



Course guide

820733 - AER - Renewable Energy Technology

Last modified: 16/05/2023

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: ERASMUS MUNDUS MASTER'S DEGREE IN ENVIRONMENTAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2012). (Compulsory subject).
MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Compulsory subject).
MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2022). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: JOSE BORDONAU FARRERONS

Others: Primer quadrimestre:
JOSE BORDONAU FARRERONS - T10, T30
EDUARDO EGUSQUIZA ESTEVEZ - T10, T30
XAVIER FLOTATS RIPOLL - T10, T30
ORIOL GOMIS BELLMUNT - T10, T30
RAFAEL MARTIN LAMAISSON URIOSTE - T10, T30
JORDI LLORCA PIQUE - T10, T30
CARLOS DAVID PEREZ SEGARRA - T10, T30
ENRIQUE VELO GARCIA - T10, T30

PRIOR SKILLS

- Fundamentals of applied physics
- Fundamentals of economy
- Economic analysis of projects

REQUIREMENTS

- There are no specific requirements.

TEACHING METHODOLOGY

Teaching methodology:

The course teaching methodologies are as follows:

- Lectures and conferences: presentation of knowledge by lecturers or guest speakers.
- Participatory sessions: collective resolution of exercises, debates and group dynamics, with the lecturer and other students in the classroom; classroom presentation of an activity individually or in small groups.
- Theoretical/practical supervised work (TD): classroom activity carried out individually or in small groups, with the advice and supervision of the teacher.
- Homework assignment of reduced extension: carry out homework of reduced extension, individually or in groups.
- Homework assignment of broad extension: design, planning and implementation of a project or homework of broad extension by a group of students, and writing a report that should include the approach, results and conclusions.
- Evaluation activities (EV).

Training activities:

The course training activities are as follows:

- Face to face activities
 - o Lectures and conferences: learning based on understanding and synthesizing the knowledge presented by the teacher or by invited speakers.
 - o Participatory sessions: learning based on participating in the collective resolution of exercises, as well as in discussions and group dynamics, with the lecturer and other students in the classroom.
 - o Presentations (PS): learning based on presenting in the classroom an activity individually or in small groups.
 - o Theoretical/practical supervised work (TD): learning based on performing an activity in the classroom, or a theoretical or practical exercise, individually or in small groups, with the advice of the teacher.
- Study activities
 - o Homework assignment of reduced extension (PR): learning based on applying knowledge and presenting results.
 - o Homework assignment of broad extension (PA): learning based on applying and extending knowledge.
 - o Self-study (EA): learning based on studying or expanding the contents of the learning material, individually or in groups, understanding, assimilating, analysing and synthesizing knowledge.

LEARNING OBJECTIVES OF THE SUBJECT

Objectives

The scope of the course corresponds to technologies for harnessing renewable energy. In this area it is intended that students acquire the knowledge and skills necessary for the description, selection and sizing, as well as for calculating the performance of equipment and pre-existing installations at a basic level or pre-project. The subject aims to give an overview of the technologies and methods that allow the student to perform assessments and studies of alternatives in engineering projects. Also, the course should serve as an introduction for students who follow the speciality of renewable energy which will deepen the study of the different technologies in optional courses.

Learning outcomes

Upon completing the course, the student should:

- Understand the role of renewable energy in product and service sectors, as well as its importance in the energy chain: processing, transportation, distribution and end use; understand energy efficiency and be capable of developing valuable judgments about opportunities, threats and barriers to their use.
- Know and understand the characteristics and key players in the renewable energies sector in Spain and Europe, as well as its importance in a productive economic context.
- Know and be able to critically analyse policies to promote renewable energy.
- Have the knowledge, skills and elements of analysis and judgment necessary to select the most appropriate systems from an energetic standpoint for different types of applications (industrial or service) as well as the ability to analyse the behaviour of a system in operation and make a diagnosis on the operating system.
- Have the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the use of renewable energy systems in different industrial sectors and services.
- Know the main lines of research in the field of technologies for harnessing renewable energy.



STUDY LOAD

Type	Hours	Percentage
Hours small group	13,5	11.20
Self study	80,0	66.39
Hours large group	27,0	22.41

Total learning time: 120.5 h

CONTENTS

Introduction

Description:

- Basic concepts about energy
 - o Basic units.
 - o Primary energy, final energy, useful energy.
 - o System, sector and service.
- Key factors in the exploitation, production and use.
- Renewable energy sources; main features.

