



School of Environmental Studies
ENVS 6675 660 Global Supply Chain Decarbonization
Fall 2025

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Teacher's Assistant TBD
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Office hours: TBD or by appointment.

Class Plan/Schedule: This course will take place in-person. The weekly class lecture is scheduled for Wednesdays at 5:15-8:15 pm in TBD Building, Room TBD. Each student will have access to meet individually with me (primarily online) throughout the term. Please see scheduling of weekly content and assignments listed below.

Course Pre-requisites: Graduate standing

Course Objective:

After four generations of explosive global trade growth, a growing awareness of climate change and other environmental externalities has triggered a global movement toward decarbonization, localization and re-shoring. Pressure from investors as well as carbon-related taxes, incentives and reporting requirements have been driving operations and supply management to go green. However, lowering the current supply chain management decision-making toolbox is cost-driven and doesn't consider carbon. This course content teaches a sequence of management decision-making frameworks and optimization tools for eliminating carbon throughout the supply chain via lectures, exercises, and case studies that incorporate decarbonization techniques into classic operations management decisions. Students will apply logistical and supply management models that integrate carbon objectives with cost, service level, and other conventional supply chain management objectives, making the course valuable for supply chain professionals and students alike. The combination of academic constructs and real-life case studies is designed to equip students to successfully lead their companies' decarbonization programs. It also prepares students to take the optional REVchain™ supply chain decarbonization [certificate exam](#).

Course Structure:

The course consists of five components:

1. Textbook readings inform the core understanding of the principles, strategies, and techniques.
2. Lectures elaborate on the readings and provide additional insights and examples.
3. Case studies provide a comprehensive examination of real-world situations and challenges.
4. Quizzes (weekly) ensure a minimum level of preparedness for class discussion.
5. A group project (lasting the whole semester) allows students to apply the frameworks and concepts within the context of a real company.

The course is structured to provide ample opportunity for interaction among students, and between the students and the instructor. We will be discussing case studies and relevant reading material during this course. It is expected that you actively participate in keeping up with the lectures and reading. Since class interaction is vital to understanding the practical aspects of in supply chain management, students are expected to actively participate in class discussions, and in order to do so, they must have completed assigned readings and be prepared to knowledgeably discuss the material when called upon.

Required Course Assigned Reading:

We will be discussing research papers, case studies and relevant reading material in addition to the assigned text during this course. Therefore, students are expected to obtain the textbooks and the bulk pack of cases, as these are required readings.

Required Reading Material:

- Case Study pack: <https://hbsp.harvard.edu/import/1278232>
- Textbook 1 (required): [*Getting to Net Zero: The Complete Guide to Decarbonizing Businesses and Supply Chains*](#)
 - Ebook is available online via the link above.
 - Hard copies are available [here](#) or via Amazon (with a lead time)
 - If you buy this book on Amazon, be sure to follow the above link, as there is a different book by a similar name.
- Textbook 2 (recommended): [*Guide to Supply Chain Management*](#)

Course Assignments and Grading:

Final Group Project Report and Presentation	40% of Final Grade
Assignments & Quizzes	30% of Final Grade
Interim Group Project Update	20% of Final Grade
Class Participation	10% of Final Grade

Grading Schema:

<u>Grade</u>	<u>Range %</u>		
A	95.00+	B-	80.00-82.99
A-	90.00-94.99	C+	77.00-79.99
B+	87.00-89.99	C	70.00-76.99
B	83.00-86.99	F	<70.00

Group Project Report and Presentation (Report (30%) + Presentation (10%) = 45% of total grade):

