



A boost for biochar

Biochar Science and Technology Chief Engineer **Edward Soméus** discusses the developments made in this field as part of a large-scale EU project, and outlines the positive impact biochar could have on agriculture throughout Europe

Could you recap the objectives of the REFERTIL project, and any key developments since we last spoke in 2013?

REFERTIL is a scientific development and combined industrial engineering project with the purpose of developing zero-emission technologies to efficiently transform agri- and food industrial organic by-products into high quality, nutrient-rich compost and biochar products for farmers. The aim is to improve food and environmental safety and enhance the overall sustainability of food crop production, including saving costs and generating new bio-economy.

This project has successfully converted applied science into validated and market-competitive technology in the fields of concentrated phosphorus recovery, carbon refinery and biochar products. A next-generation, zero-emission, industrial-scale biochar technology has been developed for safe, economical and ecological phosphorus nutrient recovery. Furthermore, EU Fertiliser Regulation revision policy support has been completed for biochar and compost cases, and specific SME farmer-oriented application strategies developed. Finally, a member of the REFERTIL consortium has become the first laboratory in Europe to successfully obtain accredited status for comprehensive quality and safety analyses of biochar samples.

Can you outline the differences between animal bone biochar (ABC) and plant-based biochar (PBC)?

ABC is a highly macroporous calcium phosphate mineral and carbon complex, with a formulation optimised for significant enhancement of soil microbiological life. ABC is specifically formulated for the controlled release phosphorus solubility that plants need. It has high water holding and macromolecular organic nutrient retention capacity. ABC is clearly identified for cost-efficient applications in safe food production, controlled release

organic phosphorus fertilisers with 30 per cent P_2O_5 content, soil improver and growing media. The pure and natural ABC composition makes food production safer and less costly compared to organic farming.

PBC is a micro- and mesoporous carboniferous soil improver product for long-term effects, with relatively high water holding, nutrient retention and carbon sequestration capacity, but almost no economically valuable soil fertilisation effects. The short-term economic, business and market structure of PBC is highly application-specific. Applications for this biochar must therefore be carefully designed and most importantly take into account SME end-users and location-specific conditions.

Now that REFERTIL has entered its final phase, has the consortium reached any important conclusions?

Over the past three decades, several different types of industrial pyrolysis system have been designed and built in Europe for a wide range of 'all-in-one' general applications. These units are mostly based on traditional or modified incineration/gasification technology concepts, sometimes with exotic solutions. Many of these modified industrial pyrolysis units have failed or been found to have low efficiency in terms of technical, environmental and/or economical performance. Therefore, REFERTIL's main conclusion is that there is no 'one-size-fits-all' solution. Instead, specific technology and carbon processes need to be considered for particular feed materials. This is critically important in this case, because any biochar that is put into soil must have high and proven quality, and official permit documentation both for the production technology and the product itself.

As such, an improved and product-specific pyrolysis industrial design that makes use of next-generation, zero-emission reductive thermal treatment processing has been successfully developed, industrially engineered,

completed, qualified, demonstrated and validated for high-grade and safe biochar production and applications, on both industrial and European scales.

A key aim of REFERTIL is to inform and support EC policy. What progress has been made in this endeavour?

REFERTIL has been working to set up a framework of standard quality requirements for biochar products in order to guarantee high-level protection for human health and the environment. Extensive and advanced scientific efforts have also been put into developing supporting policy reports that unite all applicable biochar science and technology knowledge generated since 1983 and during REFERTIL execution. Finally, the team has compiled factual economic, market, end user and legal information relating to several biochar technologies, processing conditions and products.

What further successes do you hope to achieve in the final year of the programme?

At the end of 2014, a REFERTIL biochar survey was launched in seven languages aimed at end-user SME farmers and other stakeholders. The results will be used for evaluation of consumer and market acceptance and awareness of biochar materials. A practical SME farmer information package will also be set up in order to share good practice guidance for biochar application.

In 2015, we will complete and qualify our validation of the improved REFERTIL technologies and biochar products. We are continuing biochar application field trials throughout Europe and the final results are expected by September. REFERTIL will also organise an international biochar conference on June 23, 2015, that will be held in Brussels, Belgium.

Carbon bio-refinery: the answer to food and environmental security?

