



July 2013 News from the International Biochar Initiative

[IBI Welcomes New Executive Director Wiley Barbour](#)

The Board of Directors of the International Biochar Initiative (IBI) is pleased to announce that Mr. Wiley Barbour has been appointed to serve as the organization's Executive Director. Mr. Barbour, P.E. is a licensed professional engineer with 20 years of relevant experience in growing new markets for environmental products and services, and technical expertise in greenhouse gas emissions, climate change strategies, and project management.

Mr. Barbour comes to IBI from Camco Clean Energy, a project development company investing in emission reduction projects around the world. During his four years as a Vice President at Camco, Mr. Barbour led a successful effort to develop the first forest carbon project in the state of Alaska and created and launched the Nitrace project, a first of its kind program to help farmers in the US corn belt access environmental markets.

Mr. Barbour previously served as the Executive Director of Environmental Resources Trust, an early pioneer in market based solutions to environmental problems. At ERT he developed standards and protocols for the emerging carbon market, working with a variety of governmental and corporate clients. After leading ERT into a merger with Winrock International, he helped to found and launch the American Carbon Registry.

As a Senior Policy Analyst in the US Environmental Protection Agency in the Clinton Administration, Mr. Barbour was responsible for the US Government's Greenhouse Gas Emission Inventory Program. At the EPA, he participated in numerous US delegations to the United Nations climate change negotiations, and contributed to the work of the Intergovernmental Panel on Climate Change, particularly on issues related to national reporting, emissions accounting, and verification of emission inventories.

Says Mr. Barbour, *"I am thrilled to join the thousands of researchers, supporters and members of the International Biochar Initiative. As CO2 levels in our atmosphere rise above 400 ppm for the first time in human history, the world is looking for inexpensive and sustainable ways to pull that excess carbon back out of the atmosphere. Biochar production and use holds the promise to do just that, while improving the fertility and resiliency of degraded and marginal soils."*

The board also wishes to thank Ms. Debbie Reed who served as the IBI Executive Director for many years. Ms. Reed will continue to work with IBI as the organization's Policy Director to expand our focus on creating a more supportive policy environment for biochar, and will continue work on the Biochar Carbon Offset Protocol and other initiatives.

[Biochar Carbon Offset Protocol Development Update](#)

The Quantification Methodology for Biochar Projects (aka the Biochar Carbon Offset Methodology) continues to advance through the American Carbon Registry's (ACR) validation

process. A first set of revisions was recently submitted to ACR by the methodology project team—comprised of IBI, the Climate Trust and The Prasino Group. The revised methodology will be reviewed by ACR, and pending any further clarification requests, will be distributed for a 4-week public comment period. During that time ACR will also offer a stakeholder consultation webinar to solicit public input. The project team will respond to public comments as necessary in a further revision of the document, and this version will then undergo at least two rounds of comment-and-response by a scientific peer review panel convened by ACR. Upon completion of the peer review and approval by ACR, the final methodology will be published on ACR's website and available for use by project developers. IBI will circulate the draft methodology and announce the webinar through our website, press releases, and selected mailings as soon as it becomes available for public comment.

[UC Davis Launches a Biochar Database Utilizing the *IBI Biochar Standards*](#)

The Environmental Soil Chemistry Group at the University of California Davis, led by Dr. Sanjai Parikh, recently launched the UC Davis Biochar Database, designed to fill critical knowledge gaps and become an open source of information on biochars. The Biochar Database utilizes the *IBI Biochar Standards* as a framework for collecting information on important aspects of biochars, from basic physico-chemical properties to the concentrations of potential toxicants to production parameters. Dr. Parikh envisions the database growing to include a wide range of biochars so that researchers, end users, regulators and others can view trends and make informed decisions on biochar usage. The database already contains nearly 350 entries. Interested parties are invited to view and upload information on their biochars at <http://biochar.ucdavis.edu/>.

[Profile: Carbon Gold Finding a Market Niche with a Pilot-Scale Biochar Kiln](#)

Carbon Gold, a UK-based company, is working to fill what they see as a market demand for a small-scale transportable kiln that can utilize a variety of feedstocks. The company designed the unit based on the traditional ring kiln with additional adaptations that address issues of transportability and sustainability for pilot scale projects around the world. Now in its second iteration, the Superchar 100 kiln can produce up to 100 kgs of biochar per 8 hour carbonization cycle from a broad range of feedstocks from forestry and agricultural residue streams. The kiln can be transported from site to site on a small trailer. With feedstocks such as wood chips, rice husks, coffee husks, and other agricultural residues, users can utilize materials at hand.



