

SUMA K4197: Financing the Green Economy

1 Course Overview

The last several years have marked a turning point for green energy. Once considered a fringe sector best confined to places like Berkeley, Boulder, or maybe Denmark, green energy is now a serious industry with major financial and industrial players.

However green energy's ascendance as one of the 21st century's major industries is not pre-ordained. Yes, countering the threat of global climate change, increasing energy independence, and providing good jobs for our citizens are all reasons why green energy is important. But a host of complications will make sustaining and growing the transition to a green economy challenging. These complications involve technology, finance, politics - and simply the low cost and convenience of our existing fossil fuel based infrastructure.

"Financing the Green Economy" will focus on understanding these challenges, so that students - whether as citizens or in their careers - can help overcome them. The course will emphasize the financial aspects of green energy, but in doing so, will bring together many of the other factors that affect whether and how much the green economy takes hold.

This course satisfies the program's financial management requirement. The financial management requirement gives students a foundation in finance and financial models, and an understanding of how environmental commodities markets regulate polluting industries and provide incentives for encouraging desired behaviors. Students will also investigate the credibility of "non-financial metrics" that often accompany sustainability efforts.

2 Course Objectives

The course has several objectives:

- Provide a basic understanding of how existing energy markets function, and how green technologies are developing within and apart from these markets
- Compare the kinds of policy tools that governments are using to support green technologies and assess the benefits and costs of each
- Describe the major "players" in the industry, from university labs and venture-backed start-ups to the world's largest banks and industrial conglomerates
- Assess the strengths and weaknesses of the different technologies, including wind, solar, energy efficiency and advanced vehicles
- Explain the emerging business models for bringing clean energy to market
- Introduce the fundamentals of clean energy project financial modeling

After taking this course, you will have a better understanding of the major opportunities and challenges affecting the emergence of clean energy technologies. Appreciating these issues should prepare you to pursue further scholarship in related areas, and equip you with an understanding of the dynamics and players that will serve you well as you pursue work professionally in the clean energy finance industry, or in related commercial, governmental, and not-for-profit organizations.

3 Course Content

Session 1: How We Got Here: A Short History of Innovation in Energy

- History of America's electricity infrastructure and how it was built
- What factors have driven innovation?
- Role of government
- America's current energy mix and how it compares to other countries

Session 2: Electricity Markets

- Level set on metrics and measures
- Current industry structure and drivers of profitability
- Energy markets and how they function
- Heat rate and fixed vs. variable cost
- Emissions factors

Required Readings:

[Pew Center on Global Climate Change, "Electricity Sector Overview", June 2011](#) - Provides an overview of carbon emissions from current electric generating technologies

[Energy Information Administration, "Energy in Brief" Series](#) - There are a variety of short articles. Read "What is the role of coal in the United States?" and "How much of our electricity is generated from renewable sources?"

[US Department of Energy, "A Primer on Electricity Utilities, Deregulation, and Restructuring of US Electricity Markets" May 2002](#) -

Read pages 2.1 to 2.3, 3.1 to 3.12, 4.1 to 4.7 for an overview of how electric utilities provide power to their customers.

["MIT Researchers See Natural Gas as the Choice for Lower Carbon Emissions" ClimateWire June 25, 2010](#) -

Session 3: Clean Energy: Where Are We Now and Where Do We Go From Here?

- Fossil fuel vs. green energy cost
- Introduction to levelized cost of energy (LCOE)
- Current market penetration of clean energy
- - Overview of clean energy technologies

Required Readings:

[National Renewable Energy Lab, "2009 Renewable Energy Data Book", August 2010](#) -

This can be skimmed, but it is a good reference source for the current status of renewable energy in the U.S. and globally.

[Energy Information Administration, "Levelized Cost of New Generation Resources in the Annual Energy Outlook 2011"](#) -

This is a short explanation of levelized cost of energy (LCOE). Provides the U.S. government's current view of LCOE for the various power generation technologies.

