



## High Quality Biocoal to Replace Fossil Fuels

- Sustainably certified feedstock from forest waste
- 22 Gigajoule/metric ton
- No binders in production of HM3 biocoal
- Water resistant for easy shipping & handling
- Hardgrove Index grindability of approximately 45



**Torrefaction technology for  
production of biocoal and biochar**

January 2026

[HM3Biocoal.com](http://HM3Biocoal.com)

# Environmentally Friendly Feedstock

## Biocoal can Help Restore Western U.S. Forests

Many dryland U.S. western forests are overcrowded, with small trees close together. This presents a high risk for wildfire. Federal and state forest managers are removing the small diameter trees and leaving room for the bigger trees to thrive and grow, storing more carbon. These biomass residues are typically piled and burned in place, emitting smoke and particulate into the atmosphere.



*Biomass Residue*

## Waste-to-Energy

HM3's biocoal technology uses biomass residues, both from trees and agricultural operations. **Production of biocoal provides a market for residues, eliminating pile burning and accelerating the pace and scale of the important work to restore forest health.**

*Forest restoration work removing small diameter trees. The remaining trees grow stronger and store more carbon.*

# Biomass Waste is Sized for Even Torrefaction

## Pretreatment of Feedstock

HM3 has worked with forest waste from Ponderosa pine and juniper, sawmill residues from Douglas fir and empty fruit bunch (EFB). HM3 prepares the biomass prior to torrefaction by compacting it into uniformly sized “thin pucks.” This process allows HM3 to use waste material rather than clean wood chips or white pellets and ensures even torrefaction.



Juniper forest waste

EFB bales



EFB



# Patented Energy Efficient Torrefier

## Vertical Mass Flow Reactor

Gravity is used to move uniformly sized feedstock down HM3 Energy's patented mass flow torrefier. The reactor has few moving parts, thus lowering energy and maintenance costs. Uniformly torrefied biomass exits the reactor, ensuring excellent densification downstream. (In rotary dryers the smaller particles often move faster than the larger particles, resulting in uneven torrefaction.)



HM3 used this vertical torrefier design in its proof-of-concept plant over a 3-year period, optimizing its technology.



# Densification into Sturdy Briquettes

## Die Temperature Control

HM3's engineers invented a die temperature control system for the briquetter so the dies don't overheat and plug. The torrefied material enters the dies at the optimum temperature and stays at that temperature throughout the densification to ensure good compaction.



## Post Conditioning Treatment



## Post Conditioning Treatment

After densification, HM3 conditions the briquettes for a short period of time. This makes them water resistant without the use of binders.

# HM3 Energy's Keys to High Quality Biocoal

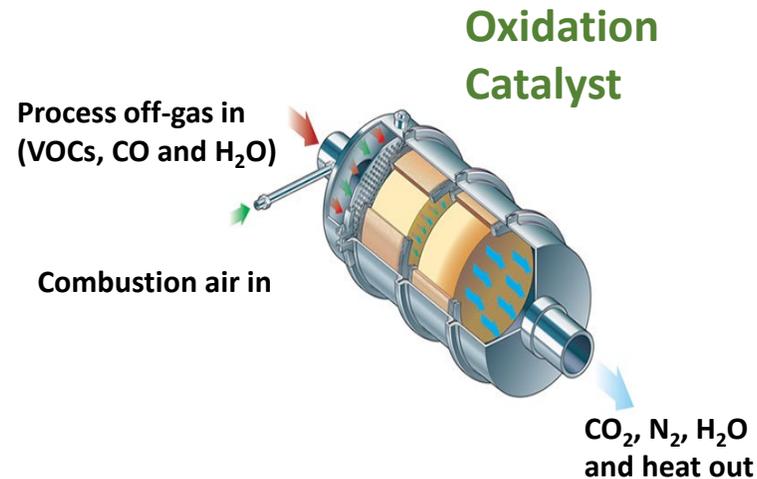
## Uniform Torrefaction

HM3's patented **vertical** torrefier has uniform gas temperatures across the horizontal plane, with no mixing of material as it is torrefied.



## VOC Destruction

HM3 uses Advanced Torrefaction System's patented ATS TorreCAT™ Torrefaction Gas System to eliminate VOCs with an up to 99.5% conversion efficiency. The ATS Torrefaction Gas Treatment System produces large amounts of essentially inert gas for use throughout the torrefaction system, ensuring safe and efficient operations.



## No Die Plugging

HM3's patented die temperature control system keeps the dies at a constant temperature, providing uniform briquette production.



