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# Biochar Status Under International Law and Regulatory Issues for the Practical Application

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Biochar is the carbon-rich product obtained by heating biomass in a closed system under limited supply of oxygen. Currently, there are several thermochemical technologies such as pyrolysis, gasification, and hydrothermal conversion to produce biochar. Pyrolysis involves the heating of organic materials in the absence of oxygen to yield a series of bioproducts: biochar, bio-oil, and syngas. Biochar is a charred carbon-enriched material intended to be used as a soil amendment to sequester carbon and enhance soil quality. Addition of sustainable biochar to soil has many environmental and agricultural benefits, including waste reduction, energy production, carbon sequestration, water resource protection, and soil improvement. Therefore, the use of sustainable biochar as a soil amendment is an innovative and highly promising practice for sustainable agriculture. The prospect of global scale biochar application to soils highlights the importance of a sophisticated and rigorous certification procedure. We propose that a sustainability framework for biochar could be adapted from existing frameworks developer for bioenergy. Sustainable land use policies, combined with effective regulation of biochar production facilities and incentives for efficient utilization of energy, and improved knowledge of biochar impacts on ecosystem health and productivity could provide a strong framework for the development of a robust sustainable biochar industry. The objective of this work was to discuss the concept of integrating biochar properties with environmental factors and with sustainable biochar certification procedure.

## 1. Introduction

Biochar is a fine-grained charcoal-like material, which is generated by heating biomass in air-deprived conditions called pyrolysis (Figure 1.). A feedstock for biochar production can be purpose-grown biomass as well as the residual material from forestry or agriculture. Chemical properties of carbon bound in the biomass are changed by the pyrolysis into a form which is more resistant to microbial decomposition in comparison with the original material. Such thermally transformed material has a mean residence time in soil up to several thousand years, which offers a potential method for carbon sequestration, since biochar decomposition into $CO_2$ and other greenhouse gases is very slow (Lehmann, 2007).
Biochar production and its application to soil, in addition to climate change mitigation, provide economic benefits in several other important areas such as waste management, energy production and soil improvement (De Filippis et al., 2013). As a waste management strategy, biochar can be produced from a variety of feedstock that would otherwise constitute a financial and environmental liability. Another value is the utilization of energy that is released during pyrolysis process. Production of biochar can be linked with local heat generation. The third benefit is improving the soil quality by enriching it with biochar. On soils with productivity constraints, it is possible to significantly increase crop yields. Losses of agrochemicals such as fertilizer nutrients, herbicides and pesticides can be mitigated by biochar's ability to retain these compounds. Biochar improves several key soil properties (e.g. water retention in sandy soils, aerate and lighten clay soils) and is not only more stable and longer-acting than the original decaying organic matter, but also exhibits higher efficiency per unit of carbon added to soil. Measurement and verification of biochar

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sequestration is facilitated by the fact that the amount of added carbon can easily be calculated at any time and need not be measured continuously.

