture, challenging you to think critically about how society approaches issues related to energy resources. You should be prepared to debate and deliberate – we want to know what you think! Example questions you might be asked to consider for the readings or in-class discussions (see the lecture slides on Canvas for the specific questions for each lecture):

- 1) What are the potential and realized social, environmental, political, and economic implications of the energy resource?
- 2) How is society dealing with the consequences or encouraging the benefits? What policies and regulations are in place, and what is missing? How do policies and regulations differ around the world, and how does that change the benefits and consequences of using that energy resource?
- 3) How do we as a society value the different aspects of the energy resource? Do we do a good job of balancing the costs and benefits?
- 4) What are your recommendations concerning the energy resource and how society should be valuing it?

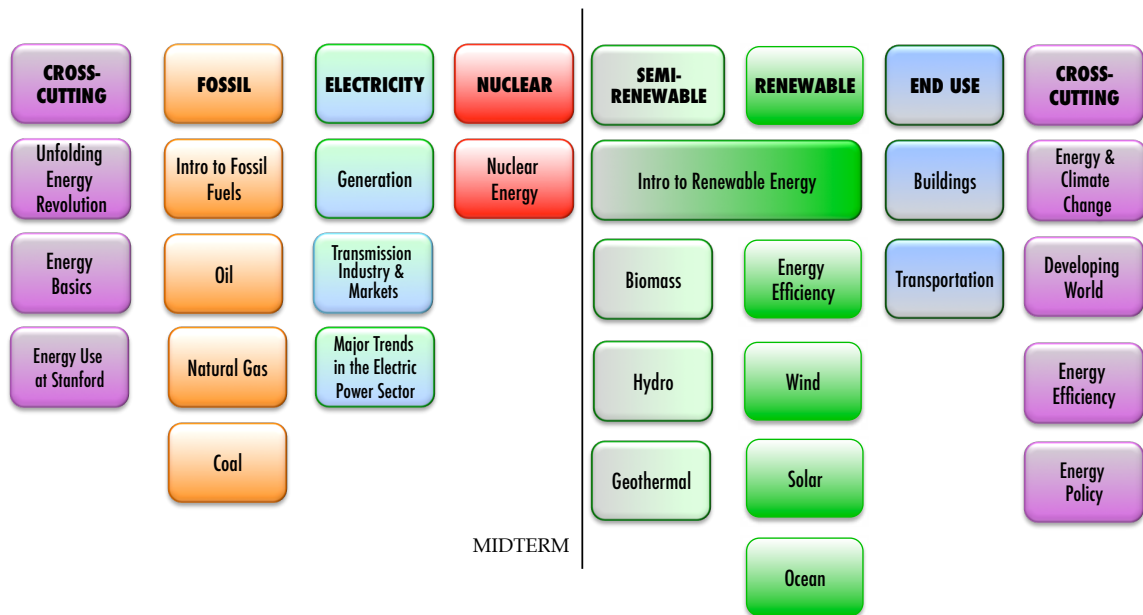
Additional, optional videos can be found on our YouTube channel:

<https://www.youtube.com/user/EnergyResourcesVideo>

Piazza is the online forum for this course where students can ask questions and discuss and analyze energy resource topics outside of lecture. Students can ask questions about the course material, homework, and energy in general and receive rapid responses from the teaching team. Students are encouraged to respond to your peer's questions too! Piazza is also where students and instructors will post "**energy in the news**" to share and analyze with your classmates – including a required post and response as part of the homework assignments (more details on Canvas). To register, select the Piazza tab from Canvas, then select "Join as Student". Students should be aware that Stanford does not consider Piazza to be compliant with the Family Educational Rights and Privacy Act of 1974 (FERPA). You can find more information here <https://registrar.stanford.edu/students/student-record-privacy> and here <https://piazza.com/legal/ferpa>.

Office Hours will be held almost daily (timing and location listed on Canvas) by TAs and instructors. Come by and visit us – we love talking about your energy questions!