[Shayle Kann, "Does Grid Parity Matter?" Greentech Media, June 22, 2011](#) - A useful explanation of the term "grid parity" and whether it is a meaningful concept.

[Joel Kirkand, "Utilities Face the Decision Point of Big Shifts - to Gas, Renewables and Efficiency" ClimateWire July 9, 2010](#) -

An overview of some of the choices facing utilities as they decide where their resources are going to come from in the future.

[Paula Mints, "PV Market Analysis" Renewable Energy World August 11, 2011](#) -

An analysis of how far solar has come globally and where it is going from here.

[Tildy Bayar, "World Wind Market" Renewable Energy World August 4, 2011](#) - An analysis of the current global wind market.

Session 4: Clean Energy: Where Are We Now (Continued)

Class Plan:

No specific required reading for this class given that we are going to cover the original content for Lecture 3 now in Lecture 4.

If you get a chance, read the Fortune article on wind power in Wyoming.

<http://tech.fortune.cnn.com/2011/09/14/the-power-struggle-for-wyomings-wind/>

Required Readings:

[Eric Wesoff, "It's Official: 33% RPS Now the Law in California" GreenTech Media, April 12, 2011](#)

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California officially enacting the 33% renewable portfolio standard.

[Tom Johnson, "Is the Solar Sector Headed for a Fall" NJ Spotlight August 4, 2011](#) - Highlights some of the challenges for solar in New Jersey, the U.S.'s second largest solar market.

[EPA Renewable Portfolio Standards Fact Sheet](#) - An overview of how state renewable portfolio standards work

Assignment: Problem Set Due

Session 5: A Comparison of Global Clean Energy Policies

- State Renewable Portfolio Standards / RECs and SRECs
- US Tax Incentives
- Feed in Tariffs
- Loan Guarantees
- Politics of Green Energy Subsidies
- EU
- -China

Required Readings:

[The Pew Charitable Trusts, "Who's Winning the Global Clean Energy Race 2010"](#) - Pew Trust report on clean energy investments for countries and regions. Skim through to get a sense of major points.

[Paul Gipe, "New Record for German Renewable Energy in 2010" Renewable Energy World, March 25, 2011](#) - Update on German solar program implementation.

[Keith Bradsher, "On Clean Energy, China Skirts Rules" The New York Times, September 28, 2010](#) -

An article on the success of Chinese renewable energy manufacturing.

[Solar Energy Industries Association, "The Case for the Section 1603 Treasury Program," July 25, 2011](#) - Argues for the extension of one of the core renewable incentive programs

[Solar Energy Industries Association, "History and Overview of the Section 48c ITC"](#) - A summary of the investment tax credit

[American Wind Energy Association, "Production Tax Credit"](#) - Explanation of the core incentive for wind power in US

[US Partnership for Renewable Energy Finance](#) - Read white papers on [Tax Credits, Tax Equity and Alternatives for Clean Energy Financing](#). Discusses some of the problems with relying on the 30% investment tax credit on its own if the case grant is not extended.

[EPA's Renewable Portfolio Standards Fact Sheet](#) - Good overview on renewable portfolio standards

Session 6: Overview of Project Financial Modeling

- Basic financial modeling concepts
- Role of government subsidies
- Role of debt
- Understanding levelized cost of energy

Class will focus on financial modeling of energy projects. For those without any financial modeling exposure, it will be useful to read about a few key concepts including the time value of money, cost of capital, and internal rate of return. Brighthub.com has good online articles, and Khan Academy has some good videos on present value (www.khanacademy.org). The below recommended links are from BrightHub.

Recommended Readings:

[Time Value of Money](#) -

[Present Value](#) -

[Cost of Capital/Hurdle Rate](#) -

[Internal Rate of Return](#) -

Session 7: The Challenge of Bringing Clean Technology To Market

- The clean energy R&D lifecycle
- Role of venture capital
- The "valley of death"
- -The role of project financing

Required Readings:

[US Partnership for Renewable Energy Finance](#) - Read white paper entitled "US PREF Venture Capital White Paper". Overview of clean tech venture capital investment by one of the Vantage Point partners.

