

ME-409

**Energy conversion and renewable energy**

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Cursus	Sem.	Type
Civil Engineering	MA1, MA3	Opt.
Electrical and Electronical Engineering	MA1, MA3	Opt.
Energy Science and Technology	MA1, MA3	Obl.
Energy minor	H	Opt.
Environmental Sciences and Engineering	MA1, MA3	Opt.
Managmt, dur et tech	MA3	Opt.
Minor in Engineering for sustainability	H	Opt.
Nuclear engineering	MA1	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Written
Workload	120h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Courses	2 weekly
Exercises	1 weekly
Project	1 weekly
<b>Number of positions</b>	

**Summary**

This course presents an overview of (i) the current energy system and uses (ii) the main principles of conventional and renewable energy technologies and (iii) the most important parameters that define their efficiency, costs and environmental impacts.

**Content**

The course gives an **overview** of:

- **Energy systems and uses**
- **Thermodynamic, economic and environmental principles** relevant for energy conversion systems (energy and exergy efficiencies, levelised cost of energy, emission factors)
- **Power cycles** (Rankine, Brayton and combined cycles)
- **Thermal power plants** (coal, natural gas and nuclear)
- **Carbon capture, storage and use**
- **Heat pumps and Geothermal**
- **Wind and Hydro**
- **Solar (PV and Thermal)**
- **Biomass**
- **Energy storage**
- **Fuel cells**

Focus is on the presentation of the current energy system and uses (electricity, heat and mobility) and of the main conversion technologies (thermodynamics and processes) to satisfy our energy demands. The course does **not** go in details in the physics of each technology. The first half of the course is on the presentation of the **energy system, thermodynamics and conventional power sources**, and the other half on the **main renewable sources**. The **goal** is therefore (i) to describe the relation between the energy system and our demands, (ii) to explain the principles of each energy conversion technology and resources and assess their costs and impacts, (iii) assess their role in future energy systems.

**Keywords**

Energy system ; Energy conversion ; Fossil and renewable sources

**Learning Prerequisites****Required courses**

Physics I  
Physics II

### Recommended courses

This course is **recommended** to master students in their **first year** - as it presents different topics covered in more details in other courses, it is **NOT recommended** to take it in the second year if possible.

### Important concepts to start the course

- Thermodynamics (conservation laws - 1st and 2nd principles)
- Conservation principles (energy, mass, momentum)

### Learning Outcomes

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

- Model energy conversion systems and industrial processes
- Draw the energy balances of an energy conversion system
- Describe the principles and limitations of the main energy conversion technologies
- Quantify the efficiency and the main emission sources of energy conversion processes
- Explain principles and limitations of the main energy conversion technologies
- Characterize fossil and renewable energy resources and their corresponding conversion technologies
- Explain the challenges related to energy: resources, energy services, economic and environmental impacts
- Compare energy conversion systems (efficiency, economics and impacts)
- Model energy conversion systems and industrial processes

### Transversal skills

- Use a work methodology appropriate to the task.
- Demonstrate the capacity for critical thinking
- Write a scientific or technical report.
- Access and evaluate appropriate sources of information.
- Identify the different roles that are involved in well-functioning teams and assume different roles, including leadership roles.

### Teaching methods

Ex-cathedra lectures of 2 hours per week, completed by 1 hour of exercises and 1 hour of project

### Expected student activities

- Active participation to the **lecture sessions**
- **Exercices** consisting of theory questions and case studies, for the exam preparation
- **Mini-project** consisting in proposing an energy transition pathway for Switzerland

### Assessment methods

- Written exam at the end of the semester (60%)
- Intermediate and final project report (40%)

### Supervision

Office hours	No
Assistants	Yes
Forum	Yes

## Resources

### Notes/Handbook

The course material consists of the following:

- Course compendium (lectures, exercises, solutions, project and former exams with corrections), available as a .pdf and on a dedicated website
- Slides and Pre-recorded videos, available on Moodle and on a SWITCHtube channel

Note that the course compendium and the slides/videos present the same content, the main difference lies in the addition of examples and further details in the coursebook in case of interest or need of explanations. This is done so that the interested student can choose the most suitable material and follow the course in case of conflict with other courses.

### Websites

- <http://moodle.epfl.ch>
- <http://www.energyscope.ch>

### Moodle Link

- <https://go.epfl.ch/ME-409>

### Videos

- <https://tube.switch.ch/channels/90cbb52f>