Curricular Unit Sheet

1. Curricular Unit Syllabus.

1.1. Curricular Unit

Renewable Energy - ER

1.2. Scientific area acronym

EE

1.3. Duration

1 semester

1.4. Total of Working Hours

162 h

1.5. Contact hours

T: 22.5 TP: 22.5 PL: 22.5

1.6. ECTS

6

1.7. Observations

2. Responsible Academic staff and lecturing load in the curricular unit (enter full name)

Victor Manuel Fernandes Mendes	4.5 h

3. Other academic staff and lecturing load in the curricular unit

4. Learning outcomes of the curricular unit

1. Provide knowledge, skills, and competence in the field of renewable energy sources. Particularly concerning the assessment of investment in the consolidated domain of the use of small hydro, wind, and solar energy
2. Integrate knowledge of Physics, Chemistry, Mathematical Analysis, Probabilities and Statistics, and Electrotechnics to model the evaluation of investment problems by estimation and qualitative analysis, including uncertainty
3. Develop computational applications for assessing the economic potential of a location for exploring renewable energy sources in the preliminary phase, considering the availability of energy and both economic and technical indicators
4. Develop a critical attitude and promote research and debate habits, using scientific communications, textbooks, and the Internet on the state of the art of energy conversion technology using renewable energy sources

5. Promote professional attitudes supported by a scientific and technological basis for approaches in line with the "7th United Nations Development Agenda 2030 Objective" and subsequent decisions.

5. Syllabus

1. Introduction
    1.1. Climate change impact, greenhouse gases
    1.2. Energy sources and sustainable development
    1.3. Characteristics of renewable energy sources
    1.4. Solar, geothermal, tidal energy; conversions to other forms of energy
2. Analysis of economic and financial viability
    2.1. Cash flows, investments; inflation, risk, minimum attractiveness rate
    2.2. Recovery period, capital recovery factor
    2.3. Net present value, internal rate of return and return on investment
    2.4. 0pportunity cost, current energy value, level energy cost
3. Small hydro
    3.1. Basic description and formulation: flow, drop height, power, energy
    3.2. Site selection: hydrological pattern versus fall, environmental impact
    3.3. Flow evaluation, classified flow curve and probabilistic distribution
    3.4. Nominal flow and optimal nominal flow design criteria
4. Wind turbine
    4.1. Description and classification, basic formulation, Betz limit
    4.2. Conversion of wind energy into mechanics, Bernoulli's theorem, Coanda effect
    4.3. Power and energy, Weibull and Rayleigh distribution for wind speed
    4.4. Logarithmic law and power law for the vertical wind speed profile
5. Natural energy conversion and transmission
    5.1. Conversion of solar energy into hydro, wind; and wind energy into ocean energy
    5.2. Fourier's law and Newton's law for cooling
    5.3. Physics of the Sun and p-p chain, blackbody, spectral density, Planck equation
    5.4. Radiance and solar radiation, average values on Earth, solar constant
6. Solar thermal
    6.1. Flat, tubular and concentrator collectors,
    6.2. Orientation of collectors, radiance and radiation
    6.3. Series and parallel association of collectors,
    6.4. DHW and space heating systems
7. Photovoltaic solar
    7.1. State of the art, Shockley – Queisser limit
    7.2. Equivalent circuit of three and five parameters, parameter identification
    7.3. Orientation, serial and parallel module association, diode protection
    7.4. Grid-connected and stand-alone systems.

6. Demonstration of the syllabus coherence with the curricular unit's objectives

Global-scale environmental problems, in particular those arising from changes in the chemical composition of the atmosphere, such as anthropogenic greenhouse emissions, are not only threats but also a technological, economic and financial challenge to meet the needs of production, consumption and growth of society, without compromising the bases for the development of future generations, harmonizing economic growth with the preservation of the environment and the quality of life, i.e., without compromising sustainability. The syllabus content of the UC has the adequation to meet the challenge of the exploitation of renewable energy sources into a more global energy matrix, providing the ability to support decisions on the exploitation of energy from sustainable energy systems on a technical or economic framework appraisal. The syllabus has the necessary interdisciplinarity that accordingly faces the target under study at UC and framing the challenges of research and development on sustainable energy systems.

7. Teaching methodologies (including evaluation)

Each point of the syllabus corresponds approximately to two academic weeks. First, teaching the fundamental concepts and techniques for each point to allow enough knowledge for the issues worked in practical classes, e.g., economic, and financial feasibility analysis to support economic assessments of energy sources; Fourier and Newton laws to support questions about thermal conduction and convection in the appraisal of energy efficiency issues; Planck's equation before land radiance and radiation estimates. The practical lectures follow the theoretical ones, thus allowing for the student to immediately use the acquired knowledge for participating in discussions of subjects and interrelationship with ones acquired with the research done by the students, having the possibility of perspectives of research and development. This methodology contributes to a healthy competition among students and to the assimilation of the contents that give rise to the syntheses that, over time, contribute to the satisfaction and safety in the use of the acquired skills.

8. Demonstration of the coherence between the teaching methodologies and the learning outcomes

Lectures adapted to the concepts and perspectives of society and contemporary technological means, with an explanation with a lively rhythm and a thread of logical understanding, stimulating the interest of students. Teaching centred on the student with work beyond the contact hours, including not only the individual but also in groups to foster the critical spirit and teamwork to accompany and respond to the challenges of the future.
The UC is adapted to the concepts and perspectives of society promoting attractive lectures with greater proximity to the consolidated reality but motivating lines of R&D. In the paradigm of sustainable energy systems, the UC is an essential contribution to the tendency towards greater integration of renewable energy sources in the global energy matrix. In the nowadays paradigm of sustainable energy systems, the UC is an essential contribution to the tendency towards greater integration of renewable energy sources in the global energy matrix.

9. Bibliography

– Renewable energy resources / John Twidell and Tony Weir. Routledge (Taylor & Francis Group), 2015.
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– Hydroelectric energy: renewable energy and the environment / Bikash Pandey and Ajoy Karki. CRC Press, 2016.
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