## No Binders Necessary

After densification, HM3 cures the torrefied briquettes for a period of time. This makes them hard and water resistant without the need for binders.



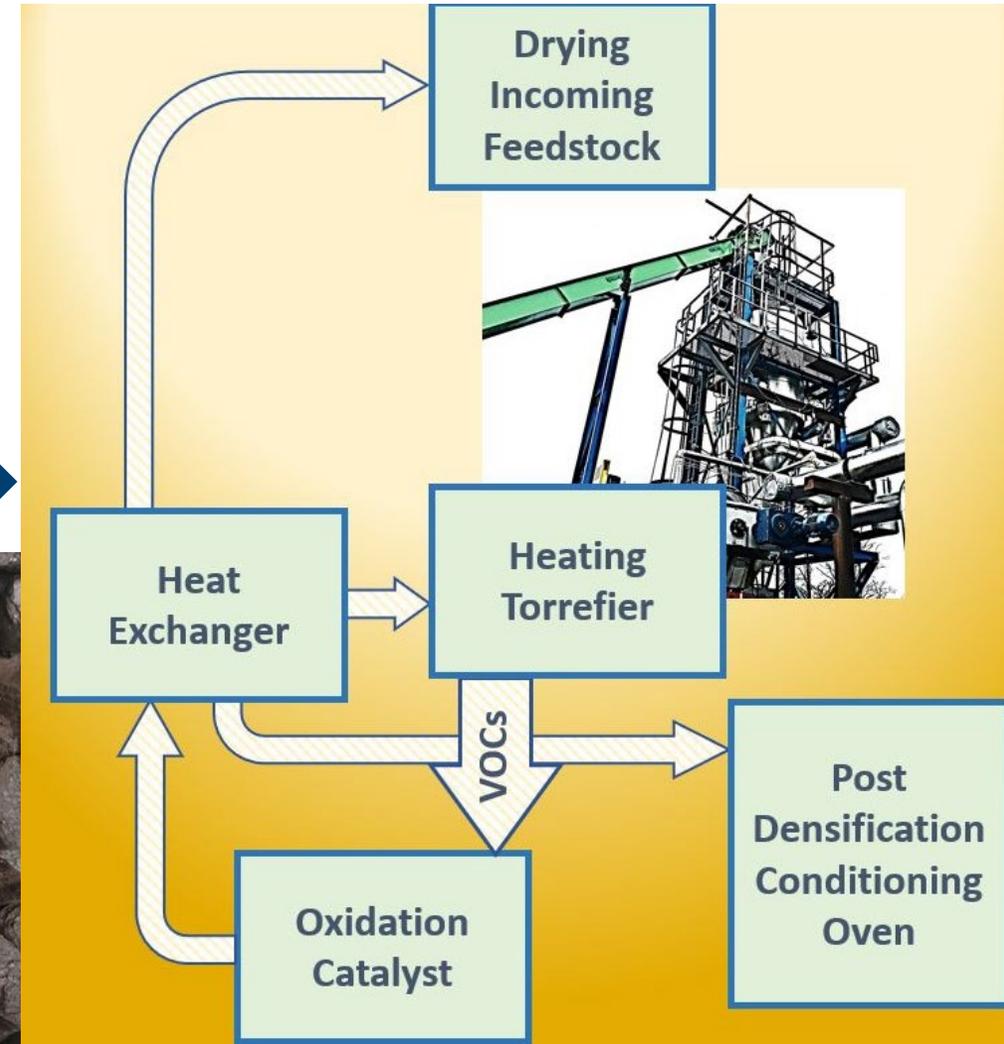
# Superior Technology Lowers Cost/GJ

HM3 Energy spent years developing a **lower cost torrefaction technology** that:

- ✓ *Uses cheaper forest slash as feedstock*
- ✓ *Torrefies feedstock evenly and without mixing*
- ✓ *Uses an energy-efficient mass flow reactor*
- ✓ *Produces water resistant briquettes without need for costly binders*
- ✓ *Efficiently uses energy by using heat from VOC destruction for other parts of the process*



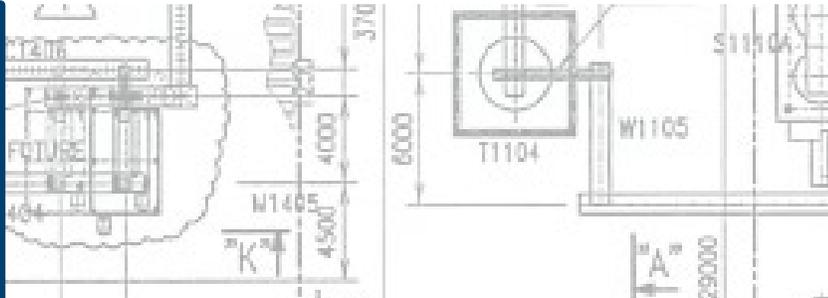
## Efficient Use of Heat in HM3 Energy's Process



# Proof of Concept Plant

## Proof of concept

HM3 designed and constructed a \$4.4 million proof-of-concept plant next to its pilot facility. All the equipment was commercial in design and linked together.



