COLUMBIA UNIVERSITY
School of Professional Studies

Master of Science in Sustainable Management

SUMA 5160 CLIMATE FINANCE AND SUSTAINABLE DEVELOPMENT
Dates: TBA
3 Credits

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Office Hours: By Appointment via Zoom: https://columbiauniversity.zoom.us/my/satyajitbose
Response Policy: I usually respond within 24 hours to email inquiries.

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Office Hours: TBD
Response Policy: I usually respond within 24 hours to email inquiries.

Course Overview

The course provides an overview of the opportunities and challenges of transnational financing from public and private sources that seeks to support mitigation and adaptation investments intended to address climate change. Although there is increased and widespread commitment to taking climate action on the part of corporations, financial institutions, countries and sub-national actors, there remains a paucity of examples where a just transition has been furthered. The conditions engendered by the advent of widespread pandemics have exacerbated global differences in capacity and access to solutions. Nevertheless, the emergence of new financial mechanisms and global cooperative responses to the pandemic have revealed potential methods to finance enhancements in mitigation and adaptation in the regions where these are most lacking. We examine current capital and trade flows and their relationship to flows of embedded carbon, methods of carbon pricing and the implementation of low-carbon pathways, with an evaluation of decentralized co-benefits that can advance sustainable development. We combine analysis of carbon accounting and financial structuring to design potential investments in example decarbonization projects which integrate additionality in mitigation and adaptation, co-benefits and poverty alleviation.

The course has following related goals:

- Outline in detail the types of financial institutions and financing instruments at macroeconomic, enterprise and project levels that can facilitate a just transition to a low emissions and climate-resilient development path;
- Examine the UNFCCC principle of "common but differentiated responsibility and respective capabilities" in the context of the economic and technological capacities of developed and developing countries;
- Provide a set of tools to examine investment and trade flows among developed and developing countries that can elucidate the flows of embedded carbon through global supply chains;
- Review the possibilities for reversing in part the accumulated impact on climate justice of past capital and trade flows.

Who should take this course?

This course is for those who need to explore financing and implementation of investments in carbon mitigation and climate change adaptation in developing countries. Although there are no prerequisites for the course, it will be easier to absorb the material if students have already taken courses in economics or finance that have touched upon the concepts of marginal cost, carbon taxes, emissions trading systems, tariffs and trade and capital budgeting.

Learning Objectives

By the end of the course, students should to be able to:

L1 Articulate stylized facts about GHG emissions, the flow of capital, trade and embedded carbon between and among major developed and developing countries.

Adapted from: **The Course Syllabus: A Learning-Centered Approach, 2nd Edition,** Judith Grunert O'Brien, Barbara J. Millis, Margaret W. Cohen. ISBN: 978-0-470-60539-4. Available as an E-Book by Jossey-Bass at: http://www.josseybass.com/WileyCDA/WileyTitle/productCd-0470605391.html

- **L2** Outline the econometric relationship between measures of economic growth, human well-being and energy access and the need to develop sources of well-being decoupled from continued growth in emissions.
- **L3** Demonstrate an ability to differentiate between different types of climate action commitments and targets espoused by companies, countries and sub-national actors.
- **L4** Compute the monetary costs of carbon reductions in a range of illustrative mitigation projects employing different technologies.
- **L5** Explain the current state of carbon pricing initiatives in a range of jurisdictions around the world and the possibilities for interlinkages between them.
- **L6** Compute the portfolio warming potential of collections of financial assets and explain the limitations of such metrics.
- **L7** Articulate examples of local co-benefits of climate action which can make mitigation and adaptation activities locally viable and financially feasible.

Readings

All the readings and resources will be made available through the Canvas course site and Columbia University Libraries.

Given the emergent nature of the field of climate finance, there is no required textbook for this course. The content material comes from relevant journals, articles, infographics, book chapters, case studies, and videos.

Weekly Readings:

Required weekly readings are organized by module in the course schedule located at the end of the syllabus. For your convenience, links to each reading are provided in the resource section of each Canvas module.

