

CLIMATE FINANCE (B8363)

Fall 2021

Professor Bruce Usher

Uris Hall 316A

917 287 5638

bmu2001@gsb.columbia.edu

Office Hours: Schedule an appointment by email

All course readings and cases are posted on Canvas, and all course announcements are made through Canvas. Students should regularly check Canvas for announcements and course materials.

COURSE DESCRIPTION

Climate change may be today's most serious challenge to the future of humanity. Scientists have concluded that avoiding catastrophic climate change will require a reduction in greenhouse gas emissions to zero by 2050 or shortly thereafter, a dramatic reversal after several hundred years of industrial growth. Accomplishing this objective will require a rapid transformation of the global economy, employing the latest technologies and business strategies, creating new and risks and opportunities for business leaders and investors. It is profoundly important to get this transition right – there will be no second chances to avoid climate change and altering course mid-way will be costly for both the economy and the environment.

This course explores the science of climate change and its related economic and environmental impacts, and carefully examines the financial tools and investment products that can be used to mitigate and adapt to climate change. Specific areas to be covered include the use of capital markets to create market-based emissions trading systems, project finance to build renewable energy projects, venture and growth capital to fund innovative low emissions technologies, and investment management to direct capital toward public companies engaged in climate change solutions and away from companies emitting greenhouse gases.

This is a finance course, designed around a combination of cases and financial tools to reach the course objectives. The course is composed of 5 modules:

I. Introduction to Climate Finance

Understanding the science of climate change and related impact on the planet, and the key drivers affecting business strategy and investment.

- Climate Change Science: What is the problem, and what are the forecasts for the future?
- The Role of Business and Finance: What is the role of business in causing climate change, and how are businesses adapting to a low-carbon future? What is the role of investors in financing mitigation and adapting to climate change? What are the risks and opportunities?

- Investing Strategies: What strategies are investors using to minimize risk and maximize returns with respect to climate change?

II. Climate Solutions

Renewable Energy. Understanding the technologies and strategies behind a global transition in energy sources with the potential to dramatically reduce greenhouse gas emissions.

- Electricity: Renewable wind and solar power is forecast to replace fossil fuels in the generation of electricity. What are the implications for fossil fuel companies and for electric utilities? How do renewables mitigate risks associated with industry's reliance on fossil fuels? What are the economics of wind and solar projects? How can we increase the availability of renewable energy through project finance and financial innovation?
- Energy storage: Renewable energy is intermittent, requiring a dramatic expansion in energy storage to balance the electric grid. Which technologies are likely to solve the energy storage challenge, and how are they being financed?

Electric Vehicles. Transportation represents the second largest and fastest growing contributor to greenhouse gas emissions and faces disruption from electric vehicles and other advanced technologies.

- Ground transportation: The rapid growth in electric vehicles is the most significant change to the automobile sector in over a century. How is a new product financed in a traditional industry? What are the implications for auto manufacturing companies?

Energy Efficiency. The built environment is responsible for significant emissions from heating, cooling and lighting, which can be reduced via energy efficiency.

- How can building owners and investors finance energy efficiency? What financial tools can incentivize the upgrading of existing buildings in competitive real estate markets? Why is this low-cost climate solution often overlooked?

Industry and Green Hydrogen. Steel and cement are significant contributors to climate change, but businesses attempting to reduce emissions face challenges from global competitors with lower prices. Green hydrogen offers a zero-emission alternative that is rapidly gaining investor interest.

- Cement: What are the options for reducing emissions in an industrial sector, and what are the implications for companies operating in global commodity businesses?
- Air and sea transport: Airlines and shipping are the fastest growing source of emissions; what are the options for reducing emissions using green hydrogen?

Carbon Removal. Commercially available technologies can reduce global greenhouse emissions by more than 50%, but the remaining emissions will require carbon removal technologies that are currently early-stage and lack commercial business models or financing. How can companies implement carbon removal in their business models? Several technologies are available for doing so, offering very different challenges and opportunities.

- Forestry: Planting trees is a simple tool for fighting climate change. How do emissions markets provide a financial mechanism for protecting trees, and what are the challenges to implementation?

- Agriculture: A traditional sector resistant to change, how will farmers be financially incentivized to convert to no-till farming, or incorporate technologies to reduce livestock methane?
- Carbon capture and storage: A solution for the fossil fuel sector that may be controversial but necessary.
- Direct air capture: What is the potential for removing CO₂ directly from the atmosphere?

III. Climate Policy and Climate Finance Risk Mitigation

- Climate Policy: A brief review of U.S. and international climate policy, and implications for investors and finance professionals.
- Risk Mitigation: How can financial institutions measure and manage exposure to climate change? What is the TCFD and how is it being used?

