PhD Position in Distributed Learning for Adaptive Control

of Local Batteries for Renewable Energy Integration in electrical networks

Keywords: Distributed computing, intermittent renewable energy integration, Supervised and unsupervised learning, power systems, adaptive prediction, local area balancing, optimal operation control, decentralized operation, multiagent system

Lab: L2EP, Laboratory of Electrical Engineering and Power electronics, located at Lille – France (https://l2ep.univ-lille.fr), power system group. The research project is managed by professors Bruno FRANCOIS and Ferréol BINOT.
Graduate school in Engineering and Systems Sciences (ENGSYS-632) – Centrale Lille Institute

Context:

Frequency control within micro grids was historically managed through power reserves that are provided by synchronous machines. The significant penetration of DERs, connected to networks by power electronics, tends to reduce the number of synchronous machines. Power reserves must therefore be partly provided by these DERs. But, their controllability is much more difficult because PV and wind generation are intermittent, and highly dependent on external conditions (wind, sun, etc.).

Scientific objective:

More adaptive controls are required to connect renewable, intermittent and uncertain power sources. Balancing of power systems in time scales of one day ahead to instantaneous time involves contextual information coming from predictions (load demand, PV production, …) and state measurements (grid voltages, currents, ….) that contain various types of uncertainties. The edge computing and the increase in computing power have enabled the development of learning techniques, which improve local control algorithms in on line operation. Distributed learning techniques offer the advantage of being able to control electrical networks more resiliently than current centralized techniques.
The aim is to investigate the design of a distributed grid control system with ANN that will improve the local real time balancing and not require complex physics based models of power systems. This research project is based on developed works by the research group “Power systems”. The considered use case will be a local energy community, which includes several types of each DER (batteries, PV, water heater, controllable electrical vehicle charger, a small synchronous generator) and tests will be performed onto the experimental demonstration EPMLAB of the L2EP lab.

Ideal profile:

- A MSc in Computing Science or Electrical Engineering with a focus on process control
- Knowledge in power systems, control engineering, artificial neural networks, distributed and parallel computing will be appreciated
- Strong analytical and programming skills, experience in at least one software platform: Python, MATLAB, Julia, GAMS and optimization solvers like CPLEX and Gurobi.
- Research experience/publications in project related areas
- The candidate must have the ability to work independently, good analytical, synthesis and innovation skills
- Good communication and writing skills in English
- Experiences in on board implementation of software as OPAL-RT, DSpace, Spherea, Typhoon, Arduino, Raspberry, … are added values

Benefits:

- Fully funded position with competitive stipends
- Mentorship of experts in the field and guiding by a current PhD on a neighborhood research topic
- Support for international conferences and research related travels
- Access to lab facilities, computational ressources and home industrial demonstrators for tests

Starting date: As soon as possible from now or delayed to maximum 1st December 2025, duration 36 months, full time position. Posdoc or Trachchair position can be considered after the PhD.

How to apply ?

The application must include in the first round:

- Curriculum vitae (CV).
- Cover letter
- Obtained grades obtained during your last 3 years of graduate studies and program of courses attended by students graduated from a university abroad. Official academic transcripts must be provided for each semester of each year. If you do not have a transcript (examples: internships, breaks,...), you must enclose a justification.
- Copy (pdf) of your personal works (internship reports, professional experience, academic projects, etc...)

And in the second round:

- Photocopy of diplomas. For students with foreign degrees, the translation must be certified by a consular officer.
- Letter, name and email address of two referees
- Copy of your passport or ID card
- Deadline: 16th May, 2025

Send your application to the following email address: bruno.francois@centralelille.fr

Local key bibliography:

[1] "Orthogonal Considerations in the Design of Neural Networks for Function Approximation", B. FRANCOIS, Mathematics and Computers in Simulation, Vol. 41, p.95-108, Elsevier, July 1996

[2] Artificial Neural Network for Real Time Load Flow Calculation : Application to a Micro Grid with Wind Generators, H. HADJ ABDALLAH, L. KRICHEN, B. FRANCOIS, Journal of Electrical Systems, 1-3, 2005, p. 1-14

[3] Optimisation de l'autoconsommation dans une communauté énergétique locale via une blockchain, PhD report, Matthieu Stephant, 21/05/2021, L2EP – JUNIA, École doctorale Sciences des métiers de l'ingénieur, HESAM

[4] A review of self-learning and adaptive techniques for grid balancing, Antonella Tannous, Ferréol Binot, Bruno Francois, Symposium de génie électrique (SGE 2023), Jul 2023, Lille, France.

[5] Artificial Neural Network-Based Fast Power Reserve Control for Active Power Balancing, A. Tannous, R. Razi, F. Binot, and B. Francois, Electrimacs 2024: 15th International Conference of TC-Electrimacs Committee, 2024.

[6] Fast Power Reserve Provision Shift from Conventional Sources to a Battery Energy Storage System: A Deep Learning – Based Control, Antonella Tannous, Ferréol Binot, Reza Razi, Bruno Francois, Sustainable Energy, Grids and Networks, Elsevier,accepted