Readings:

- Bakarich, K., et. al. (2020). The Use of Blockchains to Enhance Sustainability Reporting and Assurance. Accounting Perspectives. Vol. 19 No. 4. 389-412. (24 pages).
- Beyond income. (2019). Human Development Report 2019. (336 pages)
- Black, R., Cullen, K., Fay, B., Hale, T., Lang, J., Mahmood, S., Smith, S.M. (2021). Taking Stock: A global assessment of net zero targets, Energy & Climate Intelligence Unit and Oxford Net Zero. (30 pages)
- Borges, V. (2020). Societal Governance, Chaotic Institutions, and Complex Systems Resilience. After the Nation-State. (15 pages).
- Bose, S. (2021). Adaptation Finance: A Review of Financial Instruments to Facilitate Climate Resilience. The Palgrave Handbook of Climate Resilient Societies. (34 pages).
- Bose, S. et al.(2019). The Financial Ecosystem. Palgrave Studies in Impact Finance. Chapter 12. 283-310. (28 pages).
- Butu, H., et. al. (2021).Leveraging community based organizations and fintech to improve small-scale renewable energy financing in sub-Saharan Africa. Energy Research & Social Science. Vol 73. 1-11. (11 pages).
- Dasgupta, P. (2021). The Economics of Biodiversity: The Dasgupta Review. Chapters 1,5, 12. (38 pages).
- Eis, J., Schafer, J. (2019). Changing Course. UNEP Finance Initiative. (129 pages).
- Environmental Defense Fund. (2020). “What makes a high-quality carbon credit?” WWF. (16 pages).
- Gilbertson, T. L. (2020). Financialization of nature and climate change policy: implications for mining-impacted Afro-Colombian communities. Community Development Journal, 56(1), 21–38. (18 pages).
- Global States and Regions Annual Disclosure Report 2020: Annex. (2020). Climate Group. (26 pages).
- Global States and Regions Annual Disclosure Report 2020. (2020). Climate Group. (19 pages).
- GPIF (2019). Analysis of Climate Change-Related Risks and Opportunities in the GPIF Portfolio.(94 pages).
- Hossain, M., Hales, R.; Sarker, T. (2018). In Pathways to a sustainable economy: bridging the gap between Paris climate change commitments and net zero emissions. Chapter 12. pp. 209-221. (12 pages).

