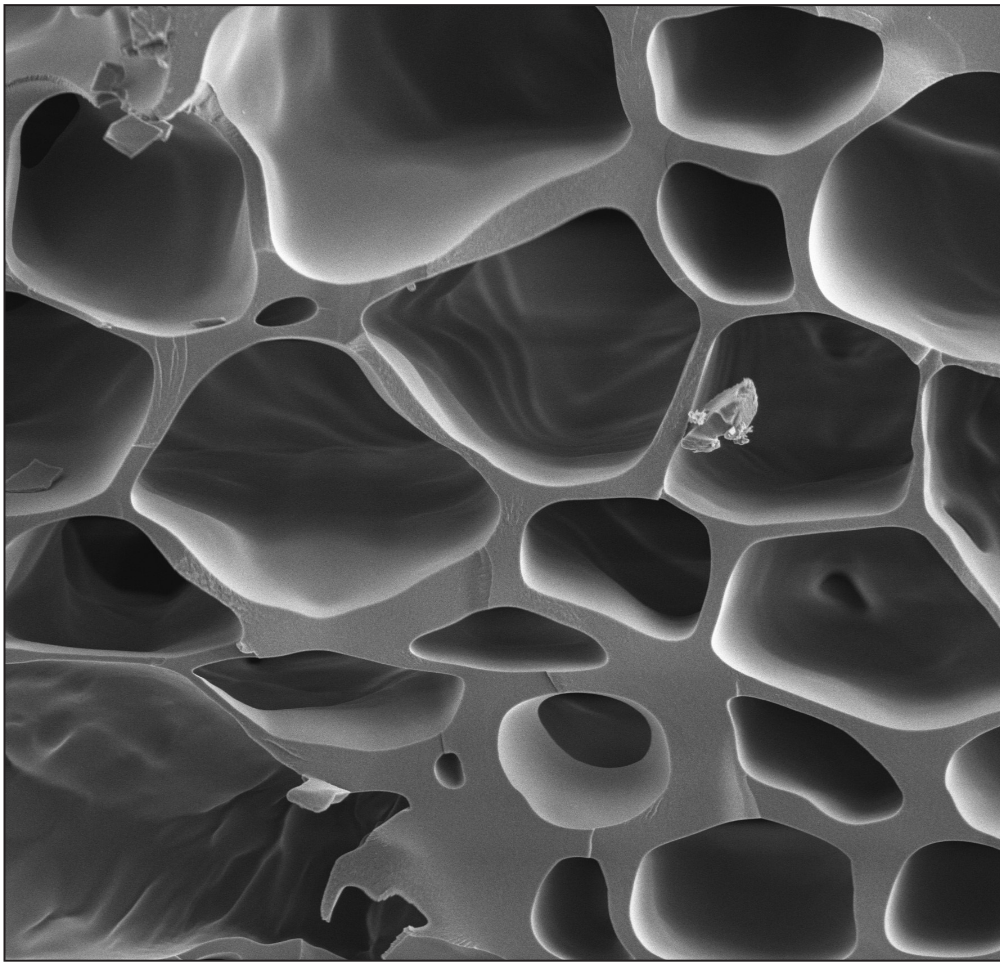

ABOVE: *© Dr. Jocelyn, Photographer* ***INSERT:*** *© Raymond Baltar, Photographer*

ABOVE: *A microscopic photograph of biochar showing its porous structure.*
INSERT: *Maddie from Agra Marketing shows off biochar produced by Oregon Biochar Solutions.*

BIOCHAR:
A CLIMATE MITIGATION STRATEGY

by Raymond Baltar, MBA
Director Sonoma Biochar Initiative and Biochar Projects Manager, Sonoma Ecology Center

and David Morell, PhD
Chair, Sonoma Ecology Center Board of Directors / ex-EPA official

The stunning movie *Ice on Fire* reinforces the powerful impact of a recent UN Intergovernmental Panel on Climate Change (IPCC) report / our planet faces catastrophic impacts within a very few years from society's excessive use of fossil fuels. Effective action immediately is imperative. Indeed, even a rapid shift to solar power, EVs and wind turbines, the core elements of any "carbon neutral" strategy (that is, reducing new carbon emissions), is not sufficient by itself. In addition, we need extensive action that is truly "carbon negative," pulling vast amounts of carbon out of the atmosphere and figuring out how to use it in safe, measurable, and beneficial ways.