- Each student will be randomly assigned to a group project team. Each group team will select three potential organizations to study, in priority order, in the first weeks of the course. Each group should create their group on Canvas and add a place-holder group name until the choice of company is finalized. Contact Deepthi with any issues related to project group formation.
- The organizations must be **existing entities**. Publicly traded companies or entities that report their results publicly are recommended, to maximize the amount of information available via disclosures and investor communications. For obvious reasons, the company cannot be one that we cover through case material within the course. The professor will help you make a final decision on which organization to study.
- For publicly traded companies there should be information available in the company's investor reports, such as 10-K reports, sustainability reports, carbon disclosure reports, and earnings calls with equity analysts.
- Upon completion of the project students should understand how a company does or can implement its supply chain decarbonization strategy; and have explored in depth the supply chain decarbonization opportunities in that organization.
- The project involves the development of a report and an in-class presentation. This project is meant to help you apply what you have learned in the course. This project is focused on your chosen organization. Your selection of topics should allow you to best demonstrate your mastery of the tools and techniques and provide valuable insight into how operations management drives success or failure at the company.
- The report should answer the following questions:
 - What is [Company X's] Carbon Footprint?
 - Is Decarbonization Aligned with [Company X's] Business Strategy?
 - To What Extent Does [Company X] Stimulate Norms and Behavior Change Across the Supply Chain?
 - Which Clean Energy Technologies Should [Company X] Implement?
 - How (and how much) Can [Company X] Lower its Energy Intensity?
 - How (and how much) Can [Company X] Reduce Emissions Through Transport Optimization?
 - How (and how much) Can [Company X] Reduce Building Emissions Through Green Design?
 - How (and how much) Can [Company X] Use Clean Energy Offsets and Credits?
 - How (and how much) Can [Company X] Design Products and Services to Minimize Lifecycle Carbon Footprint

- How Can [Company X] Source to Minimize CO₂, and how much carbon can be eliminated through supply management?
- How Can [Company X] Decarbonized Its Supply Chain Using Tech Tools?
- What Should Be [Company X's] Carbon Reduction Target Be, and By When? What Should Be Its Decarbonization Schedule?
- One or more sample reports will be provided to help you understand how to structure and write your group project reports.
- The report must conform to the below specifications:
 - Written Report
 - The written report should be in Microsoft Word and be at least 25 pages long, using Times New Roman font no larger than 12pt font and double spaced.
 - The Final report must include analysis of six (6) of the topics covered in the course (each class is a topic).
 - The report should employ the tools taught in the textbook and the class, and in particular must include a business case for (or against) decarbonization including a waterfall chart (based on at least some quantitative analysis), and a timetable for decarbonization including a Gantt chart. Make reasonable assumptions as needed to fill gaps in available data on the company.
 - Include a cover page including full course information and the names of the group members, the date and the professor; Table of Contents with course info, etc.; and include page numbers on all the pages.
 - Make sure all charts, tables, and diagrams are labeled with titles, units of measure, etc. so there is no ambiguity about what is being displayed.
 - Attach any supporting logic and analysis, including quantitative analysis¹
 - Attribute all ideas that are not your own. Do not plagiarize.
 - Use footnotes, not end notes. Put citations adjacent to or immediately below the text, chart, or other content. Be specific enough for the reader to locate the source, including page numbers for large documents. A list of references at the end of a document is insufficient.
 - Please name the file that you upload starting with the name of your Company (e.g., “Nike Decarbonization Plan – Draft”, not “Group 4 report”).
 - In-Class Presentation
 - The slide deck should be in Microsoft PowerPoint
 - The presentation should address at least four (4) of the analyses that are in your report.
 - Include a cover page including full course information and the names of

¹ Upload any calculations in a native Excel workbook and make all calculations visible and traceable. Show formulas in Excel; if you submit work with hard coded numbers that make it hard or impossible to trace where your numbers came from, points will be deducted.

the group members, the date and the professor; Table of Contents with course info, etc.; and include page numbers on all the pages.

- The headlines of each page should be full sentences (subject, verb, noun, and period) explaining the idea that is on the page.
- Put as much information on each page as you want: pages can be information-rich since this is to be presented to a small audience.
- Every member of the team must equally participate and present.

The group assignment reports and presentations will be graded according to the following rubric:

- Relevance of your answers to the textbook and other assigned readings: 35%
- Breadth (% of the class materials practiced): 20%
- Depth of analysis: 20%
- Accuracy of your prescriptions and recommendations (if applicable), and & internal consistency: 10%
- Supporting logic and analysis (including originality and traceability)*: 10%
- Communication (format, compelling, professional): 5%

Case Study Quizzes (30% of total grade):

Case studies offer real life examples of the concepts and theories introduced in the readings and lectures. Your answers to case study quizzes should pertain specifically to that week's readings and the associated case study. Do not do external research for case studies; base your answers solely on the material provided.

