Sustainable energy

Lecturers
Michel HUART (Coordinator) and Julien BLONDEAU

Course mnemonic
MECA-H417

ECTS credits
3 credits

Language(s) of instruction
English

Course period
First term

Campuses
Solbosch and Other campus

Course content

Today, energy and sustainability are matters of primary concern. Through a general overview of applied energy and a series of seminars, the course provides some references and keys to understand applied energy, discuss the sustainable energy challenges and gives an insight of some innovative solutions for electro-mechanical engineering students.

A. General overview (6 x 2 hours) - Applied energy and sustainability - Michel HUART – ULB

- Basics of science applied to energy systems: Energy, power, units, forms, main energy vectors (fuels, electricity, heat), combustion, conversions, rough estimates;
- Energy systems: Overview of the energy commodities, standard technologies to provide heat, fuels, work, transport, electricity or storage; Resources and reserves (fossil, nuclear, renewable).
- Energy statistics: World trends (Primary energy, final energy, electricity); Conventions; Energy flow chart, UE and National energy consumption;
- Energy chain: Concept and main steps; Activities of supply; Electrical sector; Energy demand: Efficiency, introduction to sociology; EROEI, embodied energy (material and transport energy intensity);
- Prices and costs of energy: Energy markets (Belgian retail and international wholesale), energy bill and unit prices, components, values (average, marginal, current, constant); Discounting; Price evolutions (observed and projected); Costs: CAPEX, OPEX, LCOE, Externalities.
- Energy efficiency, energy savings, energy sufficiency : Definitions, indicators and methods.
- Energy sustainability: How to make our energy society more sustainable?

B. Sustainable Energy applications – A series of seminars and discussions, also with invited speakers (10 x 2 hours) – Julien BLONDEAU – VUB

The seminars will give an insight into the current status, the perspectives and the challenges associated to various technologies. Non-exhaustive list of the discussed topics:

- Biomass
- CO2 emissions and Carbon Capture and Storage
- Mobility
- Near Zero Emissions Building
- Energy Storage
- Impact of renewables on the electricity network
- Waste to Energy
- ...

The students will prepare abstracts of the attended seminars that will be discussed during the oral exam.

The attendance to the seminars is mandatory.

Objectives (and/or specific learning outcomes)

By the end of the program of study, the student is able:

- To define, use and illustrate key concepts of applied energy and sustainability.
- To solve exercises in concrete situations of energy consumption (or generation) in order:
  - To characterize energy in its physics and technological aspects, efficiency, energy chain, sustainability, statistics of consumption, energy prices and costs;
  - To look at quantitative aspects by applying simple calculations with basics formulas of science, and using some assumptions based on realistic orders of magnitude and finally to express the estimate in an appropriate way (rounding, significant digits, unit);
  - To demonstrate critical approach on results (given or personal) by having in mind rough estimates and applying specific formulas related to energy systems;
- To build an energy chain of a defined activity in a given context (energy systems, commodity, energy intensity of the service, need) and to analyse its sustainability and economical aspects
  - describing energy systems (commodities, resources, technologies, processes, services)
  - applying well-reasoned first estimation approaches (energy quantification, economics, sustainability, alternatives, efficiency)
  - selecting realistic assumptions
  - investigating alternatives and efficiency options;
- To describe and to analyse sustainable energy applications (renewable, efficiency, demand response, rational use of energy, energy system innovation) through case studies in industry, buildings and transport (seminars);

- To deliver a professional report (format, legibility);
- To summarize a technical presentation given by a guest speaker and to express one's opinion based on sound technical arguments.

Teaching method and learning activities

Up to 18 sessions of 2 hours given by professors and external experts.

Graded homework (feedbacks, readings, exercises, reports, abstracts).

Attendance to the seminars and course activities are compulsory.

Contribution to the teaching profile

Competence framework of electro-mechanical engineering related in energy systems, energy efficiency, sustainable energy. In particular:

- Demonstrate expertise and versatility in energy systems and energy consumption of given activities
- Formulate and analyse sustainable energy applications and suggest optimal solution in a given context
- Adapt scientific and technical communication
- Be a responsible person aware of societal, environmental and economic issues through sustainability

References, bibliography and recommended reading

B. EVERETT, G. BOYLE, S. PEAKE, J. RAMAGE - *Energy Systems and Sustainability* –Oxford University Press, 2012 - 653 pages - ISBN: 978-0-19-959374-3 – 42 £

D. MACKAY - *Sustainable Energy – without the hot air* – UIT Cambridge Ltd, 2009 – 380 pages - ISBN: 978-0954452933 - Free download: http://www.withouthotair.com/

IEA: "Energy statistics Manual", 2005 *and 'Energy Efficiency Indicators: Fundamentals on Statistics*", 2014. – Free download - https://webstore.iea.org/statistics-data

NREL – *A manual for the Economic Evaluation of Energy Efficiency and Renewable Energy Technologies*, 1995 - Free download - https://www.nrel.gov/docs/legosti/old/5173.pdf

Course notes

Université virtuelle

Other information

Place(s) of teaching

Solbosch and Other campus

Contact(s)

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Evaluation method(s)

Oral examination, Personal work, Written report and Other

Evaluation method(s) (additional information)

In order to be allowed to take the exam, homework and the abstracts have to be submitted on time.

The submission of answers and feedbacks (regularity[1] [#_ftn1] , clarity[2] [#_ftn2] , relevance[3] [#_ftn3] , quality[4] [#_ftn4]) takes part of the marks of the general overview part.

[1] [#_ftnref1] The regularity of submission of feedback is evaluated on the period of six lectures. A penalty is given if less than four feedbacks are submitted.

[2] [#_ftnref2] Clarity: terminology and concern of being understood.

[3] [#_ftnref3] Related to the issue and a sense of synthesis.

[4] [#_ftnref4] Care in following the instructions, intention in the resolution.

Determination of the mark (including the weighting of partial marks)

Assessment of knowledge and skills through (1) answering questions and giving feedbacks after each lecture and submitting homework for general overview and (2) reporting the relevant insights of the given seminars.

50% General overview

50% Seminars

Main language(s) of evaluation

English

Programmes

Programmes proposing this course at the Brussels School of Engineering

MA-IREM | Master of science in Electromechanical Engineering | finalité Professional/unit 1