The **REFERTIL** consortium has now entered the final phase of its project, which aims to streamline the transformation of organic by-products into agriculturally useful compost and biochar products at an economical, industrial scale

FARMING IS ESSENTIAL to European prosperity and competitiveness, with approximately 40 per cent of land in the EU currently used for agriculture. However, extensive human activity linked with a growing population and rising industrialisation has disrupted the natural nitrogen and phosphorus cycles on which agriculture relies. As such, modern farming increasingly depends upon the heavy use of chemosynthetic fertilisers, which are non-renewable and energy-intensive. To make matters worse, these substances negatively impact the environment through the emission of greenhouse gases and unwanted contamination with toxic elements, such as cadmium and uranium. Moreover, modern-day industrial agriculture produces large amounts of organic waste and by-product streams that are costly to dispose of and can pose a risk to both human and environmental health.

If the human population is to achieve food and environmental security and sustainability in the forthcoming years, the linear food system must become circular and more sustainable. New ways must be found to reduce the need for mineral fertilisers and agrichemicals, while also recycling the organic by-products generated. Increasingly, attention has fallen on the possibilities presented by compost and biochar products in fulfilling these aims.

A EUROPE-WIDE APPROACH

It is for this reason that 12 partners from eight different EU countries founded the REFERTIL consortium and project, which is coordinated by Swedish biochar engineer Edward Soméus. Now entering the final phase of its four-year duration, REFERTIL aims to develop existing composting treatments, biochar scientific investigations, production and processing techniques and economical applications, with a particular focus on bringing about advances that can be directly translated into SME farmer and end user benefits. The ultimate objective is to support the development and implementation of effective, standardised, zero-emission by-products treatment and nutrient recovery processes, capable of producing

high-quality biochar and compost products that contain recycled, pure and natural phosphorus.

To achieve its goals, REFERTIL is simultaneously working to convert science into engineered industrial practice; develop and optimise composting/biochar production technologies and processes at an economical, industrial scale; and improve product performances and safety, while also supporting EC policy and law harmonisation activity in this area. To date, the group has made significant progress in all areas.

STEPPING STONES

In terms of science and technology development, comprehensive investigation of biochar use – accounting for efficiency, actual benefit and risk evaluation – has been conducted by the REFERTIL team. Importantly, improvements have been made to the economical industrial scale pyrolysis technology – central to their vision of biochar production – through the significant scale-up of the ‘3R zero-emission carbon refinery’ pyrolysis technology that Soméus has been developing since the 1980s. Moreover, horticultural field trials for the validation of these improved technologies and products began last year at sites in the Netherlands, Italy, Slovenia, Ireland, Denmark, Germany and Hungary – thus representing a variety of climates and soil types.

Already, the findings have demonstrated that the nutrients present in certain types of biochar products can be taken up by food crop plants, meaning that organic by-products can be efficiently recycled to replace or at least reduce mineral phosphorus fertilisers in crop production. It has also been proven that mycorrhizae, nutrient solubilising bacteria and other fungi are ideal combination partners for the application of REFERTIL’s specific high-quality biochar products in agriculture and horticulture due to their ability to mobilise phosphorus.

PHOSPHORUS RECOVERY AND BEYOND

Initial data also suggest that the application

of high-quality animal bone biochar (ABC), made from food grade animal bones, shows significant promise as a soil improver, organic phosphorus fertiliser and mixer within growing media. “ABC is safer, better, less costly and more environmentally friendly than any competing chemosynthetic agri-products, when all costs are included,” enthuses Soméus. “Overall, it is a viable and market competitive organic fertiliser product that can provide an alternative solution for low input and organic farmers in the horticultural sector throughout Europe aiming to reduce the use of mineral fertilisers and chemicals.” The project’s research on plant-based biochar (PBC), however, is still ongoing. Field tests have shown that this variety has fewer short-term direct effects on yields, and varies more significantly according to soil type.

Considerable headway has also been made in supporting biochar policy development. Notably, REFERTIL prepared comprehensive biochar policy support documents for the EC that compiled the vast amount of knowledge gained both throughout the



3R pyrolysis plant

DATE FOR YOUR DIARY

The REFERTIL consortium will be presenting its findings at several upcoming workshops and events, including:

REFERTIL INTERNATIONAL CONFERENCE

23 June 2015
Brussels, Belgium

http://bit.ly/REFERTIL_2015

REFERTIL

IMPROVEMENT OF COMPREHENSIVE BIOWASTE TRANSFORMATION AND NUTRIENT RECOVERY TREATMENT PROCESS FOR PRODUCTION OF COMBINED NATURAL PRODUCTS

OBJECTIVE

To reduce the need for mineral fertilisers and chemicals in agriculture by added value treated, safe and economical biochar and compost products.