Most of the quizzes are divided into two parts – one or two questions to answer in advance of the class, and some more in-depth questions to be answered during the class (in the case of group exercises) or before the next class.

You will be graded on relevance to the readings, completeness, and accuracy of your answer, as well as the effectiveness of your communication. The quizzes will be graded based on:

- Relevance of your answers to the case study and the assigned readings: 45%
- Accuracy of your solutions, prescriptions and recommendations (if applicable): 30%
- Precision of your answers: 15%
- Supporting logic and analysis, including quantitative analysis²: 10%

All assignments are expected to be submitted by the stated deadline. If you anticipate any challenges meeting these deadlines, please reach out to me in advance so that we can consider your options together. **Extensions will not be granted after the case has been addressed in class.**

Interim Group Project Update (20% of Final Grade): The **Interim report** must include an analysis of all of the topics covered through the due date (each class is a topic).

² Upload any calculations in a native Excel workbook and make all calculations visible and traceable. Show formulas in Excel; if you submit work with hard coded numbers that make it hard or impossible to trace where your numbers came from, points will be deducted.

Class Participation and Peer Assessment (10% of Final Grade): You will be assessed on your contribution to the group project, to discuss the topics focused on in class, and ask and answer questions that help in generating productive conversations.

Diversity at the University of Pennsylvania

The Earth and Environmental Science (EES) Department embraces human diversity and intends equity and inclusion in our community and our classrooms. We expect instructors, staff, and students to respect our diversity. We encourage you to contact our Climate, Diversity, Equity and Inclusion (CDEI) Committee EES-CDEIC@groups.sas.upenn.edu if you need support or have suggestions for how our CDEI efforts in EES can improve.

Academic Integrity

Since the University is an academic community, its fundamental purpose is the pursuit of knowledge. Essential to the success of this educational mission is a commitment to the principles of academic integrity. Every member of the University community is responsible for upholding the highest standards of honesty at all times. Students, as members of the community, are also responsible for adhering to the principles and spirit of the Penn Code of Academic Integrity. More details about this policy can be found online at <https://catalog.upenn.edu/pennbook/code-of-academic-integrity/>

Plagiarism: presenting others' work without adequate acknowledgement of its source, as though it were one's own. Plagiarism is a form of fraud. We all stand on the shoulders of others, and we must give credit to the creators of the works that we incorporate into products that we call our own. When doing any work for this class the highest marks will go to original work that precisely and accurately connects to the assigned textbook chapters and to the lectures, cases and class discussions.

If you use generative artificial intelligence (AI) for any intermediate work-in-process or final work product, you must cite the application used, the question asked, and the date of the query. Mashups of AI-generated responses without citation will result in a failing grade.

University Services

Penn Libraries: Students can access all online resources available at the University of Pennsylvania by using the website www.library.upenn.edu/ and logging in with their PennKey and password. Students wishing to visit the Library in person and borrow books will need to obtain a PennID card first.

Student Disability Services (SDS): Although the self-identification process is confidential and completely voluntary, it is required for those requesting accommodation. Student Disability Services (SDS) can be reached by phone at 215.573.9235, by TDD at 215.746.6320 or online at https://www.vpul.upenn.edu/lrc/sds/contact_us.php.

Add/Drop Period: Students may drop a class before the end of the first two weeks of the semester by using Path at Penn. Please see the LPS Academic Calendar for relevant dates and links (<https://www.lps.upenn.edu/about/academic-calendar>). Failure to

attend/participate in a course does not automatically result in being dropped from the course. Courses that are dropped will no longer appear on a student's transcript. <https://www.sas.upenn.edu/lps/lps-online/form/course-withdrawal> The Add/Drop deadline with no financial obligation is September 13th.

Withdrawing from a course: Students may withdraw from a course through the sixth week of the semester with no notation on the transcript and half financial obligation by filling out a late drop form and with the permission of the instructor and program director, and until the end of the twelfth week of the semester with full financial obligation by submitting the withdrawal form and gaining permission from the instructor and program director.

