

ENERGY/ENVIRON 588.01: Introduction to Solar PV Project Development

Syllabus

Course Logistics

Class Time:	Thursdays, 3:20 PM –5:50 PM
Location:	BioSciences Room 130 Zoom/Remote attendance by advance request only
Instructors:	Scott Starr (scott.starr@duke.edu) Rory Huntly (rory.huntly@duke.edu)
<i>Office Hours:</i>	By appointment; typically before class ~2:30pm EST
Teaching Assistant:	Mallory Poff (mallory.poff@duke.edu)
<i>Office Hours:</i>	Upon request (please email)

Caveat: This syllabus is a work-in-process guide and subject to change at instructors' or assistant's discretion; readings, in particular, may be added and amended regularly.

Course Overview

Historically, while most of the electricity in the U.S. was generated using fossil-based fuels, there is growing supply and demand for power from renewable sources. Market factors and societal pressures are pushing electric utilities, corporations, and individuals to consider, and in many cases, embrace renewable power generation throughout the U.S. Increased regulatory costs threaten the coal industry, while public awareness of climate change drives corporations and municipalities to demand clean electricity. Meanwhile the installed cost of solar power has plummeted over the last ten years. In this course, we will explore these drivers of change while examining how non-residential solar energy projects are developed, financed and built. The intent is to provide a practical introduction to the process of developing non-residential solar projects in the U.S. by examining the major players and steps in a complex process. Students will learn that professionals with expertise in law, engineering, real estate, public policy, regulation, finance, environmental consulting, and construction must work together over a period of years to get a solar generation facility de-risked and built.

The class will cover project siting, how site control is established, and how land use permitting can affect timelines and budgets. We will explore how utilities oversee the interconnection study process, and why uncertainties related to this can make project development difficult. Students will learn about the necessary real estate due diligence steps required to satisfy investors, including title, environmental and cultural resource assessments. We will touch on how states regulate the construction of power generation facilities, and we will explore the financing mechanisms commonly used to provide the capital required to construct a facility. Students will learn the roles of the major stakeholders involved with the development process, with a focus on the “Developer.”

Learning Objectives

This course will provide a foundation of knowledge and a set of tools useful for students interested in solar development, corporate sustainability or the energy industry at large. At the end of the class, students will be able to:

- Understand how public policy affects non-residential solar development, including key aspects of the Inflation Reduction Act (IRA) and state level solar programs and goals
- Define various non-residential solar market segments including utility-scale, community solar, and commercial and industrial
- Define the role of Developer, EPC (Engineering, Procurement, Construction) provider, Lender, Long-term project Owner, and Tax Equity investor
- Apply the tools used in siting and infrastructure evaluation
- Describe the major steps in an interconnection process
- Describe key steps in real estate / siting due diligence
- Describe the critical elements of legal contracts including Power Purchase Agreements, Interconnection Agreements, and EPC agreements
- Describe the commonly used project financing structures, and how solar system value is split amongst stakeholders
- Build a basic financial model to calculate project IRR

Course Requirements and Grading

This course is designed such that students will have a deliverable prior to every class, either in the form of an assignment or a reading summary.

Assignments (70%)

The bulk of the grading from this course will come from four assignments that will be done in teams.

Assignments will be released one week prior to the due date and are due by 11:59 PM on the given date:

- Assignment #1: Site, Land, and Production Analysis | 15%
- Assignment #2: Interconnection and Permitting Analysis | 15%
- Assignment #3: PPA and Financial Analysis | 15%
- Final Presentation | 25%

All team members will receive the same score on the assignment. However, to ensure balanced contribution, I reserve the right to adjust individual grades based on level of contribution, which will be assessed via a peer feedback survey due prior to the last class of the semester.

Reading Summaries (15%)

Reading summaries are due before specific lectures. These summaries are to be completed individually and consist of 300-word write-ups in responses to questions provided on 2-5 brief readings. These assignments will be available one week prior to their due date on Sakai and may be discussed at the beginning of class or by Guest Speakers..

Reading summaries will be scored along the following guidelines:

- 2 points (max): summary answers all provided questions thoroughly and thoughtfully
- 1 point: summary does not address all provided questions and/or misses the point of the questions
- 0 points: reading summary not turned in or turned in late

Attendance & Participation (15%)

With only one class session per week, attendance is critical for learning the ins and outs of renewable project development. The more participation and discussion we have as a group, the better this class will be. This portion of your grade will be based on your attendance and your participation throughout the class.

Late Policy

Assignments must be uploaded to Sakai by the posted due date. Assignments handed in after the posted deadline will incur a 25 percent penalty for each 24-hour period they are late. Assignments submitted more than 3 days after the posted due date and time will receive a grade of zero.

