Marketing Data Sheet

Product: Biowastes-To-Energy Business Models 1 & 2

Business Model 1 consists of:

1. The production of sufficient electricity to achieve complete energy independence for communities, i.e., cities and counties. The production of electricity is accomplished through the anaerobic digestion of organic based wastes such as food waste, green waste, animal waste, food processing waste, and municipal solid waste. The anaerobic digestion of these wastes results in the production of methane gas and other co-products. The methane gas is used to fuel an electric generator. Through the digestion of sufficient wastes a community becomes totally energy independent permitting it to permanently disconnect from the grid power supply which currently provides electricity to the community. The electricity generated will be sold to community citizens and businesses at a permanent 20% discount from existing retail prices that are able to achieve lasting marketplace price stability. The discount will be greater in Hawaii, perhaps as much as 40%, due to its total reliance on imported oil. The discount will be even greater in Latin America which must pay off past debts in the form of extremely high electricity prices. The 40% discount will be applied in countries which lack petroleum resources similar to Hawaii. The 20% discount will otherwise generally apply throughout the world. When making electricity from biowastes its cost of generation is considerably less than the cost (referred to as avoided costs) of electricity produced by coal fired power plants, nuclear power plants, and hydroelectricity plants.
2. The production of sufficient fuels to achieve complete fuels independence for communities, i.e., cities and counties. The fuels consist of biodiesel, compressed natural gas (CNG), E85, LP Gas, natural gas, and liquefied natural gas (LNG). **Biodiesel** is destined to completely replace petroleum diesel because of its superior lubricity, engine performance, environmental friendliness, and increasingly favorable price. As petroleum diesel supplies continue to diminish in availability biodiesel will fulfill the need. If biodiesel suppliers do an excellent job in the marketplace biodiesel will replace petroleum diesel before petroleum diesel supplies become obsolete. Biodiesel is currently being made from waste cooking oils, animal fats (tallow), and vegetable oils. The concept of using vegetable oil as an engine fuel dates back to 1895 when **Rudolf Diesel** (1858-1913) developed the first engine to run on peanut oil, as he demonstrated at the World Exhibition in Paris in 1900. Most unfortunately, Mr. Diesel died in 1913 before his vision of a vegetable oil powered engine was fully realized.

Rudolph Diesel

"The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become in the course of time as important as the petroleum and coal tar products of the present time." Rudolph Diesel, 1912

After Mr. Diesel's death the petroleum industry was rapidly developing and produced a cheap by-product "diesel fuel" powering a modified "diesel-engine". Thus, clean vegetable oil was forgotten for many years as a renewable source of power.

Modern diesels are now designed to run on a less viscous fuel than vegetable oil but, in times of fuel shortages, cars and trucks were successfully run on preheated peanut oil and animal fat. It seems that the upper rate for inclusion of rapeseed oil with diesel fuel is about 25% but crude vegetable oil as a diesel fuel extender induces poorer cold-starting performance compared with diesel fuel or biodiesel made with fatty esters (*McDonnel K et al. JAOCS 1999, 76, 539*). Today's diesel engines require a clean-burning, stable fuel operating under a variety of conditions. In the mid 1970s, fuel shortages spurred interest in diversifying fuel resources, and thus biodiesel as fatty esters was developed as an alternative to petroleum diesel. Later, in the 1990s, interest was rising due to the large pollution reduction benefits coming from the use of biodiesel. The use of biodiesel is affected by legislation and regulations in all countries (*Knothe G, Inform 2002, 13, 900*). On February 9, 2004, the Government of the Philippines directed all of its departments to incorporate one percent by volume coconut biodiesel in diesel fuel for use in government vehicles. The EU Council of Ministers adopted new pan-EU rules for the detaxation of biodiesel and biofuels on October 27, 2003. Large volume production occurs mainly in Europe with production there now exceeding 1.4 million tons per year. Western European biodiesel production capacity was estimated at about 2 million metric tons per year largely produced through the transesterification process, about one-half in Germany (440,000 and 350,000 MT in France and Italy, respectively). In the United States, by 1995, 10 percent of all federal vehicles were to be using alternative fuels to set an example for the private automotive and fuel industries. Several studies are now funded to promote the use of blends of biodiesel and heating oil in USA. In USA soybean oil is the principal oil being utilized for biodiesel (about 80,000 tons in 2003). Details may be viewed on-line through the National Biodiesel Board Website. Rather than using vegetable oil drops Business Model 1 will use microalgae that produce lipids (fats). The lipids are then converted into biodiesel using conventional transesterification processing. Microalgae are capable of producing more than 30 times the amount of biodiesel than vegetable oils on a per acre basis. Business Model 1 will grow microalgae in an enclosed photobioreactor which will further improve lipid/biodiesel production. The biodiesel (B100) will be sold at a 20% discount from retail in direct competition with petroleum diesel. B100 is full strength 100% biodiesel that is a perfect replacement for petroleum diesel in all respects. The cost of producing biodiesel from high rate photobioreactors is considerably less than the production cost of petroleum diesel.