Course Topics



Lectures

The basic outline of lectures is listed below. **Please check Canvas for schedule changes.**

Week/Date	Topic
Week 1 (9/23-9/27)	1. Introduction – The Unfolding Energy Revolution
	2. Energy Basics, Environment, History of Fossil Fuels
	3. Intro to Fossil Fuels & Prospecting for Oil & Natural Gas
Week 2 (9/30-10/4)	4. Oil and Natural Gas Drilling and Well Completion
	5. Oil Production and Transportation
	6. Oil Refining and Products
Week 3 (10/7-10/11)	7. Coal
	8. Natural Gas
	9. The Grid: Electricity Transmission, Industry, & Markets
Week 4 (10/14-10/18)	10. Electricity Generation
	11. Major Trends in the Electric Power Sector
	12. Nuclear Energy
Week 5 (10/21-10/25)	13. Energy at Stanford
	14. Local Field Trips
	MIDTERM EXAM (and get your Understanding Energy t-shirt!)
Week 6 (10/28-11/1)	15. Energy in the Developing World
	16. Intro to Renewable Energy
	17. Biomass
Week 7 (11/4-11/8)	18. Hydroelectricity
	19. Wind Energy
	20. Solar Heat and Photovoltaics

Week 8 (11/11-11/15)	21. Geothermal
	22. Energy Efficiency as a Resource
	23. Energy and Climate Change
Week 9 (11/18-11/22)	24. The Peas: CSP, Ocean, Fusion
	25. Energy Policy
	26. Energy Industry Panel
11/25-11/29	THANKSGIVING BREAK
Week 10 (12/2-12/6)	27. Energy for Buildings
	28. Energy for Transportation
	29. Course Wrap-Up
12/11	FINAL EXAM 3:30 – 6:30 pm

Course Grading

4 Unit Option		5 Unit Option	
Homework	20%	Homework	15%
Field Trips	15%	Field Trips	12%
Midterm Exam	23%	Midterm Exam	18%
Final Exam	37%	Final Exam	30%
Participation	5%	Participation	5%
		Workshop	20%
Extra Credit	0.5%	Extra Credit	0.5%

Final letter grades are assigned based on a curve. The undergraduate course (CEE 107A/EARTHSYS 103) is curved separately from the graduate course (CEE 207A).

All assignments must be submitted online via Canvas by 5:00 PM on the day they are due. Please make sure the submitted homework is legible, otherwise points may be taken off. Either type all of your homework, showing all work, in Word and export to PDF at the end, or hand-write your assignment and take photos and convert to PDF at the end. Some students have found that using photo / scanning software made it easier to submit their hand-written homework assignments as one document (e.g., TurboScan or GeniusScan).

Homework:

- Students are assigned **8 homework sets**. Your 7 highest scores will be used to calculate this part of your grade (one HW grade is dropped). You may choose not to turn in one homework assignment, but absolutely no extensions will be given. Students taking the graduate level course (CEE 207A) will have additional problems on the homework sets. Please refer to the Homework Policy on Canvas.
- Students must post an **'Energy-in-the-News' article** on Piazza once during the quarter, and **respond to one** from another student once during the quarter. More information is provided on Canvas.

Exams: Exams are closed-book and closed-notes. Prior to each exam, the TAs will provide a study list and hold a review session.

- The midterm exam covers all lectures and reading prior to the midterm exam.
- The final exam covers the entirety of course lectures and readings, but will emphasize the material covered post-midterm.

Field Trips:

- Students must attend one on-campus, local field trip offered during class time, and two off-campus field trips (choosing out of ~9 field trips offered). **Students must write an 800-word report for each off-site field trip (2 total).**
- Field trips are graded on attendance (15%) and on the two field trip reports (85%).
- If you must withdraw from a field trip that you are signed up for, notify the Field Trip TA at least 7 days prior to the trip. If you withdraw before the deadline, you will be placed on a waitlist for another trip. Missing or withdrawing from a trip after this deadline, even if the trip is not one of your required field trips, will result in zero attendance points, except in cases of emergency.
- For more information, please refer to the Field Trip Policy and Writing Guidelines document available on Canvas, and the Field Trip section in this syllabus.

