Three Essentials of the Electric Grid: Business Essentials

Vermont Law School Summer
Session 2020, Term
June 1, 2020- June 4, 2020
10:30 AM to 12:00 PM
1:00 PM to 2:30 PM

James C. Cater

Syllabus and Course Information

1. Course Overview: This course will focus on the application of conventional economic and financial concepts and methods to the evaluation renewable energy projects with particular emphasis on solar electricity generation projects. Through this course, students will gain an understanding of how to evaluate, compare and rank proposed business projects, especially renewable energy projects, and become familiar with benefit-cost analysis and the development and use of project pro forma financial analysis for business and public policy decision making.

2. Required Materials: Various videos, readings and reference materials are listed for each class session. Students should view the videos and engage the readings before each class session. The reference materials will support in class presentations. Most required materials can be accessed through the links provided in this syllabus. In some cases, the indicated materials will be posted on TWEN. Required material include an Excel spreadsheet, developed by the instructor, that students must upload and be prepared to use and discuss during class sessions.

3. In addition, students will be required to upload and work with Excel spreadsheet provided by the instructor

4. Note that many of the topics listed under the four class sessions are interrelated and best understood when considered together as opposed to separate segments. Depending on class dynamics, discussion topics might overlap class sessions or be addressed in slightly different order. Thus, students are encouraged to review as much material as possible before, or as early within, the term, so they have some familiarity with topics whenever particular topics are presented in class.

5. Examination: Open book, take home, due on June 8, 2020 at 4:00 PM. Further instructions will be provided during the course.

6. Instructor Contact Information:

    a. Phone: 802-558-6630
    b. E-mail: James.C.Cater@gmail.com
    c. Office Hours: Online sessions can be schedule during non-class hours June 1, 2020 – June 4, 2020

7. Course Requirements:

   i. Class Attendance: Vermont Law School (VLS) requires that you attend class and attendance will be verified for each online class session.

   ii. Preparation: So that we can have a meaningful discussion of the issues, you are expected to come to class fully prepared by reading all the required materials in advance. You will be held responsible for the contents of all non-optional reading materials on the final exam.

   iii. Final Exam: There will be a written final examination. This examination will be take home, open book. Performance on the exam will be the major determinant of your grade for the course.

   iv. Conduct/Honor Code: You are expected to conduct yourself in a professional manner throughout all aspects of the course. You are expected to abide fully by the VLS Honor Code.

8. Grading: Grades will be based primarily on the final examination, but earnest class participation is encouraged and will have a favorable impact on final grades.

9. Further Information/Updates: This course syllabus provides tentative assignments for this course. The syllabus may be amended, depending on how the class develops. Additions or modifications to assignments will be posted on TWEN and announced in class.

10. Class Schedule and Required Materials

CLASS 1

Monday, June 1, 20

Electricity Sector Fundamentals

Topics

- Fundamentals of Electric Grid
- Distributed Energy Resources
- Smart Grid
- RTOs, ISOs and DSOs
- Production, Transmission and Distribution
- Energy, Capacity, Capacity Factor and All-In Cost
- Avoided Cost
- Electric Utility Rate Making
    - Revenue Requirement
    - Tariffs

- Discounted Cash Flows
    - Present value and future value
    - Time value of money
    - Net present value of cash flows
- Levelized Cash Flows
- Levelized Cost of Electricity
- Levelized Avoided Cost of Electricity

Videos

- https://www.studentenergy.org/topics/electrical-grid (Video – Grid Basics)
- https://www.youtube.com/watch?v=TlecJcCJ7zg&vl=en (Video- Distributed Energy Resources)
- https://www.youtube.com/watch?time_continue=149&v=JwRTpWZReJk&feature=emb_title (Video – Smart Grid)

Readings

- https://en.wikipedia.org/wiki/Regional_transmission_organization_(North_America) (RTO and ISO Defined)
- https://www.power-grid.com/2010/03/01/why-we-can-t-avoid/ - gref (Avoided Cost Concepts)
- https://www.profitwell.com/blog/discount-rate-formula (Discounting and Net Present Value)

Reference Materials

- Instructor Provided Spreadsheet (Posted on TWEN)
- https://www.eia.gov/electricity/generatorcosts/ (Reference Material on Construction Costs of Electricity Generation Resources)
- https://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf (Reference Material on Total Costs of Electricity Generation Resources)
- https://www.world-nuclear.org/information-library/economic-aspects/economics-of-nuclear-power.aspx (Reference Material on Cost of Nuclear Generation Resources)
- https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b (Reference Material on Non-Fossil Resource Capacity Factors)
- https://www.eia.gov/electricity/annual/html/epa_04_08_a.html (Reference Material on Fossil Resource Capacity Factors)
  https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf (pages 1-7) (EIA Presentation on Levelized Cost of Electricity and Levelized Avoided Cost)

