### Syllabus

**Course title**  
Renewable Energy and Meteorology

**Course code**  
45524

**Scientific sector**  
FIS/06

**Degree**  
Master Energy Engineering

**Semester**  
2

**Year**  
2

**Academic year**  
2020/2021

**Credits**  
6

**Modular**  
No

**Total lecturing hours**  
60

**Total lab hours**

**Total exercise hours**

**Attendance**  
Not mandatory

**Prerequisites**  
Basic background of mathematics and physics usually learned to achieve a 3-year bachelor degree in engineering or physics is enough.

### Specific educational objectives

The course offers an overview of the main atmospheric factors affecting the processes controlling the conversion of renewable energy sources and the efficient use of energy. In particular the course will focus on factors affecting solar radiation (season, weather, cloud cover, atmospheric absorption, orographic effects, urban effects, etc.), wind (dynamical mechanisms, terrain effects, urban effects, vertical profiles, etc.), temperature (vertical profiles, terrain and urban effects, etc.) and pollutant dispersion (turbulent mixing, atmospheric stability, etc.).

### Lecturer

Giovannini Lorenzo, Zardi Dino

### Scientific sector of the lecturer

### Teaching language

English

### Office hours

On appointment by email.

### List of topics covered

**Introduction to atmospheric processes**

- Overview of the mean atmospheric properties (chemical composition, thermal structure).
- Atmospheric thermodynamics
- Atmospheric dynamics: scales of atmospheric motions, synoptic-scale motions, geostrophic wind, mesoscale circulations, coastal breezes, mountain and valley winds.
- Atmospheric boundary layers and turbulence.
- Environmental impacts of energy production and use: elements of atmospheric pollutant dispersion.
- Elements of urban meteorology (Urban Heat Island)
- Climate change and its impacts on renewable energies.

**Solar radiation measurement and modelling**
- Factors determining the solar radiation availability at the Earth's surface.
- Instruments and types of radiation measurements.
- Empirical models for the estimate of the solar resource from other meteorological quantities.
- Clear-sky and real-sky models for the estimate of the solar radiation.
- Transposition models for the estimate of solar radiation over inclined surfaces.
- Overview of solar atlases presently available: strengths and weaknesses.
- The assessment of solar potential for complex terrain areas: the case study of Trentino.
- Overview of approaches for forecasting solar radiation for energy-related applications.
- Exercise: assessment of solar resource availability and optimal panel inclination from real solar radiation data.

**Wind field measurement and modelling**
- Wind climatology: effects of synoptic-scale events and terrain-induced winds.
- Monin-Obukhov similarity theory and dependence of vertical wind profiles on atmospheric stability.
- Instruments and types of wind measurements.
- Planning wind field measurements and siting of anemometers.
- Analysis of wind data from experimental campaigns: relevant statistics for wind power assessment (e.g. Weibull distribution).
- Overview of meteorological models for wind resource assessments.
- Overview of wind atlases presently available: strengths and weaknesses.
- The assessment of wind resource for complex terrain areas: the case study of Trentino.
- Exercise: assessment of the wind resource availability from real wind data.

### Teaching format
Class lectures. Exercises in class on practical examples of analysis of meteorological data for the assessment of solar and wind resources. Slides will be available for download by the students.

### Learning outcomes
The learning outcomes need to refer to the Dublin Descriptors:

1. **Knowledge and understanding:** The students will learn the basics of atmospheric processes
affecting renewable energy sources availability in view of their optimal planning and management.

2. **Applying knowledge and understanding:** The students will learn to use meteorological concepts, models and instruments for the assessment of the availability of renewable energy resources (especially solar radiation and wind).

3. **Making judgments:** The students will be able to identify the most appropriate information source, critically assess the quality of datasets and the uncertainty of the results from the application of meteorological data processing and modeling.

4. **Communication skills:** The students will learn the basic technical vocabulary and concepts of the discipline. Through the exercises the students will learn how to write a short technical report.

5. **Ability to learn:** The students will be stimulated to search for proper datasets and other useful information required to assess renewable energy resources. They will learn to critically evaluate and sort sources of data according to their use.

**Assessment**

In the final exam (oral only) the candidate is expected to show he/she has learned and understood the basic concepts explained during the course, and to discuss the exercises proposed.

**Assessment language**

English

**Evaluation criteria and criteria for awarding marks**

Final grade will be determined from an overall assessment of the oral exam and of the exercises.

**Required readings**


Troen, I. e Lundtang Petersen, E., 1990, European Wind Atlas


https://www.eoas.ubc.ca/books/Practical_Meteorology/prmet/PracticalMet_WholeBook-v1_00b.pdf

**Supplementary readings**

Supplementary readings