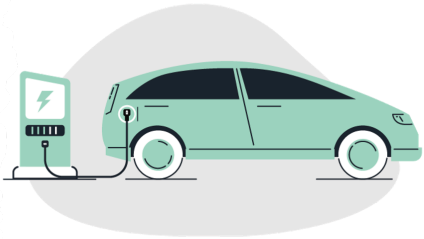
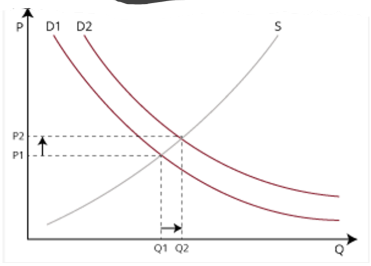
Energy Economics and Markets

ESM 286 - Spring 2025 | Professor Ranjit Deshmukh





Course description
The energy sector is undergoing a profound transition as we move towards lower carbon resources, phase out fossil fuels, and increasingly electrify end-uses. The direction and pace of this transition to a large extent, will depend on the evolving economics of different energy technologies and fuels, and the markets and regulations that govern different energy subsectors. Drawing on concepts, methods, and examples from engineering and economics, we will cover a range of topics including wholesale electricity and fossil fuel markets, electric power systems, energy project valuation, electricity planning and resource adequacy, auctions, retail rate design, externalities, and energy equity and justice.

Professor: Ranjit Deshmukh (Run-jeet They-sh-mook / RD) (he/him/his)
Office: Bren Hall 4003 (Laboratory floor 4L)
Mailbox: Environmental Studies Program, 4312 Bren Hall
Email: rdeshmukh@ucsb.edu
Office Hours: Wednesdays 2 pm-4 pm
(Sign up for OH. Link also on Canvas. Send an email if you can't make OH.)
Class time and location: Tuesdays and Thursdays at 2:00 - 3:15 am in Bren Hall 1424
Communication : Add "ESM 286" in the subject line of all email communication

Instruction
Lectures will be in person unless there is a change in University policy.

Readings
There are no assigned textbooks for this class, but the following books are great references.
Electric Power Systems - A conceptual introduction - Alexandra Von Meier
Fundamentals of Power System Economics - Kirschen and Strbac
Economics of Regulation and Antitrust - Viscusi, Harrington, and Vernon

I will post reading assignments every week on Canvas. The reading list, which will include academic papers, reports, and news articles will evolve as the course progresses.

Evaluation

Participation	10%
Group assignment (Project valuation)	30%
Electricity Market Game + Strategy Memos	30%
Group Presentations and short paper	30%

Project valuation assignment
The goal of this assignment is to estimate renewable energy generation from renewable resource data, develop an understanding of electricity markets and locational marginal prices, and understand the concepts of cost and value.

In this group assignment, you will estimate the value of a renewable energy (and storage) project. You will choose to build both a solar PV and a wind project at locations that you will identify using renewable resources and other infrastructure and environmental spatial data sets. You will then create generation profiles for your project based on weather (resource) data and estimate the levelized cost of energy based on various cost parameters and government incentives. You will then estimate the value of your project using both, historical locational marginal prices and future expected wholesale energy prices to understand how the value of an energy generation project may change as the power system decarbonizes in the future. Lastly, you will add a battery storage asset at your site to analyze how that might affect the cost and value of your project.

Electricity Markets Game
The objective of this game is to develop an understanding of wholesale electricity market planning and operations. In this group project, you will estimate the value of different generation portfolios and then be given an opportunity to buy a generation portfolio through an auction. Your group will then compete with the other groups by selling your electricity on the market to maximize your profits. Multiple scenarios will be introduced including a carbon tax and a cap and trade market. Your group will be required to submit memos to explain your strategies and learnings in the capacity and energy auctions.

Special Topic project
This is a group project assignment to explore new entities in the electricity sector who are adding a unique value to the sector OR a key policy, regulation, or market mechanism that has especially been a part of recent debates. This is an opportunity for you to explore unique and new business models, go deeper into a topic of your interest, and educate your peers.

Your group will select a topic on either
(a) a sector entity (e.g. OPower, a company trying to change consumer behavior and encourage energy efficiency, A Community Choice Aggregator aiming to procure green power for its consumers, or a solar-storage project developer trying to derive value from its investment); OR
(b) a policy, regulation, or market mechanism (e.g. the Energy Imbalance Market, which is trying to increase the geographical footprint of balancing areas, the Federal Energy Regulatory Commission's Demand Response and Storage rule, or the California Independent System Operator's resource adequacy requirements)

You will identify 3-5 readings and write a brief on your topic that you will share with the rest of the class. The brief will include a short description of your topic, key points in the shared readings, and key debates linking your topic to the larger energy sector. Finally, your group will give a presentation and lead a discussion in class. The purpose of the brief is to introduce your peers to your topic before your final presentation so that they can meaningfully participate in the discussion.

Laptops/tablets/phones
Please use laptops or tablets only for taking notes in class. Using your laptops, tablets, or phones for chatting, email, browsing the internet, and other non-class related activities are not only a distraction for you, but it unfairly affects the learning of your fellow students.

Resources

The Mental Health Peer Program (MHPP) is a UCSB campus resource offering guidance with regard to stress management, anxiety, depression and other related challenges. They offer a range of resources, including psychological counseling services and the Test Anxiety Program (for students experiencing mild to moderate anxiety before and/or during an exam). MHPP is located in Counseling and Psychological Services (CAPS), Building 599. Phone consultations are available 24 hours: (805) 893-4411.

