Background Information

Second generation biomass: cleaner burning biomass energy that replaces coal directly in coal-fired power plants

HM3 Energy has developed the proprietary TorrB™ process to turn biomass into clean fuel to replace coal in coal-fired power plants. Unlike standard pellets made from wood chips, HM3 Energy's TorrB™ biomass pellets can be burned in existing coal plants without any plant modification. HM3 Energy TorrB™ pellets provide utility companies a reliable, but clean, base load source of energy as clean fuel to directly replace coal.

During HM3 Energy's TorrB™ torrefaction process, biomass is dried and heated in the absence of air above 200^{o} and below 320^{o} Celsius for less than 30 minutes. When the biomass is properly torrefied, it is hydrophobic and is easily ground up to form pellets. HM3 Energy TorrB™ torrefied biomass pellets have many advantages over standard wood chips or pellets:

- They are completely dry and dense, therefore inexpensive to ship and store.
- They do not absorb water, so can be stored and shipped outside.
- They are easily crushed into a powder, just like coal is in a power plant.
- They have a similar heating value to coal.
- Switching to HM3 Energy's TorrB™ pellets requires no modifications to the existing coal-fired power plant.

TorrB™ pellets 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 life cycle of biomass based fuel is taken into account, the fuel is carbon neutral. Replacing ten or twenty percent coal would result in an immediate reduction of CO2 generated by coal emissions by that percentage. Other harmful emissions such as mercury, sulfur, and nitrous oxides would also be substantially reduced.

HM3 Energy's TorrB™ pellets can be made sustainably from readily available biomass sources such as urban waste wood, agricultural residue, and forest waste (woody biomass with low to no commercial value, such as limbs, tops, and bark left behind after logging and the deadwood and small trees thinned in fuel reduction treatment). HM3 Energy has developed a process to economically turn this abundant resource into clean fuel.

Company

HM3 Energy was formed first as HM3 Ethanol in January of 2008 to create a process to produce cellulosic ethanol from residual biomass resources as raw material. Sustainably harvested forest waste was our first source of feedstock for ethanol because it has little commercial value and is currently being gathered and burned to reduce the risk of catastrophic forest fires.

After changing our philosophy and focus in late 2008, we changed our name from HM3 Ethanol to HM3 Energy in 2009. Our research had led us to believe that by creating a solid fuel to replace coal in coal-fired power plants, our biofuel product would have a much greater impact on reduction of carbon emissions, and thus global warming. Research is conducted at our laboratory, located in Troutdale, Oregon.

Test burn results

HM3 Energy has demonstrated the ability to produce torrefied biomass and burn it successfully at the highest blend rates yet accomplished, worldwide. In February of 2010 we conducted two test firings of TorrB™ torrefied wood waste at the Western Research Institute in Laramie, Wyoming. First a 50/50 blend of torrefied wood waste and coal, then 100% torrefied wood waste in place of coal were test burned.

The result was remarkably successful. Handling, firing, slagging, fouling were similar to, or superior to, coal in every regard. In fact, the feed rate was turned down 20% compared to coal in order to maintain the desired boiler temperature. This lower feed rate indicates that TorrB™ torrefied biomass burns more efficiently than coal, which is partly due to the lower moisture content. Furthermore, NOx emission with 100% torrefied wood was 30% less than with coal.

Biomass feedstock

HM3 Energy's TorrB™ technology creates clean energy using woody biomass and other ligno-cellulosic material as feedstock. This includes a wide range of residual materials, such as:

- **Agricultural residues,** such as corn stover, wheat straw, ryegrass straw, orchard prunings and similar material left after harvest

- **Woody biomass,** left as residual from harvesting or thinning conducted to improve forest or rangeland ecological health in overstocked forest stands, and also the high risk of wild fires

- **Urban wood waste,** including construction and demolition debris, yard debris, and brush cleared from right of ways

- **Farmed energy crops** grown solely to be used for energy, such as fast growing poplar trees

HM3 Energy *does not use food sources.* We may use corn stover, but not corn. We do not plan to compete for feedstock with value-added manufacturers (such as lumber, wood chips for pulp and paper, or mill residue used by fiber board manufacturers). We also require that our biomass feedstock be sustainably grown, harvested or gathered.