Participation:

- The goal of the participation part of the course is to engage you in the discussion, enhance the learning experience for yourself and your peers, and give you another avenue to test out your thoughts and views on energy in a welcoming and supportive environment. We want to **reward** you for participating – through giving you credit, but also through the enhanced experience you will have in class.
- **Participation will be graded based on both the quantity and the quality of your statements during lecture.** Questions, while welcome, do not count towards your participation grade.
- **Quality** is measured in terms of effort – meaning, we want you to be thinking, paying attention, offering your perspective. It is not about being right or wrong or super knowledgeable on the topic.
- Example of participation events include:
 - o Energy-in-the-news – what is going on in the news that is relevant to energy topics? What are your views on it?
 - o Readings / videos – what did you learn? What struck you about it? How does your experience shape your views on x?
 - o Engagement in lecture – what are two important things we just covered (in the last section, or last 10 minutes)? Why are they relevant? Does anything you've learn challenge/expand your perspectives on x?
 - o In-lecture discussion – led by instructor, pros and cons of a topic (i.e. Name one thing in support of and one thing against x technology), digging deeper into an issue, etc.
 - o Field trip summary – what was most surprising about the off-campus field trip you attended? What would your fellow classmates find most interesting?
- If you have **concerns or questions** about your participation grade, please feel free to contact Diana or a TA at anytime.

Workshop:

- The Workshop will be graded on **attendance (20%), participation (60%), and a short (800-900 word) paper (20%)**. Refer to the Workshop Paper Writing Guidelines document on Canvas.

Extra credit:

- Submit a single slide about yourself and your interest in energy for the slide show on the last day of class (0.5%)

Field Trips

Field trips give students the opportunity to:

- 1) Gain a deeper understanding of energy fundamentals from lecture and reading by providing a physical context in which to apply key concepts.

- 2) Observe and analyze, first-hand, how society makes decisions about energy resources by interacting with decision-makers within Stanford and California.
- 3) Interact with operators in the energy industry and gain insight on their views on the industry's job opportunities, environmental impacts, policies and regulations, etc.
- 4) Obtain real-world skills, through host interactions and trip preparation and synthesis.

All students must attend three field trips planned by the teaching team, **one local field trip** during normal class time and **two off-campus field trips** outside of normal class meetings.

On the local field trip, students will explore a campus energy-related facility, including the Stanford Energy System Innovations (SESI), Stanford's Parking and Transportation Services (P&TS), and others. A full list of options will be provided when local field trip sign-ups occur.

For the off-campus field trips, students will choose two from the list of field trips provided. Listed below are some possible field trip sites. **The final list with dates and times will be provided for students to sign-up the first week of the quarter.**

Site
San Ardo Oil Field
Moss Landing Natural Gas Combined Cycle Power Plant (and energy storage)
Diablo Canyon Nuclear Power Plant
Rancho Seco Solar PV, Retired Nuclear Power Plant and Biodigester
Shasta Dam & Hydroelectric Power Plant
PG&E Pacific Energy Center

Students will write a short report (800 words max) for each off-campus field trip they attend to reflect on and think critically about the trip. Detailed field trip policies, writing guidelines and prompts, schedules, and handouts are available on Canvas.

Workshop

TBD

The 5th unit involves an interactive workshop where we examine cross-cutting energy-relevant issues like water use, land use, transportation and policy. We discuss some of the most fascinating systems-level concepts surrounding energy and develop your thinking in these small-group discussions, taught by Dr. Diana Gragg and the TAs. Workshop sessions meet once per week for 80 minutes. Session topics may change – check with instructors for an up-to-date schedule.

Topics:

Week 1 (9/23-9/27)	1. Energy and Sustainability
Week 2 (9/30-10/4)	2. Hydraulic Fracturing
Week 3 (10/7-10/11)	3. Surprising Truths about Energy Data
Week 4 (10/14-10/18)	4. EnRoads: Technology to the Rescue?
Week 5 (10/21-10/25)	5. Air Quality, Human Health, and the VW Scandal

Week 6 (10/28-11/1)	6. In-Depth on Energy Storage
Week 7 (11/4-11/8)	7. Microgrids and Fires
Week 8 (11/11-11/15)	8. Cap-n-Trade and Carbon Taxes
Week 9 (11/18-11/22)	9. Energy and Climate Policy Transportation Policies and Programs – U.S., California, and Stanford
11/25-11/29	THANKSGIVING BREAK
Week 10 (12/2-12/6)	10. Climate Change Communication Strategies

Attendance: 20% of your grade

Attendance is a key part of Workshop and we will enforce a strict attendance policy. Out of the 10 weeks of the Workshop, you are allowed one excused absence with the completion of a two page paper on the topic of the class you miss. Please e-mail Diana or Emily at least a week in advance to request permission to miss class, or as soon as possible in case of emergency. You will receive 0 credit for attendance and participation with each unexcused absence. If you cannot make your normal workshop time but can attend another workshop section the same week (if offered), please discuss this possibility with an instructor.

