BIOCHAR climate saving soils

The project Biochar: climate saving soils is a project which is funded by the Interreg IVB North Sea Region Programme.

In this series of newsletters partners from 7 different countries around the North Sea share their knowledge about standards, production, application and environmental impact of biochar.

This fifth newsletter, written by the Joint Implementation Network, discusses how carbon markets could support the process of biochar production with application to soils, what methods already exist for the greenhouse gas accounting of this process, and where further improvements are needed. In September of this year a more extensive article on this subject will be published.

All of our previous newsletters can be downloaded from the Biochar: climate savings soils website. 
www.biochar-interreg4b.eu

F. Debets
project leader

About the newsletter
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Upcoming Events

June 3rd – 7th 2013
21st European Biomass Conference and Exhibition (Copenhagen)

June 20th – 21st 2013
Inaugural Meeting of the British Biochar Foundation (Oxford)

October 1st and 2nd 2013
ANS congress: Wastemanagement meets Biochar - Perspectives for Climate Protection? (Potsdam)

Written by
Eise Spijker
Wytze van der Gaast

Reviewed by
Simon Shackley
The Joint Implementation Network (JIN) was established in 1994 with the aim to create an information platform for the relatively new climate change concept of Joint Implementation (JI). Two years earlier JI had been included in the UN Framework Convention on Climate Change as an instrument for greenhouse gas emissions trading between countries through projects. The platform was targeted at key players in JI projects, such as business community representatives, policy makers, knowledge centers, and consultants.

**The Greenhouse Gas abatement impact of biochar in relation to the Carbon market**

**Introduction**

Since the mid-1990s carbon markets have internationally become accepted as a way to provide additional financial incentives to climate-friendly investment options. The main framework for carbon markets has been the UN Framework Convention on Climate Change (UNFCCC) and its 1997 Kyoto protocol. This was followed by the EU emissions trading scheme in 2005. A clear benefit of carbon markets is that they mobilise additional private sector funding and therefore relieve pressure on governmental budgets. Challenges are that tradability of carbon credits in carbon markets require a justification that the underlying emission reduction has been verified based on validated methodologies.

This paper discusses how carbon markets could support the process of biochar production with application to soils, what methods already exist for the greenhouse gas (GHG) accounting of this process, and where further improvements are needed.

**Carbon market update**

The main objective of carbon markets is to internalise environmental impacts of GHG emissions as a cost in economic decision making and to create incentives for low emission investments. The carbon credit price ideally reflects the
environmental costs of GHG emissions. Carbon credit trading was adopted internationally under the 1997 Kyoto Protocol, which contained quantified commitments for industrialised countries (for years 2008-2012). Countries could comply with these commitments through purchase of carbon credits through projects in developing or other industrialised countries. As a result, a global market for carbon credits emerged.

As part of its Kyoto Protocol policy package, the EU launched an emissions trading scheme (ETS) in 2005. The scheme caps GHG emissions for over 10,000 energy-intensive installations (around 40% of the EU’s total emissions) and allows trade between installations to remain below their caps.

Both the Kyoto and EU carbon markets were linked (although with limitations): European installations could buy Kyoto-credits as a compensation if their annual emissions were higher than their caps. As a result, during 2008-2012, European installations developed the strongest demand for Kyoto-based carbon credits of any major trading block.

In addition to the EU scheme, several other cap-and-trade scheme have been established such as the Regional Greenhouse Gas Initiative and Western Climate Initiative (in the USA) and

[Figure 1: Supply and demand in the EU emissions trading scheme. The installation with higher emission than its cap can buy the surplus from the installation which has stayed below the cap.]

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1 In reality, however, it has turned out difficult to realise this ideal situation. As will be explained below, at present there is a very large gap on carbon markets between carbon prices and science-based estimates of the costs of climate change.

2 Developing countries were exempted from such commitments.

3 Carbon trading projects in developing countries were guided by the Kyoto Protocol Clean Development Mechanism (CDM) while projects between multiple industrialised countries took place as Joint Implementation (JI) activities.
New Zealand emissions trading scheme, whereas domestic schemes are being prepared in Australia and China.