The Superchar 100 was first used in Belize where Carbon Gold is working with cocoa growers within the Kraft Foods supply chain (for an earlier story on this project, please see: <http://www.biochar-international.org/carbongold>). The Belize project is now in its fifth year and the cacao farmers are using biochar produced from cacao and shade tree prunings to improve their cultivation systems. When the work in Belize started in 2009, the team at Carbon Gold and the local farmers were using brick-built retorts to produce biochar, but it soon became apparent that

the project required a different kiln design to better suit the local environment. Carbon Gold therefore designed and used the first Superchar 100 kilns as part of the project's expansion following the first positive crop trial results with biochar. With the new kiln models, the project entered a second phase of implementation and biochar production—including field trials that followed more rigorous scientific protocols. To read the remainder of this story, please see: http://www.biochar-international.org/profile/carbon_gold.

Photo: The unit in transit; courtesy of Carbon Gold.

Biochar Briefs: News Roundup for July

We update the website daily with new articles on biochar. For more information, please see: <http://www.biochar-international.org/newsbriefs>.

Australia

The South Australian No-Till Farmers Association is working on biochar trials investigating the application of several biochar amendments on soils at a farm in Freeling, Australia. These amendments include biochar, biochar with fertilizer, and a product called "biochar complete": biochar added to chicken litter to capture ammonia that is otherwise lost to the atmosphere. (link to: <http://www.theland.com.au/news/agriculture/cropping/general-news/biochar-creates-options/2663817.aspx>)

Canada

The Collège Boréal and the EACOM Timber Corp.'s Nairn Centre sawmill in Canada are collaborating on the school's first applied research project on the analysis and use of biochar. The research project includes studying the effects of varying doses of biochar on soil samples to look at their effect on the growth of jack pine and birch seedlings. By summer 2014, the results of the research will allow a first set of large-scale experiments using biochar in the area to proceed. (link to: <http://www.northernontariobusiness.com/Industry-News/forestry/2013/07/Research-project-to-test-viability-of-biochar.aspx>).

Costa Rica

As part of Costa Rica's goal to become the world's first carbon-neutral nation by 2021, farmers are looking at how to reduce agricultural GHG emissions. One of those farmers, Maria Luisa Jimenez, is using a low-carbon soil management system she calls "organoponics" in place of commercial fertilizer. Organoponics uses a mixture of dried rice husks, coconut fiber, composted cow manure and biochar. Jimenez participated in a government training program to learn these techniques and is now a trainer herself. More than 550 Costa Rican families have learned to utilize these processes over the past five years. (link to: http://www.theworld.org/2013/07/carbon-neutral-lunch-costa-rica-looks-to-lead-on-climate-friendly-ag/?utm_source=rss&utm_medium=rss&utm_campaign=carbon-neutral-lunch-costa-rica-looks-to-lead-on-climate-friendly-ag)

Germany

A research project at the Center for Environmental Research and Sustainable Technology (UFT), University of Bremen is looking at how to use biochar to filter drug residues from wastewater. Says project collaborator Dr. Ingo Dobner of the University of Bremen on the biochar filter, "It is a very effective, but also cost-effective and technically easy-to-use method." (link to: <http://www.deutsche-apotheker-zeitung.de/spektrum/news/2013/07/02/mit-pflanzenkohle-arzneirueckstaende-filtern/10464.html>)

India

To reduce stubble burning in fields in India, UK-based Aston University and the Indian Institute of Technology (IIT) in Ropar have developed the Pyroformer which uses field residues and converts

them to oils, gas, charcoal, and biochar for use in rural villages. The charcoal will be used as a fuel in small domestic stoves and the biochar as a soil amendment. (link to: http://articles.timesofindia.indiatimes.com/2013-07-03/chandigarh/40350953_1_iit-ropar-stubble-diesel-engine).

