The Oil Drum: Campfire

Discussions about Energy and Our Future

Biodiesel, Biochar & Biodiversity in Costa Rica -- An Example of Small-Scale, Locally-Appropriate Action

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This is a guest post by Ryan King. Ryan is a biologist, independent journalist, and community "eco-preneur" in Costa Rica. Below, he provides a brief introduction to decentralized biodiesel and biochar production in Costa Rica. His story will interest readers for at least two reasons: (1) he outlines specific and repeatable measures to address peak oil and climate change through the synergy of local energy production and carbon sequestration; and (2) he provides a working example of the benefits of increasing localized self-sufficiency. Ryan is expanding biodiesel, biochar, environmental projects through eco-hotels and sustainability projects, as well as looking for funding and experienced and non-experienced participants to contribute. He can be reached via email at theunabummer@gmail.com, or for further information visit www.ranchodiandrew.com, and www.flutterbyhouse.com .

As global change related to resource depletion and climate change becomes increasingly severe, the ineffectiveness of world governments as well as mainstream environmental organizations and movements is obvious. It appears that there are few immediate alternatives to relying on large, centralized initiatives in the realms of environment and energy. Instead of relying on these approaches, it seems the safest and most secure adaptive route is the introduction of decentralized, local alternative energy and environmental solutions. Below the fold, I discuss one such set of projects currently underway in Costa Rica. While some aspects of these solutions in Costa Rica may not be directly applicable to non-tropical climates, I think this example of locally-appropriate, small-scale but scalable action can be of value everywhere.

Though Costa Rica markets itself as a pioneer in environmental protection, its national oil refinery, 'RECOPE' is still failing after more than two years since its pledge to introduce biodiesel, and the country has not been able to provide legitimate carbon negative programs. While some reforestation programs have received significant funding under the assumption that planting trees in tropical forests sequesters carbon in a way that is easily quantifiable, research indicates that tropical forests may increasingly become sources and not sinks of carbon as drought and climate change events worsen.

Costa Rica's economy depends primarily on "eco-tourism," and within areas dependent on fragile biodiversity and rapidly changing ecosystems decentralized energy and environmental solutions are desperately needed. My interest has been to begin exploring the means to introduce emerging non-hierarchical social organizational theory in environmental and alternative energy applications by spreading biodiesel and biochar programs through existing environmental education and eco-tourist projects.

While simple, local-scale projects such as the biodiesel and biochar projects discussed below individually make minute contributions to global change threats, their ease of application and potential to spread rapidly through networking, the internet, and community programs as well as ability to provide immediate economic and environmental benefits make them especially appealing. ***The last detail is crucial: solutions that are economically viable without reliance on outside subsidy or centralized control are urgently needed to directly benefit local biodiversity in threatened areas and to build community-scale self-sufficiency through improved soils and local energy and food production***. Previous top-down approaches have been unable to distribute the technology or the awareness to adjust in the wake of the overwhelming failures of mainstream organizations and governments. As a result, and especially as the current economic downturn continues, alternative, networked distribution models will find increasing popularity and success.

Biodiesel

Several years ago I began producing biodiesel at home by converting waste vegetable oil (WVO) collected from local restaurants in Monteverde, Costa Rica. A friend and science teacher working at a local environmentally-themed primary/secondary school invited me to teach the process and produce biodiesel for use in school vehicles. After relocating the used hot water heater I had converted into a simple biodiesel processor and churning out a few batches of fuel, the project attracted the attention of philanthropists. After generous donations from locals, the Cottonwood Foundation, and the Atmosphere Conservancy we constructed a biodiesel system capable of easily producing over 100 gallons of high quality biodiesel from converted WVO per week, providing a significant degree of self-sufficiency to the local school vehicle fleet.

[Image 1] A local scale biodiesel processing set-up in Costa Rica.

We have run 3 of the school's buses as well as several diesel SUVs on biodiesel mixtures ranging from 10% biodiesel/90% diesel (B10) to 100% biodiesel (B100). The 55 gallon barrel design with welded-on metal cone was easy to use, though the insulation and thicker sidewalls of the used water heater design are preferred for safety and energy conservation.

[Image 2] The “greasercycle” – a hand pump welded to the crank of an exercise bike, connected to a converted water heater makes a cheap, safe, and reliable human powered biodiesel processor.

Our biodiesel batches are produced utilizing the 2 stage base-base catalyzed transesterification reaction with methoxide as a catalyst, though I am investigating ethanol-catalyzed reactions. One of the benefits of processing with ethyl instead of methyl alcohol is independence from reliance on industrially-produced methanol. Ethanol may be fermented and distilled from local, renewable sources then “dried” further to ensure the correct purity for biodiesel production. I am presently fermenting locally-obtained fruits to produce ethyl alcohol for experimentation but its likelihood of reaching beyond the mango/pineapple wine stage is rather dubious.

