EAS 575: Climate Economics and Policy

Winter 2023 Course Syllabus
(Version: March 3rd, 2023)

Logistics

Lecture: T/Th 10:00-11:20 a.m. (Dana 1028)

Professor: Samuel Stolper (sstolper@umich.edu)

Graduate Student Instructor: Olivia David (odavid@umich.edu)

Website: https://umich.instructure.com/courses/577011

Office Hours: Sam: T 2:30-3:30pm, Th 4:00-5:00pm (Dana 3006)

               Olivia: M 1:15-2:15pm, W 10:45-11:45am (Dana 4046)

About this course

Climate change is an existential threat to all of humanity. It is a truly global collective action problem, whose damages are massive, widespread, unpredictable, and inequitably distributed. How, and how fast, will we decarbonize? In this course, we will investigate these questions from an economic perspective. Economic analysis of the climate problem is valuable for a number of reasons: economics provides a framework for understanding incentives for human behavior; it facilitates the evaluation of markets and policies; and it is a language to which people listen, from the highest levels of government down to the individual household. In this course, we will use the lens of economics to clarify the challenge of climate change, understand market function in emissions-intensive industries, and evaluate the theoretical and empirical impacts of the climate policies at our disposal. We will start by reviewing some foundational economic concepts, as well as modeling and comparing the impacts of market-based and prescriptive policies. In the second unit of the course, we will zoom in on electricity, a sector with enormous greenhouse gas emissions and enormous importance for widespread decarbonization. In the third unit, we will consider several other applications of climate economics: energy efficiency, transportation, food and agriculture, water, nature-based solutions, and carbon neutrality.

Suggested prior coursework: EAS 570. Environmental Economics: Principles, Methods, and Tools; or equivalent coursework elsewhere. If you are not sure you have adequate preparation to take the course, come talk to (or email) me!

Teaching goals and class format

I have designed this course with several teaching goals in mind. Most importantly, I aim for students to:

- Become knowledge experts in the area of climate economics and policy

- Develop a versatile economic intuition, for use in any environmental professional setting

- Become more comfortable with quantitative thinking and analysis

This course meets on Tuesdays and Thursdays from 10:00 to 11:20am in the Dana building, room 1028. Class time will be primarily lecture and discussion, with semi-regular breakout activities. About halfway through the semester, we will begin playing a multi-week, team-based game simulating a wholesale electricity market. Students complete regular readings, periodic quantitative and written assignments, and two quizzes through the course of the semester. Course materials are maintained on the Canvas course website.

Assignments and grading

Assignments give you practice with quantitative analysis and professional writing, as well as illustrating the concepts we learn in this course. Your course grade will be determined according to your performance in these assignments, two quizzes, and participation in course activities. Graded activities are listed below, with numbers in parentheses denoting weights for each activity in the calculation of your final grade.

- Participation (10%): Engagement in the course in keeping with what is outlined above under "Attendance and participation".

- Problem sets (30%): Four problem sets combining graphical/mathematical analysis and qualitative assessment in different settings. We will drop your lowest grade (that is, omit that assignment from final-grade consideration).

- Quizzes (30%): Two in-class quizzes testing your understanding of the relevant unit's course material.

- Electricity game memo (10%): A team writeup of your strategy and experience with the electricity game.

- Policy paper (20%): A 1,000-1,500 word "brief" arguing in favor of a policy of your choosing.

Problem sets and written assignments are due at the beginning of class, unless otherwise stipulated. They should be submitted via Canvas (you are very welcome to handwrite your answers and scan an image of them for submission). Unexcused late submissions will be penalized 5 percentage-points per day, but please let us know if you are having trouble keeping up with deadlines; we will try to be flexible!

I plan to assign final grades according to the following rubric:

- A+: 97-100; A: 93-96; A-: 90-92

- B+: 87-89; B: 80-86; B-: 70-80

- C+: 65-69; C: 60-64; C-:55-60

- D: 50-55

- F: below 50

I may adjust final grades upwards, if assignments turn out to have been harder than expected. I will not adjust final grades downwards.