IV. Investment Products

Venture Capital Financing of Cleantech. Investing in new technologies and business models is crucial to addressing climate change but is fraught with risk and challenges.

- What are the challenges that venture capital investors must overcome to finance climate solutions? What products and business models are best suited to venture financing?

Public Equities. Strategies for divesting shares in fossil fuel companies, shareholder activism to influence public companies, and strategies for investing in companies with plans to transition to net zero emissions.

- Divestment: University endowments are actively divesting from fossil fuel companies. What are the benefits and challenges to this strategy?
- Shareholder activism: How do activists influence companies to change plans with respect to climate change?
- Incumbents vs Disruptors: Public companies are making pledges to reduce greenhouse gas emissions. How should investors evaluate efficacy and feasibility of pledges? What are the advantages of new ventures when disrupting a market? What are the advantages of incumbents in adopting new technologies to defend and dominate markets? When should investors finance disruptors, and when should they finance incumbents?

Fixed Income Securities. The fixed income markets are significantly larger and more cost-effective than the equity markets, yet they receive less attention when it comes to climate finance.

- Green Bonds: How do they benefit both issuers and investors? What are the challenges to continued growth in this market?
- Muni bonds: What are the risks that climate change poses for this market?

Funds and ETFs: Most investors will finance climate solutions through intermediary financing vehicles such as funds and ETFs.

- Climate funds: What are the types of climate funds currently available, and what are the risks and opportunities for investors?
- Infrastructure funds: The rapid growth in renewable wind and solar assets is creating an opportunity for investors to finance increasingly large infrastructure funds.

V. Course Wrap-Up

Understanding the future trajectory of greenhouse gas emissions in the context of the mitigation opportunities discussed in the course, and the implications for business, investors and climate change. As future business leaders and investors, what is your role and what are your responsibilities when it comes to addressing climate change?

- Will humanity avoid catastrophic climate change? What are the implications for the future of business, the economy, and society?
- What is your responsibility for addressing climate change? As a businessperson? As an individual?

COURSE OBJECTIVES

This course is designed for both MBA students planning careers in financial services who want to understand the financial implications of climate change, and for students planning careers in a climate change-related field (such as renewable energy companies, non-profit or government organizations) who want to understand the application of the relevant financial tools. The course will also be useful for future consultants or general managers helping their clients or employers develop and implement “green business” strategies.

Specifically, the course objectives are to:

1. Understand the scientific issues underlying climate change.
2. Analyze the technologies and strategies tools that have been used to date, their relative effectiveness in combating climate change and the implications for businesses.
3. Evaluate technologies and strategies that might be used in the future, in the context of a carbon-constrained global economy and national and international policy developments.

REQUIRED COURSE MATERIAL

To prepare for each class, students will be required to read the following cases, articles and background notes:

Introduction to Climate Finance

- Climate Change in 2020: Implications for Business (HBS 320087)
- BlackRock: Linking Purpose to Profit (HBS 120042)

Renewable Energy

- The Jersey-Atlantic Wind Farm (Caseworks 120307)
- Orsted’s Offshore Wind Farms (Caseworks 210304)
- ELP Greenport Solar (Caseworks 210305)
- From Pioneer to Pariah: SunEdison, Inc (Caseworks 180303)

Electric Vehicles

- Speeding Ahead to a Better Place (HBS 512056)
- Architects of the Future? Tesla, Inc., Energy, Transportation, and the Climate (Caseworks 170306)

Buildings and Energy Efficiency

- Climate Change Is Going to Transform Where and How We Build (HBR H0583W)
- Reawakening the World's Most Famous Office Building: Economics behind a Groundbreaking Energy Efficiency Retrofit (KEL 669)

Industry and Green Hydrogen

- Grey to Green – The Sustainability Journey of Dalmia Cement (IMB 845)
- Why We Need Green Hydrogen (Columbia Climate School)

Carbon Removal

- International Carbon Finance and EcoSecurities (HBS 208151)
- American Electric Power: Investing in Forest Conservation (OIT-96)
- Carbon Engineering (HBS 814040)

Climate Policy and Risk Mitigation

- What Biden’s Sustainability Agenda Means for Businesses (HBS H067MW)
- TCFD reading tbd

Venture Capital Financing of Cleantech

- Prime Coalition: Catalytic Capital for Climate Innovation (820-007)
- Beyond Meat: Taking on the Beef Industry (Case Center 319-0130-1)