# 3 Years of Test Runs

## Optimization of Technology

Upon completion of the facility, HM3 optimized its technology by performing numerous production test runs ranging in length from 36 to 72 hours. All equipment was linked together, running continuously. Feedstocks included juniper and ponderosa forest woody biomass, sawmill residues, EFB and other agricultural residues.



# Test Burn in Coal Boiler

## Test Burn in Western Research Institute (WRI) Coal Boiler

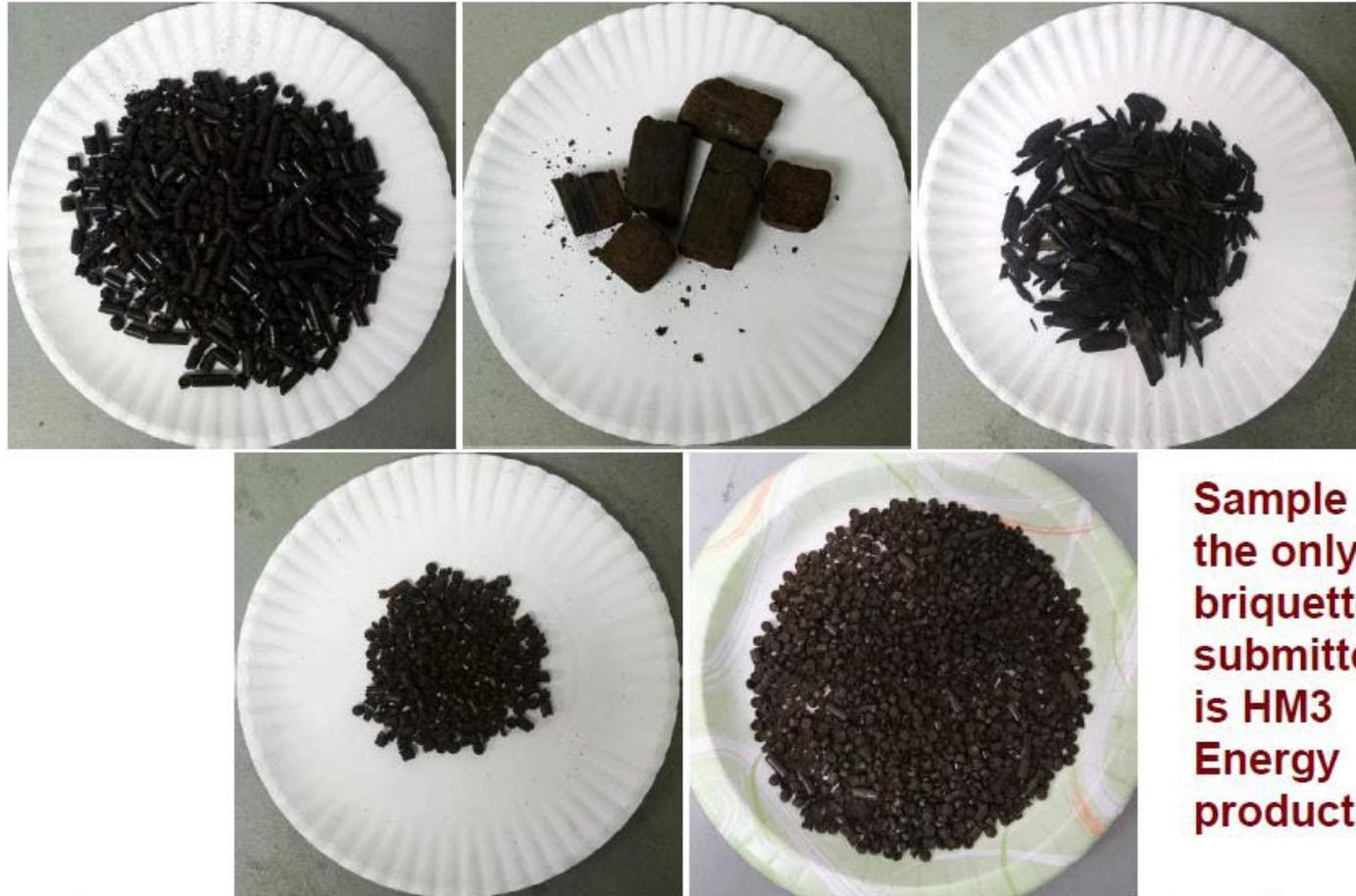
Many U.S. companies with coal-fired boilers use the 8-foot test furnace at WRI in Laramie, Wyoming, to perform test burns when they switch to new coal sources. All of the needed components to simulate a large-scale boiler are included at the facility.