[Katie Fehrenbacher, "Greentech Investing: Not Working for Most" Gigaom, September 29, 2010](#) - Discusses some of the challenges of clean tech venture capital investment.

[Katie Fehrenbacher, "Alan Salzman: It's all or nothing for greentech investing" Gigaom, August 4, 2011](#) - A perspective on what it takes to succeed as a clean tech venture investor.

[Josh Freed, "Making a Case for Innovation Investment in an Era of Austerity", May 2011](#) - A case for focusing limited federal dollars on innovation.

[Emily Yehle, "No Home Run Yet for ARPA-E, but Chief Says Motivated Team on Track" The New York Times, April 7, 2011](#) - A discussion of the Department of Energy ARPA-E program.

Assignment Due: Excel Spreadsheet Model- Wind Project Financial Analysis

Session 8: Major Issues and Themes: A) Shale Gas B) Clean Coal C) The Green Consumer

- Is Shale Gas a "Blessing" or "Crack Cocaine"?
- Does Clean Coal Have A Future?
- Will the Green Consumer Ever Be a Mass Consumer?

Required Readings:

[Matthew Wald, "Scattered Attempts at Carbon Capture" The New York Times, July 14, 2011](#) - Summary of current carbon capture project efforts.

[Saqib Rahim and Peter Behr, "DOE Chief Says Carbon Capture Will Eventually Happen" ClimateWire July 22, 2011](#) - Secretary Chu on the long-term prospects for carbon capture.

[Daniel Yergin, "Stepping on the Gas" The Wall Street Journal, April 2, 2011](#) - History of breakthroughs in shale gas technologies.

[John Rowe, "Energy Policy: Above All Do No Harm" John Rowe Speech at American Enterprise Institute, March 8, 2011](#) - Speech by the CEO of America's largest utility on the importance of natural gas.

[Stephen Lacey, "If Natural Gas is the Crack Cocaine of the American Power Industry, it Could Prove an Unhealthy Habit" Think Progress Blog June 20, 2011](#) - Blog posting on whether natural gas is a blessing or a curse.

[Katie Fehrenbacher, "The Future of Clean Energy Rests on Consumers and Electric Vehicles" GigaOm](#) -

Discusses how adoption of electric vehicles is key to making consumers care about electricity.

[Cheryl Hall, "Wyly Always Saw Bright Days Ahead for Clean Electricity" The Dallas Morning News September 19, 2011](#) -

[Jonathan Fahey, "Electricity Deregulation Finally Takes Off" Forbes April 10, 2010](#) -

Session 9: Existing Models/Structures for Financing Clean Technology

- Project finance industry
- Impact of project finance on returns and deployment
- Market players
- DOE loan guarantee program
- Transition from government to private sector

<http://energy.gov/articles/energy-department-finalizes-loan-guarantee-transformational-rooftop-solar-project>

<http://www.climatepolicyinitiative.org/files/attachments/167.pdf>

Required Readings:

[Mintz Levin, "Renewable Energy Project Finance in the U.S.: An Overview and Midterm Outlook" 2010](#) - Overview of U.S. project finance market.

[Project Amp Article](#) - This is the DOE press release on Project Amp, which will be the focus of our discussion on November 1.

[Climate Policy Initiative Paper on Project Finance](#) - A good set of project finance case studies.

Session 10: No Class

Assignment Due: Issue Paper

Required Readings:

[Kate Galbraith, "Wind Power Gains as Gear Improves" The New York Times August 7, 2011](#) - Discusses some of the improvements in wind technology aimed at reducing costs and improving reliability.

[Stephen Lacey, "Anatomy of a Solar PV System" Renewable Energy World July 13, 2011](#) - Discusses how cost reductions in solar not only need to come from module manufacturing, but also from "balance of plant" costs, and "soft costs" such as permitting.

Recommended Readings:

[Peter Behr, "How Texas Lassoed the Wind" Scientific American February 28, 2011](#) - Texas' success with wind power and building transmission lines to support it.

