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Biochar – A Sink for Carbon and a Soil Improver?

Natural England – Save Our Soils!

Tattersalls, February 18th

Zoe Wallage
Low Carbon Innovation Centre
University of East Anglia

Biochar: A Sink for Carbon and a Soil Improver?

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Outline:

- Introduction & Overview
- Production - Technologies & Feedstocks
- Biochar-Soil Interactions & Benefits
- Costs & Potential in the East of England
- The Future…

What is Biochar?

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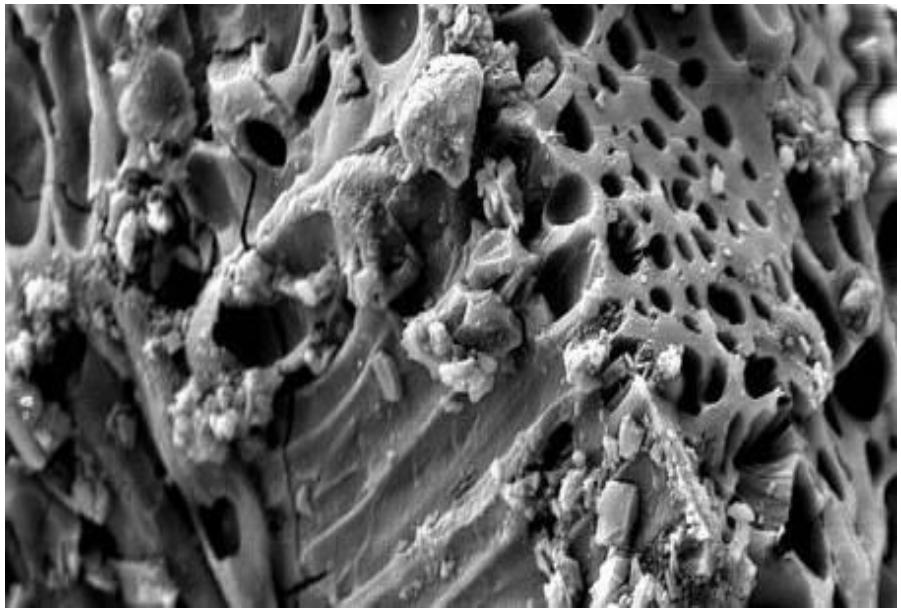
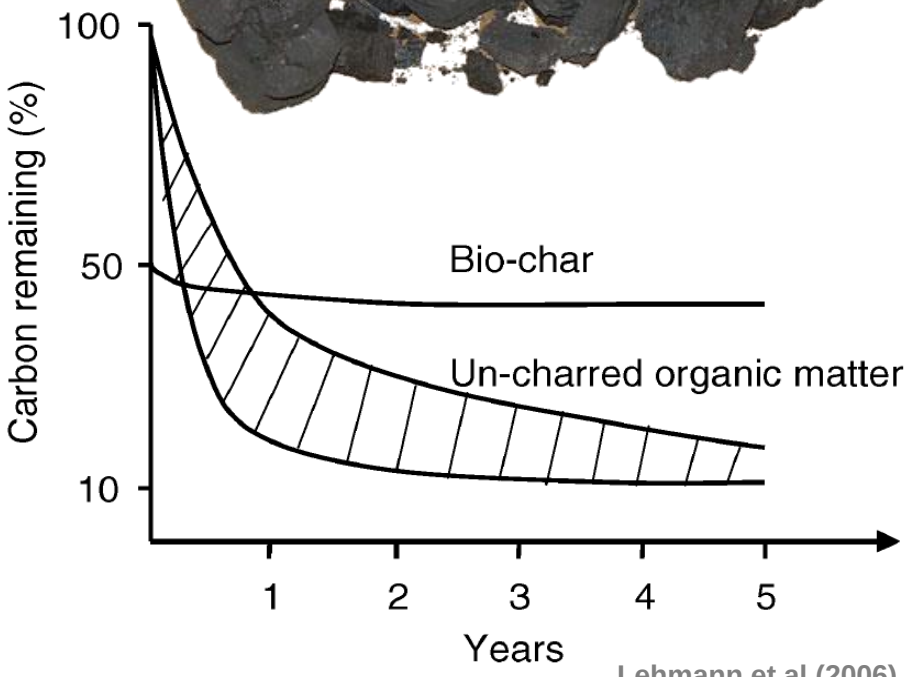
- Brittle, low density charcoal-like material;
- High carbon content (60 – 95% C);
- Resistant to biodegradation;
- Highly adsorptive;
- Microscopic structure.