Assigned media

I have recorded (or will record) about a dozen mini video lectures, which you will be assigned to view throughout the semester but especially earlier on. I aim for these lectures to be 10-15 minutes each, and you may be assigned 1 or 2 (or 0) of them for a given class. They will focus on economic modeling of and measurement in relevant markets, policies, etc.

You will also be assigned 1-2 other pieces of media per class – mostly articles from news sources, blogs, and academic journals, as well as a few podcast episodes. I purposefully assign modest reading loads, to encourage you each to do all of the readings. I also have added optional readings to some classes, for those with further interest in what I think is interesting/important with regard to a given topic.

During the first unit of the course, there are several optional readings from a textbook – Nathaniel O. Keohane and Sheila M. Olmstead, <u>Markets and the Environment</u>, 2nd Edition (2016). These readings provide helpful context and support for the content of my earlier lectures. The textbook is available in digital form from the University of Michigan library system, at <https://ebookcentral-proquest-com.proxy.lib.umich.edu/lib/umichigan/detail.action ?docID=4787531>.

A few of the assigned readings come from the blog run by the Energy Institute at Haas, based at the University of California Berkeley, Haas School of Business. There is an excellent group of environmental and energy economists at Berkeley, and I encourage you to peruse the blog (https://energyathaas.wordpress.com/) beyond the assigned readings.

Other course policies

Attendance and participation: I expect you to attend class and to enter the classroom on time. However, you may miss up to three class meetings without excuse, and we will be understanding about conflicts or other challenges to attendance, so please talk to us if you need to miss a class. I expect you to participate in breakout sessions, speak or chat in the larger group at least occasionally, and show respect for everyone else in the course.

Device policy: Laptops, tablets, and phones are not generally allowed open in class. While they can certainly aid in your learning in a variety of ways, they also inevitably draw your attention away from class lecture and discussion. If you feel that you need a device to learn, please write or come talk to me about it.

Office hours: Office hours are an opportunity for you to come talk to us about any number of things, including: questions about any element of the course; careers; environmental issues in general; or your well-being at school or otherwise. The first page of this syllabus lists Olivia's and my tentative office hours schedule. If at any point you would like to meet with us but cannot make any of the regular office hours, just email us!

Correspondence: We will try to get back to your emails within 24 hours. Please note EAS 575 in your subject line. If you plan on asking multiple involved questions, please come to office hours or schedule a meeting.

Grade grievances: You must submit requests for a re-grade within one week of receiving the original grade. You must also attach the original graded item and provide a clear written explanation of what you would like to be re-evaluated and why. Your adjusted grade may be higher or lower than the original.

Work ethic: Do not plagiarize. If you paraphrase or copy work that is not your own, you must reference that work. The risk of plagiarizing is not worth the reward. More generally, cheating and academic dishonesty in any form will not be tolerated. Any student found to have cheated or behaved unethically or dishonestly will be given a zero on the assignment or exam involved and referred to the appropriate disciplinary committees at U of M.

Resources for learning and well-being

I am actively trying to create an economics course that reflects a commitment to diversity, equity, and inclusion. To that end, I aspire to build a reading list that features diverse perspectives, create a classroom environment that promotes open and respectful dialogue, and shine a light on distributional considerations in climate change and climate policy. Please tell me if any element of your course experience does not match this stated intent. I will very much appreciate your thoughts.

Below are a few learning resources, available through the University, that may be helpful to you:

- The Sweetland Center for Writing offers one-on-one writing assistance, among many other services. It also offers mini-courses and casual conversation groups for international students or anyone wanting to improve their English.

- The English Language Institute provides a variety of resources for international students.

- The Services for Students with Disabilities (SSD) office coordinates accommodations for disability. Come talk to us if this applies to you, so that we can make those accommodations as soon as possible.

And here are some resources for well-being at UM:

- [Campus Maize and Blueprint](#) is the online hub for UM news and information related to COVID-19.

- The UM Office of Student Life provides [resources for student well-being](#).

- The Rackham Graduate School offers a resource for [Supporting Graduate Students During Stressful Times](#), prepared by the Mental Health Task Force.

