

820733 - AER - Renewable Energy Technology

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2019
Degree: MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Teaching unit Compulsory)
ERASMUS MUNDUS MASTER'S DEGREE IN ENVIRONMENTAL PATHWAYS FOR SUSTAINABLE ENERGY SYSTEMS (Syllabus 2013). (Teaching unit Compulsory)
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MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Teaching unit Compulsory)
ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: 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.

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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 specialty 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.

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- 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

Total learning time: 125h	Hours large group:	30h	24.00%
	Guided activities:	15h	12.00%
	Self study:	80h	64.00%

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Content

<p>Introduction</p>	<p>Learning time: 8h 20m</p> <p>Theory classes: 2h Practical classes: 1h Guided activities: 1h Self study : 4h 20m</p>
<p>Description:</p> <ul style="list-style-type: none"> - Basic concepts about energy <ul style="list-style-type: none"> 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. <p>Related activities:</p> <ol style="list-style-type: none"> 1. Exercise on introduction <p>Specific objectives:</p> <p>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.</p>	
<p>The renewables sector</p>	<p>Learning time: 8h 20m</p> <p>Theory classes: 2h Practical classes: 1h Guided activities: 1h Self study : 4h 20m</p>
<p>Description:</p> <ul style="list-style-type: none"> - The renewables sector in Spain and Europe. - Policies, plans and regulatory frameworks to promote. <p>Related activities:</p> <ol style="list-style-type: none"> 2. Exercise on the renewables sector <p>Specific objectives:</p> <ul style="list-style-type: none"> - 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. 	

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Solar energy	Learning time: 8h 20m Theory classes: 2h Practical classes: 1h Guided activities: 1h Self study : 4h 20m
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Description:

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

Related activities:

3. Exercise on solar energy

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.

Solar thermal energy	Learning time: 8h 20m Theory classes: 2h Practical classes: 1h Guided activities: 1h Self study : 4h 20m
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Description:

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

Related activities:

4. Exercise on solar thermal 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 solar thermal systems in different industrial sectors and services.

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<p>Solar photovoltaic energy</p>	<p>Learning time: 8h 20m</p> <p>Theory classes: 2h Practical classes: 1h Guided activities: 1h Self study : 4h 20m</p>
<p>Description:</p> <ul style="list-style-type: none"> - Photovoltaic generator. - Other components of a photovoltaic installation. - Isolated photovoltaic installations. - Installations connected to the network. <p>Related activities:</p> <p>5. Exercise on solar photovoltaic energy</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> - 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. 	
<p>Wind energy</p>	<p>Learning time: 8h 20m</p> <p>Theory classes: 2h Practical classes: 1h Guided activities: 1h Self study : 4h 20m</p>
<p>Description:</p> <ul style="list-style-type: none"> - Features of wind. - Measure and calculate the energy available. - Turbines. <p>Related activities:</p> <p>6. Exercise on wind energy</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> - 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. 	

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<p>Hydropower and ocean energy</p>	<p>Learning time: 8h 20m</p> <p>Theory classes: 2h Practical classes: 1h Guided activities: 1h Self study : 4h 20m</p>
<p>Description:</p> <ul style="list-style-type: none"> - Central hydropower. - Ocean energies: tidal energy, energy flows, ocean thermal energy, osmotic power or blue energy, wave energy. <p>Related activities:</p> <p>7. Exercise on hydropower and ocean energy</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> - 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. 	
<p>Geothermal energy</p>	<p>Learning time: 8h 20m</p> <p>Theory classes: 2h Practical classes: 1h Guided activities: 1h Self study : 4h 20m</p>
<p>Description:</p> <ul style="list-style-type: none"> - Assessment of available resources. - Geothermal systems. <p>Related activities:</p> <p>8. Exercise on geothermal energy</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> - 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. 	

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<p>Biomass and waste</p>	<p>Learning time: 8h 20m</p> <p>Theory classes: 2h Practical classes: 1h Guided activities: 1h Self study : 4h 20m</p>
<p>Description:</p> <ul style="list-style-type: none"> - Biomass as an energy source. - Sources of biomass. - Production of heat and electricity. <p>Related activities:</p> <p>9. Exercise on biomass and waste</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> - 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. 	
<p>Biogas and biofuels</p>	<p>Learning time: 8h 20m</p> <p>Theory classes: 2h Practical classes: 1h Guided activities: 1h Self study : 4h 20m</p>
<p>Description:</p> <ul style="list-style-type: none"> - Biofuels. - Biofuels (biodiesel, bioethanol). - Biogas. - Biorefineries. <p>Related activities:</p> <p>10. Exercise on biogas</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> - 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. 	

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<p>Hydrogen and fuel cells</p>	<p>Learning time: 8h 20m</p> <p>Theory classes: 2h Practical classes: 1h Guided activities: 1h Self study : 4h 20m</p>
<p>Description:</p> <ul style="list-style-type: none"> - Hydrogen production technologies. - Storage and transport of hydrogen. - Fuel cells. <p>Related activities:</p> <p>11. Exercise on hydrogen and fuel cells</p> <p>Specific objectives:</p> <p>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.</p>	
<p>Hybrid systems</p>	<p>Learning time: 16h 40m</p> <p>Theory classes: 4h Practical classes: 2h Guided activities: 2h Self study : 8h 40m</p>
<p>Description:</p> <ul style="list-style-type: none"> - Description. - Calculation software. <p>Related activities:</p> <p>12. Exercise on hybrid systems</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> - 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. 	

