

ENV-500

**Solid waste engineering**

Ludwig Christian

| Cursus                                  | Sem.     | Type |
|---|----------|------|
| Energy Science and Technology           | MA1, MA3 | Opt. |
| Energy minor                            | H        | Opt. |
| Environmental Sciences and Engineering  | MA1, MA3 | Opt. |
| Minor in Engineering for sustainability | H        | Opt. |

|                            |                     |
|----------------------------|---------------------|
| Language of teaching       | English             |
| Credits                    | 4                   |
| Session                    | Winter              |
| Semester                   | Fall                |
| Exam                       | During the semester |
| Workload                   | 120h                |
| Weeks                      | 14                  |
| <b>Hours</b>               | <b>3 weekly</b>     |
| Courses                    | 2 weekly            |
| Exercises                  | 1 weekly            |
| <b>Number of positions</b> |                     |

**Summary**

The book "Solid Waste Engineering - A Global Perspective" is the basis for this course. This textbook is an excellent introduction to the field of Solid Waste Engineering and gives insight into relevant solid waste treatment technologies and practices. Transversal skills will be fostered as well.

**Content**

With the third edition of Solid Waste Engineering, the authors have decided to expand this college textbook to focus on the worldwide problem of solid waste management. This change is illustrated by the addition of "A Global Perspective" to the title. Given that we are currently using our natural resources at an unsustainable rate, polluting our oceans and land with a variety of waste products and altering our atmosphere with gases that are causing further global warming, now is the time to educate future engineers with knowledge and tools to address these worldwide problems.

The 3rd Edition was also adapted in view of the needs of the students who are taking the Solid Waste Engineering course at EPFL. The course is following the logic structure and the chapters of the book. The third edition has been rearranged to follow the hierarchy of solid waste management: reduce, reuse, recycle and recovery. Thus, students will first learn about integrated waste management strategies, an expertise which will support the future engineer to take measures for pollution prevention as well as for resources conservation. In chapter 2 the students are introduced to municipal solid waste characteristics, including the identification of different waste components and materials.

Component specific information is needed for recovery, separation and recycling of waste materials. The relevance of chemical, physical and mechanical properties are discussed in more detail as a basis for the chapters which follow. These properties are most helpful in order to identify potentially meaningful recycling pathways, as well as to decide about possible technological separation and purification options. The next chapter is dedicated to the collection of municipal solid waste, a key, but many times overlooked, component of integrated waste management. Following collection is mechanical processing, in most cases the necessary first step to the recycling and recovery of municipal solid waste. The students will then study mechanical, biological, and thermal processes. For each of these topics the authors have dedicated a separate chapter which will introduce the students to the basic principles of these separate disciplines in the context of waste management. Since not all waste streams can be recovered, students move on to residue management by combustion and landfilling. Finally, students are exposed to the current issues in solid waste management and the principles of integrated and sustainable solid waste management.

It is recommended to buy the book in advance of the course as e-book or as printed edition. (One can get the book at the Rolex Learning Center book store, but if they run out of stock the delivery may take several weeks). A limited stock of books can be borrowed from the teacher for a deposit of CHF 100.

In a few cases the activities at EPFL and the home reading will be complemented with field visits to waste treatment facilities. In addition a group work will focus on specific waste related aspects. These learnings will be transcribed into a video so that these group specific learnings can be made available to the other students of the course.

**Keywords**

Waste Technologies, Recycling, Recovery, Secondary Resources, Mechanical Treatment, Thermal Treatment, Co-treatment, Landfilling, Residues, Stabilization, Heavy Metals, Biomass, Bioenergy, Technical Ordinance on Waste, Material and Elemental Flow Analysis

## Learning Prerequisites

### Required courses

No specific course is required.

### Recommended courses

Environmental chemistry  
Analyse des polluants dans l'environnement  
Informatique pour l'ingénieur  
Numerical analysis  
Microbiologie pour l'ingénieur  
Communication pour l'ingénieur

## Learning Outcomes

By the end of the course, the student must be able to:

- Judge some waste characteristics
- Assess / Evaluate waste treatment pathways
- Estimate flows and quantities of waste and materials
- Justify the choice of different waste treatment options
- Perform simple calculations to determine relevant parameters and process efficiencies
- Take into consideration measures for resources conservation and pollution prevention
- Transcribe teaching content into a video presentation

## Transversal skills

- Identify the different roles that are involved in well-functioning teams and assume different roles, including leadership roles.
- Respect relevant legal guidelines and ethical codes for the profession.
- Demonstrate a capacity for creativity.
- Manage priorities.
- Demonstrate the capacity for critical thinking

## Teaching methods

The book "Solid Waste Engineering" is the basis for the course content which will be complemented with information from other sources (see "further literature" given below).

