SELECTED RESOURCES

General Biochar Information:
International Biochar Initiative
www.biochar-international.org

U.S. Based Biochar Information:
U.S. Biochar Initiative
biochar-us.org

Biochar for Forest Restoration in the Western United States. 2015. Wilson Biochar Associates White Paper for South Umpqua Rural Community Partnership (SURCP).
www.wilsonbiochar.com

Biochar as an Innovative Wood Product: A Look at Barriers to Realization of its Full Potential. 2017. Groot, et al. Dovetail Partners, Inc.

Kon-Tiki - The Democratization of Biochar Production. 2014. H. Schmidt & P. Taylor. The Biochar Journal.

The Biochar Journal. Ithaka Institute for Carbon Intelligence.
biochar-journal.org/en/home

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Great Plains Biochar Initiative

BIOCHAR PRODUCTION ECONOMICS

Fabricating a small scale kiln is most economical when you have the materials on hand and the skills (i.e. welding) to manufacture it. While small scale kilns are not necessarily cost-effective for commercial production of biochar these methods may be appropriate for:

- Nurseries, tree care companies, green industry
- Farmers and ranchers looking to utilize waste products
- Gardeners, permaculturists, small scale farmers
- Windbreak renovations
- Loggers, forestry contractors
- Anyone interested in producing biochar for small, niche markets such as farmers markets

Example: Assuming a biochar recovery rate of 33%, a 55 gallon drum retort kiln would yield ~2.5 cubic feet of biochar per batch. One cubic foot of biochar retails between $30 and $60. Per batch, a profit between $75 and $150 could be generated.

GREAT PLAINS BIOCHAR INITIATIVE

The Great Plains Biochar Initiative is a collaborative effort with the Nebraska Forest Service, Kansas Forest Service, U.S. Forest Service, High Plains Biochar, and Wilson Biochar Associates to promote the production and utilization of biochar in the great plains and beyond.

The Great Plains Biochar Initiative promotes biochar by speaking to interested parties about opportunities to use and produce char, hosting workshops, and offering small grants to trial, produce, and/or market biochar.

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Nebraska Forest Service, University of Nebraska-Lincoln

SMALL SCALE BIOCHAR PRODUCTION

IANR | Nebraska Forest Service

A large-scale retort kiln produces biochar from locally-sourced biomass

Nebraska is home to a wealth of untapped resources, some that are viewed as problematic. Nebraska has 1.3 million acres of forested land containing over 41 million oven-dry tons of standing woody biomass. This includes hundreds of thousands of acres of eastern redcedar that needs removal to improve forest health. Not included in this statistic are the acres of pastureland upon which eastern redcedar has encroached, nor the hundreds of communities that deal with storm damaged trees, hazardous tree removal, and trees that will come down as a result of emerald ash borer infestation.

The wood waste generated from forest and community management activities is typically burned or landfilled. Creating value added products such as biochar will play a significant role in reducing the environmental impacts of burning and prolong the life of our landfills. Among other solutions, biochar will be part of a holistic response to forest and wood waste management in the state of Nebraska.

MAKING BIOCHAR

The process of producing biochar is called pyrolysis. Pyrolysis, by definition, is the "decomposition of material by heat." It occurs in processes as simple as a campfire and as complex as a state-of-the-art biorefinery.

Biochar production methods are scalable and can be adjusted based on local conditions, feedstock availability, and the intended final use of the biochar.

This publication is an introduction to small scale biochar production methods that can be modified to suit the operator's preferences.

SELECTING A METHOD

There are many designs to choose from when selecting a biochar production method. How do you know which is right for you? Before choosing a method, you should ask yourself a few questions:

- How much can I spend on equipment?
- How much time can I dedicate to production?
- What will I use for a feedstock?
- Am I going to try to use the waste heat?
- Does the system need to be portable?
- Are there any local zoning restrictions or regulations?

The methods described in this publication can be scaled up or down to reach desired outputs. The images and descriptions are representative of how each system functions.

