Course guide
2500238 - GEA0238 - Energy Model Transition

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Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: BACHELOR'S DEGREE IN ENVIRONMENTAL ENGINEERING (Syllabus 2020). (Optional subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: IGNACIO CASANOVA HORMAECHEA

Others: IGNACIO CASANOVA HORMAECHEA, VALERI NOVELL GRAU

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
14458. Apply the methodologies of studies and evaluations of environmental impact and, in general, of environmental technologies, sustainability and waste treatment and of the management of international standards of environmental quality. Life cycle analysis, carbon footprint and water footprint and assess natural hazards (river, coastal floods, droughts, fires, soil erosion and landslides).
14465. Identify renewable energy generation techniques and energy transition concept.

Generical:
14440. Identify, formulate and solve problems related to environmental engineering.
14441. Apply the functions of consulting, analysis, design, calculation, project, construction, maintenance, conservation and exploitation of any action in the territory in the field of environmental engineering.
14442. To use in any action in the territory proven methods and accredited technologies, in order to achieve the greatest efficiency respect for the environment and the protection of the safety and health of workers and users.
14443. Apply the necessary legislation during the professional practice of environmental engineering.
14444. Apply business management techniques and labor legislation.

TEACHING METHODOLOGY

2.3 hours are devoted to theoretical classes in large groups, in which the teachers explain the basic concepts and materials of the subject, present examples and carry out exercises. An equivalent number of hours is spent solving problems and analyzing professional publications, with greater interaction with the student body. Practical exercises are carried out in order to consolidate the general and specific learning objectives. Support material is used in the form of a detailed teaching plan through the ATENEA virtual campus: contents, schedule of assessment and directed learning activities and bibliography. Although the majority of sessions will be held in the language indicated in the guide, sessions supported by other guest experts from time to time may be held in another language.

LEARNING OBJECTIVES OF THE SUBJECT

The energy metabolism and energy intensity of the economic model are questioned. Scenarios and alternatives for the transition from the hydrocarbon-based economic model to a more sustainable model are proposed.
The international context of policies against climate change is presented. At a more regional level, energy policies and management and planning instruments are reviewed. Finally, at a local level, local savings, self-sufficiency and renewable energy policies are observed in sectors such as the smart city, electric mobility (buses, cars, bicycles, scooters) and building.

1. Know the strategies and processes that are being carried out to implement the global energy transition towards the use of renewable energies.

Transition of the Energy Model. The transition of the energy model to solve the problem of global warming is considered the most important challenge facing humanity in the 21st century. This subject addresses the various international processes and approaches to implement such change.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours medium group	15,0	10.00
Hours large group	30,0	20.00
Hours small group	15,0	10.00

Total learning time: 150 h

CONTENTS

Principles of energy science and engineering

Description:
Description and rationale of the different energy units
Exercises on the conversion of energy units
A refresher of the main concepts behind the first and second laws of Thermodynamics.
Exercises on formulation and applications of the first and second lwa of thermodynamics

Specific objectives:
Become familiar with the utilization of different energy units in different disciplines and environments.
Become familiar with the conversion and quantification methods of energy measurement.
Understand and differentiate the different types of energy (mechanical, electrical, chemical, ...) and their formulations. There is no zero-cost work.
Identification and utilization of the concepts of enthalpy and entropy in te context of energy measurement.

Full-or-part-time: 19h 12m
Theory classes: 4h
Practical classes: 4h
Self study : 11h 12m

Technologies for Energy Transition

Description:
Description of the current technologies in CCUS
Identification and comparisom among different CCUS technologies
Technologies and possibilities of solar energy
Comparison and applications of different types of solar energy
Windmills, wind energy production and distribution
Exercises on the application of wind energy in energy transition
Is nuclear green? How will its development affect current views on energy transtion?
Will nuclear energy play a significant role in energy transition during the 21st century?
State of the art of hydrogen production technologies and their application in decarbonization.
How is hydrogen technology being cenceived and applied in different countries?
Identification and study of other renewable energies

Specific objectives:
Become familiar with different approaches to CCUS and being able to assess theit potential application in energy transition
Reading and in depth analysis of the state of the art on CCUS technologies
Reading and exercises on the possibilities of photovoltaig and thermosolar technologies in energy transition.
A discussion of the physical principles behing wind energy technologies
Reading and analysis of the state of the art technologies in wind energy production and applications
Update on physical principles and technologies of nuclear energy production. View of the potential roles of fission and fusion technologies.
Reading and discussion on current views and developments of "green nuclear energy"
Concepts of hydrogen production, storage and distribution
Reading and comparative analysis on the applications of hydrogen technologies
Know how to locate other renewable energies in the field of the energy transition and advise on their complementarity in the use of Iturra technologies.

