International Biochar Initiative

# CONTAINING CONTAMINANTS:

## Harnessing Biochar for Effective Pollution Control

# INTRODUCTION

**We urgently need innovative solutions to persistent pollutants like PFAS. Biochar is a viable solution to address chemical contamination. By allocating resources and investments, policymakers and funders can propel biochar solutions and reduce PFAS contamination.**

## Key Messages:

**1**

The persistence and widespread presence of PFAS compounds pose a significant threat to human and ecological health, necessitating innovative solutions to address their contamination.

**2**

Biochar offers a versatile solution to PFAS contamination and beyond, addressing a wide range of environmental challenges by immobilizing and decomposing pollutants. Its potential extends to industrial runoff, agricultural residues, stormwater management, land remediation, and erosion control.

**3**

Policymakers are crucial in advancing cleaner solutions by directing resources to research, policy development, and scientifically-proven circular technologies like biochar. Similarly, funders contribute to pollution control and sustainability by investing in studies, pilot projects, and practical applications for tackling PFAS.

# PFAS CONTAMINATION:

## A Complex Threat

As the world faces devastating environmental challenges, a particular class of persistent pollutants known as PFAS [1] has garnered significant attention. PFAS, or per- and polyfluorinated substances, are a group of synthetic chemicals that have been widely used in various industrial and consumer products for their water- and grease-resistant properties.

However, back in 1999, the U.S. Center for Disease Control's national health survey exposed a disturbing reality: PFAS compounds were detected in the blood of most participants. [2] PFAS are linked to health effects ranging from organ damage to immune system suppression. [3] PFAS break down extremely slowly, if at all, over long periods of time, with the U.S. Environmental Protection Agency often calling them forever chemicals. [4] PFAS' resistance to decomposition and their high mobility — the ability to move easily through the environment due to their structure and properties — allows them to escape their original setting (i.e., a food wrapper) and contaminate our environment.

In this context, the application of biochar offers a promising approach to address the protracted decomposition issue associated with PFAS compounds. Two-thirds of PFAS are challenging to contain, and their many varieties complicate containment. While the global scale of the problem is unknown, in the United States, these compounds are now nearly ubiquitous in surface water, [5] the primary source of drinking water. PFAS have also been detected in the air we breathe [6] and our soil, where it can transfer to plants and up the human food chain. [7]

The persistence of these compounds in our environment and even living organisms [8] has raised alarm bells with health and environmental scientists and government bodies, prompting the need for market-ready and scalable solutions.

# A BIOCHAR REVOLUTION:

## Tackling Contamination

**Enter biochar, a scientifically-proven solution that addresses PFAS contamination.**

Biochar is created when organic materials, such as agricultural crop residues or forestry biomass, undergo a high-heat and low-oxygen process called pyrolysis. Amid a paucity of other viable solutions to PFAS contamination, biochar's benefits are numerous and extend to a broad range of pollutants. Using biochar provides two main strategies for tackling PFAS contamination. First, it immobilizes compound movement, and second, its creation through pyrolysis aids PFAS decomposition.

### Immobilization: Stopping Compound Movement

Immobilization is a strategy to minimize the spread of PFAS and other compounds grouped under this umbrella, such as fluoropolymers like PTFE (Teflon™), fluorotelomers, and perfluoro alkyl acids, or PFAAs. Biochar can effectively immobilize PFAS due to its adsorptive properties, meaning it can attract and hold molecules or particles onto its surface. This powerful material can be deployed in various ways, from capturing harmful compounds in contaminated water to mixing it into soil for broader treatment. [9] Incorporating biochar into the soil can prove especially valuable for remediating sites where PFAS was used or produced. Ground injection of activated carbon particles can also offer a targeted approach that limits PFAS movement in underground water flows. [10] By harnessing hydrophobic interaction (the mechanism that causes oil and vinegar in salad dressing to separate), electrostatic attraction, i.e., static cling, and physical adsorption mechanisms, biochar can immobilize PFAS compounds. However, when it comes to biochar's efficacy in capturing PFAS compounds, there is no one-size-fits-all approach; the type of biochar used —chosen for the size of its contaminant-trapping pores and other properties —should be targeted toward the specific pollutant and context. As such, what to make biochar from and how to make it need careful consideration. Different feedstocks, whether agricultural residues, wood chips, or other organic materials, yield biochar with distinct properties. Likewise, the production techniques, such as pyrolysis temperature and duration, can further impact the biochar's characteristics.

