USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Rocky Mountain Research Station
USDA Northwest Climate Hub

# Black to the Future: Biochar and Forests

Developed in Summer 2023

## Biochar as a climate change mitigation strategy

Biochar production is an alternative method for reducing forest slash and is a viable climate change mitigation strategy. Reducing forest slash through biochar production alleviates many of the air quality and soil health issues that may result from traditional fuel reduction methods. To mitigate climate change effects on drought, wildfire, and other processes, biochar is one tool that can be used across many types of sites to store carbon in the soil immediately.

Efforts to scale up forest fuels reductions mean more forest waste and low value slash production. Traditionally, slash is either masticated, chipped, and hauled to mills, distributed on-site, or it is piled and burned. Burning slash piles on-site can take a forest decades to recover from, because burning scorches the soil under the pile and leaves behind unproductive soil patches that are often colonized by invasive plants. Additionally, air quality restrictions, short burn weather windows, and the risk of escaped fire combine to limit the feasibility of large-scale pile burning.

### The case for biochar and climate mitigation

Biochar production and use can offset between 8 percent and 19 percent of all greenhouse gas emissions in Washington state alone. In addition to storing carbon, biochar can increase water retention in the soil. For example, if biochar acts similarly to native organic matter, then a 1 percent increase in soil organic matter could increase water storage by 1.5 to 5 percent, depending on soil texture. This increase in soil organic matter equates to an extra 200 gallons of water for each 1 percent increase. This is an amazing amount of water!

Biochar production generates heat that can support power generation and reduce the need

### What happens to the carbon from forest waste biomass?


Adapted from Amonette et al. 2021.

for nonrenewable fuels. The combined impact of carbon sequestration in the soil and power generation could offset nearly 10 gigatons (GT) of carbon dioxide when extrapolated out to a century.

Beyond reducing forest waste biomass, generating biochar can help to mitigate climate change by storing some of the carbon in the soil that would otherwise have been added to the atmosphere as carbon dioxide when burned in a traditional slash pile. Carbon dioxide accounts for about 60 percent of greenhouse gas emissions and reducing those emissions by putting biochar into the soil can be an effective strategy.

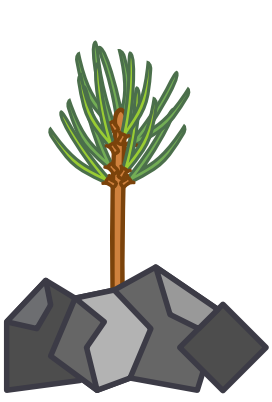
## How it works: Biochar and carbon sequestration

Open burning of slash releases stored carbon and sends it into the atmosphere, contributing to global warming. Estimates of atmospheric carbon contribution by slash pile burning are 92 percent to 94 percent of the stored carbon in the pile. By comparison, if biochar is created from slash and applied to the soil, it can ultimately be carbon negative compared to burning or natural biomass decomposition, due to its greater stability and high carbon content. The increase in soil organic matter on forest sites can also increase water retention and availability that leads to greater forest resilience to drought, insect or disease outbreaks, and other events magnified by climate change.

## Tradeoffs: The biochar balance

Creating biochar near where trees are harvested can be done in many ways, but largely production is done in (1) hand- or mechanically-stacked piles; (2) kilns of various sizes; or (3) air curtain burners.

The amount of carbon stored in biochar depends on how it is made, the temperature during burning, the species of wood, and other factors. It is important to note that all biochar creation methods release some carbon to the atmosphere because biomass is burned. However, these methods release significantly less carbon than traditional open pile burning because if slash is ignited at the top of the pile, a flame cap develops. Using the flame cap technique in kilns contains the combustion, which burns the wood more efficiently and results in less smoke. Using an air curtain burner forces a curtain of air over the burn bin, which blocks smoke and particulates from being released to the atmosphere.



Air curtain burners like the Charboss® waste burning system can increase efficiency and reduce the amount of particulates released into the atmosphere.

## Black Carbon

"Black carbon" is emitted from all fires, but it is considered an aerosol because of its small particle size. Black carbon and biochar should not be confused. Biochar is created for land application, but black carbon is residues from the combustion process (i.e., soot) and is a small enough particle size to be airborne. Since the black carbon particles are so small, they remain suspended in the air and can be easily carried on the wind. Black carbon at high elevation can accelerate snow melt, cause air pollution, and impact public health, including through increased incidences of allergies or cardiovascular diseases. Limiting these emissions by cleaner burning of slash in air curtain burners or kilns can reduce climate impacts.

Rocky Mountain Research Station researchers work at the forefront of science to improve the health and use of our Nation's forests and grasslands. More information about Forest Service research in the Rocky Mountain Region can be found here.

The Northwest Climate Hub serves Alaska, Idaho, Oregon, and Washington by delivering science-based, region-specific technologies and practical information that will assist with climate-informed decision making.

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