- [Counseling and Psychological Services](#) (CAPS) provides confidential support options for any issue including stress, mood changes, and problems with eating and/or sleeping. CAPS now has a dedicated staff member for SEAS, Andrea Sieg (andsieg@umich.edu).

Course calendar

Date	Day	#	Unit	Assignment Due
1/5	Th	1	Introduction	
1/10	T	2	Markets	
1/12	Th	3	Externalities	
1/17	T	4	Impacts of climate change	
1/19	Th	5	Impacts of policy	Problem set 1
1/24	T	6	Theory of market-based policy	
1/26	Th	7	Critical perspectives on market-based policy	
1/31	T	8	Review	Problem set 2
2/2	Th	9	Quiz	
2/7	T	10	Inflation Reduction Act	
2/9	Th	11	Electricity I: Overview	
2/14	T	12	Electricity II: Electricity Strategy Game	
2/16	Th	13	Electricity III: Costs of electricity production	
2/21	T	14	Electricity IV: Intermittency and PPAs	Problem set 3
2/23	Th	15	Electricity V: Emissions impacts, policy, and siting	
2/28	T	–	NO CLASS – VACATION	
3/2	Th	–	NO CLASS – VACATION	
3/7	T	16	Electricity VI: ESG auction	
3/9	Th	17	Electricity VII: Retail electricity	
3/14	T	18	Review	
3/16	Th	19	Quiz	
3/21	T	20	Energy efficiency	
3/23	Th	21	Transportation I: Electric vehicles	
3/28	T	22	Transportation II: Public transit	Problem set 4
3/30	Th	23	Food and agriculture	
4/4	T	24	ESG debrief	ESG memo
4/6	Th	25	Water	
4/11	T	26	Nature based solutions	
4/13	Th	27	Climate action in Michigan	
4/18	T	28	Carbon neutrality	Policy paper

Detailed course schedule

Class #1 – January 5. Introduction

No readings

Class #2 – January 10. Markets

Readings/viewings

1. Recorded lecture: marginal cost and marginal benefit
2. Recorded lecture: equilibrium
3. Kilian, Lutz and Xiaoqing Zhou. "Gasoline Demand More Responsive to Price Changes than Economists Once Thought." Federal Reserve Bank of Dallas, June 16th, 2020.
4. *(Optional)* KO: Chapter 3, pp. 44-55; Chapter 4, pp. 69-79.

Class #3 – January 12. Externalities

Reading/viewing/listening

1. Recorded lecture: negative externalities
2. Klein, Ezra with Leah Garcés. "The Hidden Costs of Cheap Meat." *The Ezra Klein Show.* November 29th, 2022.
3. Naam, Ramez. "How to decarbonize America – and the world.." TechCrunch, Feburary 15th, 2019.
4. *(Optional)* KO: Chapter 5, pp. 80-85.

Class #4 – January 17. Impacts of climate change

Readings

1. Hsiang, Solomon, Robert Kopp, Amir Jina, James Rising, Michael Delgado, Shashank Mohan, D.J. Rasmussen, Robert Muir-Wood, Paul Wilson, Michael Oppenheimer, Kate Larsen, and Trevor Houser (2017). "Estimating Economic Damage from Climate Change in the United States." *Science* 356: 1362-1369.
2. Carleton, Tamma and Michael Greenstone (2022). "A Guide to Updating the US Government's Social Cost of Carbon." *Review of Environmental Economics and Policy* 16(2):196-218.

Class #5 – January 19. Impacts of policy

Readings/viewing

1. Recorded lecture: pass-through and elasticities
2. Recorded lecture: policy impacts

3. (*Optional* Fullerton, Don (2011). "Six Distributional Effects of Environmental Policy." *Risk Analysis* 3(6): 923-929.
4. *(Optional)* Hernández-Cortés, Danae and Kyle C. Meng (2022). "Do Environmental Markets Cause Environmental Injustice? Evidence from California's Carbon Market." *Journal of Public Economics* 217: 104786.