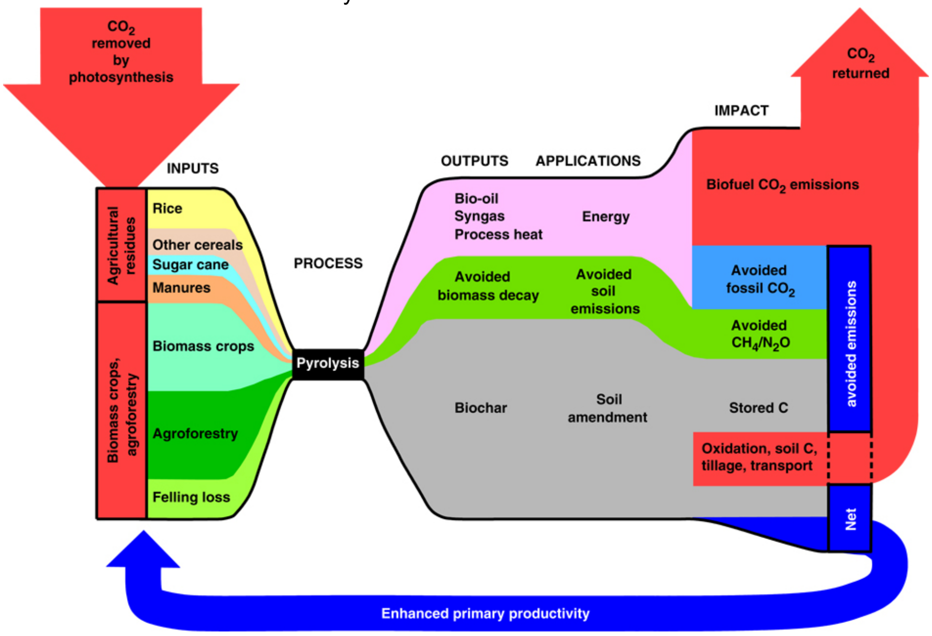


*Figure 1: Schematic diagram of biochar production (Woolf et al., 2010)*

## 2. Possible uses of biochar

Biochar is much too valuable for it to be just worked into the soil without having it used at least once for more beneficial purposes. Biochar is without doubt one of the decade's most exciting fields of research, with findings and their practical implementation increasing exponentially from year to year. A shortly list highlighting the particular use of biochar in several fields with the latest research findings:

- The cascaded use of biochar in animal farming (silage agent, slurry treatment, feed additive)
- Use as a soil conditioner (carbon fertiliser, compost, plant protection)
- Use in the building sector (insulation, air decontamination, humidity regulation)
- Biogas production (biomass additive, biogas slurry treatment)
- The treatment of waste water (active carbon filter, pre-rinsing additive)
- The treatment of drinking water (micro filters)
- Other uses (exhaust filters, carbon fibers, semiconductors, etc.) (Schmidt, 2012).

To remove obstacles in the implementation of biochar systems, establishment of appropriate policies at national and international levels is required. It is also necessary to bring to life such mechanisms for carbon trading, which recognize carbon sequestration in soils (Zheng and Sharma, 2010). Biochar has the potential to make a major contribution to the mitigation of climate change, and enhancement of plant production. However, in order for biochar to fulfill this promise, the industry and regulating bodies must take steps to manage potential environmental threats and address negative perceptions. Sustainability certification could be introduced to provide confidence to consumers that sustainable practices have been employed along the production chain, particularly where biochar is traded internationally.

## 3. Biochar application under international law

Biochar has implications in various EU policy areas, including environment protection, waste management, agricultural and climate change policy, etc. The main goal is to integrate benefits and impacts into a common framework, finding the most suitable and cost-effective solutions. The waste-to-energy technologies have become a keystone and are increasingly interesting as viewed from both an energy supply perspective and waste management (Peres et al., 2013). Chemicals are widely used in our daily life, almost everywhere and in everything. To control and protect human health from chemical exposures, regulators need scientific input regarding potential harmful impacts of the chemicals on the market and in the environment (Lee et al., 2013). Legislative requirements for commercial use of biochar are most often associated with ensuring the safety, health and environment protection. The basic premise is the creation of a legal background that would provide these guarantees and would create general confidence in biochar as a useful product.

### 3.1 Biochar as waste material or production residue

The task of legislation is primarily to introduce such measures and to define rules that ensure the highest standard of protection and make undesirable impacts on the environment as small as possible. Application of regulatory measures and restrictions is based on the intended use of biochar. Waste management issues should be considered first. Legislation in this area is relatively new, and although has undergone a great development in the last years, still it is not entirely systematic and comprehensive. The basic EU legislation governing this area is Waste Framework Directive (WFD), which sets the basic concepts and definitions related to waste management. Proper implementation, application and enforcement of EU waste legislation are among the key properties of EU environmental policy. The revised WFD introduces new provisions in order to boost waste prevention and recycling as part of the waste hierarchy and clarifies key concepts namely, the definitions of waste, recovery and disposal and lays down the appropriate procedures applicable to by-products and to waste that ceases to be waste (EC, 2008).

Biochar is produced simultaneously with syngas in a reactor. The pyrolysis process is adapted to ensure that biochar will have the necessary technical quality. At the beginning of the process, technical decision was made in order to get desired type of biochar. The further use of biochar is certain in agriculture and gardening. Biochar can be used directly without processing, such as mixing with other substances, which is not an integral part of the manufacturing process. Under these circumstances, biochar should not be considered as a waste. The question of distinguishing between ‘waste’ and ‘product’ has been raised in particular in the framework of European Union law and the results of this process are undoubtedly of great importance for national decision-making bodies in all Member States. The problem involved mainly the distinction between waste and usable materials produced in the manufacturing process, whose main objective was to produce different material. The present situation is such that the law does not distinguish between products, production residues or non-waste by-products. Relevant is only determination whether the material is a waste or not (EC, 2008). An object considered a by-product under the WFD is in principle subject to REACH Regulation which applies to waste only (EC, 2006). The Commission has a mandate under the WFD to define ‘by-product’ criteria for specific substances or objects through procedure. Additionally, Member States may set out by-product criteria at national level. Excluded from the scope of the Directive are also straw and other natural non-hazardous agricultural or forestry material used in farming, forestry or for the production of energy from such biomass through processes or methods which do not harm the environment or endanger human health in compliance with the standards of EU environmental legislation. It is therefore obvious that the uncontaminated biomass used as feedstock for pyrolysis process whose output is a syngas and biochar, is not a waste.

