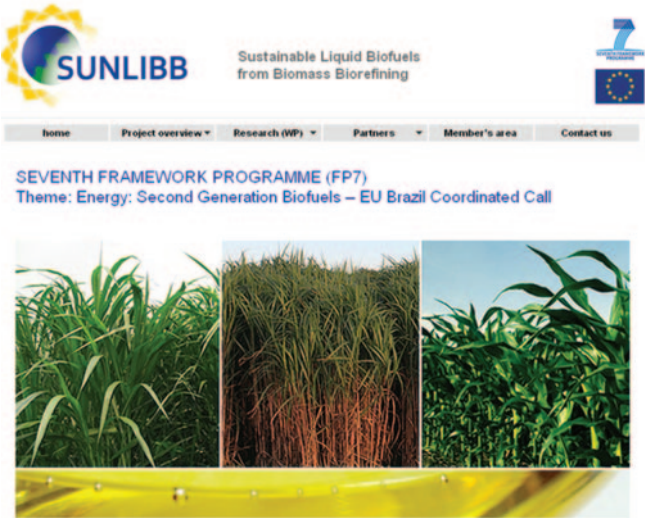
Developing sustainable biofuels

The SUNLIBB Project explains the benefits of focusing on sustainable biofuels in helping reduce greenhouse gas emissions

SUNLIBB is the acronym for an FP7 Research, Training and Development programme that began in 2010 and is working closely with colleagues from the CeProBIO programme in Brazil to help underpin the development of sustainable liquid biofuel production from agricultural residues. The European research is sponsored by the EC, whilst research in Brazil is funded by CNPq, an office of the Brazilian federal government.

Developing sustainable biofuels is critical in helping Mankind to reduce emissions of CO_2 and other greenhouse gases that are causing increased global warming – and thereby destabilising global weather systems. First generation bioethanol is produced from sugar and starch and expanding the use of these feedstocks raises concerns for food security and sustainability. The environmental sustainability of biofuels produced from the non-food residues of crops (straw and husks, for example) is more attractive. These woody (or lignocellulosic) residues are mostly made of polysaccharides (sugar polymers) that can be depolymerised into sugars for fermentation to make bioethanol. In almost all crops, there is more sugar potentially available in the woody stems than in the grains we eat, but it is hard to digest and hence not eaten.

Using this lignocellulosic material improves the carbon emission savings arising from the use of biofuels, as well as reducing concerns over food security and land-use impacts. Lignocellulosic residues from tropical Brazilian crops such as sugar cane and temperate EU crops such as maize, as well as dedicated biomass crops such as miscanthus, are all potential bioethanol feedstock. Processing the biomass from these three crops raises common technical challenges because they are closely related plants, and there is potential for breakthroughs in one species to be rapidly exploited in the others.



The SUNLIBB and CeProBIO co-operation is working on the development of sustainable biofuels from lignocellulosic residues from sugar cane, miscanthus and maize. Image is the front page of our website (www.sunlibb.eu)

Despite the clear environmental benefits of moving to lignocellulosic bioethanol production, the current inefficiency of production makes it economically uncompetitive. The aim of the work is to combine European and Brazilian research strengths to open the way for cost-competitive lignocellulosic bioethanol production, whilst ensuring that this also brings the anticipated environmental benefits. The project integrates Brazilian expertise in sugar cane breeding and bioethanol process engineering with EU expertise in genomics, plant science and green chemistry.

The joint programme of work includes the elements outlined below:

- Improving the feedstock quality of lignocellulose in biofuel crops to make them easier to digest. This involves using modern crop breeding approaches, in combination with cutting-edge plant cell wall research, to introduce improved digestibility traits to elite crop varieties. This will help to reduce the high costs associated with biomass conversion. Our work builds from modern genomic science, which is revealing the genetic basis of how woody materials are made by plants, and what makes them hard to digest. This will allow us to breed plants with better quality polysaccharide content and improved digestibility for easier conversion to biofuels;
- To make biofuel production more cost-effective, we are exploring how we can create value from other parts of the plant biomass. This involves extracting and upgrading other parts of the plant materials such as waxes, oils and lignin (a polyphenol). A number of our partners use natural raw materials in their products and are interested in the potential of some of these co-products;
- Working to improve the conversion process by which we produce sugars for fermentation from woody materials. We achieve this by integrating the improved feedstock emerging from the breeding work, as well as by developing new combinations of pre-treatments (some derived from added value product extractions) with new enzymes for biochemical conversion of lignocellulosic material being produced in leading science programmes in Europe and Brazil;

- Developing processes that capture maximum value from lignocellulosic biomass, by integrating a range of product streams in addition to bioethanol. This aspect of the work brings together developments from the different parts of the project and looks at how best to integrate these with one another. To do this we make use of pilot biorefinery facilities at the Brazilian Bioethanol Science and Technology Laboratory (www.bioetanol.org.br) in Brazil, the Processum Biorefinery in Sweden (www.processum.se) and the Biorenewables Development Centre in the UK (www.biorenewables.org);
- Making sure that the new processes developed fulfil sustainability requirements by reducing carbon emissions, cutting other forms of air pollution, having minimal impacts on local environments and biodiversity, building sustainable rural industries, and not affecting food production and prices.

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The opportunities presented by such research have never been greater. The pressing need for truly sustainable biofuel production makes it imperative that world-leading expertise from across the globe is focused in a co-operative manner to make this a reality. The SUNLIBB programme in co-operation with CeProBIO, our sister project in Brazil, will bring about the critical mass, appropriate range of expertise, and vision to ensure that it pioneers in this field. In order to realise these ambitious aims we have assembled a multidisciplinary team of scientists working on different aspects of second-generation biofuel production including:

- Plant biologists, biochemists, cell biologists, and crop geneticists with a focus on biomass quality improvement;
- Process chemists developing methods for the extraction of value-added products such as waxes, secondary metabolites, and oligosaccharides from biomass;
- Process engineers who are expert in the integration of bioprocesses in the production of biofuels;
- Environmental scientists able to develop the tools to assess the impacts of biorefineries in environmental, economic and societal terms; and
- Industrial participants who will provide biomass crop breeding, lignocellulose conversion, and process chemistry expertise, as well as the marketing of value-added products.

The SUNLIBB-CeProBIO co-operation has succeeded in closely aligning European and Brazilian work in developing technologies for sustainable lignocellulosic bioethanol production. As well fostering close transatlantic collaboration between groups with complementary skills to deliver the joint aims of the programme, the project has also produced value in the form of joint scientific publications, and the production of policy documents for Europe and Brazil. Of particular note, our co-operation has led to new jointly funded projects. For example, a Bilateral BBSRC-FAPESP project entitled 'Targeted analysis of microbial lignocellulolytic secretomes – a new approach to enzyme discovery', identifying enzymes for biomass processing, has been awarded to SUNLIBB and CeProBIO partners in Sao Paolo and York.

Finally, the SUNLIBB-CeProBIO partners are planning for the future with aims to further broaden the international scope of their research. This is being achieved through an International Workshop in Bioenergy and Industrial Biotechnology being held on 9-11 December 2013 in Buenos Aires, Argentina. This meeting will bring together experts in this area from Europe, Brazil, Argentina and Chile to establish an international working group to foster wider integration, co-operation and dissemination of work in this area to help reduce fragmentation in what is a global research priority for the coming decades.

List of the SUNLIBB partner institutions and companies

- University of York, CNAP, UK;
- University of York, Green Chemistry, UK;
- Biocaldol Ltd, UK;
- Borregaard, Norway;
- Biogemma, France;
- Ecover, Belgium;
- INRA, France;
- North Energy Associates Ltd, UK;
- Processum, Sweden;
- University of Cambridge, UK;
- University of Leeds, UK;
- University of Sheffield, UK;
- VIB, Belgium; and
- Wageningen University, The Netherlands.

The SUNLIBB (EC grant agreement, 251132) programme is co-ordinated by Professor Simon McQueen-Mason of the Centre for Novel Agricultural Products (CNAP) in the University of York, UK, and the CeProBIO project is co-ordinated by Professor Igor Polikarpov at the University of Sao Paulo in Brazil. For further information please contact Simon McQueen-Mason (simon.mcqueenmason@york.ac.uk).

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