Frequently Asked Questions

What has HM3 Energy done?
Using its $4 million demonstration plant, HM3 Energy has proven that its proprietary TorrB® torrefaction technology turns forest slash into TorrB® briquettes as fuel for both coal- and biomass-powered electric generation plants.

What are the primary features of HM3 Energy's torrefied biomass briquettes?
Torrefied biomass briquettes have many advantages over standard wood chips or pellets as fuel. Together, these properties make torrefied biomass an appealing drop-in coal replacement fuel and superior fuel for biomass electric generation power plants:

- Pound-for-pound, HM3 Energy's TorrB® torrefied briquettes contain similar energy content to coal and 30 percent more energy than raw wood pellets.
- TorrB® briquettes are sturdy and water resistant. Because they can be shipped and stored without cover, shipping and handling costs are lower than those for raw pellets.
- TorrB® briquettes are similar to coal in that they are easily ground prior to feeding into a coal-fired plant boiler. Raw wood pellets, which are fibrous, do not grind sufficiently in the pulverizing equipment that most coal plants use.

What are the features of the HM3 Energy TorrB® torrefaction process?
During TorrB® torrefaction, ground biomass is dried and heated in the absence of air above 200^{o} and below 320^{o} Celsius for less than 30 minutes. The resulting torrefied biomass is dark brown in color, brittle and water-resistant. This material is then densified into sturdy, energy-dense briquettes that can be easily shipped via open hopper rail cars.

During heating, all biomass releases volatile materials. If not completely combusted, these volatile gases are harmful to the environment. This is what happens with the smoke from forest fires and burning of forest slash piles and agricultural residues. However, during HM3 Energy's production process, the volatiles are captured and completely combusted, and the heat from the combustion is used to dry the incoming biomass. The exhaust gases from this torrefaction process are CO_2 and steam, thus non-polluting.

How much energy is required to produce torrefied biomass pellets or briquettes?
In the TorrB® process, all heat is provided by an average of 10 percent of the feedstock energy if the biomass contains less than 35 percent moisture. In fact, the energy

required to dry, torrefy, and pelletize TorrB® briquettes is much less than that of producing standard wood pellets for several reasons:

1) HM3 Energy's TorrB® drying and torrefaction processes use a small portion of the feedstock for energy needs, while traditional pellets need an external energy source for drying.
2) Grinding fibrous raw wood is more energy intensive than grinding brittle torrefied wood.
3) The pelletization used in raw pellet production requires more energy than HM3 Energy's briquetting process.

How does HM3 Energy's torrefied biomass fuel compare in cost with coal?

Power utilities are already making assumptions about the future cost of carbon in their investment horizon. If limits on CO_2 emissions are imposed via a carbon tax or a cap-and-trade system, the operating cost of fossil-fuel based power plants will substantially increase. And because the burning of coal releases more CO_2 per unit of energy than any other energy source, coal-fired power plants would be hit the hardest. Using a carbon neutral source of energy such as torrefied biomass will permit utilities to continue operating existing power plants *already connected to the grid* with no additional capital investment and with no worries about carbon tax or cap and trade. When this is taken into account, torrefied biomass compares very favorably with coal.

What feedstock does HM3 Energy use for its torrefied biomass?

HM3 Energy's TorrB® technology creates clean energy using woody biomass and other ligno-cellulosic material as feedstock. Residual materials such as the following have great potential as process feedstock:

- **Woody biomass,** left as residual from harvesting or thinning conducted to improve forest or rangeland ecological health in overstocked forest stands. This includes juniper, a particularly problematic tree in much of the western U.S. because it draws so much water from the ground, destroying native grasses and habitat for wildlife.
- **Agricultural residues from crops** such as sugarcane, coconut, wheat, ryegrass, orchards (via tree pruning) and similar material left after harvest.
- **Urban wood waste,** such as downed trees and other woody yard debris, as well as brush cleared from right of ways.

Wouldn't it be expensive to haul bulky forest waste out of the forest to a torrefied biomass production facility?

After logging or thinning operations, the forest slash is tub ground or chipped right in the forest where it is collected so it can be easily transported. HM3 Energy recommends torrefaction plants be built within 50 miles of available biomass to keep the

transportation costs reasonable. Our study of available biomass reveals many locations in Oregon alone where forest waste is sustainably available, and where biomass can be delivered to a 100,000 ton/year torrefied biomass production plant for many, many years.

Is there enough biomass for this new clean energy application to be feasible?
Yes. Recent nationwide studies by government agencies have analyzed the amount of biomass that could be available for bio-energy on a sustainable and economical basis. The 2005 (updated 2016) "Billion Ton Study" (Oak Ridge National Laboratory, USDA and DOE) analyzed biomass supply: http://energy.gov/articles/department-energy-releases-new-billion-ton-study-highlighting-opportunities-growth. HM3 Energy has reviewed what it considers incremental supply in the Northwest that is sustainably available as feedstock for its torrefied briquette production. We conclude that some 35 million bone dry tons per year of underutilized biomass resources exist in Oregon, Washington and British Columbia alone. These include timber harvest slash, forest and rangeland restoration residue and restoration of dead forest residue.