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- ICAP. (2021). Emissions Trading Worldwide: Status Report 2021. Berlin: International Carbon Action Partnership. (173 pages).
- ICAP. (2021). Emissions Trading Worldwide: Status Report 2021. Berlin: International Carbon Action Partnership. (173 pages).
- ICROA. (2020). Timeline: Evolution of Voluntary Carbon Market (VCM). (1 page).
- Kojima, M.; Trimble, C. (2016). Making Power Affordable for Africa and Viable for Its Utilities. (43 pages).
- Kollmuss, A., & Zink, H. (2008). Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards. WWF Germany. (88 pages).
- Mateo-Márquez, A. J., González-González, J. M., Zamora-Ramírez, C. (2019). Countries' regulatory context and voluntary carbon disclosures. Sustainability Accounting, Management and Policy Journal, 11(2), 383–408. (25 pages).
- Michaelowa, A., Shishlov, I.; Brescia, D. (2019). Evolution of international carbon markets: lessons for the Paris Agreement. Wiley Interdisciplinary Reviews: Climate Change, 10(6). (24 pages).
- Minx, J.C., et. al. (2009). Input-Output Analysis and Carbon Footprinting: An Overview of Applications. Economic Systems Research. Vol. 201(3). 187-216. (31 pages.)
- Nauman, B. (2021, May 19). How much is a tree worth? Investors seek to build a market for nature. Financial Times. (5 pages).
- Ness, B. (2015). Sustainable diffusion of sustainable technologies? SSPP. Vol 1,. Issue 1. 53-63. (10 pages).
- Ritchie, J. (2014). Understanding the shadow impacts of investment and divestment decisions: Adapting economic input–output models to calculate biophysical factors of financial returns. Ecological Economics. Vol 106. 132-140. (9 pages).
- Schinckus, C. (2020). The good, the bad and the ugly: An overview of the sustainability of blockchain technology. Energy Research and Social Science. Vol 69. (10 pages).
- Schneider, L. Kollmuss, A, & Lazarus, M. (2014). "Addressing the risk of double counting emission reductions under the UNFCCC". Stockholm Environment Institute. (50 pages).
- Spuler, F. et.al. (2020). Bridging the Gap: Measuring progress on the climate goal alignment and climate actions of swiss financial institutions. 2DII. (104 pages).
- Stephan, B. (2015). The politics of carbon markets. Routledge. Chapter 7. pp. 133-150. (17 pages).
- The Climate Reality Project. (2017). 2017 Handbook of Carbon Pricing Instruments. (60 pages).
- The Sustainable Development Goals Report 2019. (2019). The Sustainable Development Goals Report. (64 pages).
- Tracking SDG7: The Energy Progress Report 2019. (2018). (176 pages).
- UNEP. (2021). Adaptation Gap Report 2020. (120 pages).
- UNFCCC (2015). The Paris Climate Agreement. (16 pages).
- UNIDO. (2020). How Industrial Development Matters to the Well-Being of the Population. (67 pages).
- Vasudevan, R. (2010). Financial intermediation and fragility: the role of the periphery. International Review of Applied Economics. Vol 24. 57-74. (19 pages).
- Weston, P. (2018). Financial and operational bundling strategies for sustainable microgrid business models. National Renewable Energy Laboratory. (39 pages).
- Wettestad, J., & Gulbrandsen, L. H. (2018). In The evolution of carbon markets: design and diffusion., Routledge. Chapter 13. pp. 229-252. (23 pages).
- World Bank. (2020, May 27). State and Trends of Carbon Pricing 2020. Open Knowledge Repository. (109 pages).
- World Bank. (November 2019). First International Conference On Carbon Pricing. World Bank Paper Series. Chapter on Blockchain & Double Counting by Schneider (14 pages).
- World Resources Institute. (2010). Bottom Line on Offsets. Issue 17. (2 pages).
- Xia, L., et. al. (2017). Virtual carbon and water flows embodied in international trade: a review of consumption-based analysis. Journal of Cleaner Production. Vol. 146. 20-28. (9 pages).

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Videos:

- Cardano - Simply Explained https://www.youtube.com/watch?v=Do8rHvr65ZA

Case Studies:

- Streck, C. (2020). "Who Owns REDD+? Carbon Markets, Carbon Rights and Entitlements to REDD+ Finance." MDPI. Forests. (15 pages).
- Machado de Morais Junior, V.T., et. al. (2020). "Growth and survival of potential tree species for carbon-offset in degraded areas from southeast Brazil." Ecological Indicators. Vol. 117. (9 pages).
- West, T., et. al. (2020). "Overstated carbon emission reductions from voluntary REDD+ projects in the Brazilian Amazon." PNAS. Vol. 117. No. 39. (7 pages).
- Wettestad, J. (2020). The Evolution of Carbon Markets: Design and Diffusion. [*Select Case Study in Book*]. (~10 pages).
- Hossain, M., Hales, R.; Sarker, T. (2018). In Pathways to a sustainable economy: bridging the gap between Paris climate change commitments and net zero emissions. Chapter 11. pp. 191-209. (18 pages).

Resources

Columbia University Library
Columbia's extensive library system ranks in the top five academic libraries in the nation, with many of its services and resources available online: http://library.columbia.edu/.

SPS Academic Resources
The Office of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: http://sps.columbia.edu/student-life-and-alumni-relations/academic-resources.

Course Requirements (Assignments)

Your final course grade will be computed using a weighted index of numeric grades that combine performance under problem sets, written assignments, attendance and participation, the midterm exam, and the final term project. The weighted index will be scaled into a letter grade scale from F to A+ based on an expectation that a class representative of the population of Columbia masters students will receive a median grade of B+ or A-.