Reading summaries turned in after the deadline will be given zero credit.

Duke Community Standard:

Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and nonacademic endeavors, and to protect and promote a culture of integrity. **The Pledge:** Students affirm their commitment to uphold the values of the Duke University community by signing a pledge that states: **To uphold the Duke Community Standard:** I will not lie, cheat, or steal in my academic endeavors; I will conduct myself responsibly in all my endeavors; and I will act if the Standard is compromised.

Course Schedule

Lecture	Date	Topic	Reading/Assignment (subject to change)
1	8/29	Introduction & Energy Trends	<ul style="list-style-type: none"> None
2	9/5	Solar Technology & Solar Project Development Intro	<ul style="list-style-type: none"> Solar Energy Industries Association (SEIA) - US Solar Data Cheat Sheet Solar Basics - Components and Terms (NCSP) Solving the Renewable Energy Project Development Puzzle - (R. Huntly) Reading Summary #1 Due
	9/12	No Class	<ul style="list-style-type: none"> Renewable Energy+ Convention in Anaheim, CA
3	9/19	Solar Public Policy & Regulatory <i>Guest Speaker:</i> Tyler Norris J.B. Duke Fellow & PhD student, Energy Systems	<ul style="list-style-type: none"> FERC 101: Electricity Regulation and the Federal Energy Regulatory Commission An Introductory Guide to Electricity Markets Regulated by FERC Policies and Regulations for Renewable Energy. (Read single sections of interest) What are public utility commissions? A beginner's guide. Reading Summary #2 Due
4	9/26	Siting & Land Control <i>Guest Speaker:</i> Carson Harkrader CEO, Carolina Solar	<ul style="list-style-type: none"> Solar Energy Industries Association (SEIA): Guide to Land Leases for Solar Broker's Guide: How to Find a Suitable Solar Site Realtors Land Institute: The Top Three Real Estate Title Issues Realtors Need to Know Klavens Law Group: Know Your Title - Managing Real Estate Title Risks in Project Development Reading Summary #3 Due
5	10/3	Due Diligence, Interconnection & Project Engineering <i>Guest Speaker:</i> Daniel Copple VP Risk Management, Leyline Renewable Capital <i>Duke MEM</i>	<ul style="list-style-type: none"> Sandia National Laboratories: Utility-Scale Photovoltaic Procedures and Interconnection Requirements (pages 18-26) FERC: The Federal Energy Regulatory Commission's Open Access Rule Assignment #1 Due @ 11:59pm the day before class
6	10/10	Land Use Permitting <i>Guest Speaker:</i> Lyra Perez Dumdum Senior Project Developer, EIP Energy Storage	<ul style="list-style-type: none"> Town of Farmville Solar Overlay District A Battle is Raging Over the Largest Solar Farm East of the Rockies - NPR Concerned Citizens of Spotsylvania Website Reading Summary #4 Due

7	10/17	PPAs, Offtake, & Community Solar <i>Guest Speaker:</i> TBD	<ul style="list-style-type: none"> • Environmental Protection Agency (EPA): Solar Power Purchase Agreements • Overseas Private Investment Corporation (OPIC): Important Features of Bankable Power Purchase Agreements for Renewable Energy Power Projects • Assignment #2 Due @ 11:59pm the day before class
8	10/24	Financial Modeling & Project Finance	<ul style="list-style-type: none"> • Project Finance Primer for Renewable Energy Projects_WSGR Law Firm • USDOE_Introduction to Renewable Energy Project Finance Structures_2012 • Cost of Capital_2024 Outlook_Norton Rose Fulbright - February 2024 • Reading Summary #5 Due
9	10/31	Project Management & EPC <i>Guest Speakers:</i> Jim Halley, Director of Development Engineering at Urban Grid	<ul style="list-style-type: none"> • Halloween! Shortened Class
10	11/7	Developer Trends & Investment Exercise <i>Guest Speaker:</i> Adam Medoff, Principal, Lacuna Sustainable Investments	<ul style="list-style-type: none"> • Solar Industry Association Solar Market Insight • Assignment #3 Due @ 11:59pm the day before class
	11/14	No Class	<ul style="list-style-type: none"> • Duke Energy Week
11	11/21	Battery Energy Storage <i>Guest Speaker:</i> Ron deFelice Co-Founder & Managing Partner Energy Intelligence Partners	<ul style="list-style-type: none"> • U.S. Energy Storage Monitor, Executive Summary - Wood Mackenzie • Reading Summary #6 Due
	11/28	No Class (Thanksgiving)	<ul style="list-style-type: none"> • Final Project Preparation
12	12/5	Final Presentations	<ul style="list-style-type: none"> • Final Presentation Due @ 11:59pm the day before class