


High Quality Biocoal to the World's Decarbonization Goals

- Sustainably certified feedstock from forest waste
- 22 Gigajoule/metric ton
- Low COD levels in outdoor leachate; ash below 2%
- No binders in production of HM3 biocoal
- Water resistant for easy shipping & handling
- Hardgrove Index grindability of approximately 45
- Samples available by 2025

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Environmentally Friendly Feedstock

Helping 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. Many 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 empty fruit bunch (EFB), forest waste from Ponderosa pine and juniper, and sawmill residues from Douglas fir. HM3 prepares the biomass prior to torrefaction by compacting it into uniformly sized “thin pucks.” This simple 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 "cures" the briquettes for a short period of time. This makes them water resistant without the use of binders.

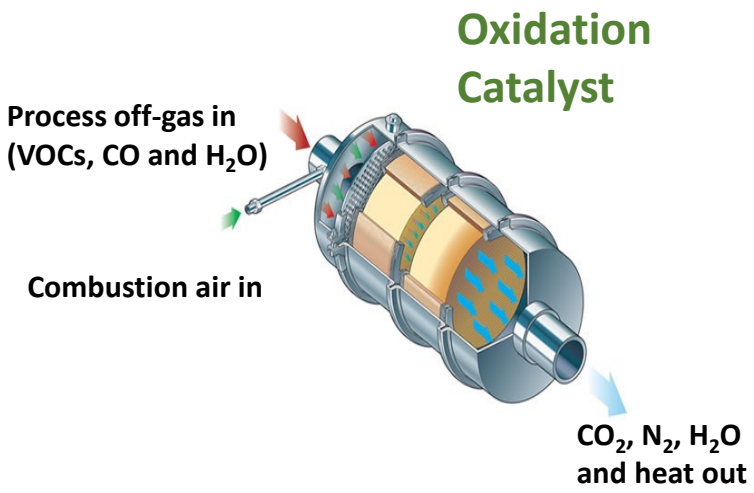
HM3 Energy's Keys to High Quality Biocoal

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

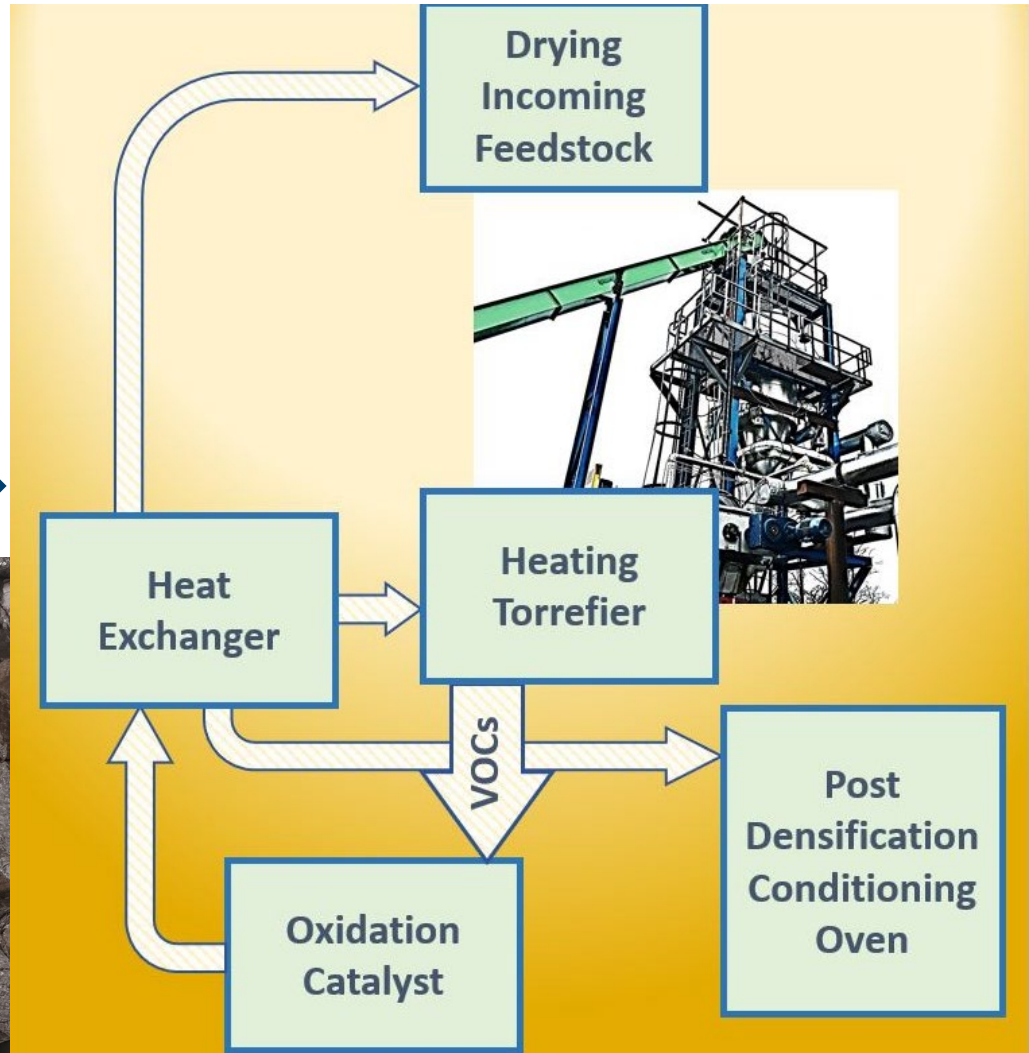
After densification, HM3 "cures" the torrefied briquettes for a period of time. This makes them hard and water resistant without the need for binders.