Assignments

1. Problem set 1 due

Class #6 – January 24. Theory of market-based policy

Readings/viewing

1. Recorded lecture: emissions tax
2. Recorded lecture: cap-and-trade
3. Recorded lecture: cost-effectiveness
4. Rabe, Barry G. Chapter 1 in <u>Can We Price Carbon?</u>, Cambridge: MIT Press, 2018.
5. *(Optional)* KO: Chapter 8, pp. 143-162; 168-184.

Class #7 – January 26. Critical perspectives on market-based policy

Readings

1. Stokes, Leah and Matto Mildenberger. "The Trouble with Carbon Pricing." The Boston Review, September 24th, 2020.
2. (Some part of) Climate Justice Alliance and Indigenous Environmental Network. "Carbon Pricing: A Critical Perspective for Community Resistance." Volume 1, 2017.
3. (*Optional*) Wall Kimmerer, Robin. "The Gift of Strawberries", in <u>Braiding Sweetgrass</u>, Milkweed Editions, 2015.

Class #8 – January 31. Review

No readings

Assignments

1. Problem set 2 due

Class #9 – February 2. Quiz

Class #10 – February 7. Inflation Reduction Act

Listening

1. Klein, Ezra with Jesse Jenkins. "The Single Best Guide to Decarbonization I've Heard." *The Ezra Klein Show.* September 20th, 2022.

Class #11 – February 9. Electricity I: Overview

Readings/viewing

1. Recorded lecture: electricity systems
2. "Energy Data Explorer". *Our World in Data*, 2021.
3. (Optional) "Electricity Explained: How Electricity is Deliver to Consumers." *Energy Information Administration*, last updated August 31st, 2018.

Class #12 – February 14. Electricity II: The Electricity Strategy Game (ESG)

Readings

1. ESG instructional materials

Class #13 – February 16. Electricity III: costs of electricity production

Readings

1. Lazard. "Levelized Cost of Energy, Version 15.0." October 28th, 2021.
2. (*Optional*) Sengupta, Somini. "The Shift to Renewable Energy is Speeding Up. Here's How." *The New York Times*, January 31st, 2023.

Class #14 – February 21. Electricity IV: intermittency and PPAs

Readings

1. Wolfram, Catherine. "Is the Duck Sinking?" *Energy Institute Blog*, University of California – Berkeley, April 24th, 2017.
2. Noor, Dharna. "The U.S. Needs a Supergrid." *Earther*, February 24th, 2021.
3. Kansal, Rachit. "Introduction to the Virtual Power Purchase Agreement." Rocky Mountain Institute, November 2018.

Assignments

1. Problem set 3 due

Class #15 – February 23. Electricity V: emissions impacts, policy, and siting

Readings

1. Recorded lecture: renewables, pollution, policy, and siting

2. Borenstein, Severin. "Finding Homes for Wind and Solar." *Energy Institute Blog*, University of California – Berkeley, April 26th, 2021.
3. Raimi, Daniel with Sarah Mills. "Who Wants Wind and Solar in Their Communities?" *Resources Radio.* December 13th, 2022.

February 28. NO CLASS – VACATION

March 2. NO CLASS – VACATION

Class #16 – March 7. Electricity VI: ESG auction

In class: electricity game portfolio auction

Class #17 – March 9. Electricity VII: retail electricity

Readings

1. Recorded lecture: retail electricity
2. Roth, Sammy. "California just slashed rooftop solar incentives. What happens next?" *Los Angeles Times*, December 15th, 2022.
3. Davis, Lucas and Catherine Hausman. "Who Will Pay for Legacy Utility Costs?" *Energy Institute Blog*, University of California – Berkeley, July 6th, 2021.
4. (*Optional*) Borenstein, Severin. "Rationalizing Compensation for Rooftop Generation." *The Energy Institute* blog, University of California – Berkeley, December 14th, 2022.

Class #18 – March 14. Review

No readings

Class #19 – March 16. Quiz

Class #20 – March 21. Energy efficiency

Readings

1. Recorded lecture: energy efficiency
2. Berkouwer, Susanna and Joshua T. Dean. "Can energy efficiency subsidies improve welfare in low-income countries? Evidence from Kenya says yes." *VoxDev*, May 25th, 2020.