Public Equities

- Stanford Dumps Coal (Columbia Caseworks 150307)
- Can a Tiny Hedge Fund Push ExxonMobil Towards Sustainability (HBR HO643B)
- Your Company Pledged to Reduce Its Carbon Footprint. Now What? (HBR H06E8X)

Fixed Income Securities

- Green Bonds Benefit Companies, Investors, and the Planet (HBR H04NXS)

Funds and ETFs

- MSCI Low-Carbon Indices: A Free Option on Carbon (IN1678)

REQUIRED PREREQUISITES AND CONNECTION TO THE CORE

Students must have completed or be concurrently enrolled in B8306 - Capital markets and investments. The learning in this course will utilize, build on and extend concepts covered in the following core courses:

Core Course	Connection with Core
Corporate Finance	1. Time value of money

	2. WACC + leverage
Strategy Formulation	1. Cost leadership 2. Differentiation
Marketing	1. Segmentation and targeting 2. Influencing customer behavior
Managerial Economics	1. Consumer demand 2. Cost analysis 3. Agency and incentives

Students will be expected to have mastered these concepts and be able to apply them in the course.

ASSIGNMENTS

As this is predominantly a case-based course, it is essential that every student carefully reads the assigned cases and comes to class prepared to actively participate and contribute to the class discussion. To make the most effective use of your time, the assigned readings will inform you of what cases and readings to focus on. Students will be required to complete short quiz questions on the case readings, due online in Canvas prior to the start of each class. Completion of the quiz questions will contribute towards your class participation grade.

Students are required to complete an assignment building a project finance model for the financing of a renewable energy project. The purpose of the assignment is to ensure that students understand the key concepts, not to build financial modeling skills. Students who are less comfortable with financial modeling may find the assignment challenging but can still receive a high grade by demonstrating knowledge of the key concepts in the cases and the course.

Students will complete a group project during the course that evaluates the strengths and weaknesses of disruptive companies as they compete with incumbents in sectors of the economy that are changing rapidly due to climate change.

The final take-home exam will be available at the end of the last class and is due one week later.

METHOD OF EVALUATION

This course relies predominately on the case method. The focus of most of the classes is on understanding concepts, and the challenges and opportunities of applying those concepts in real-world settings. The chosen cases analyze technologies and businesses to mitigate and adapt to climate change, to understand why certain business strategies have succeeded while others have failed. This course requires active class participation, and students' grades will be heavily dependent on the quality of class discussion. Students are expected to challenge one another and to challenge the professor.

Class participation (Type C - individual)	35%
Project finance model	10%

(Type C - individual)	
Emissions Trading Model (Type C - individual)	10%
Disruptors vs Incumbents Project (Type A – group/group)	10%
Final take-home exam (Type C - individual)	35%

CLASSROOM NORMS AND EXPECTATIONS

Students are expected to adhere to CBS Core Culture in this course by being Present, Prepared, and Participating. Students are required to prepare for each class by reading and analyzing the assigned cases, utilizing the study guidance questions which are provided in the Canvas system, and completing the on-line question set. In class, students are expected to add thoughtful points to each class discussion.

ATTENDANCE POLICY

Students are required to attend each class in-person. Students should contact the TA regarding excused absences (for religious observances; personal, medical, and family emergencies; military service; court appearances such as jury duty). Unexcused absences will affect your class participation grade and your overall course grade.

- Students that miss more than 33% of their classes (unexcused absences) will at most receive a P for the course grade.
- Students that miss more than 50% of their classes (unexcused absences) will receive an F for the course grade.

INCLUSION, ACCOMODATIONS, AND SUPPORT FOR STUDENTS

Columbia Business School will make reasonable accommodations for persons with documented disabilities. Students are encouraged to contact the Columbia University’s Office of Disability Services for information about registration. Students seeking accommodation in the classroom may obtain information on the services offered by Columbia University’s Office of Disability Services online at www.health.columbia.edu/docs/services/ods/index.html or by contacting (212) 854-2388.

Columbia Business School is committed to maintaining a safe environment for students, staff and faculty. Because of this commitment and because of federal and state regulations, we must advise you that if you tell any of your instructors about sexual harassment or gender-based misconduct involving a member of the campus community, your instructor is required to report this information to a Title IX Coordinator. They will treat this information as private, but will need to follow up with you and possibly look into the matter. Counseling and Psychological Services, the Office of the University Chaplain, and the Ombuds Office for Gender-Based Misconduct are confidential resources available for students, staff and faculty. “Gender-based misconduct” includes sexual assault, stalking, sexual harassment, dating violence, domestic violence, sexual

exploitation, and gender-based harassment. For more information, see <http://sexualrespect.columbia.edu/gender-based-misconduct-policy-students>.