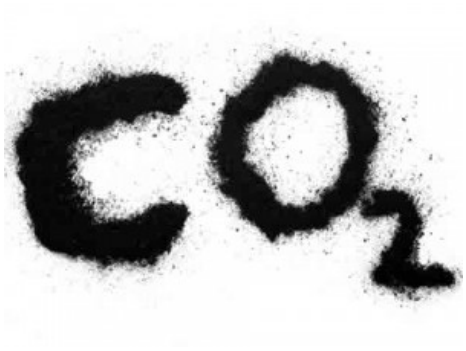
Carbon: from pollutant to potential resource

Tom Levitt

17th December, 2009

Instead of dumping carbon deep underground we could be exploring ways to use it and reduce our overall emissions at the same time



Instead of dumping carbon underground we could use it as a resource for making oil, plastics and cement

While we wait to see if Copenhagen paves the way towards a long term fall in global carbon dioxide emissions, the short-term reality is that emissions of the pollutant will continue to rise.

So what do we do with such huge quantities of what is essentially a waste product?

The answer in most cases in recent history - think rubbish or nuclear - has been to bury it underground in landfill sites. The same theory is being suggested for carbon.

With fossil fuel-burning power stations continuing to be built rather than closed down there has been focus on technologies that capture and store the carbon pollution produced. The resulting carbon is then compressed to a liquid so that it takes up less space, and then potentially buried deep underground.

As Robert Kunzig and Wallace Broecker point out in their book, *Fixing Climate*, Carbon Capture and Storage would mean landfill on a 'stupifying' scale:

'If the twenty-nine gigatons produced by the world's fossil-fuel burning in a single year were liquefied and spread over Manhatten, they would bury the island to about the eighty-fifth floor of the Empire State Building.'

Frank Zeman, from the Department of Earth and Environmental Engineering at Columbia University says we have not yet even started to address the huge issues involved with disposing of carbon.

'We already have a huge waste problem: imagine what it is going to be like with CO2 as well. It'll be nimbyism.'

Carbon resource

But some experts are now starting to ask: what if we used the carbon as a resource instead of disposing of it?

As far-fetched as it may sound there are already a number of experimental technologies that are making use of carbon either by absorbing it from the air or taking it in concentrated form from industry or power plants.

They may not all be carbon negative but they do at least make more use out of the carbon that we are producing through human activities.

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Algae

Through the process of photosynthesis algae is able to use sunlight to absorb carbon dioxide and provide an end product – oil or feedstock.

Unlike agricultural crops grown for fuel, algae do not need good quality agricultural land: they can be grown anywhere and do not require as much water or even clean water.

In the US, the University of Minnesota has been demonstrating the technology using waste water from sewage works. The benefit is two-fold as municipal waste treatment plants often burn the waste sludge and left alone it will also emit carbon dioxide.

Although there is no reason why algae production could not be located next to any fossil-fuel burning power station, the best location may be in tropical countries.

'[Algae's] water and land needs, combined with the fact that tropical climates bring the best yields, all point to developing nations,' says Ben Graziano, research and development manager for the UK Carbon Trust's Algae Biofuels Challenge.

The Carbon Trust's project aims to develop low carbon microalgae biofuel technology to a commercial scale by 2020. There are also ongoing projects looking at using the oil produced by algae to make biodegradable plastics.

'In the short term the whole world sees carbon as a waste but we see that there are uses for carbon and opportunities to displace other fuels and reduce overall emissions,' says Graziano.

'Algae could absorb CO2 and displace fossil fuels – giving twice the energy for your emissions.'

Demonstration scale

Current yields for algae are already better than other biofuels: 10-15,000 litres of oil per hectare per year against 5-6,000 litres for palm oil plantations.

However, production is still only at demonstration scales of 10-20 hectares and needs to reach 1,000 hectares to become commercially viable. It is this scaling up that poses a challenge. Biological production is at risk from infection and maintaining the purity of the algae cultures is critical.

Despite the difficulties, Professor Roger Ruan, director of the Centre for Biorefining at the University of Minnesota, still expects commercial scale production within five years.

The Carbon Trust plans to have a pilot project up and running in a less-industrialised country by 2015.

The academic largely credited with designing the Kyoto protocol, Graciela Chichilnisky, believes carbon negative technology could be a financial coup for less-industrialised countries.

