

CentraleSupélec

Major ENERGY

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Track 2

ENERGY MANAGEMENT AND SMART GRIDS





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Semester 7
Semester 8
Projects
SES Concentration

2020/02

Rennes Campus

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Semester 7

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Engineering Challenge Term:
Smart Energy and Smart Buildings:

- Automatic Control
- System modeling
- High energetic efficiency wireless communications
- Challenge week

2 or 3 elective courses² with at least 1 among:

Model-based design of critical embedded systems
The objective of this course is to present the different processes of critical systems design. Based on the skills acquired in the system modeling course (ST5), the different activities will illustrate the use of formal methods and models in the different stages from specification to solution design and code generation.

Compositional Multi Physical modelling with Modelica
Technical systems are usually made by assembling components which behavioral models come from different technical fields that are mastered by different people raising difficulties in exchanging and building up models. This elective aims to learn two commonly used modeling tools to meet these needs: Modelica and bond graphs.


**Common Core
Cursus**

- Project¹
- Economics
- Humanities
- Engineering professional skills
- Languages

¹ the project will be included in the Smart and Secure Life domain see below

² at least 5 elective courses should be validated during semester 7 and 8

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Semester 8

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Engineering Challenge Term:
 Smart Grid and Energy Challenge:
 Energy management in non connected sites:

- Optimization
- Renewable energy and micro-grids

2 or 3 elective courses² with at least 1 among:

Micro-grids
 Microgrids are complex interconnections of components whose control is both a difficult and crucial problem for its proper operation. The course enables students to discover the overall modeling and operation of a microgrid with its electrical components (wind turbines, solar panels, etc.) and at the same time to learn how to operate a complex system.

Advance Control
 This course will provide students with basic knowledge of analysis and control of linear systems based on the state equation representation.


Common Core
Cursus

- Project¹
- Humanities
- Engineering professional skills
- Languages

¹ the project will be included in the Smart and Secure Life domain see below

² at least 5 elective courses should be validated during semester 7 and 8

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Projects

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Smart and Secure Life

"Since the democratization of the Internet, digital technology has emerged as one of the major challenges for the society. The proliferation of connected objects and interactions between systems opens up many perspectives in all scientific fields: **renewed energy management**, preservation of the environment, individualized health monitoring, etc. It requires designing and developing, among others, adapted communication systems, big data management systems, and **optimized decision-making algorithms**. Obviously, a big attention must also be paid to the security aspects.

These concerns are in the center of interests of the "Smart and Secure Life" pole in which digital sciences and technologies are at the service of society. It is a multidisciplinary center which draws on the skills of the four research teams on the Rennes campus. Projects can also emerge from student initiatives to respond to a concrete problem, with experienced supervision provided by the professors of the Rennes Campus, as it happened before. For instance, this past experience has resulted in the creation of "Immersive therapy", a start-up that exploits virtual and augmented reality in the medical domain."

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Major **ENERGY**
Dominante Energie


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Concentration:

SUSTAINABLE ENERGY SYSTEMS

Mention :


SYSTÈMES & ENERGIE DURABLE



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.

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Sustainable Energy Systems

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- **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

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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

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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

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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

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