Prospectus: Biochar Production Unit

In 2014, Sonoma Ecology Center (SEC) acquired an Adam Retort biochar production unit. The unit is designed to make high quality biochar while minimizing the environmental impacts of the biochar production process. The unit was designed and manufactured by New England Biochar LLC. SEC purchased the unit as part of the Sonoma County Biochar Project (SCBP). SEC conducted the SCBP project with a grant from USDA NRCS. The purpose of the SCBP was to produce biochar from local excess biomass, field test its benefits in varied local soil types, and demonstrate small scale biomass utilization for drought adaptability and water conservation.

With completion of the SCBP in 2016, funding is no longer available for SEC to continue to operate this unit on a regular basis. It now only runs on very limited occasions.

In cooperation with the Sonoma County Water Agency (SCWA), SEC is exploring the next steps for using this machine to produce biochar and/or for use as a carbon-neutral heating system. As such, we seek interest from other parties who may wish to operate the unit within Sonoma County or the broader North Coast region at a location where the unit could be used successfully and efficiently. Specifically, as project partners SEC and SCWA now offer via sale or donation as appropriate this retort unit, combined with training by knowledgeable and experienced operators, a detailed operations and production manual, and substantial amounts of starter biomass feedstock.

SEC's Adam Retort Biochar Production Unit

We believe that this Adam Retort would be best sited at an educational or similar non-profit facility where its availability could be fully integrated into that organization's ongoing teaching and community outreach curriculum. In that way the biochar production unit's presence and use would reinforce a wide range of the components of that organization's existing programs**.**

Biochar Production and Use

Adam Retort units are designed to create biochar using mostly woody waste materials as their biomass feedstock. To minimize air pollution, the retort recirculates and burns most of the off-gasses that would otherwise enter the atmosphere. Other gasses are condensed into a liquid termed wood vinegar.

Biochar is a specialized form of charcoal made at relatively high temperatures in the absence of oxygen in a process termed “pyrolysis.” In this effort, biomass feedstock is not burned; instead it is heated indirectly in a separate oxygen scarce steel chamber by hot gases generated and then circulated in a separate closed chamber. The woody feedstock (shaped and sized similar to rough fireplace logs) is placed inside a stainless steel “tub.” Lighting a gasifier filled with wood chips starts the process. This starter heat flows through a steel channel located underneath the main tub. As the wood temperature rises, gasses are produced that are repeatedly recirculated to provide heat to continue to feed the ongoing hot pyrolysis process. More gases are created as the wood heats up and develops flammable volatile gases. These gases are then burned to supply the heat to the unit, which allows the gasifier to be turned off. As the batch process is completed, the biochar that remains behind in the retort contains an extremely high percentage of carbon in a physical structure containing literally millions of tiny microscopic pores. Essentially, all of the water vapor, volatile wood gases, and condensed wood vinegar have now been extracted; what’s left behind is pure carbon also known as biochar.

According to USDA NRCS, biochar has been proven to act as a valuable resource for agricultural production and/or forest maintenance in a changing climate (prolonged drought conditions/dry soil conditions, unprecedented trees mortality rates/bark beetle infestations, decreasing soil nutrient capacity, etc.). Mixed with compost, biochar used as a soil amendment has been shown to:

- increase soil water retention
- increase soil nutrient uptake
- increase crop yields
- sequester carbon

Char produced by SEC's Adam Retort

Field trials conducted by SEC on three Sonoma County farms using Adam Retort-produced biochar reinforced global research conclusions that biochar improves crop yields and decreases water use.

Clean Burns & Regulatory Compliance

To minimize air pollution, the retort recirculates the wood off-gases through the pyrolysis chamber. These off-gasses would otherwise enter the atmosphere if the biomass were burned openly. Rated at just below 1 million BTUs of heat capacity, the retort does not require an operational permit from the Bay Area Air Quality Management District (BAAQMD). This would be true in most and perhaps any other California location. Review of regulatory compliance should be included as part of any relocation.