United States

A vegetable production specialist for Iowa State University Extension and Outreach, Ajay Nair, is sharing information with growers to help them utilize more sustainable practices. Nair is doing trials with biochar and other soil amendments such as compost, and is looking at methods to extend the growing season. (link to: http://globegazette.com/news/local/new-isu-state-lab-looks-at-sustainable-vegetable-production/article_9bf6ad8a-ef61-11e2-aa72-001a4bcf887a.html)

Cool Planet Energy Systems, which produces both biogas and biochar, is moving its headquarters to the Denver, CO area. The new facility won't make biogas or biochar, but will make equipment and materials that the company will ship by rail to other parts of the country for use in opening smaller plants. (link to: <http://www.bizjournals.com/denver/news/2013/07/10/cool-planet.html>).

Virginia Military Institute researchers are using biochar made from llama manure to clean water in parts of South America, most recently in villages in Bolivia. "Because of all the mining there, they have heavy metal contamination in their streams," said Major Tim Moore, an Associate Professor of Engineering at VMI and faculty sponsor of Engineers Without Borders. "They drink directly from those streams. And because of that they end up with a lot of health problems." (link to: <http://www.wsls.com/story/22840209/say-what-vmi-researchers-cleaning-water-with-llama-manure>).

Special Registration Price until July 31 for the International Conference on Biochars, Composts, and Digestates/2013 International Biochar Conference

The Bari, Italy-based event will focus on and develop various aspects of scientific and applied biochar, compost and digestate science and technology, including laboratory and field approaches and social, economic, marketing and regulatory implications. Special emphasis will be devoted to the fundamental role of agriculture, and soil as an instrumental but limited resource for a correct, sustainable, and harmonized application. The "Regular Registration" level for the conference is open until July 31.

For more information on the conference, details, and registration, please see: <http://www.bcd2013.eu/generale-information>.

Register Now for the 2013 USBI North American Biochar Symposium

There couldn't be a more exciting time to join 400 colleagues for a North American conference on biochar. Over the past six years, growers, scientists, engineers and entrepreneurs worldwide have experienced the remarkable properties and benefits of using biochar as a soil conditioner, as a medium for ecosystem restoration, as an agent for wastewater remediation, and even as a food additive to enhance livestock nutrition. Registration is now open for this event at: www.symposium2013.pybiochar.org/register.

In addition to learning about exciting new developments in the field through networking and formal presentations at the event, participants will also have the opportunity to attend the following:

- Ignite Talks – Monday night presentations by experts in the biochar field
- Exhibit tables
- Poster Presentations & Book Signings
- A Biochar Banquet with food stations that will feature local produce grown in biochar conditioned soil, as well as a variety of meats and adult beverages enhanced by biochar
- A Video Lounge
- A post-conference field day to learn more about technologies with a hands-on approach.
- To volunteer, ask questions, or share comments, please contact the conference organizer, Karen Ribeiro at: karen@pybiochar.org

Opportunities in Biochar

- Submit an Abstract to the Biomass 2013 International Conference with a special session on biochar: **due July 31**. For more information: <http://www.biochar-international.org/node/4272>.
- Submit an Abstract to the 2013 Geological Society of America's Annual Meeting: **due August 6**. For more information: <http://www.biochar-international.org/node/4129>.
- Submit an Expression of Interest for the Second International Biochar Training Course at Nanjing Agricultural University (NJAU), planned for October, 2013. For more information: <http://www.biochar-international.org/node/3845>.
- Vote for Biochar in the EU Commission Contest "A World as You Like It". Support the Istituto di Biometeorologia-Consiglio Nazionale delle Ricerche's biochar project entry by voting for their project at: <http://lnkd.in/uC2mrd>. A World as You Like It is a contest launched by the EU Commission to search for new projects and ideas on climate change mitigation/adaptation; more information is available at: <http://world-you-like.europa.eu/en/>.

New job postings at: <http://www.biochar-international.org/network/jobs>.

Upcoming Calendar Events

- August 26 – 31: The International Conference on Agriculture, Renewable Energy and Science. Location: United Kingdom. For more information: <http://www.biochar-international.org/node/4233>.
- September 1: CHAR FEST "Up the Back". Location: Mullumbimby, Australia. For more information: <http://www.biochar-international.org/node/4270>.
- September 1 – 13: GEPP Executive Summer School on Global Environmental Policy. Location: Geneva, Switzerland. For more information: <http://www.biochar-international.org/node/3780>.
- September 6: Agricultural and Environmental Benefits from Biochar use in ACP Countries (Bebi). Location: Rome, Italy. For more information: <http://www.biochar-international.org/node/4271>.
- September 11: Biomass 2013 International Conference with a special session on biochar. Location: Singleton, United Kingdom. For more information: <http://www.biochar-international.org/node/4272>.

