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.

"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 (NOx) 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 afore-
mentioned 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 pre-treatment 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.
**Product:** Biowaste Energy Regional Industrial Park Utilizing The OAT™ Process

**Industrial And Community Wastes** are generated within population centers that we call cities. Rather than transporting these wastes to distant **landfills**, they may now be transported to local or regional industrial parks thus eliminating long distance hauling costs. If the wastes are managed as resources rather than a burden on society, the parks may be operated at a profit while offering very attractive tipping fees.

**Sanitary landfills** accommodate putrescible wastes whereas **C&D** (construction and demolition) landfills accommodate non-putrescible wastes. Within any community C&D wastes are always far less on a dry weight basis. This fact permits regional parks to simultaneously process both types of wastes without reservation or compromise.

**Putrescible or organic based wastes** can be anaerobically digested to produce methane gas, carbon dioxide gas, organic fertilizer, liquid fertilizer concentrate, and reverse osmosis permeate water. All of these co-products may be sold at a profit.

**C&D** wastes cannot be anaerobically digested to produce methane gas. However, if these wastes are ground to a small size they may be added to the organic wastes and fed to the digester on a commingled basis. The **C&D** inorganic based wastes add to the organic fertilizer constituent of the putrescible wastes and therefore contribute to the value of this particular co-product. C&D wastes can therefore be accommodated at the park.

**Traditional landfills** charge a tipping fee and thereafter store wastes while accruing associated ownership liability for future management of the site. Each and every landfill site always emits methane and carbon dioxide gasses while generating high strength leachate which is generally regarded as a problematic waste stream. Ground and groundwater pollution is an ever present danger. A gross improvement in MSW management is environmentally desirable.

**Biowaste Energy Industrial Parks** process wastes as and when they arrive. No long term storage is necessary, contemplated or practiced. Since the co-products represent profits for the industrial park operator, there is always present a strong incentive to process wastes as soon as possible.

Effective odor control is achieved by processing wastes within closed buildings and vessels under negative air control to eliminate emissions to the environment.

**MSW** (Municipal Solid Wastes) are always generated within population centers at a rate of 5-6 pounds per person per day. In very poor countries MSW generation is around 1 lb/person/day. Steel and aluminum are mechanically removed and the remainder is ground into particles of about 1 mm in size. When digested with the OAT™ process the putrescible matter is converted into methane gas and the several other co-products. Aerosols, corrosives, pesticides, antifreeze, oils, asbestos, mercury, poisons, batteries, paints, cylinders, oxidizers, photo fluids, flammables, PCB ballasts, plastics, glass, fluorescent tubes, computers, tires, incinerator ash, and solvents are commingled with putrescible wastes and simultaneously digested together. The inorganic constituents always end up in the organic fertilizer in very small concentrations due to the large dilution factor which is always present. Small concentrations of heavy metals, iron, aluminum, magnesium, and calcium are regarded by soil scientists as micronutrients which are essential for plant growth.

**Municipal Sewage Treatment Plants** (POTW) always generate sludge. While some sludge is incinerated, most are spread on local fields or hauled off to distant landfills. The practice of spreading sludges on fields and farmland is under significant regulatory pressure from the Centers For Disease Control And Prevention, Occupational Safety and Health Administration (OSHA), and the National Academy of Sciences to convert to safer and environmentally benign sludge management. These sludges can also be treated at biowaste energy regional industrial parks.

**Green wastes** (grass clippings), wood pallets, sawdust, food, and chemicals can also be accommodated by commingling with the putrescible wastes in the same manner that municipal sludge and C&D wastes are added. In short, there is no practical limitation on the wastes which can be accommodated except for radioactive and medical wastes which must be otherwise managed. Attached engineering drawings S-5079 and S-5079-1 show material flow schematics of a regional biowaste energy industrial park.