Effectively managing the machine's operations to achieve clean burns with regards to smoke and temperature can ensure ongoing positive results, as it has for SEC. Byproducts condensed and captured as distillates through the unit's condenser further reduce potential impacts to air quality. The unit's design transforms these possible pollutants into useful byproducts such as wood oil, wood tar, wood vinegar, and excess heat.

Sonoma County Biochar Project Background & Conservation Innovation Grant

SEC purchased the Adam Retort in 2014 from New England Biochar LLC with financial support from SCWA and the US Department of Agriculture's Natural Resources Conservation Service (NRCS). SEC then used the high-quality biochar produced from its Adam Retort to carry out field trials at three local Sonoma County farms. Results are presented in the project's final report, available on request. Partners

tested, operated, and produced high quality biochar from local woody biomass. The demonstration project proved local abilities to produce high quality char at farm scale. This experience has shown that the unit's design and size are ideal for teaching and demonstrating biochar production, use, sales, and outreach. This retort was California's first demonstration unit dedicated specifically to using pyrolysis to produce biochar as a soil amendment for agricultural test plots.

Operating the Adam Retort

The efficiency of operating the Adam Retort and the quality of the biochar produced are affected by a number of factors such as the quality of feedstock used and the retort's operational temperature.

The Adam Retort uses a batch process to produce about 18 cu. ft. of high-grade biochar in approximately 8 hours, based on a load of about 40 cu. ft. of appropriately shaped waste wood**.** The unit operates at a maximum design temperature of about 800 degrees C. Each batch generates about 40 gallons of liquid wood vinegar from the unit's condenser. About 4 hours are needed to load the unit prior to each batch operation and a batch operation lasts approximately 8 hours. After cooling overnight, 2 to 4 hours are needed to unload the newly produced biochar the next day. As with any mechanical process, appropriate maintenance and repair hours need to be figured into overall operational costs. A total of 3 or 4 batch operations can be completed each week. Altogether, it takes around 14-16 total hours of labor to produce 18 cu. ft. of excellent-quality biochar, including ongoing maintenance and expected adjustments/routine repairs.

As a guideline, the optimal wood for processing into biochar in the Adam Retort has about 20 – 30 percent moisture content. Firewood-sized pieces are ideal for the Adam Retort, i.e. 12 inches or less in width, and about 4 feet long with rough edges. The unit is not suited to run wood chips, except in its starter gasifier.

Feedstock woodpile at Swallow Valley Farm

Since the production process produces considerable heat, the ideal site for the unit would be a location that can use this heat energy in some way, such as a greenhouse, an industrial process needing hot water, a firewood drier, fruit drier, etc.