- September 23 – 25: 3rd Annual World Congress of Agriculture 2013. Location: Hangzhou, China. For more information: <http://www.biochar-international.org/node/3995>.
- October 13 – 17: 2013 USBI North American Biochar Symposium: Harvesting Atmospheric Carbon: the Science and Synergies of Biochar. Location: Massachusetts, US. For more information: <http://www.biochar-international.org/node/3694>.
- October 14 – 18: 10th Meeting of the Grupo Brasileiro da Sociedade Internacional de Substâncias Húmicas (IHSS), Brazil. For more information: <http://www.biochar-international.org/node/4048>.
- October 17 – 20: International Conference on Biochars, Composts, and Digestates/2013 International Biochar Conference. Location: Bari, Italy. For more information: <http://www.biochar-international.org/node/4096>.
- October 25 – 31: The Second International Biochar Training Course held at Nanjing Agricultural University (NJAU). Location: Nanjing, China. For more information: <http://www.biochar-international.org/node/3844>.
- October 27 – 30: 2013 Geological Society of America's Annual Meeting with a session on "Pyrogenic black carbon, or biochar, in soils and sediments, its characterization and fate, its effects on the carbon cycle and carbon sequestration, and its effects on soil properties". Location: Colorado, US. For more information: <http://www.biochar-international.org/node/4128>.
- October 29 – 30: "bioenergy+recycling" Conference with Exhibition American-European Technology and Business Exchange. Location: Pennsylvania, US. For more information: <http://www.biochar-international.org/node/4101>.
- November 17 – 20: SETAC North America 34th Annual Meeting with "Environmental implications of biochar" symposium. Location: Tennessee, United States. For more information: <http://www.biochar-international.org/node/4094>.

See the [IBI Calendar page](#) for more events. To add an event to the calendar, send the information to info@biochar-international.org.

Regional Biochar Group Updates

To read more on the 54 regional and national biochar groups, please see IBI's website (link to: <http://www.biochar-international.org/network/communities>). This month includes two new groups, the Alberta Biochar Initiative (Canada) and the Biochar Interest Group in New Zealand, as well as updates from the Biochar Association of Indonesia and the Mongolian Biochar Initiative (MoBI).

Alberta Biochar Initiative (Canada)

The mission of the Alberta Biochar Initiative (ABI) is to support the development and commercial deployment of biochar production technologies and the generation and collation of data that assists in the establishment of commercial markets for biochar products made from local feedstock for the benefit of rural Albertans. The ABI envisions a robust, commercial-scale biochar production, application and carbon trading market in Alberta by 2016. For more information on this group, please see:

<http://www.biochar-international.org/regional/ABI>.



ABI officially celebrated its opening with a one-day event comprising a ribbon-cutting ceremony and biochar seminar on May 23, 2013. More than 90 researchers, business representatives, government officials and enthusiasts from all over the world gathered at Alberta Innovates Technology Futures's (AITF) facility in Vegreville to celebrate ABI's accomplishments over the last year and discuss the potential for biochar to help grow Alberta's bioeconomy.

Richard Wayken, Vice President of Bio & Industrial Technologies at AITF, praised the Alberta Biochar Initiative for the work its members have done since it was formed 17 months ago. "The team has made great strides in determining which locally-available feedstock work best, and in optimizing the two demonstration-scale pyrolysis units that produce biochar," said Wayken. "Thanks to their efforts, I'm increasingly certain the Alberta Biochar Initiative will contribute to the emergence of a strong bioeconomy in Alberta." Click here for the full announcement (link to: http://www.biochar-international.org/sites/default/files/ABI_IBI%20newsletter_July_2013.pdf).

Photo: Photo caption: MLA Jacquie Fenske and Mayor Richard Coleman cut the ribbon at ABI's grand opening and biochar seminar, May 23rd, 2013

Biochar Interest Group in New Zealand

BIG-NZ is an independent, volunteer group interested in the production and application of biochar in New Zealand. The concept of a New Zealand-biochar interest group has been under discussion between biochar enthusiasts for a number of years. A call was circulated in March 2012 to a list of ~130 people and the group is gathering a voluntary 'interim management team' to undertake the work leading to a NZ interest group. To undertake these tasks the group needs a mix of biochar-knowledgeable, skilled, and enthusiastic volunteers. For more information, please see: <http://soilcarbon.org.nz>.

