Northwestern | INSTITUTE FOR SUSTAINABILITY AND ENERGY

Course Syllabus
ISEN 440 *Energy Infrastructure Development and Finance*
Winter 2021

Northwestern University

Instructor – Tom O'Flynn - thomas.oflynn@northwestern.edu
Tom O'Flynn has spent over 30 years in the energy and finance industry. He was with AES Corporation from 2012 until October 2020, serving as Executive Vice President and Chief Financial Officer from Sept. 2012 – Dec. 2018 and also as Head of U.S. Renewable Energy and following that as CEO/ CIO of AES Infrastructure Advisors. Prior to AES, Tom's previous roles included 1) Senior Advisor to the Private Equity Group of The Blackstone Group, 2) Chief Financial Officer of PSEG, a New Jersey-based merchant power and utility company and President of PSEG Energy Holdings, 3) and various positions within leadership of the Global Power and Utility Group of Morgan Stanley. Tom is based in New Jersey.

Teaching Assistant – Matt Calvi
Matt Calvi is an Investment Associate at New Fortress Energy, a global power and energy infrastructure developer. Prior to NFE, Matt worked with Tom as an Investment Associate at AES Corporation and as an Associate at CIBC Global Infrastructure and Power Investment Banking Group.

Expected Guest Lecturers

- **Paul Astolfi** - Partner, Mayer Brown, co-lead of the Global Projects Group and the Infrastructure Team
- **Stephen Byrd** - Equity Analyst, Managing Director, Morgan Stanley
- **Ryan Creamer** - CEO sPower
- **Woody Rubin** - CEO, AES Distributed Energy
- **Sandip Sen** - Managing Director, Global Power, Citigroup

Office Hours: Tuesdays from 11:30 a.m. to 12:30 p.m.
Class Timing: Winter Quarter 2021, January 4 - March 12, 2021; 12:30 to 1:50 p.m. in Tech L211 (map)
Finals: March 15 - 19, 2021

Course Synopsis
This course takes students through the design, permitting, financing, and implementation process of large-scale energy infrastructure developments, solar, wind, electricity storage, natural gas and hydro facilities.

Course Goals
The objective of this course is to help students gain an understanding of the financial, legal, policy and operations factors affecting the projected lifetime value of various electric energy systems. Through lectures, guest speakers, financial modeling and case studies, students will learn how to quantify business opportunities tied to new energy infrastructure, understand the motivations and interaction of various stakeholders, and optimize the selection of a site, entity structure, finance partners, and proposed offtake customers. There will be a focus on renewable energy, particularly solar, wind, storage

and other related technologies. At the end of this course, a student should:

- Detail the factors which must be considered when assessing the suitability of a new energy infrastructure project;
- Understand the distribution of risk interest and capacity among project stakeholders, including developers, project finance lender, and infrastructure equity investment firms;
- Understand and evaluate the capital stack of a renewables project including tax equity, debt and sponsor equity
- Stipulate a detailed financial project IRR given various project entity structure, financing and power offtake agreements

Prerequisites

A basic working level of excel is recommended. Students will be asked to build and analyze project finance forecasting models. Each student will be asked to construct a fairly simple, multi-year forecast model in week #2. There will also be three subsequent cases that will involve more detailed forecasting that will be performed in teams of 3 to 5 students.

Grading/Assessment

All questions and problems regarding grades must be presented in writing within one week after the test, homework, or project has been returned. The grading scale is fixed, please do not wait until the end of the quarter if you are concerned about the direction of your grade. Grades will be assigned based on all the work you have completed during the semester using the following scale:

A	93.333 to 100	**C**	73.333 to 76.666
A-	90.000 to 93.333	**C-**	70.000 to 73.333
B+	86.666 to 90.000	**D+**	66.666 to 70.000
B	83.333 to 86.666	**D**	63.666 to 66.666
B-	80.000 to 83.333	**D-**	60.000 to 63.333
C+	76.666 to 80.000	**F**	< 60.000

Grading will be based 10% on class participation, 20% on a mid-term exam, 25% on a final and 45% on written assignments, primarily case studies. Written assignments will include case studies, which will be roughly 3-5 pages in nature along with scenario analysis performed in excel. Class participation will include ownership and mastery of discussion topics.