Learn more: nfs.unl.edu/great-plains-biochar-initiative

THE BASICS OF BIOCHAR PRODUCTION

Batch kilns are typical of small scale biochar production and require all feedstock to be loaded at the beginning of the production cycle. Batch kilns can easily handle a variety of feedstock sizes. They are used when the production of biochar is the primary goal and recovery of by-products is secondary in importance.

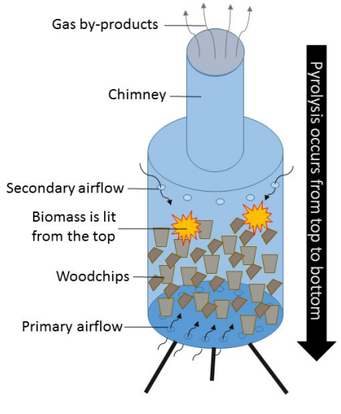
Batch production requires ignition followed by a heating up period during which the biochar is produced. Depending on the size of the system, production of biochar may last for a few hours, or a few days. When the biomass has been completely converted to char, it is important to end production with a quenching or cooling period. This is necessary to prevent the char from completely combusting and turning into ash.

RETORTS

A retort kiln is based on a two chamber design. This simple design uses an inner cylinder filled with wood and sealed except for a vent to let tar and gas escape. An outer chamber surrounds the inner cylinder and acts as an insulator. The inner cylinder is heated from the outside by building a fire between the inner and outer cylinders and allowing it to burn until the biomass inside the cylinder begins to release gas. Once the biomass reaches a temperature that allows it to release gas, the reaction is self-sustaining. The reaction is complete when the gas is gone, leaving only biochar.

Courtesy: biocharetort.com

A retort kiln is relatively inexpensive and can be made from a variety of materials, such as a 15 gallon steel drum placed inside a 55 gallon steel drum. Retorts are effective at excluding oxygen and producing a quality char at small scales however can become costly when built for large scale production. Retorts require small dimension feedstocks that won't pack together. Sawdust and woodchips are too small.



TOP LIT UP-DRAFT (TLUD)

The top lit up-draft gasifier (TLUD) model is constructed from cylindrical containers. The TLUD model relies on airflow from two sources. Biomass is placed into a container with holes on the base for the primary air source in the system. After ignition, a holed chimney is placed on the cylinder. The holes serve as the secondary air source to feed the flame (lit from the top) and the chimney directs the gas out of the system and away from the operator. Some designs used for cook stoves utilize an outer cylinder to hold heat and improve efficiency.

The TLUD design requires small feedstocks and produces a high quality char with consistently efficient conversion rates. Wood chips, chunks, or pellets are all suitable feedstocks.

FLAME CAP PYROLYSIS

A flame cap kiln, or open fire kiln, is perhaps the most basic of kiln options. It consists of one single container that is open at the top to allow air to reach the burning biomass. Cone and pyramid designs are typical of this style of kiln. An initial pile is built inside the container and a fire is lit at the top. As it burns down, more biomass is added in layers until the entire container is full of hot coals. Finally, the coals are quenched with water, or by covering the kiln with an airtight lid to prevent full combustion. Unlike true open burning, this method excludes air from accessing the pile on each of the sides of the kiln and burns from the top down, instead of the traditional method of lighting piles from the bottom.

Courtesy: Wilsonbiochar.com

Courtesy: Mother Earth News

OPEN BURN

Biochar can also be produced through an open burning method without a container. Similar sized material is piled then lit from the top, burning downwards. It is quenched with water or covered with soil when the bottom of the pile is charred. The only requirement for this method is labor, and perhaps water. This method has the least capital costs of all methods however is also has the least consistent conversion rate and product. It is estimated that just 10-15% of the initial volume is converted to char. Check with your local fire department for regulations regarding open burning.

SELECTING A TECHNOLOGY BASED ON FUEL TYPE