Specific objectives:

The student understands the role of renewable energy in product and service sectors, as well as its importance in the energy chain: processing, transportation, distribution and end use; understand energy efficiency and be capable of developing valuable judgments about opportunities, threats and barriers to their use.

Related activities:

1. Exercise on introduction

Full-or-part-time: 8h 20m

Theory classes: 2h
Practical classes: 1h
Guided activities: 1h
Self study : 4h 20m

The renewables sector

Description:

- The renewables sector in Spain and Europe.
- Policies, plans and regulatory frameworks to promote.

Specific objectives:

- To know and understand the characteristics and key players in the sector of renewable energies in Spain and Europe, as well as its importance in a productive economic context.
- To know and be able to critically analyse policies to promote renewable energy.

Related activities:

2. Exercise on the renewables sector

Full-or-part-time: 8h 20m

Theory classes: 2h
Practical classes: 1h
Guided activities: 1h
Self study : 4h 20m



Solar energy

Description:

- Measure and calculate available solar radiation.
- Data sources.

Specific objectives:

- The student has the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the use of solar energy in different industrial sectors and services for the assessment of available resources.

Related activities:

3. Exercise on solar energy

Full-or-part-time: 8h 20m

Theory classes: 2h

Practical classes: 1h

Guided activities: 1h

Self study : 4h 20m

Solar thermal energy

Description:

- Solar thermal collectors for low, medium and high temperature (solar receivers).
- Thermal systems of medium and high temperature.
- Applications.

Specific objectives:

- The student has the knowledge, skills and elements of analysis and judgment necessary to select the most appropriate systems from an energetic standpoint for different types of applications (industrial or service) as well as the ability to analyse the behaviour of a system in operation and make a diagnosis on the operating system.
- The student has the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the use of solar thermal systems in different industrial sectors and services.

Related activities:

4. Exercise on solar thermal energy

Full-or-part-time: 8h 20m

Theory classes: 2h

Practical classes: 1h

Guided activities: 1h

Self study : 4h 20m

Solar photovoltaic energy

Description:

- Photovoltaic generator.
- Other components of a photovoltaic installation.
- Isolated photovoltaic installations.
- Installations connected to the network.

Specific objectives:

- The student has the knowledge, skills and elements of analysis and judgment necessary to select the most appropriate systems from an energetic standpoint for different types of applications (industrial or service) as well as the ability to analyse the behaviour of a system in operation and make a diagnosis on the operating system.
- The student has the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the use of solar PV systems in different industrial sectors and services.

Related activities:

5. Exercise on solar photovoltaic energy

Full-or-part-time: 8h 20m

Theory classes: 2h

Practical classes: 1h

Guided activities: 1h

Self study : 4h 20m

Wind energy

Description:

- Features of wind.
- Measure and calculate the energy available.
- Turbines.

Specific objectives:

- The student has the knowledge, skills and elements of analysis and judgment necessary to select the most appropriate systems from an energetic standpoint for different types of applications (industrial or service) as well as the ability to analyse the behaviour of a system in operation and make a diagnosis on the operating system.
- The student has the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the use of wind power systems in different industrial sectors and services.

Related activities:

6. Exercise on wind energy

Full-or-part-time: 8h 20m

Theory classes: 2h

Practical classes: 1h

Guided activities: 1h

Self study : 4h 20m



Hydropower and ocean energy

Description:

- Central hydropower.
- Ocean energies: tidal energy, energy flows, ocean thermal energy, osmotic power or blue energy, wave energy.

Specific objectives:

- The student has the knowledge, skills and elements of analysis and judgment necessary to select the most appropriate systems from an energetic standpoint for different types of applications (industrial or service) as well as the ability to analyse the behaviour of a system in operation and make a diagnosis on the operating system.
- The student has the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the use of hydropower and marine systems in different industrial sectors and services.

Related activities:

7. Exercise on hydropower and ocean energy

Full-or-part-time: 8h 20m

Theory classes: 2h

Practical classes: 1h

Guided activities: 1h

Self study : 4h 20m

Geothermal energy

Description:

- Assessment of available resources.
- Geothermal systems.

Specific objectives:

- The student has the knowledge, skills and elements of analysis and judgment necessary to select the most appropriate systems from an energetic standpoint for different types of applications (industrial or service) as well as the ability to analyse the behaviour of a system in operation and make a diagnosis on the operating system.
- The student has the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the utilization of geothermal energy systems in different industrial sectors and services.