Specific rubrics for each assignment will be provided on the Canvas course site. General evaluation criteria is provided in each description.

Attendance and Participation (Individual) - 15% of final grade

Regular attendance in lectures is required. Students are expected to have done the readings for each session prior to the lecture. Participation in all lectures and project activities is required. We expect your contributions to enhance the quality of the class experience for yourself and others.

Problem Sets and Written Assignments (Individual) - 25% of final grade

Problem sets and written assignments are contextually linked and will be completed simultaneously in relation to the corresponding subject matter. The problem sets required the application of concepts to gain insights while written assignments are reflections upon the constraints and limitations on data. Students are given one week to complete these. Please review below for further details.

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These assignments will be evaluated in four general areas: Completeness, Accuracy, Relevance, and Formatting. Specific rubrics for each assignment will be provided on the Canvas course site.

Problem Sets

Students will complete five short, highly simplified, problem sets in order to crystallize the concepts and techniques used to gather and analyze statistical and economic data. Each set will be submitted via Canvas in an Excel sheet. Each problem set combines quantitative exercises with short written reflective responses to articulate the variations, levels of complexity, and insights that can be learned from available information. Weekly subject matter and learning objectives determine the context of each set. Full descriptions of the following problem sets will be outlined in detail in the Canvas course site.

Problem Set 1: Quantitative allocation of emissions reduction responsibilities
Problem Set 2: Summary analysis of Sustainable Development using quantitative SDG indicators
Problem Set 3: Analysis of the emission reduction potential of available technologies and offset possibilities
Problem Set 4: Scale of trade flows and potential impact of carbon pricing
Problem Set 5: Simplified methods to aggregate climate risk across a portfolio of financial assets

Written Assignments

Students will write five short essays, each approximately 600-750 words. These assignments will be submitted via Canvas in a Word document. Although related to the problem sets, these assignments challenge students to reflect more on the limitations of the available quantitative data and what those limitations imply for the broader possibilities for climate finance. Full descriptions of the following written assignments will be outlined in detail in the Canvas course site.

Writing Assignment 1: The allocation of emissions reduction responsibilities
Writing Assignment 2: Summary Analysis of Sustainable Development using SDG Indicators
Writing Assignment 3: Analysis of the emission reduction potential of available technologies and offset possibilities
Writing Assignment 4: Scale of trade flows and potential impact of carbon pricing
Writing Assignment 5: Simplified methods to aggregate climate risk across a portfolio of financial assets

Midterm Exam (Individual) - 30% of final grade

At the end of week 9, students are given 48 hours to complete a written midterm exam. The exam has two parts. First, students will solve several higher-order quantitative problems in an Excel spreadsheet. These problems will reflect the concepts covered in weeks 1-8. Second, students will write an analytical essay to demonstrate the synthesis and transfer of concepts and techniques covered in previous modules. Students will select a prompt from a short list and submit a Word document with their response of approximately 1000 words, excluding references.

Final Term Project (Groups of 2-3 people) - 30% of final grade

General purpose and challenge of the final project: The project will outline a strategy and implementation plan that addresses energy access and carbon reduction objectives in the context of one or more developing countries, and also contributes to meeting the Net Zero ambitions of a developed country decision-maker.

A total of 100 points, the deliverables for the project will be submitted in a sequence of milestones. They are as follows:

Topic choice (Non-Graded)

This will consist of a group topic choice, an outline, and a group feedback meeting.

Outline - Each group will present a project outline by the end of week 8. The outline will consist of:

- The context for the energy and emissions reduction challenges faced by the chosen stakeholders

- An articulation of an implementable plan to address these challenges within a defined timeframe (up to 5 years)
- Identification of appropriate carbon markets or other mechanisms that serve to monetize the value of emissions reductions and related co-benefits
- Identification of appropriate parties and technologies needed to render the plan feasible and financially viable

Feedback Meeting - After submission of the outline, groups will schedule a feedback meeting where they will be provided the necessary guidance for the project to be successful moving forward. In addition, students will be afforded the opportunity to ask questions for clarification.

