

Theory & Practice of Life Cycle Assessment

<u>Instructor:</u>	Christoph J. Meinrenken
<u>Office hours:</u>	tba
<u>Prerequisites:</u>	No specific pre-requisites, familiarity with spreadsheet software and with quantitative, data-driven analyses strongly recommended

1 CONTENT OVERVIEW

Life Cycle Assessment (LCA), a methodology to assess the environmental impact of products, services, and industrial processes, is an increasingly important tool in corporate sustainability management. This course teaches both the theoretical framework as well as step-by-step practical guidelines of conducting LCAs in any organization. Particular emphasis is placed on separating the more academic, but less practically relevant aspects of LCA (which will receive less focus) from the actual practical challenges of LCA (which will be covered in detail, including case studies). The course also covers the application of LCA metrics in a companies' management and discusses the methodological weaknesses that make such application difficult, including how these can be overcome. Product carbon footprinting (as one form of LCA) receives particular focus, owing to its widespread practical use in recent and future sustainability management.

2 LEARNING OBJECTIVES

The overall learning objective of this course is for students to be able to speak intelligently about the management benefits, strengths, and weaknesses of LCA, when to apply this tool, knowing the basic steps and processes of how to conduct one, and having detailed knowledge of where and when to find additional resources such as software packages, databases, and (government) standards and protocols.

Particular learning objectives are:

- Mastery of the LCA project management roadmap, from data collection to report writing (focus on hands-on expertise to be able to "hit the ground running" if tasked with conducting an LCA)
- Basic understanding and mastery of LCA software and tools
- Familiarity with concepts and procedures for quality management of LCA data
- Difference of LCA on one hand and related approaches on the other (such as enterprise GHG accounting and economic input/output analysis); understanding of the relative merits and when to use them
- Ability to critically interpret LCAs carried out by third parties or competitors
- Benefits and perils of applying LCA metrics in corporate management and product design

- Role of standards and how government, NGOs, and the private sector can affect their evolution

3 WEEKLY SYLLABUS & READINGS

The week-by-week syllabus will be shared at the beginning of the semester and may be updated during the course of the semester in order to include current news and events as well as, class time permitting, to accommodate practitioners as guest lecturers. Selected readings will be assigned each week (twice a week for certain summer courses), and the instructor will give detailed guidance how to use the readings and which part of the readings to focus on.

4 METHOD OF INSTRUCTION AND EVALUATION

This section provides an overview of instruction methods and assignments (above and beyond the lectures themselves) as well as the respective weights attributed for the final grade. Details of students' assignments and respective expectations are laid out in section 5.

- **Assignments [40%]**
 - Homework assignments will be assigned each week, to be turned in usually a week later. Assignments will be of qualitative and quantitative nature, focusing on practical examples and challenges of conducting and interpreting LCAs in business settings. Typical are, e.g., LCA exercises using real (but sanitized) company data
- **5min pitch presentation [10%]**
 - Throughout the semester, each student is expected to give one "pitch presentation". These are intended to hone the presenter's and the audience's understanding of the basic steps of an LCA, awareness of the variety of products and processes to which it can be applied, and skills in quantitatively and succinctly "pitching" sustainability ideas one is passionate about
- **Class participation [15%]**
 - Attendance and active participation in classroom discussions is required. In addition, students can engage in topic-specific, a-synchronous discussions on *Canvas*, e.g., to exchange hints and advice on particular homework sets and additional sources
- **Collaborative final project [35%]**
 - The final group project practices LCA thinking and its application in advising companies in more sustainable practices. The resulting white paper will be centered on the sustainability of a product, project, or service of the group's choice – and then using LCA-type analyses to infer the respective environmental impact reductions and recommendations for the company. The grade (A+ ... F) will be assessed based on (i) accuracy of analyses and (ii) completeness of the white paper

4.1 Letter grade system and final grades

Unless indicated otherwise by the instructor during the course, each individual assignment (a specific homework, class participation, etc.) will be assigned letter grades (A+ ... F) across students, based on a curve centered around A-. The final grade for each student will be the weighted average (weights see above) of the four grades, using the standard GPA metric (i.e., A+ = 4.33, A = 4.00, A- = 3.67, B+ = 3.33, etc.).

4.2 Policies for late assignments, incompletes, missed lectures, etc.

Towards the beginning of the course, the instructor will clearly communicate the respective policies. Please note in particular:

- Home-work assignments past the deadline will not be accepted for credit unless an extension has been arranged with the instructor prior to each deadline. Specifically, this course does not follow a rule such as "HWs may be turned in late but will get partial credit/penalty"
- Individual assignments not in line with Columbia University's Academic Integrity may receive zero credit (F) at the discretion of the instructor. Severe and/or repeated occurrences may result in the student receiving no credit for the class at all (grade F) and/or reporting to the Dean's Office

5 COURSE ASSIGNMENTS AND EXPECTATIONS OF STUDENTS

Homework assignments will be assigned each week, to be turned in a week later. Assignments will be of both qualitative and quantitative nature, focusing on practical examples and challenges of conducting and interpreting LCAs in business settings.