Lehmann et al (2006)

Why is it Important?

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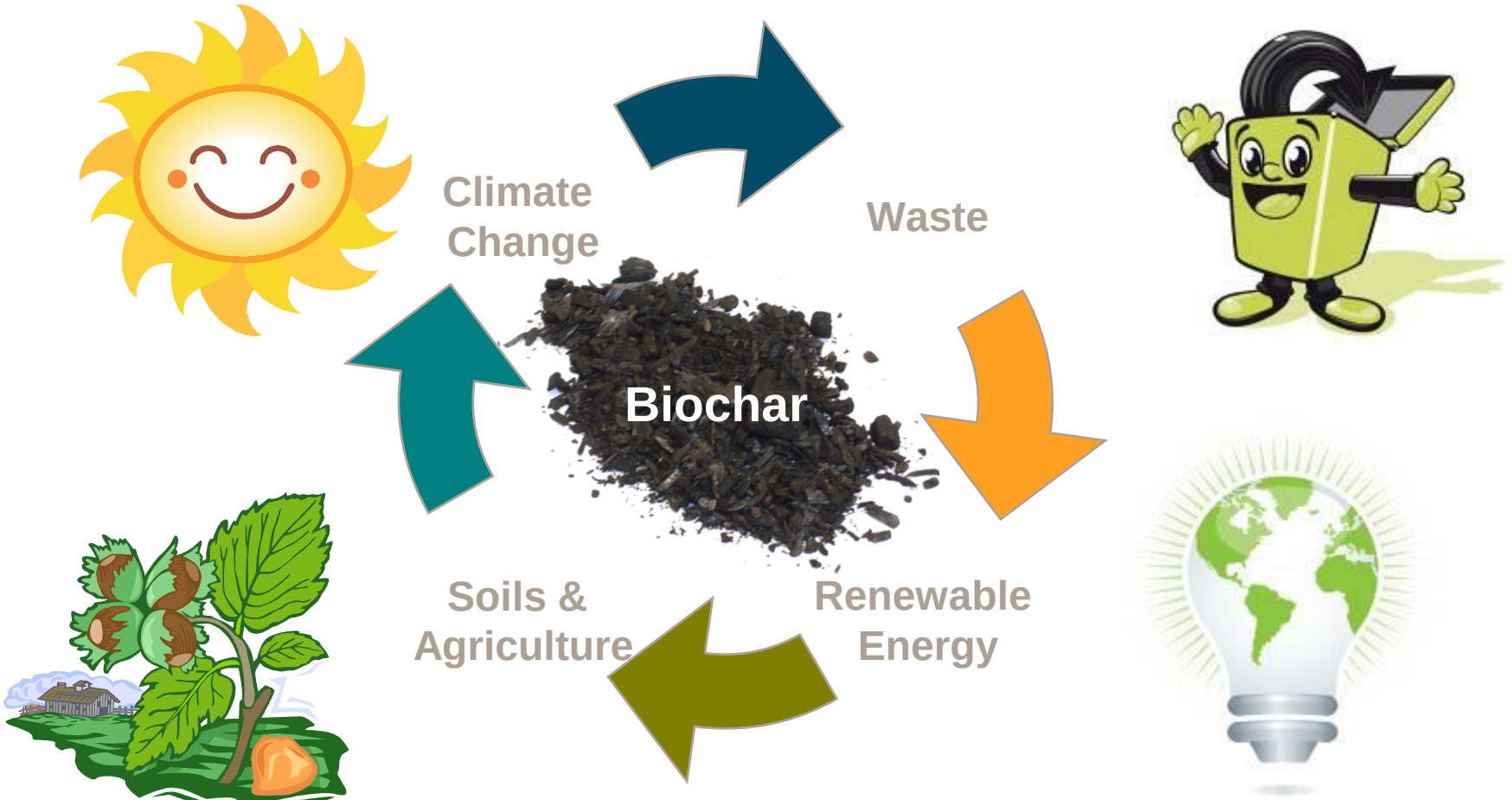

