

## Economics of Energy, Innovation, and Sustainability

FALL 2020 SYLLABUS

*Both sections will be taught entirely online*

15.020 (Graduate): MW 11am - 12:30pm

15.0201/14.43 (Undergraduate): MW 9:30am - 11am

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 social welfare, strategic firm interactions, consumer behavior, 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, 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?
- Jeff Bezos, Microsoft, and others have committed billions of dollars toward addressing climate change. What are effective ways to spend that money?
- What are the short- and long-run impacts of Covid-19 on energy markets and the environment?
- What are the economic and policy barriers to the transition to decreasing carbon emissions from the transportation system, and how can they be overcome?
- Several airlines have committed to becoming carbon neutral. Besides going bankrupt and ceasing operations due to the Covid-19 pandemic, how can they achieve this? How do the carbon offset markets behind these promises work?
- How are electricity markets regulated and organized, and how do the regulatory institutions impact the transition to low-carbon electricity?
- Should we subsidize renewable energy? If so, how should the subsidies be structured?

We welcome anyone interested in learning about energy or economics. This course may be especially useful for Sloan students working 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

As in previous semesters of this course, we are fortunate to have Prof. Paul Joskow again for a module on electricity. Prof. Joskow is faculty in MIT's Department of Economics. He was Director of the MIT Center for Energy and Environmental Policy Research from 1999 through 2007. At MIT he is engaged in teaching and research in the areas of industrial organization, energy and environmental economics, competition policy, and government regulation of industry.

## 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. We are mindful of unusual challenges you may face during the pandemic. Therefore, we offer some flexibility for you to make up absences asynchronously for **partial** credit. This class is not possible to take entirely asynchronously.
  - *Synchronous*: Students who are able to attend synchronously are expected to join the Zoom class with video turned on, to have read the assigned materials, and to be engaged in class (such as through discussions, asking questions, answering your student colleagues’ questions, etc.) Note: Zoom provides information on the times when each participant joined and left. The TA will be answering your questions in the Zoom chat/Q&A box or flagging certain comments or questions for verbal discussion.
  - *Asynchronous*: Students may “make up” attendance in each session of this course by watching the Zoom recording of a particular class and answering a few questions that are meant to be very easy for anyone who has watched the recording. Asynchronous make-up questions will be posted on Canvas shortly after each class and responses are due two weeks after the original date of the class. This asynchronous make-up option can earn up to 8/10 of the attendance grade compared to synchronous participation.
  - *Grading*: An absence is defined as both not attending synchronous Zoom class as well as not submitting answers to asynchronous make-up questions. Absences will have *increasing marginal costs* on your grade. You’ll have three (3) no-penalty absences, 10 percentage points of your total grade (2/5 of this category) will be deducted for the fourth absence, and 15 percentage points 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, and we may adjust the times to span more time zones depending on the needs of enrolled students. We will have a Piazza course site for students to ask and answer questions. We will take into account engagement through these channels when assigning grades for the attendance and engagement category.
- 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 will add complexity later 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, and your explanation of your performance during game wrap-ups. During the game, you will have small weekly tasks such as submitting your team’s electricity supply bids.
- Problem sets (20% of grade) – We will assign 5 problem sets over the semester, and we will drop your lowest problem set score. You may do these exercises 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 present 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, including those made on Zoom chat, will be graded. Guest judges may join the course teaching staff in evaluating your performance.

- Slide decks (5% of total grade for 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 for 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 get permission in advance to use their electronic devices. Please silence your phone and put it away during class.

Here is a references to evidence for the curious among you:

- Research has shown that just having your phone out nearby impairs your cognition:  
<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

15.020/15.0201/14.43 Fall 2020

Date	Number	Topic	Notes
9/2 Wed	1	Course introduction	
9/9 Wed	2	Markets, market failures, and policy	PS1 due
9/14 Mon	3	Economics of climate change (I)	
9/16 Wed	4	Economics of climate change (II)	PS2 due
9/21 Mon	5	Transportation - Fuel economy	
9/23 Wed	6	Transportation - Regulating fuel and driving	PS3 due
9/28 Mon	7	Case: Better Place	
9/30 Wed	8	Transportation - Alternative fuel vehicles	Debate I slides due
10/5 Mon	9	Behavioral energy & environmental economics	
10/7 Wed	10	Debate I	
10/12 Mon		Columbus Day Institute Holiday	
10/13 <b>Tue</b>	11	Joskow guest lecture: Electricity intro, supply, demand, & industrial organization	
10/14 Wed	12	Joskow guest lecture: Wholesale electricity market design & resource adequacy	
10/19 Mon	13	Joskow guest lecture: Decarbonizing the Electricity Sector	
10/21 Wed	14	Market power in electricity markets; Introduce ESG	PS 4 due
10/26 Mon	15	Innovation (I) - demand response	Debate II slides due
10/28 Wed	16	Innovation (II) - valley of death & project finance; ESG portfolio auction	ESG Memo 1 due
11/2 Mon	17	Debate II	
11/4 Wed	18	What can individuals and businesses do?	
11/9 Mon	19	Emerging markets (I)	
11/11 Wed		NO CLASS – Veteran’s Day Institute Holiday	
11/16 Mon	20	Emerging markets (II); ESG carbon permit auction	
11/18 Wed	21	Markets for carbon: storage, offsets, & international cooperation	PS5 due
11/23 Mon		NO CLASS – Happy Thanksgiving!	
11/25 Wed		NO CLASS – Happy Thanksgiving!	Debate III slides due
11/30 Mon	22	Debate III	
12/2 Wed	23	ESG debrief; Class review and wrap-up	
12/4 Fri			ESG Memo 2 due