'We need negative carbon technologies to bring most of the Clean Development Mechanism (CDM) investment to the regions that need it most: the low emitters in Africa, Latin America and the Small Island States that need energy to grow and to adapt and mitigate the catastrophic risks of climate change,' says Chichilnisky.

Green cement

Cement production accounts for 5 per cent of greenhouse gas emissions and 50 per cent of the carbon emitted comes from converting limestone into cement.

So-called 'green cement' uses non-carbonate materials that cut out most of the CO2 emitted during production. It also absorbs CO2 during production to help make it carbon negative.

In the UK, researchers at Imperial College London have developed their own form of green cement and an independent company, Novacem Ltd, is now bringing it to commercial scale. They use a magnesium oxide composition in place of the limestone used in conventional cement. The final product is also recyclable, unlike conventional cement.

Novacem researchers estimate that for every tonne of ordinary Portland cement replaced by their green cement, around 0.75 tonnes of CO2 could be captured and stored indefinitely in construction products.

Although green cement plants could be located next to conventional cement plants and be potential absorbers of carbon dioxide, Novacem chairman Stuart Evans says the main benefit is likely to be in displacing carbon, rather than using it as a 'resource'.

Novacem expects to have an industrial scale plant up and running by 2011, and for the cement to be mainstream by 2014-15.

Hydrocarbons

Perhaps the most significant method for turning carbon into a resource is in the production of hydrocarbon fuels. You start with carbon dioxide, react it with hydrogen and make a fuel that can power existing vehicles.

Dr Frank Zeman, of Columbia University, co-authored a report on the potential for hydrocarbons made from captured and stored carbon dioxide.

'We have shown that it is not technically difficult, the only challenge is the cost because at present it is cheaper to make cars more efficient than switching to hydrocarbons,' says Zeman.

The big hope for a renewable hydrocarbons sector is the ability to use solar energy to split water (H2O) to make hydrogen.

'The million-dollar question is solar-pv [photovoltaic] hydrogen. It's too expensive at the moment but it is the panacea. This kind of closed loop system is the future if we are ever to reach zero carbon emissions,' says Zeman.

Resource or waste?

With all carbon technologies there are questions about whether they are carbon negative (taking carbon out of the atmosphere) or simply carbon reducing, for example using pressurised CO2 to extract more oil which is then burned as fuel.

This doubt leaves some sceptical of whether carbon can ever become a true resource. 'You can call it a resource, but it is one which we will have in abundance so I still see it as something we need to get rid of,' says Professor John Shepherd, who chaired the Royal Society's recent study into the prospects for geoengineering the climate.

'If we manage to capture as much as we could it's hard to imagine us ever using up all the CO2. It is good to try and find a use for carbon. If you can use it to make a fuel through algae or hydrocarbons then great but equally I'd be happy to see it pumped into the ground,' says Shepherd.

However, Dr Zeman, from Columbia University, says while fossil carbon will always be a pollutant, active carbon (already in the atmosphere) could be a resource if we can find uses for it through hydrocarbons, algae and the like.

'We can't permanently inject liquid carbon into the ground. Negative carbon technologies are a short-term solution that will help us get to a sustainable situation,' says Zeman.

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Royal Society report on geoengineering
Carbon neutral hydrocarbons study
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The second green revolution? Plant-based biodegradable plastics
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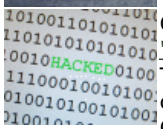

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Re: Carbon: from pollutant to potential resource