Presentation Deck *(15 points)*

Before presenting the final paper, students will design and submit a PowerPoint presentation slide deck. This will lay out preliminary results designed to persuade a decision maker to approve the implementation of the plan laid out in the paper. It will illustrate the plan's assumptions, the resources required, and describe the cost and benefits.

The presentation deck will be evaluated on the following criteria:

Organization 3 pts
- Investment background: introduction, context for recommendation, results appropriately interpreted, balance between elements, flow

Content 4 pts
- Clarity, relevance, accuracy, detailed coverage, statements supported by data

Illustrations, tables, graphs 8 pts
- Emissions chart, quality of other charts, relevance, number

Recording *(25 points)*

Students will record a persuasive presentation of their slide deck using the BigBlueButton video conference application housed in Canvas. The recording will be a maximum length of 12 minutes, and students must choose and define their roles for evenly distributed work. Everyone in the course will view these presentations before the final class Q&A session. The Q&A session is an opportunity to inform the final changes to the project paper.

The presentation recording will be evaluated on the following criteria:

Organization 3 pts
- Investment background: introduction, context for recommendation, results appropriately interpreted, balance between elements, flow

Content 5 pts
- Clarity, relevance, accuracy, detailed coverage, statements supported by data

Illustrations, tables, graphs 3 pts
- Emissions chart, quality of other charts, relevance, number

Presentation/Delivery 5 pts
- Language, confidence, eye contact, movement/gestures

Questions & Answers 6 pts
- Quality and depth of responses to peer questions

Timing 3pts
- Pacing and length, between 10-15 minutes, depends on the number of students

Written Paper *(35 points)*

Each group will submit a feasibility report detailing the technical and financial viability of the project. This includes an Executive Summary, a Technical and Operations Plan, a Financing Plan, and a Timeline and Milestone Calendar. The paper will utilize concepts developed throughout the class, especially those synthesized in weeks 11 & 12. The paper will be a length of 10 pages maximum (excluding appendices). This will be the final project submission.

The written paper will be evaluated on the following criteria:

Organization 6 pts
- Investment background: introduction, context for recommendation, results appropriately interpreted, balance between elements, flow

Content 17 pts
- Clarity, relevance, accuracy, detailed coverage, statements supported by data

Illustrations, tables, graphs 9 pts
- Emissions chart, quality of other charts, relevance, number

Formatting 3 pts
- Language, clarity, style, works cited

Excel Sheet *(25 points)*

An Excel spreadsheet detailing technical, operations and financing assumptions, relationships and scenarios for the planned strategy will be submitted with the final paper.

The project Excel sheet will be evaluated on the following criteria:

Comprehensiveness 7 pts
- Appropriateness and completeness of tabs, documentation of sourcing

Accuracy 10 pts
- Use of correct formulae within-cells and cross-tab referencing

Relevance 3 pts
- Link between analysis and arguments made in presentation/paper

Formatting 5 pts
- Clarity in location and content of tabs, sub-sections, numerical formatting

Evaluation/Grading

The final grade will be calculated as described below:

FINAL GRADING SCALE

Grade	Percentage
A+	98–100 %
A	93–97.9 %
A-	90–92.9 %
B+	87–89.9 %
B	83–86.9 %
B-	80–82.9 %
C+	77–79.9 %
C	73–76.9 %
C-	70–72.9 %

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D	60–69.9 %
F	59.9% and below

ASSIGNMENT	% Weight
Attendance and Participation (Individual)	15%
Problem Sets and Written Assignments (Individual)	25%
Midterm Exam (Individual)	30%
Final Term Project (Group)	30%

Course Policies

Participation and Attendance
Regular attendance in lectures is required. Students are expected to have done the readings for each session prior to the lecture.