### 3.2 Biochar for $CO_2$ sequestration

Carbon dioxide removal from the atmosphere is an example of a mitigation strategy. Carbon dioxide, the most prevalent of greenhouse gases, is the greatest total contributor to the radiative forcing that is the source of climate change (Ingwersen et al., 2013).

In case of application of biochar in agricultural land solely for the purpose of carbon sequestration, this is not treated by any particular regulation, as is the case for carbon sequestration in natural rock structures - Directive 2009/31/EC on the geological storage of carbon dioxide (EC, 2009). It is possible that future legislative development in carbon sequestration by biochar application into agriculture land will follow principles laid down in the Directive on the geological storage.

### 3.3 Biochar as natural soil amendment

Biochar has many positive properties that make it suitable for use in agriculture or gardening. Due to its porosity increases the soil's ability to retain water and nutrients dissolved in it. Its huge internal surface is a substrate for microbial colonization. There are no known negative aspects on soil properties if biochar is produced from uncontaminated feedstock and the production conditions are in accordance with the requirements and continuously controlled (Verheijen et al., 2010).

Despite the fact that raw biochar does not have enough nutrients to be classified as a nutrient fertiliser, it can be considered as soil amendment, growing media or soil improver. Soil improvers are primarily applied to improve the physical structure by adding stable organic matter to the soil. Application of biochar into agricultural land must be in accordance with relevant legislation. The core European provisions concerning fertilisers is Regulation EC 2003/2003 relating to fertilisers. The Fertilisers Regulation aims to ensure the free circulation on the internal market of “EC fertilisers”, i.e. those fertilisers that meet the requirements of this legislation for their nutrient content, their safety, and their absence of adverse effect on the environment. The Regulation in its current form applies only to inorganic mineral fertilisers (EC, 2003). The Fertilisers Regulation does not affect other categories of fertilisers placed on the market of the Member States in accordance with national legislation. These “national fertilisers” include organic and organo-mineral fertilisers, liming material but also non-fertiliser products such as growing media and organic soil improvers. While those provisions do not need to comply with the specific EU legislation in the area of fertilisers, they have nevertheless to respect the basic principles of the EU Treaty; especially the principle of free movement of goods. This is covered by Regulation EC No 764/2008 on mutual recognition which ensures the intra-community free movement of goods in the non-harmonised area. It obliges a Member State to accept products lawfully marketed in another Member State unless the Member State of destination can demonstrate that the product poses a risk for human health or the environment (EC, 2008). The mutual recognition is considered as an alternative approach to registering according to national regulations because companies may place products on the market of another EU Member State without going through an application procedure. However, most of the companies are not familiar with the requirements of the Regulation and there still is chance that Member States will use environment and public safety safeguards to block the entry of their products in the national markets.

Biochar is not excluded from the scope of the national waste regulation in Member States of the EU. Excluded are those kinds of biomass which comply requirements of by-products and/or requirements of end-of-waste status in accordance with WFD. There is not existing and allowed technology infrastructure for processing of biochar in MS yet. It means, that biochar is not considered as by-product and biochar do not comply the end-of-waste status requirements in accordance with WFD. Some Member States have established very detailed national rules whereas others have not. Once a manufacturer has decided to apply for the registration of a new fertiliser type, it must submit a technical dossier to the competent authority of the Member State in which it is established. Register of fertilizers is administered by the Central Control and Testing Institute of Agriculture as a legal person the establisher of which is the Ministry of Agriculture of MS. The dossier must contain scientific evidence that the candidate fertiliser is not harmful to the environment and human health. Then a Member State will examine the dossier and then have to express its opinion on the candidate fertiliser type. When registration applies, safety and agronomic efficacy assessments must be carried out. Safety is addressed via a methodology based on the establishment of threshold values for heavy metals and a limited number of organic pollutants and microbiological criteria. These rules are not identical throughout the EU and thus constitute potential barriers to mutual recognition.