Students should expect each assignment to take **several hours** of independent work. This time is in addition to students doing the weekly suggested readings which will be the basis for discussions in the lectures.

5.1 Quantitative – simple spreadsheet calculations

Quantitative assignments will be practical exercises to reinforce the learning of LCA's basic mechanics and mathematical steps. These will be set by the instructor, in co-ordination with the case studies in the syllabus and/or based on current events. Typical are e.g., specific portions of complete LCA exercises, using real (but sanitized) company data, and typically performed as (simple) spreadsheet analyses.

5.2 Qualitative - essays

For qualitative assignments, an essay format will be employed. These can be longer assignments where students are asked to think creatively about a certain topic and present the results in a concise writeup. In addition, short-answer essays will be assigned during the course of the semester. Essays are designed to reinforce the basic concepts presented in class and to ensure that students master the main concepts. Or they are designed to guide the student in analyzing a specific case study. The essays will consist of multiple questions. Answers to each question should be no longer than a paragraph (2-4 sentences). For

example, you may be asked: What are the four basic steps of a proper LCA as laid out by ISO standards? Or “what was the carbon intensity identified by the study at hand?” The objective is to gain experience concisely identifying key concepts and arguments.

Grading: The essays will be graded on a letter grade scale from A+ to F.

5.3 Final group project and term paper (here: “company white paper”)

The term paper will be assigned about half way into the semester, to be centered around a case study in LCA, at a specific topic of the students’ choosing. Students will be expected to form groups (3-6 students per group) and select a topic that is interesting to them personally and/or of interest in developing their career (e.g., focus on bioplastics or on storm water management). The instructor will support student groups in selecting a suitable topic by (i) providing examples of past projects early in the semester and (ii) discussing data availability and scope of each proposed topic early with each student group before the bulk of the project work begins. The central goal of the group project is to provide students with a hands-on experience of all the steps necessary and challenges faced to perform LCA-type analyses from a-z and to use the results to distill recommendations for a company’s management – as students may have to do in their professional careers. The term paper should be 5,000-7,000 words in length. More detailed requirements and direction around the term paper will be provided in class.

Grading (group): The ‘Term-paper’ component will be graded on a letter grade scale from A+ to F.

During the last session(s), student groups will present their findings around the white paper in presentation format to the entire class. Each group should prepare slides or other material to cover about 20min per project, including Q&A by the class. In addition to providing engaging class room discussion and a variety of topics to all students, the goal of the in-class presentations is to train students to present research findings in a clear and succinct manner.

Grading: Group presentations will not be graded but rather serve as an opportunity for presenting students to get input from other students and the instructor on their work in progress towards finalizing the term paper.

6 LOGISTICS AND SOFTWARE

Unless communicated otherwise, Columbia University's platform *Canvas* will be used to distribute reading materials, lecture slides, and to turn in assignments.

7 POLICIES

7.1 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 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.

7.2 Accessibility Statement

Columbia University 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>

7.3 Columbia University Information Technology (CUIT) Computer Use Policy

Columbia University requires that all individuals accessing University electronic information resources to abide by the standards of acceptable usage indicated within this policy. The University is not responsible for information or materials residing on non-University systems or available over publicly accessible networks even if accessed via the University's network. Such materials do not necessarily reflect the attitudes, opinions, or values of the University, its trustees, faculty, staff, or students. Columbia University's network and computing technology provides information, data, and communication services. Responsible use of electronic information resources is necessary to create and maintain an open community of responsible users based on mutual respect and cooperation, commitment to the integrity of resources and data, and compliance with all University policies and federal, state, and local statutes.

7.4 Other School Policies and Expectations

Accessibility Statement – I want you to succeed in this course. Contact disability@columbia.edu for learning accommodations.

Names/Pronouns – You deserve to be addressed in a manner that reflects your identity. You are welcome to tell me your pronoun(s) and/or name (if different from University records) at any time, either in person or via email.

Discrimination – We embrace the diversity of gender, gender identity & expression, sex, sexual orientation, race, ethnicity, national origin, age, religion, disability status, family status, socioeconomic background, and other visible and non-visible identities. Columbia University does not tolerate unlawful discrimination, discriminatory harassment, sexual assault, domestic violence, dating violence, stalking, or sexual exploitation and all such conduct is forbidden by Columbia University Policy.

