GROUPE DE RECHERCHE SUR LES ENERGIES RENOUVELABLES (GRER)
RESEARCH GROUP ON RENEWABLE ENERGY

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Brief presentation

The research group on renewable energy has its principal activities on tropical regions: heat transfer in building, particularly on natural convection, wind and solar resource, and energy conversion and storage.
Briefly let us recall that the geographical position of the Guadeloupe and Guyana in tropical and subtropical zone (Fig. 1). Guadeloupe is already equipped with several systems of production of electricity connected to the network: photovoltaic, wind farms, hydroelectric, geothermic. On the contrary, Guyana has more isolated sites off-line to the network.

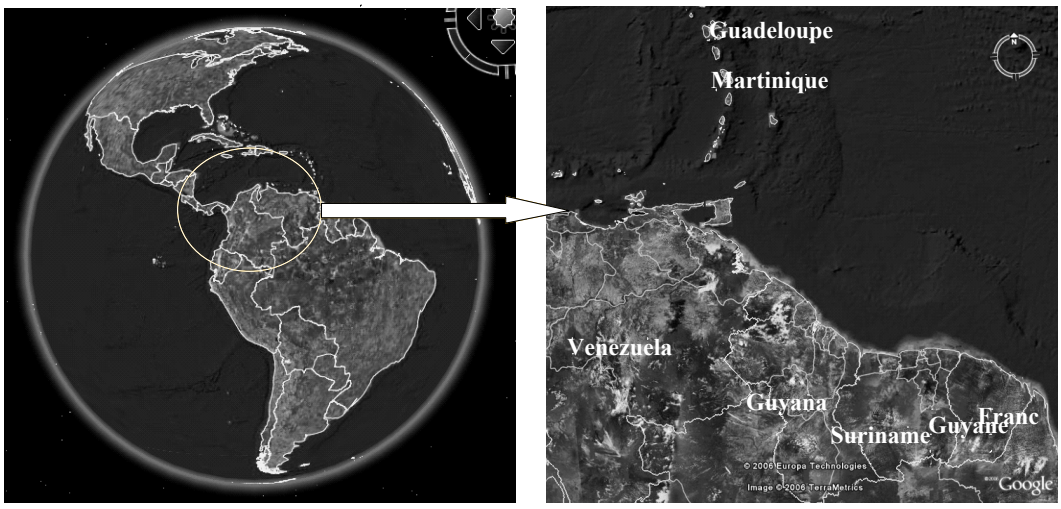

Fig. 1. *Guyana and Guadeloupe location*

Statistical analysis of wind and solar power

Moreover, located in tropical or subtropical zone these areas have a strong sunning (5 kW·h/m^2) and gain advantage of the Trade Wind during all every day. These sites are particularly well adapted to produce energy from the renewable sources. These areas are thus a natural laboratory with regard to use renewable energies. The GRER is thus working on the control and the decentralized production of electricity and on the heat transfer in the habitat in tropical climate.

In Guadeloupe are studied the statistical approach of the wind and the solar resource (Fig. 2) and the natural convection in bioclimatic approach of building.
In Guadeloupe, the electric output from wind farms can currently reach 5 % of the power consumption by the network. The 10 % should be exceeded in the next years. From its fluctuating nature, the power produced by the wind farm, which cannot be for the moment stored, poses an obvious problem of management of the electrical production. The fluctuations on the short scales of time (a few seconds to 1 hour) however pose drastic problems of

management of the network (choice and started means of substitution) as the amplitude of these fluctuations can reach the total potential power of the site.

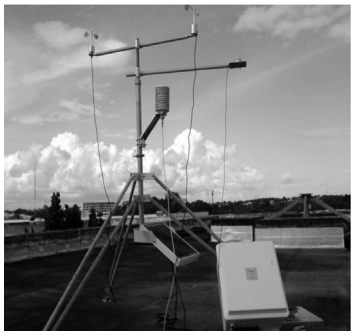

Fig. 2. *Wind velocity and solar radiation measurement apparatus*

It appears necessary to provide the following tools: i) a more exact qualification of the real energy contribution of a wind farm and its dynamics, to test its impact on the network, ii) the forecast, in real-time and on the short scales of time (<1 hour), of the delivered power.
To do that, the aerodynamic measurements and electric output measurements (step: one second) are carried out on the existing production sites in Guadeloupe (Fig. 3).

