



Concentration:

# **SUSTAINABLE ENERGY SYSTEMS**

*Mention :*

*SYSTÈMES & ENERGIE DURABLE*



**Rennes Campus**

A global approach for managing **consumption** and **production** in a system that optimizes the **quality of service** to users, **energy** and **environmental** and **economic** benefits.

# Sustainable Energy Systems



CentraleSupélec

- **Objectives:** This concentration trains students in the **system** dimension necessary for the **energy transition**. Considering the application of the major energy challenges (**sobriety, flexibility, autonomy**, etc.) in different fields such as **building, transport, industry, digital services**, etc., and the interactions between these fields and **human activities**, it provides a mastery of the concepts related to **dynamic systems** and the associated tools to ensure that the energy system has the properties of **adaptability, flexibility, stability** and **reliability** necessary for quality of service.
- **Teaching methods:** The concentration includes common Energy major activities such as presentations of the issues of the energy transition and is structured around seven challenges for the energy system.
  - each module introduces the technical and societal challenges of the energy and system dimensions,
  - each module includes industrial partners presentations, conferences, courses and labs allowing the mastery of the concepts that are introduced,
  - the project (industrial partnership or research) is carried out over the three terms (MT 9, CT 10 & CT 11) with an increase in hours during the year.
- **Employment sectors and companies:** Energy (EDF, Engie, Enercoop, Akuo...), Grid operators (RTE, Enedis, ...), Equipment and Services (Schneider Electric, GE, ABB, DeltaDore, Bouygues Energies et Services, ...), local authorities (SDE, métropoles, ...), Advisory
- **Double Degree Masters :** under discussions with Rennes University et ENS Rennes

# Energy Major Term (MT 9)

## Special features



Academics courses (260WLH)

### Environment and Energy challenges (40 WLH)

Economics growth, Energy indices, World wide view  
Conferences, Industrial partners and Site visits

### Decarbonization of Energy production [60 WLH] (challenge 1)

Classical energy production (nuclear, fossil), Renewable Energy (hydro, solar, wind,..), CO2 balance

### Transport phenomena [40 WLH]

Advanced fluid flow  
Advanced heat transfert

### Dynamical Electric Conversion [20 WLH]

Transient and dynamical modeling of synchronous generators and inverter. Park transform

### Buildings and net 0 area [100 WLH] (challenge 2)

Uses, comforts, acceptability,  
Consumption, generation, integration  
Model identification, high level control, predictive management

Project (20 WLH)

Industrial or Research Project



# Sustainable Energy Systems (CT 10)



## Energy Conferences (10 WLH)

Technical, economic and societal challenges of the energy sector

(Energy and finance, strategy of industrial energy groups, European energy policy, technological innovation, acceptability, corporate social responsibility, energy insecurity)

## Academics courses (210 WLH)

### Grids and massive integration of renewable energy [70 WLH] (challenge 3)

- Electrical system architecture, Grids quality of service, Modeling and control of grids, Renewable integration
- Physical system modeling, non-linear systems

### Energy security [60 WLH] (challenge 4)

- Safety of production sites (nuclear, thermal,...), Safety of networks and infrastructures, Cyber-security.
- Dysfunctional modeling, Reliability model, Risk analysis, Operational safety, Validation and verification

### Consumption flexibility [80 WLH] (challenge 5)

- Methodology for analyzing consumption in industry and services, adaptation to generation, flexibility, local market flexibility,
- Storage and operating constraints
- Learning for modelling and control, distributed command and consensus

## Project (60 WLH)

Industrial or Research Project



# Sustainable Energy Systems (CT 11)



## Energy Conferences (10 WLH)

Technical, economic and societal challenges of the energy sector  
(Energy and finance, strategy of industrial energy groups, European energy policy, technological innovation, acceptability, corporate social responsibility, energy insecurity)

## Academics courses (110 WLH)

### Decision making in an uncertain world [65 WLH] (challenge 6)

- Sizing of multi-energy systems, sizing and operating criteria
- Uncertainties and uncertainty modeling
- Project development process
- Optimization and multi-criteria decision making, optimization and uncertainties

### Energy and new mobility [45 WLH] (challenge 7)

- Energy and mobility, electric vehicles, smart-cities, interactions between networks and electric vehicles,
- Mobility management, hydrogen sector
- Modeling and simulation of large multi-agent systems

## Project (160 WLH)

Industrial or Research Project