# PhD position: Flexibility of energy systems for sustainability: the case of large research instruments

## Context

Energy consumption related to human activities has significant ecological impacts: responsible for nearly three-quarters of greenhouse gas (GHG) emissions [1], it also plays a role in overcoming planetary boundaries [2]. Various levers have been identified to move towards sustainable energy systems: energy sufficiency, energy efficiency and the development of renewable energy (REn) to replace carbon-based sources [3]. Flexibility and synergy strategies between the different energy carriers contribute to the proper operation of energy systems, especially in the face of the intermittency of renewable energies.

It seems relevant to mobilize these levers and strategies on energy-intensive systems, in order to have a significant impact in an identified context. The European project FlexRICAN (Flexibility in Research Infrastructures for global CArbon Neutrality) takes note of these challenges in the particular case of major European research instruments. These unique infrastructures, which host researchers from all over the world to carry out fundamental research activities, are also very energy-intensive. The project has a twofold objective: to work on the sustainability of these major research instruments, and to develop actionable methods and practices to be disseminated for the sustainability of large energy consumers. Working on research infrastructures offers the unique opportunity to work on real case studies with high stakes, with an opening up of the entire energy modelling process: open data, open-source codes, open access publications and documented methods. The FlexRICAN project focuses in particular on the development of renewable energy consumed locally through the development of flexibility strategies in energy management, or the recovery of waste heat, i.e. the heat dissipated by electricity consumption and that is not the first aim of the process, in order to supply heating networks (Figure 1).

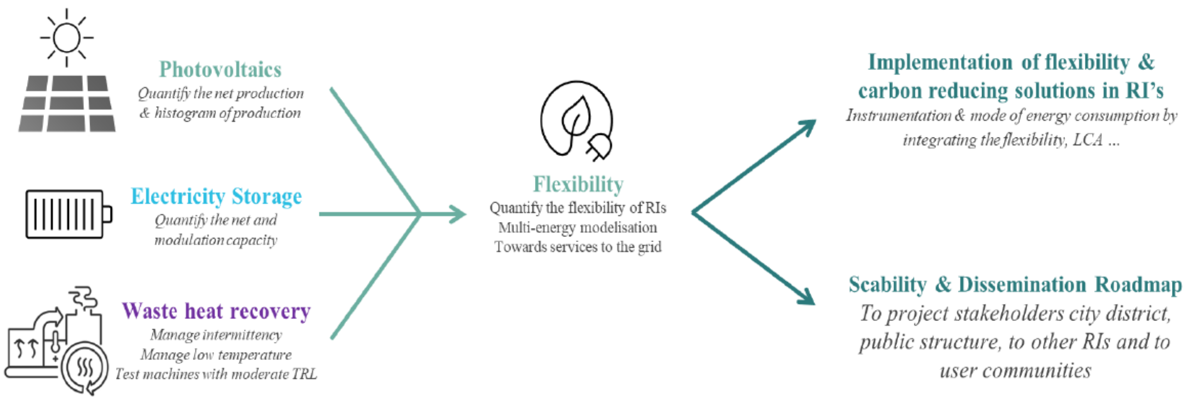


*Figure 1: FlexRICAN Project concept from intermittency to flexibility and services to networks*

It mobilizes 7 major research instruments and 2 industrial partners (Energy Pool as an electrical aggregator, and Alfa Laval for the design of thermal components).

FlexRICAN Project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement: 101131516

## Objective

The objective of the thesis is to develop actionable energy modelling methods and practices for the sustainability of large energy consumers.

## Method

The thesis work will be divided into different stages:

- State-of-the-art on the notion of energy flexibility. This notion needs to be clarified to make it fully understandable and actionable, in particular according to the point of view one adopts: engineer with a socio-technical vision of the energy system via energy flows and stakeholders, network manager with a vision of flexibility as a service for electrical stability, or user with a reflection on the impact of flexibility on the activities carried out. In this way, flexibility can be cross-referenced:
    - Direct (automated via technical systems) / Indirect (via signals to users) [4]
    - Implicit (internal optimization of energy management to save financial or ecological resources)/ Explicit: participation in market mechanisms for additional revenues and service to the grid
    - Invisible / Visible to infrastructure users.

  This work will be based both on literature and on interviews with project partners.

- Overview of energy-intensive players in the French and European electricity system.
- Open energy modelling method of flexibility, integrating the different visions identified in the first task. In particular, the objectives and constraints (environmental, energy, exenergy, social, economic, etc.) as well as the variables (electricity and heat consumption profiles or management of energy components such as storage and heat pumps) will have to be specified. Historic works have been carried out in Grenoble and will be a base on which to build the works. The development will be carried out using the OMEGAlpes energy optimization problem modeler, developed in Open-Source in the laboratory [5].
- Application to case studies of the FlexRICAN project, through the appropriation of local characteristics (inquiries, data collection) and modelling.
- Presentation of the results and dissemination of methods in an accessible and actionable way, in particular towards large research infrastructures, and more broadly, energy-intensive actors.

## Case Study

As mentioned above, the FlexRICAN project benefits from a set of real and open case studies on which the energy management work is based. These include the intense magnetic field laboratories located in Grenoble (France) and Nijmegen (Netherlands), the Extreme Light Infrastructure ERIC (ELI) in Prague (Czech Republic) which have a variable consumption of around 30 MW – 10 GWh/year; or the European Spallation Source ERIC (ESS) in Lund (Sweden) which has a fairly constant consumption of nearly 180 GWh/year.

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## Skills

- Knowledge of energy systems
- Interest in sustainability
- Good level of English
- Knowledge of optimization
- Development (Python)

## Thesis environment

- EEATS Doctoral School, Electrical Engineering Option
- Host laboratory: Grenoble Electrical Engineering Laboratory (G2Elab)
- Supervisors: Frédéric Wurtz, Sacha Hodencq (G2Elab)
- Collaborations
    - with the members of the European FlexRICAN project, and in particular the National Laboratory for Intense Magnetic Fields (LNCMI-Grenoble).
    - with other PhD students and researchers in the field, as part of the Ecological Transition Observatory (OTE) project.

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## Bibliography


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