Dynamic management of an electricity storage device based on PEM water electrolysis in a microgrid

Keywords

Micro-grid, Electrolyzer, Hydrogen, Power electronics, Energy management, Energy storage

Project description

This PhD 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.

Microgrid are featured by severe dynamic solicitations caused by the variable loads of the renewable energy sources: buffering the energy production that ensures correct power quality and constant supply as well as managing the transitory regimes are then key points Hydrogen is produced by PEM electrolysis of water which is well is well suited for dynamic operation, compressed at 200 bars and stored in a tank. Dedicated power electronics components, constituting the energy management system, allow managing the dynamic solicitations due to the variable energy load and optimizing the energy share that is needed by either by the electrolyzer nor the compressor, this last depending on the hydrogen tank load.

The PhD work will meet these three 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 literature review, the innovative work here lies in deriving precise multi-physical models while being simple enough for use in a dynamic energy management system.

ii- Designing the power electronics of the energy management system and comparing modeling to experiments on a test rig. 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 device (electrolyzer and tank) 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 and increase the life span of the electrolyzer, this last by identification of parameters characterizing aging.

Profile and skills required

The candidate will join two research teams one specialized in electrical engineering and the other specialized in mechanical engineering applied to electrochemical systems. The two labs are located in the same place. The candidate will be dynamic and will have skills in modeling and experimental methods. He/she will have solid knowledge in electrical engineering but knowledge in electrochemical systems applied to electrical systems will be appreciated.

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