NNFCC

Newsletter

Issue 11 - Summer 2008

# Renewable Polymers and Renewable Carbon

## Welcome to the National Non-Food Crops Centre's 11th Newsletter

The total market share for renewable polymers is currently around 1% and the sector continues to grow. The speed of the industry's development has been surprising. Renewable polyethylene can now be made from sugarcane, and it is indistinguishable from petrochemical polyethylene – at the time of the last renewable polymers newsletter in 2006, entirely renewable polyethylene seemed a remote prospect. Durables such as polyethylene will form an increasing proportion of the renewable polymers market. Consumers are becoming more aware of the issues surrounding plastics and sustainability. This year has also seen a great deal of media interest in plastics, particularly their disposal.

Polyethylene can now be made from sugar cane

Renewable polymers don't just have the advantage of a good environmental message: Renewable polymers work. Petrochemical polymers were developed with functionality in mind and renewable polymers can now fulfil many of the roles of conventional polymers – if renewables don't perform consumers will not be interested. The cost of crude oil and the pace of technical development have meant renewable feedstocks have become more and more favourable from an economic perspective. But renewable polymers also have two major advantages over petrochemical-derived polymers:

- Renewable carbon content
- Range of end of life options.

In this edition we introduce the concept of renewable carbon content. It is the renewable carbon in renewable polymers that provides a means to manage carbon in a sustainable manner. The amount of carbon in a product that comes from a renewable source, as opposed to a finite petrochemical source, can be measured. Inside, you can follow a carbon atom from the atmosphere, through a plant and into a renewable material, and learn how this renewable carbon can be quantified.

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## Building Sustainable Supply Chains: from crops to cashflow

The National Non-Food Crops Centre

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## Standard Tests for Determining Biobased Content

The methods for determining the biobased content of materials with radiocarbon and isotope ratio mass spectrometry analysis are described in ASTM D6866. It is likely that, if a European standard is developed, it will follow this protocol.

## Renewable Carbon Labelling?

Advertising renewable carbon content can be useful, particularly where a renewable polymer is indistinguishable from a conventional polymer. Renewable polyethylene, for example, can only be distinguished from conventional polyethylene by tests like those mentioned above. However, measuring renewable carbon content does not address the full environmental impact of a product. A label will not mean much on its own and it is important that it does not become inappropriately seized upon as a marketing tool. This test should be combined with other tools such as Life Cycle Assessment (LCA) to ensure the net environmental impact of renewable polymers is as low as possible.

## Life Cycle Assessment of Renewable Polymers

LCA is an important tool for demonstrating the positive environmental effects of renewable polymers compared to conventional polymers. Currently when comparisons are made between renewable polymers and conventional polymers, a novel, relatively small scale product is being compared to a mature commodity, which can be an unfair comparison. It is important for LCAs to consider possible future optimisation of renewable polymers, or LCAs could inadvertently stifle the renewables industry. See Newsletter 9 for more information on LCA.

## Food and Materials

It is possible that the sector will suffer the same accusations that have dogged the biofuel industry. Some (but not all) renewable polymers are made from raw materials that could also be used for food or feed e.g. maize. However, renewable polymers consume an extremely small percentage of the global harvest and currently have no effect on food prices, a situation that is unlikely to change. The demand for materials is small, so even if the industry expands considerably it will have little effect on the price of food.