3. Reames, Tony (2016). "Targeting energy justice: Exploring spatial, racial/ethnic, and socioeconomic disparities in urban residential heating energy efficiency." *Energy Policy* 97: 549-558.

Class #21 – March 23. Transportation I: electric vehicles

Readings

1. Springel, Katalin. "It's Not Easy Being "Green": Lessons from Norway's Experience with Incentives for Electric Vehicle Infrastructure." *Review of Environmental Economics and Policy* 15(2): 352-359.
2. Carreon, Alessandra, EJ Klock-McCook, Sudeshna Mohanty, Caitlin Odom, Charles Teplin, and Sarah Toth. "Increasing Equitable EV Access and Charging: A Path Forward for States." Rocky Mountain Institute, October 2022.
3. (*Optional*) Maximilian Auffhammer. "The EV Revolution Will Be Heavily Subsidized." *Energy Institute Blog* at UC Berkeley, January 28th, 2019.
4. (*Optional*) Campbell, Andrew. "Electric Vehicles for Renters: Getting Landlords to Act." *Energy Institute Blog* at UC Berkeley, January 18th, 2022.

Class #22 – March 28. Transportation II: public transit

Readings

1. Manville, Michael, Brian D. Taylor, and Evelyn Blumenberg (2018). "Transit in the 2000s: Where Does It Stand and Where Is It Headed? *Journal of Public Transportation* 21(1): 104-118.
2. Schaper, David. "Public transit is having a slow comeback after the pandemic." *National Public Radio*, September 11th, 2022.
3. Auffhammer, Maximilian. "Riders on the Strom*?" *Energy Institute Blog* at UC Berkeley, February 13th, 2023.

Assignments

1. Problem set 4 due

Class #23 – March 30. Food and agriculture

Readings

1. Ritchie, Hannah. "Food production is responsible for one-quarter of the world's greenhouse gas emissions." *Our World in Data*, November 6th, 2019.
2. Johnson, Ayana Elizabeth and Alex Blumberg. "Soil: The Dirty Climate Solution." *How to Save a Planet*, January 2021.

Class #24 -April 4. ESG debrief

No readings

Assignments

1. ESG memo due

Class #25 – April 6. Water

Readings

1. Kumar-Rao, Arati. "India's water crisis could be helped by better building, planning." *National Geographic.* July 15th, 2019.
2. Smith, Stacy Vanek and Robert Smith. "The Bottom of the Well." *Planet Money* Episode 640. July 22nd, 2015.

Class #26 – April 11. Nature-based solutions

Guest lecturer: Michael Moore (SEAS)

Readings

1. Fargione, Joseph E. et al. (2018). "Natural climate solutions for the United States." *Science Advances* 4.
2. (*Optional*) Noon, Monica L., Allie Goldstein, Juan Carlos Ledezma, Patrick R. Roehrdanz, Susan C. Cook-Patton, Seth A. Spawn-Lee, Timothy Maxwell Wright, Mariano Gonzalez-Roglich, David G. Hole, Johan Rockstrom, and Will R. Turner (2022). "Mapping the irrecoverable carbon in Earth's ecosystems." *Nature Sustainability* 5: 37-46.
3. (*Optional*) Coffield, Shane R., Cassandra D. Vo, Jonathan A. Wang, Grasyon Badgley, Michael L. Goulden, Danny Cullenward, William R.L. Anderegg, and James T. Randerson (2022). "Using remote sensing to quantify the additional climate benefits of California forest carbon offset projects." *Global Change Biology* 28: 6789-6806.

Class #27 – April 13. Climate action in Michigan

Readings

1. Michigan Department of Environment, Great Lakes, and Energy (2022). "MI Healthy Climate Plan."

Class #28 – April 18. Carbon neutrality

Readings

1. Tabuchi, Hiroko. "Switzerland Is Paying Poorer Nations to Cut Emissions on Its Behalf." *The New York Times*, November 10th, 2022.
2. Sallee, James. "Voluntary Green Power to the Rescue?", *Energy Institute Blog* at UC Berkeley, August 1st, 2022.

Assignments

1. Policy paper due