Superior Technology Lowers Cost/GJ

HM3 Energy spent ten 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

From 2014-2015, 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.

Test Runs: 2015-2018

Optimization of Technology

From late 2015 to the end of 2018, HM3 optimized its technology by performing numerous production test runs ranging in length from 36 to 72 hours. Linked equipment ran continuously during the runs. Feedstocks included EFB and other agricultural residues, juniper and ponderosa forest woody biomass, and sawmill 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 contracts. 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 300 lbs of 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

Sample B, the only briquette submitted, is HM3 Energy product.

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

"Combustion Evaluation of Torrefied Biomass for Heat and Power Generation," September 6, 2017. Western Research Institute.

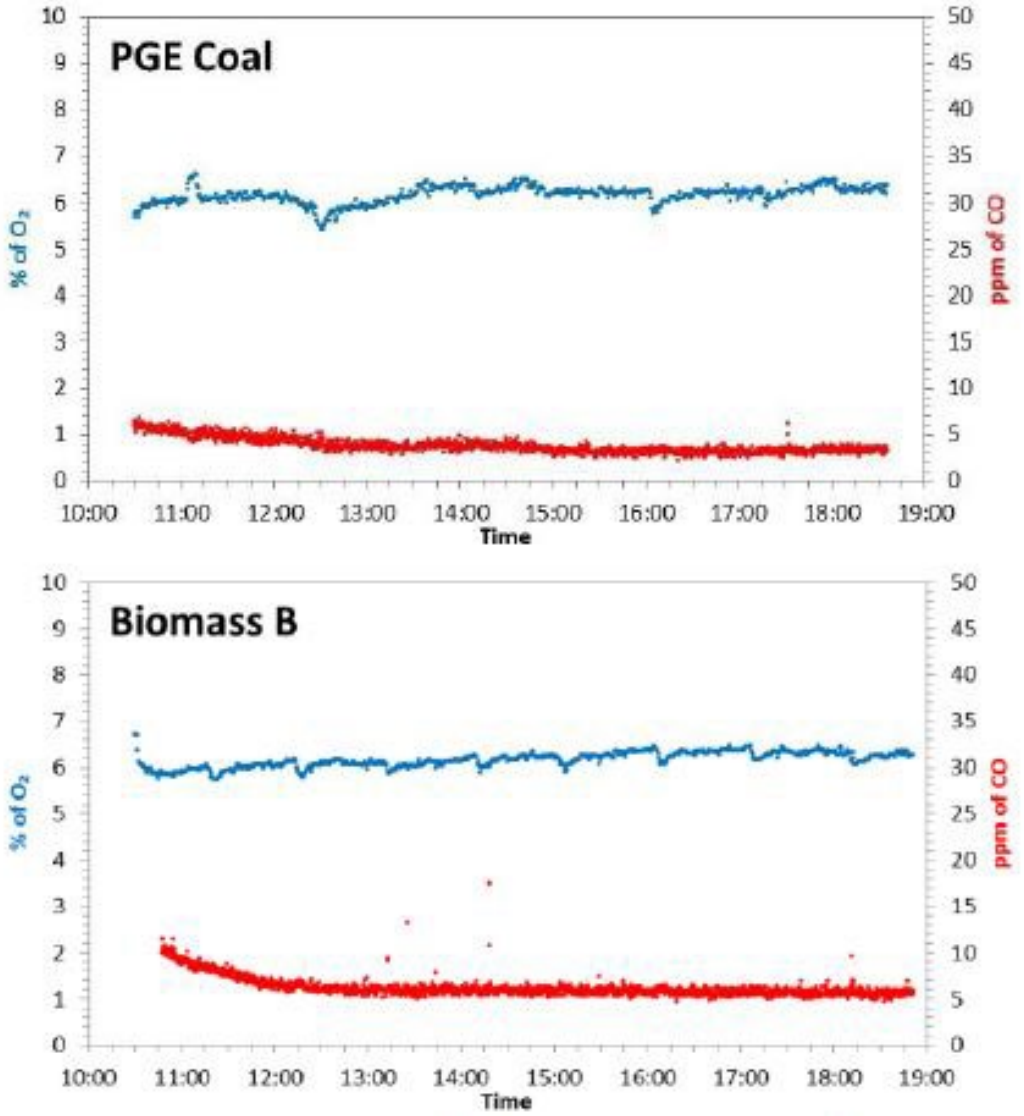
HM3 Energy Sample in Test Burn

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_2 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_2



Next Step: 24/7 Demo Plant for Sample Production

HM3 Energy's Proof of Concept plant closed at the beginning of 2019. **HM3 Energy plans to build a 1 metric ton/hour demonstration plant** that can be operated 24/7.

The purpose of this demonstration plant is to **show continuous plant operations 24/7 while annually producing 8000 metric tons of samples** for interested customers.

While the demo plant will closely resemble the proof of concept plant, two notable changes will be implemented:

- The use of an **oxidation catalyst** in place of a thermal oxidizer to destroy the volatile organic compounds. This will result in an acceptable level of VOC destruction.
- **Dirt will be removed from the biomass** to ensure lower ash content and raise the Btu content of the biocoal.

Location of Demo Plant: *HM3 has determined several potential locations in the western U.S.(Arizona, California and Washington) where large sustainable supplies of juniper, ponderosa pine or Douglas fir are available to supply future commercial (50,000 to 100,000 metric ton or larger) biocoal production plants.*