There are sufficient under-utilized feedstock resources in Oregon, such as logging slash, forest restoration treatment, juniper removal, agricultural residue and even urban waste wood. This is ample feedstock to replace, for example, the 2 million + tons of coal burned annually at Portland General Electric's 600-megawatt coal-fired power plant in Boardman, Oregon.

Woody biomass from logging slash, forest restoration and juniper removal alone amount to 3.5 to 7 million dry tons per year that is available economically to biomass torrefaction plants located within 40 miles of the resource. Agricultural residues (straw and manure residual solids from anaerobic digesters) as well as urban waste wood, may provide an additional 1 to 2 million dry tons per year of available feedstock.

HM3 Energy is in contact with major timberlands owners and providers of biomass from agricultural residue and urban waste wood who have expressed interest in long-term supply agreements. Supply agreements providing access to the logging slash of just two or three of Oregon's major timberlands and sawmill owners will provide secure supply of at least 1 million tons of annual feedstock. This could be complemented with material from smaller private timberlands and from restoration of overstocked federal forests and juniper invaded rangeland.

Grants & Awards

Northwest Regional Finalist – Cleantech Open Competition— HM3 Energy was one of 3 finalists selected from the Northwest (and 18 out of all US Competitors) to compete in the November 2011 national competition in San Jose, CA.

USDA – SBIR Phase II Grant— HM3 Energy was awarded $540,000 in August, 2011 for its grant proposal entitled "Practical Torrefaction of Forest Waste for Conversion into Clean Fuel for Coal-fired Power Plants."

USDA – SBIR Phase I Grant— HM3 Energy was one of only two Oregon companies to receive this grant in 2010. HM3 Energy received the largest award available—$90,000—to develop an economical method to remove almost all rocks and soil without the use of water from normally wet and dirty forest waste feedstock. This research was successfully completed at the end of 2010.

US Endowment for Forestry and Communities—On July 30, 2010, the U.S. Endowment for Forestry and Communities awarded $241,000 to HM3 Energy for equipment modifications and operation of a pilot plant which produces torrefied biomass pellets. HM3 Energy is one of eight businesses and educational institutions nationwide receiving US Endowment awards to demonstrate new processes and practices to sustainably produce green energy, provide market for forest residual material, and add jobs in rural communities using woody bio-based energy.

Plans for commercialization

At the end of 2010 HM3 Energy completed pilot plant testing. We moved to a larger facility in Troutdale, Oregon, where we are building a demonstration plant in preparation for commercial application of our technology. Over half of the equipment is in place and being tested. The remaining pieces will be fabricated and installed this summer and fall.

HM3 Energy has selected a site for its first commercial plant in Prineville, Oregon. This 45,000 tons-per-year facility is now being designed and is scheduled to be completed by early 2013. This plant would produce enough TorrB™ torrefied biomass product to enable utilities such as Portland General Electric (Boardman), TransAlta (Centralia, Washington), and PacifiCorp to perform test burns of TorrB™ biomass and coal blends in their coal-fired power plants.

Leadership

HM3 Energy was founded by Hiroshi Morihara, Ph.D., the president and CEO. Dr. Morihara assembled a technical team of six experienced senior chemists and engineers who have studied conversion of lignocellulosic feedstock for commercial application. The team was specifically formed to bring a full complement of skills and experience to move from research to pilot plant design and operation to commercial plant design and operation.

Together, Dr. Morihara and Senior Process Engineer William Breneman are listed as co-inventors on a number of patents pertaining to polysilicon technology. Both were instrumental in facilitating the integration of technology purchased by Union Carbide from Komastu Electronic Materials for the pyrolysis of silane into polysilicon rods, the favored shape factor for the electronic industry and solar industries. This technology was demonstrated in the semi-commercial scale facility and later up-scaled to a $250 million, 1200 ton/year facility which began operation in Moses Lake, WA in 1985.

While ownership of the enterprise has changed hands over the past thirty years, the basic process remains fundamentally unchanged as the leading technology for low cost and high quality. Today, as REC Silicon, that original Moses Lake facility continues to produce high quality materials for use in both electronic and photovoltaic applications. The plant has just completed a $1.7 billion expansion.

Dr. Morihara was also involved in biotechnology in the Bay Area. He served as chairman and CEO of Peninsula Laboratories from 1995 to 2000, and as president of American Peptide Company from 1990 to 1994. During his tenure, the companies developed numerous new peptide and immunology products for drug development and won NIH grants.

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