Schedule of Classes, Readings and Assignment Due Dates

Class	Day & Date	Topic	Read Before Class ³	Due Today	Case ⁴	Poss Guest
1	Wed Aug 28	Introducing Low-Carbon Supply Chains	<ul style="list-style-type: none"> Introduction pp. 3-9 FYI: The Long-Term Strategy of the US: Pathways to Net-Zero Greenhouse Gas Emissions by 2050 FYI: EU Corporate Sustainability Reporting Directive FYI: SEC Rule on Climate Disclosure 	Nothing Due Today	Net Zero Climate Commitments: Realistic Goal or Greenwashing?	Industry Experts: Net Zero
2	Wed Sep 4	How to Calculate CO2 Across the Supply Chain	<ul style="list-style-type: none"> Guide to SCM Ch. 3 Ch 2. How to Calculate the Baseline Carbon Footprint Corporate Greenhouse Gas Accounting: Carbon Footprint Analysis 	<ul style="list-style-type: none"> Frito-Lay quiz Q1 Group Team Lists 	Frito-Lay North America: The Making of a Net Zero Snack Chip	Rio Tinto: CO2 Footprint
3	Wed Sep 11	How to Align Decarbonization with the Business Strategy	<ul style="list-style-type: none"> Guide to SCM Ch. 4, 5, and 6 Ch 3. How to Reduce “Scope 1” Emissions – Introduction Ch 3.1 How to Align Net Zero with the Business Strategy Ch 6.3. How to Construct a Realistic Program Schedule ESB Annual Report from 2005 	<ul style="list-style-type: none"> Finish Frito-Lay quiz ESB Quiz Q1+2 Group Company Preferences 	Playing To Win: Leadership And Sustainability at ESB Electric Utility	ESB: Sustainability Strategy
4	Wed Sep 18	How to Stimulate Norms and Behavior Change Across the Supply Chain	<ul style="list-style-type: none"> Guide to SCM: Ch. 7, 8, and 9 Ch 1: How to Organize for Your Decarbonization Initiative Ch. 6.2 How to Make the Business Case for Net Zero Ch 3.2 How to Engage Adaptive Behavior Ch 3.3 How to Establish Net Zero Goals, Objectives, Targets, Metrics and Standards, and OPTIONAL (next 3): GHG Scope 3 Consumer Use Emissions Guidelines (in Files) NYU Orphan Emissions Presentation (in Files) Understanding Orphan Emissions (in Files) 	<ul style="list-style-type: none"> Finish ESB quiz Unilever quiz Q1+2 	Unilever's New Global Strategy: Competing through Sustainability	NYU: Orphan Emissions
5	Wed Sep 25	Which Clean Energy Technologies Will Win?	<ul style="list-style-type: none"> Ch 3.4 How to Shift to Clean Energy Operations FYI: National Academies Accelerating Decarbonization of the U.S. Energy System FYI: IEA Net Zero by 2050 - A Roadmap for the Global Energy Sector 	<ul style="list-style-type: none"> Finish Unilever quiz NPV warm-up exercise 	Eric Thames Powerlines: The Hybrid Truck Decision	CBMM: Battery Tech
6	Wed Oct 2	How to Reduce Carbon Footprint by Lowering Energy Intensity	<ul style="list-style-type: none"> Ch 4 How to Reduce Scope 2 Emissions – Introduction Ch 4.1 How to Reduce Power Consumption by Decreasing Energy Intensity and Increasing Energy Efficiency 	<ul style="list-style-type: none"> Complete Eric Thames quiz Mandalay quiz Q1 	Mandalay Homes: Building Sustainable Innovation in Residential Construction	BR+A: Embodied Carbon
7	Wed Oct 9	How to Reduce Emissions Through Transport Optimization	<ul style="list-style-type: none"> Ch 4.2 How to Reduce Fuel Emissions and Cost Through Transportation Optimization 	<ul style="list-style-type: none"> Finish Mandalay quiz DHL quiz Q1 	DHL Supply Chain Part 1	Kinaxis: Optimization
8	Wed Oct 16	How to Reduce Building Emissions Through Green Design	<ul style="list-style-type: none"> Ch 4.3 How to Reduce Building Emissions via Green Building Design Ch 4.4 How to Access Clean Energy Offsets and Credits FYI: US DOE Solar Futures Study 	<ul style="list-style-type: none"> Finish DHL quiz Aquarium quiz Q1 Interim Group Project Report 	DHL Supply Chain Part 2 Renewable Energy at the National Aquarium, Part 1	National Aquarium: Solar Power
9	Wed Oct 23	How to Use Clean Energy Offsets and Credits	<ul style="list-style-type: none"> Ch 6 Compiling the Net Zero Plan – Introduction Ch 6.1 How to Get to Net Zero – Breaking Down the Carbon Take-Out and the Financial Payback 6.4 How to Document the Plan 6.5 How to Present the Plan 	<ul style="list-style-type: none"> Finish Aquarium quiz 	Renewable Energy at the National Aquarium, Part 2	Therm: Offsets and RECs
10	Wed Oct 30	How to Design Products and Services to Minimize Lifecycle Carbon Footprint	<ul style="list-style-type: none"> Ch 5 How to Reduce Scope 3 Emissions – Introduction Ch 5.1 How to Design Products and Services to Minimize Lifecycle Carbon Footprint Ch 5.2 How to Manage the Portfolio of Products and Services to Minimize Lifecycle Carbon Footprint 	<ul style="list-style-type: none"> Allbirds quiz Q1 	Allbirds: Decarbonizing Fashion	Exxon Mobil: Circularity
11	Wed Nov 6	How to Source to Minimize CO2	<ul style="list-style-type: none"> Ch 5.3 How to Source to Minimize CO2 in Global Supply Chains Ch 5.4 How to Incentivize Supplier Collaboration 	<ul style="list-style-type: none"> Finish Allbirds quiz IKEA quiz Q1 	Sustainability at IKEA Group	New Balance: Supply Chain
12	Wed Nov 13	How to Design a Decarbonized Supply Chain Using Tech	<ul style="list-style-type: none"> Supply Chain & Omni-Channel Technology M&A Report, Q1 2024 	<ul style="list-style-type: none"> Finish IKEA quiz Cardinal Healthcare Quiz Q1 	Cardinal Health Care Blockchain	REFashiond: SC VC
13	Wed Nov 20	How to Design a Cost-Effective Recycling Network	<ul style="list-style-type: none"> Conclusion 	<ul style="list-style-type: none"> Finish Cardinal quiz Dell Ocean Plastics quiz 	Dell: Upcycling Ocean Plastics Through Supply Chain Innovation	Google: Data Centers
	Wed Nov 27	NO CLASS	Thanksgiving Holiday			
14	Wed Dec 4	Group Project	Group presentations			
	Mon Dec 9	Group Project	Complete Group Project report due as an MS-Word document			
	Tue Dec 10	Group Project	Peer assessments to evaluate individual participation on teams			
“15”	Wed Dec 11	Certificate Exam	Supply Chain Decarbonization Certificate Exam (optional) , preregistration required, click here)			

³ Readings refer to *Getting to Net Zero: The Complete Guide to Decarbonizing Businesses and Supply Chains* unless otherwise noted.

⁴ Cases refer to those in the *Harvard Business School Publishing* course pack unless otherwise noted.

Class Detail

Class 1

Topic: Introducing Low-Carbon Supply Chains

Learning Objectives:

- Why decarbonization is needed
 - Benefits of a net zero project
 - Stages of the journey
 - How to make the business case for net zero
 - How to organize for a decarbonation initiative
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Class 2

Topic: How to Calculate Carbon Footprint Across the Supply Chain

Learning Objectives:

- Understand Global Warming Potential
- Differentiate between Scope 1, Scope 2, and Scope 3 emissions
- Define a company's carbon footprint boundaries
- Calculate Scope 1 and 2 carbon footprint
- Estimate CO₂ reduction potential

Case: Frito-Lay North America: The Making of a Net Zero Snack Chip

Class 3

Topic: How to Align Decarbonization with the Business Strategy

Learning Objectives:

- Articulate the business strategy, mission, vision, business model and operations strategy
- Anticipate potential misalignments between the current business and a decarbonized one
- Identify potential gaps in cost, quality and performance that may need to be mitigated

Case: Playing to Win: Leadership and Sustainability at ESB Electric Utility

Class 4

Topic: How to Stimulate Norms and Behavior Change Across the Supply Chain

Learning Objectives:

- Apply a framework for evaluating which goal is appropriate (net zero, low-carbon, etc.)
- Know which principles and practices are needed to achieve various decarbonization goals
- Learn techniques for creating a net zero mindset
- Define an internally consistent set of supporting goals, objectives, targets, metrics and standards

