

# Theory & Practice of Life Cycle Assessment

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<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 companies and organizations. 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 presentations [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 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 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-/B+. 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 = 4.0, 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 communicate clearly 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 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 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 discussion 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 analysis or publicly available LCA calculators.

#### 5.2 Qualitative - short-answer essays

For qualitative assignments, a short answer essay format will be employed. Several 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. These essays will consist of multiple questions. Answers to each question should be no longer than a paragraph (5 to 6 sentences). For example, you may be asked: What are the four basic steps of a proper LCA as laid out by ISO

standards? The objective is to gain experience concisely identifying key concepts and arguments.

*Grading:* The 'Short-Answer Essays' component will be graded on a letter grade scale from A+ to F.

### **5.3 Term paper (here: "company white paper") and in-class presentation**

The term paper will be assigned about half way into a semester, to be centered around a case study in LCA, at a specific topic of students' choosing. Students will be expected to form groups (3-6 students per group) and select a topic that is both interesting to them and of interest in developing their career (e.g., focus on bioplastics or 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:* 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.