Next to these ‘compliance markets’ also markets developed for crediting voluntary actions to offset emissions related to, e.g., travelling and conference organization. The voluntary carbon market has been diverse with, e.g., varying standards for accounting of carbon benefits. Nonetheless, voluntary carbon schemes have become a stable carbon market with improved standards. Examples of voluntary schemes are: Verified Carbon Standard, Climate Action Reserve, Gold Standard, American Carbon Registry and Plan Vivo.

In the meantime, over 6750 Kyoto-based projects have entered the carbon market. Initially, in 2008, credit prices were between €15 and 20, but they dropped after 2010 due to the economic recession and the international disagreements on an ambitious extension of the Kyoto Protocol beyond 2012. As a result, carbon credit prices dropped to less than €2 in December 2012. This has resulted in a bleak market perspective for Kyoto-based credits: despite the agreed extension of the Kyoto Protocol at the Doha climate summit of 2012, it remains unclear whether this will stimulate carbon credit demand.

![Fig. 2](image.png)

**Fig. 2:** The Mazurskie Landfill Gas Project in Lubin, Poland. The plant uses innovative technology to reduce the landfill’s emission of greenhouse gases. Methane gas from the rotting trash heaps is siphoned via a series of pipes to generators, which produce electricity.

The price development in the EU emissions trading market has shown a similar downward trend from almost €30 per emission allowance around mid-2008 to €2.81 in January 2013. The EU market was unable to accommodate the economic recession and repair attempts to bring

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4 For most cap-and-trade schemes, biochar credits can only be included with the help of linking offset mechanisms to the cap-and-trade mechanism. However, the New Zealand Emissions Trading Scheme also includes sink categories, and here biochar could also potentially be included directly under this scheme. In addition, the Kyoto protocol allows carbon credits under the CDM and JI to be generated through sinks.
markets back in balance have failed thus far. As a result, the European Commission expects a cumulative surplus of allowances of 2 billion during 2013-2020.\(^5\)

Voluntary market prices, however, have remained relatively stable, as they are not immediately linked to the EU and Kyoto carbon markets.\(^6\) In addition, improvements in GHG accounting and environmental integrity standards of voluntary market credits have generally enhanced the credibility of these markets.\(^7\) As a result, prices are nowadays at levels around € 6 to € 8 per tonne CO\(_2\) which is considerably higher than the current carbon credit and allowances prices on the ETS and under the Kyoto protocol.

**How can biochar-to-soil projects reduce GHG emissions?**

For determining biochar’s fit with carbon markets\(^8\) the following GHG emission reductions from pyrolysis-biochar-soil projects can be identified. First, the pyrolysis process itself generates syngas or synoil which can be used for heat, oil and electricity production.\(^9\) Its emission reduction impact depends on what the syngas/-oil replaces, e.g. fossil fuels such as coal, oil or natural gas. Second, pyrolysis sequesters CO\(_2\) that is contained by organic materials such as biomass in a solid material, biochar, which can be applied to soils.

From here, biochar could have further climate benefits such as replacement of fertilizers (otherwise produced in GHG emitting processes) and reduced emissions of nitrous oxide as a result of the improved soil composition. As Shackley and Sohi (2012) argue, the latter benefits are relatively uncertain, although they could potentially contribute 25-40% of the total GHG emission reduction impact of the biochar production and application process.\(^10\)

For estimating the climate benefits of applying syngas/-oil for energy production, there are several similarities with experience already gained under, for instance, the Kyoto Protocol. This has resulted in methodologies for calculating GHG emission reductions when replacing fossil fuels with alternative energy sources. For example, if the syngas resulting from pyrolysis were used for electricity production and supplied to a grid-connected system, Kyoto-based methodologies help to determine which capacity is likely to be replaced by that. These

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5 To compare: annually, the EU ETS allocates around 2 billion allowances to the installations covered by the scheme (http://ec.europa.eu/clima/policies/ets/cap/index_en.htm).

6 In principle, voluntary market buyers could also buy CDM credits, but procedures for that have been relatively complex, as it requires approval of the buying and selling governments. In the future, however, sale of CDM credits on non-compliance, voluntary market may increase.