Posted By erich 1 December 18, 2009 05:46:22 AM

All political persuasions agree, building soil carbon is GOOD. To Hard bitten Farmers, wary of carbon regulations that only increase their costs, Building soil carbon is a savory bone, to do well while doing good. Biochar provides the tool powerful enough to cover Farming's carbon foot print while lowering cost simultaneously. Another significant aspect of bichar is removal of BC aerosols by low cost ($3) Biomass cook stoves that produce char but no respiratory disease emissions. At Scale, replacing "Three Stone" stoves the health benefits would equal eradication of Malaria. http://terrapretapot.org/ and village level systems http://biocharfund.org/ The Congo Basin Forest Fund (CBFF).recently funded The Biochar Fund $300K for these systems citing these priorities; (1) Hunger amongst the world's poorest people, the subsistence farmers of Sub-Saharan Africa, (2) Deforestation resulting from a reliance on slash-and-burn farming, (3) Energy poverty and a lack of access to clean, renewable energy, and (4) Climate change. The Biochar Fund : Exceptional results from biochar experiment in Cameroon http://scitizen.com/screens/blogPage/viewBlog/sw_viewBlog.php?idTheme=14&idContribution=3011 The broad smiles of 1500 subsistence farmers say it all (that , and the size of the Biochar corn root balls) http://biocharfund.org/index.php?option=com_content&task=view&id=55&Itemid=75 Mark my words; Given the potential for Laurens Rademaker's programs to grow exponentially, only a short time lies between This man's nomination for a Noble Prize. This authoritative PNAS article should cause the recent Royal Society Report to rethink their criticism of Biochar systems of Soil carbon sequestration; Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions http://www.pnas.org/content/early/2009/10/09/0902568106.full.pdf+html There are dozens soil researchers on the subject now at USDA-ARS. and many studies at The up coming ASA-CSSA-SSSA joint meeting; http://a-c-s.confex.com/crops/2009am/webprogram/Session5675.html The Clean Energy Partnerships Act of 2009 The bill is designed to ensure that any US domestic cap-and-trade bill provides maximum incentives and opportunities for the US agricultural and forestry sectors to provide high-quality offsets and GHG emissions reductions for credit or financial incentives. Carbon offsets play a critical role in keeping the costs of a cap-and-trade program low for society as well as for capped sectors and entities, while providing valuable emissions reductions and income generation opportunities for the agricultural sector. The bill specifically identifies biochar production and use as eligible for offset credits, and identifies biochar as a high priority for USDA R&D, with funding authorized by the bill. To read the full text of the bill, go to: http://www.biochar-international.org/sites/default/files/END09F94.pdf. Senator Baucus is co-sponsoring a bill along with Senator Tester (D-MT) called WE CHAR. Water Efficiency via Carbon Harvesting and Restoration Act! It focuses on promoting biochar technology to address invasive species and forest biomass. It includes grants and loans for biochar market research and development, biochar characterization and environmental analyses. It directs USDI and USDA to provide loan guarantees for biochar technologies and on-the-ground production with an emphasis on biomass from public lands. And the USGS is to do biomas availability assessments. WashingtonWatch.com - S. 1713, The Water Efficiency via Carbon Harvesting and Restoration (WECHAR) Act of 2009 Individual and groups can show support for WECHAR by signing online at: http://www.biocharmatters.org/ Congressional Research Service report (by analyst Kelsi Bracmort) is the best short summary I have seen so far - both technical and policy oriented. http://assets.opencrs.com/rpts/R40186_20090203.pdf . United Nations Environment Programme, Climate Change Science Compendium 2009 http://www.unep.org/compendium2009/ Al Gore got the CO2 absorption thing wrong, (at NABC Vilsack did same), but his focus on Soil Carbon is right on; http://www.newsweek.com/id/220552/page/3 Research: The future of biochar - Project Rainbow Bee Eater http://www.sciencealert.com.au/features/20090211-20142.html Japan Biochar Association ; http://www.geocities.jp/yasizato/pioneer.htm UK Biochar Research Centre http://www.geos.ed.ac.uk/sccs/biochar/ My 09 field trials with the Rodale Institute & JMU ; http://terrapreta.bioenergylists.org/node/1408 Alterna Biocarbon and Cowboy Charcoal Virginia field trials '09 Carbon to the Soil, the only ubiquitous and economic place to put it. Cheers, Erich

Re: Carbon: from pollutant to potential resource

Posted By EC0085891 December 18, 2009 06:20:18 AM

We still need to adopt a near-zero CO2 economy and the debate at Copenhagen should be about when all countries will have such a plan up and running. Then we can cut CO2 allready created by man by creating biochar as fast as possible. The Kadir-Buxton Near-Zero CO2 Plan can raise £100 billion a year in the UK alone, enough to make such a plan a reality. We just need a government to adopt the plan.

Re: Carbon: from pollutant to potential resource

Posted By Bosnorth 1 February 25, 2010 01:19:12 PM

Putting this together with the issue of methane and the scary possibility of Siberian permafrost warming to the extent of releasing the methane reservoirs, how about burying it under waste carbon? It's carfbon that's keeping methane locked up under the oceans. Could it work as a landfill over permafrost?

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