IPCC compared the costs and storage potential of six methods of carbon dioxide removal that could be deployed at scale, either now or in the future, to assist mankind in limiting global warming to 1.5 degrees Celsius, the cutoff point above which scientists warn uncontrollable climate shifts threaten civilization and ecosystems as we know them. These include Direct Air Capture and Storage (DACCS), Bioenergy Capture and Storage (BECCS), Enhanced Weathering, Biochar Production and Use, Afforestation and Reforestation, and Soil Carbon Sequestration. While there are pros and cons with each of these approaches, including cost, known and unknown environmental impacts, and readiness for immediate implementation, the last three could

BIOCHAR: A CLIMATE MITIGATION STRATEGY

LEFT: *Biochar produced during wildfires is nature's way of kickstarting regrowth of trees and plants in forest ecosystems.* ***RIGHT:*** *Biochar production can replace the lop and scatter technique in some situations.*

LEFT / RIGHT: *© Raymond Baltar, Photographer*

be scaled up NOW if enough resources were made available and a "Carbon Conservation Corps" were established to educate the public and do the work. Afforestation and reforestation should absolutely be implemented in both urban and wildland areas, where appropriate, and funding found to scale these actions. But these long-term actions can take many years to achieve their results. We can make a critical and imperative impact quickly by managing our forests properly, preventing them from being clear cut in the first place for short-term profit and conversion to ranching and mono-cropping, and dramatically increasing funds for land trusts to purchase timber rights from landowners thereby keeping more forests intact as carbon sinks. Carbon markets already recognize this approach, paying landowners such as the Redwood Forest Foundation, Inc. for the carbon it is now sequestering in the Usal Redwood Forest in northern California.

Likewise, improving soil health and resiliency in farming through reduced chemical use, increased addition of organic matter such as compost, and encouraging and supporting alternate methods such as no-till, rotational grazing, and cover cropping are other critical, easily implemented approaches that are known to work now, though conversion to these techniques will also take time to achieve results.

All of this, and more, is needed. But applying biochar to soils represents an IMMEDIATE as well as long-term strategy for burying carbon underground and keeping it out of the atmosphere. In addition to its carbon sequestration value, biochar has been shown to have a multitude of benefits for farmers, especially when used in conjunction with compost and other amendments, such as reduced water and nutrient use, improved production of beneficial soil microbes, and frequently, improved plant yields.

What is Biochar?

Biochar is a form of elemental carbon made by heating woody materials or crop residues in the absence of oxygen (a process termed "pyrolysis"). It can also be made as a byproduct of the gasification process used to produce biomass energy. Plant materials are made up primarily of cellulose, hemi-cellulose, and lignin, and when they are heated to high temperatures a thermo-chemical reaction occurs whereby the cellulosic material gasifies and much of the lignin is converted to a carbonaceous material we call charcoal. If this charcoal meets certain criteria we call it biochar. Biochar is highly porous, with an incredibly high surface area, and is both absorptive and adsorptive. It is the perfect home for microorganisms.

The inherent physical and chemical properties of biochar make it highly advantageous to increase soil health. Biochar's literally millions of tiny pores and adsorptive qualities are ideally suited to retain water and nutrients near plants' roots, rather than having these vital substances leach away. Inherent chemical interactions from the biochar stimulate microrrhizal fungi growth and increase cation-exchange activity in the soil, further enhancing plant growth.

