Sustainable energy

Summer course

Module 1. Renewable Energies and Hydrogen as an Energy Vector

1.1. Introduction to Renewable Energy Sources

Content:

The fundamentals of the different types of renewable energies are explained. The solar thermal, the solar photovoltaic and the wind energy systems are presented in more detail.

Objectives:

• Know the different types of renewable energy sources.

• Learn the main technological features of solar thermal, solar photovoltaic and wind energy systems.

Methodology:

A master lesson of 2 hours of duration.

1.2. Green Hydrogen Generation and Use to Decarbonize Industrial Processes

Content:

Description of the current technologies in use or under development to produce green hydrogen. Description of hydrogen use in industrial processes: electrification of steel production. Hydrogen alternatives for transport: trains, cars, heavy transport, planes.

Objectives:

• Know the different technologies to generate green energy.

• Learn the main technological features of the use of hydrogen in different sectors.

Methodology:

A master lesson of 3 hours of duration. Analysis and discussion of a case study (1 hour).

1.3. Hydrogen Logistics: Storage, Transport and Distribution

Content:

Description of the different alternatives for the supply chain of hydrogen. Physical and chemical storage. Transport in different states: gas, liquid or as carriers. Distribution in short/medium distances, or for long distances.

Objectives:

• Know the problematic of the hydrogen logistics.

Methodology:

A master lesson of 1.5 hours of duration. Analysis and discussion of a case study (0.5 hours).

1.4. Design and optimization of hybrid power systems with HOMER

Content:

The content of this module introduces the attendants to the dimensioning of hybrid RE systems (photovoltaic solar, wind energy and hydrogen/fuel cell) for electric energy supply of sustainable buildings, and their integration in the distribution electric system. A case study will be developed for a better understanding of these technologies. In addition, attendants will learn to use the software HOMER to design and size distributed generation (DG) systems based on different energy sources (renewable energy sources, hydrogen as an energy vector, hybrid systems). We will use the software to simulate different types of systems, to optimize them technically and economically, and to perform sensitivity analysis in the system parameters.

Objectives:

• Learn to use the HOMER software to simulate and optimize Distributed Generation (DG) systems based on renewable energy sources: photovoltaic solar energy, wind energy and hydrogen/fuel cell.

• Know what a DG system is and which are its possible components.

• Learn how the power sources are technically and economically modeled in HOMER.

• Analyze and optimize a specific installation changing the configuration and the type of system.

Methodology:

• Explanation of what HOMER is, what it can do and how it works.

• Development of a case-study: Definition and study of the electric supply of a building, using the HOMER software of a specific DG system composed of: a hydrogen tank, a fuel cell, an electrolyzer, a photovoltaic array and a wind turbine.

• Homer personal exercise: The students will work in a new DG system, introducing all the components in Homer, running the simulations and analyzing the results.

Evaluation of Module 1:

The students will have to hand in 3 reports analyzing the results of the Homer case-study and the 2 hydrogen case studies.

Module 2. Renewables Energies and Energy Efficiency

2.1. Solar Thermal and Solar Photovoltaic Energy Lab Exercises

Content:

The theoretical explanations of previous section are complemented with 2 laboratory exercises to analyze and characterize the actual performance of solar thermal and photovoltaic energy systems.

Lab Exercise 1: Performance of a solar collector.

Lab Exercise 2: Characteristic curve of a solar cell.

Objective:

• Analyze the performance of solar thermal and photovoltaic energy systems under different operating conditions.

Methodology:

Realization of the lab exercises to understand the practical aspects of solar thermal and photovoltaic energy systems. Duration: 2 hours each lab exercise. 2.2. Energy

2.2. Efficiency in Buildings

Content:

Different technologies oriented to improve the energy efficiency of buildings will be described: efficient lighting systems, insulation materials, ventilation strategies, radiant floor heating, phase-change materials, solar thermal collectors.

Objectives:

• Know the actual energetic problems in buildings.

• Know the different technologies involved for Energy Efficiency.

• Make the attendants aware of the importance of energy consumption to the environment.

Methodology:

Explanation of the basic concepts with PowerPoint presentations. Case study methodology: Case 1: EE in Buildings. 2.3.

2.3. Energy Efficiency in Transport and Industry

Content:

Description of different technologies oriented to improve the energy efficiency in industry and transport: efficient and sustainable transport, hybrid and electric vehicle, urban mobility, fuel cells in industry, smart grids and efficient network.

Objectives:

• Know the actual energetic problems in industry and transport.

• Know the different technologies involved for sustainable mobility.

• Know the implementation of energy efficiency in Industry 4.0.

Methodology:

Explanation of the basic concepts with PowerPoint presentations. Case study methodology: Case 2: EE in Transport.

Evaluation of Module 2:

The students will have to hand in 3 reports analyzing the results of the 2 lab exercises and the 2 energy efficiency case studies.