# 1SC2492 – Modeling the energy consumption of a group of buildings

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**Department:** DOMINANTE - ENERGIE
**Language of instruction:** FRANCAIS
**Campus:** CAMPUS DE PARIS - SACLAY
**Workload (HEE):** 40
**On-site hours (HPE):** 27,00

**Description**

Design and develop software tools for the simulation of the energy consummation of an existing building complex. Determine the primary sources of energy consumption and device methods for reducing energy consumption.

**Quarter number**
ST2

**Prerequisites (in terms of CS courses)**
Be enrolled in and pursuing courses specific to ST2 « Transition énergétique ».

**Syllabus**
The work for this course will be done by teams of 7 students each (7 groups total). The students will receive a Google Earth image of a suburban district (18 buildings). 6 of the 7 groups must separately treat 3 buildings. The remaining group will be in charge of developping and testing a model for a photovoltaic system. The goal of the study is to transform the neighborhood into an « energy positive » area through a combined approach of renovation and the integration of a photovoltaic solar power system. For this, the students will construct a model for each building in the zone ; they must identify appropriate hypotheses used and develop a model based upon these. The groups are expected to discuss amongst one another to develop a unified strategy for making the zone « energy positive » (e.g. identification of most and least efficient buildings in the neighborhood, primary sources of energy consumption, …) They must then integrate this strategy into their models and use their simulations to argue for its use in making the neighborhood « energy positive ».

**Class components (lecture, labs, etc.)**
Project-based learning

**Grading**
Oral presentations with Powerpoint supports

**Course support, bibliography**

Presentation slides discussing the functionality and use of BuildSysPro, direct use of the open source code BuildSysPro (https://github.com/edf-enerbat/BuildSysPro) during courses specific to ST2 and during the week of the EI.

**Resources**
Team of professors: 2 engineers from EDF R&D, 1 professor from CentraleSupélec
Software tools and licenses: BuildSysPro (gratuit)

**Learning outcomes covered on the course**

- Realistic data analysis and interpretation
- Develop a coherent and practical model using the tools given
- Data analysis and presentation of results

**Description of the skills acquired at the end of the course**

- Study a problem in its entirety. Identify, formulate and analyze a problem with an eye towards both its scientific and human dimensions.
- Develop and utilize models tailored to the particular situation, identify the appropriate level of model complexity and simplifying hypotheses appropriate for the problem
- Solve a problem using a combination of modeling and simplified estimation for model verification

# ST2 – 25 – MODELING, SIMULATIONS AND EXPERIMENTS FOR THE DESIGN OF VEHICLES AND STRUCTURES

**Dominante :** CVT (Construction, City and Transportation)
**Langue d'enseignement :** English, except a couple of conferences by external experts that might be in French
**Campus où le cours est proposé :** Paris-Saclay

**Engineering problem**

When developing a new project, whether it concerns a building, an infrastructure, a car or an airplane, modeling plays a key role. Indeed, it is necessary to evaluate the relevance of the concept at all stages of a project, not just at the final stage for obvious cost reasons. Several levels of modeling are therefore required. In the pre-conception phase, very simple modeling tools (e.g. a spreadsheet) allow to specify the orders of magnitude and the main levers of improvement at a lower cost, often on the basis of empirical correlations. In a more advanced phase of evaluation of technological choices, experimental or numerical models are used. In both cases, modeling is required either to measure the relevant data experimentally or to define the physical model to be simulated numerically. At this stage, the engineers have at their disposal a wide range of solutions, from the reduced model to the real system, or from the simple and fast numerical simulation – but not very accurate – to the high-fidelity numerical simulation – accurate but costly in computing time.

In this thematic sequence, these different modeling aspects will be presented. The societal and economic context, as well as the diversity of modeling tools used by the engineer will be the subject of "Introductory Lectures". The "Specific Courses" will allow the implementation of experimental and numerical simulation approaches, with an emphasis on validation. Finally, based on relevant modeling choice, it will be shown in the context of the "Engineering Challenge Week" how to model the performance of a complex system to a first approximation, particularly in a hybridization approach.

**Recommended prerequisites**

S.I., programming notions in Matlab

**Introductory lectures:**

These lectures will allow, through contact with actors concerned by the pre-dimensioning aspects of complex systems and multiphysics modeling, to have an overview of the CVT theme from several angles, including economic and industrial constraints. In addition to these lectures, students will participate in bibliographic workshops, during which they will have to produce a group study on the topic of their choice within the CVT major.

**Specific course (40 HEE):** Modeling, simulations and experiments

At the end of the course, students will be able to

- follow a modeling approach via experimentation. By giving them a model adapted to the description of the studied phenomenon at the beginning, they will build an experimental approach making sure to answer the objective by controlling the uncertainty and to implement this experimental approach iteratively between the model and the acquired data.
- follow modeling approach via numerical simulation. We wish to make a numerical prediction of a given problem from a model. By giving them a model adapted to the description of the phenomenon, they will build a simulation approach making sure to answer the objective by controlling the uncertainty and implement this numerical approach.

This course is divided into 4 sub-sections: numerical simulation in fluid mechanics or in solid mechanics, and experiments in fluid mechanics or in solid mechanics. Students will have to choose two of the 4 courses at the beginning of the sequence.

**Engineering challenge week:** Performance and hybridization of a vehicle by functional modeling

- Associated partner: Renault

- Location: Paris-Saclay campus

For this Challenge Week, the objective is to position the students as the partner's design team. The partner will impose specifications for a hybrid car from Renault. The students will have to carry out a market study, define the product and carry out a pre-design. The pre-design will require the creation of a global model of the vehicle, including not only the aerodynamic aspects but also the motorization aspect. In addition, they will have to work as a team to meet the CO2 emission limits.