Session 11: Alternative Vehicles

- Carbon emissions of different technologies
- Overview of biofuels, electric vehicles
- Department of Energy Advanced Vehicle Program

Required Readings:

[Boston Consulting Group. "Powering Autos to 2020" July 2011](#) - Boston Consulting Group projections on vehicle technology trends.

["The Post-Alcohol World" The Economist October 28, 2010](#) - Overview of current renewable fuels technologies.

["Automakers Agree to 54.5 MPG Fuel Standard" Bloomberg Business Week, July 29, 2011](#) - Recent mileage standard agreement.

Session 12: Group Presentation I

Session 13: Group Presentation II

Session 14: Group Presentation III

4 Method of Instruction and Evaluation

Class Structure: This course is designed to explore the large-scale transition to a low-carbon economy through several distinct vantage points, including (a) emerging environmental markets (e.g., carbon, energy efficiency, water, wetlands, nitrates, weather, etc.) intended to provide market based mechanisms for achieving environmental objectives, (b) new businesses and industries (e.g., renewable energy generators, sustainability ventures, eco-IT, ecosystem services, etc.) positioned to capitalize on perceived market opportunities in addressing environmental and other national priorities, and (c) effects of changing energy and climate change policies (e.g., Federal and state renewable energy and portfolio standards, "Cap-and-Trade", etc.) on prevailing social norms.

The course is divided into five parts. Part I will focus on key foundational materials related to (a) how we produce and use energy, (b) environmental impacts of our current economy, (c) as well as key stakeholder perspectives. Part II will focus on emerging environmental market mechanisms and the business of new energy. Part III will focus on new businesses and industries focused on energy, climate change, and adaptation. Part IV will focus on current policy initiatives and the politics of changing current societal norms. Part V will be class presentations on specified project topics.

Grading:

The final grade will be based on your performance on 3 problem sets/case studies assigned during the semester (50%), final class presentation (35%), and class participation (15%).

Class Participation (15%)

- Contribute to class discussions. Contributing to class discussions means enhancing the quality of the class experience for yourself and others. It involves making relevant, useful and non-obvious comments, or posing pertinent questions, in clear and succinct language;
- Be prepared to give 2-3 minute answers in a previously-chosen class to impromptu questions regarding the readings for that class; and
- Provide at least 1 carefully considered and substantive (2-3 paragraphs) comment or response to a discussion in the bulletin-board.

3 Problem Sets/case studies assigned during the semester (50%)

Assignment 1:

Please see Appendix A. The first problem set will include a set of quantitative and qualitative short answer questions

Assignment 2:

Please see Appendix B. The second problem set will involve the creation of a financial model for a clean energy project

Assignment 3:

Please see Appendix C.

Final Class Presentation (35%)

Please see Appendix D. The final presentation will be a group presentation summarizing the key aspects of a particular clean energy project. The deliverable will be the in-class presentation, plus the associated PowerPoint slides.

5 Resources and Software Packages

All readings will be listed in Courseworks. Any readings whose full-text is not available through the links in Courseworks will be placed on reserve at the Library.

6 Textbooks and Reading

All readings will be listed in Courseworks. Any readings whose full-text is not available through the links in Courseworks will be placed on reserve at the Library.

7 Policies

Academic Integrity

The School of Continuing Education does not tolerate cheating and/or plagiarism in any form. Those students who violate the Code of Academic and Professional Conduct will be subject to the Dean's Disciplinary Procedures. The Code of Academic and Professional Conduct can be viewed online:

<http://ce.columbia.edu/node/217>

Please familiarize yourself with the proper methods of citation and attribution. The School provides some useful resources online; we strongly encourage you to familiarize yourself with these various styles before conducting your research:

<http://library.columbia.edu/help/howto/endnote.html>

Violations of the Code of Academic and Professional Conduct will be reported to the Associate Dean for Student Affairs.

Accessibility Statement

Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website:

<http://health.columbia.edu/services/ods/support>