PARTNERS

Terra Humana Clean Technology Development, Engineering and Manufacturing Ltd, Hungary • Stichting Dienst Landbouwkundig Onderzoek, Netherlands • Aarhus University, Denmark • Knowledge Center for Agriculture, Denmark • University of Torino – Agroinnova, Italy • Gottfried Wilhelm Leibniz University, Germany • BIOMASA del GUADA LQUIVIR, Spain • WESSLING Hungary Kft, Hungary • KOTO, Slovenia • Comune di Grugliasco, Italy • Renetech Bioresources Ltd, Ireland • Profikomp Environmental Technology Plc, Hungary

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CONTACT

Edward Soméus

Project Coordinator, Biochar Science
and Technology Chief Engineer

Terra Humana Ltd
H-8154 Polgardi
Gyula Manor
Hungary

T +36 20 201 7557

E biochar@3ragrocarbon.com

Skype: edwardsomeus

www.refertil.info

www.refertil.info/refertil-survey-questionnaire

www.refertil.info/community

www.agrocarbon.com

[www.twitter.com/edwardsomeus](https://twitter.com/edwardsomeus)

www.facebook.com/refertil

www.linkedin.com/in/3ragrocarbon



EDWARD SOMÉUS is a Swedish environmental and biochar engineer with core competence in organic waste added value recycling and valorisation

by zero emission pyrolysis technology, carbon refinery and reuse applications. He graduated with an MSc in Natural and Environmental Sciences from the University of Lund, Sweden, in 1978.

project's implementation and in the decades of scientific research that preceded it. REFERTIL has also put forward recommended biochar quality and safety criteria; suggested appropriate biochar labelling; and hosted a wide range of policy support meetings and public consultations. Indeed, consultation with a wide range of SME farmers, users and stakeholders is a key part of the REFERTIL strategy, particularly as the project now enters its final phase. The consortium partners have established a web portal targeted specifically at SME farmer end users that is available in eight common European languages, and are in the process of gathering data from these farmers via an online survey.

INTO ACTION

Over the course of 2015 and after the project's end in September, the final steps will be made towards completing the industrial biochar replication model, getting industrial permits from relevant authorities and meeting Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulations. In 2016, REFERTIL will have paved the way for the establishment of the first industrial replication system proven in an operational environment for market-competitive manufacturing of ABC at a rate of 10,000 tonnes of biochar per year. Additionally, the group will increase its focus on commercialisation and preparing the market for the introduction of these products over the upcoming months.

The REFERTIL scientific research team is adamant that it will continue its important work, even after the current project draws to a close. The most credible demonstration of this will be through a biochar manufacturing, knowledge and training center. EU-organised work on 3R 'Recycle-Reduce-Reuse' pyrolysis technology and ABC biochar product development has been ongoing since 2002, and Soméus and his collaborators have no plans to stop at this crucial stage. "We are preparing proposals to qualify for EU co-finance to implement industrial demonstration of the REFERTIL follow-up project in 2016," he reveals. Strong industrial and ABC premium product marketing cooperations with key players in the fertiliser industry are in preparation. "This will be a demonstration of how to convert science into industrial practice, not to mention efficient use of EU co-finance to create new, knowledge-based bioeconomy – as well as environmental and social improvements."



ABC greenhouse trials in Torino, Italy

REFERTIL WORK PACKAGES

1. Identification, sampling and quantification of the main urban organic waste and agriculture organic residue flows and logistic systems in participating countries
2. Development of a detailed pyrolysis technology and biochar product matrix database ranking available biochar producing technologies and a biochar policy supporting report
3. Development of a detailed composting technology and compost product matrix database ranking the available compost production technologies and a compost policy supporting report
4. Development of a microbiological strategy for fungi, bacteria and mycorrhizal fungi for compost activator and compost nutrient enrichment application
5. Improvement of the biochar production and treatment process towards high-quality standardised 'end-of-waste' quality biochar production and zero-emission performance
6. Composting process optimisation and product improvement for nutrient retention and emission minimisation
7. Best available technology demonstrations and trials for improved and sustainable compost and biochar production
8. Validation of improved technologies and recycled products against end-of-waste criteria in field crop trials under different conditions
9. Establishment of a framework for common quality standard requirements and new application methods for biowaste treatments and compost/biochar products
10. Extensive EU-wide dissemination and end-user (specifically SME farmers) involvement, including networking and field demonstrations