CLASS 2
Tuesday, June 2, 2020

Project Analysis

Topics:

- Basic Project Financing
    - Debt, Equity and D/E Ratio
    - Weighted Cost of Capital
- Discount Rate Measurement
    - Opportunity Cost (WACC)
    - Private versus Social
- Basic Cost-Benefits Analysis
- Cost-Benefits Metrics
- Comparative Resource Analytics

Videos:

- https://www.youtube.com/watch?v=7tdKkeNCIPE (Introduction to Cost-Benefit Analysis)

Readings:

- Instructor Provided Spreadsheet (Posted on TWEN)
- **https://www.nrel.gov/docs/legosti/old/5173.pdf,** pages 9-14 (Cost of Capital and Cash Flow Discounting)
- https://obamawhitehouse.archives.gov/sites/default/files/page/files/201701_cea_discounting_issue_brief.pdf (Development Private and Social Discount Rate)
- https://www8.gsb.columbia.edu/faculty/jstiglitz/sites/jstiglitz/files/2006_High_Cost_of_the_Iraq_War.pdf (Applied Cost-Benefit Analysis)
- https://www.heritage.org/homeland-security/commentary/iraq-weighing-the-costs-benefits (Applied Cost-Benefit Analysis)
- https://insight.kellogg.northwestern.edu/article/economic-cost-coronavirus-recession-covid-deaths (Applied Cost-Benefit Analysis)
- https://www.forbes.com/sites/theapothecary/2020/03/27/how-economists-calculate-the-costs-and-benefits-of-covid-19-lockdowns/ - a814e4c6f630 (Valuing Human Life)
  https://www.nrel.gov/docs/fy12osti/52197.pdf pages 6-11 (Investment Decision Metrics)

Reference Materials:

- https://www3.epa.gov/ttnecas1/docs/ria/utilities_ria_final-clean-power-plan-existing-units_2015-08.pdf (EPA Analysis of Clean Power Plan)

CLASS 3
Wednesday, June 3, 2020

Financial Analysis of Renewable Energy Resources

Topics:

- Basic Analytics of Renewable Resources
- Key Cash Flows
    - Revenue
    - Avoided Cost
    - Investment Cost
    - Operating Costs
    - Taxes
        - Investment Tax Credit (ITC)
        - Production Tx Credit (PTC)
        - Modified Accelerated Cost-Recovery System (MACRS)
    - Incentives
    - Externalities
- Proforma Cash Flow Analysis

Readings:

- http://large.stanford.edu/courses/2018/ph240/liang1/docs/gdae-2014.pdf
- APPA Value of Solar Primer, 2016 American Public Power Associationwww.PublicPower.org (Available on TWEN)
- https://rmi.org/wp-content/uploads/2017/05/RMI_Document_Repository_Public-Reprts_eLab-DER-Benefit-Cost-Deck_2nd_Edition131015.pdf (pages 7-17)
- https://www.seia.org/initiatives/depreciation-solar-energy-property-macrs (MACRS)
- https://programs.dsireusa.org/system/program/detail/676 (MACRS)
- https://programs.dsireusa.org/system/program/detail/734 (PTC)
- https://programs.dsireusa.org/system/program/detail/658 (ITC)
- https://www.seia.org/initiatives/solar-investment-tax-credit-itc

Reference Materials:

- Instructor Provided Spreadsheet (Posted on TWEN)
- https://www.nrel.gov/docs/fy14osti/62447.pdf
- http://mdvseia.org/wp-content/uploads/2014/12/SSG-Value-of-Solar-Study-Final-10-31-14.pdf
- https://www.nrel.gov/analysis/solar-manufacturing-cost.html

CLASS 4
Thursday, June 4, 2020

Alternate Perspectives on Resource Economics and C/B outcomes

Topics:
- Developer Cash Flows versus Utility Revenue Requirement
- Cross Customer Subsidization
- Stakeholder perspectives
    - Developer
    - Solar Customer
    - Utility
    - Society
- Stakeholder Perspective and Cost-Benefit Metrics

Readings:
- APPA Paper – Solar Photovoltaic Power: Assessing the Cost and Benefits (Posted on TWEN)
- https://rmi.org/wp-content/uploads/2017/05/RMI_Document_Repository_Public-Reprts_eLab-DER-Benefit-Cost-Deck_2nd_Edition131015.pdf (pages 18-19)

Reference Materials:
- Instructor Provided Spreadsheet (Posted on TWEN)
- http://www.irecusa.org/wp-content/uploads/2013/10/IREC_Rabago_Regulators-Guidebook-to-Assessing-Benefits-and-Costs-of-DSG.pdf