In some processes both the gases and the heat generated can be captured and used for renewable energy production. In others, bio-oil is produced as well that can be refined into a number of products, including biofuels for vehicles and aircraft. So biochar production provides a number of products that can be monetized in addition to the biochar itself. Ideally biochar production operations would be co-located in "ecoparks," where other businesses could use these byproducts. The biochar field is ripe for development by entrepreneurs wanting to help make an impact on climate

continued

BIOCHAR: A CLIMATE MITIGATION STRATEGY

Phoenix Energy's Gasification/Biochar Plant in Merced, California. *© Raymond Baltar, Photographer*

change and food security while also getting rewarded financially.

As outlined in the recent book "Burn: Using Fire to Cool the Earth" by Albert Bates and Kathleen Draper, different forms of biochar (perhaps a better term might be biocarbon), can be produced from abundant surplus feedstocks. While not suitable for agriculture, it could help sequester C02 in other ways — some with potentially enormous climate impacts such as replacing a portion of the sand used in cement and concrete production. Biochar/Biocarbon is also showing promise as a filtration medium for stormwater, in pollution remediation applications, and as a way to reduce enteric methane release in cattle when used as a feed supplement.

Official standards for biochar are still under development, and there are differing views within the industry about what these standards should be. But organizations such as the International Biochar Initiative, the United States Biochar Initiative, and a number of organizations developing carbon credit protocols along with universities working on grant-funded projects are collaborating to help build a consensus on standards. In California, biochar must contain at least 60% carbon by law to be labeled as such. However, its other characteristics are likely just as important when determining its efficacy in certain soils and with certain plant types, and this type of research is currently underway worldwide.

Available scientific results demonstrate that biochar can remain in the soil for centuries and perhaps even millennia time scales — just where we want this carbon, away from the atmosphere. This has been confirmed by analyzing the highly fertile, ancient "Terra Preta" soils in the Amazon, and discovering that they contain large percentages of charcoal, between 30% and 40% in some samples. It is thought that these soils were created by indigenous peoples over centuries to improve the poor, leached soil conditions in the tropics and enable or enhance agricultural activities.

Developing a Sustainable Biochar Industry

We believe that biochar production and use can play a role in a responsible, safe, and impactful carbon drawdown strategy that can be deployed to address the climate disruption crisis. However, it is critical that this be done in a way that does not lead to increased destruction of the world's forests, that does not

A Conservation Burn pile, using vines from a local winery, can reduce smoke pollution and produce biochar. *© Raymond Baltar, Photographer* adversely affect communities where production plants and harvesting activities are undertaken, and in a way that has a verifiably carbon-negative end result. For these reasons we believe that in a phased scaling strategy, ONLY surplus biomass sources should initially be used and that the technology or method used for biochar production should have the lowest possible emissions.

Some business models include farming fast-growing plants like miscanthus, bamboo, or even hemp as feedstock for biochar production, and there are arguably good reasons for this type of operation, including (perhaps) better consistency and quality control of the final product, a potentially smaller environmental impact than the use of forestry-related materials, and lower transportation costs and environmental impacts. But growing monocrops present a different set of environmental impacts and problems, and given the amount of surplus biomass that could be better managed, upscaling these materials into a value-added product like biochar, where practical, makes the most sense.

Millions of tons of “waste” forest biomass are generated in the United States annually, along with millions of tons of agricultural “waste” residues. Much of this material is not being used in ways that can provide valuable co-benefits. Thus there is an enormous opportunity to convert a large portion of this material into baseload renewable energy, biochar and compost in community-based processing facilities. These processes would help reduce catastrophic wildfire damage to our communities, reduce harmful air pollution from wildfires as well as from standard open pile burning, sequester carbon beneficially in farm, rangeland and forest soils, and create healthier soils. This must and can be done responsibly and with as little damage to local ecosystems as possible.

We understand that the range of options may be limited depending on location, local support resources, and access to power, water, and other balance of system requirements. With training, even low-tech methods like pit, flame-cap kiln, or conservation burning can be used to produce good quality biochar with relatively low emissions. While we do not support the use of these techniques for commercial biochar production, each can play a role in better forest and ag waste management activities when compared to standard open burning.