Biodiesel production amounts in both the “appleseed”/”greasercycle” designs (used hot water heaters with about 30 – 50 gallon capacity, as well as the larger barrel design (the 55 gallon drum with welded cone bottom) typically averages about 100 gallons per week. The greatest limiting factors to production in these designs tend to be collection, transport, and storage of initial WVO volumes, as well as immediate post-processing storage. A small biodiesel processor such as the greasercycle is easily capable of producing multiple batches (processing is about 1 ½ hours per batch) per day, but processed biodiesel must be allowed to settle and separate 12 hours. Larger volume settling containers yield higher daily production amounts. After total processing costs (including excess methanol recovery from glycerin byproduct) biodiesel created from WVO in Costa Rica averages about 30% cheaper in cost than petroleum diesel purchased at the pump. Additionally, glycerin created as a byproduct during the reaction can be made into soap or other valuable items.

Safe, quality biodiesel production requires, in my opinion, a knowledge of chemistry and the scientific method that cannot be fully shared within online DIY texts, unless the practitioner has some experience handling potentially dangerous and reactive chemicals such as methoxide. While

I have summarized some of the basics of DIY biodiesel, if you are going to do it on your own its best to consult with someone experienced at least for your first few batches in order to learn the ins and outs of the properties of the chemicals and equipment – at the very least in an open internet forum. Biochar, on the other hand is incredible easy, safe, and able to be learned with a short amount of time reading and practicing.

Biochar

In addition to biodiesel, I have been producing and promoting biochar (see www.biochar.org) from decomposing plant litter for use as a carbon-negative soil amendment. Biochar refers to charcoal produced from leaves, grasses, agricultural waste, wood and other plant material. Production of biochar requires as little investment as a metal container (coffee tin, 55 gallon barrel), and results in the carbon-negative production of a wonderful soil amendment.

While we have experimented with a variety of biomass: woods, twigs, old lumber, leaves, cut bamboo, etc, we require much more investigation to determine the efficiency and benefits of different types of biomass. We are currently adopting the methods for DIY biochar found at woodstovewizard (http://www.woodstovewizard.com/makebiochar.html), and considering creating test plots to determine the effects of biochar sorption on agricultural runoff ("cleaning" rivers filled with excess N, P, and K fertilizers and comparing these to non-amended plots).

For a very first-timer biochar processing, follow these simple steps and info from: www.biochar.org, http://www.woodstovewizard.com/makebiochar.html, or http://www.instructables.com/id/Make-your-own-BioChar-and-Terra-Preta/ .

[Image 3] An example of rich, fertile biochar soil at an organic garden in Costa Rica.

[Image 4] The Flutterby House eco-hostel in Uvita has incorporated biochar production and use into their existing gardening and sustainability projects. See http://www.flutterbyhouse.com/sustainability.html for additional details.

Biochar has a wide variety of benefits to soils, including:

• Enhanced plant growth
• Suppressed methane emission
• Reduced nitrous oxide emission (estimate 50%) (see 5.10 below)
• Reduced fertilizer requirement (estimate 10%)
• Reduced leaching of nutrients
• Stored carbon in a long term stable sink
• Reduces soil acidity: raises soil pH (see 5.01 below)
• Reduces aluminum toxicity
• Increased soil aggregation due to increased fungal hyphae
• Improved soil water handling characteristics
• Increased soil levels of available Ca, Mg, P, and K
• Increased soil microbial respiration
• Increased soil microbial biomass
• Stimulated symbiotic nitrogen fixation in legumes
• Increased arbuscular mycorrhyzal fungi
• Increased cation exchange capacity

Sources: Assessment of Biochar's Benefits for the USA, Steiner, ed.; Biochar Application to Soils, Verheijen, et al.; Sustainable Biochar to Mitigate Global Climate Change, Woolfe, et al.; Biochar Soil Management, Lehmann

[Image 5] Biochar production, from left to right - a 55 gal drum biochar processor, a wheelbarrow with char and compost amended soil, and a small biodiesel sample in a glass jar sits near a new batch of vegetables.

[Image 6] A row of pineapples growing in front of banana plants and a large mango tree. Rancho DiAndrew was initially purchased about 20 years ago when the area was almost entirely cattle pasture. The land has naturally reforested remarkably well, and now supports a wide variety of native plants and animals. Massive reforestation of tropical ecosystems is crucial for stabilization of biodiversity and nutrient cycling. Recent research, however, indicates that with drought and rising temperatures due to climate change many of these forests may become carbon sources and not sinks. Converting desiccating plant matter into biochar to be used in tropical soils has the potential to capture carbon that would be released into the atmosphere as well as amend soils by maintaining nutrients and prevent additional greenhouse gas release.

Biochar been proven to greatly increase plant growth, and is promoted by Dr. James Lovelock as one of the few legitimate approaches to sequestering carbon dioxide. As shown in my illustration above, biochar lends itself well to decentralized production and distribution . Creating the structural framework to provide rapid, efficient, decentralized biochar production coupled with organic farming, soil and forest restoration efforts could become extremely beneficial in addressing local and global scale environmental issues. Of particular importance, biochar has the potential to be economically valuable even without assuming any income from global carbon markets.

By connecting both the biodiesel and biochar projects with eco-tourist/volunteer projects here in Costa Rica we are able to connect with a wide range of travelers and introduce and involve visitors in environmental education and restoration. The simplicity and immediate benefits of the biochar process have helped it spread rather quickly, and we are currently re-building networked internet applications to estimate biochar production rates as well as provide information and resources for participants.

Biodiesel production chemistry and processor design can be found at www.journeytoforever.org . Biochar information can be found at http://terrapreta.bioenergylists.org/Making_BioChar, or www.biochar.org .

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