Compressed Natural Gas (CNG) is domestically produced and readily available to end users through the utility infrastructure. It is also clean burning and produces significantly fewer harmful emissions than reformulated gasoline or petroleum diesel when used in natural gas vehicles. In addition, commercially available medium and heavy-duty natural gas engines have demonstrated over 90% reductions of carbon monoxide (CO) and particulate matter and more than 50% reduction in nitrogen oxides (NO_x) relative to commercial petroleum diesel engines. Natural gas can either be stored onboard a vehicle as CNG at 3,000 or 3,600 PSI or as liquefied natural gas (LNG) at typically 20-150 PSI. According to the Natural Gas Vehicle Coalition (NGVC), as of 2005 there are 130,000 light- and heavy-duty compressed natural gas (CNG) and liquefied natural gas (LNG) vehicles in the United States and 5 million worldwide. Dedicated natural gas vehicles (NGVs) are designed to run only on natural gas. Bi-fuel NGVs have two separate fueling systems that enable the vehicle to use either natural gas or a conventional fuel (gasoline or diesel). In general, dedicated NGVs demonstrate better performance and have lower emissions than bi-fuel vehicles because their engines are optimized to run on natural gas. In addition, the vehicle does not have to carry two types of fuel, thereby increasing cargo capacity and reducing weight. In general, a natural gas vehicle can be less expensive to operate than a comparable conventionally fueled vehicle depending on natural gas prices. Natural gas can cost less than gasoline and diesel (per energy equivalent gallon), however, local utility rates can vary. Purchase prices for natural gas vehicles are somewhat higher than for similar conventional vehicles. The auto manufacturers' typical price premium for a light-duty CNG vehicle can be $1,500 to $6,000, and for heavy-duty trucks and buses it is in the range of $30,000 to $50,000. Natural gas quantity is normally stated or measured in Standard Cubic Feet (SCF) while liquid fuels such as gasoline or diesel are sold in liquid gallons. To provide a simple way to compare CNG fuel mileage with gasoline fuel mileage the CNG industry adopted a standard measurement called the Gasoline Gallon Equivalent (GGE). The standard states that 124 SCF of natural gas is equal to 1 gallon of liquid gasoline (135 SCF for diesel). CNG storage tank manufacturers specify the GGE rating for each size of storage tank they produce. When filled to capacity a 10-GGE tank provides the same operating range as 10 gallons of gasoline. Compared with vehicles fueled by conventional diesel and gasoline, NGVs can produce significantly lower amounts of harmful emissions such as nitrogen oxides, particulate matter, and toxic and carcinogenic pollutants. NGVs can also reduce emissions of carbon dioxide, the primary greenhouse gas. For details, see the following publications from the U.S. Environmental Protection Agency:

- Clean Alternative Fuels: Compressed Natural Gas (PDF 76 KB)
- Clean Alternative Fuels: Liquefied Natural Gas (PDF 72 KB)

The cost of a gasoline-gallon equivalent of CNG can be favorable compared to that of gasoline, but varies depending on local natural gas prices. or regional fuel prices. Natural gas is mostly domestically produced. In 2004, net imports of natural gas was approximately 15% of the total used, with almost all the imports coming from Canada. Some natural gas vehicle owners report service lives 2 to 3 years longer than gasoline or diesel vehicles and extended time between required maintenance. Vehicle range for CNG and LNG vehicles generally is less than that of comparable gasoline and diesel fueled vehicles because of the lower energy content of natural gas. Extra storage tanks can increase range, but the additional weight may displace some payload capacity.

