Three Essentials of the Electric Grid: Business Essentials

Vermont Law and Graduate School Summer Session 2025, Term 1

June 2, 2025 - June 5, 2025

9:00 AM to 12:00 PM

Instructor: Steve Letendre, PhD Syllabus and Course Information

1. Course Overview: This course will explore business aspects of the electric grid by focusing on the application of conventional economic and financial concepts and methods to the evaluation of energy projects, with particular emphasis on solar electricity generation. Through this course, students will gain an understanding of how to assess the comparative economics of resources that make up the electric grid, especially renewable energy projects and demand-side resources, 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. Students should view the videos and engage the readings before each class session. The reference materials will support 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 Canvas. Required material includes an Excel spreadsheet, developed by the instructor, that students must upload and be prepared to use and discuss during class sessions.

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

4. Examination: Open book, take home, due on Sunday, June 8, 2025, at 4:00 pm. Further instructions will be provided during the course.

5. Instructor Contact Information:

- Phone: 802-779-3580
- E-mail: sletendre@vermontlaw.edu or steve@v2gnews.com
- Office Hours: Virtual or in-person meetings can be scheduled during non-class hours June 2, 2025 – June 6, 2025

6. Course Requirements:

- Class Attendance: Vermont Law and Graduate School (VLGS) requires that you attend class and attendance will be recorded.
- Preparation: So that we can have a meaningful discussion of the issues, you are expected to come to class fully prepared by reviewing the required materials in advance. You will be held responsible for the contents of the reading materials on the final exam.
- Final Exam: There will be a written final. This examination will be take-home, open book. Performance on the exam will be the predominant determinant of your grade for the course.
- Conduct/Honor Code: You are expected to conduct yourself in a professional manner throughout all aspects of the You are expected to abide fully by the VLS Honor Code.

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

8. Class Schedule and Required Materials:

CLASS 1

Monday, June 2, 2025

Fundamentals of Financial Decision-Making & the Grid

Topics:

- Brief course overview
- Decision-making frameworks
    - Qualitative vs. quantitative
    - Cost-effectiveness versus benefit-cost analysis
- First case study--Rooftop solar
    - Payback period
    - Time value of money (present value and future value)
    - Net present value of cash flows
    - Internal rate of return
    - Levelized cost of electricity
- Fundamentals of the U.S. Electric Grid
    - Production, transmission, & distribution
    - RTOs & ISOs
    - Distributed energy resources (DER)
    - Smart grid & Micro Grid
- Q & A

Videos

- Electrical Grid 101: All you need to know!Links to an external site.
- U.S. DOE, What Is the Smart Grid?Links to an external site.
- NPV and Net Present Value Explained with NPV Example (Quickest Overview)Links to an external site.
- The Rise of Distributed Energy Resources (DERs) in Energy & UtilitiesLinks to an external site.

Readings

- Wikipedia, RTOs and ISOsLinks to an external site.
- GridLabs, The Role of Distributed Energy Resources in Today's Grid TransitionLinks to an external site..

- New York Times, Grid Constraints Facing Renewable Energy DevelopmentLinks to an external site.
- Primer on Discounting and Net Present ValueLinks to an external site.

Reference Materials

- Lezard, Levelized Cost of Energy+Links to an external site.
- NREL, Electricity Annual Technology Baseline (ATB) Data DownloadLinks to an external site.

CLASS 2

Tuesday, June 3, 2025

Cost of Electricity, Project Analysis, and Revenue Requirements & Tariffs

Topics:

- Measuring Electricity Costs
    - Focus on Production
    - Energy, Capacity, Capacity Factor, & All-In Cost
    - Internal and External Costs
- Basic Project Financing
    - Debt, Equity, and D/E Ratio
    - Weighted Cost of Capital
- Discount Rate Measurement
    - Opportunity Cost (WACC)
    - Private versus Social
- Second case study--Natural gas power plant
- Electric Utility Rate Making
    - Revenue Requirement
    - Tariffs
- Third case study--The link between revenue requirements and rates
- Q&A

Videos:

- Renewables vs. Fossil Fuels: The True Cost of EnergyLinks to an external site.
- What is project finance?Links to an external site.
- Utility Ratemaking, Part 1: Revenue RequirementsLinks to an external site.