The engineers, chemists, dedicated scientists, and senior management at **WaterSmart Environmental** welcome your inquiries with enthusiasm.
Product: Biowaste Energy Regional Industrial Park Business Model

Waste Processing Components consist of:

1. Solid waste grinding equipment to reduce particle size to about 3 mm.
2. Ferrous and non-ferrous metals sorting and recovery utilizing rare earth and magnetic separation equipment.
3. Waste dilution and slurry mixing equipment.
4. Slurried waste grinder feed pumping equipment.
5. OAT™ Process two-phase anaerobic digester.
6. Digester digestate solids dewatering, drying, packaging, and storage equipment.
7. Reverse osmosis membrane treatment equipment.
8. Liquid fertilizer concentrate storage and transfer equipment.
9. Reverse osmosis permeate storage and transfer equipment.
10. Methane gas compression and drying equipment.
11. Carbon dioxide gas transfer and dry ice manufacturing equipment.

Industrial Park Projects always consist of:

1. Fish farming and associated processing. All farming and processing wastes are transferred to the anaerobic digester.
2. Microalgae lipid production and subsequent refining to biodiesel fuel. All production and refining wastes are transferred to the anaerobic digester.
3. Ethanol production to support biodiesel refining. All ethanol production wastes are transferred to the anaerobic digester.
4. And may additionally consist of third party economic development projects which are always desirable and encouraged.

Industrial Park Utilities always include:

1. Electricity generation,
2. Methane gas storage and transfer,
3. Reverse osmosis water storage and transfer, and
4. May also include steam generation and transfer.

Biowaste Energy Industrial Parks always generate carbon dioxide, nitrogen oxides, and sulfur oxide credits as well as renewable energy certificates. The parks accomplish consumptive use of produced and captured process carbon dioxide by beneficially utilizing all of it to engage in microalgae lipid production as well as algae fish farming activities. Produced and captured carbon dioxide is converted into carbohydrates through photosynthesis. A simplified chemical equation for biosynthesis is as follows: $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$. Whenever carbon dioxide is converted into a different chemical direct biofixation occurs because the above referenced chemical process is nonreversible thereby resulting in zero leakage and therefore permanent credits. Traditional carbon sequestration marketplace efforts generally rely on a capture and store approach rather than the capture and beneficially use approach that the Biowaste Energy Regional Industrial Parks will pursue.

Industrial Park Revenue Producing activities consist of:

1. Charging a tipping fee for accepting municipal solid wastes,
2. Charging a tipping fee for accepting construction demolition wastes,
3. Charging a tipping fee for accepting green and food wastes,
4. Charging a tipping fee for accepting storm related wastes,
5. Charging a tipping fee for accepting liquid and solid organic wastes,
6. Charging a tipping fee for accepting inorganic wastes,
7. Charging a tipping fee for accepting agricultural solid and liquid wastes,
8. Charging a tipping fee for accepting animal deads,
9. Charging a service fee for treating sanitary wastewater,
10. Charging a service fee for treating animal wastes,
11. Charging a service fee to treat third party project wastes,
12. Selling CO₂, Mercury, NOx, and SOx credits as well as renewable energy certificates,
13. Selling compressed methane gas,
14. Selling generated electricity,
15. Selling liquid fertilizer concentrate,
16. Selling organic fertilizer,
17. Selling anhydrous ammonia and urea fertilizers,
18. Selling biodiesel fuel,
19. Selling ferrous and non-ferrous metals,
20. Selling processed fish, and may include
21. Selling steam and perhaps RO process water.