Related activities:

8. Exercise on geothermal energy

Full-or-part-time: 8h 20m

Theory classes: 2h

Practical classes: 1h

Guided activities: 1h

Self study : 4h 20m

Biomass and waste

Description:

- Biomass as an energy source.
- Sources of biomass.
- Production of heat and electricity.

Specific objectives:

- The student has the knowledge, skills and elements of analysis and judgment necessary to select the most appropriate systems from an energetic standpoint for different types of applications (industrial or service) as well as the ability to analyse the behaviour of a system in operation and make a diagnosis on the operating system.
- The student has the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the use of biomass and waste systems in different industrial sectors and services.

Related activities:

9. Exercise on biomass and waste

Full-or-part-time: 8h 20m

Theory classes: 2h

Practical classes: 1h

Guided activities: 1h

Self study : 4h 20m

Biogas and biofuels

Description:

- Biofuels.
- Biofuels (biodiesel, bioethanol).
- Biogas.
- Biorefineries.

Specific objectives:

- The student has the knowledge, skills and elements of analysis and judgment necessary to select the most appropriate systems from an energetic standpoint for different types of applications (industrial or service) as well as the ability to analyse the behaviour of a system in operation and make a diagnosis on the operating system.
- The student has the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the use of biogas and biofuels in different industrial sectors and services.

Related activities:

10. Exercise on biogas

Full-or-part-time: 8h 20m

Theory classes: 2h

Practical classes: 1h

Guided activities: 1h

Self study : 4h 20m



Hydrogen and fuel cells

Description:

- Hydrogen production technologies.
- Storage and transport of hydrogen.
- Fuel cells.

Specific objectives:

The student has the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the use of hydrogen and fuel cells in different industrial sectors and services.

Related activities:

11. Exercise on hydrogen and fuel cells

Full-or-part-time: 8h 20m

Theory classes: 2h

Practical classes: 1h

Guided activities: 1h

Self study : 4h 20m

Hybrid systems

Description:

- Description.
- Calculation software.

Specific objectives:

- The student has the knowledge, skills and elements of analysis and judgment necessary to select the most appropriate systems from an energetic standpoint for different types of applications (industrial or service) as well as the ability to analyse the behaviour of a system in operation and make a diagnosis on the operating system.
- The student has the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the use of hybrid systems in different industrial sectors and services.

Related activities:

12. Exercise on hybrid systems

Full-or-part-time: 16h 40m

Theory classes: 4h

Practical classes: 2h

Guided activities: 2h

Self study : 8h 40m



Research and development

Description:

- Main lines of research in the field of technologies for harnessing renewable energy.
- Main lines and business opportunities associated with developing new products and services in the field of technologies for harnessing renewable energy.

Specific objectives:

- Know the main lines of research in the field of technologies for harnessing renewable energy.
- Know the main lines and business opportunities associated with developing new products and services in the field of technologies for harnessing renewable energy.

Related activities:

13. Exercise on research and development

Full-or-part-time: 16h 40m

Theory classes: 4h

Practical classes: 2h

Guided activities: 2h

Self study : 8h 40m

ACTIVITIES

1. Exercise on introduction

Description:

Individually carry out an exercise on units, energy (primary, final and useful) and renewable resources.

Specific objectives:

Deepen knowledge and its application in solving basic exercises of calculations of quantities of energy.

Material:

- Description of the exercise.
- References and data sources.

Delivery:

Report of the results.

Full-or-part-time: 6h 20m

Practical classes: 1h

Guided activities: 1h

Self study: 4h 20m



2. Exercise on the renewables sector

Description:

Independent exercise on the renewables sector.

Specific objectives:

Develop the capacity for critical analysis of the student regarding the renewables sector.

Material:

- Description of the exercise.
- References.

Delivery:

Report of the results.

Full-or-part-time: 6h 20m

Practical classes: 1h

Guided activities: 1h

Self study: 4h 20m

3. Exercise on solar energy

Description:

Individual exercise of an assessment and analysis of a solar resource.

Specific objectives:

Deepen knowledge and its application in practical cases related to the use of solar energy in different industrial sectors and of services for the assessment of available resources.

Material:

- Description of the exercise.
- References.

Delivery:

Report of the results.

Full-or-part-time: 6h 20m

Practical classes: 1h

Guided activities: 1h

Self study: 4h 20m

4. Exercise on solar thermal energy

Description:

Independent exercise on solar thermal energy.

Specific objectives:

- Deepen knowledge and its application in practical cases.
- Develop the skills of the student in the selection and evaluation of equipment and of installation equipment.