Photosynthetic Carbon Cycle

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Cyclical Transfer of Carbon

CARBON NEUTRAL

Lehmann (2007)
Nature 447: 143 - 144

Biochar Carbon Cycle

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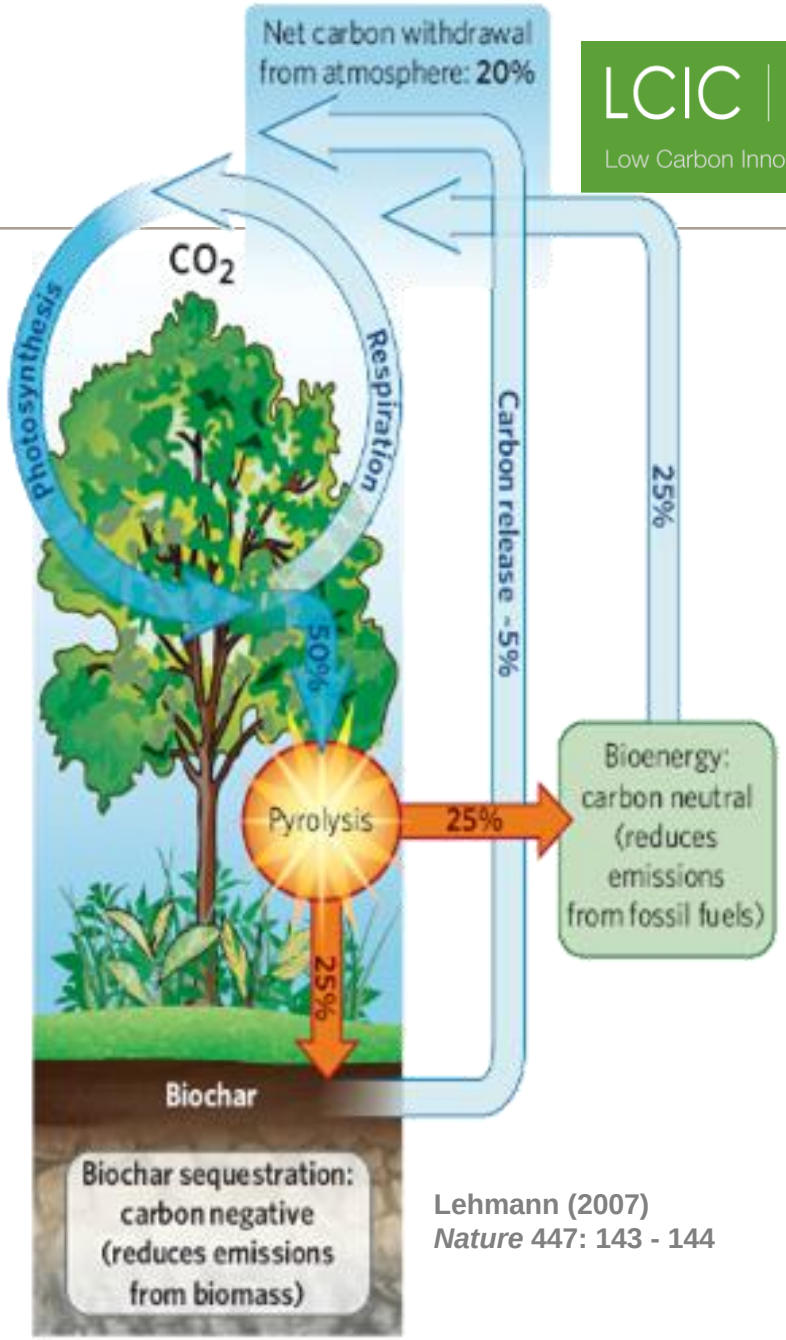
Cyclical Transfer of Carbon with Long-lived Sequestration



CARBON NEGATIVE

Lehmann (2007)
Nature 447: 143 - 144

Biochar Stability

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Unlike compost, manure or crop residues, biochar does not appear to degrade so rapidly in soils…

Compost & other organic material in soils is valuable but mineralises (converts to CO_2) in just a few years.