In 2016 five leading torrefaction companies were invited to each submit torrefied material for a blind test to evaluate combustion performance of their torrefied biomass samples as drop-in coal replacement fuel. Powder River Basin Coal, typically used in the Western U.S., was used as the baseline.

Prior to combustion, the torrefied material from each company was prepared to specifications of 80% passing 200 mesh.



# Samples in Test Burn



**Figure 6** As-received Biomass Samples; (left to right, top to bottom) A, B, C, D, and E

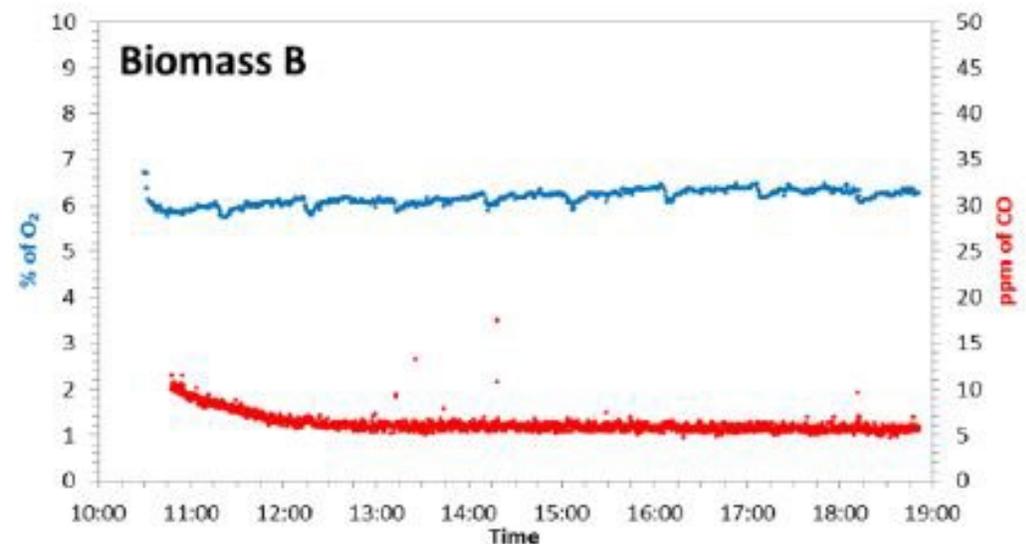
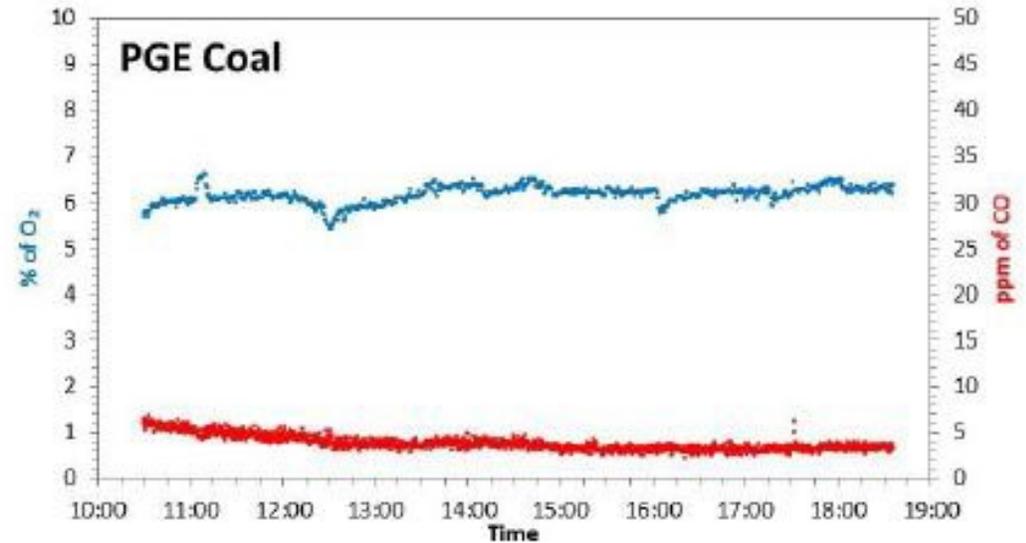
# HM3 Energy Sample in Test Burn

