1 INFORMATION GÉNÉRALES

Laboratory	FEMTO-ST
University	University of Technology of Belfort-Montbéliard (UTBM), Univ. Bourgogne Franche-Comte (UBFC)
Supervisor	Daniel DEPERNET, Associate Professor, FEMTO-ST, Energy Department, SHARPAC Team

2 TITLE

Optimal design and control of agrivoltaic systems based on a systemic approach

Keywords : systemic design; energy storage; hydrogen; electrolyser; optimal control

3 CONTEXT OF THE LABORATORY

FEMTO-ST (Franche-Comté Electronique Mécanique Thermique et Optique – Sciences et Technologies) is a joint research unit which is affiliated with the French National Center of Scientific Research (CNRS), the University of Franche-Comté (UFC), the National School of Mechanical Engineering and Microtechnology (ENSMM), and the University of Technology of Belfort-Montbéliard (UTBM).
FEMTO-ST is an Institute which consists of 7 departments active in different fields of engineering science: mechanics, optics and telecommunications, electronics, time-frequency, energetics and fluidics, energy and electrical engineering, and computer sciences.
The PhD student will realize his thesis at the UTBM site in Belfort in the ENERGY Department of FEMTO-ST Institute. This department has two teams whose research themes focus on energy conversion and storage systems, thermal, fluidics and system design.

4 SUBJECT OF THE THESIS

The increase in greenhouse gases and the resulting atmospheric warming cause extreme climatic phenomena which have harmful and sometimes devastating effects on agricultural production. This is why the need today to develop solutions that provide an effective response to the problem of climate change is important. Agrivoltaic systems make it possible to combine photovoltaic electricity production and agricultural production on the same surface while providing a crop protection solution. The process makes it possible to reconcile the preservation of agricultural land and the use of land areas for the development of renewable energies. Its main advantage is to avoid blocking off land areas to install only solar panels and it thus helps to preserve ecological environments. The coexistence of solar panels and crops implies a distribution of light between these two types of production, but also induces thermal and water interactions between them. The technique makes it possible to seek the best efficiency of solar panels, at the same time as an increase in agricultural production by seeking an intelligent balance between sunshine, watering, shade and protection against cold and bad weather.

The thesis work will consist in carrying out the multiphysical modeling of the agrivoltaic system, then proposing solutions for the optimal design of the system taking into account the multi-criteria objectives. Decentralized energy storage solutions combining hydrogen or electrochemical batteries will be studied while respecting the constraints of sustainable development and energy efficiency. Finally, strategies for controlling the various controllable parameters of the system will be proposed. They will be able to draw inspiration from techniques that come under artificial intelligence.

5 BACKGROUND REQUIRED FOR THE APPLICANT

Basic knowledge in power sources, photovoltaïc systems, fuel cells and electrolysers, electrochemical batteries, power converters and main control algorithms. Experience in the use of simulation and modeling softwares. Basics of optimization principle and artificial intelligence will also be appreciated.

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