SMART-V (Smart Villages project)

Contribution to the control and diagnosis of a hybrid electric power generation system based on renewable energies and recycled constituents for the supply of an isolated village: pico-hydro generation, MPPT and use of smartphones

The installation of renewable energy production systems is an interesting solution for the electrification of villages not connected to the grid. The recent development of applications using small hydroelectric power stations associated with a photovoltaic generator allows the exploitation of natural energy sources, with relatively easy production and transformation. This study will ultimately concern a central pico of a few tens or hundreds W, which will be hybridized by a photovoltaic generator with dc storage. The whole system is expected to supply a remote village (lighting, refrigerators, TV and radio).

The solution of the rich countries consists in using new components and dedicated to this use, manufactured for these functions ("solar" batteries, dedicated static converters, synchronous generators with magnets, asynchronous generator with double supply as in wind turbines…). But it is possible to go further. Thus, we are studying the possibility of re-using discarded components (in whole or in part) to make the same solutions for generating energy from renewable sources and to reduce their global footprint. The list of equipment includes in particular lead-acid car batteries, homemade pico hydro turbines, cf Fig 1 and 2. and discarded inverters. Moreover, our project is based on the existence of smartphones in families living in isolated rural villages, which will be used to supervise the design, configuration and control of energy production units.

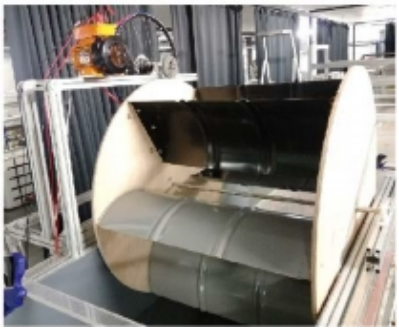

Fig 1 : hydraulic wheel made with metal can

Fig 2 : belt transmission with cycle wheel

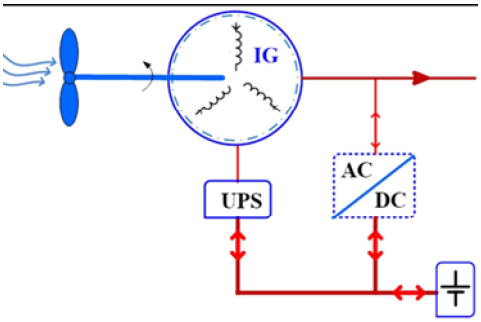

Fig 3 : discarded inverters and IG

This internship will include 2 parts.

The first part will deal with the simulation (Psim, Matlab-Simulink) of the whole system in two configurations: with direct supply of the end users by the AC generator (a 3 phase AC motor turned into a single phase AC generator), see Fig 3 or through an intermediate DC link. Existing simulation elements will be combined and optimized to obtain the most accurate simulation results, which will be verified through experimental tests.

The second part aims to implement the best of the simulated solutions on the shaft of the home-made turbine. Measurements of speeds, voltages, currents, powers, ripple on the output voltage, global efficiencies are on the menu. An MPPT (Maximum Power Point Tracking) control, will be implemented in an Arduino microcontroller. From an existing program, an Android smartphone will be used for communication with the Arduino microcontroller, in order to transmit a set point, retrieve live measurements and make adjustments.

Required skills: in AC and DC machines, power electronics (inverters and choppers), control, tests and experiments in these fields. Arduino programming will be appreciated.

Bonus for the student

- The internship will be paid, 600€/ month above 2 months
- The Toul'Box full pack, the resource specially designed for students and doctoral students, as well as lecturers and researchers, to help get settled in Toulouse and the surrounding region, will be provided for free, see https://toulbox.univ-toulouse.fr/en/packages/student
- The French language summer school will be provided for free, see https://www.inp-toulouse.fr/en/international/summer-schools/fle.html

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Pascal MAUSSION, PhD, MIEEE'06, SIEEE'17, got his PhD in Electrical Engineering in 1990 from Université de Toulouse, Institut National Polytechnique (INP), France. He is currently full Professor at Université de Toulouse and researcher with CNRS research Laboratory: LAPLACE, LAboratory for PLAsma and Conversion of Energy in CODIASE (Control and Diagnostic of Electrical Systems) group. His research activities deal with the design of experiments as an optimisation and modelling tool in control and diagnosis, the diagnosis of electrical systems such as drives and lighting, the control of power converters for induction heating or energy efficiency improvement in renewable energy systems, life cycle assessment in renewable energy systems. He is currently Toulouse INP Vice President for the International Affairs.