Proposition of Master Internship

Title: smart microgrids supplied by distributed generation with renewable energy sources - Analysis of couplings between sizing and energy management process

Context:

The internship subject is part of the Hymazonie project in which the LAPLACE lab is responsible for developing smart micro-grid design methods that integrate distributed generation based on renewable energies, multiple storage devices controlled by energy management strategies. This microgrid allows contributing to grid services such as self-consumption, self-production, etc.

Subject:

The objective of the developed methods is to determine ratings of the devices to be installed (battery, solar panels, hydrogen storage, etc.) in order to assess their technical and economic relevance with regard to input requirements. For example, which systems should be installed to make an isolated village self-sufficient in energy, at a lower cost?

To answer such questions, optimization methods are used which make it possible to obtain the optimal sizing of the equipment according to the constraints (ensuring the supply of energy to the consumer, etc.) and the objectives (minimizing the total cost) of the studied case.

The optimal sizing of an installation (ex: microgrid) necessarily depends on the management strategy for controlling power flows within the system. Indeed, the total cost of the system does not only depend on investments but also on operational cost, itself determined by the way in which the power flows are managed in the micro-grid. Thus, the sizing and the management strategy must be "co-optimized" for obtaining the optimal sizing of the equipment. However, in order to limit the calculation times, the co-optimization problem is generally simplified and the management law used for sizing can be different from the management law which will be used in the end in real time.

The objective of the internship is therefore to study the link between the management strategy and the sizing of the systems. What is the impact of the simplification of this management law on sizing? Can we quantify it? What are the technical and economic consequences when using the real piloting law implemented in real time?

To try to answer these questions, the internship will take place as follows:

- Initially, the objective will be to develop the methodology on a simplified benchmark with solar production and electrochemical batteries. The student will use existing optimization tools developed by a doctoral student in the laboratory to carry out his work.
- Once the methodology has been proven, the student will implement it on a more complex system, comprising several energy vectors (electrical, thermal) and heterogeneous storage devices (batteries, thermal storage, hydrogen, etc.).

Depending on the results obtained, the work may be published in a scientific journal.

Skills:

To be attracted by applied mathematics and computer programming. Continuation in PHD thesis envisaged.

Responsible(s) : *Bruno Sareni, LAPLACE (sareni@laplace.univ-tlse.fr, +33 5 34 32 23 61)*
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Short biography below

Location of internship and conditions: ENSEEIHT (Toulouse Downtown) ; internship fees 600€ for 5-6 months. Funding for student Toul'Box (https://toulbox.univ-toulouse.fr/en/packages/student)

Xavier Roboam received the Ph.D. Degree of Université de Toulouse, France in 1991. He is full-time researcher (Directeur de Recherches CNRS) since 1992 and is the deputy director of the Laboratory of Plasma and Conversion of electrical Energy (LAPLACE) of Toulouse where he is recognized on design methodologies specifically oriented towards multi-fields devices for embedded (more electric aircraft) or renewable energy systems and smart microgrids. He has published more than 250 references (h-index=22 / Scopus).

Bruno Sareni received the Ph.D. Degree of from École Centrale de Lyon, Écully, France, in 1999. He is currently a Professor in Electrical Engineering and Control Systems with the National Polytechnic Institute of Toulouse (ENSEEIHT), Toulouse, France. He is also a Researcher with the Laboratory on Plasma and Conversion of Energy (LAPLACE), Université de Toulouse, Toulouse. His research interests include integrated design approaches for electrical embedded systems or renewable energy systems using evolutionary algorithms and multiobjective optimization. He has published more than 150 references (h-index=18 / Scopus).