## Waste

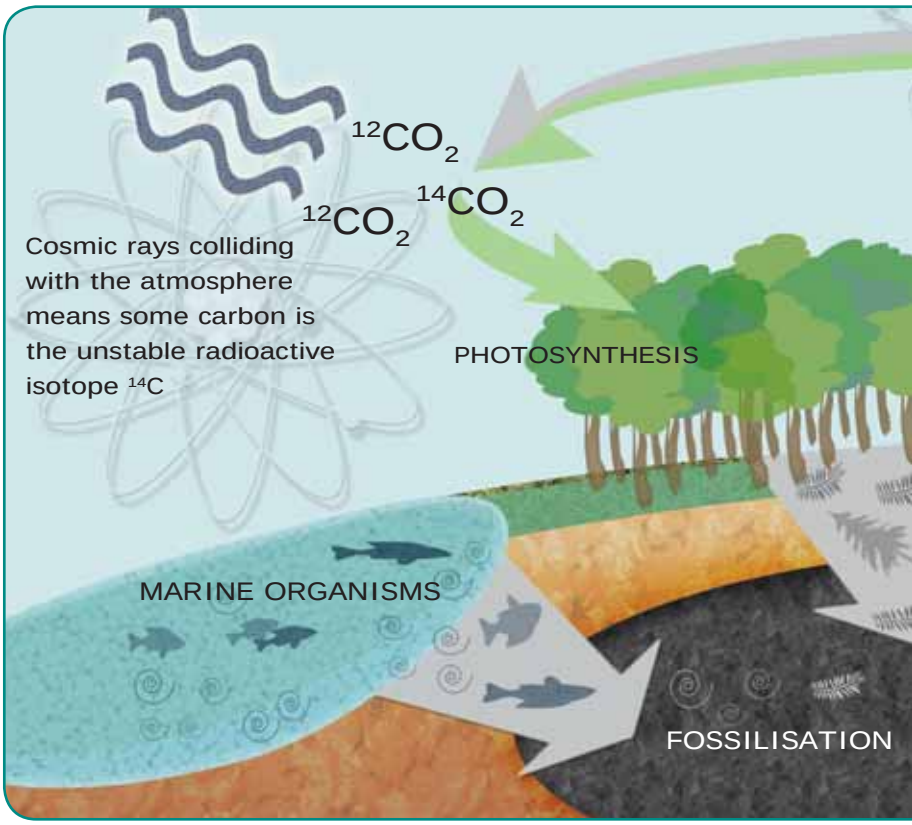
The UK generates around 12.5 tonnes of municipal organic waste each year. About half of this is food waste - in the UK we throw away about one third of the food we buy. Most of this waste still goes to landfill, where it breaks down producing methane. The methane from biodegradables in landfill accounts for 40% of all UK methane emissions.The UK's landfill diversion targets require the amount of municipal biodegradable waste being sent to landfill to fall by around 10 million tonnes by 2013.

A second waste problem the UK is tackling is packaging waste. The recycling rate for plastic packaging remains low at around 22%, reflecting the difficulty of dealing with contaminated plastic. At first these problems might seem unrelated, but both these waste streams could be capitalised on by using the appropriate renewable polymer for food packaging.

Using renewable food packaging could simplify the waste stream, divert waste from landfill and provide renewable low-carbon energy. The energy content of renewable polymers could be recovered by incineration, which would release renewable $CO_2$. It is possible that some renewable polymers could be compatible with Anaerobic Digestion (AD). AD is a process where bacteria digest biomass inside a sealed vessel producing biogas. Biogas can be used to provide heat and electricity but it can also be used as a road fuel. One tonne of food waste could provide 300 kWh of energy (for more information on AD, see our recent report on our website). This year the NNFCC is undertaking a project on the potential for anaerobic treatment of packaging waste.

## Closing the Loop With Renewable Carbo

Carbon is the basis of all life on earth. Petrochemicals were once living organi Petrochemicals are formed over a geological timescale, so their large-scale us $CO_2$ released by the use of fossil fuels also contributes to climate change. Hov manage carbon in a more sustainable way.




Cosmic rays colliding with the atmosphere mean that some of the carbon is the radioactive (but not dangerous) isotope $^{14}C$. 99% of the carbon in the atmosphere is $^{12}C$. Only 1 C in 1 trillion will be $^{14}C$, but this is still enough to measure. $CO_2$ from the atmosphere is used by plants in photosynthesis, so new plant material will contain both $^{14}C$ and $^{12}C$. Under the right conditions, and over geological timescales, the remains of living organisms can be transformed into fossil fuels. After ~100,000 years all the $^{14}C$ present in the original organic material will have undergone radioactive decay leaving only $^{12}C$. A product made from biomass will have a relatively high level of $^{14}C$, while a product made from