The engineers, chemists, dedicated scientists, and senior management at WaterSmart Environmental welcome your inquiries with enthusiasm.
Product: Biowaste Energy Regional Industrial Park Operations

Park Product Management Requirements include:

- Biodiesel Fuel
- Carbon Dioxide (CO₂) Gas
- Construction and Demolition (C&D) Wastes
- Electricity
- Environmental and Energy Credits
- Ethanol
- Ferrous and Non-Ferrous Metals
- Liquid Fertilizer Concentrate
- Methane (CH₄) Gas
- Municipal Solid Wastes (MSW)
- Nitrogen oxide (NOₓ) Gases
- Organic Fertilizer
- Potable Water Treatment
- Processed Fish
- Reverse Osmosis (RO) Water
- Sanitary Wastewater
- Stormwater
- General Considerations

Biodiesel Fuel:

1. Ponds will be constructed to grow microalgae through photosynthesis. Carbon dioxide gas and micronutrients will be added to optimize growth rates. Microalgae produce lipids which will be refined into biodiesel fuel and glycerine through transesterification. The glycerine and other refining waste products will be processed in the anaerobic digester.

2. Will be sold to the local market in competition with the fuel distributor for use in diesel cars, diesel trucks, and diesel buses as an alternative fuel under DOE’s Clean Cities Program. In order to achieve competitive sales the price of the biodiesel will be less than the price of petroleum diesel. Biodiesel is now highly recognized both nationally and internationally as a much cleaner fuel than existing petroleum derived diesel fuel. (see www.biodiesel.org).

3. 100% of the warm saturated carbon dioxide gas produced in the anaerobic digester will be transferred to the microalgae and fish ponds to accomplish its biofixation through photosynthesis. This gas will be fine bubble distributed in order to capture its heat and moisture contents while enhancing photosynthesis potential through liquid mixing.

4. 100% of the warm moisture laden carbon dioxide gas produced in the internal combustion engine and/or turbine generator will be transferred to the microalgae and fish ponds to accomplish its biofixation through photosynthesis. This gas will be fine bubble distributed in order to capture its heat, moisture, and oxygen contents while enhancing photosynthesis potential and associated pond aeration through liquid mixing.

5. The microalgae and fish ponds will be entirely covered and equipped with fluorescent lighting to accomplish photosynthesis 24/7 while preventing the release of carbon dioxide to the atmosphere. Covered ponds also permit pond production throughout the entire year regardless of the local climate. Capturing the heat content of the carbon dioxide gases enhances microalgae and fish farming production rates. Capturing the moisture content of the carbon dioxide gases also enhances total water management practice.

6. Each mole of methane, or methane equivalent in the case of biodiesel fuel, produces two moles of water and one mole of carbon dioxide in the combustion process. The combustion process also provides 5-10% of excess air 20% of which is oxygen gas. The anaerobic digester additionally produces two moles of methane and one mole of carbon dioxide. Since the methane gas represents two moles of water and one mole of carbon dioxide, the total mole production resulting from anaerobic digestion and combustion activities equates out to one mole of water for each mole of carbon dioxide. During photosynthesis, six moles of carbon dioxide react with six moles of water for each mole of carbohydrate biofixation. Photosynthesis causes a significant consumptive use of both water and carbon dioxide. The moisture content of the anaerobic digestor carbon dioxide gas plus the moisture content of the associated combustion gas fully satisfies the water component of carbohydrate biofixation thereby achieving pond water balance automatically. The pond levels will rise during microalgae and fish rearing and automatically return to their prior levels subsequent to microalgae and fish harvesting.

Carbon Dioxide (CO₂) Gas:

1. Is produced in the anaerobic digester.

2. Is also produced in the internal combustion engine and/or turbine generator.
7. Will be used to produce dry ice for processed fish packaging requirements.

8. Sales of carbon dioxide to the marketplace are not being considered.

Construction and Demolition (C&D) Wastes:

1. Are always produced within communities and sometimes managed separately or combined directly with municipal solid wastes (MSW).

2. Will be processed by grinding to about 3 mm in size and subsequently combined with the MSW feedstock for addition to the digester.

Electricity:

1. Green renewable energy will be provided to the regional citizenry and businesses at a generous discount from existing retail prices. Discounted electricity becomes possible because of the existence of inexpensive digester gas that is produced in significant quantity from ordinary wastes.

