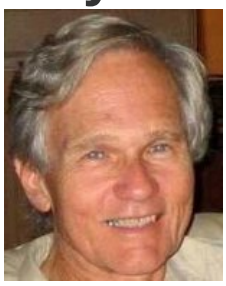
Biochar

Key to Carbon-Negative Biofuels



by Thomas R. Blakeslee, Clearlight Foundation

THE WORLD IS LOSING ITS BATTLE against global warming. Even in Europe, where they have valiantly fought to reduce greenhouse gas emissions, the imbalance gets worse every day. Biofuels are the biggest disappointment. They still emit CO2 when burned and require fertilizer, processing and transportation which all emit even more CO2. The justification for biofuels is that the growing plants take CO2 out of the air. However, plants growing on the land before planting were already capturing CO2, so only the increase in CO2 capture (if any) should be counted.

The natural balance of the earth has always included carbon storage in the plants and soil. The problem is that we have disrupted that balance. We have burned in one century much of the carbon that nature sequestered over millions of years. Coal is almost pure carbon, gathered by plants and sequestered by natural processes. We need to stop burning it!

Though growing plants take CO2 from the air and fix it in their cells, the carbon is only borrowed: 99% of that carbon ends up back in the atmosphere as the plant is eventually burned or consumed by animals, termites, fungi, nematodes or worms, which then return the carbon to the atmosphere. Pyrolysis is a way to grab the carbon in plants before it can become a meal for these creatures and return it to the soil as pure carbon biochar.

Pyrolysis mimics the natural process that turned ancient plants into coal: When biomass is heated up with no oxygen supply it melts into carbon, syngas and bio-oil. Pyrolysis was used thousands of years ago by the natives of Brazil to enrich their poor, acidic soil into Terra Preta, one of the richest, most productive soils known to man.

Terra Preta still contains as much as 9% carbon. It is always found with pottery shards and other evidence that it was man-made. It is so productive that it is bagged up and sold today as potting soil. We're still trying to match their superb results. If we succeed, we will solve world hunger, global warming and our energy shortage in one stroke.

The Amazon culture that made these soils was killed by conquest and disease. The primitive people in the area today practice slash and burn agriculture, which quickly depletes the soil and spews CO2 and pollutants into the atmosphere. The Terra Preta was created by slash and char, which involves cutting off oxygen to the burning biomass. Without oxygen, little CO2 is produced and biomass melts into carbon with a very fine structure called biochar. Hydrogen in the plant molecules produces heat, syngas and bio-oil as the plant molecules are reshuffled.

The buried biochar retains some of the micro-cellular structure of the plant. It is activated charcoal with very high surface area. It can hold water and nutrients and gradually release them as needed. The nanoscale structure of biochar, like a coral reef, hosts a whole ecosystem of soil fungi and bacteria that feed the roots of plants and hold soil together. This part of the terra preta story is still not fully understood. It takes some time for this microscopic biological culture to develop and produce the amazing increases in yield for the soil.

Experiments show that burying biochar in soil can increase productivity significantly. For poor acidic soil, it has sometimes been known to double or triple production! The pyrolysis process converts cellulosic matter into syngas, bio-oil and biochar by heating in the absence of oxygen. The bio-oil produced can be used like low-grade diesel fuel for heating and power generation. Syngas can be burned like natural gas or converted with catalysts to ethanol and chemicals usually made from petroleum.

Energy in bio-oil and syngas produced is much greater than obtained by fermentation to ethanol. For example, Miscanthus, a wild grass, produces 340 GJ/hectare/year of bio-oil. Compare with corn fermentation, that only produces 120 GJ/hectare/year (net) of ethanol. Fermentation uses lots of energy, and is only 3-5% efficient at converting plant energy into fuel.

While the fermentation process emits a lot of CO2 into the atmosphere, Pyrolysis can be carbon negative if the biochar produced is buried for carbon credits and crop enhancement. Every ton of biomass produces about 400 lbs of biochar by weight, which is equivalent to about a half ton of CO2. (CO2 is only 27% carbon.)

