820752 - GEPFR - Power Generation From Renewable Energy Sources

**Coordinating unit:** 240 - ETSEIB - Barcelona School of Industrial Engineering  
**Teaching unit:** 709 - EE - Department of Electrical Engineering  
**Academic year:** 2019  
**Degree:** MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Teaching unit Optional)  
**ECTS credits:** 5  
**Teaching languages:** Catalan, English

### Teaching staff

**Coordinator:** ORIOL GOMIS BELLMUNT  
**Others:** Segon quadrimestre:  
ORIOL GOMIS BELLMUNT - T10

### Prior skills

Electrical systems. Electric Machines. Electrical Engineering.
Electrical aspects of renewable energy will be addressed, from the modelling and control of the required electrical machines to electrical grid integration issues.

1. Introduce the generation principles of the different renewable sources.
2. Introduce the different renewable energy sources focusing on photovoltaic solar and wind systems.
3. Delve into the the electrical aspects of the treated energy sources: induction and synchronous generators, PV panels, etc.
4. Work with energy conversion technologies to integrate renewable energies into the electrical grid or microgrid.
5. Focus on control techniques to maximise generation and control optimally the grid interconnection.
6. Analyse issues related to grid integration: voltage and frequency stability, effect of perturbations into the renewable source generation, etc.

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
  - Lectures and conferences: learning based on understanding and synthesizing the knowledge presented by the teacher or by invited speakers.
  - 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.
  - Presentations (PS): learning based on presenting in the classroom an activity individually or in small groups.
  - 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
  - Homework assignment of reduced extension (PR): learning based on applying knowledge and presenting results.
  - Homework assignment of broad extension (PA): learning based on applying and extending knowledge.
  - 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

Electrical aspects of renewable energy will be addressed, from the modelling and control of the required electrical machines to electrical grid integration issues.

1. Introduce the generation principles of the different renewable sources.
2. Introduce the different renewable energy sources focusing on photovoltaic solar and wind systems.
3. Delve into the the electrical aspects of the treated energy sources: induction and synchronous generators, PV panels, etc.
4. Work with energy conversion technologies to integrate renewable energies into the electrical grid or microgrid.
5. Focus on control techniques to maximise generation and control optimally the grid interconnection.
6. Analyse issues related to grid integration: voltage and frequency stability, effect of perturbations into the renewable source generation, etc.
### Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours small group: 30h</th>
<th>24.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guided activities:</td>
<td>15h</td>
<td>12.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>80h</td>
<td>64.00%</td>
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</tbody>
</table>
# Content

<table>
<thead>
<tr>
<th><strong>Introduction and context of renewable electricity generation</strong></th>
<th><strong>Learning time:</strong> 5h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> A global introduction to the course will be given covering all the main aspects related to renewable energy generation. The different generation principles will be introduced. Methodologies to conduct technical-economical studies will be presented. Design and sizing methodologies will be exposed. Modelling and analysis techniques will be described.</td>
<td><strong>Theory classes:</strong> 2h</td>
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<tr>
<td><strong>Specific objectives:</strong> Introduction and context of the course.</td>
<td><strong>Self study:</strong> 3h</td>
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<thead>
<tr>
<th><strong>Wind generation</strong></th>
<th><strong>Learning time:</strong> 57h</th>
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<tbody>
<tr>
<td><strong>Description:</strong> Wind power. Principles and basic elements. Analysis of configurations of terrestrial and marine wind farms. Electric machines for wind: induction generator and synchronous generator. Converters used. Control of wind turbines and wind farms.</td>
<td><strong>Theory classes:</strong> 6h</td>
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<tr>
<td><strong>Related activities:</strong> Activity 1</td>
<td><strong>Practical classes:</strong> 7h</td>
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<tr>
<td><strong>Specific objectives:</strong> Introduce the principles of wind generation. Deepen knowledge of the electrical aspects: induction and synchronous electric generators and converters. Deepen knowledge of control techniques to maximise the generation and optimally control the grid connection.</td>
<td><strong>Guided activities:</strong> 7h</td>
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<td><strong>Self study:</strong> 37h</td>
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**Solar photovoltaic generation**

<table>
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<tr>
<th>Learning time: 24h</th>
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<tr>
<td>Theory classes: 3h</td>
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<tr>
<td>Self study: 21h</td>
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</table>

**Description:**

**Specific objectives:**
- Introduce the principles of photovoltaic solar generation.
- Deepen knowledge of the electrical aspects: panels and converters.
- Deepen knowledge of control techniques to maximise the generation and optimally control the grid connection.

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**Network integration of renewable generation**

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<th>Learning time: 39h</th>
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<tbody>
<tr>
<td>Theory classes: 4h</td>
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<tr>
<td>Practical classes: 8h</td>
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<tr>
<td>Guided activities: 8h</td>
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<tr>
<td>Self study: 19h</td>
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**Description:**
Introduction to the electricity system with the presence of renewables. Grid codes. Grid support with renewables. Microgrids and supergrids.

**Related activities:**
Activity 2

**Specific objectives:**
- Introduce the principles of integration of renewable generation to the grid.
- Understand codes and support of the grid necessary with strong penetration of renewables.

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**Qualification system**

Written test (PE). 50%
Work performed individually or in groups (TR). 50%
Bibliography

Complementary:


