

Science Community Focus

BEACON – From Plants to Products – a Biorefining Centre of Excellence in Wales

Led by Aberystwyth University's Institute of Biological, Environmental and Rural Science (IBERS), in collaboration with its partners at Bangor and Swansea Universities, the BEACON initiative integrates expertise and facilities to assist companies in developing new products and processes or to upgrade existing processes, using low carbon technologies including biomass where possible. Backed with £8 million from the European Regional Development Fund (ERDF), BEACON aims to establish Wales as a Biorefining Centre of Excellence and make a vital contribution to mitigating climate change and growing the Welsh bioeconomy.

Increasing awareness of the environmental impact and resource limitation of producing chemicals, materials, transport fuels and energy from fossil fuels such as natural gas, coal and oil is driving a reappraisal of how best to manufacture these products. Plant biomass is the world's largest biorenewable resource that can be converted (biorefined) into innovative, sustainable transport fuels, fibre, chemical and pharmaceutical commodities to help grow the Welsh bioeconomy. BEACON researchers partner with companies operating in a range of sectors, providing access to expertise and pilot scale biorefining facilities, bringing sustainable innovations closer to domestic and international market deployment. As such, public-private partnerships with BEACON have the potential to support economic growth and job creation, while revolutionising the traditional manufacturing base.

Partnering with BEACON offers a company access to the broad range of expertise available at the three Welsh Universities along with some unique Welsh processing facilities. In addition to developing new products and processes, engagement with BEACON can result in the creation of preliminary data or assessment of 'proof of concept' ideas and technologies that can attract investment or support further funding to help drive innovation.

What is biorefining?

Biorefining takes organic material e.g. plants and uses a series of mechanical, biological and chemical processes to convert the biomass into a broad range of commercially important products including pharmaceuticals, transport fuels, energy sources and chemicals.

The benefits of biorefining

- Replacing some of the industrial chemicals produced from oil with similar molecules from plants that could supply potentially lucrative markets within easy reach of Welsh producers.
- Turning crops like rye grass, miscanthus and oats into valuable fuels and chemicals would cut back on greenhouse gases and increase fuel and chemical security whilst adding value to the Welsh economy.
- Chemicals derived from plants have uses in a range of sectors, including transport, food, health, hygiene and the environment.
- Producing new materials such as bio-composites and bio-plastics. As well as creating and safeguarding jobs in West Wales and the Valleys, the pioneering work will help develop science in Wales.

Key areas of focus for BEACON include:

- Bio-based and bio-degradable packaging materials for the packaging and retail industries.
- Low carbon materials for use by the transport and construction industries that are lighter in weight and have improved insulation properties.
- Platform chemicals (e.g. lactate and succinate) that are building blocks used by the chemical industry for the production of biopolymers for industrial materials.
- Separation technologies to provide products for the pharmaceutical, cosmetic and chemical industries.

- Development of solutions for end-of-life products (e.g. polyethylene) to meet the needs of the chemical industry and society in general.
- Pyrolysis to create biochar and activated carbon for filtration and bioremediation.
- The integration of gasification and biotechnology as a source of chemical building blocks and fuels.
- Microbial development for improved production of chemicals and pharmaceuticals.
- Industrial symbiosis, the holistic treatment of products and processes to minimise waste and maximise value.
- Process optimisation and sustainability including greenhouse gas inventories through life cycle assessment coupled to technoeconomic analysis of processes.

The Aim of BEACON

The main aim of BEACON is to use the concept of biorefining to work with end user companies, in order to identify a wide range of products from plant material which are tailored to their requirements.

The biorefinery concept uses non-food crop feedstocks in much the same way that oil refineries use crude oil to produce a broad spectrum of commodity products. It seeks to give manufacturing companies a commercial advantage in the marketing of these renewable products as well in the future environmental and economic sustainability of their businesses through application of these developing technologies.

BEACON offers businesses with interests in the biorefining sector access to the research, expertise and knowledge base of universities in Wales.

BEACON helps:

- Companies in the construction, packaging and manufacturing industries by developing new biocomposite materials
- The bioscience industry – for example, developing new microbial or enzyme systems and technologies for the processing of biomass
- The chemical industry by providing new sources of 'green' chemicals
- Rural communities by
 - a) applying biorefinery technology to the processing of non-food crops
 - b) offering alternative markets for existing biomass
 - c) creating skilled jobs

Examples of the work BEACON partners can undertake:

- Formulation of new biocomposites
- Extrusion / bioplastics
- Novel chemistries / applications
- Metabolic engineering of yeasts
- Protein modelling such as new enzymes for e.g. food industry or bioprocessing



BEACON has a number of core strategic activities. These are:

- Understanding how to efficiently process wet biomass using mechanical and physicochemical technologies
- Conversion of lignocellulose biomass into biofuels
- Conversion of wet biomass into platform chemicals and fine chemicals
- Developing and enhancing enzymes and microbial systems for the production of products such as fine chemicals and transport fuels
- Isolating commercially important molecules using membrane technologies and supercritical fluids
- Production of bioplastics from biomass
- Production of biobased packaging from biomass
- Developing 'End of Life' methodologies associated with pyrolysis and the production of biochar and bio-oil
- Evaluation of processing routes from biomass to products and developing the associated economic modelling

The impact of BEACON has been recognised internationally, winning the prestigious European Commission's (EC) top award for innovative regional development at the RegioStars Awards 2014 under the category: 'Sustainable Growth'.



"BEACON have added value to our company through the use of pilot-scale equipment which is not currently available at any other organization we know about."

Robert Nash – Director, Phytoquest

"BEACON has provided considerable support to Pennotec, including providing network support for the future development of the business and a compelling Technology Strategy Board grant application."

Jonathan Hughes – Director, Pennotec

Life Cycle Assessment (LCA)

Developing sustainable, low-carbon, bio-based products and technologies is a key aim of the BEACON Biorefining Centre of Excellence. A central component of this is our environmental impact assessment work, which runs in tandem with the physical research undertaken through the project.

Life Cycle Assessment (LCA) allows us to assess which processes and materials offer the most sustainable solutions to the research questions we address. It allows us to identify environmental 'hotspots' within a production chain, optimise design, and can form the basis of public declarations, such as eco-labels and Environmental Product Declarations (EPDs). As a result, LCA is increasingly seen as an important aspect of corporate product R&D programmes, eco-design and environmental bench-marking.

At BEACON, our LCA expertise includes access to the most academically respected LCA databases as well as market-leading LCA modelling software. Nearly all our pre-treatment and pilot scale processing equipment has hard-wired energy monitoring equipment fitted, allowing for detailed process energy usage analysis and process optimisation work.

The facilities BEACON can offer to its commercial partners include:

1. BEACON Biorefining Pilot Plant and Analytical Support Facilities at Aberystwyth University



Working with a wide range of plant biomass, BEACON scientists are currently investigating the value of sugars extracted from seaweed

The BEACON pilot scale facility at Aberystwyth University is a multi-feedstock 'plug and play' processing plant. It comprises key processing equipment and expertise to enable

academic and industrial partners to develop and translate laboratory research into new products and processes at an industrially relevant scale. The facility includes a primary feedstock processing area, a secondary (downstream) processing laboratory and a separate bio-char pilot rig. All are sited close to the main IBERS research laboratories and feedstock breeding facilities and includes the National Plant Phenomics Centre. IBERS research laboratories host an extensive range of analytical equipment to support BEACON activities and are available to commercial partners



BEACON Technical staff with the 350 litre pilot scale fermenter based at Aberystwyth University

2. The BioComposites Centre and School of Chemistry at Bangor University



Gas Chromatography and Mass Spectrometry (GCMS) being used to identify trace organic molecules at Bangor University's School of Chemistry (Credit Glyn Davies)

The BioComposites Centre at Bangor University undertakes collaborative research projects to develop sustainable, bio-based technologies and products that will minimise the impact on the environment. The BioComposites Centre collaborates with companies across a wide range of industry sectors including forestry and agriculture; construction and packaging; cosmetics and functional foods; polymers and coatings. It works with large multinationals, SMEs, micro companies and research institutes in the fields of materials science, green chemistry, bio-refining and sustainability assessment. A range of key equipment and associated expertise enables academic and industrial partners to develop and demonstrate scale-up processes, taking laboratory research through to industrial applications.

Bangor University's School of Chemistry houses all the analytical equipment and expertise needed for R&D work. Its extensive research facilities are available to BEACON's commercial partners.



BEACON is working with industry to develop plant biomass applications for sustainable building materials.

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BEACON provides microbiological routes to products from plant biomass and alternatives to oil-based processes (see above and below image)



3. Microbiology facilities at Swansea University

The BEACON capability at Swansea University is centred on the microbiology facilities in the Institute of Life Science (ILS), the research arm of the Swansea University Medical School. Completed in 2007, with support from the Welsh Government and the European Union, the ILS laboratories house state-of-the-art facilities and equipment. The highly trained personnel have a history of industrial biotechnology experience going back 30 years, with a wealth of experience of working with a range of industries including leading international pharmaceutical, agrochemical, chemical and food industries as well as local SMEs.

Business Development

Within BEACON you may work with experts from Aberystwyth, Bangor, or Swansea Universities or a combination of all three depending on the nature of the activity.

Initial contact should be made via our Business Development Managers who will assess what skills and facilities are suited and which institute(s) best meet your requirements:

Selwyn Owen, North and Mid Wales

Selwyn's interest in the last five years has been in the waste management, renewable energy and biorefinery markets. In his previous role, he assisted companies to identify waste-to-energy and water treatment technologies in the commercialisation stage. His current research interests include strategic partnerships and developing new green business models.

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Dr Mike Morris, South and Mid Wales

Mike is a multidisciplinary scientist and expert analytical chemist with supplementary industrial experience ranging from medical sciences, agrochemicals, pharmaceuticals, gas sensor technology, biodiversity, soil science and multivariate modelling to the biorefining of high sugar ryegrasses to fuel ethanol and higher value platform chemicals.

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