Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Renewable Energy and Meteorology
Course code	45524
Scientific sector	FIS/06
Degree	Master Energy Engineering
Semester	2
Year	2
Academic year	2018/2019
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.
Course page	

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	Lavinia Laiti
Scientific sector of the lecturer	
Teaching language	English
Office hours	On appointment by email.
List of topics covered	<u>Introduction to atmospheric processes</u> • 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. <u>Solar radiation measurement and modelling</u> • 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. <u>Wind field measurement and modelling</u> • 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 for 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 asses 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	
Supplementary readings	Wallace J.M. & Hobbs P.V., Atmospheric Science, Academic Press, New York, 2nd edition, 2006. Stull R. B., An Introduction to Boundary Layer Meteorology, Kluwer Academic Publishers, 1988. Panofsky, H. A. & Dutton J. A., Atmospheric Turbulence: Models and Methods for Engineering applications, John Wiley & Sons, New York, 1984. Iqbal, M., 1984: An introduction to solar radiation, Academic Press. Badescu, V., 2008, Modeling Solar Radiation at the Earth's Surface: Recent Advances, Springer, 518pp. Oke, T. R., 1987, Boundary layer climates (Second edition), Routledge, 435pp. Troen, I. e Lundtang Petersen, E., 1990, European Wind Atlas http://www.wasp.dk/News/2015/08/European-Wind-Atlas-now-available-for-download?id=f999e21a-4243-428c-a878-f2268113221c Stull, R.B., 2015: Practical Meteorology: An Algebra-based Survey of Atmospheric Science. 938 pp. https://www.eoas.ubc.ca/books/Practical_Meteorology/prmet/PracticalMet_WholeBook-v1_00b.pdf