Participation in all lectures and project activities is required. We expect your contributions to enhance the quality of the class experience for yourself and others. This involves making relevant, useful and non-obvious comments, or posing pertinent questions, in clear and succinct language. During the lectures, come prepared to answer impromptu questions about the readings and course assignments.

Late work
All assignments must be submitted on the published due dates. In the absence of well-documented extenuating circumstances, I will deduct 10 points from the assignment grade score for each day that you are late in submission.

Citation & Submission
All written assignments must use **APA**, cite sources, and be submitted to the course website (not via email).

School Policies [Include all school/university policies as written below.]

Copyright Policy
Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity
Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It

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is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at http://sps.columbia.edu/student-life-and-alumni-relations/academic-integrity-and-community-standards. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Accessibility
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.

Course Schedule/Course Calendar

Week	***Topic***	***Readings and Resources***	***Activities/Assignments***
1	**Course Introduction and Review** **&** **Climate Equity** (L1) *A review of the principle of 'common but differentiated responsibilities and respective capabilities,' a founding principle of UNFCCC, analysis of data on historical cumulative emissions and emission per capita by country, and a review of the intergenerational and intergenerational equity considerations.*	**Readings** UNFCCC (2015). The Paris Climate Agreement. (16 pages). Stephan, B. (2015). The politics of carbon markets. Routledge. Chapter 7. pp. 133-150. (17 pages). Hossain, M., Hales, R.; Sarker, T. (2018). In Pathways to a sustainable economy: bridging the gap between Paris climate change commitments and net zero emissions. Chapter 12. pp. 209-221. (12 pages).	• Complete readings and review of media resources • Participate in "Getting to Know You Discussion" forum before the block week begins • Attend the Class Session
2	**Energy Access & Human Development** (L1, L2) *The link between energy access for the most vulnerable populations and human*	**Readings** Tracking SDG7: The Energy Progress Report 2019. (2018). (176 pages). Beyond income. (2019). Human Development Report 2019. (336 pages)	• Complete readings and review of media resources • Attend the Class Session • Problem Set 1 • Writing Assignment 1

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	well-being and climate adaptation. The need for equitable opportunities for human development in developing countries to support the legitimacy of the global climate mitigation actions.	The Sustainable Development Goals Report 2019. (2019). The Sustainable Development Goals Report. (64 pages). Kojima, M.; Trimble, C. (2016). Making Power Affordable for Africa and Viable for Its Utilities. (43 pages). UNIDO. (2020). How Industrial Development Matters to the Well-Being of the Population. (67 pages).	
3	**The Long March to NetZero** (L1, L2) *Climate targets and Net Zero commitments adopted by countries, sub-national actors and private businesses. A review of the implications for the future path of emissions by country and sector.*	**Readings** Black, R., Cullen, K., Fay, B., Hale, T., Lang, J., Mahmood, S., Smith, S.M. (2021). Taking Stock: A global assessment of net zero targets, Energy & Climate Intelligence Unit and Oxford Net Zero. (30 pages) Michaelowa, A., Shishlov, I.; Brescia, D. (2019). Evolution of international carbon markets: lessons for the Paris Agreement. Wiley Interdisciplinary Reviews: Climate Change, 10(6). (24 pages). ICROA. (2020). Timeline: Evolution of Voluntary Carbon Market (VCM). (1 page). Global States and Regions Annual Disclosure Report 2020. (2020). Climate Group. (19 pages). Global States and Regions Annual Disclosure Report 2020: Annex. (2020). Climate Group. (26 pages). ICAP. (2021). Emissions Trading Worldwide: Status Report 2021. Berlin: International Carbon Action Partnership. (173 pages). Mateo-Márquez, A. J., González-González, J. M., Zamora-Ramírez, C. (2019). Countries' regulatory context and voluntary carbon disclosures. Sustainability Accounting, Management and Policy Journal, 11(2), 383–408. (25 pages).	• Complete readings and review of media resources • Attend the Class Session • Problem Set 2 • Writing Assignment 2
4	**Transition, Offsets, Zero & Negative emissions technologies**	**Readings** Kollmuss, A., & Zink, H. (2008). Making Sense of the Voluntary Carbon Market: A Comparison of	• Complete readings and review of media resources • Attend the Class Session