## Sample B Summary from Report

Portland General Electric (PGE) provided Powder River Basin coal from the western U.S. HM3's torrefied briquettes (**Sample B**) had no difficulty feeding to the system. Combustion was sustained throughout the test with the steadiest O<sub>2</sub> and CO values compared to other biomass tests. The time temperature profile and heat recovery was very close to baseline coal.

Overall pollutant level was lower than that of coal. Fly ash distribution was different compared to that of coal, with higher ash rate and different partitioning of fly ash throughout the plant. As such, modifications on the particulate control systems, especially the ESP, will be required to fine tune fly ash removal.

**RED DATA = Parts per million of CO**  
**BLUE DATA = Percentage of O<sub>2</sub>**



## Grants and Awards (partial list)

**2019 USDA, Forest Service Wood Innovations Grant**, “Converting Forest Residues to Profitable Torrefied Briquettes.” HM3 Energy, in collaboration with Northern Arizona University and Coconino County, obtained key information needed for construction and operation of a commercial torrefied briquette plant sited in Northern Arizona, including rail logistics and detailed engineering work.

**2015 USDA-NIFA SBIR Phase 2 Grant**, *“Development and Evaluation of Continuous Biomass Torrefaction and Densification Process for Commercial Briquette Production.”* This research, completed in August of 2017, greatly helped HM3's final push to link together key components for torrefaction and densification of juniper biomass.

**2014 Demonstration Plant Construction:** A consortium of five Japanese companies reviewed torrefaction and densification technologies world-wide and selected HM3's as the best. They advanced HM3 \$2 million toward construction of a demonstration plant which would link key equipment pieces together to test and prove viability of the technologies.

**2014 USDA-NIFA SBIR Phase 1 Grant**, *“Development of Reliable, Economical Briquetting of Torrefied Forest Residue Without Binders to Produce Sturdy, Water Resistant Briquettes”*

**2011 USDA-NIFA SBIR Phase 2 Grant**, *“Practical Torrefaction of Forest Waste into Clean Fuel for Coal-fired Power Plants.”* For this grant, HM3 Energy researched densification issues regarding several different forest waste feedstocks, culminating with densification runs on commercial equipment using proprietary die cooling modifications.

**2010 US Endowment for Forestry and Communities Award**, *“Torrefaction Process and Equipment Testing Facility.”* The Endowment award contributed greatly to building our torrefaction process and equipment testing pilot facility.

**2010 USDA-NIFA SBIR Phase 1 Grant**, *“Forest Waste Contaminant Removal into Clean Fuel for Coal-fired Power Plants.”* This first grant explored how to remove contaminants from forest waste such as juniper and western pine without using water so dirty feedstock could be transformed using torrefaction into clean fuel for coal-fired power plants.

# Intellectual Property

## **Dec. 8, 2015: US Patent No. 9,206,368 B2 *System and Process for Producing Torrefied Biomass Using a Mass Flow Reactor***

A variety of torrefier designs exist, however, HM3 strove for a simple design which a) roasts the biomass to ensure even torrefaction (for later better densification), and b) has few moving parts, which is easier to maintain and uses less energy to operate.

## **August 1, 2017: US Patent No. 9,719,040 B2, *Methods and Process for Producing a Water-Resistant, Mechanically Stable Form of Torrefied Biomass***

Probably the biggest hurdle for the nascent torrefaction industry up until recently has been the challenge of densification. First, the biomass must be torrefied at just the right temperature and for the right amount of residence time for even torrefaction. This is important for later densification. Also, torrefied matter is quite abrasive, and the friction in the pelletizer dies during densification causes the dies to overheat, leading to plugging of the dies. Instead of pelletizing, HM3 modified a commercially available briquetter used primarily for agricultural operations with a patented die cooling component. Densification is followed by a curing process which ensures the briquettes are water resistant. No binder is used in HM3's process.

## **September 21, 2021: US Patent No. 9 1,124, 724 *for Method for producing a water-resistant, compressed biomass product***

After densification, it is very important that the torrefied briquettes be heated at a very high temperature for a fair amount of time in order for the lignan to become pliable and fill the interstitial space in the molecular structure of the briquettes. This makes the briquettes water resistant.