Current Location & Mobility

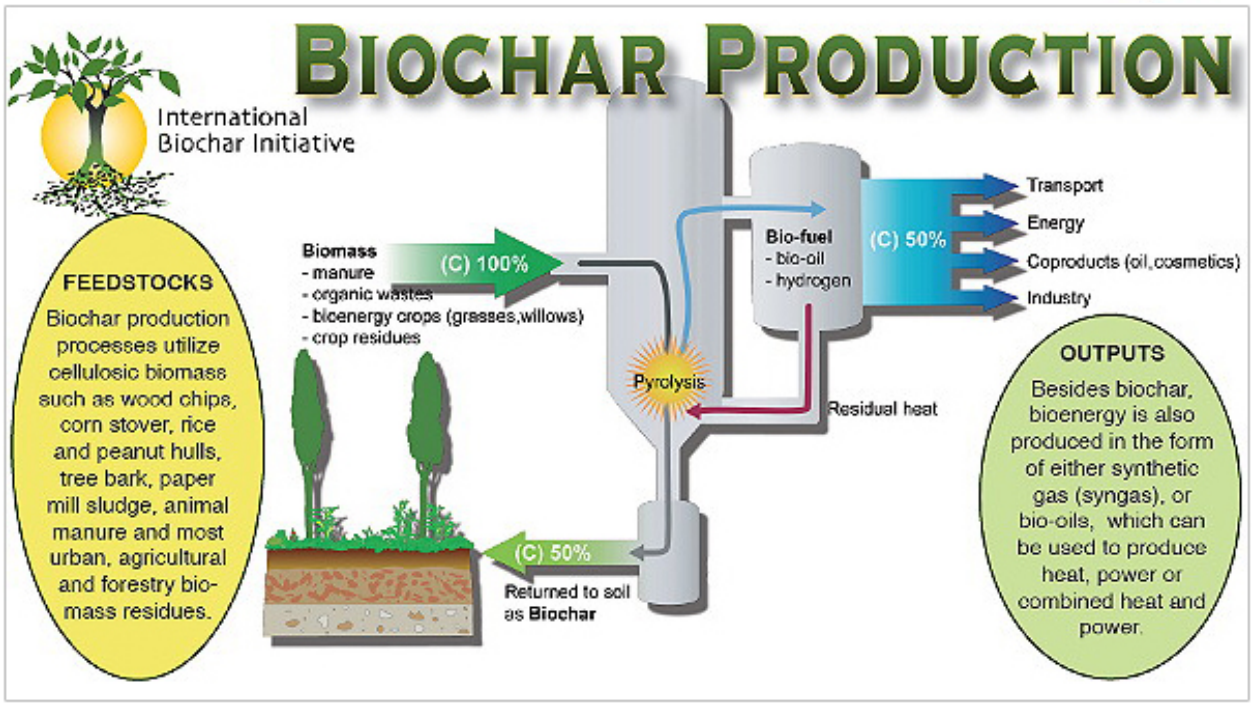
The Adam Retort is currently sited at Swallow Valley Farm, a 120-acre sheep pasture operation located in Valley Ford, in the western part of Sonoma County.

The Adam Retort can be moved fairly readily on a trailer to its new operating location. However, it should not be considered a "mobile" unit in its current configuration (though at considerable expense it would be feasible to adapt the unit for mobile use). We believe that the unit is most suitable to being operated as a stationary production facility in order to make economic use of its heat energy. Use of all of the system's products and byproducts will contribute to its overall economic and environmental efficiency.

Potential benefits

Feedstock available: Large amounts of local biomass available (downed bay, pine, and eucalyptus trees) were diverted from landfill and obtained by SEC in 2014/15. This biomass was delivered to the production area by a local tree service where it was restructured into the size and shape desired for use in the retort; much of this feedstock is still available for use by the Adam Retort's next owner.

Heat Energy: If practical, it would be desirable to further use the heat energy produced by running the retort. Use of the off-gases could fuel an engine/generator or a boiler. The unit's water-cooled condenser combined with a heat exchanger on the exhaust stack could produce hot water for use in farm, greenhouse or building applications.



Training available: A comprehensive Adam Retort *Operations Manual* is available. SEC will provide one free introductory training session in how to operate the unit. If additional training is desired, SEC would be willing to enter into a contract for additional training, since this specific biochar production facility requires training and skill to operate successfully and safely.

Examples of what the unit could be used to do:

- conduct research projects and field trial demonstrations of biochar used for water use efficiency, water quality, recycled heat energy, and carbon uptake
- demonstrate pyrolysis as a means of producing useful products from agricultural or forestry woody waste materials
- carry out a range of practical low-tech renewable energy solutions
- further utilize se biochar in agricultural, industrial, or land restoration applications.
- produce very high-quality biochar suitable for laboratory analysis and field studies
- foster awareness, education and cultural shift to new trade, jobs, and carbon cycling industry.

Contacts and Resources:

For further information about possibly hosting the unit, please contact:

Sonoma County Water Agency: Susan Haydon (707) 547-1937 susan.haydon@scwa.ca.gov

For details on unit operations, please contact

Sonoma Ecology Center: Raymond Baltar (707) 996-0712 raymond@sonomaecologycenter.org

For more information on the Adam Retort, how it is maintained and operated, and other inquiries, visit these links:

1) http://sonomabiocharinitiative.org/projects/sonoma-county-biochar-project-2/

2) http://sonomabiocharinitiative.org/wp-content/uploads/2014/03/Oak-Hill-Farm-Biochar-Results.pdf

3) http://sonomabiocharinitiative.org