# THERMAL DECOMPOSITION:

## Transforming the Pollutants

Beyond immobilization, the very process used to create biochar holds potential for addressing PFAS, particularly in terms of treating contaminated carbonaceous materials. PFAS compounds are notoriously resistant to degradation, especially at lower temperatures. The high temperatures in pyrolysis can transform PFAS compounds into harmless byproducts. [11] Yet, challenges persist in achieving complete decomposition of PFAS in real-world conditions; [12, 13] some PFAS are particularly resistant and may require even higher temperatures, [14] which may not be practical or economically feasible. [15] Though we urgently need more research to optimize the creation and deployment of biochar to mitigate PFAS contamination, biochar and innovative pyrolysis technologies already have many real-world applications.

### Real-World Biochar and Pyrolysis Applications

#### Reducing emissions

Biochar has the potential to reduce global greenhouse gas emissions by at least 6%, and national emissions by over 10% in 28 countries, making it a viable option for carbon dioxide removal and climate change mitigation efforts. [16]

#### Reducing cruise ship waste and emissions

Vow ASA pyrolysis technology can produce a wide range of circular carbon products and $CO_2$-neutral energy, using the waste generated on cruise ships, including plastic waste. [17] Doing so reduces carbon emissions by over 70% compared to the existing processes for recycling unsorted plastic waste.

#### Valorizing organic waste

The Biogreen [18] pyrolysis process changes organic waste and biomass into valuable products and energy. It has been applied to garden waste, waste timber, organic food/mixed waste, and sewage sludge in several industries. Its outputs include high-quality biochar, carbon-storing soil improver, emissions-reducing bio-coke for steel mills, char for tire production, biocarbon for power plants, and renewable energy sources. Many outputs, particularly energy, can be directed back into the industry, creating more sustainable, circular economies and reducing waste.

## Tackling industrial runoff

Biochar combats industrial runoff by capturing heavy metals and organic contaminants in water sources. As a purifier, biochar filters can be introduced into drainage systems to immobilize harmful substances, curbing their impact on aquatic ecosystems.

## Managing industrial agricultural residues

Biochar offers a sustainable solution for agricultural residue management and pollution reduction. Integrating biochar into fields facing pesticide or fertilizer runoff can enhance soil health, adsorb pollutants, and safeguard the environment.

## Treating urban stormwater

Urban areas grappling with stormwater runoff loaded with contaminants benefit from biochar-based filtration. Infusing biochar into stormwater management systems traps pollutants, lessening their entry into water bodies and alleviating the strain on natural ecosystems.

## Aiding land remediation

Biochar aids land remediation for polluted industrial sites. Introducing biochar to these areas immobilizes pollutants, including volatile organic compounds and hydrocarbons, preventing migration into groundwater and facilitating contaminated land recovery.

## Controlling soil erosion and nutrients

Biochar's soil stabilization properties combat erosion and nutrient runoff from agricultural and construction sites, reducing water pollution. Its presence curtails sediment and pollutants from reaching water bodies, enhancing overall water quality.

# A PROMISING PATH FORWARD

**As efforts to combat PFAS contamination intensify, biochar emerges as a versatile tool with immense potential. Its application extends beyond addressing PFAS pollutants, offering solutions for other harmful compounds.**

***Policymakers' support for biochar initiatives can pave the way for a PFAS-free future.***

It's imperative to recognize the role of innovative solutions like biochar in addressing complex pollution challenges. By allocating resources to research, policy development, and incentivizing the adoption of scientifically proven circular technologies like biochar, policymakers can pave the way for a world where PFAS contamination is a thing of the past. Similarly, funders can directly contribute to effective pollution control and sustainable practices by investing in biochar and PFAS studies, pilot projects, and practical implementations. With dedicated research and investments, we can refine and expand biochar solutions for effective pollution control and sustainable environmental stewardship.

**To learn more about how biochar can help address PFAS and other contaminants, visit [biochar-international.org](biochar-international.org)**

# FOOTNOTES

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