## 4. Biochar certification

The development of a sustainability framework for biochar, employing the approaches described above, will facilitate acceptance of biochar by society and individual consumers. Options for implementation of a sustainability framework vary from good practice guidelines, through voluntary certification, to regulation. A sustainability scheme could be supported by regulation that specifies requirements for certification to access particular markets; biochar producers and users will be motivated to develop appropriate management systems and obtain certification to enable them to access these markets. Establishment of a certification scheme will take time, to agree on intent, substance, and to develop the necessary institutional support and governance structures, including verification processes. Multiple schemes may emerge, requiring producers and consumers to choose between them (Cowie et al., 2012). To support a certification scheme, methods for assessing biochar are required to identify whether biochar have undesirable properties or have been produced in environmentally unsound manner. Recent research into methods for characterizing key properties of biochar could support such assessments (Ronsse et al., 2013; Cross and Sohi, 2011).

Recognizing that sustainability should consider the whole product life cycle, certification must assess all stages from feedstock production or procurement through processing to utilization. In some jurisdictions, all aspects of the biochar lifecycle are already regulated by various disconnected but overlapping schemes. The biochar system may also be measured, monitored and verified to meet mandated or voluntary greenhouse gas emissions targets. Where existing systems for monitoring and reporting on sustainability are considered adequate, these systems could be recognized as meeting the requirements for sustainable biochar certification, in much the same way as the EU Renewable Energy Directive accepts biofuels certified under a range of certification schemes. Such a process for mutual recognition of existing and developing sustainability certification schemes would minimize unnecessary burden on participants and encourage adoption (Cowie et al., 2012).

Different biochar certificates recently have put forward a proposal for guidelines for specification of biochar, with the aim of providing a product definition and specification for quality requirements, while ensuring confidence from the consumers. The International Biochar Initiative (IBI), European Biochar Certificate (EBC), Biochar Quality Mandate (BQM) and the European Community Biochar Criteria (ECBC) prepared guidelines for sustainable application of biochar to soil. These initiatives are trying to define production criteria and biochar properties and quality, but are not recognized by any national legislation as official methods within EU. However, the view expressed in this paper is that a robust certification framework should extend beyond a technical description and labeling of the biomass feedstock and biochar material to also include the environmental and socioeconomic context relevant to the site where biochar would be applied to soils.

Biochar certificates were developed by biochar scientists to ensure a sustainable biochar production and low hazard use in agronomic systems. They are based on the latest scientific data's; it's economically viable and close to technical and agricultural practice. Users of biochar and biochar-based products will benefit from a transparent and verifiable monitoring and independent quality control. Biochar produced in accordance with the standards fulfills all the requirements of sustainable production and a positive carbon footprint; however there are essential differences between standards. The following comparison shown in Table 1 was made to articulate some differences between the biochar standards.

*Table 1: Comparison of limited values by different biochar certificates (Refertil, 2013)*

| Contaminants | Biochar standards | | | | | |
|---|---|---|---|---|---|---|
| | **IBI** (USA) | **BQM** (UK) | | **EBC** (CH) | | **ECBC** |
| | | *high grade* | *standard* | *base* | *premium* | |
| | mg/kg dm | | | | | |
| As | 12-100 | 10 | 100 | - | - | - |
| Cd | 1.4-39 | 3 | 39 | 1.5 | 1 | 1 |
| Cr | 64-1,200 | 15 | 100 | 90 | 80 | 100 |
| Cu | 63-1,500 | 40 | 1,500 | 100 | 100 | 100 |
| Hg | 1-17 | 1 | 17 | 1 | 1 | 0.5 |
| Ni | 47-600 | 10 | 600 | 50 | 30 | 50 |
| Pb | 70-500 | 60 | 500 | 150 | 120 | 120 |
| Zn | 2,000-7,000 | 150 | 2,800 | 400 | 400 | 600 |
| PAH | 6-20 | 20 | 20 | 4 | 12 | 6 |
| PCB | 0.2-0.5 | 0.5 | 0.5 | 0.2 | 0.2 | 0.1 |

These standards guarantee ecologically sustainable procurement and production of biomass feedstock for biochar production, compliance with emission standards and environmentally safe storage. Biochar quality is comprehensively monitored and documented.

