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
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:
- Compare energy conversion systems (efficiency, economics and impacts)
- Describe the main thermodynamic cycles
- Apply the concepts of thermodynamic efficiencies
- Model energy conversion systems and industrial processes
- Explain the main principles and limitations of energy conversion and storage technologies
- Characterize fossil and renewable energy resources and their corresponding conversion technologies
- Assess / Evaluate the challenges related to energy: resources, energy services, economic and environmental impacts
- Derive the energy balances of an energy conversion system

**Teaching methods**

Ex-cathedra lectures of 2 hours per week, completed by 1-2 hours of exercice/project sessions with the teaching assistants

**Expected student activities**

- Active participation to the **lecture sessions**
- **Exercises** 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 (67%)
- Final project report (33%)

**Supervision**

- Office hours: Yes
- Assistants: Yes
- Forum: No

**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.

**Moodle Link**
- [https://go.epfl.ch/ME-409](https://go.epfl.ch/ME-409)

**Videos**
- [https://tube.switch.ch/channels/90cbb52f](https://tube.switch.ch/channels/90cbb52f)