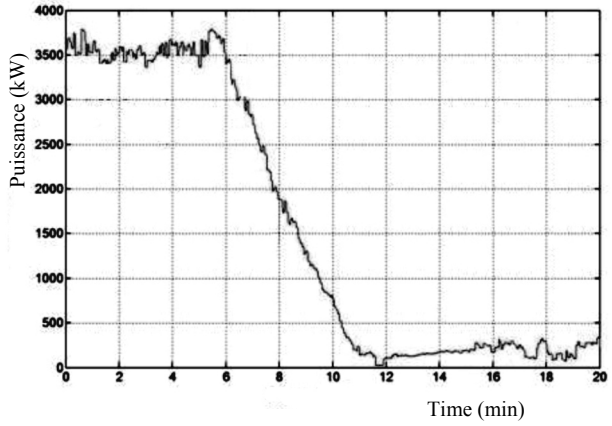

Fig. 3. *Farm power drop following the wind fluctuations*

PV and hydraulic program in French Guyana

Guyana has several sites isolated with centralized or individual photo voltaic installations, dimensioned for villages. The study of the malfunctions of a photo voltaic power station has been done using a method of classification adapted to the measured data. The need for better controlling storage has appeared, particularly because of the variability of a source like solar energy and on the other hand for knowing the statistical and dynamic characteristics solar radiation on the site, but also the dynamic behavior of the accumulators. A dynamic model has been proposed to describe in the most precise possible way the state of load of an accumulator. An experimental device has been set up in the laboratory to follow the dynamic behavior of accumulators in load and in discharge, subjected to constraints. A PhD thesis in joint management with the LEM of Montpelier concerns the validation of the model.
In Guyana, the isolated villages are generally located along the rivers. The weather data highlight a strong seasonal variation of pluviometry complementary to the variations of the sunning (with however a shift: maximum of sunning in October, whereas the low water level is in November). A machine of the hydrokinetic type ("hydrolienne"), using the kinetic energy of the current with a minimum of work of civil engineering, will be an interesting solution to produce electricity for the isolated village. An alternator has been elaborated to compensate the variability of the mechanical renewable energy sources (hydraulics, wind).

Solar protection of building

The solar protection of the building is necessary to reduce the energy consumption. This research topic gave place for three principal subjects of study: i) a study of the not established modes of natural convection in a channel inclined in the field of gravity (thermal boarding in roof), ii) experimental comparative study in condition of real sunning of various types of solid insulators (including reflective thin insulators) for the solar protection of the roofs, iii) thermal response of roof depending of the solar absorptivity (Fig. 4).

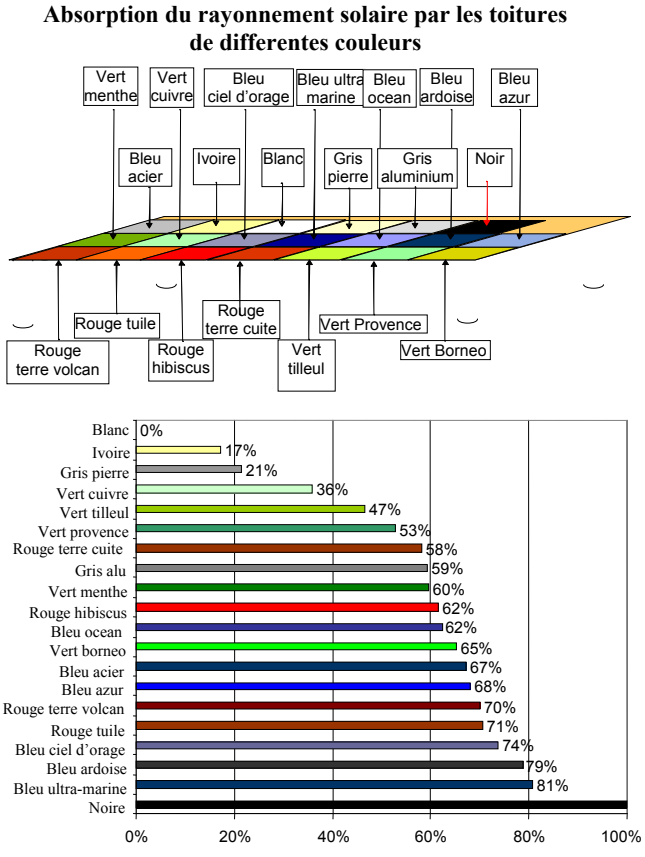

Fig. 4. *Experiment on solar absorption in steel sheet and percentage of temperature increase with the color*