7 Although there are examples of voluntary crediting schemes which collapsed due to poor understanding of the carbon accounting rules and consequences of sectoral policies for carbon credit potential.


9 At present, pyrolysis technologies for syngas and -oil are relatively immature. Hence these remain potential technological extensions of pyrolysis units that are today used for biochar production only.

10 As a general estimate, the largest contribution from the biochar production process through pyrolysis is assumed from the stabilization of carbon from biomass in biochar (40-50%), whereas the replacement of fossil-fuel based energy technologies by syngas/-oil is could account for approximately 10 to 25% of the process’ total potential GHG emission reduction (Shackley and Sohi 2012).
methodologies have also been adopted by voluntary market schemes such as Gold Standard and Verified Carbon Standard. Similarly, methodologies exist for fuel switch projects in transport (which might be relevant for the use of synoil as transportation fuel).

Potentially, most carbon credits from biochar projects originate from storing carbon in biochar and applying it to soils (about 40-50% of total). For that part, biochar can be considered a carbon sink.\(^\text{11}\) A key issue related to carbon credits that originate from sinks is how permanent the sequestration of the carbon is.\(^\text{12}\) In other words: if credits are issued for storing carbon, what needs to be done if the carbon is released again? This issue is particularly relevant for forestry projects where the permanence of carbon sequestration depends on what happens with the forest or the wood after tree logging and which strongly depends on the forest management plan and the institutions that enforce this.\(^\text{13}\)

Fig. 3: LaTour Demonstration State Forest, northeast of Redding, California. Here it was demonstrated how to implement a certification of sequestered carbon with the California Climate Action Registry using the Forest Project Protocol. A Forest Project Protocol certifies a portion of a forest as opposed to the whole property.

While forestry project permanence can be uncertain for project management reasons, uncertainty about biochar carbon permanence mainly relates to the stability of biochar carbon in a climate relevant timescale. The advantage of biochar over forests is that it does

\(^{11}\) The UNFCCC defines “sink” as “any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere”. Carbon sequestration through forestry and land-use activities is covered by Articles 3.3 and 3.4 of the Kyoto protocol.

\(^{12}\) See \url{http://unfccc.int/resource/docs/2012/sbsta/eng/misc16.pdf} for the views of the UNFCCC’s SBSTA on non-permanence.

\(^{13}\) The permanence issue of forestry relates to the time that trees need before reaching full maturity during the rotation periods of forests and how to guarantee that a forest would stay intact overtime. In the CDM, a crediting period of 60 years was agreed for forestry projects which project developers should break up in three periods of 20 years. After each period the project plan is renewed to guarantee permanence of the carbon credits. After 60 years no carbon credits can be generated anymore from such a project. \url{http://cdmrulebook.org/715}
not have to mature as trees in forests and could therefore be considered more stable. However, as yet there is no agreed methodology for determining the stability of biochar carbon and it can even be quite low for certain feedstocks and production conditions.\textsuperscript{14}

In the next section, an overview is provided of different existing methodologies for calculating GHG emission reductions which could be relevant for biochar-to-soil projects and the related activities.

\textbf{How to calculate biochar-to-soil project GHG emission reductions?}

Up to now, no biochar-to-soil offset project has been approved for supplying carbon credits to carbon markets (neither in compliance, nor in voluntary carbon markets). The complexity here is that, as explained above, the biochar-to-soil application process contains multiple emission reduction stages and each stage requires different methods for calculating the net emission reduction.\textsuperscript{15} Currently, an integral methodology combining such methods does not exist. The next questions would be whether in existing carbon markets methods are available for each stage and whether these could be buttoned together into one integral method.

The table below presents the result of a (non-exhaustive) inventory of existing methodologies in the Kyoto protocol’s main carbon credit market (CDM\textsuperscript{16}), grouped in 4 categories:

1) Renewable energy production into a fuel, heat or power (relevant for syngas or biofuels produced through pyrolysis);

2) Carbon sequestration or fixation (relevant for storing carbon in biochar);

3) Biochar production process (relevant for pyrolysis process), and

4) Soil enhancement (relevant for soil improvement impact of applying biochar to soils).