Full-or-part-time: 67h 12m
Theory classes: 12h
Practical classes: 10h
Laboratory classes: 6h
Self study : 39h 12m

Models of energy transition

Description:
Factors of energy transition at the local level
Analysis of the integration of energy transtion concepts at the region and state level
The European Green Deal focuses on 3 key principles for the clean energy transition, which will help reduce greenhouse gas emissions and enhance the quality of life of our citizens:

ensuring a secure and affordable EU energy supply

developing a fully integrated, interconnected and digitalised EU energy market

prioritising energy efficiency, improving the energy performance of our buildings and developing a power sector based largely on renewable sources

International interdependence and effects on global change
Energy system models are crucial to plan energy transition pathways and understand their impacts. A vast range of energy system modelling tools is available, providing modelling practitioners, planners, and decision-makers with multiple alternatives to represent the energy system according to different technical and methodological considerations. To better understand this landscape, here we identify current trends in the field of energy system modelling. First, we survey previous review stu- dies, identifying their distinct focus areas and review methodologies. Second, we gather information about 54 energy system modelling tools directly from model developers and users. Unlike previous questionnaire-based studies solely focusing on technical descriptions, we include application aspects of the modelling tools, such as perceived policy-relevance, user accessibility, and model linkages. We find that, to assess the possible applications and to build a common understanding of the capa- bilities of these modelling tools, it is necessary to engage in dialogue with developers and users. We identify three main trends of increasing modelling of cross-sectoral synergies, growing focus on open access, and improved temporal detail to deal with planning future scenarios with high levels of variable renewable energy sources. However, key challenges remain in terms of representing high resolution energy demand in all sectors, understanding how tools are coupled together, openness and accessibility, and the level of engagement between tool developers and policy/decision-makers.
Trends and tools in the modeling of the energy transition (II)

Specific objectives:
Reading for the identification and discussion of different factors constraining energy transition at the local level
Reading and in-depth analysis of the main initiatives of energy transition approaches
build interconnected energy systems and better integrated grids to support renewable energy sources

promote innovative technologies and modern infrastructure

boost energy efficiency and eco-design of products

decarbonise the gas sector and promote smart integration across sectors

empower consumers and help EU countries to tackle energy poverty

promote EU energy standards and technologies at global level

develop the full potential of Europe's offshore wind energy
Reading and in-depth analysis of the potential effects of energy transition on a variety of global factors, including climate, biodiversity or migrations, among others

Full-or-part-time: 57h 35m
Practical classes: 16h
Laboratory classes: 8h
Self study : 33h 35m

GRADING SYSTEM

Arithmetic mean of the results of 3 partial exams (50% of the final grade), participation in class and proactivity in discussions (20%) and end-of-course project (30%). Students who have failed the ordinary evaluation and who have regularly taken the evaluation tests of the failed subject will have the option of taking a re-evaluation test in the period set in the academic calendar. Students who have already passed or students who have not been submitted or who have not handed in all the exercises/problems (Pr) and the papers and reports (Tr) may not take the reassessment test of a subject. The reassessment (RE) will consist of a single exam that covers all the content of the course. The maximum grade for the reassessment will be five (5.0) and the final grade for the course will be the maximum grade between the continuous assessment and the reassessment exam, that is, MAX(EO/RE). The non-attendance of a student summoned to the re-evaluation test, held in the set period, may not lead to another test at a later date. Extraordinary evaluations will be carried out for those students who, due to accredited force majeure, have not been able to take any of the continuous evaluation tests. These tests must be authorized by the corresponding head of studies, at the request of the professor responsible for the subject, and will be carried out within the corresponding school period.

EXAMINATION RULES.

If any of the laboratory or continuous assessment activities are not carried out in the scheduled period, it will be considered a zero score. The tests will be carried out individually, with multiple choice questions that can be theoretical or problem type questions. The exams can include short questions to be developed by the students and exercises to be solved.

BIBLIOGRAPHY

Basic:

- Armstrong, J. The Future of energy: the 2023 guide to the energy transition. Energy Technology Publishing, 2023. ISBN 9781838388676.
- Valero, Alicia; Valero, Antonio; Calvo, Guiomar. The Material Limits of Energy Transition: Thanatia. Springer International Publishing, 2021. ISBN 9783030785321.