ENERGY 590-5: Introduction to Solar Project Development Syllabus

Course Logistics
Class Time: Wednesday, 3:05 PM – 5:35 PM
Location: Gross Hall 100C (The Generator)
Number of Credits: 3 (graduate), 1 (undergraduate)

Instructor: Cullen Morris (cullen.morris@duke.edu), founder of Cooperative Solar
Office Hours: Wednesdays, 2 PM – 3 PM, Gross Hall 100B (adjacent to the Generator)

Teaching Assistant: Mike Penansky (michael.penansky@duke.edu)
Office Hours: Upon request (please email Mike)

Course Overview
While most of the electricity in the U.S. is generated using fossil based fuels, there is growing demand for power from renewable sources. Market factors and societal pressures are pushing electric utilities to consider, and in some 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 and wind power has plummeted over the last ten years. In this course, we will explore these drivers of change while examining how utility-scale solar energy projects are built. The intent is to provide a practical introduction to the process of developing utility-scale 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 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 management 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 utility-scale solar development
- Define the role of developer, sponsor, EPC (Engineering, Procurement, Construction) provider, lender, 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 due diligence
Describe the critical elements of a legal contract including Power Purchase Agreement, Interconnection Agreement, and EPC agreement

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% | due Tuesday, 2/18
- Assignment #2: Interconnection, Utility, and Market Analysis | 15% | due Tuesday, 3/3
- Assignment #3: PPA and Financial Analysis | 20% | due Tuesday, 3/24
- Final Presentation | 20% | due Tuesday, 4/7

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%)
Seven reading summaries are due before lectures 2, 3, 4, 5, 7, 9, and 11. These summaries are to be completed individually and consist of 300-word write-ups in responses to questions provided on 2-3 brief readings. These assignments will be available one week prior to their due date on Sakai.

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

Participation (15%)
With only one class session per week, attendance is critical for learning the ins and outs of renewable project development. Please email Mike ahead of class if you are not able to attend 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

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<thead>
<tr>
<th>Lecture</th>
<th>Date</th>
<th>Topic</th>
<th>Reading/Assignment</th>
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<tbody>
<tr>
<td>1</td>
<td>1/15</td>
<td>Introduction &amp; Solar Equipment</td>
<td>● National Renewable Energy Laboratory (NREL): Facility-Scale Solar Photovoltaic Guidebook, Section 3 on PV System Components (pg. 8-17)  &lt;br&gt; ● Solar Power Online: Solar Inverters and Clipping</td>
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<tr>
<td>5</td>
<td>2/12</td>
<td>Real Estate</td>
<td>● Shelby Star: Shelby Places New Zoning Restrictions on Solar Farms  &lt;br&gt; ● Midwestern News: Small Communities and Counties Struggle to Zone Big Solar  &lt;br&gt; ● Solar Energy Industries Association (SEIA): Guide to Land Leases for Solar  &lt;br&gt; ● Klavens Law Group: Know Your Title - Managing Real Estate Title Risks in Project Development  &lt;br&gt; ● Realtors Land Institute: The Top Three Real Estate Title Issues Realtors Need to Know  &lt;br&gt; ● Sample Ground Lease Agreement <em>(reference only – will be used in class)</em></td>
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<tr>
<td>6</td>
<td>2/19</td>
<td>Engineering, Procurement, &amp; Construction</td>
<td><strong>Assignment #1 due 2/18; no reading summary (lecture prep only)  &lt;br&gt; ● Solar Power World: An EPC Can Help Make Your Solar Project A Reality</strong></td>
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<td>Date</td>
<td>Event</td>
<td>Guest Speaker/Details</td>
<td>Reading/Assignment Notes</td>
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<td>7</td>
<td>2/26 Utility Interconnection</td>
<td>John Gajda, Manager of Operations Support</td>
<td>Duke Energy</td>
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<td>8</td>
<td>3/4 Power Purchase Agreements</td>
<td>Bill DuFour, Partner</td>
<td>DuFour Conapinski</td>
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<td>9</td>
<td>3/18 Project Management</td>
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<td>No reading summary due</td>
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<td>10</td>
<td>3/25 Project Finance</td>
<td>Patrick McConnell, Co-Founder and Partner</td>
<td>Lacuna Sustainable Investments</td>
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<td>11</td>
<td>4/1 Developer Landscape &amp; Trends</td>
<td>Latham Grimes, Principal &amp; Co-Founder at Cooperative Solar</td>
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<td>12</td>
<td>4/8 Final Presentation; Energy Storage</td>
<td>Ron DiFelice, Co-Founder &amp; Managing Director at Energy Intelligence Partners</td>
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<td>13</td>
<td>4/15 Final Presentation</td>
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