2. The actual operation of the power generation facility will be provided by the local municipality or county. As an automatically qualified operator of an eligible power generation facility the municipality or county becomes the recipient of the quite significant CO₂, Mercury, NOx, SOx, and renewable energy credits. The income represented by these credits can be used by the municipality or county in the same manner as tax revenues. Since some municipalities or counties may well have an interest in participating in project financing, the very same credits may be used for that purpose as well. The credits represent a hot commodity in today’s marketplace as many energy credits purchasers are quite willing to part with their cash before an eligible project begins actual construction.

Environmental and Energy Credits:

1. Carbon dioxide credits are produced to the extent that biosynthesis accomplishes its permanent biofixation. Determination of actual biofixation can be accomplished through microalgae and fish production and related processing tonnage. There is a direct chemical relationship between carbohydrate formation (biofixation) and both biodiesel and fish yields. Verification of biofixation is necessary in order to establish quantity and validity of CO₂ credits.

2. Mercury credits are produced to the extent that gaseous emissions are prevented from the power generation facility. Verification of zero gaseous emissions from the microalgae and fish farming activities is necessary in order to establish quantity and validity of Mercury credits.

3. NOx credits may determined through direct measurement of these gases in the exhaust emissions of the power generation facilities. In that the total exhaust is beneficially used in microalgae and fish farming activities maximum NOx credits are generated. Verification of zero gaseous emissions from the microalgae and fish farming activities is necessary in order to establish quantity and validity of NOx credits.

4. SOx credits are determined by the difference in SOx emissions between a specific electricity generation facility and that required by regulations. Since the power generation facility has zero emissions maximum SOx credits are generated. Verification of zero gaseous emissions from the microalgae and fish farming activities is necessary in order to establish quantity and validity of SOx credits.

5. A renewable energy credit represents one megawatt hour (MWh) of energy generated from a renewable energy source.

6. There is currently robust international trading of all above credits especially SOx credits which have now surpassed US$600/ton.

Ethanol:

1. Biodiesel refining requires about 12% ethanol or methanol feedstock to accomplish complete transesterification. Methyl alcohol (methanol) is produced from the petroleum industry whereas ethyl alcohol (ethanol) is produced from the agricultural community. It therefore makes economic project sense to ferment one’s own ethanol for biodiesel production rather than purchase it or methanol from the marketplace. Producing one’s own feedstock rather than its procurement from the marketplace is referred to as vertical integration of a comprehensive technology.

2. Sales of ethanol to the marketplace are not being considered.

3. All the wastes associated with ethanol refining will be processed in the anaerobic digester.

Ferrous and Non-Ferrous Metals:

1. Ferrous and non-ferrous metals are the only materials in municipal solid wastes (MSW) that have recycling value. These components will be mechanically separated, cleaned, and sold to the scrap metal marketplace.

2. After ferrous and non-ferrous metals removal, plastics, tires, automotive batteries, fluorescent lights, computer parts, paints, solvents, carpets, appliances, dead animals, and all other troublesome type wastes, including unauthorized medical and radioactive wastes, will be ground up, mixed
with sanitary wastewater and immediately processed in the anaerobic digester. In each and every instance, divalent cations always end up in the digestate as insoluble sulfides where they add micronutrient value. The monovalent cations always end up in the liquid fertilizer concentrate where they add fertilizer value.

**Liquid Fertilizer Concentrate:**

1. Will be sold to the local community for landscaping and the countryside for agricultural crop farming at a generous discount from retail.

2. Will be used to fertilize microalgae and fish ponds.

3. A shallow and deep soil samples with plant tissue analyses land management program will be offered to local area crop farmers. This program will determine the amount of fertilizers and soil amendments to apply in order to maximize crop yields while eliminating the possibility of total maximum daily load (TMDL) violations and associated excessive fertilizer usage. The program will also advise when and how to apply the fertilizer and associated amendments. Optimized land management is currently practiced nationally by but very few farmers. The cost of the land management program will be borne by WaterSmart Environmental.