Material:

- Description of the exercise.
- References.

Delivery:

Report of the results.

Full-or-part-time: 6h 20m

Practical classes: 1h

Guided activities: 1h

Self study: 4h 20m

5. Exercise on solar photovoltaic energy

Description:

Independent exercise on solar photovoltaic energy.

Specific objectives:

- Deepen knowledge and its application in practical cases.
- Develop the skills of the student in the selection and evaluation of equipment and of installation equipment.

Material:

- Description of the exercise.
- References.

Delivery:

Report of the results.

Full-or-part-time: 6h 20m

Practical classes: 1h

Guided activities: 1h

Self study: 4h 20m



6. Exercise on wind energy

Description:

Independent exercise on wind energy.

Specific objectives:

- Deepen knowledge and its application in practical cases.
- Develop the skills of the student in the selection and evaluation of equipment and of installation equipment.

Material:

- Description of the exercise.
- References.

Delivery:

Report of the results.

Full-or-part-time: 6h 20m

Practical classes: 1h

Guided activities: 1h

Self study: 4h 20m

7. Exercise on hydropower and ocean energy

Description:

Independent exercise on hydropower and ocean energy.

Specific objectives:

- Deepen knowledge and its application in practical cases.
- Develop the skills of the student in the selection and evaluation of equipment and of installation equipment.

Material:

- Description of the exercise.
- References.

Delivery:

Report of the results.

Full-or-part-time: 6h 20m

Practical classes: 1h

Guided activities: 1h

Self study: 4h 20m



8. Exercise on geothermal energy

Description:

Independent exercise on geothermal energy.

Specific objectives:

- Deepen knowledge and its application in practical cases.
- Develop the skills of the student in the selection and evaluation of equipment and of installation equipment.

Material:

- Description of the exercise.
- References.

Delivery:

- Report of the results.

Full-or-part-time: 6h 20m

Practical classes: 1h

Guided activities: 1h

Self study: 4h 20m

9. Exercise on biomass and waste

Description:

Independent exercise on biomass and waste.

Specific objectives:

- Deepen knowledge and its application in practical cases.
- Develop the skills of the student in the selection and evaluation of equipment and of installation equipment.

Material:

- Description of the exercise.
- References.

Delivery:

Report of the results.

Full-or-part-time: 6h 20m

Practical classes: 1h

Guided activities: 1h

Self study: 4h 20m



10. Exercise on biogas and biofuels

Description:

Independent exercise on biogas and biofuels.

Specific objectives:

- Deepen knowledge and its application in practical cases.
- Develop the skills of the student in the selection and evaluation of equipment and of installation equipment.

Material:

- Description of the exercise.
- References.

Delivery:

Report of the results.

Full-or-part-time: 6h 20m

Practical classes: 1h

Guided activities: 1h

Self study: 4h 20m

11. Exercise on hydrogen and fuel cells

Description:

Independent exercise on hydrogen and fuel cells.

Specific objectives:

- Deepen knowledge and its application in practical cases.
- Develop the skills of the student to consider a pre-feasibility study, related to the use of hydrogen and fuel cells in different industrial sectors and services.

Material:

- Description of the exercise.
- References.

Delivery:

Report of the results.

Full-or-part-time: 6h 20m

Practical classes: 1h

Guided activities: 1h

Self study: 4h 20m

12. Exercise on hybrid systems

Description:

- Independent exercise on hybrid systems.
- o Dimension and optimisation of a hybrid system to generate electricity independently.

Specific objectives:

- Deepen knowledge and its application in practical cases.
- The student has the knowledge, skills and elements of analysis and judgment necessary to consider a pre-feasibility study, related to the use of hybrid systems in different industrial sectors and services.

Material:

- Description of the exercise.
- References.

Delivery:

Report of the results.

Full-or-part-time: 12h 40m

Practical classes: 2h

Guided activities: 2h

Self study: 8h 40m

13. Exercise on research and development

Description:

Independent exercise on research and development.

Specific objectives:

The student is capable of making a sketch on the approach of a line of research or of product development.

Material:

- Description of the exercise.
- References.

Delivery:

Report of the results.

Full-or-part-time: 12h 40m

Practical classes: 2h

Guided activities: 2h

Self study: 8h 40m

GRADING SYSTEM

Written test (PE). 60%

Work performed individually or in groups (TR). 40%

RESOURCES

Other resources:

Documentation is prepared by the teachers of the course and available in Atenea.

The documentation is updated every year.