NGV horsepower, acceleration, and cruise speed are comparable with those of an equivalent conventionally fueled vehicle. Depending on the number of cylinders and their locations, some payload capacity may be compromised with NGVs. Bi-fuel NGVs offer a driving range similar to that of gasoline vehicles. The cost of producing CNG from biowaste-to-energy facilities is considerably less than the production costs of both natural gas and crude oil derived CNG.

Driven by environmental, economic, and energy security concerns, the availability and use of **E85** is growing nationally. E85 is composed of 85 percent ethyl alcohol (ethanol) and 15 percent petroleum. E85 is designed for use in flexible fuel vehicles, referred to as "FFVs." According to the Energy Information Administration, there are over four million light-duty flexible fuel vehicles (FFVs) in the United States. These are operated by private citizens as well as business and government fleets. FFVs may fuel with either E85 and/or gasoline interchangeably. Most FFVs are still fueled with gasoline, but the availability of E85 and FFVs is expected to increase significantly in the next few years. Because of its superior combustion properties the use of E85 is strongly supported by the United States Environmental Protection Agency (USEPA) through its "Clean Cities" program. Since ethanol contains 27% less energy than gasoline, E85 will be sold at a 38.5% discount from retail. If gasoline is selling at $2.00/gallon, the E85 will be sold at $1.23/gallon. The 38.5% discount from retail results in a 20% actual discount based on its energy content. The E85 user will therefore achieve a 20% discount in total fuel costs per mile traveled whenever directly compared with gasoline. The ethanol fraction of E85 will be produced using microalgae produced in the photobioreactor. The cost of producing E85 from biowaste-to-energy facilities is considerably less than the production costs of E85 made from marketplace supplied ethanol and petroleum.

Motor Fuel Propane, otherwise known as **Liquefied Petroleum Gas** (LPG), is produced as part of natural gas processing and crude oil refining. In natural gas processing, the heavier hydrocarbons that naturally accompany natural gas, such as LPG, butane, ethane, and pentane, are removed prior to the natural gas entering the pipeline distribution systems. In crude oil refining, LPG is the first product that results at the start of the refining process, and is therefore always produced when crude oil is refined. Propane is a gas that can be turned into a liquid at a moderate pressure, 160 pounds per square inch (psi), and is stored in pressure tanks at about 200 psi at 100 degrees Fahrenheit. When propane is drawn from a tank, it changes to a gas before it is burned in an engine, stove, grill, or furnace. Propane has been used as a transportation fuel since 1912, and is the third most commonly used fuel in the United States, behind gasoline and diesel. More than four million vehicles fueled by propane are in use around the world in light, medium, and heavy-duty applications. Propane holds approximately 86 percent of the energy of gasoline and so requires more storage volume to drive a range equivalent to gasoline, but it is price competitive on a cents-per-mile-driven basis. LPG has a long and varied history in transportation applications. It has been used in rural and farming settings since its inception as a motor vehicle fuel. Over time, propane has been used in several niche applications such as for fork-lifts, both inside and outside warehouses, and at construction sites. Use of propane can result in lower vehicle maintenance costs, lower emissions, and fuel costs savings when compared to conventional gasoline and diesel. CNG becomes a perfect replacement for LP Gas by increasing the distribution nozzle orifice size on a British Thermal Unit (Btu) delivered basis. Any appliance running on LP Gas can be converted over to run on CNG with zero loss of Btu output. In fact, since CNG is a much cleaner fuel than LP Gas any appliance so converted would exhibit the need for far less maintenance. Over the last 50 years the LP Gas Industries have collaborated with the Natural Gas Industries to keep the price of LP Gas at its highest level when the demand for the fuel is at its greatest—namely as the winter heating period begins. Since LP Gas is produced continuously throughout the year as a result of 24/7 natural gas processing and crude oil refining activities, LP Gas supplies are at their greatest as the winter heating period begins. The associated marketplace price is thus in direct conflict with the classical laws of supply & demand. Because of the extreme ease of converting an LP Gas appliance to run on natural gas the natural gas industry has the inherent ability to compete with the LP Gas industry. Due to the artificially high existing marketplace price of LP Gas, CNG will be marketed to the LP Gas markets at a 40% discount from retail on a Btu equivalence basis. The cost of producing CNG from biowaste-to-energy facilities is considerably less than the production costs of natural gas and petroleum derived LP Gas.