**Methane (CH₄) Gas:**

1. Will be sold as a compressed natural gas (CNG) for cars and buses as an alternative fuel under the Clean Cities Program. The goal of the U.S. Department of Energy's (DOE) Clean Cities Program is to advance the economic, environmental, and energy security of the United States by supporting local decisions to adopt practices that contribute to the reduction of petroleum consumption in the transportation sector. Clean Cities carries out this objective through a network of more than 80 volunteer, community-based coalitions, which develop public/private partnerships to promote alternative fuels and vehicles, fuel blends, fuel economy, hybrid vehicles, and idle reduction. Many thousands of cars and buses have been converted to operate on CNG to increase the useful life of the engine while decreasing harmful emissions to the environment. Recent bus and car models are today being manufactured and sold to run directly on CNG without requiring engine modification.

2. Will be sold as natural gas for heating homes and businesses.

3. Will be used to produce renewable energy utilizing internal combustion ignition engine generation or CNG turbine generation. The associated waste heat will be beneficially used to heat the anaerobic digester and to generate steam. The steam will be used to generate additional power thereby increasing the efficiency of electrical generation from about 37% to about 51% using a steam turbine generator. The gaseous exhaust from the combustion engine and the steam turbine will be piped to the algae ponds to capture and use the contained heat, moisture, NOx, and carbon dioxide contents. Utilizing two different methods of generating power from a single project or system is referred to as **combined cycle** power generation. Highly efficient combined cycle renewable energy only becomes possible by utilizing anaerobic digestion. Other forms of renewable energy are scientifically incapable of achieving combined cycle generation. Any industrial process which generates both heat and power (CHP) is today called ** cogeneration**. Combined cycle generation and cogeneration are both highly respected technologies in the energy marketplace. **Biowaste Energy Regional Industrial Parks** represent the first worldwide renewable energy technology to commercialize the simultaneous use of both combined cycle and cogeneration science.

4. Can also be used to produce anhydrous ammonia and urea fertilizers for sale to the local marketplace. About 90% of the fertilizers sold within the United States are now imported due to the high and ever increasing price of local natural gas. Natural gas is the principal feedstock used in the production of anhydrous ammonia and urea fertilizers.

**Municipal Solid Wastes (MSW):**

1. Are always produced within communities and sometimes managed separately or combined directly with (C&D) wastes.

2. Will be processed by grinding to about 3 mm in size and subsequently combined with the C&D wastes for addition to the digester.

3. Are highly consistent respecting their many contents and always contain some locally prohibited constituents such as tires, batteries, solvents, paints, residual pesticides, fluorescent tubes (mercury), computer components, oils, greases, appliances, crates, medical wastes, radioactive wastes, heavy metals, dead animals, dead humans, and

**Nitrogen Oxide (NOx) Gasses:**

1. Is produced during the combustion process.

2. Is beneficially consumed during subsequent photosynthesis reactions.

**Organic Fertilizer:**

1. Will be sold to the local community for landscaping and the countryside for agricultural crop farming at a generous discount from retail.

2. The associated land management program will be encouraged.
Potable Water Treatment:

1. Will be changed to membrane treatment to reduce hardness and total dissolved solids thereby producing somewhat better water quality while reducing chemical and sludge disposal costs. Membrane treatment also eliminates the possibility of many chemical species from entering the potable water distribution system. Chemical species are today showing up in surface water resources due to concentrated animal feeding operations (CAFO) and municipal or county wastewater treatment plants (POTWs). Membrane treatment captures these species in its concentrate stream that is subsequently used as MSW slurry dilution water.

2. Treatment of both ground and surface water consists of 1 micron bag filtration followed by membrane treatment followed by required ultraviolet light and residual chlorine disinfection. Fluorides may also be added to satisfy local community or state regulations.