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Research and development	Learning time: 16h 40m Theory classes: 4h Practical classes: 2h Guided activities: 2h Self study : 8h 40m
<p>Description:</p> <ul style="list-style-type: none">- 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. <p>Related activities:</p> <p>13. Exercise on research and development</p> <p>Specific objectives:</p> <ul style="list-style-type: none">- 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.	

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Planning of activities

<p>1. Exercise on introduction</p>	<p>Hours: 6h 20m Guided activities: 1h Practical classes: 1h Self study: 4h 20m</p>
<p>Description: Individually carry out an exercise on units, energy (primary, final and useful) and renewable resources.</p> <p>Support materials: - Description of the exercise. - References and data sources.</p> <p>Descriptions of the assignments due and their relation to the assessment: Report of the results.</p> <p>Specific objectives: Deepen knowledge and its application in solving basic exercises of calculations of quantities of energy.</p>	
<p>2. Exercise on the renewables sector</p>	<p>Hours: 6h 20m Guided activities: 1h Practical classes: 1h Self study: 4h 20m</p>
<p>Description: Independent exercise on the renewables sector.</p> <p>Support materials: - Description of the exercise. - References.</p> <p>Descriptions of the assignments due and their relation to the assessment: Report of the results.</p> <p>Specific objectives: Develop the capacity for critical analysis of the student regarding the renewables sector.</p>	
<p>3. Exercise on solar energy</p>	<p>Hours: 6h 20m Guided activities: 1h Practical classes: 1h Self study: 4h 20m</p>
<p>Description: Individual exercise of an assessment and analysis of a solar resource.</p> <p>Support materials: - Description of the exercise. - References.</p>	

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Descriptions of the assignments due and their relation to the assessment:
Report of the results.

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.

4. Exercise on solar thermal energy

Hours: 6h 20m

Guided activities: 1h

Practical classes: 1h

Self study: 4h 20m

Description:

Independent exercise on solar thermal energy.

Support materials:

- Description of the exercise.
- References.

Descriptions of the assignments due and their relation to the assessment:

Report of the results.

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.

5. Exercise on solar photovoltaic energy

Hours: 6h 20m

Guided activities: 1h

Practical classes: 1h

Self study: 4h 20m

Description:

Independent exercise on solar photovoltaic energy.

Support materials:

- Description of the exercise.
- References.

Descriptions of the assignments due and their relation to the assessment:

Report of the results.

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.

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<p>6. Exercise on wind energy</p>	<p>Hours: 6h 20m Guided activities: 1h Practical classes: 1h Self study: 4h 20m</p>
<p>Description: Independent exercise on wind energy.</p> <p>Support materials: - Description of the exercise. - References.</p> <p>Descriptions of the assignments due and their relation to the assessment: Report of the results.</p> <p>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.</p>	
<p>7. Exercise on hydropower and ocean energy</p>	<p>Hours: 6h 20m Guided activities: 1h Practical classes: 1h Self study: 4h 20m</p>
<p>Description: Independent exercise on hydropower and ocean energy.</p> <p>Support materials: - Description of the exercise. - References.</p> <p>Descriptions of the assignments due and their relation to the assessment: Report of the results.</p> <p>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.</p>	
<p>8. Exercise on geothermal energy</p>	<p>Hours: 6h 20m Guided activities: 1h Practical classes: 1h Self study: 4h 20m</p>
<p>Description: Independent exercise on geothermal energy.</p>	

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Support materials:

- Description of the exercise.
- References.

Descriptions of the assignments due and their relation to the assessment:

- Report of the results.

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.

9. Exercise on biomass and waste

Hours: 6h 20m

Guided activities: 1h

Practical classes: 1h

Self study: 4h 20m

Description:

Independent exercise on biomass and waste.

Support materials:

- Description of the exercise.
- References.

Descriptions of the assignments due and their relation to the assessment:

Report of the results.

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.

10. Exercise on biogas and biofuels

Hours: 6h 20m

Guided activities: 1h

Practical classes: 1h

Self study: 4h 20m

Description:

Independent exercise on biogas and biofuels.

Support materials:

- Description of the exercise.
- References.

Descriptions of the assignments due and their relation to the assessment:

Report of the results.

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.

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<p>11. Exercise on hydrogen and fuel cells</p>	<p>Hours: 6h 20m Guided activities: 1h Practical classes: 1h Self study: 4h 20m</p>
<p>Description: Independent exercise on hydrogen and fuel cells.</p> <p>Support materials: - Description of the exercise. - References.</p> <p>Descriptions of the assignments due and their relation to the assessment: Report of the results.</p> <p>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.</p>	
<p>12. Exercise on hybrid systems</p>	<p>Hours: 12h 40m Guided activities: 2h Practical classes: 2h Self study: 8h 40m</p>
<p>Description: - Independent exercise on hybrid systems. o Dimension and optimisation of a hybrid system to generate electricity independently.</p> <p>Support materials: - Description of the exercise. - References.</p> <p>Descriptions of the assignments due and their relation to the assessment: Report of the results.</p> <p>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.</p>	

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<p>13. Exercise on research and development</p>	<p>Hours: 12h 40m Guided activities: 2h Practical classes: 2h Self study: 8h 40m</p>
<p>Description: Independent exercise on research and development.</p> <p>Support materials:</p> <ul style="list-style-type: none"> - Description of the exercise. - References. <p>Descriptions of the assignments due and their relation to the assessment: Report of the results.</p> <p>Specific objectives: The student is capable of making a sketch on the approach of a line of research or of product development.</p>	

Qualification system

Written test (PE). 60%

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

Bibliography