	(L1, L3, L4, L5) *Green, sustainability-linked and Transition Bonds; VCO finance: Verra, Gold Standard, RGGI, SBTI for Finance, Pvt Equity; Financing of storage, resiliency, air capture*	Carbon Offset Standards. WWF Germany. (88 pages). Schneider, L. Kollmuss, A, & Lazarus, M. (2014). "Addressing the risk of double counting emission reductions under the UNFCCC". Stockholm Environment Institute. (50 pages). Environmental Defense Fund. (2020). "What makes a high-quality carbon credit?" WWF. (16 pages).	• Problem Set 3 • Writing Assignment 3
5	**Trade flows, virtual carbon trading, and border price adjustments** (L1, L2, L3, L5) *An introduction to global carbon trading, both voluntary and regulated, with a review of actual carbon flows and virtual flows embedded within the flow of goods and services.*	**Readings** Wettestad, J., & Gulbrandsen, L. H. (2018). In The evolution of carbon markets: design and diffusion., Routledge. Chapter 13. pp. 229-252. (23 pages). Nauman, B. (2021, May 19). How much is a tree worth? Investors seek to build a market for nature. Financial Times. (5 pages). Dasgupta, P. (2021). The Economics of Biodiversity: The Dasgupta Review. Chapters 1,5, 12. (38 pages). Vasudevan, R. (2010). Financial intermediation and fragility: the role of the periphery. International Review of Applied Economics. Vol 24. 57-74. (19 pages).	• Complete readings and review of media resources • Attend the Class Session • Problem Set 4 • Writing Assignment 4 • Project Outline Assigned
6	**Trade flows, virtual carbon trading, and border price adjustments** (L1, L2, L3, L5) *Continued analysis of global carbon trading, with a focus on the implications of carbon pricing and border price adjustments for export-led models of economic development and foreign direct investment.*	**Readings** World Bank. (2020, May 27). State and Trends of Carbon Pricing 2020. Open Knowledge Repository. (109 pages). ICAP. (2021). Emissions Trading Worldwide: Status Report 2021. Berlin: International Carbon Action Partnership. (173 pages). The Climate Reality Project. (2017). 2017 Handbook of Carbon Pricing Instruments. (60 pages). World Resources Institute. (2010). Bottom Line on Offsets. Issue 17. (2 pages). Xia, L., et. al. (2017). Virtual carbon and water flows embodied in international trade: a review of consumption-based analysis. Journal of Cleaner Production. Vol. 146. 20-28. (9 pages).	• Complete readings and review of media resources • Attend the Class Session • Problem Set 5 • Writing Assignment 5