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Renewable Carbon

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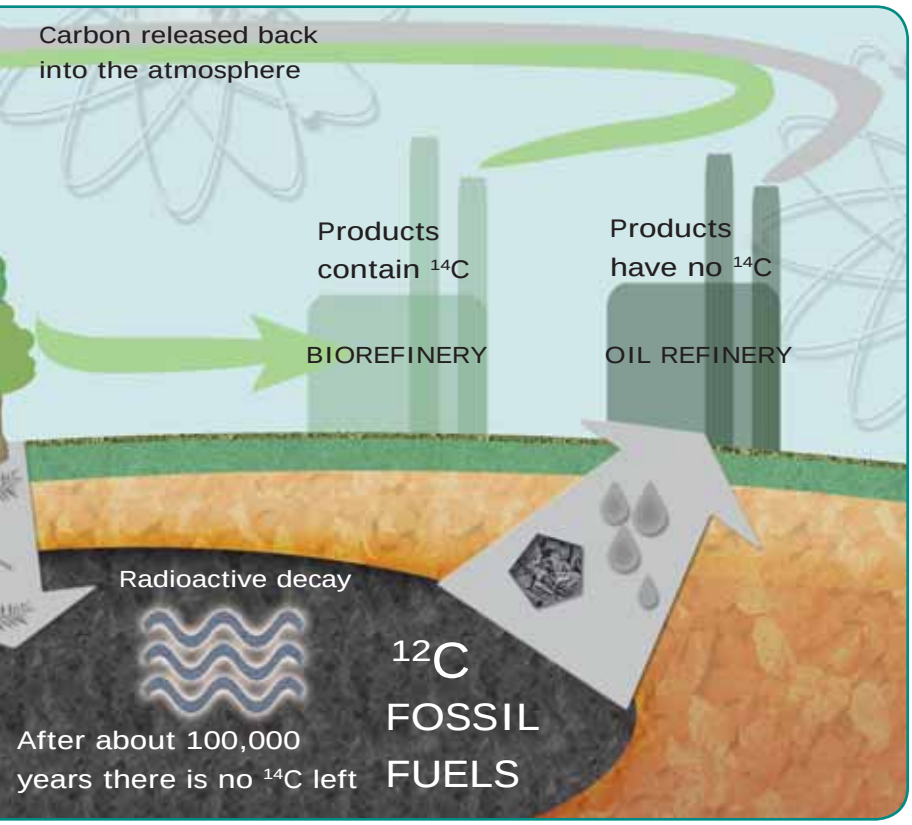
sms and the carbon they contain is the product of ancient photosynthesis. se for fuels and materials means they are finite on a human time scale. The wever, by using renewable materials, and thus renewable carbon, we can




petrochemicals will have no $^{14}C$.
The percentage of renewable carbon in a material (solid or liquid) can be measured with an accelerator mass spectrometer – basically a very sophisticated way of distinguishing the $^{14}C$ and $^{12}C$ by their mass.
The renewable content calculation only considers the part of a material that is organic carbon. For example, a product can be only 50% carbon but 100% biobased. This would mean that 100% of the carbon in the product is from a renewable source. Equally, a product could be 100% organic carbon but only 50% biobased.

## End of Life Options

Renewable polymers provide us with a greater range of end-of-life options than conventional polymers. Nearly all types of plastic are recyclable, but current levels in the UK are low. Once the renewable polymers market develops to such a level that they have a significant presence in the waste stream it will become economical to recycle them, a situation no different from any other material. The issues around plastics recycling (consumer confusion, lack of facilities, cost etc.) affect *all* classes of plastic. Recycling issues should not hamper the development of the renewable polymers industry.

| Option | Traditional Polymers | Renewable Polymers |
|---|---|---|
| Mechanical recycling | ✓ | ✓ |
| Chemical recycling | ✓ | ✓ |
| Energy from Waste | ✓ | ✓ |
| Landfill | ✓ | ✓ |
| Anaerobic Digestion | ✗ | ✓ |
| Composting | ✗ | ✓ |

## Summary

- Market is growing rapidly from a low base.
- Expansion of market will depend on feedstock price, legislative policy/incentives.
- Applications beyond the biodegradable/ compostable market.
- Can significantly reduce greenhouse gas emissions and reduce fossil energy depletion, but it is important that this is assessed on a case-by-case basis.
- Increasingly attractive economics.
- Could face a similar backlash to biofuels if their benefits are not communicated widely enough.