The natural convection air flow resulting from the heating with a constant heat flow of the upper wall of a channel (two-dimensional), opened at each end and inclined in the field of the gravity has been experimented. The lower wall is thermally insulated. This study is directly related to the solar protection of the habitat (roofs and walls) in tropical medium to prevent air conditioning. We thus undertook to make a detailed cartography of the speed and temperature fields of the flow and of the parietal temperatures for a range of number of Grashof corresponding to not established flows. Three goals are pursued: i) to specify the sensitivity of the flow to its boundary conditions and in particular at the entrance of the channel, ii) to specify the conditions of similarity of the flow, iii) to provide the data bases necessary to the comparisons with the numerical studies of this type of open flow. With a laser anemometer device, the non inclusive measurement in the air flow was done simultaneously with the measurement of the temperature profile of the heated wall. The results were analyzed according to the numbers without dimension defining the experimental device: Grashof, Prandlt numbers, depending of the lengthening and slope of the channel. The Fig. 5 shows the experimental device with the laser equipment and a visualization of a reverse air flow which has never been published in the literature before.

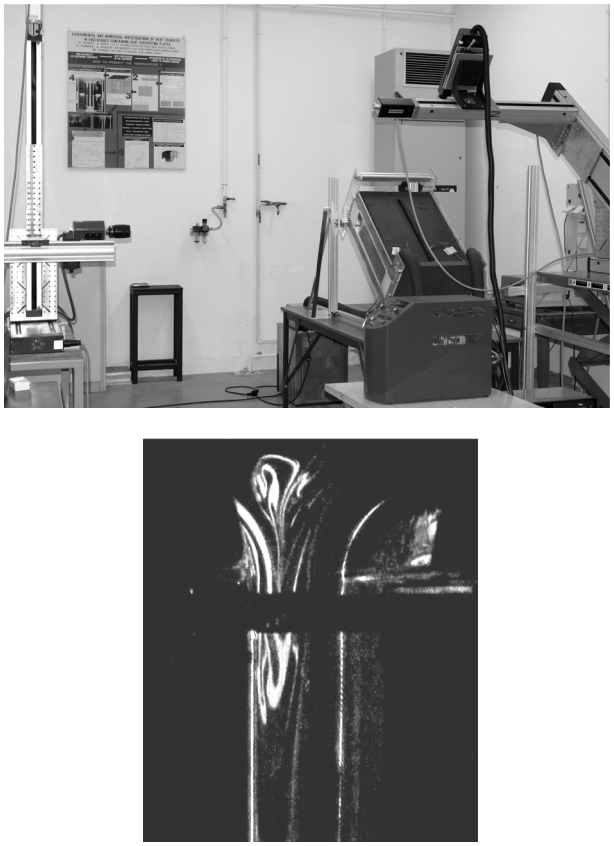

Fig. 5. *Experimental device to generate natural convection flow in an air channel with the laser equipment, reverse flow visualization*

Solar dryer working day and night

In regions where solar energy is abundant, the solar dryer is an adequate solution for the food conservation. However the lack of sun during the night stop the drying process and could be responsible of the degradation of the product. To prevent this damage, a solar dryer has been completed with a solar hot water storage which is used during the night. A patent has been filed in which a solar open cycle air dryer was included at the entrance of the process air flow using a solid desiccant to decrease air moisture. When the air temperature is controlled, the drying process is more reproducible. An experimental device have been experimented in Guadeloupe (FWI) and in French Guyana (Fig. 6). To improve the prototype components size, a dynamic numerical simulation have been done in the electrical analogy scheme. Electrical tools, PSPICE / MATLAB and the thermal transient code TRNSYS have been used. The numerical results has been compared with the experimental data when the air temperature and (or) the air flow was controlled. A good agreement have been obtained.