7	**Climate risk analysis for economic sectors** (L2, L4, L5) *An introduction to environmentally extended economic input-output analysis EEEIO, a sector-based method to predict economic and climate outcomes in standard scenario analysis.*	**Readings** Minx, J.C., et. al. (2009). Input-Output Analysis and Carbon Footprinting: An Overview of Applications. Economic Systems Research. Vol. 201(3). 187-216. (31 pages.) Ritchie, J. (2014). Understanding the shadow impacts of investment and divestment decisions: Adapting economic input–output models to calculate biophysical factors of financial returns. Ecological Economics. Vol 106. 132-140. (9 pages). Eis, J., Schafer, J. (2019). Changing Course. UNEP Finance Initiative. (129 pages).	• Complete readings and review of media resources • Attend the Class Session
8	**Portfolio climate warming potential** (L4, L5, L6) *A review of PACTA and other protocols to assess the impact on a financial portfolio of climate change scenarios.*	**Readings** Spuler, F. et.al. (2020). Bridging the Gap: Measuring progress on the climate goal alignment and climate actions of swiss financial institutions. 2DII. (104 pages). GPIF (2019). Analysis of Climate Change-Related Risks and Opportunities in the GPIF Portfolio.(94 pages).	• Complete readings and review of media resources • Attend the Class Session • Project Outline Due
9	**Adaptation Finance** (L4, L5, L7) *An enumeration of the special problems of financing adaptation efforts, especially for the most vulnerable populations such as smallholder farmers and micro-enterprises.*	**Readings** Bose, S. (2021). Adaptation Finance: A Review of Financial Instruments to Facilitate Climate Resilience. The Palgrave Handbook of Climate Resilient Societies. (34 pages). Borges, V. (2020). Societal Governance, Chaotic Institutions, and Complex Systems Resilience. After the Nation-State. (15 pages). UNEP. (2021). Adaptation Gap Report 2020. (120 pages).	• Complete readings and review of media resources • Attend the Class Session • Midterm
10	**Blockchain and smart contracts for decentralized climate finance** (L5, L7) *An introduction to third generation distributed ledger applications to enable a balance between scalability of verification protocols and*	**Readings** World Bank. (November 2019). First International Conference On Carbon Pricing. World Bank Paper Series. Chapter on Blockchain & Double Counting by Schneider (14 pages). Bose, S. et al.(2019). The Financial Ecosystem. Palgrave Studies in Impact Finance. Chapter 12. 283-310. (28 pages).	• Complete readings and review of media resources • Attend the Class Session • Outline Feedback Appointment

	decentralized construction of trust. A discussion of the implications for energy demand and bottom-up governance.	Schinckus, C. (2020). The good, the bad and the ugly: An overview of the sustainability of blockchain technology. Energy Research and Social Science. Vol 69. (10 pages). Bakarich, K., et. al. (2020). The Use of Blockchains to Enhance Sustainability Reporting and Assurance. Accounting Perspectives. Vol. 19 No. 4. 389-412. (24 pages). **Videos** Cardano - Simply Explained https://www.youtube.com/watch?v=Do8rHvr65ZA	
11	**Designing decentralized carbon reductions with co-benefits I** (L6, L7) *An in-depth analysis of the bankability and financing of carbon reduction projects with co-benefits for local populations, with examples drawn from clean cook stoves, renewable micro-grids. Design of mechanisms to link developed country Net Zero commitments to poverty alleviation and climate adaptation.*	**Readings** Ness, B. (2015). Sustainable diffusion of sustainable technologies? SSPP. Vol 1,. Issue 1. 53-63. (10 pages). Butu, H., et. al. (2021).Leveraging community based organizations and fintech to improve small-scale renewable energy financing in sub-Saharan Africa. Energy Research & Social Science. Vol 73. 1-11. (11 pages). Weston, P. (2018). Financial and operational bundling strategies for sustainable microgrid business models. National Renewable Energy Laboratory. (39 pages).	• Complete readings and review of media resources • Attend the Class Session
12	**Designing decentralized carbon reductions with co-benefits II** (L6, L7) *An in-depth analysis of the bankability and financing of carbon reduction projects with co-benefits for local populations, with examples drawn from reforestation, regenerative agriculture and biosphere sequestration. Design of mechanisms to link*	**Readings** Gilbertson, T. L. (2020). Financialization of nature and climate change policy: implications for mining-impacted Afro-Colombian communities. Community Development Journal, 56(1), 21–38. (18 pages). Hossain, M., Hales, R.; Sarker, T. (2018). In Pathways to a sustainable economy: bridging the gap between Paris climate change commitments and net zero emissions. Chapter 11. pp. 191-209. (17 pages). Streck, C. (2020). Who Owns REDD+? Carbon Markets, Carbon Rights and Entitlements to	• Complete readings and review of media resources • Attend the Class Session • Presentation Deck • Recording

	developed country Net Zero commitments to poverty alleviation and climate adaptation.	REDD+ Finance. MDPI: Forests, 11, 959. (15 pages).	
13	Presentation Q & A	**None**	• Attend the Class Session
Finals Week	Wrap-Up	**None**	• Written Paper • Excel Sheet