

## Economics of Energy, Innovation, and Sustainability

### FALL 2022 SYLLABUS

15.020 (Graduate): MW 8:30am - 10am, E51-395

15.0201/14.43 (Undergraduate): MW 10:30am - noon, E51-376

Life in the modern world runs on energy. We use energy to light and heat our homes, transport people and things, and to perform countless other tasks that have improved productivity and quality of life. However, increased energy use has led to dire and worsening environmental consequences that affect human health and well-being. At the same time, large parts of the world still lack energy access. This course presents the economics of the world energy challenge – how to provide access to reliable and affordable energy while addressing adverse health, environmental, and climate impacts.

Class lectures and discussions will examine the frictions among social, policy, and private objectives in energy and environmental markets. We will apply microeconomic concepts such as externalities, strategic firm interactions, and causal inference in data analysis. The problem sets will aim to help you become astute consumers of data and evidence. Readings will include peer-reviewed academic journal articles, business cases, policy briefs, news articles, and op-eds.

In this course, we will tackle questions such as the following:

- What role can businesses play in addressing climate change? What can you do?
- Should governments subsidize renewable energy? If so, how should the subsidies be structured?
- What are the economic and policy barrier to decreasing carbon emissions and other air pollution from the transportation system, and how can they be overcome?
- What are the short- and long-run impacts of Covid-19 on energy markets and the environment?
- How are electricity markets regulated and organized, and how do the regulatory institutions impact the transition to low-carbon electricity?
- Tech giants have committed nearly one billion dollars toward “permanent” carbon removal. How could we effectively spend this money?

We welcome anyone interested in learning about energy or economics. This course may be especially useful for Sloan students working toward the Sustainability Certificate and undergraduates working toward the Energy Studies Minor. This course satisfies an Institute HASS-S requirement for undergraduates. Listeners are welcome but are expected to participate and be engaged in class. Prerequisites: Introductory Microeconomics (14.01 or 15.010/15.011) or equivalent; a prior course in probability/statistics would be helpful.

### Guest Lectures

Professor Paul Joskow will deliver a guest lecture in both 15.020 and 15.0201/14.43 on decarbonization of the electricity sector and the recent MIT Future of Energy Storage study. Professor Paul Joskow is a professor in the MIT Economics department, and his MIT website is here: <https://economics.mit.edu/faculty/pjoskow>

We will have Dr. Hunt Allcott deliver a guest lecture in 15.020 (Prof. Li will cover the same content in 15.0201/14.43) about corporate social impact. Dr. Hunt Allcott is a Senior Principal Researcher at Microsoft Research, and his professional website is here: <https://sites.google.com/site/allcott/home>

## Grading and Assignments

- Class attendance and engagement (25% of grade) – The purpose of the attendance and engagement policy is to help you get the most out of this class.
  - *Engagement*: Students are expected to come to class having read the assigned materials and to be engaged in class through discussions, asking questions, and responding to other students' questions.
  - *Grading*: Absences from class will have *increasing marginal costs* on your grade. In recognition of unique challenges that may arise for each student, we give three (3) no-penalty absences. Ten (10) percentage points of your total grade (2/5 of this category) will be deducted for the fourth absence, and 15 percentage points will be deducted for the fifth. Please *optimize dynamically* and plan to use your no-penalty absences for emergencies.
  - *Office hours and Piazza*: The course staff will hold weekly drop-in office hours. We will have a Piazza course site for students to ask and answer questions (see Canvas for the link to Piazza). We will take into account engagement through these channels when assigning grades for the attendance and engagement category.
  - *Absences on key discussion days*: Days with in-class debates and the ESG wrap-up discussion count for two sets of grades: attendance/engagement and the discussion quality grades for those categories (see below). The no-penalty absences may be used on these days for the attendance/engagement grade, but the discussion quality grade will need to be made up separately. As the debates and ESG wrap-up discussions are meant to replace exams, the replacement assignment or verbal exam will mirror the levity of a written exam. The exact make-up format will be arranged with Professor Li as needed.
- Electricity Strategy Game (ESG, 15% of grade) – The ESG is designed to replicate the exciting and lucrative world of deregulated wholesale electricity markets. Each team of students will own a portfolio of generation units and bid those units into an electricity spot market. The ESG starts with a simple cost and bidding structure; we then add complexity with a tradable greenhouse gases permit market. Grading will be based on the memo each team will write before and after the game, performance in the game (2 memos in total) and the explanation of the team's performance during game wrap-up discussions. During the game, students will have small weekly tasks such as submitting the team's electricity supply bids.
- Problem sets (20% of grade) – We will assign 5 problem sets over the semester. The lowest problem set score will be dropped. Problem sets may be completed individually or in groups of up to four students. Teams may submit one document, though some questions that ask for individual experiences or answers will require individual submissions. To receive credit, problem sets must be submitted *online via Canvas* and *on time*. Late submissions will not be accepted.
- Debates/presentations (40% of grade) – three classes will be reserved for debates. Teams of 3 or 4 students will make a case for or against a particular position on the following questions (subject to change):
  1. The US Federal Government should substantially increase incentives for development and/or use of zero-emissions transportation infrastructure, vehicles, and systems, including a tax credit of up to \$10,000 per vehicle for consumers and 30% of construction costs for refueling infrastructure.
  2. The US should eliminate greenhouse gas pollution from power plants by 2035 through technology-neutral standards for clean energy and energy efficiency.
  3. The US Federal Government should substantially increase market-based regulations requiring reductions in greenhouse gas emissions and pricing greenhouse gas emissions at \$60 per metric ton CO<sub>2</sub>-equivalent or more.

