**IPL Summer School 2020**

**Science & Engineering program**

**A multidisciplinary approach to the subject of Energy and Sustainability.**

Most of the largest challenges we will face in the future (global warming, increasing scarcity of fossil fuels, the impact of production methods and materials, etc.) are related to how we produce and use energy and the consequences of those actions. The course aims to teach future engineers the industrial and regulatory context, the technical concepts and tools needed to comprehend these challenges, and explore the solutions of tomorrow.

Drawing from ECAM Lyon’s expertise in the areas of energy, electrical and mechanical engineering, as well as materials science, this program is composed of a series of lectures and practical courses that will include case studies, labs and individual work on the themes covered. Students will also be asked to work on a team project that will be presented at the end of the course.

*For program and application details, go to:* [*http://www.iplsummerschool.com/index.php*](http://www.iplsummerschool.com/index.php)

**Total credits: 6 ECTS[[1]](#footnote-1), European Transfer System**

**Hours: 54**

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|  | **Session - Course content [[2]](#footnote-2)** | **Instructor** | **Hours** |
| 1 | **Production of Electrical Energy 1: Conventional power generation and basics of power systems** | Prof. Nagham El Ghossein, Professor-Researcher in the Energy Department | 3 |
| - Operating principle of a nuclear reactor, fission chain reaction, schematic diagram of a nuclear power plant with electro-mechanic-thermal conversion, performance analysis- Three-phase and one-phase power grid, current and power calculations- Electrical test with a transformer and some receivers |
| 2 | **Production of Electrical Energy 2: Renewable power generation** | Prof. Nagham El Ghossein, Professor-Researcher in the Energy Department | 3 |
| - Operating principle of a photovoltaic cell, main characteristics, performance of a solar panel installation, examples of applications- Test of a solar panel- Operating principle of a wind turbine, main characteristics, conversion of mechanical energy to electrical energy with or without coupling network, with synchronous or induction generator, schemes of associated electronic convertor, installation examples. |
| 3 | **Production of Electrical Energy 3: Fuel Cells** | Prof. Christophe Jouve, Head of the Automation & IT Department  | 3 |
| * + Operating principle of a fuel cell, main characteristics, performance, hydrogen generation and stocking means, applications examples (e.g. electric vehicles)
	+ Test bench of a 500W fuel cell
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| 4 | **Efficiency and Control System** | Prof. Christophe Jouve | 3 |
| * + Presentation of an industrial programmable logic controller PLC, performances and industrial applications. Drivers & controllers of actuators. Rules of regulation.
	+ Test bench of a device with on-off inputs and outputs and of a small process control, small controller programming and analysis of the system response.
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| 5 | **Energy: From primary sources to sustainability I** | Prof. Alexandre Vaudrey, Professor-Researcher in the Energy Department | 3 |
| * + A short reminder of the two laws of thermodynamics and their consequences on the management of energy and environment: why we must take energy from somewhere, but it cannot come from anywhere.
	+ What we need and what we have: what are the primary energy sources (PES), energy carriers (EC) and final energy (FE)? Why do we always need to convert, to transport and to store energy?
	+ How to assess all energy systems: is it better to talk about efficiency or effectiveness? What are the other typical performance criteria and when are they used? How should the environment be taken into account in our calculations?
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| 6 | **Energy: From primary sources to sustainability II** | Prof. Alexandre Vaudrey | 3 |
| * + Current state of our world: what are our actual primary sources and how are we using them?
	+ The problem: what is the Energy Transition and why must we care about sustainability?
	+ The future: what are the possible solutions for tomorrow? What are the critical parameters to take into account before adopting a new technology? How to stay hopeful.
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| 7 | **Heat Ventilation and Air Conditioning (HVAC) systems and energy consumption of buildings** | Prof. Alexandre Vaudrey | 3 |
| * + Thermal comfort and acceptable indoor air quality in buildings.
	+ The concept of humid air: importance of temperature and humidity.
	+ How does an HVAC system works.
	+ Energy balance and efficiency of HVAC systems.
	+ Laboratory work: practical use of a real HVAC equipment with case studies.
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| 8 | **Materials for sustainable energy** | Prof. Aurélien Etiemble, Professor-Researcher, Materials and Structures Department | 3 |
| * + Introduction to materials science: classification of materials and common properties.
	+ Materials in energy conversion and storage devices.
	+ Laboratory work: Characterization of materials for photovoltaic solar cell and Li-ion batteries.
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| 9 | **Group Project** | ECAM Lyon instructors | 5 x 3h sessions |
| * + Research project related to one of the subjects covered during the course
	+ Students work in teams; regular contact with supervising professors
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| 10 | **Final evaluation + oral presentation** | ECAM Lyon instructors | 3 |
| * + Final exam covering the taught classes and laboratory work
	+ 20-minute oral presentation of the group project followed by questions from the panel of professors
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| 11 | **Energy Engineering Workshop** | ECAM Lyon instructors | 5 x 3h sessions |
| Development of a low cost wind turbine:* + Design of the physical prototype of the low-tech wind turbine.
	+ Analysis of the electromechanical properties.
	+ Measurement of the electrical output power.
	+ Test of the prototype connected to a load (LED).
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1. Equivalent to 3 or 4 US credits, depending on your program and university. [↑](#footnote-ref-1)
2. The school reserves the right to modify the course modules and/or their content for updating or improvement purposes. [↑](#footnote-ref-2)