Component	Weight	Details	Due
Case Studies	45%	See below	Weeks #3, 5, 7, and 9
Mid-term	20%	Written exam – will cover all lecture and reading material in first half of course (through Week #5)	Week #6
Final	25%	Written exam – will cover all lecture and reading material	Week #10
Participation	10%	Based on attendance and instructor assessment of preparation and participation in class on a weekly basis	All quarter

Case Studies

There will be one financial modelling assignment, performed individually and three Case Study assignments, performed in teams of 3 to 5 students. Case studies in weeks 5, 7, and 9 will be performed in assigned teams. Cases will be assigned in one week and due the Friday of the following week (students will have at least eight days to complete). The Case will be reviewed in class the Tuesday following submission.

Case	Weight	Details	Due
Solar Modeling Exercise	5%	Short scenario with summary review and analysis including excel model	Week 3
Solar Case Study	10%	Solar case study, review primary considerations and alternatives, financial modeling with capital stack to include debt, sponsor equity	Week 5
Solar + Storage Case Study	15%	Solar + battery storage case study, review primary considerations and alternatives, financial modeling with capital stack to include debt, tax equity, sponsor equity	Week 7
Wind Case Study	15%	Solar + battery storage case study, review primary considerations and alternatives, financial modeling with capital stack to include debt, tax equity, sponsor	Week 9

Course Readings

Weekly discussions will draw on materials for the below texts, reports, and primers. Renewable Energy Finance, Theory and Practice by Raikar and Adamson is a required text and should be purchased. It is available through Amazon and other retailers. The other materials will be provided or are available online, at no charge. The instructor may also assign a number of industry news services to discuss timely/current updates in Project Finance that are illustrative of core course topics.

- Santosh Raikar, Seabron Adamson, "Renewable Energy Finance, Theory and Practice": Academic Press, 2019 **(REQUIRED TEXT) ("REF" in below Class Outline)**
- Charles Donovan, "Renewable Energy Finance: Powering the Future" (ICP, 2015)
- U.S. EIA Energy Outlook
- RPS Standards, Berkeley DOE, 2019
- Fitch Renewable Energy Project Rating Criteria
- Lazard LCOE Report
- Google 24x7 carbon free energy data centers
- Wood Mackenzie Market Methodology
- PJM Market review
- International Renewable Energy Agency (IRENA), "Unlocking Renewable Energy Investment: The Role of Risk Mitigation and Structured Finance" (2016, report accessible online)
- EIA AEO2020 Electricity
- S&P 2021 Top Trends
- Deloitte Tax Renewable
- Lawai EEI Award

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CLASS OUTLINE

The first two weeks will be remote and the following seven weeks will be hybrid with Tuesday being in person and Thursday being remote. Guest lecturers will be remote and generally on Thursdays.

Weekly Topic	Description	Required Reading & Assignments
Week 1 (Jan 5 and 7) Market evaluation and project finance overview	Topics: • Key trends in energy supply (renewables, thermal, storage, hydro, other) • Financing the new energy economy • Primary policy considerations and mechanisms (Renewable Portfolio Standards, tax, etc.) • Project finance concepts and application • Understanding value split among infrastructure stakeholders, including sponsor, customer, lender, tax equity, EPC, operator	Reading: • REF Chapters 1,2 • EIA AEO2020 Electricity • RPS Standards Berkeley DOE • Lazard LCOE Study
Week 2 (Jan 12 and 14) Financial modelling and returns	Topics: • Perspective of large electricity customers • Modeling project cash flows and debt service • Capital/operating costs and related considerations • Rating Agencies and Credit Risk • IRR and debt coverage ratios - gearing (debt-to-equity), annual debt service coverage, project life coverage, etc.	Reading: • REF Chapters 3,4, • Google24*7 Carbon Free Energy • Fitch Renewable Energy Rating Criteria • S&P 2021 Top Trends Homework Assigned: Solar Modeling Exercise
Week 3 (Jan 19 and 21) Project finance, continued	Topics: • Typical project finance lenders (banks, capital markets) • Why create a Special Purpose Vehicle/Project Company? Benefits/disadvantages • Tax structures for financing U.S. renewable projects • Entity structure – LLC, JVs, strategic alliances, YieldCo, SPAC etc. • Sale of Project Company: partnership flip, Sale-leaseback and inverted lease	Reading: • REF 5,6 • Deloitte Tax renewable Assignment Due (Jan 22): Solar Modeling Exercise

