ULHyS - LUE PhD thesis proposal - March 2018

Title	Dynamic management of an electricity storage device based on PEM water electrolysis in a microgrid
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Sci. Environment	*(other teams/labs involved, planned and considered partnerships ...)* Multidisciplinary environment: electrochemical systems modeling and electrical engineering (power electronics)
Doctoral school	EMMA
Description	This Ph.D. thesis will give the opportunity to a motivated student to build innovative dynamic management system applied to the storage of renewable variable electricity (e.g. produced by wind turbines or solar PV modules) by means of hydrogen production by electrolysis of water in a microgrid. This work will definitively contribute to the promotion of hydrogen-based system for electricity storage. Microgrids are featured by harsh dynamic solicitations caused by the variable loads of the renewable energy sources. Buffering the energy production ensures power quality and constant supply as well as managing the transient responses are the key points. Hydrogen energy storage is a good candidate for energy buffer unit. It is produced by proton exchange membrane (PEM) electrolysis of water, then compressed at 200 bars and stored in a tank. Power electronic devices constitute the energy management system. They allow managing the dynamic solicitations due to the variable energy load and optimizing the energy share that is needed by either the electrolyzer or the compressor, this latter depending on the hydrogen tank load. The Ph.D. work will meet the following objectives and undertake modeling and experimental work: i- Modeling of the dynamic behavior of an electrolyzer cell, taking into account electrochemistry and transport phenomena (heat, mass, and electric charges). Regarding the state-of-the-art, the innovative work here lies in deriving precise multi-physical models while being simple enough for use in a dynamic energy management system. Developed model has to be verified on a test rig. ii- Designing the energy management system. For resilience purposes, the energy management system of the microgrid will be distributed, which imposes significant constraints on real-time control of the different components of the microgrid. In particular, the energy management of the hydrogen storage system depends tightly on its dynamic, so its hybridization has to be considered to relax some constraints. iii- Optimizing the energy management strategy and control laws to improve the overall efficiency (ratio between stored and available energy) and to limit the degradation of the electrochemical components. Identification of parameters characterizing aging of the electrolyzer cell is an essential step to realize this task.
Keywords	Electrolyzer, hydrogen production, energy management system