Academic Year/course: 2022/23

66374 - Smartgrids and electric mobility

Syllabus Information

Academic Year: 2022/23
Subject: 66374 - Smartgrids and electric mobility
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 636 - Master's in Renewable Energies and Energy Efficiency
ECTS: 6.0
Year: 1
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

The objectives of the subject are:

- Identify current electrical system problems
- Propose solutions to these problems
- Know the concept of Distributed Generation
- Know the concept of micro-network
- Know the concept of Smartgrid
- Delve into the technologies that allow the above concepts, with particular emphasis on:
  - Electrical storage
  - Photovoltaic and mini wind
- Explain the need for a change in the road transport sector towards electric mobility.
- Analyze the impact of electric vehicles on the network and how to solve it
- Consider the vehicle as a manageable network element with V2X and V2H capacity.

These approaches and objectives are aligned with some of the Sustainable Development Goals, SDG, of the 2030 Agenda (https://www.un.org/sustainabledevelopment/es/) and certain specific goals, in such a way that the acquisition of learning outcomes of the subject provides training and competence to the student to contribute to some extent to their achievement:

- Goal 1: No poverty

  Target 1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of 13 property, inheritance, natural resources, appropriate new technology and financial services, including micro-finance
- Goal 3: Good Health and Well-being

  Target 3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
- Goal 7: Affordable and clean energy

  Target 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix

  Target 7.3 By 2030, double the global rate of improvement in energy efficiency
- Goal 8: Decent Work and Economic Growth

  Target 8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors

  Target 8.4 improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead

Target 8.7 Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms

- Goal 9: Industry, Innovation and Infrastructure

  Target 9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all

- Objetivo 11: Sustainable cities and communities

  Target 11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

  Target 11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management

- Goal 12: Responsible consumption and production

  Target 12.2 By 2030, achieve the sustainable management and efficient use of natural resources

- Goal 13: Climate action

  Target 13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

1.2. Context and importance of this course in the degree

The electricity sector is undergoing a transformation motivated by the problems of the current centralized system and the appearance of new technologies associated with distributed renewable generation systems, storage systems, power electronic configurations and communication technologies.
In previous subjects, students have studied various sources of RE, the characteristics of traditional electrical networks and power converters in general. In this course, these concepts are particularized, expanding them with aspects such as storage and transmission systems. Likewise, the electric vehicle is included as one more component of smart networks, whose charging process must be managed appropriately, also considering its capacity as a support element for the network through V2X technologies.

1.3. Recommendations to take this course

A series of previous knowledge is required from the students for correct learning of the subject. Above all, the student needs a background in electrical engineering, electrical networks and power converters.

Previous knowledge is required for correct learning of the subject. Above all, the student needs a good base of solar photovoltaic energy and wind energy.

Following the lectures, problems, laboratory, and external practices are essential, as well as personal study and the preparation of the assignments for the subject.

Continuous work is fundamental to good use of the knowledge transmitted in the classes and passing it successfully. To facilitate this ongoing work, the student has the teacher's advice, both during lessons and tutoring hours, specially designed for this purpose.

2. Learning goals

2.1. Competences

BASIC SKILLS

CB6.- Possess and understand the knowledge that provides a base or opportunity to be original in the development and/or application of ideas, often in a research context.

CB7.- That students know how to apply the knowledge acquired and their ability to solve problems in new or little-known environments within broader (or multidisciplinary) contexts related to their study area.

CB8.- That students can integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to applying their knowledge and judgments.

CB9.- That students know how to communicate their conclusions and the knowledge and ultimate reasons that support them to specialized and non-specialized audiences clearly and unambiguously.

CB10.- That students have the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

GENERAL COMPETENCES

CG1.- Carry out research, development and innovation in products, processes and methods concerning energy efficiency.

CG2.- Carry out research, development and innovation in products, processes and methods concerning renewable energies.

CG4.- Follow the technological evolution of renewable energies and have prospective knowledge of this evolution.

CG5.- Apply knowledge of advanced sciences and technologies to the professional or investigative practice of efficiency.

CG6.- Identify current legislation and regulations applicable to the renewable energy and energy efficiency sector.

CG7.-Assess the application of emerging technologies in energy and the environment.

CG9.- Solve complex problems in the field of energy efficiency and sustainability.