Duty to Report – You deserve a University community free from discrimination, harassment, and gender-based misconduct including sexual harassment, sexual assault, domestic and dating violence, stalking, and sexual exploitation. It is therefore University policy to require Columbia faculty and staff to report to EOAA any instance or allegation of prohibited conduct involving any undergraduate or any graduate student that is disclosed to, observed by, or otherwise known to that employee. This

requirement to report is in place to help ensure that students are provided appropriate resources and to allow the University to mitigate harm to our community.

Confidential Resources - There are confidential resources on campus who do not have a Duty to Report, including:

- Sexual Violence Response & Rape Crisis/Anti-Violence Support Center (SVR)
- Ombuds Office
- Medical Services
- University Counseling and Psychological Services
- University Pastoral Counseling
- Columbia Office of Disability Services

University employees working in a confidential capacity will not report information shared with them.

Inclusion - In the M.S. in Sustainability Management program, faculty and staff are committed to the creation and maintenance of “inclusive learning” spaces – classrooms and other places of learning where you will be treated with respect and dignity, and where all individuals are provided equitable opportunity to participate, contribute, and succeed.

In our *Theory and Practice of LCA* classroom, you are welcome regardless of your race/ethnicity, gender identities, gender expressions, sexual orientation, socio-economic status, age, disabilities, religion, regional background, Veteran status, citizenship status, nationality and other diverse identities that each of you bring to class.

Master of Science in Sustainability Management

Theory & Practice of Life Cycle Assessment; PS5021 Section 001

Tuesdays and Thursdays 4:10pm – 6:00 pm

Number of credits 3

Elective Course

Instructor:	Adriana Kliegman abk2145@columbia.edu 917-756-8637
Office Hours:	Wednesdays @ 5:00 pm by appointment (via Google Meets)
Response Policy:	My preferred means of communication is via email. I will respond to you within 1 business day.
Teaching Assistant	Zach Russell zrr2002@columbia.edu
Office Hours:	Wed @ 7pm; Fri @ 9am; Saturday & Sunday by appointment (All via Zoom or Google Meets)
Response Policy:	My preferred means of communication is via email. I will respond to you within 1 business day.

Course Overview

Life Cycle Assessment (LCA), a methodology to assess the environmental impact of products, services, and industrial processes, is an increasingly important tool in corporate sustainability management.

The course will provide continuous context regarding the need for environmental analysis of product design, services, and industrial processes. LCA will be thoroughly explained and conducted, including both the advantages and shortcomings. The course will humanize the environmental data through readings and discussion. Design strategies will also be examined as a larger system context for which to conduct an LCA.

The course also covers the application of LCA metrics in a companies' management and discusses the methodological weaknesses that make such an application difficult, including how these can be overcome. Product carbon footprinting (as one form of LCA) receives particular focus, owing to its widespread practical use in recent and future sustainability management.

This elective course is in person (304 Hamilton Hall) and will not be permitting cross-registrants from other fields or Columbia University programs. This Summer 2023 course starts on July 6th and ends on August 10th.

Learning Objectives

Upon successful completion of this course students should be able to:

- L1: Know the basic steps of how to conduct an LCA using an LCA software package
- L2: Be able to critically interpret LCAs carried out by third parties or competitors
- L3: Speak intelligently about the management benefits, strengths, and weaknesses of LCA
- L4: Navigate seemingly contradictory issues within the field of sustainability management such as offshoring and onshoring, production and sustainability, materialism and equity, consumerism and need, as

well as globalism and localism; and in at-least one area of such dichotomies propose products and/or product-service-systems that consider a more integrated and meaningful future.

- L5: Explore eco design approaches to reduce the impact of products and services.

Readings

The week-by-week syllabus will be shared at the beginning of the semester and may be updated during the semester to include current news and events as well as, class time permitting, to accommodate practitioners as guest lecturers. Selected readings/videos will be assigned each week and the instructor will give detailed guidance on how to use the readings/videos and which part of the readings/videos to focus on. Discussions on these readings/video assignments will be held during the following class.

Assignments and Assessments

This section provides an overview of instruction methods and assignments (above and beyond the lectures themselves) as well as the respective weights attributed for the final grade.