Use of forest slash as feedstock provides a way for private and public forest management to help pay for more active forest management. It is quite probable that by thinning and restoring forests, and selling the forest slash as feedstock to torrefaction facilities instead of burning it in place, forests can be healthier and more economically managed. This may lead to a reduction in catastrophic forest fires as fuels are reduced within the stands.

What tests have you performed to demonstrate HM3 Energy's briquettes as viable drop-in coal replacement fuel?
In 2010, HM3 performed two test burns in which TorrB® torrefied woody biomass material was blended with coal in a pulverized coal-fired boiler. The pulverized torrefied biomass material was first blended 50 percent with coal, and fired in Western Research Institute's small pulverized coal combustion facility, which models the operation of large pulverized coal power plants. After we observed the steady-state combustion of the 50/50 blended feed for about two hours, we switched the feed to 100 percent of the pulverized TorrB® biomass. It performed just as coal, with the exception that a feed rate of about 20% less was needed to maintain the same furnace temperature as with the coal. The test burn ran for more than two hours of steady-state operation before being terminated.

The analytical data of the TorrB® material shows that the sulfur content was 0.03% versus 0.79% for coal on a dry basis; furthermore, the mercury concentration in TorrB® torrefied material was below detection. Notably, the furnace operator observed that

the slag build-up near the burners after this test burn was in the normal range experienced with burns of 100 percent coal.

HM3 briquettes also have a Hargrove Grindability Index of 45, right in the mid-range of coal's, which means they can be ground in the same pulverizing equipment used in coal-fired plants.

Are any utility companies interested in using torrefied biomass to replace coal?
Many utility companies both in the U.S. and internationally have explored the use of torrefied biomass as drop-in coal replacement fuel, including Portland General Electric, TransAlta, and Duke Energy. In order to make the switch from coal to torrefied biomass, however, they require several thousand tons of product to perform the required qualifying test burns. Commercial production facilities would be able to supply this quantity, but they have not yet been constructed.

Isn't biomass already being used in power plants?
Europe has been using traditional wood pellets instead of coal for many years, but the biomass is in the form of traditional wood pellets or hog fuel that requires the plant owners to spend time and money building a separate feeding system. In 2014, pellet manufacturers in the South Eastern Region of the United States exported over five million tons of pellets to Europe. There are currently large pellet plants being built in the region, and the export volume to Europe has increased annually.

Japan, Korea and China will soon join Europe as large importers of raw pellets as these countries recently enacted feed-in tariff legislation to encourage a reduction in coal use. Since almost all coal-fired power plants use pulverized coal and raw pellets cannot be easily pulverized, power plants must invest in new feeding systems that may cost up to $100 million per every 300MW capacity. Also, since traditional wood pellets will fall apart if exposed to moisture, the pellets require enclosed storage for weather protection from the time the pellets are produced, through transport, and storage at the final destination. This extra cost in comparison to coal is significant.

Is wood energy "clean?"
There is no simple answer to this question, as there are a number of different wood energy technologies using woody biomass from a number of different sources. For example, when traditional wood pellets or hog fuel is burned, the first thing that comes out of the burning wood are volatiles contained in hemicellulose. When not completely combusted, these volatiles will produce harmful smoke. This is also what happens during forest fires and the burning of slash piles after logging or thinning operations. Rather than leave the slash behind on the forest floors, which would provide potential

fuel for catastrophic forest fires, the slash (which has no commercial value) is burned in place.

HM3 Energy believes that instead of burning the slash (and releasing particulates, carbon monoxide and such into the air), we should harness the energy contained in the slash to generate electricity. The TorrB® process HM3 Energy uses to create our torrefied biomass briquettes/pellets a) uses only sustainably gathered woody biomass which has little or no commercial value, such as forest slash, b) is energy efficient in both the gathering of the woody biomass and creation of the solid biofuel, and c) creates no harmful emissions during production and combustion of the fuel. The feedstock is forest slash, which is currently burned in place or left to rot. And the final product is a clean replacement fuel for coal. This is good for the environment and good for rural economies.

HM3's TorrB® briquettes are specifically designed to immediately reduce the CO2 and other greenhouse gas (GHG) emissions of coal-burning power plants. As a renewable alternative to coal that is CO2 neutral, it is a clean burning, high BTU biomass fuel that can be mixed in any ratio with coal. When the lifecycle of biomass based fuel is taken into account, the fuel is carbon neutral. When TorrB® biomass is burned, the CO2 in the TorrB® biosphere is released into the atmosphere. That CO2 goes back into the biosphere as the trees from which the woody biomass comes grow and absorb it. Harmful emissions such as mercury and sulfur are virtually non-existent, and nitrous oxides are substantially reduced by 30 percent.

Will manufacturing these torrefied biomass briquettes create jobs?
Jobs created include construction work to create the plants, followed by permanent staff for each plant. HM3 anticipates approximately 30 permanent staff would be needed for each facility using this technology to run 24/7. Furthermore, when using forest waste as a feedstock, there will be 55+ forestry workers collecting, grinding, and transporting the forest waste biomass to plants.