Solar energy

ECTS credits
3 credits

Semester
Spring

In brief

> **Course langage:** French

Presentation

Prerequisites

Basic knowledge of :

- photometry
- electricity
- differential equations

Learning objectives

Upon completion of the course, the student will be able to:

* calculate solar radiation on a terrestrial reference point

* argue and choose a photovoltaic technology according to the context

* define a first sizing of a photovoltaic installation (solar power plant or individual installation)

* calculate the efficiency of a thermal plane collector according to the application

* define the thermal energy needs of a building and size a heating solution

Description of the programme

Solar energy

Among the sustainable energies available, energy from solar radiation is very abundant and renewable. This resource can be used directly as heat (solar thermal) or transformed into electricity (thermal power plants or direct transformation into electricity by photovoltaic effect). Due to its abundance, solar energy is becoming an increasingly important part of the global resource.
In this course, we will study the characteristics of this resource and the technologies associated with it in order to have all the necessary tools to design electrical and thermal installations. The knowledge provided throughout the course is also aimed at understanding the current socio-economic and scientific issues.
This UE is located at the crossroads of several disciplines: electronics, optics, optronics, physics, thermics.

1. **General introduction :**
   Societal issues
   Economic and technical problems, challenges
2. **Solar resource**
   Physic aspects
   Principle of solar radiation, atmospheric absorption and local, temporal and spectral dependence of the irradiance, photometry
   Optimization of irradiance: solar concentrators. Energy efficiency (received solar energy, thermal radiation, greenhouse effect)
3. **Photovoltaic sensors**

** Principle of operation:
Calculation of a photovoltaic system, semiconductors, diodes and photovoltaic effect; cells; cell arrays, impedance matching, challenges (cost, efficiency, storage)
** Technological fields:
- Crystalline silicon: mono and polycrystalline (Mono-Si, Poly-Si) - inorganic thin film cells: a-Si :H, CdTe, CIS, SIGS, a-Si :H, μ-Si, HIT, GaAs.
- Organic and hybrid cells: principles of organic cells, particularity of perovskite cells
** Advanced concepts :
Surface structure, photonic crystals, plasmonics, quantum structures, concentration, ...
Conclusions and perspectives on photovoltaics: what hopes, what future uses?

4. **Solar thermal energy**

** Solar thermal collectors
- The flat plate collector: structure, performance, test standard
- Vacuum collectors: operation, lifetime, applications
- Other collectors: without glazing, current applications
- Concentration collectors: calculation of the concentration factor, sun tracking, boiler temperature, efficiency, the different types of concentration thermal plants in the world today and their electricity production capacity

** Sizing of thermal installations, application of solar energy for housing:
- Positioning (need/supply)
- Main components (collectors, storage, emitters, regulation)
- Calculation of the coverage rate (case of DHW and heating)

Generic central skills and knowledge targeted in the discipline

- Analyze the solar resource of a location: calculate its seasonal changes and identify the sources of shading

- In a directed work, on an example of application, the student will be able to define a first sizing of a photovoltaic plant. In particular, he will be able to propose a location for a power plant and the duration of its use. He will be able to adapt the energy production to the needs.
- Acquire knowledge of the most commonly used photovoltaic technologies. Be aware of the development of new technologies. Know how to compare these technologies.
- Know the energy pay back time (energy cycle) and correlate it with the technology and the site of operation
- Anticipate the temperatures necessary for the optimization of the yield of a flat thermal collector estimate a solar coverage rate
- Recognize the advantages and drawbacks of different geographical locations for solar thermal or photovoltaic plants

How knowledge is tested

Continuous assessment: 2 bonus points (average of small 5 min assessments or document analysis)
Supervised assessment: 50% (thermal, photovoltaic), 50% (thermal)

Bibliography

1. Jannot, Y. & Moyne, C. (2016). *Transferts thermiques : Cours et 55 exercices corrigés*. Édilivre.
2. A., L. (s. d.). *Energie solaire photovoltaïque (French Edition)*. dunod.
3. Reddy, J. P. (2019). *Solar Power Generation : Technology, New Concepts & Policy* (1re éd.). CRC Press.
4. Solanki, C. S. (2015). *Solar Photovoltaics - Fundamentals, Technologies and Applications (English) 3rd Edition* (3e éd.). Prentice Hall.

Teaching team

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- David DUCHE
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Sustainable Development Goal

Affordable and clean energy

Building Resilient Infrastructure

Sustainable cities and communities

Responsible consumption and production

Total des heures **72h**

CM	Master class	36h
CM	Master class	28h
TD	Directed work	8h

Useful info

Name responsible for EU

Lead Instructor

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