Anaerobic Digestion could produce biogas from waste packaging made from renewable polymers

## References and Further Reading


**NNFCC Renewable Polymers Thematic Working Group**
*www.nnfcc.co.uk/metadot/index.pl?id=3922;isa=Category;op=show*

**NNFCC Anaerobic Digestion FAQs**
*www.nnfcc.co.uk/metadot/index.pl?id=2192;isa=Category;op=show*

**European Bioplastics FAQ paper on bioplastics**
*www.european-bioplastics.org/index.php?id=191*

**BS EN 13432:2000 - Requirements for packaging recoverable through composting and biodegradation**
*www.bsi-global.com/en/Standards-and-Publications/Industry-Sectors/Environment/more-products/BS-EN-134322000/*

**The Compostability Mark of European Bioplastics**
*www.dincertco.de/en/competencies/products/certification_in_the_environmental_field/the_compostability_mark_ibaw_e/index.html*

**Standard tests for determining biobased carbon content**
*www.astm.org*

**Green Alliance**
*www.green-alliance.org.uk/*

**WRAP**
*www.wrap.org.uk*

**Defra – Waste Strategy for England**
*www.defra.gov.uk/environment/waste/strategy/strategy07/index.htm*

**INCPEN - The Industry Council for Packaging and the Environment**
*www.incpen.org*

*www.plantic.co.uk*
*www.innoviafilms.com*
*www.novamont.com*
*www.natureworksllc.com*
*www.braskem.com*

## Projects Update

**Lignocellulosic Ethanol Plant in the UK - Feasibility Study, by Black & Veatch Ltd.**
*www.nnfcc.co.uk/metadot/index.pl?id=7607;isa=DBRow;op=show;dbview_id=2539*

**Cost calculator for straight vegetable oil and biodiesel production.**
*www.nnfcc.co.uk/metadot/index.pl?id=2376;isa=Category;op=show*

**NNFCC 08-006 A Detailed Economic Assessment of Anaerobic Digestion Technology and its Suitability to UK Farming and Waste Systems** (in collaboration with Andersons).
*www.nnfcc.co.uk/metadot/index.pl?id=7197;isa=DBRow;op=show;dbview_id=2539*

**NNFCC 08-017 International Biofuels Strategy Project. Liquid Transport Biofuels - Technology Status Report,** by Dr Geraint Evans.
*www.nnfcc.co.uk/metadot/index.pl?id=6597;isa=DBRow;op=show;dbview_id=2539*

# Events

MEET NNFCC HERE

### Beyond Today's Fuels, 23 September 2008, London

Registration is now open for this event. The NNFCC will present the findings of a series of Defra-funded studies which map a course for the development of a sustainable renewable fuels, chemicals and materials industry. This event will bring together the authors of each of these studies, together with representatives from the NNFCC to explain the key findings.

### Green Supply Chain '08, 6-7 November 2008, York

Registration is now open for our fifth annual conference. To see the full programme and register, go to the Events page on our website.


## Cereals 2008

A record 23,900 people attended Cereals 2008. This year's Cereals saw the introduction of the Arable Outlook area dedicated to the renewables, biofuels and non-food crops sector. Arable Outlook was specially developed by the Cereals Event team and NNFCC. We launched our AD economics study and interactive calculator to great media interest.

## Great Yorkshire Show

The NNFCC stand was buzzing with visitors at the 150th Great Yorkshire show. We brought renewables to life for kids, with a chance to crush some OSR and see how it can be made into biodiesel. Many visitors wanted to discuss the potential for anaerobic digestion with Lucy Hodsman. If you missed Lucy please contact us by phone or e-mail.

## NNFCC's 'Carbon Angels'


NNFCC entered a team for the 'Race for Life'. After many weeks of lunchtime training the 'Carbon Angels' were all able to jog or run around the 5km course even though we did not train for the torrential rain we ran in on the day! Thanks to everyone who supported us we raised £1,210 for Cancer Research UK.

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