Readings:

- International Renewable Energy Agency, The True Cost of Fossil FuelsLinks to an external site.
- Synapse Energy Economics, Ratemaking Fundamentals Fact SheetLinks to an external site.
- Project Finance Primer for Renewable Energy and Clean Tech ProjectsLinks to an external site.

Reference Materials

- U.S. DOE Energy Information Administration, U.S. energy facts explainedLinks to an external site.
- Federal Energy Regulatory Commission (FERC), Accounting MattersLinks to an external site.

CLASS 3

Wednesday, June 4, 2025

Demand Side Resources, Avoided Costs, and Benefit-Cost Analysis

Topics:

- Demand Side Resources
    - Energy efficiency
    - Distributed energy resources (DER)
    - Behind the meter (BTM) resources
- Fourth case study--Energy efficiency math problemset
- Avoided Costs

    - Avoided costs defined
    - Components of avoided costs: energy, capacity, transmission, distribution, environment, etc.
    - Avoided cost uses
- Virtual power plants (VPP)
- Benefit-Cost Analysis
    - Benefit-Cost Analysis
        - Cost-effectiveness screening tests (TRC, RIM, etc.)
        - BCA in a long-term societal context
            - Value of statistical life (VSL)
            - Current economy vs. future quality of life
            - Effects of discounting
- Fourth case study-BCA for BTM resources
- Q&A

Video

- Energy Efficiency 101Links to an external site.
- Virtual Power PlantLinks to an external site.
- Intro to Cost-Benefit AnalysisLinks to an external site.
- What is the Value of a Statistical Life?Links to an external site.

Readings:

- Canary Media, The avoided-cost calculator: The controversial metric at the center of California's solar net-metering fightLinks to an external site.
- WeaveGrid, Is It Time to Reassess Avoided Costs? The Case for Managed ChargingLinks to an external site.
- U.S. DOE, Virtual Power Plants - Pathways to Commercial LiftoffLinks to an external site.

- NESP, The National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources--SummaryLinks to an external site.

- APPA Value of Solar Primer, 2016 American Public Power Association (On Canvas)
-
- https://rmi.org/wp-content/uploads/2017/05/RMI_Document_Repository_Public- Reprts_eLab-DER-Benefit-Cost-Deck_2nd_Edition131015.pdf (pages 7-19)
- https://seia.org/initiatives/solar-investment-tax-credit-itc (SEISLinks to an external site. ITC)
- https://seia.org/initiatives/depreciation-solar-energy-property-macrs (MACRS)Links to an external site.
- https://epa.gov/green-power-markets/renewable-energy-certificates-recs (RECs)Links to an external site.
- https://nrdc.org/resources/regional-greenhouse-gas-initiative-model-nation (RGGI)Links to an external site.

Reference Materials:

- Georgia Interfaith Power & Light, Southern Environmental Law Center, Southface and Vote Solar, Utility Avoided Cost – A Tool for Valuing Renewable Energy and Utility Energy Efficiency Programs in GeorgiaLinks to an external site.
- Links to an external site.E3, 2024 Distributed Energy Resources Avoided Cost Calculator Documentation For the California Public Utilities CommissionLinks to an external site.