Week 4 (Jan 26 and 28) Tax Equity and Offtake agreements	Topics: • PPA • Renewable Energy in Power Markets • Capacity markets & ancillary services • Environmental and renewables attributes • Energy Storage Overview	Reading: • REF Chapter 8 • Wood Mackenzie • PJM Market Overview Case Assigned: Solar Case Study
Week 5 (Feb 2 and 4) Power markets, Legal / regulatory	Topics: • Basics of power market design (energy, capacity, ancillary services) • Transmission, congestion and LMP • Federal and state regulatory bodies/statutes, including PURPA, FPA, and Energy Policy Act of 2005 • Real estate, siting, and land use due diligence, environmental assessment and permitting *Mid-term will cover all content through Week #5 lecture	Reading: • REF Chapter 9 Assignment Due (Feb. 5): Solar Case Study

Week 6 (Feb 9 and 11)
 	
Project risk overview
	Topics:
	• Risk source
	  ○ Technology maturity
	  ○ Fuel / resource availability / intermittency
	  ○ Long-term market pricing risk
	  ○ Construction delay/completion risk and operational/O&M
	  ○ Regulatory risk – both permitting and financial
	  ○ Competitor performance – risk of obsolescence by time project is complete
	  ○ Other – management performance, risk majeure, budget estimate accuracy, etc.
	• Stakeholder risk-management capabilities, risk-bearing capacities, and ownership (e.g. contractors, operators, financiers, etc.)
		Reading:
		• REF Chapters 10, 12
		
		Assignment: Mid-term (written exam, Feb 9)
		
		Case Assignment (Feb 11):
		Solar + Storage

Week 7 (Feb 16 and 18)
 	
Managing Risks
	Topics
	• Solutions and tools to manage risks
	• Financing (reserve accounts, syndication)
	• Alternative offtake strategies
	  ○ Commodity hedges
	  ○ Credit derivatives
	• Valuation of assets and portfolios
	
	Assign wind Case
		Reading:
		• REF Chapter 11
		• Lawai EEI Award
		
		Assignment Due (Feb 19):
		Solar + Storage Case Study

Week 8 (Feb 23 and 25) International project considerations, Energy Storage	Topics: • Risk: Tariffs, Currency risk, Political / sovereign • IP • Workforce skill base • Multilateral Development Banks Wind Case Study	Reading: • REF Appendix Sample Term Sheets Assignment: Wind Case Study
Week 9 (Mar 2 and 4) Specific resource considerations	Topics: • Other technologies • Hydro • Green hydrogen	Reading: Assignment Due (Mar 5): Wind Case Study
Week 10 (Mar 9) Sample project	Topics: • Final, covering all weeks of the class (Mar 9)	

Northwestern University Policies & Resources

COVID-19 Implications

Students must follow all University policies and procedures surrounding COVID-19. This includes, but is not limited to:

- Masks: Northwestern requires community members to wear masks in all campus public and shared environments, including outdoor spaces and instructional spaces.
  - Disposable face masks will be available at identified building entrances in all campus buildings.
  - Clear face coverings may be worn to improve ability to read lips; if an accommodation is needed, please contact Accessible NU (students) or Office of Equity (faculty).

  - Face shields are no longer allowed as an alternative to a face mask, per guidance from the CDC and Northwestern Medicine. This includes instructional spaces regardless of social distancing.
- Social Distancing: Physical distancing of at least 6 feet must also be maintained where possible. Classroom occupancy has been adjusted and signage has been placed around buildings to facilitate social distancing.
- Hand Washing: Across the University, community members are expected to maintain responsible personal hygiene. Hands should be washed frequently, faces should be covered when sneezing or coughing, and individuals should not come to campus if they are sick. Limiting the touching of shared surfaces reduces the spread of the virus.
- Seating Chart: To facilitate contact tracing, should it occur, MSES will create a seating chart for each course and post it on the course Canvas page. Please be sure to sit in your assigned seat.
- Symptom Tracker: Completing your daily symptom check and staying home if you have any symptoms are important steps to fostering a healthy campus environment. Faculty, students, staff and visitors are expected to use the web app for daily health monitoring on days they come to campus.
- COVID Testing: As noted below, ALL graduate students must receive a negative test during Wildcat Wellness and before starting in-person classes on January 19. Throughout the semester we expect MSES students to be tested weekly or bi-weekly. Please abide by the email reminders you receive from the testing center.
- Wildcat Wellness: The University will again hold a Wildcat Wellness period from Jan 4 through January 17. During this time ALL graduate students must be tested for COVID-19 and ALL classes will be held remotely.
- Review Student Expectations here.

