



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Sistemi Energetici

2627-2-F7503Q029

Aims

The course aims to provide the student with basic knowledge on energy conversion systems, and the transport, distribution, and end-use of electrical energy, with particular attention to the methodologies and technologies employed for the control and reduction of pollutant emissions. Through this educational path, the following skills will be acquired and developed:

- **Understanding of Energy Systems:** Knowledge of electrical energy conversion, transport, distribution, and end-use systems. Understanding of the performance characteristics and operation of different types of electricity generation plants (fossil fuels, renewables, and nuclear), along with the fundamental principles of thermodynamics, fluid dynamics, mechanics, electronics, and electrical engineering necessary for the analysis of the plants and the security and safety issues of the electrical system (including smart grids and storage systems).
- **Evaluative and Environmental Analysis:** Ability to critically analyse, also from a proactive perspective, evolving energy and environmental policies at national and supranational levels. Application of the main methodologies for environmental impact assessment and damage control, with the ability to analyse the main data sources and relevant target indicators.
- **Regulatory Framework and Energy Scenarios:** Understanding and critical analysis of energy and environmental issues, future scenarios, as well as policies and laws in the energy field (directives, resolutions, national and European regulations), combined with the ability to interpret scientific articles related to energy conversion technologies and storage systems.
- **Critical Autonomy and Scientific Literature:** Ability to critically examine international scientific literature (including in English), databases and technical reports from research centers, governments, and international organizations, as well as technical-regulatory documents in the sector, evaluating with independent judgment the advantages, disadvantages, and limitations of the various available methodologies and technologies. Ability to formulate an independent judgment on environmental policies, plans, and programs, also from a sustainability perspective and in line with the UN Agenda 2030.
- **Communication Skills:** Ability to communicate environmental information, ideas, problems, and solutions to specialist and non-specialist interlocutors, using appropriate technical-scientific language.

Contents

The course provides a comprehensive and up-to-date overview of global energy scenarios, analysing both traditional conversion technologies and cutting-edge solutions for the energy transition. Key areas of study will include generation systems (fossil, renewable, and nuclear), energy storage systems, smart grids management, and the relevant regulatory framework.

Detailed program

****Unit 1: Global Energy Scenarios and Energy Transition****

- National and international energy statistics.
- Primary and secondary energy sources: evolution of production and consumption.
- Trends in atmospheric carbon dioxide (CO₂) and other greenhouse gas emissions.

Unit 2: Fossil Fuel Energy Conversion Technologies

- Thermoelectric power plants with steam and gas turbines; gas microturbines.
- Combined cycle gas-steam power plants (CCGT).
- Reciprocating engines: Diesel, Otto, and Stirling cycles.
- Integrated Gasification Combined Cycle (IGCC) plants.
- Systems for the control and reduction of pollutant emissions in combustion processes.
- Cogeneration (CHP) and trigenerative plants.
- Vapor-compression and absorption heat pumps.

Unit 3: Renewable Energy Generation Plants and Waste Management

- Hydroelectric, photovoltaic, and wind power plants.
- Biomass utilization plants and geothermal power plants.
- Waste-to-energy (WTE) plants.

Unit 4: Advanced Nuclear Technologies

- The nuclear fission process; thermal and fast reactors.
- Generation IV nuclear reactors and Small Modular Reactors (SMRs).

Unit 5: Energy Storage Systems, Energy Carriers, and Electrochemical Generators

- Energy storage systems: pumped-storage hydro and Compressed Air Energy Storage (CAES).
- Electrochemical accumulators (batteries).
- Renewable hydrogen production.
- Electrochemical generators: fuel cells and secondary batteries.

Unit 6: Power Grids, Energy Market, and Regulatory Framework

- Transmission and distribution of electricity.
- The electricity market and power system balancing: primary, secondary, and tertiary reserve.
- Evolution of the electrical system: distributed generation and smart grids.
- Italian and European energy regulatory frameworks: European directives, national decrees, and laws.

Prerequisites

General Physics

Teaching form

24 lessons two hours lectures, in person, Delivered Didactics

The course is in Italian.

Textbook and teaching resource

Availability of teaching materials (slides) provided by th teacher

Semester

first semester

Assessment method

The exam consists of an oral assessment in which the topics of the lessons are discussed, there are no ongoing tests.

The learning of the different technologies of electricity production, of energy storage systems and their different impact on the environment as illustrated in the course is evaluated. Furthermore, the student's abilities and attitudes are tested for the critical and comparative analysis of conversion technologies, illustrating advantages and limitations. Furthermore, the student's speaking ability and language property are taken into consideration.

For the admission to the oral examination it is necessary to present a brief written report on a topic exposed in the course, this allows in particular to evaluate the student's synthesis ability, the report is then discussed in the exam.

In case of not passing the exam, there is no jump call and the preparation of a new written report is not required.

Office hours

The teacher is available to receive students by appointment via e-mail.

Sustainable Development Goals

AFFORDABLE AND CLEAN ENERGY