Biochar remains essentially unchanged for hundreds or even thousands of years.

How is Biochar Produced?
Thermal Conversion of Biomass

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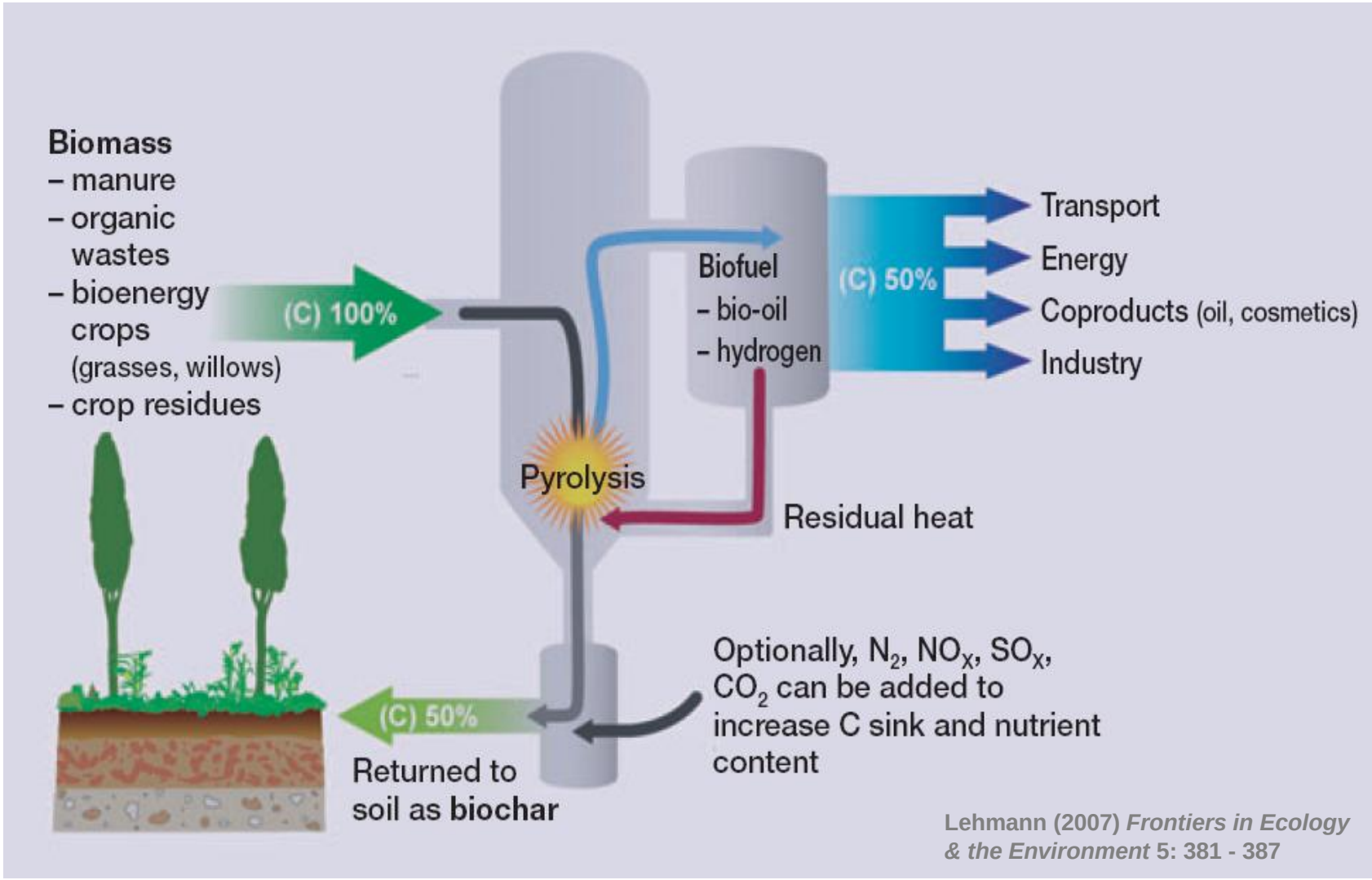