Despite not being exhaustive, the inventory in Table 1 shows that there is much experience with calculating carbon credits from renewable energy projects, whereas the experience in other categories is small or only limited to drawing tables. Especially, the soil-related impacts (e.g. avoidance of carbon and nitrous oxide release) require additional science-based evidence and related methodological development for different soil types under different (climatic and hydrological) conditions. Therefore, with current knowledge, simply buttoning methodologies from different categories together into one integrated biochar-to-soil project method is not possible.

\textsuperscript{14} For example, in a submission by the United Nations Convention to Combat Desertification (5\textsuperscript{th} Session of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention, AWG-LCA 5, Bonn, Germany, 29 March 2009), it was stated that “[T]he mean residence time of Biochar’s recalcitrant carbon in soils is about 2,000 years”. However, the statement was not supported by expert review. Moreover, an attempt to develop a voluntary carbon standard for biochar fell down on the lack of a convincing stability test.

\textsuperscript{15} Such a methodology would need to contain rules for determining a reference scenario for what would have happened in absence of the project (‘baseline’) and for monitoring the performance of the project. The baseline is usually determined before the project start and the monitoring forms input for third-party verification and certification of emission reductions as credits.

\textsuperscript{16} See footnote 3.
## Table 1: Existing baseline and monitoring methodologies with elements useful for biochar-to-soil offset projects

<table>
<thead>
<tr>
<th>Biochar mitigation activities</th>
<th>Methodology (applied registered and at validation)</th>
<th>Number of CDM projects to which methodology is applied17</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Renewable energy production (large scale)</td>
<td>ACM0002 Consolidated baseline methodology for grid-connected electricity generation from renewable sources</td>
<td>&gt; 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Credits issued to &gt;100 projects</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Grid connected renewable electricity generation (small scale)</td>
<td>AMS-I.D Small-scale project methodology for grid-connected electricity generation from renewable sources</td>
<td>&gt;100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Credits issued to &gt;100 projects</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>ACM0004 “Consolidated methodology for electricity and heat generation from biomass”</td>
<td>&gt;100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Credits issued to &gt;40 projects</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>AM0047 “Production of biodiesel based on waste oils and/or waste fats from biogenic origin for use as fuel”</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Carbon sequestration</td>
<td>SSC_069: Chemical and biological stabilization of solid waste carbon content for permanent storage, through controlled pyrolysis</td>
<td>0</td>
</tr>
<tr>
<td>2/3</td>
<td>Carbon sequestration / biochar production process</td>
<td>General Methodology for Quantifying the Greenhouse Gas Emission Reductions from the Production and Incorporation into Soil of Biochar in Agricultural and Forest Management Systems</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Biochar production process</td>
<td>Small-scale Methodology SSC-III.BG: Emission reduction through sustainable charcoal production and consumption</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>AMS-III.L: Avoidance of methane production from biomass decay through controlled pyrolysis</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Soil enhancement</td>
<td>AMS-III.BF Small-scale Methodology Reduction of N₂O emissions from use of Nitrogen Use Efficient (NUE) seeds that require less fertilizer application</td>
<td>0</td>
</tr>
</tbody>
</table>

17 Projects registered by the CDM Executive Board or under validation.
Conclusion

This paper has described how a process of producing biochar and applying it to soil could generate carbon credits, partly by offering an alternative energy fuel and partly from storing carbon sustainably in soils. It has been concluded that although for the different biochar process stages methods exist or are being developed for calculating GHG emission reductions, these methods taken together are currently insufficient to form an integrated methodology for calculating biochar carbon credits.

Potentially, there is a wide range of markets in which biochar carbon credits could be traded, both official ‘compliance’ markets and voluntary action markets. The official markets have proven to be highly liquid to help countries and installations comply with their Kyoto protocol and EU (or other national) climate commitments, but recently they have experienced a serious price fall for economic and political reasons. Voluntary markets have remained relatively stable though with a relatively stable price.

With a view to the question what would be the climate impact of biochar in relation to the carbon market, it can be concluded that the main challenge lies with the development of clear and acceptable accounting rules for GHG emission reductions, including the mitigation of uncertainties. With such rules developed, biochar projects would be well positioned for attracting additional funding through carbon credits, when carbon markets catch up.