- **Class participation** - Attendance and active participation in classroom discussions is required. In addition, students can engage in topic-specific, a-synchronous discussions on Canvas, e.g., to exchange hints and advice on homework sets and additional sources (L1, L2, L3, L4, L5)
- **Individual Homework Assignments**- Six homework assignments will be assigned to reinforce the basic concepts presented in class and to ensure that students master the main concepts. (L1, L2, L3, L4)
- **Project 1: Collaborate LCA project of existing design** – Working in teams of 2 or 3, an LCA will be conducted on an existing product using Sustainable Minds (an ISO compliant LCA software tool). This hands-on assignment will allow students to understand the different phases of an LCA and to be able to identify the impact hot spots in a product's life cycle (e.g. materials). (L1, L3, L4)
- **Project 2: Collaborate LCA of existing redesigned product**–Working with same team as Project 1, impact reduction goal(s) will be identified based on the results of Project 1. Then eco design strategies will be explored to meet the goal(s) and the Sustainable Minds LCA tool will be used to verify that the impact reduction goal(s) have been met. (L1, L3, L4, L5)

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 %

D	60–69.9 %
F	59.9% and below

Assignment/Assessment	% Weight	Individual or Group/Team Grade
Class participation	15	Individual
Individual Homework Assignments	40	Individual
Project 1: Collaborate LCA project of existing design	20	Group/Team
Project 2: Collaborate LCA of existing redesigned product	25	Group/Team

Course Schedule/Course Calendar

Date:	Topics and Activities	Group Project Assignments (due on this date)	Individual Homework Assignments (due on this date)
6-Jul	Review Syllabus LCA Introduction		
11-Jul	Sustainable Minds Software Introduction Project 1 Introduction		HW 1: ISO 14040 and 14044
13-Jul	Toaster Example in class Ecological damage		
14-Jul		Project 1: Select team and existing product	HW 2: A new, realistic, sustainability friendly, holistic prosperity indicator
18-Jul	Human health damage Product Process Tree	Project 1: Create BOM and Exploded view of existing product	HW 3: Dark Waters
20-Jul	Resource Depletion: Water, Land, Fossil Fuel	Project 1: Determine System Boundary, Product Lifetime, and Functional Unit for existing product	
25-Jul	Project 1 Workshop	Project 1: Obtain and interpret LCA results of existing product	HW 4: Project 1: Existing Product Process Tree
27-Jul	Project 2 Introduction	Project 1 Presentations	

1-Aug	Eco Design Strategies	Project 2: Update Project 1 deliverables Define project goals for redesign	HW 5: Review and Interpret publicly available product LCAs
3-Aug	Project 2 Workshop	Project 2: Select eco design strategies for redesign Illustrate redesign Determine System Boundary for redesign Determine Product Lifetime for redesign	
8-Aug	Project 2 Workshop	Project 2: Obtain and interpret LCA results of redesign	HW6: Personal summary/review of class
10-Aug	Project 2 Presentations	Project 2 Presentations	

Course Policies

Participation and Attendance

I expect you to come to class on time and thoroughly prepared. I will keep track of attendance and look forward to an interesting, lively and confidential discussion. If you miss an experience in class, you miss an important learning moment, and the class misses your contribution. More than one absence will affect your participation grade.

Late work

Work that is not submitted on the due date noted in the course syllabus without advance notice and permission from the instructor will be graded down 1/3 of a grade for every day it is late (e.g., from a B+ to a B).]

Citation & Submission

All written assignments must use standard citation format (e.g., MLA, APA, Chicago), cite sources, and be submitted to the course website (not via email).

School and University Policies and Resources

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

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and will be dealt with severely. It 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 <https://sps.columbia.edu/students/student-support/academic-integrity-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.

Diversity Statement

It is our intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength and benefit. It is our intent to present materials and activities that are respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture.

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: <https://health.columbia.edu/content/disability-services>.

Class Recordings

All or portions of the class may be recorded at the discretion of the Instructor to support your learning. At any point, the Instructor has the right to discontinue the recording if it is deemed to be obstructive to the learning process.

If the recording is posted, it is confidential and it is prohibited to share the recording outside of the class.

SPS Academic Resources

The Division of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: <https://sps.columbia.edu/students/student-support/student-support-resources>.

Columbia University Information Technology

[Columbia University Information Technology](#) (CUIT) provides Columbia University students, faculty and staff with central computing and communications services. Students, faculty and staff may access [University-provided and discounted software downloads](#).

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.

The Writing Center

The Writing Center provides writing support to undergraduate and graduate students through one-on-one consultations and workshops. They provide support at every stage of your writing, from brainstorming to final drafts. If you would like writing support, please visit the following site to learn about services offered and steps for scheduling an appointment. This resource is open to Columbia graduate students at no additional charge. Visit <http://www.college.columbia.edu/core/uwp/writing-center>.

Career Design Lab

The Career Design Lab supports current students and alumni with individualized career coaching including career assessment, resume & cover letter writing, agile internship job search strategy, personal branding, interview skills, career transitions, salary negotiations, and much more. Wherever you are in your career journey, the Career Design Lab team is here to support you. Link to <https://careerdesignlab.sps.columbia.edu/>