There are legitimate concerns, based on past experience, that some large biomass energy facilities have not been good neighbors, both from environmental justice and pollution perspectives. While scaling the nascent biochar/biocarbon economy we need to make sure that mistakes of the industrial revolution are not repeated; that care is taken to site facilities properly; and that air and water resources are rigorously protected. A different ethic is needed in the

***TOP:** © Photo courtesy Pacific Biochar*
***CENTER TOP & BOTTOM, BOTTOM:** © Raymond Baltar, Photographer*

***TOP:** Biological Activation of Biochar. Biochar should always be blended with nutrients before application.*
***CENTER TOP:** The ROI Carbonator 500 is designed to process 15 tons per hour of surplus forestry residues while also converting a portion of the material to biochar.*
***CENTER BOTTOM:** Biochar blended with compost is applied topically to a sheep pasture at Swallow Valley Farm in Sonoma County, California.*
***BOTTOM:** A Comptech Crambo biomass shredder processes logs into material suitable for use in a pyrolysis machine called an Adam-Retort.*

BIOCHAR: A CLIMATE MITIGATION STRATEGY

business of forest materials management. While large plants typically source from otherwise unmerchantable “waste” streams, the amount of feedstock needed to keep these large plants in service 24/7, 365 can put pressure on operators to purchase materials from unsustainable or rogue logging operations when other sources are interrupted or are no longer available, especially in the developing world.

We therefore recommend “right-sizing” all biochar production facilities based on the long-term, sustainable flow of feedstock in each community Aa s w e l l a s on production efficiencies, and co-locating these plants wherever possible with other businesses that could use all of the systemic outputs—including greenhouses that could potentially use any C02 emissions and process heat.

This might mean a 500 KW biomass power and biochar plant located at a local co-packing facility in a farming community, or a 3 MW plant located at a composting operation closer to a city with a constant flow of urban wood “waste.” A system of smaller biomass plants, capable of supplying baseload or peak power needs would also add to the resiliency of the power grid, especially during emergencies.

With oil and gas extraction we have been pulling fossil carbon out of the ground, often with great harm to the environment, and burning it, wreaking havoc on our weather system that is already threatening human and other ecosystems all over the planet. We need to need reverse this process, and if done right, scaling biochar production could begin to pull gigatons of carbon out of the short-term carbon cycle IMMEDIATELY, using only materials that are otherwise improperly utilized and existing and proven technology. In addition, integrating biochar into farming activities offers a “direct deposit” of valuable soil carbon that, when blended with natural materials like compost, could regenerate millions of acres of depleted soils and make good soils more resilient.

While there is much still to learn about biochar use, and production technologies need continual improvements, we strongly believe there is enough evidence that this simple, ancient act of charring biomass and using it to grow healthier soils, if done sustainably and with environmental safeguards, would, both now and into the future, help us address climate change and food security.

While much research still needs to be done to quantify and better understand which types of biochar have carbon that persists best in soils, data show that the time has come to start returning right away as much carbon as we can back into badly depleted soils throughout the farming community, and back into forest ecosystems as well. ***This can easily be done using biochar, providing a model for others to emulate elsewhere. Let’s do this now!***

TOP: *Loren Poncia of Stemple Creek Ranch, Carbon Farmer.*
BOTTOM: *Biochar produced from tanoak by the Redwood Forest Foundation in northern California.*

About The Sonoma Ecology Center

The Sonoma Valley is home to an amazing variety of species living in a small space. As many as a quarter of California’s species exist in this compact area, a place that comprises only a tenth of 1% of California’s entire land area!

The Sonoma Ecology Center is a non-profit organization with a mission is to work with the community to identify and lead actions that achieve and sustain ecological health in the Sonoma Valley. Since the Valley is mostly privately owned over thousands of parcels, it works to address challenges related to water supply and quality, open space, rural character, biodiversity, energy, climate change, and a better quality of life for all residents.

For more information:
https://sonomaecologycenter.org/