The Indonesian Biochar Association (IBA)

The IBA hosted a workshop on Biochar Promotion on Wetlands of Indonesia. The conference was located in Bogor, Indonesia and held 12-13 July. The purposes of this workshop were the following:

1. To strengthen communication between the Japan Biochar Association (JBA) and the IBA
2. To look at establishing a Biochar certification system in conjunction with other established systems
3. To exchange ideas among scientists and stakeholders in different fields
4. To discuss how to develop new projects
5. To visit potential farmer groups to contribute to sustainable agriculture

Participants of the workshop came from Japan Biochar Association (JBA), Indonesia Biochar Association (IBA), Japan International Cooperation Agency (JICA), Indonesian Agency for Agricultural Research and Development (IAARD), Forestry Research and Development Agency (FORDA), Indonesian Institute of Sciences (LIPI), International Rice Research Institute (IRRI), Hokkaido University, University of Lambung Mangkurat, University of Palangkaraya, Universitas of Padjadjaran, Borneo University, Agency for Assessment and Application of Technology (BPPT), National Council on Climate Change (NCCC), and PT Great Giant Pineapple. Click here for a full report on the conference (link to: http://www.biochar-international.org/sites/default/files/Report_Indonesia_workshop.pdf).

The Mongolian Biochar Initiative (MoBI)

A report entitled *Low Tech Production and Application of Biochar in Mongolia* was compiled on work that has been done by MoBI members on:

- A comparative one month October 2012 winter wheat grow-out with and without biochar
- A comparative one season grow-out test with and without biochar using Impala potatoes

- The hollow core biochar retort oven
- The low tech, natural draft metal box retort oven for fine grain feedstock such as sawdust and rice husks
- The UB JR test bed natural draft 200 l TLUD biochar oven and its derivative, the simplified UB J-RO with inter-changeable primary air ports

The report can be found at: http://www.biochar-international.org/sites/default/files/Low_Tech_Production_and_Application_of_Biochar_Mongolia.pdf.

Recently Published Biochar Research

IBI tracks all published research on biochar and includes it in our [online bibliography](#). The following articles were added in the last month. Please visit the website bibliography for more information on any of these articles. Due to copyright, we cannot provide full copies of articles unless we have permission from the publisher. If you have published work that is not included, [please email us](#).

Ameloot, N.; E. R. Graber; F. G. A. Verheijen; S. De Neve (2013). Interactions between biochar stability and soil organisms: review and research needs. *European Journal of Soil Science*. Volume 64, Issue 4, pages 379–390.

Chauhan, Bhagirath S. (2013). Rice Husk Biochar Influences Seedling Emergence of Jungle rice (*Echinochloa colona*) and Herbicide Efficacy. *American Journal of Plant Sciences*.

Githinji, Leonard (2013). Effect of biochar application rate on soil physical and hydraulic properties of a sandy loam. *Archives of Agronomy and Soil Science*.

Harsono, Soni Sisbudi; Philipp Grundman; Lek Hang Lau; Anja Hansen; Mohammad Amran Mohd Salleh; Andreas Meyer-Aurich; Azni Idris; Tinia Idaty Mohd Ghazi (2013). Energy balances, greenhouse gas emissions and economics of biochar production from palm oil empty fruit bunches. *Resources, Conservation and Recycling*. Volume 77, Pages 108–115.

Headlee, William L.; Catherine E. Brewer; Richard B. Hall (2013). Biochar as a Substitute for Vermiculite in Potting Mix for Hybrid Poplar. *BioEnergy Research*.

Herath, H.M.S.K.; Marta Camps-Arbestain; Mike Hedley (2013). Effect of biochar on soil physical properties in two contrasting soils: An Alfisol and an Andisol. *Geoderma*. Volumes 209–210, Pages 188–197.

Jiang TY; Jiang J; Xu RK; Zhou LX; Wang SM (2013). Effects of different temperatures biochar on adsorption of Pb(II) on variable charge soils. *Europe Pub Med Central*.

