| *Code* | *Title* |
|---|---|
| 5.1 | **Energy efficiency (residential and industrial sectors) and storage applications** |
| *ECTS/Credits* | *Language* |
| Up to 12 ECTS | English |

| *Specific teaching Objectives of the course/Learning outcomes (Dublin Descriptors )* |
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| *a. Knowledge and Understanding* |
| At the end of the course, students should be able to:<br>1. Understanding of basic areas of energy efficiency and storage methods;<br>2. Know energy efficient technologies for the different final users such as residential and industrial;<br>3. Introduce the concepts of energy storage and efficiency and how they may be applied;<br>4. Identify the optimal (appropriateness, cost and sustainability) solutions to any potential energy storage and efficiency applications;<br>5. Emphasize the math and science principles used to design, develop, test, and supervise production/construction energy efficiency and conservation methods.<br>6. Identify Multiple Energy Savings Programs;<br>7. Model a country's energy demand and supply using the LEAP model. |
| *b. Applying knowledge and understanding* |
| At the end of the course, students should be able to:<br>1.Calculate power and energy consumption for simple equipment (Degree Day, Bin Methods, annual energy consumption);<br>2. Apply the principles of energy auditing, energy flow diagram, economics of energy conservation opportunities in buildings;<br>3. Identify energy efficiency/conservation methods available for energy use reduction in residential and commercial settings.<br>4. Estimate energy savings and environmental impacts for most energy efficiency methods in order to identify and assess energy conservation opportunities.<br>5. Evaluate the appropriate usage of energy monitoring and measuring equipment commonly used by energy specialists and energy auditors. |
| *c. Making Judgements* |
| At the end of the course, students should be able to:<br>1. To discuss the theory and applications of different energy storage devices;<br>2. Enhance decision making skills through comparison of scenarios in Group/project assignments. |
| *d. Communication skills* |
| At the end of the course, students should be able to:<br>1. Describe the various types of energy efficiency solutions;<br>2. Explain the benefits in the use of a more efficient approach;<br>3. Make presentations of modelled scenarios in group/project assignments. |
| *e. Learning skills* |
| At the end of the course, students should be able to:<br>1. Enhance learning skills through application of knowledge attained in case studies, projects work assignments;<br>2. Use platform as Moodle and Google class. |

*Main topics*

| | Estimated number of hours | | |
|---|---|---|---|
| | **Lectures** | **Laboratory** | **Tutorial** |
| INTRODUCTION | | | |
| 1. Overview of primary and final energies, energy intensity<br>2. Definition of energy efficiency, final users and sectors. Assessment of energy flows, demand and management.<br>3. The role of energy efficiency<br>4. Types of interventions, potential, uses.<br>5. Introduction to the needs of energy storage. | | | |
| CHAPTER 1 | | | |
| EVALUATION OF ENERGY CONSUMPTION<br>1. Assessment of energy efficiency indicators in different sectors (households, commercial and industrial);<br>2. Audit and Energy Diagnosis;<br>3. Measurement instruments: Data loggers, universal data recorder, flue gas analyzer, thermometer, utility meters, combustion analyzers, infrared thermography, airflow velocity meters, relative humidity measures, electrical meters, refrigeration measures, light meters, and sling psychrometer;<br>4. Energy bill analysis: power factor correction, peak demand limiting, rate structure and comparison to alternative rate opportunities, including green power;<br>5. Energy certification and LEED certification. | | | |
| CHAPTER 2 | | | |
| ENERGY EFFICIENCY IN BUILDING<br>1. Street design and urban microclimate (Optional)<br>2. Energy insulation:<br>a. Opaque surfaces: wall, roof and foundation<br>b. Transparent surfaces: windows<br>c. Direct heat gain, indirect heat gain, isolated gain and sunspaces.<br>3. Solutions, materials and calculation of energy losses<br>4. Heating and conditioning systems<br>5. Illumination<br>6. Definition of Passive House and Zero Consumption Building. | | | |
| CHAPTER 3 | | | |
| ENERGY EFFICIENCY IN INDUSTRY<br>1. Motivation, socio and economic effects | | | |

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| 2. Energy production: renewable technologies, co-generators, tri-generators<br>3. Energy consumption:<br>a. Electric: pumps, blowers, compressors, chillers, lighting systems, HVAC<br>b. Thermal: insulation, combustion engines, boilers<br>4. Energy Saving: replacement of systems, interventions of efficiency<br>5. Best-practice examples | | | |
| CHAPTER 4 | | | |
| PASSIVE COOLING CONCEPTS<br>1. Evaporative cooling and radiative cooling.<br>2. Application of wind, water and earth for cooling, shading, paints and cavity walls for cooling, roof radiation traps and Earth air-tunnel.<br><br>RENEWABLE TECHNOLOGIES INTEGRATION<br>1. Building Integrated Photovoltaic (BIPV). | | | |
| CHAPTER 5 | | | |
| ENERGY MANAGEMENT<br>1. Energy Audit<br>2. Data collection<br>3. Data analysis and reporting<br>4. Energy Management System (ISO 50001:2011) | | | |
| CHAPTER 6 | | | |
| ENERGY STORAGE<br>1. Storage of thermal, mechanical and electrical energy<br>2. Role of storage in the electricity grid<br>3. Type of energy storage systems and components: Lead batteries, various Li-ion batteries, unlike electrolysis of water, different hydrogen storage, and various fuel cells<br>4. Performance indicators<br>5. Costs and risks<br>6. Thermal energy storage<br>7. Types of storage: heat reservoirs, phase transition utilization and chemically bound heat<br>8. Mechanical energy storage<br>9. Types of storage: spin Wheels, hydro power pumping, turbines and heat recovery<br>10. Capacitors and super capacitors: principles, performance and applications. (Optional) | | | |

| *Course description* |
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| The course aims to introduce the concept of energy efficiency and how it may be applied for carrying out all types of energy-dependent activities, such as manufacturing products, heating/cooling buildings.<br>The course seeks to inform students about the real benefits which energy efficiency measures and aid them to understand why energy efficiency is a high priority in supporting greater sustainable energy supplies for development. In this course, emphasis will be placed on incorporation of energy efficiency component especially in the utilization of energy. Thus, through energy audits, efficiency in utilization of energy in the residential and industrial sector will be taught. This will be enhanced by practical applications where energy audits for selected facilities will be carried out by student groups. Also, considering storage of energy is still a major challenge globally, this course will also ensure that measures of energy storage and their application in the local context are handled. Innovative measures of energy storage and resource requirements there in will also be explored in this course. |