Lehmann (2007) *Frontiers in Ecology & the Environment* 5: 381 - 387

Biochar Production: Technologies

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Gasification

Slow Pyrolysis (retort)

Slow pyrolysis (kiln)

	Temp & Duration	Solid (Biochar)	Liquid (Bio oil)	Gas (Syn Gas)
Slow Pyrolysis	~500°C Days	**35%**	30%	35%
Fast Pyrolysis	~500°C Seconds	**12%**	75%	13%
Gasification	>800°C Hours	**10%**	5%	85%

Fast Pyrolysis

Biochar Production: Feedstock Materials

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Manure


Poultry Litter


Biodegradable Waste


Managed Woodland


Miscanthus

Biochar Properties: Feedstock Materials

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The variable nature of the chemical constituents in the feedstock biomass influence the structure, properties & yield of biochar.

UEA Biomass Gasification Combined Heat and Power Plant

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Input:
10,000t/yr woodchip

Output:
1.4 MWe
2.0 Mwh
300t/yr biochar

University of East Anglia

UEA Biomass Gasification Combined Heat and Power Plant

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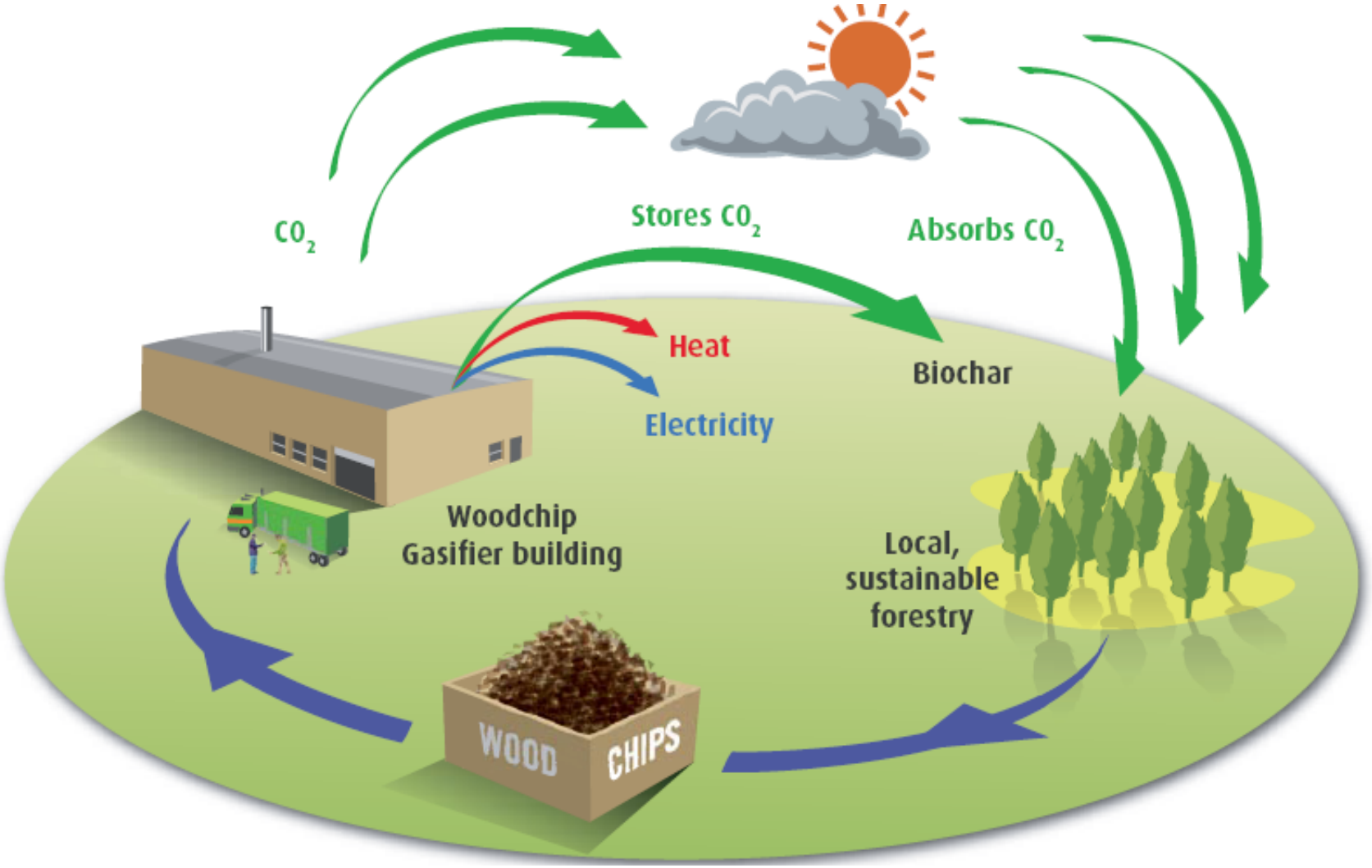

