PhD Position

Planning of distributed renewable energy systems with machine learning

Project description and objective

Many countries have made commitments to reduce greenhouse gas (GHG) emissions, and more than a hundred have pledged to achieve carbon neutrality by 2050 or 2060. Thus, national and European environmental policies aim to significantly reduce, or even abandon, the use of fossil fuels, increase the share of renewable energies, and increase the electrification of uses, as with the development of electric vehicles. In order to anticipate future changes in energy requirements or environmental regulations, it is vital that policy-makers or stakeholders need decision-support tools for medium and long-term planning of energy system evolution. These decisions are based on cost control, ability to meet expected increases in demand and energy reliability, while reducing GHG emissions.

One step in the development of these decision support tools is to scenario the future evolution of energy consumption and production on the scale under consideration, as well as the costs of electricity and energy production and storage equipment, so as to be able to decide on the changes to be made to the energy system over time.

The ORION project "*Novel Digital Components For International Renewable Energy Value Chains*" is funded by the European Union's Horizon Europe research and innovation action program. The project brings together 11 partners from 8 countries, representing an international consortium of R&D&I laboratories and companies. Within this consortium, the laboratories of Télécom Sud Paris and IMT Mines Albi aim to implement a methodological approach and associated numerical tools for the development of a decision-making tool to assist the evolution of local electricity networks integrating a growing share of renewable energies.

PhD objectives and methodological approach

The PhD student's main objective will be to develop algorithms for predicting and planning the evolution of local energy systems (microgrids) over a time horizon of several years, using machine learning and numerical optimization techniques. Particular attention will be paid to taking account of the random nature of certain variables in the design of predictive scenarios. For this reason, stochastic optimization techniques are expected to be combined with machine learning.

On the other hand, the ORION project will provide two use cases on which to apply the methodology developed. These use cases correspond to the isolated energy networks of seaports, with sustained fishing and tourism activities (cruise ships). The specificities of these applications will naturally have to be integrated into the proposed approaches. It will therefore be necessary to consider large-scale data classification and aggregation algorithms.

In practical terms, the main stages of the research work will consist of :

- the inventory of available data needed to implement the methodology,

- the setting up a distributed architecture for data processing, using federated learning methods that do not require data to be shared or transported.
- the analysis, classification, aggregation and modeling of time series, such as consumption and production profiles, in order to integrate them into the decision support tool,
- the development of a procedure for drawing up future production and consumption scenarios based on the data collected,
- the actual development of the digital tool for proposing the planning of the local energy system, according to the predictive scenarios. Modular modeling of the various infrastructures in the local energy system will be employed to provide a tool that can be generalized to a wide range of situations.

In addition to research activities related to the thesis objective, the PhD student will take part in ORION project progress meetings to present the results obtained. The PhD student will also have the task of communicating his/her results at events outside the project, such as international conferences. He/she will also be required to write scientific articles.

Candidate profile

The candidate should have a master's degree in data science or closely related to machine learning, or a general engineering background.
Advanced English language skills (reading, writing and speaking) are required, as all exchanges with the ORION consortium will be in English.
A strong motivation for scientific research is required. Essential skills, knowledge or experience are data analysis and processing, machine learning, and mastery of at least one programming language. A solid foundation in applied mathematics and physics would be appreciated.

Working conditions

The thesis will be supervised by two laboratories at Télécom Sud Paris and IMT Mines Albi. It is planned to spend periods of time in each laboratory during the thesis. The PhD student will be required to travel to European countries for ORION project progress and coordination meetings.
The contract will be a 3-year fixed-term contract at IMT Mines Albi.

Application process

Applications should be submitted by June 15, 2024. The desired start date is October 1st, 2024, with some flexibility.
Interested candidates should send their CV + cover letter + M2 grades and dissertation + letter of recommendation by June 15, 2024 to :

- Jean-Louis Dirion, IMT Mines Albi, dirion@mines-albi.fr
- Hossam Afifi, Télécom Sud Paris, hossam.afifi@telecom-sudparis.eu