Jingchun Tang; Wenying Zhu; Rai Kookana; Arata Katayama (2013). Characteristics of biochar and its application in remediation of contaminated soil. *Journal of Bioscience and Bioengineering*.

Khan, Naseem; Zahir Shah; Nazeer Ahmed; Saeed Ahmad; Nasir Mehmood; Muhammad Junaid (2013). Effect of integrated use of biochar, FYM and nitrogen fertilizer on soil organic fertility. *Pure Appl. Bio.*, 2(2): 42; <http://www.thepab.org/Docs/2013/june/PAB-MS-13006.pdf>.

Marchal, Geoffrey; Kilian E.C. Smith; Arno Rein; Anne Winding; Lis Wollensen de Jonge; Stefan Trapp; Ulrich G. Karlson (2013). Impact of activated carbon, biochar and compost on the desorption and mineralization of phenanthrene in soil. *Environmental Pollution*. Volume 181, Pages 200–210.

Mayer, Zsuzsa A.; Yousif Eltom; Dwayne Stennett; Elisabeth Schröder; Andreas Apfelbacher; Andreas Hornung (2013). Characterization of engineered biochar for soil management. *Environmental Progress & Sustainable Energy*.

Milla, Odette Varela; Wu-Jang Huang (2013). Identifying the Advantages of Using Municipal Solid Waste Bottom Ash in Combination with Rice Husk and Bamboo Biochar Mixtures as Soil Modifiers: Enhancement of the Release of Polyphenols from a Carbon Matrix. *Journal of Hazardous, Toxic, and Radioactive Waste Management*, Vol. 17, No. 3, pp. 204-210.

Moon, Deok Hyun; Jae-Woo Park; Yoon-Young Chang; Yong Sik Ok; Sang Soo Lee; Mahtab Ahmad; Agamemnon Koutsospyros; Jeong-Hun Park; Kitae Baek (2013). Immobilization of lead in contaminated firing range soil using biochar. *Environmental Science and Pollution Research*.

Morrow, Perry R. (2013). Biochar: Saturated hydraulic conductivity and methylene blue sorption characteristics as applied to storm water treatment. Thesis for Oregon State University.

Mubarak, N.M.; R.F. Alicia; E.C. Abdullah; J.N. Sahu; A.B. Ayu Haslija; J. Tan (2013). Statistical optimization and kinetic studies on removal of Zn²⁺ using functionalized carbon nanotubes and magnetic biochar. *Journal of Environmental Chemical Engineering*.

Ngo, Phuong-Thi; Pascal Jouquet; T.T Doan; D.K Dang; Cornelia Rumpel (2013). Long-term impact of organic amendments (compost, vermicompost and biochar) on soil organic matter quality; http://www.ramiran.net/doc13/Proceeding_2013/documents/S1.11..pdf.

Reid, B.J.; F.L. Pickering; A. Freddo; M.J. Whelan; F. Coulon (2013). Influence of biochar on isotopuron partitioning and bioaccessibility in soil. *Environmental Pollution*. Volume 181, Pages 44–50.

Sohi, Saran (2013). Pyrolysis bioenergy with biochar production – greater carbon abatement and benefits to soil. *GCB Bioenergy*. 5, i–iii.

Subedi R., Kammann C., Pelissetti S., Sacco D., Grignani C., Monaco S. (2013). Use of biochar and hydrochar to reduce ammonia emissions from soils fertilized with pig slurry; http://www.ramiran.net/doc13/Proceeding_2013/documents/S9.16..pdf.

Uchimiya, Minori and Desmond I Bannon (2013). Solubility of Lead and Copper in Biochar-Amended Small Arms Range Soils: Influence of Soil Organic Carbon and pH. *Journal of Agricultural and Food Chemistry*.

Wang, C.; M.T. Walter; J.-Y. Parlange (2013). Modeling Simple Experiments of Biochar Erosion from Soil. *Journal of Hydrology*.

Yao, Ying; Bin Gao; Jianjun Chen; and Liuyan Yang (2013). An engineered biochar reclaims phosphate from aqueous solutions: mechanisms and potential application as a slow-release fertilizer. *Environ. Sci. Technol.*

Yong Yuan; Tian Yuan; Dingmei Wang; Jiahuan Tang; Shungui Zhou (2013). Sewage sludge biochar as an efficient catalyst for oxygen reduction reaction in an microbial fuel cell. *Bioresource Technology*.