UTC at the heart of interdisciplinary projects

What fuels could become substitutes for petrol in our car reservoirs? Is it possible to build a zero-energy-balance house? Several UTC laboratories have been studying these vital issues for the 21st Century, in interdisciplinary projects that associate UTC scientists with external teams. Interactions looked at the SISAF and Geo-EcoHome projects and this was what we found:

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Faced with rarified petroleum products, development of bio-fuels is attracting more and more industrial outlets. Also, given that first generation bio-fuels, from crops such as colza, sunflowers, etc., compete with the same crops used for food purposes, research has been reoriented over the past few years on possible 2nd generation biofuels. These are derived from biomass that is not useful in food compositions, such as agricultural and forestry wastes. The only drawback is that such wastes are more difficult to 'degrade' into fuel components, viz., lingo-cellulose calls for more complex, more energy hungry treatment that straight crop processing.

SISAF: studies on ionic liquids

SISAF (acronym for Simultaneous Saccharification and Fermentation of cellulose) focuses on production of 2nd generation bioethanol with conditions that respect the environment. "Today, if you want to transform lingo-cellulose biomass into bio-ethanol, you go through 3 stages: pre-treatment of the cellulose, hydrolysis to obtain fermentable sugars followed by fermentation of the sugars into ethanol", specifies Isabelle Gosselin, senior lecturer and research scientist with the Enzyme and cellular Engineering units (GEC), located at the Picardie Region University Jules Verne (UPJV-Amiens) who is the project coordinator. The 3 stages mentioned above are conducted at high temperatures and pressures and involve very acidic molecules to degrade and transform the biomass. "What we are seeking to produce is bioethanol in the 'softest' conditions", explains Isabelle. "Ionic liquids are liquid salts at room temperature and have been used for a decade or so by the chemical industry sector and more recently in biology. We are currently studying the interactions between these liquids and enzymes and yeasts involved in ethanol production".

Five academic partners in the Picardie Region

Five academic partners are investigating the subject matter: alongside UPJV, together with GEC who are studying laboratory scaled processes (100 ml), the electron-beam microscope facility has been called in to observe at each stage the evolution of the biomass ingredients when mixed with ionic liquids and an analytic platform to study the component mix dosing using chromatography and nuclear magnetic resonance (NMR). With UTC, we find the laboratory dedicated to Integrated transformation of Renewable Matter (UTC-TIMR) that bring the scale up to 1 liter (1 000 ml) and the Applied Maths Laboratory (UTC-LMAC) whose task it is to model cell and enzyme behavior. SISAF is an academic 3 year research project financially supported by the Picardie region authorities and by the REC FEDER fund. "We have collaborated with UTC-LMAC in the past, but not so far with UTC TIMR. The partnership is moving forward very smoothly, given that our tools and know-how are complementary and we have already registered some interesting results in respect to use of ionic liquids. These solvents open up large prospects for industrial applications", assures Isabelle Gosselin. Following an 18 month research phase, SISAF chose two ionic liquids that allow the operators to work at lower temperatures and pre-treatment pressures (300° to 40°C and from 50 bar to normal atmospheric pressure (1 bar), and with neutral pH. The next target is to bring the three stages together into a single process!

How do you build a zero energy house?

Geo-EcoHome, (acronym in French for 'Management, Optimization and Energy Conversion for 'Eco energy' homes' is a3 year project that began in October 3011. The objective is to build (adapt) a normal home, with 2 adults and 2 children, using production and storage of renewable energies (Ren) – small scale wind turbines, solar arrays and a lithium-iron- phosphate battery. The project is financially supported by the Picardie Region authorities and the EC-FEDER fund; coordination is assured by Jérome Bosche, a research scientist with the UPJV-MIS Lab (Models, Information and Systems). The other laboratories associated with the project are UPJV-LRCS (Reactivity and Solid State Chemistry), UTC-AVENUES-GSU (Analysis of Environmental and Urban Vulnerabilities) and UTC-LEC (electromechanical engineering lab.). The partnership is based on three physical test facilities: the LEC SIRTEX for battery modelling, the photovoltaic equipment at UTC-GSU and the platform specialized in renewable energy sources (UTC-MIS). "The platforms will be used not only to validate and corroborate

our research work but will also serve as show-cases for the public at large", explains Jérôme Bosche.

Energy management algorithms

Eleven research scientists and one PhD student are engaged in this project, the main production of which, for the moment, being definitions of algorithms used to optimize and manage various energy sources possible. The first algorithms relate to forecasting protocols – you have to be able to anticipate on weather conditions in order to store a maximum energy should a long, unfavorable climate period set in – and the second set of algorithms relate to energy management protocols: which energy sources should be brought on line to feed houses and when? Lastly, a third group relates to control algorithms that lead to optimized use of equipment such as voltage converters and life expectancies of facilities. "More recent algorithms under development could be used to manage power requirements and supply to villages in Morocco. They are self-adapting as a function of consumption patterns and local weather databases", underscores Jérôme Bosche. The challenge facing the scientists is to correctly measure and scale the renewable energy sources: the aim is to find the best compromise cost/feasibility not only for solar arrays but also for small-scale wind power turbines. The test house is equipped with a heat pump and a 1 280 W battery, plus an electricity generator for extreme conditions and a depleted battery. "The house consumption data is based on a typical energy consumption profile for the Region. We guarantee energy supply (except for heating purposes) even if heating needs will be 60% met. Integrating the home heating parameter would have required an oversized ensemble for only a few yearly power peaks and it would have been complex in an interdisciplinary sense: power control electronics, chemistry, modelling, control, energy, etc. This is the first time that these 4 fully complementary laboratories are collaborating on a joint project. For the time being, we have kept to the provisional work programme. What we hope is that the experiments run on the test platform will validate our research results". Thanks to the project, the laboratories have learned to collaborate efficiently, stresses Jérôme Bosche, adding "We shall hopefully be able to continue to launch and develop new projects together!