Because biomass has low energy density, it is expensive to ship. Pyrolysis units should therefore be close to the biomass source. Since bio-oil occupies about one-tenth as much volume

as the biomass that produced it, it is easily shipped by tanker truck or used locally. Pyrolysis units available to fit in a standard shipping container can handle the needs of a small village.

Carbon-inefficient slash and burn agriculture is practiced by 300-500 million people today. If these people convert to slash and char methods, we could stop the growth of greenhouse gas in its tracks. The International Biochar Initiative and Biochar Fund are dedicated to make that happen. This is a win-win proposition because crop yields significantly improve, while global warming is brought under control, and bio-oil produced provides a local source of fuel for electricity, cooking or heating. More crops, free fuel plus a revenue stream from selling carbon credits could transform these subsistence cultures while saving the planet.

As a direct result of global warming, large tracts of forests in Canada and the United States have been decimated by bark beetles. Though fast growing trees initially take in a lot of CO2 and sequester it temporarily in their wood, dead wood absorbs nothing. If we burn the trees all of the carbon they took in will be returned to the atmosphere. If termites consume the trees they will produce methane and CO2 with even worse effects. Methane is forty times worse for global warming than CO2. Pyrolysis could pay for itself by producing biooil and biochar while disposing of the dead trees to make room for healthy new ones.

The 2008 farm bill (passed over Bush's veto!) included amazingly strong provisions for encouraging development of Biochar. The farm lobby finally got it right! Agriculture has become a big contributor to global warming and now they can be a major part of the solution. To quote James Lovelock, creator of the Ghia theory: "The biosphere pumps out 550 gigatonnes of carbon yearly; we put in only 30 gigatonnes. Ninety-nine percent of the carbon that is fixed by plants is released back into the atmosphere within a year or so by consumers like bacteria, nematodes and worms. What we can do is cheat those consumers by getting farmers to burn their crop waste at very low oxygen levels to turn it into charcoal, which the farmer then plows into the field."

Modern farming practices have increased greenhouse gas emissions dramatically. Fertilization emits oxides of nitrogen, which are 140 times worse than CO2. Tilling of the soil lets carbon escape as CO2. Since agriculture began, about 140 billion tons of soil-based CO2 have been lost to the atmosphere. Carbon trading provides a financial incentive for improving farming practices. By growing our fuel using no till, no fertilizer crops such as elephant grass, the farmer can help save the planet, improve yields and make good money too.

click here
to watch a 49-minute BBC movie about Terra Preta

Reader Comments

Author: Lou Gold

Thanks for this fine round-up of biochar news.

I truly believe the ancient wisdom of Terra Preta de Indio—translated into modern processes of pyrolysis—will be the game-changer whereby the wastes and depletions of the Industrial Age will be transformed transcended into an Anthropocene Age of human-and-nature reciprocities and renewals.

I'm looking into cultural and spiritual basis for this transition, for the narrative that might guide a changing consciousness toward healing the relationship between people and nature.

Here is one of my essays:
www.re-char.com/2009/04/17/terra-preta-de-indio/

Here's a broad range of materials I gathered for my blog:
http://lougold.blogspot.com/search?q=biochar

Keep up the good work.

lou

Author: Edgar van Wingerden

Again a good exposition!

For large populations it is the only long-term sustainable agriculture in the Americas and many other parts of the world.

Research indicates that this soil type must have produced 4-10 times as much food as other tropical soils.

Currently Wageningen University researchers attempt to unravel some of the remaining mysteries surrounding Petra Terra (attempts of recreation)

Presence of fish bones and special bacteria & fungi suggest an aquacultural and agricultural hybrid soil—with Amazonic aquatic material used as powerful fertiliser (algae) in addition to favorable adsorption/desorption and temperature control of char with high surface area that slash-and char brings.

Thanks again for spreading some light.

www.algaelink.com

(Venture Capital, Banks: 50% annual roi in the PRC!)


Sequestering 'biochar' in soil, which makes soil darker in colour, is a robust way to store carbon.