Processed Fish:

1. Algae type fish ponds will be constructed to grow several varieties of fresh fish using photosynthesis to grow the phytoplankton fish food. The farming method of the aquaculture system consists of placing nutrients into ponds to stimulate the growth of algae. The algae are then used as feed for small invertebrates or fish growing in the pond. The idea is modeled after Oriental aquaculture systems. This method of fish farming is referred to as algae fish farming and represents well known technology. Many prior algae fish farms have been shut down due to inadequate waste management practices. All wastes associated with algae fish farming will be processed in the anaerobic digester. Tilapia, shrimp, and salmon represent the three largest markets in the United States. Since the fish will be grown under cover they will be mercury free. Certified mercury-free fish represent a significant value-added activity.

2. All caught fish will be processed and sold to the local marketplace as a value added activity. All of the wastes associated with fish processing will be processed in the anaerobic digester.

3. Dry ice packaging will be used for processed fish sales to distant markets. Carbon dioxide generated from the digester will be the source of carbon dioxide for dry ice manufacturing.

4. About two-thirds of the fish consumed within the United States are currently being imported. Per capita consumption of fish is about 15 lbs compared with 80 lbs of chicken, 70 lbs of beef, 50 lbs of pork, and 20 lbs of turkey. Since 1970 the worldwide increase in aquaculture has been increasing at an average compounded rate of 9.2% compared with only 1.4% for terrestrial farmed meat (protein) production systems.

5. The term income enhancement describes the process of increasing income by undertaking a new management, marketing or production practice. Feeding on-farm corn production to one’s hogs is one potential means of enhancing farm income; another is building on-farm storage for corn to take advantage of seasonal basis trends. Some producers enhance income by placing marginal land in a conservation program or leasing land out for hunting or by producing an alternative crop that may have a greater return on investment than a commodity crop. Others enhance income by adding value. Thus, value added is a subcategory of income enhancement. It is important to realize that value added is only one of several approaches that may need to be used jointly to meet the goal of enhancing income. Aquaculture products can be an answer to the growing problem of world dietary animal protein shortages. Fish convert feed into flesh about two times more efficiently than chickens and five to ten times more efficiently than beef cattle. Feed conversion rates of fish are higher than other common commercial livestock because a) fish can utilize foods that are less usable by most land animals and b) they require less energy from their foods. Moreover, fish can use the entire pond, top to bottom, for living space, while terrestrial animals are entirely confined to the ground. The proper combination of fish species, control of the environment and careful feeding can result in annual yields approaching 6,250 pounds per acre, compared to approximately 1,000 pounds per acre yield from beef cattle production. The potential for increased production and the lure of high profits have accelerated the interest in fish farming and other types of aquaculture. It is general aquaculture industry knowledge that fish farming can produce about 10 times more protein per acre than soybeans. Soybeans, in turn, are known to produce about 10 times more protein per acre than beef cattle. Fish farming therefore produces far more protein per acre and more protein per pound of finished product than any other known use of farmland. Significantly higher protein yields/acre always translates into far greater farmland productivity and associated income potential than both crop and animal agriculture practice.

Reverse Osmosis (RO) Water:

1. Is available for park project process water and boiler requirements.

2. Can be sold as irrigation water.

3. Can be used as local aquifer or surface impoundment recharge.

Sanitary Wastewater:

1. Will be fully consumed as MSW slurry dilution water for anaerobic digestion feedstock processing.
2. Trash and grit removal are not required as these components are routinely ground and added to the anaerobic digester.

Stormwater:

1. Park stormwater will be captured and beneficially used for MSW slurry dilution water.
2. Community stormwater may also be captured and beneficially used for MSW slurry dilution water.