Each team will prepare their answers to each of the debate questions, sending in a deck of 5 slides (not including title slides) per question **one week before** the respective debate class. The course staff will grade the slides, and the presenting teams will be announced **on the day of the debate**.

After the presentations, or “opening arguments,” discussions will open up to the rest of the class. Students

who did not deliver opening arguments can take this opportunity to challenge the presenting teams, give their own additional insights, as well as to offer critiques of the presentations. All comments will be taken into account in grading. Guest judges may join the course teaching staff in evaluating your performance.

- Slide decks (5% of total grade from each debate; 15% of total grade for all three debates): This will be a team deliverable and all team members will receive the same grade.
- Quality of economic reasoning and engagement during debates (5% of total grade from each debate; 15% of total grade for all three debates): This will be an individual grade.
- Peer evaluation ( $\approx 3.33\%$  of total grade for each debate; 10% of total grade for all three debates): You will award each of your teammates with points on a scale of 1 to 10 for their contributions to the debate preparations. Please also write brief explanations for each rating you give. You will receive the average of the points awarded by your teammates, but you will not know the points awarded by each teammate (and your teammates will not know what you awarded them). **You will receive 0 for this category if you do not turn in a complete set of evaluations for your teammates.**

## Digital Distractions

In the spirit of making evidence-based policy, and given the importance of class participation, we ask that you *not* open other browser windows or applications on your computer and avoid keeping your phone or other distracting devices nearby. There are two exceptions: (1) presentations and discussions that require you to refer to spreadsheets or other results on your computer during class, and (2) students with special needs (more information at Student Life Services, [studentlife.mit.edu/sds](http://studentlife.mit.edu/sds)) who receive permission in advance to use their electronic devices. Please silence your phone and put it away during class.

“Brain Drain: The Mere Presence of One’s Own Smartphone Reduces Available Cognitive Capacity,”  
<https://www.journals.uchicago.edu/doi/10.1086/691462>

## Group Work and Academic Integrity

In this course, you will be held to the high standard of academic integrity expected of all students at MIT. We will follow MIT’s Academic Integrity Policy (see complete policy at [integrity.mit.edu](http://integrity.mit.edu)).

You are expected to participate fully in any exercises or other assignments that you put your name on. It is absolutely unacceptable to “rotate” assignments among members of a group or to take credit for an assignment in which you were not fully involved. You may allocate specific tasks for the assignment, but every member of the group must be substantially involved in the assignment. You should be able to explain and reproduce all answers and deliverables for which you receive class credit.

**It is your responsibility to make yourself aware of MIT’s rules of academic integrity and to adhere to them. If you are unsure whether some particular course of action is proper, it is your responsibility to consult with the professor or teaching assistant for clarification.**

## Sloan Values

Please familiarize yourself with other Sloan Values and practice them:  
<https://mysloan.mit.edu/offices/deans/values/Pages/default.aspx>.

## Schedule (Preliminary)

Date	Number	Topic	Notes
9/7 Wed	1	Course introduction	
9/12 Mon	2	Markets, market failures, and policy	
9/14 Wed	3	Economics of climate change (I)	
9/19 Mon	4	Economics of climate change (II)	
9/21 Wed	5	Allcott guest lecture: Corporate social impact	
9/26 Mon	6	Transportation - Regulating fuel and driving	
9/28 Wed	7	Transportation - Alternative fuel vehicles	
10/3 Mon	8	Case: Better Place (subject to change)	
10/5 Wed	9	Behavioral energy & environmental economics	
10/10		NO CLASS – Indigenous Peoples' Day	
10/12 Wed	10	Debate I	
10/17 Mon	11	Electricity intro, supply, demand, & industrial organization	
10/19 Wed	12	Wholesale electricity market design & resource adequacy	
10/24		NO CLASS – Sloan Innovation Period	
10/26		NO CLASS – Sloan Innovation Period	
10/31 Mon	13	Joskow guest lecture: Decarbonizing the electricity sector	
11/2 Wed	14	Market power in electricity markets; Introduce ESG	
11/7 Mon	15	Innovation (I) - demand response	
11/9 Wed	16	Innovation (II) - valley of death & project finance; ESG portfolio auction	
11/14 Mon	17	Guest speaker, TBD	
11/16 Wed	18	Debate II	
11/21 Mon	19	Emerging markets (I)	
11/23		NO CLASS – Happy Thanksgiving!	
11/28 Mon	20	Emerging markets (II); ESG carbon permit auction	
11/30 Wed	21	Markets for carbon and advance market commitments (AMC)	
12/5 Mon	22	International cooperation and agreements	
12/7 Wed	23	ESG debrief	
12/12 Mon	24	Debate III	
12/14 Wed	25	Class review and wrap-up	