Field visits, excursions, and the development of a group work will play a central role in studying and understanding wastes and resources management related challenges and process technologies. If possible, the visits will be set to best match with the learning content during the course. However, this is not always possible. Excursions and visits will take place according to the availability of companies and experts. Due to the excursions and project work less time for classic teaching is available and the amount of reading at home will be substantial. Time in the class will also be allocated for contact time with the teacher in the frame of the project development. If needed also contact hours outside the regular course time will be possible on request in person or Zoom.

A beach litter survey will be performed with the entire class together with a specialist in this field and we will visit waste treatment facilities where we will have exchange with the experts on site.

The project team will aim to produce a video, which is covering a relevant part of a book chapter in Solid Waste Engineering or is related to the litter survey which will be performed with the entire class. In addition the teacher will provide a list of topics from which the students can select. However, students can also make an own suggestion, which the teacher has to approve. Goal is to transfer teaching content into small videos which will support future teaching of this course.

Considering the learning outcomes and the transversal skills described above the students have to justify their planned approach in delivering a short proposal structured in the following way:

- a) Content and focus of the video
- b) Justification for your choice of content. Why will this be helpful for students? How does it fit into the logic and concept of the book Solid Waste Engineering. Describe cognitive levels and transversal skills which are considered in the video.
- c) Methods to be used in the video (didactic and graphic elements you want to use)
- d) Description of how the result will look like (screenplay for the video)
- e) Organizational structure of your team (roles in the team, information flow, and decision rules)
- f) Work to be performed (a time plan with milestones and deliverables complements this part: who is doing what and when)

The course structure is in such way, that the first part of the semester will be used to read and study the content of the book and learn from field experiences. Based on that we initiate the second part which is focussing on the team project.

### Expected student activities

- **Presence on the first day of the course** to decide if this course complies with your expectations. You will learn what this course is about. This is essential information for you to decide about participation.
  - **Presence in the class and participation in discussions and team activities.**
  - **Participation at the litter survey.**
  - **Once you have inscribed to an excursion your participation is mandatory** (this is because of organizational and cost reasons).
  - **Performing substantial reading and other work at home** (the working load of 120h is high and corresponds on average to about **one working day/week**).
  - **Safety.** At waste treatment facilities work is done with heavy machinery and large trucks are driving at unclear places to unloading wastes or take away residues and products. Therefore to avoid accidents the group has to stay together.
- Please follow strictly the advise given by the teacher and instructors on site.** Clothing should be appropriate for the weather conditions and a rather dirty site, compareable with a construction site. Therefore, **wear good and closed shoes.**

*Disabled students should contact the teacher as early as possible to discuss options in order to organize the participation at the litter survey and site visits.*

### Assessment methods

The students will deliver

- The proposal for the team project and video making which will account 15% of the mark
- The video which will account 36.7% of the mark
- The video production report which will account 15% of the mark
- The written exam which will account 33.3% of the mark

Further evaluation criteria will be provided when the team project will be initiated.

### Supervision

|              |  |
|--------------|--|
| Office hours | Yes  |
| Assistants   | Yes  |
| Forum        | Yes  |
| Others       | - Moodle<br>(- Google Documents, or other platforms if appropriate). |

### Resources

#### Bibliography

Course book:

William A. Worrell & P. Aarne Vesilind & Christian Ludwig (2017) Solid Waste Engineering, 3rd edition. CENGAGE Learning (also available as eBook)

It is advised to buy the book at the Rolex Learning Center (SI edition, paperback, or the e-book via webpage of the publisher).

Further advanced reading:

Christian Ludwig & Stefanie Hellweg & Samuel Stucki (2003): Municipal Solid Waste Management. SPRINGER-VERLAG BERLIN

Dr. Martin Lemann (1997): Fundamentals of Waste Technology, 1st English Edition. C. HERRMANN CONSULTING

Peter Baccini & Paul H. Brunner (1991): Metabolism of the Anthroposphere. SPRINGER-VERLAG BERLIN  
or Peter Baccini & Paul H. Brunner (2012): Metabolism of the Anthroposphere. The MIT Press

And for topics related to aquatic chemistry:

Werner Stumm, ETHZ (1992): Chemistry of the Solid-Water Interface. JOHN WILEY & SONS, INC.

### Ressources en bibliothèque

- [Lemann. Fundamentals of Waste Technology](#)
- [Stumm. Chemistry of the Solid-Water Interface](#)
- [Worrell. Solid waste engineering](#)
- [Ludwig. Municipal Solid Waste Management](#)
- [Baccini. Metabolism of the Anthroposphere](#)

### Notes/Handbook

Essential information which is not given in the book "Solid Waste Engineering" will be available as electronic copies via moodle.

### Moodle Link

- <https://go.epfl.ch/ENV-500>