SPECIFIC COMPETENCES

CE1.- Use and develop methodologies, methods, techniques, programs for a specific use, norms and computing standards.

CE3.- Assess the importance and implications of energy use in the development of society.

CE4.- Assess the environmental impact of a RES installation or energy efficiency action.

CE7.- Describe the technologies related to sustainable mobility.

CE8.- Describe the smartgrids associated with energy management and distribution.

CE15.- Project energy storage systems.

CE17.- Calculate electric power generation, transport and distribution systems, and the integration of renewable energies in each.

2.2. Learning goals

The student must demonstrate knowledge in:

- Concept of Distributed Generation
- Concept of a microgrid connected to the network and isolated
- Smart grid concept
- Knows the problems associated with the current electrical network model
- Knows the network quality and security of supply conditions that distributed generation systems and microgrids must meet for their connection to the electricity grid and islanded operation.
- Knows the distributed ER generation systems and electrical energy storage systems, in general DER, that can be used in smart grids and microgrids.
- Power electronics configurations suitable for connecting microgrids and smart grids of DERs.
- Power electronics configurations suitable for connection to microgrids isolated from DERs.
- Learn about D-FACTS and FAPS and their functionalities applied to smart grids and microgrids.
- Know the basic concepts of electric mobility and its possible integration into distributed generation
- Learn about charging methods for electric vehicles and their impact on the electricity grid
- Knows the methods necessary to mitigate the impact of EV load on the network
- Knows the essential technologies of both centralized and distributed control.

2.3. Importance of learning goals

The evolution of the current network as a centralized system towards a network with distributed generation systems in which the most important current generation and storage technologies are considered, together with the electric vehicle, is necessary to allow greater penetration of renewable energy energies and the reduction of polluting emissions and energy dependency.
It is necessary for the current engineer to know and assess the advantages and disadvantages of said change and the technologies needed to achieve it.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

In the ordinary call, the assessment will consist of:

1. Continous evaluation works (including those derived from lab sessions): 60%
2. Practical work and its oral presentations: 40%

For the practical work (number 2 in the list), different topics will be proposed for teamwork that will be presented and debated among those attending the course.

To opt for this type of assessment, it is necessary to monitor the subject continuously.

The student who does not opt for the evaluation procedure described above in the first call will have the right to take a global evaluation test. The call for extraordinary evaluation will be carried out through a global test carried out in the period established for this purpose.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

In the theory sessions, the basic concepts are explained and they are related to the technical characteristics of the processes using short exercises that are solved on the blackboard, serving as support to establish the understanding of the concepts. In both cases, the methodology is master classes.

In the practical sessions, they are carried out through computer sessions in which more complex practical cases are studied than those presented on the board, where a certain calculation power is necessary for their resolution.
Several subject works are also included in which the student will demonstrate the skills acquired progressively.

4.2. Learning tasks

In order for students to achieve the learning outcomes described above and acquire the competences designed for this subject, the following training activities are proposed:

- A01 Master class (12 hours): presentation of content by the teaching staff or external experts to all the students of the subject.
- A02 Resolution of problems and cases (30 hours): carrying out practical exercises with all the students of the course.
- A03 Laboratory practices (15 hours): carrying out practical exercises in small groups of students from the course.
- A05 Practical application or research work (30 hours)
- A06 Personalized teacher-student tutoring (10 hours)
- A07 Autonomous study by the student (48 hours).
- A08 Assessment tests (5 hours)

The times indicated are indicative and will be adjusted according to the academic calendar of the course.

At the beginning of the course, the calendar of practical sessions will be informed, which will be set according to the progress of the program and the availability of laboratories and computer rooms.

4.3. Syllabus

- The world energy system
- The electrical power system and its current problems
- Distributed generation and microgrids.
- The Smartgrid
- The Supergrid
- Core Technologies for the Smart Grid
- Need for electric mobility
- Electric mobility in the Smart grid

4.4. Course planning and calendar

The subject corresponds to the second semester. The theoretical-practical classes and the practical sessions in the laboratory are taught according to the schedule established by the center and is published prior to the start date of the course.
Each teacher will report their tutoring hours.
The rest of the activities will be planned according to the number of students and will be announced well in advance. At the beginning of the semester, the teacher will report on the planning of the teaching activities and the key dates for handing in exercises. More information on the center website: https://eina.unizar.es/

The exam will be held in the period corresponding to the subjects of the second semester