Methane gas is a near equivalent of **Natural Gas**. At one time natural gas was inexpensive. Those days are likely gone forever. Natural gas is the feedstock for making anhydrous fertilizers. Some 10 years ago the United States produced 100% of its anhydrous fertilizers. Today it is producing less than 10% with the balance arriving from Asia. It is being shipped as LNG in super tankers in the same manner than crude oil is shipped in super tankers. Because of the continuing diminishing supply of natural gas its marketplace price continues to increase in perfect harmony with the aforementioned laws of supply & demand. The cost of producing methane (natural gas) from biowaste-to-energy facilities is considerably less than the production costs of petroleum derived natural gas.

3. **Water Independence** is achieved through the effective management of potable water production wastes, storm waters, sanitary wastewaters, and the moisture content of biowastes. In the biowaste-to-energy program solid biowastes are slurry mixed with potable water production wastes, storm waters, and sanitary wastewaters. After undergoing anaerobic digestion the liquid discharge is treated using reverse osmosis membranes. This technology separates the liquid stream into a very pure reverse osmosis permeate stream and a second stream which contains the concentrated nutrients of ammonia nitrogen, orthophosphates, and potassium salts. These are the same macro nutrients identified in commercial fertilizers as simply N, P, and K (Nitrogen, Phosphorus, and Potassium). Potable water production wastes are generated when using the same reverse osmosis membrane technology which separates the liquid stream into a very pure reverse osmosis permeate stream and a second stream which contains the removed impurities such as dissolved solids, arsenic, radionuclides, asbestos particles, Protozoan cysts, Cryptosporidium, Pesticides, 1,2,4- trichlorobenzene, 2,4-D Atrazine, Endrin, Heptachlor, Lindane, and Pentachlorophenol. When pretreatment includes microfiltration bacteria and other micro-organisms are removed. When pretreatment includes aqueous phase granular activated carbon radon gas, hydrogen sulfide, methyl tertiary butyl ether (MTBE), pesticides, and dissolved organics are also removed. The water contributed by reverse osmosis potable water treatment is significant since system recovery rates are in the neighborhood of 75%. The use of microfiltration followed by granular activated carbon followed by reverse osmosis (RO) treatment achieves maximum possible effluent water quality possible. The efficient management of the produced permeate water is what achieves water independence for each community on a sustainable basis. Potable water will be sold at a 20% discount from retail.

4. The construction of a minimum four (4) story greenhouse to house all wastes-to-energy activities and to grow organic foods. The biosolids from the anaerobic digester (digestate) will be used as the soil amendment to grow the organic foods. As food demands continue to increase over time additional greenhouse stories may be added as necessary.

Business Model 2 consists of:

1. The very same activities of Business Model 1 except for the much greater size of the associated greenhouse.

2. The eventual connection of each massive greenhouse with a below grade super grid and associated subway. Please refer to WSE Publication No. 2004-1 and WSE Drawing No. SG-0202 for additional information on the super grid. Please refer to WSE Publication No. 1346 for an explanation of the fate of the heavy metals that are associated with the Class A biosolids (digestate) which are used as a soil amendment to grow organic foods.

The engineers, chemists, dedicated scientists, and senior management at ***WaterSmart Environmental*** welcome your inquiries with enthusiasm.