Case: Unilever's New Global Strategy: Competing through Sustainability

Class 5**Topic: Which Clean Energy Technologies Will Win?****Learning Objectives:**

- Understand the landscape of game-changing technologies including energy storage, hydrogen, and clean fuels
- Apply a proven framework for evaluating new technologies
- Learn which key scenarios and sensitivities will determine profitability
- Debate the pros and cons of incremental versus breakthrough change

Case: Erie Thames Powerlines: The Hybrid Truck Decision

Class 6**Class Topic: How to Reduce Carbon Footprint by Lowering Energy Intensity****Learning Objectives:**

- Understand definitions of power conversion efficiency, energy efficiency, energy cost efficiency, and energy cost effectiveness
- Catalogue the ways to achieve power conversion efficiency
- Learn how to redesign conversion process routes
- Determine if upgrades and retrofits are economical
- Explore the impact of catalysts and additives in increasing system throughput

Case: Mandalay Homes: Building Sustainable Innovation in Residential Construction

Class 7**Class Topic: How to Reduce Emissions Through Transportation Optimization****Learning Objectives:**

- Learn eight ways to reduce emissions through transportation optimization
- Conduct a pareto analysis of the impact of each method on CO₂ equivalent emissions
- Structure a logistics network optimization problem
- Integrate carbon objectives into optimization scenarios using Excel Solver

Case: DHL Supply Chain

Class 8

Class Topic: How to Reduce Building Emissions Through Green Design

Learning Objectives:

- Appreciate the magnitude and composition of CO₂ emissions from buildings
- Know what LEED is and how to qualify and implement LEED standards
- Understand the economics of greening existing buildings versus new buildings
- Learn techniques for reducing operational carbon in buildings
- Learn technologies for reducing embodied carbon in buildings

Case: DHL Supply Chain (continued) and Renewable Energy at the National Aquarium

Class 9

Class Topic: How to Use Clean Energy Offsets and Credits

Learning Objectives:

- Learn the difference between carbon credits, carbon offsets, and renewable energy certificates
- Know how to use carbon credits, offsets and certificates to reduce carbon footprint
- Know how to access carbon credits, offsets and certificates and their current prices
- Know the market prices, cash flow and investment implications of buying or selling carbon credits, offsets and certificates

Case: Renewable Energy at the National Aquarium (continued)

Class 10

Class Topic: How to Design Products and Services to Minimize Lifecycle Carbon Footprint

Learning Objectives:

- Integrate CO₂ into the House of Quality for a green design process

- Manage the portfolio of products and services to minimize lifecycle carbon footprint using the product lifecycle construct
- Use the growth-share matrix to prioritize investment and divestment in product lines and business units

Case: Allbirds: Decarbonizing Fashion

Class 11

Class Topic: How to Source to Minimize CO₂

Learning Objectives:

- Understand why Scope 3 emissions are particularly hard to address.
- Know the largest sources of CO₂ by country, industry and company.
- Learn seven techniques for reducing CO₂ from suppliers and their suppliers.

Case: Sustainability at IKEA Group

Class 12

Class Topic: How to Design a Decarbonized Supply Chain Using Tech Tools

Learning Objectives:

- Learn which technologies may be helpful for decarbonizing supply chains
- Understand the complexities and pitfalls of implementation

Case: Cardinal Health Care Blockchain

Class 13

Class Topic: How to Set a Feasible Decarbonization Project Schedule and Document the Plan

Learning Objectives:

- Construct a complex project schedule with constraints and interdependencies
- Identify bottleneck tasks and the critical path
- Know the elements of a plan to move an organization to net zero emissions
- Anticipate potential objections and pushback from stakeholders

Case: Dell – Upcycling Ocean Plastics Through Supply Chain Innovation

Class 14

GROUP PROJECT PRESENTATIONS

This in-person class will serve as an opportunity for groups to make their group presentations.

EXAM WEEK

Submit Your Group Project Report: The complete report must be submitted as an MS-Word document in “*Group Project Report and Presentation.*” Only one member of each group should submit.

Submit Your Peer assessments

“Class 15”: Supply Chain Decarbonization Certification Exam (optional; pre-registration required)