It is also the policy of the MSES Program that all lectures will be recorded and offered in a synchronous, hybrid format. In Winter Quarter 2021 this means that students are expected to attend class in-person on Mondays and Tuesdays and that class will be held completely remote on Wednesdays and Thursdays. On in-person days there will always be a synchronous Zoom option for any students that feel ill or are uncomfortable coming to class. If the professor needs to alter this schedule, they will aim to announce the changes at least 24 hours in advance.

Expectations for Class Participation

Being prepared for class is about more than just showing up, it's also about making sure you've completed the readings, homework, etc. so that you are able to make thoughtful contributions during class. Sitting silently and/or being unprepared can damage your participation grade. When in a virtual class, we expect students to keep their camera and mute on as much as possible. When in the classroom, we expect students to keep their phones off and put away.

Academic Integrity

Academic integrity is taken very seriously at Northwestern. Students are responsible for reading and understanding Northwestern's Academic Integrity policies. All suspected violations will be reported to the McCormick College of Engineering's Dean's Office. These include cheating, plagiarism, fabrication, unfair advantage, unauthorized collaboration, and aiding and abetting of academic dishonesty. Students found in violation of academic integrity may receive a zero on the assignment or a failing grade for the course, and may be suspended or permanently expelled from the University. See Academic Integrity: A Basic Guide for more information.

AccessibleNU and Disability Accommodations

Any student requesting accommodations related to a disability or any other condition is required to register with AccessibleNU (847-467-5530) and provide professors with an accommodation notification from AccessibleNU, preferably within the first two weeks of class. All information will remain confidential. See the AccessibleNU website for more information.

Illness and Medical Leave of Absence

Review the University's policy on missing academic work due to illness. Your instructor cannot waive an assignment missed due to illness unless the illness can be verified (e.g., by University Health Services or other licensed health professsionals).

Discrimination and Sexual Harassment

Northwestern's Policies on Discrimination, Harassment, and Sexual Harassment apply to all members of the University community, including students, staff, faculty, and third parties. Any student, staff, faculty member, or third party who believes that they have been discriminated against or harassed on the basis of their race, color, religion, national origin, sex, sexual orientation, gender identity, gender expression, pregnancy, parental status, marital status, age, disability, citizenship, veteran status, genetic information or any other classification protected by law, should contact the Office of Equity at (847) 467- 6571. Additional information about the University's discrimination and harassment policies, including the campus resources available to assist individuals with discrimination or harassment concerns, is available online on the Office of Equity Website. Students, staff, and faculty who report harassment, discrimination, or sexual misconduct are also protected under the University's Policy on Non-Retaliation.

Sexual Misconduct and Reporting

Northwestern University is committed to fostering an environment where students are safe and free from sexual misconduct. Confidential resources are available to those who have experienced sexual misconduct. Faculty and instructors are not confidential resources and are required to report incidents of sexual misconduct, whether discussed in your assignments or in person, to the Office of Equity, which can provide information about resources and options. We encourage students who have experienced sexual misconduct to talk with someone to get support. For more information, including how to request interim protective measures and academic accommodations or file a complaint, see the Get Help page.

Other Resources

Students can find useful resources for safety and security, academic support, and mental and physical health and well-being at the NUhelp website.

Class Recording

This class or portions of this class will be recorded by the instructor for educational purposes and available to the class during the quarter. Your instructor will communicate how you can access the recordings. Portions of the course that contain images, questions or commentary/discussion by students will be edited out of any recordings that are saved beyond the current term.

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact AccessibleNU. Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's Copyright Policy, faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction,

such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.