Biochar-Soil Interactions: Benefits & Rates of Application

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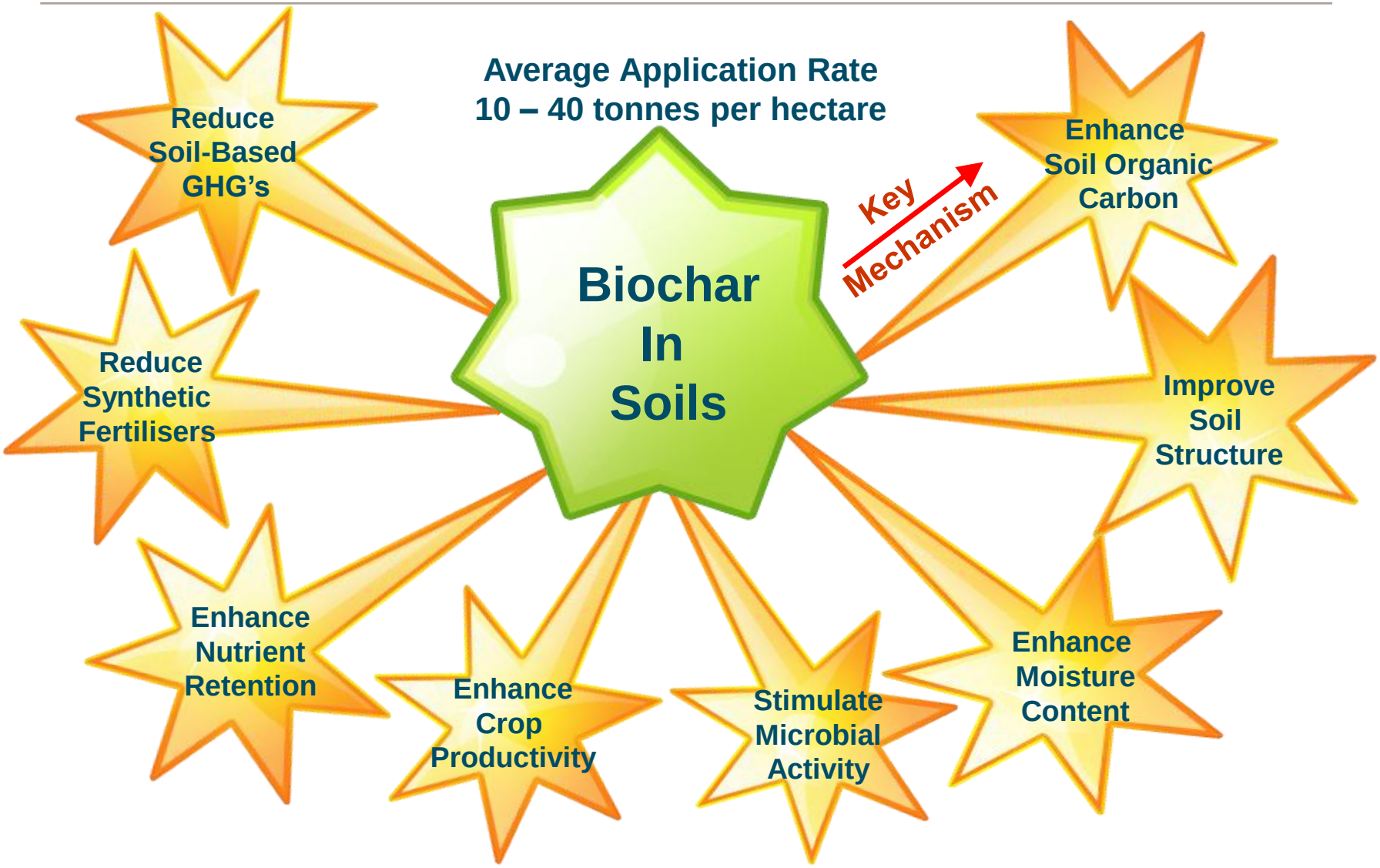