There should be the common objective of a harmonized international certification scheme that takes the national and continental differences into consideration. Any certification/regulation that may be developed for biochar requires sound scientific evidence and recommendations. It will be imperative to provide the scientific evidence to the policy community in a manner that is comprehensive, robust, objective and independent of any conflict of interest. All data should be made available in a transparent way, with full disclosure of data, statistics and funding (Verheijen et al., 2010).

## 5. Conclusions

Biochar shows great promise which can contribute significantly to mitigation of climate change, whilst assisting in the reduction of land degradation and promoting agricultural productivity. Its systematic application in the EU will require bridging substantial knowledge gaps with targeted research programs. Thanks to multidisciplinary research the understanding of the biological and chemo-physical processes involved in the use of biochar has made great progress in last years. Existing policies do not sufficiently incorporate the technological solution of biochar. Legally, in most countries it is still considered as a waste of a burning process, thus limiting its exploitation opportunities since it is not economic valuable and it is possible to add to the soil only for research purposes. Now biochar does not have any economic value and yet it is not interesting for both producers and end-users.

The adoption of pyrolysis represents an opportunity to explore new sustainable forms of waste management, biomass usage, renewable energy production as well as of production of soil amendments. Since the biochar is a by-product of pyrolysis, in order to spread out this clean energy production method it is vital to improve the governance settings through the development of a transnational strategy to fully recognized & legally approved as soil amendant. Only in this way the pyrolysis can represent a competitive alternative with other biomass transformation systems. A legislative framework for biochar may be continuously developed in order to regulate its use in European Union.

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## References

Cowie A.L., Downie A.E., George B.H., Singh B., Van Zwieten L., O'Connell D., 2012, Is sustainability certification for biochar the answer to environmental risks?, Pesqui Agropecu Bras, 47, 637-648.

Cross A., Sohi S.P., 2011, The priming potential of biochar products in relation to labile carbon contents and soil organic matter status, Soil Biol Biochem, 43, 2127-2134.

De Filippis P., Di Palma L., Petrucci E., Scarsella M., Verdone N., 2013, Production and characterizaton of adsorbent materials from sewage sludge by pyrolysis, Chemical Engineering Transactions, 32, 205-210.

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives [2008] OJ L312/3.

Ingwersen W.W., Garmestani A.S., Gonzalez M.A., Templeton J.J., 2013, A systems perspective on responses to climate change, Clean Techn Environ Policy DOI: 10.1007/s10098-012-0577-z.

Lehmann J., 2007, Bio-energy in the black, Front Ecol Environ, 5, 381-387.

Lee J., Pedersen A.B., Thomsen M., 2013, Framework for combining REACH and national regulations to obtain equal protection levels of human health and the environment in different countries - Comparative study of Denmark and Korea, J Environ Manage, 125, 105-116.

Peres A.P., Lunelli B.H., Maciel Filho R., 2013, Application of biomass to hydrogen and syngas production, Chemical Engineering Transactions, 32, 589-594.

Refertil, 2013, Refertil Biochar Policy, <www.refertil.info> accessed 8.12.2013

Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC [2006] L136/3.

Regulation (EC) No 2003/2003 of the European Parliament and of the Council of 13 October 2003 relating to fertilisers [2003] L304/1.

Regulation (EC) No 764/2008 of the European Parliament and of the Council of 9 July 2008 laying down procedures relating to the application of certain national technical rules to products lawfully marketed in another Member State and repealing Decision No 3052/95/EC [2008] L218/21.

Directive 2009/31/EC of the Uropean Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 [2009] L140/114.

Ronsse F., van Hecke S., Dickinson D., Prins W., 2013, Production and characterization of slow pyrolysis biochar: Influence of feedstock type and pyrolysis conditions, GCB Bionergy, 5,104-115.

Schmidt H.P., 2012, 55 Uses of Biochar, Ithaka J, 1, 286-289.

Verheijen F.G.A., Jeffery S., Bastos A.C., Velde M. van der, Diafas I., 2010, Biochar application to soils: a critical scientific review of effects on soil properties, processes and functions, Eur Comm, Luxembourg, p 149.

Woolf D., Amonette J.E., Street-Perrott F.A., Lehmann J., Joseph S., 2010, Sustainable biochar to mitigate global climate change, Nat Commun, 1, 56-65.

Zheng W., Sharma B.K., 2010, Using biochar as a soil amendment for sustainable agriculture. Illinois Sustainable Technology Center, Illinois, IL, USA. p 42.