- Instructor Provided Spreadsheet (Posted on Canvas)
- https://eia.gov/tools/faqs/faq.php?id=427Links to an external site. (Generation mix)

- https://nytimes.com/interactive/2024/05/07/climate/battery-electricity-solar-Links to an external site. california-texas.html?unlocked_article_code=1.q00.bJ2V.Ot9GdZ7uIJgz&smid=url- share
- https://nrel.gov/docs/fy14osti/62447.pdfLinks to an external site.
- https://nrel.gov/docs/fy19osti/72399.pdfLinks to an external site.
- https://programs.dsireusa.org/system/program/detail/1235 (DESIRE MACRS)
- https://programs.dsireusa.org/system/program/detail/1235 (DESIRE Residential Credit)
- https://programs.dsireusa.org/system/program/detail/658 (DESIRE Business ITC)
- https://programs.dsireusa.org/system/program/detail/734 (DESIRE PTC)
- https://epa.gov/sites/default/files/2018-Links to an external site. 03/documents/gpp_guide_recs_offsets.pdf

CLASS 4

Thursday, June 5, 2025

Renewable Energy Project Analysis and Alternate Perspectives on Resource Decisions

Topics:

- Basic Analytics of Renewable Resources
- Current Renewable Mix
- 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
    - Renewable Energy Certificates ("RECs)
    - Proforma Cash Flow Analysis
- Electric Utility Cross Customer Subsidization
    - Fixed versus variable cost
- Stakeholder Perspectives
    - Developer
    - Solar Customer
    - Utility
    - Society
- Stakeholder Perspective and Cost-Benefit Metrics
- Grid Expansion and Modernization
    - In many cases will be necessary to accommodate renewable generation
    - Could be costly
    - NIMBY issues
    - Will it pass B/C test
    - Does B/C analysis work in the context of long-term climate change
    - Cost effectiveness analysis as a possible alternative to B/C

Readings:

- https://rmi.org/wp-content/uploads/2017/05/RMI_Document_Repository_Public-Reprts_eLab-DER-Benefit-Cost-Deck_2nd_Edition131015.pdf (pages 12-19)
- https://nytimes.com/2023/02/23/climate/renewable-energy-us-electrical-grid.htmlLinks to an external site.

- https://greentechmedia.com/articles/read/renewable-us-grid-for-4-5-trillionLinks to an external site.
- https://americanactionforum.org/research/the-cost-of-upgrading-electricity-Links to an external site. transmission/
- https://nytimes.com/interactive/2024/03/13/climate/electric-power-climate-Links to an external site. change.html?unlocked_article_code=1.mE0.5YNJ.T_ykzA5GyL9W&smid=url- share
- https://nytimes.com/2024/04/09/climate/electric-grid-more-Links to an external site. power.html?unlocked_article_code=1.jU0.PllX.PKQLUJkJ4TDs&smid=url-share
- https://nytimes.com/2024/05/13/climate/electric-grid-overhaul-Links to an external site. ferc.html?unlocked_article_code=1.r00.c8hC.RvSL93P4YCvf&smid=url-share
- https://nytimes.com/2024/05/13/climate/electric-grid-overhaul-Links to an external site. ferc.html?unlocked_article_code=1.r00.c8hC.RvSL93P4YCvf&smid=url-share
- https://yaleclimateconnections.org/2021/10/is-cost-benefit-analysis-the-right-tool- for-federal-climate-policy/

Reference Materials:

- Instructor Provided Spreadsheet (Posted on Canvas)
- APPA Paper – Solar Photovoltaic Power: Assessing the Cost and Benefits (On Canvas)
- https://energy.mit.edu/wp-content/uploads/2012/03/MITEI-RP-2011-001.pdf

Integrating Intermittent Resources

- https://reuters.com/investigates/special-report/usa-renewables-electric-gridLinks to an external site.
- https://cnbc.com/video/2021/01/27/what-it-will-take-for-the-us-to-build-a-Links to an external site. 100percent-renewable-electric-grid.html
- https://youtube.com/watch?v=s3ScJ_FwaZk
- https://youtube.com/watch?v=qBpiXcyB7wU&t=1182s
- https://reuters.com/investigates/special-report/usa-renewables-electric-grid