Biochar-Soil Interactions: Contrasts in Organic Content

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Amazonian Dark Earth – *Terra Preta*

Right: A native Amazonian nutrient-poor oxisol
Left: An oxisol transformed into a fertile *Terra Preta*
Photo sourced from Bruno Glaser

Biochar-Soil Interactions: Impact on Crop Productivity

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Biochar Trials, New South Wales, Australia. Photo sourced from BEST Energies Ltd

Biochar-Soil Interactions: The Many Unknowns

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Interaction with soil microbiological processes

Influence on soil water retention & drought resistance

Impact on soil-based N_2O and CH_4 emissions

Process & permanence for remediating contaminated land

Influence on soil aggregate stability & workability

Factors influencing longevity & overall stability

Impact on mineralisation rates of compost & sewage sludge

Interaction with CEC & nutrient (nitrate & phosphate) retention

Biochar: Potential Costs & Benefits

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Principal costs: Capital & Feedstock

May be eligible for future carbon credits

May generate additional revenue:

- ↑ Bioenergy
- ↑ Crop yields
- ↓ Fertilisers
- ↓ Fossil fuels
- ↓ Landfill
- ↓ Irrigation
- ↓ Cultivation

Factor	Regional avg.	With biochar
Output per ha (£) – biochar +5% yield, +3% quality	5,445	5,889
Total variable costs – biochar -10% fertiliser, but +5% grading and sundries (↑ yield)	3,010	3,003
Gross margin	2,435	2,886
Fixed costs – biochar -5% (reduced cultivations)	1,885	1,791
'Profitability' £ per hectare	550	1,095

Source: Nix (2008), and calculated based on modest biochar improvements

Biochar: Production Potential in the East of England

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- Regional 'arable' area is 1.13 million ha (+20% for grassland);
- Would need 32 – 452 million tonnes of biomass!
- Region currently produces ~2 million tonnes biomass/yr
- Thus, a single dose @ 10 t/ha would take between 16-56 yrs…

Biochar process	Biochar yield as % of raw biomass	Raw biomass needed for 10tonnes per ha	Raw biomass needed for 40tonnes per ha
Gasification	10	113 million tonnes	452 million tonnes
Fast pyrolysis	15	75 million tonnes	301 million tonnes
Slow pyrolysis	35	32 million tonnes	129 million tonnes

Source: DEFRA (land areas) and calculated by Collison and Associates limited

Biochar: The Future

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- Market developing - mostly voluntary offsetting schemes;
- Application in UK currently limited to experimental trials;
- Down-scale technology for individual farm units & develop an “off the shelf” product;
- Develop guidance for production, management, application & verification.

Thank you for your attention…

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