Syllabus

Course Description

Course Title	Renewable Energy and Meteorology
Course Code	45524
Course Title Additional	
Scientific-Disciplinary Sector	FIS/06
Language	English
Degree Course	Master in Energy Engineering
Other Degree Courses (Loaned)	
Lecturers	Dott. Ing. Lorenzo Giovannini, lorenzo.giovannini@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/29031
Teaching Assistant	
Semester	Second semester
Course Year/s	Opt.
CP	6
Teaching Hours	60
Lab Hours	0
Individual Study Hours	90
Planned Office Hours	
Contents Summary	The course offers an overview of the main atmospheric factors affecting the processes controlling the availability and conversion of renewable energy sources. In particular, the course focuses on factors affecting solar radiation (season, weather, cloud cover, atmospheric absorption, orographic effects, urban effects, etc.) and wind (dynamical mechanisms, terrain effects, urban effects, vertical profiles, etc.), as well as on the tools and instruments for assessing and forecasting their availability.
Course Topics	Part I - Introduction to atmospheric processes • Overview of the mean atmospheric properties (chemical

	composition, thermal structure) • Scales of atmospheric motion • Atmospheric thermodynamics • Hydrostatic balance • Atmospheric stability • Atmospheric dynamics: synoptic-scale motion, geostrophic wind Part II - Solar radiation measurement and modelling • Factors determining the solar radiation availability at the Earth's surface • Instruments for measuring solar radiation • Models for the estimation of the solar radiation components under different meteorological conditions, and over horizontal and inclined surfaces • Overview of the databases (solar atlases) presently available for the estimation of the solar resource at a specific site • Overview of the different approaches nowadays used to forecast solar radiation for energy-related applications • Practical exercise on the assessment of the solar resource Wind measurement and modelling • Wind climatology: synoptic-scale winds, mesoscale circulations and local effects • Monin-Obukhov similarity theory and dependence of the vertical wind profile on atmospheric stability • Overview of the wind atlases presently available: strengths and weaknesses • Instruments for wind measurements, correct siting of anemometers and planning of field measurements • Tools and methodologies for wind resource assessment • Analysis of wind data from experimental campaigns: relevant statistics for wind power assessment • Introduction to meteorological models and techniques to forecast wind power production • Practical exercise on the assessment of the wind resource
Keywords	solar resource assessment; wind resource assessment; renewable energy resources; meteorology, climatology
Recommended Prerequisites	

Propaedeutic Courses	Basic background in mathematics and physics usually acquired in a 3-year bachelor's degree in engineering or physics. Basic contents of meteorology will be provided in the first part of the course.
Teaching Format	The course is mostly based on class lectures. Part of the lectures is dedicated to two practical exercises to apply methods and tools for the assessment of the solar and wind energy potential of a site. A visit to a wind farm is usually organized at the end of the course.
Mandatory Attendance	Not mandatory, but strongly recommended.
Specific Educational Objectives and Learning Outcomes	Intended Learning Outcomes: 1. Knowledge and understanding: The students will learn the basics of atmospheric processes affecting the availability of renewable energy resources to optimize planning, operation and management of renewable energy plants. 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 the availability of renewable energy resources. They will learn to evaluate critically and sort sources of data according to their use.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	Students are asked to prepare two written reports on the practical exercises on the assessment of solar and wind energy resources that will be sent to the lecturer before the oral exam for evaluation. The reports will then be discussed during the oral exam. The oral exam also includes questions to assess the knowledge and understanding of the course topics.

	- Formative assessment: Anonymous tests on the topics covered: during the course, at the end of each module; ILOs assessed: 1, 2, 3. - Summative assessment: 50% oral exam, theory: ILOs assessment: 1, 2, 3, 4; 50% written reports - practical exercises; ILOs assessment: 4, 5.
Evaluation Criteria	Oral exam at the end of the course, with the aim of evaluating the student's ability to reproduce the topics of the course with critical reasoning. Moreover, students are required to prepare two written reports on the practical sessions proposed during the course. The reports are discussed during the oral exam. The final grade is the result of the evaluation of both the oral exam (50%) and the written reports (50%).
Required Readings	Slides provided to the students and notes taken by the students.
Supplementary Readings	Wallace J.M., Hobbs P.V., Atmospheric Science, Academic Press, New York, 2006. Stull R., Practical Meteorology: an Algebra-based Survey of Atmospheric Science, University of British Columbia, Vancouver, 2015. Iqbal M., An Introduction to Solar Radiation, Academic Press, Don Mills, 1983. Badescu V., Modeling Solar Radiation at the Earth's Surface: Recent Advances, Springer, Berlin, 2008. Emeis S., Wind Energy Meteorology, Springer, Berlin, 2013. Landsberg L., Meteorology for Wind Energy: An Introduction, Wiley, Chichester, 2015. Brower M., Wind resource assessment: a practical guide to developing a wind project, Wiley, 2012.
Further Information	Connections with other courses This course focuses on the atmospheric factors affecting the availability of renewable energy resources, as well as on the methodologies and techniques for their assessment and forecast. In this regard, the topics covered in this course can be useful for other courses dealing with the infrastructures and plants to exploit

	renewable energy resources and in particular: "Hydropower and Wind Power Systems", "Solar Energy and Smart Water Systems" and "Environmental Fluid Mechanics/Hydropower Plants". Basic knowledge of the factors affecting meteorological fields can also be useful for courses dealing with energy consumption in buildings for space heating/cooling, such as: "Advanced Applications of Building Physics", "Building HVAC Systems" and "District Energy Systems Design". Professional applications of the covered topics The knowledge acquired through this course can be applied to the planning and management of renewable energy plants, with particular regard to solar and wind energy plants. Therefore, these competences can be exploited in companies operating plants and in societies providing meteorological and climate services for the energy sector.
Sustainable Development Goals (SDGs)	Climate action, Affordable and clean energy