Students with disabilities are encouraged to contact the Disabled Students Program to get documentation of needs and to generate suggestions for reasonable accommodation (room 2120 Student Resources Building, phone: 805.893.2668; email: DSP.Help@sa.ucsb.edu). Requests for accommodation via Disabled Students Program will be granted.

If you are facing any challenges securing food or housing, and believe this may affect your performance in the class, you are urged to meet with a Food Security and Calfresh Advocate, who is aware of the broad variety of resources that UCSB has to offer (see their drop-in hours at food.ucsb.edu). You are also urged to contact the professor or teaching assistant if you are comfortable doing so. Please visit food.ucsb.edu for additional resources including Calfresh, the AS Food Bank, and more.

Below is a list of additional student services available on campus. I encourage you to make use of them:

- Campus Advocacy Resource and Education (CARE): http://wgse.sa.ucsb.edu/care/home
- Counseling & Psychological Services http://caps.sa.ucsb.edu
- Educational Opportunity Program (EOP) http://eop.sa.ucsb.edu
- Health and Wellness http://wellness.sa.ucsb.edu
- MultiCultural Center http://mcc.sa.ucsb.edu/
- Non-Traditional Student Resource Center http://wgse.sa.ucsb.edu/nontrad/
- Office of International Students and Scholars http://oiss.sa.ucsb.edu/
- Office of the Ombuds https://ombuds.ucsb.edu/
- Office of Student Life (OSL) http://osl.sa.ucsb.edu/
- Opening New Doors to Accelerating Success (ONDAS) Center: http://www.ondas.ucsb.edu/home
- Resource Center for Sexual and Gender Diversity: http://wgse.sa.ucsb.edu/RCSGD/home
- Transfer Student Center (TSC) http://transfercenter.ucsb.edu
- UCSB Alcohol and Drug Program: https://alcohol.sa.ucsb.edu/

- UCSB Social Work Services: http://studenthealth.sa.ucsb.edu/behavioral-health/social-work
- UCSB Student Health Services: http://studenthealth.sa.ucsb.edu/
- Undergraduate Mentorship Program http://duels.ucsb.edu/academics/academic-success/mentor
- Undocumented Student Services http://www.sa.ucsb.edu/dreamscholars/home
- Veterans' Resource Center: http://www.sa.ucsb.edu/veterans/home
- Women's Center http://wgse.sa.ucsb.edu/WomensCenter/home

Diversity statement

This course focuses on the engineering and economics aspects of energy economics and markets. These systems and markets are not usually designed to address inequities and injustices in society, but we will discuss these institutional failures and potential remedies. I also encourage students to raise relevant issues in class. I expect students to conform to standards of respectful communication with other students and myself throughout the course. We will all adhere to engage in respectful and considerate discussion and debate in the classroom.

Academic Integrity vs. Misconduct

By enrolling at UC Santa Barbara, you agreed to uphold all of the responsibilities within the UCSB Student Conduct Code. We expect all UCSB students to support the ideal of academic integrity. You will be responsible for the integrity of your work. Academic integrity means that anything you submit must be your original work, and that any information you provide to the university (instructors, staff) must be true (e.g., regarding illness, emergencies). Any use of others' work must be properly attributed. Academic misconduct includes (among other things): cheating on assignments or tests; plagiarizing any part of work done by someone else; and submitting the same (or substantially similar) work for two courses without the professor's consent. The strictest disciplinary action will be pursued in all instances of academic misconduct.

This policy does not mean you cannot talk, brainstorm, or collaborate with other students. We encourage students and faculty to interact as much as possible on academic subjects of mutual interests. But when it comes to doing your work, it must be your own.

For more information about academic integrity see the following very helpful and accessible resources at UCSB:

- Academic Integrity at UCSB: A Student's Guide
- OISS's overview of what is academic integrity (including a video!).
- UCSB Writing Program's plagiarism in writing policy (very important in coursework and professionally)

Course schedule

(For the list of required and optional readings, see Canvas)

Week 1	
Tuesday	Overview
Thursday	Electric power system concepts
Week 2	
Tuesday	Project economics + RE project valuation introduction
Thursday	Electricity industry and restructuring
Week 3	
Tuesday	Retail electricity markets and rate design
Thursday	Distributed resources
Week 4	
Tuesday	Wholesale electricity markets
Thursday	Wholesale electricity markets
Week 5	
Tuesday	System planning, capacity markets, resource adequacy (Guest lecture Southern California Edison?)
Thursday	Auctions + Electricity Markets Game Introduction
Week 6	
Tuesday	Competition, monopoly, market power
Thursday	Electricity Markets Game (Portfolio Auction + Energy Auction)
Week 7	
Tuesday	Externalities, Taxes, Tradable Permits
Thursday	Electricity Markets Game w externality pricing (Portfolio Auction + Energy Auction)

Week 8	
Tuesday	Electricity game debrief and Oil markets
Thursday	Oil markets and transportation alternatives (EV economics)
Week 9	
Tuesday	Natural gas markets
Thursday	Economics of natural gas and end-use electrification (heat pump economics)
Week 10	
Tuesday	Group presentations
Thursday	Group presentations

Assignment schedule

(All assignments due before class, even if they are electronically submitted.)

Date	Assignment
Week 4 Thursday	RE project valuation assignment due
Week 7 Tuesday	Electricity Markets Game Strategy memo 1 due
Week 8 Tuesday	Electricity Markets Game Strategy memo 2 due
Week 9 Tuesday	Topic brief and reading list due
Week 10 Tuesday and Thursday	Group presentations