UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Sustainable energy sources: potential and limitations

2425-BbetweenSDG-08-05

Module description

Dependence on fossil-based energy is not sustainable. In recent years there has been a full realization of the harmful effects induced on our planet and a path of energy transition to renewable sources has been undertaken. However, the road to complete independence from fossil sources is still a long one, and in order to better appreciate the effort that lies ahead, one must have a correct view of how different renewable-based technologies can contribute to the goal.
In this module, the main renewable energy production techniques (solar, wind, hydro, geothermal, biomass) will be presented and analyzed. The aim is not so much to analyze them from a technical point of view, but to provide a quantitative and objective estimate of how much energy can likely be produced from these sources in the next few years, comparing it with Italian energy consumption and that of some reference countries.
In particular, it will be quantified how much of the country's surface area each renewable energy source will have to occupy in order for it to make a significant contribution compared to today's level of consumption. In this way, the potential and limitations of current renewable energy production techniques will be highlighted and, after mentioning the role of the main energy storage techniques (batteries, hydrogen, ...), some energy scenarios suitable for achieving the goal of carbon neutrality will be analyzed.

Learning goals

General goal

With these lectures, students will learn the basics of understanding the potential and limitations of current renewable energy production and storage techniques with reference to the individual citizen's energy demand for his or her daily activities. The aim is not to pick the winner among the various possibilities, but to present honest numerical data for each of the options and highlight the difficulties and/or potential of each solution.
In addition, students will gain the knowledge and tools to arrive at their own independent opinion on which energy

plan can ensure a balance between sustainable energy consumption and production.
At the end of the module a student should be able to answer some questions such as:

- can a country like Italy reasonably expect to live on energy produced from its own renewable sources?
- can a rapid shift to renewable-based technologies allow us to eliminate carbon dioxide emissions without changing our lifestyles?

Specific skills and competences

Understanding of the difference between primary energy source and secondary energy source (energy carriers).
Understanding of the concept of "quality" of energy.
Knowledge of the main environmentally friendly energy production technologies.
Ability to analyze the potential and applicability of renewable energy sources for energy transition.
Ability to analyze different intervention strategies to meet energy demand with renewable sources.
Management and processing of information on energy transition studies, surveys and evaluations.

Sustainable Development Goals of the 2030 UN Agenda

Goal 7: Affordable and clean energy

Breakdown of meetings

The 12-hour module will be organized into 6 lectures of 2 hours each.
In particular, topics at the following points will be covered:

1. Introduction to the concept of energy, description of different forms of energy and their "quality". Breakdown by energy sources of energy production at World, European and Italian levels. [3 hrs] Davide Chiesa
2. Description of the main techniques of energy production from renewable sources. Quantify the energy produced by different renewable energy sources to meet our needs.

- Geothermal energy and heat pumps. [2 hrs] Davide Chiesa
- Hydropower and biomass energy. [1 hr] Davide Chiesa
- Solar and wind energy. [2 hr] Maurizio Acciarri

3. Problem of intermittency of electricity production from inherently variable renewable sources. Analysis of possible complementary strategies to eliminate the difference between consumption and production. Hints at the role of the main energy storage techniques (batteries, hydrogen, ...). [2 hrs] Maurizio Acciarri
4. Analysis of some energy scenarios to balance energy demand and energy production from variable renewable sources. [2 hrs] Maurizio Acciarri

Number of participants

There is no numerical limit on participants.

The module is delivered remotely.

Language used in meetings

Italian

Delivery period of the module

May/June 2025

Methods of assessing the outcomes of the learning process

Closed-question test (True/False, multiple-choice quiz, ...)

Department of affiliation of the teacher

Sustainable Development Goals

AFFORDABLE AND CLEAN ENERGY