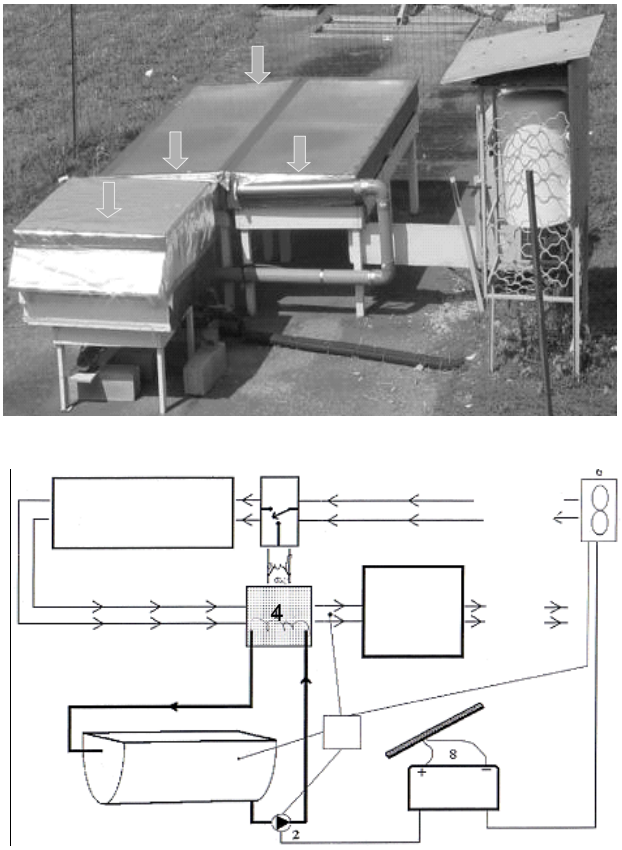

Fig. 6. *Solar dryer with a water tank for night working, view and synoptic diagram*

Joint program on sustainable development monitoring assisted by remote sensing

The GRER is involved in an ambitious project with the French IRD (Institut de Recherche et de Développement) concerning sustainable development in the Amazonian region. It makes use of remote sensing technology, and geographical information cartography. The GRER contributors have an experience in modelling, signal or image processing. This program includes the cartography and physical analysis of renewable energy resources (sun, wind, water, biomass) and the following-up of the environmental impact of biofuels (Fig. 7).

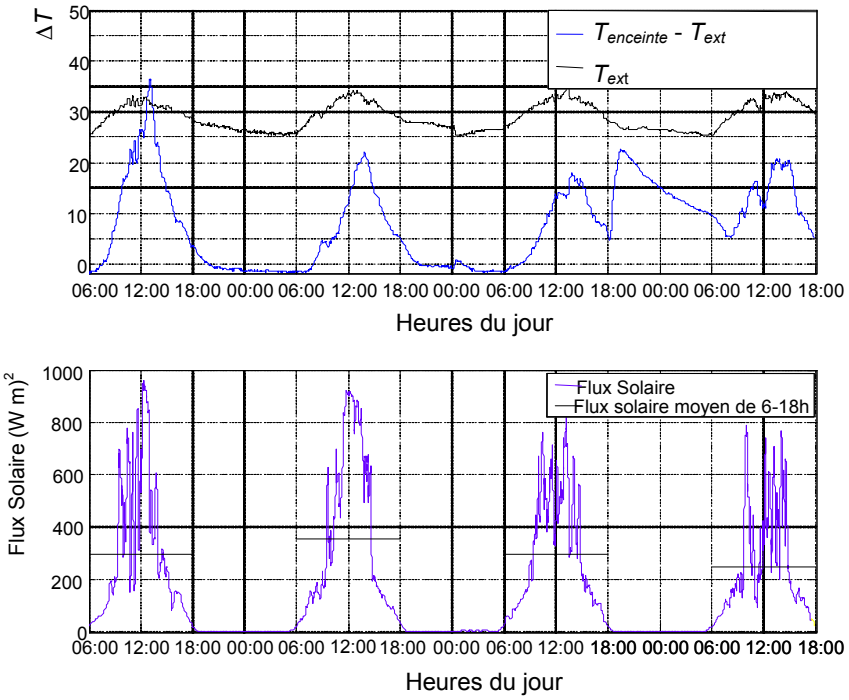

Fig. 7. *Four days drying chamber temperature difference with ambient temperature, opening the hot water tank on the 3-d night*