Participation: 60% of your grade

In order to foster a productive discussion, we will be looking for everyone to add comments, ask questions, raise issues, and think critically during the conversation and to enthusiastically participate in classroom activities. If you feel as though you are having trouble making your voice heard, please contact one of the instructors outside of class. From time to time, participation might also include a short assignment to be turned in or presented in class.

Final Paper: 20% of your grade (40 points)

The paper should be 800-900 words, due by 5 pm on the last day of classes. The paper can be submitted online through Canvas. See Workshop Report Writing Guidelines on Canvas for grading rubric.

The goal of the paper is to:

- 1) **investigate an energy source and an associated issue**, such as sustainability, climate, water, land, wildlife, air quality, etc.
- 2) **put the issue into context** – how important is it? What policies are related to it? How effective are they? What does society think about this energy source, and how has that changed over time?
- 3) **think critically** about what you would **do differently** about the issue and how you would go about making those changes happen

The Teaching Team

Diana Gragg: Diana is a Core Lecturer in Civil and Environmental Engineering (CEE) at Stanford and the Explore Energy Managing Director at the Precourt Institute for Energy. She received her M.S. and PhD in the CEE Atmosphere/Energy program in 2012, a postdoc at the Precourt Energy Efficiency Center in 2015 and has a background in the oil and chemical industry, air pollution, and sustainable transportation. She took the class way back in 2004,

and joined the teaching team in 2015. She loves animals, running, hiking, water polo, skiing – and anything that involves spending time with her two kids.

Avery McEvoy: Avery is a Lecturer in CEE at Stanford and the Explore Energy Program Manager at the Precourt Institute for Energy. Avery recently graduated from the MS Atmosphere/Energy program in Civil & Environmental Engineering at Stanford in 2019. She spent the summer as a Schneider Fellow for the Rocky Mountain Institute in Boulder, Colorado. There she worked in the Islands Energy Program, identifying critical facilities across Puerto Rico and sizing them for solar + battery storage microgrids to increase energy resilience. At Stanford, Avery was a teaching assistant for Understanding Energy, Weather & Storms, and Extreme Energy Efficiency, and was part of the Alpine Club and Stanford Ski Team. In her free time she loves to hike, climb, backpack, ski, draw, and read in her hammock. Feel free to ask Avery about energy courses at Stanford or outdoor activities around the Bay Area!

Kirsten Stasio: Kirsten is a VP at MAP Energy and is an Adjunct Professor in CEE at Stanford. She graduated from Stanford in 2014 with an E-IPER MS degree and an MBA. Her background includes working on Pacific Gas and Electric (PG&E)'s energy efficiency team, on Apple's energy team, and at the World Resources Institute (WRI), an environmental think-tank.

Jane Woodward: Jane is an Adjunct Professor in CEE at Stanford and has been teaching a version of this course since 1991. She is a founder and managing partner of MAP Energy, a local energy investment company that forms and manages natural gas, wind, solar, and storage royalty partnerships.

The teaching team's complete bios are available at: <https://energy.stanford.edu/understanding-energy/instructors>. Please use Piazza to contact the teaching team (either publically or privately).

Honor Code

Violating Stanford University's Honor Code is a serious offense, even when the violation is unintentional. The Honor Code is available at:

<https://communitystandards.stanford.edu/student-conduct-process/honor-code-and-fundamental-standard>

Specifically, adhering to the Stanford Honor Code implies that all work in exams and quizzes must be done individually. For homework, students may consult with TAs and with other students, but must write up solutions independently based on their own understanding. All references and sources (e.g., in field trip reports) must be clearly identified and properly referenced. Lastly, if you work with other students on a homework set, you must acknowledge their names on the front page of your submission. Please refer to the Homework Policy posted on Canvas regarding collaboration on homework assignments.

Students with Documented Disabilities

Students with Documented Disabilities: Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Office of Accessible Education (OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty. Unless the student has a temporary disability, Accommodation letters are issued for the entire academic year. Students should contact the OAE as soon as possible since timely notice is needed to coordinate accommodations. The OAE is located at 563 Salvatierra Walk (phone: 723-1066, URL: <https://oae.stanford.edu/>)