**Module 4:**

**End use energy efficiency**

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**Description**

The introduction of technology or management improvements in the end uses of energy, allows to obtain major amounts of consumptions reduction with lower production costs, in line with security supplying strategies (i.e. see the Green Paper on Security of Supply of European Commission of 2000, and its update of 2005, which identifies the demand management as first priority: "*we must reduce our energy consumption wherever possibile*").

The air conditioning, for example, could be drastically reduced using natural cooling techniques for buildings, both newly built or under restructuring. An adequate heat insulation used with a correct orientation permits, today, to realize buildings that demand only 15 kWh/$m^2$ per year, compared to 100-150 kWh/$m^2$ of buildings belonging to the national present stock.

Changing domestic appliances, boilers or electric engines, with the best available in the market can consistently reduce energy consumption, with economic, energy and environmental benefits.

Although some economical incentives are inside the markets and some efficient instruments or synergies already exist, for example the Third Party Financing (TFP), they are too weak and not sufficient to allow the exploitation of the entire saving potential; this saving is economically an advantage, but is hampered by market barriers of the demand side, such as: lack of information among customers, separate incentives, implicit high interest rate, difficult access to financing instruments.

Getting over the barriers is possible thanks to the adoption of adequate energy policies and energy market regulation strategies, that are a concrete support to the development of programs and services for energy efficiency, programs realized by energy companies and other actors.

End use efficiency and renewable sources development, together with economic targets definition towards different goals (i.e. growth quantity), are the keys to realize a society with low environmental impact and high wealth.

During the lectures students will go through in theory, but also with several practical applications, the following matters:

- energy efficiency market and its actors;

- energy saving potentials and costs for different end uses in the residential, tertiary and industrial sectors;
- economic and technical analysis methods for energy saving interventions;
- useful instruments to increase the energy end use efficiency (technologies, programs, services, etc);
- energy policies and regulation strategies of the energy efficiency market.

Practical

- Students will realize an energy audit of a building, with analysis and technical evaluation of the intervention potentials, investments financial evaluation;

**Programme**

- Investments analysis and micro economy short account;
- Energy efficiency introduction
    - definitions and classification (primary sources, energy vectors, energy services,...)
    - definition of efficiency (first and second principles), Exergia and exergetic analysis
    - energy efficiency indicators concerning the whole economy
    - end use consumptions disaggregation and peak demand evolution
    - brief survey of energy saving technologies;

- Comfort and efficient buildings: heating, cooling and lighting
    - Basic concepts: energy, needs, performance and regulation frame
    - Hygrometric and thermal comfort
    - Lighting comfort
    - Energy balance: physics model and global performance
  - Envelope and plants technologies, combined intervention strategies
    - Bioclimatic project introduction
    - Passive cooling strategies
    - Hybrid and natural ventilation
    - Air ground cooling
    - Thermal insulation: eco-efficiency and LCA evaluations
    - Insulating materials, transparent components: performances, costs, durability and use methods
    - Passive and hybrid solar systems for heating and their applications
    - Technologies for natural lighting development
    - Heating plants
    - Absorption plants, district and active efficient cooling
    - Heat pumps and their use

        - Dessiccant cooling
        - High performance lighting plants for indoor environments
        - Daily light integration
        - Efficient domestic appliances and rational use of water
        - Energy analysis, building project and management
        - Dynamic simulation software
    - Energy analysis and consumption monitoring: building envelope
        - Energy analysis and consumption monitoring: plants and appliances
        - Innovative domotics for energy efficiency and security
        - Building automation in tertiary sector buildings
    - Buildings Energy certification
- Energy efficiency in the industry
        - Technologies examples: compressed air, optimization solutions of energy costs
        - Technologies examples: high efficiency electric pumps and electronic control
        - Technologies examples: ORC for industrial unused heat recovery
        - Industrial energy audit for small/medium companies
        - Industrial energy audit: interventions guided individuation
        - Optimized street lighting technique project
- Markets and policies for energy efficiency diffusion
    - Potentials, barriers, incentives and intervention instruments
        - The energy markets liberalization and energy efficiency: potentials and problems
        - Energy markets, incentives and disincentives for energy efficiency
        - Energy markets, market barriers to energy efficiency and mechanisms to climb over
        - Energy price and related contracts making
- European policies for the efficiency promotion: successful experiences
        - Energy efficiency policies monitoring and evaluation
        - White Certificates: analysis and comparison between European countries
        - Voluntary agreements and successful examples in Europe
        - High efficiency engines diffusion: policies and programs
        - English methods and results
    - The Italian situation, white certificates and facilitations
        - The Italian decrees for efficiency: application norms
        - Facilitations and incentives in the Finance Acts
    - ESCo: problems, types of contract and realization examples
        - Definition of ESCo, types of contract, guaranteed savings, shared savings IMVP and ESCOs
        - Performance contracting examples
        - Example of an ESCo creation in Italy