

# SOS 574: Sustainable Energy Analytics

## Course Information

**Days and times:** Tuesday/Thursday, 1:30-2:45 pm.

## Instructor

Danae Hernandez-Cortes ([Danae.Hernandez-Cortes@asu.edu](mailto:Danae.Hernandez-Cortes@asu.edu))

## Course Description

This course will address the primary metrics, data sources, and methodologies used to measure sustainable energy, including how they are used to track progress toward sustainability goals and shape public policies. It covers the metrics for comparing the cost, efficiency, social equity, and environmental impacts of various energy sources. These metrics provide the foundation for assessing the relative merits of various energy and production options based on a variety of possible criteria. In addition to imparting factual knowledge for quantitatively evaluating a multiplicity of energy sources and systems and their impact on the environment, it will build skills in research, comparative analysis and critical thinking that will catalyze a lifetime of engagement with the complex and evolving issues surrounding sustainability.

The course has four main modules.

*Module 1:* introduction to energy markets, regulation of energy markets, and the externalities of energy markets.

*Module 2:* introduction to policy evaluation and causal inference methods applied to the energy sector.

*Module 3:* how to measure the efficiency and equity of energy policy or advances to achieve sustainable energy with applications to electricity policy (traditional sources of energy, renewables, energy efficiency), market-based policy (taxes, cap and trade, carbon offsets), and non-market based policy (emission standards, technology standards).

Given the nature of the course, we will be using R programming for some of the modules. No R knowledge is required and R code will be provided to students.

## Course Learning Outcomes

- Understand energy markets structure and their challenges.
- Understand the basics of causal inference methods for policy analysis applied to energy analysis.
- Understand some of the empirical methods to analyze the efficiency and equity of energy markets and energy policy.

## Course Textbook and Materials

The course will have one textbook for Module 2:

Cunningham, S. (2021). Causal Inference. Yale University Press. Available online for free [\[link\]](#).

The rest of the modules will have assigned readings provided by the instructor and uploaded to Canvas. Given the status of the energy transitions and how dynamic the research in this area is, the course will also incorporate podcasts and news articles as required and optional readings for some of the classes throughout the semester.

## Course content

Module	Topic	Class	Activity
0	Introduction to energy transitions and introduction to the course	01/13/2022	
1	What is a market, supply and demand, market failures	01/18/2022, 01/20/2022	
1	Market failures and market power	01/20/2022	
1	Introduction to energy markets structure: competition, monopoly, natural monopoly	01/25/2022	
1	Introduction to energy markets	01/27/2022	
1	Electricity markets in the United States	02/01/2022	
1	Natural gas markets and renewables	02/03/2022	
1	Energy markets challenges	02/08/2022, 02/10/2022	
1	Energy markets and equity	02/15/2022	
1	Midterm review	02/17/2022	
1	Midterm	02/22/2022	Midterm
2	3-min discussion of final projects Introduction to policy evaluation and why it matters	02/24/2022	
2	Guest speaker: Dr. Jonathan Cook (SRP). Energy markets and analysis in the industry world.	03/01/2022	
2	Review of statistics and regression***	03/03/2022	
	Spring break	03/08/2022, 03/10/2022	
2	Regression methods	03/15/2022	
2	How to run regressions in R	03/17/2022	Hand in data analysis activity 1 (March/19)
2	A brief introduction to standard errors	03/22/2022	
2	Introduction to causal inference methods and RCTs	03/24/2022	
2	Panel Data***	03/29/2022	
2	Difference-in-Differences***	03/31/2022,	Data analysis activity 1 (04/11/2021)
2	More on difference in differences methods	04/05/2022	
3	Nuclear energy analysis	04/07/2022	
3	Solar energy analysis	04/12/2022,	
3	There will not be class	04/14/2022	
3	Energy restructuring analysis and hydrogen	04/19/2021	
3	Guest lecture: Dr. Clark Miller. Energy transitions and the energy poverty nexus	04/21/2022	
3	Electric vehicles analysis	04/26/2022	
3	Energy transitions: moving forward	04/29/2022	
	Finals week	05/04/2022	Assignment 2 and Research activity deadline

## Assessment Details

### 1. Essay about yourself

Including: your name and program information, research interests, why do you want to learn about energy markets/energy analytics, and class expectations.

**Please upload this essay by 11:59 pm on January/11/2022.**

### 2. Midterm 1

This midterm will cover the material Module 1. The midterm includes theoretical math questions and analytical questions. The midterm will only cover material that was covered in class. The instructor will provide a set of sample questions to students.

### 3. Data analysis activities

The instructor will provide two data analysis activity intended to apply the tools learned in class to ask a question related to sustainable energy. In these activities, students will create graphs, run regressions, and interpret regression results guided by a series of question prompts. Students need to provide their R code used during the analysis of the data. Students are encouraged to collaborate but need to present their own R code and analysis of the results.

### 4. Research activity chosen by students: Policy memo/Research proposal/Research paper

The final project in this class is very flexible and depends on the interests of the students. Students can choose among the following options:

- a) Policy memo: research project that analyzes a policy-relevant issue and offer recommendations to policy makers. If you choose this alternative, you will need to use any of the methods covered in Module 2 to analyze a policy question. Students need to find the question, collect the data, analyze the data, and provide policy recommendations.
- b) Research paper on energy markets or energy policies: research project that analyzes a topic in sustainable energy related to Module 1 or Module 3. If you choose this alternative, you can use any method you are familiar with (quantitative or qualitative methods) applied to one of the topics covered in Module 1 or Module 3. The research paper needs to have the structure of an academic article, it needs to have an introduction, literature review, overview of the methods, discussion of the results, and conclusion.

**Please come to office hours in January or early February to discuss 2 or 3 ideas for your research project. Students need to talk to the instructor about their project before starting it to make sure that is feasible.**