General Considerations:

1. The electricity generated from the mixture of a community’s MSW and sanitary wastewater will provide about 15% of the local demand.
2. Microalgae biodiesel production will be designed to produce sufficient fuel to completely replace local petroleum diesel usage. Anaerobically digesting the biodiesel refining wastes, including those produced by the associated bioethanol plant, will substantially increase the percentage of electricity delivery due to the additional generation of methane gas.
3. Fresh fish farming and processing will be designed to produce sufficient fish to satisfy local marketplace demand. This activity will further increase the percentage of electricity delivery due to the additional generation of methane gas.
4. The economic development marketing motive is to engage in sufficient biodiesel and fresh fish farming to completely satisfy the local demand for electricity, biodiesel fuel, fresh fish, CNG fuel, natural gas, and LP gas. Additional biodiesel and fresh fish farming activities will permit the manufacture of anhydrous ammonia and urea fertilizers for sale to the regional marketplace. Additional biodiesel and fresh fish farming will permit the exporting of low cost electricity, biodiesel fuel, and processed fish to markets beyond while generating significant revenues from the sale of renewable energy credits.
5. Many American jobs have been lost because of outsourcing to other countries which have lower labor rates. WaterSmart’s Biowaste Energy Regional Industrial Park does not have a solution for this problem. Additional American manufacturing jobs have been lost to other countries because of the substantial increase in electricity and gas costs during the last 5 years. It is expected that some of these jobs may be won back by providing more affordable electricity and gas to the industrial marketplace.
6. Many agricultural processing companies are on the move because of the inability or unwillingness of their existing community to provide agricultural waste treatment capability. WaterSmart’s Biowaste Energy Regional Industrial Park technology has a very affordable answer to this problem by accepting all the organic wastes generated at quite affordable costs. These companies can therefore be solicited to relocate to the community having such a park. Each Biowaste Energy Regional Industrial Park itself requires several good employees. As a minimum, WaterSmart plans to hire the POTW employees whose very jobs would be automatically eliminated upon the adoption of the waste-to-renewable energy technology. Other jobs would also be created due to MSW processing as well as microalgae/biodiesel refining and fish farming/processing activities. The technology is not, however, being marketed as a jobs creation economic development activity since all Biowaste Energy Regional Industrial Park jobs will be filled based on routine necessity and on no other basis. In plain words, other than existing POTW employees no additional jobs will be offered other than those required by the technology itself. POTW employees frequently have vested job wages, security, and associated benefits that the Park will honor. Beyond that, additional park employees will be hired on bases that may well be different.
7. WaterSmart intends to donate 50% of its share of annual Park profits to the municipality or county for the purpose of enabling municipal or county projects and well as municipal or county employee compensation. The donation approach is intended to prevent and eliminate any and all assumption of Park risk management on the part of the municipality or county. The twofold intent is to make municipal or county jobs more economically attractive while enhancing the rate of municipal or county projects. Income from the sale of credits would tend to work in lock step with these annual donations. Income from credits may well disappear over the next 25 years but WaterSmart’s donations will continue forever.

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

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Biowaste Energy Regional Industrial Park Economic Development Activities

Economic Development Activities consist of:

- The generation of electricity and the production of foods, fuels, and water with subsequent marketing of each product at a discount from retail.
- The total park management of all solid and liquid wastes on a service fee basis.

Each Park Will:

1. Accept Trash For A Fee.
2. Accept Sanitary Wastewater For A Fee.
4. Produce Mercury-Free Fish.
5. Process Mercury-Free Fish.
6. Produce Microalgae.
8. Market Biodiesel At A Discount.
9. Use Microalgae Beneficially As Fish Food.
11. Market Mercury-Free Fish At A Discount.
14. Generate Electricity.
15. Market Electricity At A Discount.
17. Market Methane Gas As Natural Gas At A Discount.
18. Produce Liquid Fertilizer Concentrate.
19. Market Liquid Fertilizer Concentrate At A Discount.
23. Produce Organic Fertilizer.
27. Market Renewable Energy Credits.
28. Treat All Associated Production and Processing Solid And Liquid Wastes By Anaerobic Digestion.

Jobs Are Created By:

3. Trash Processing.
4. Fish Processing.
5. Biodiesel Refining.
7. Potable Water Marketing.
9. Electricity Marketing.
10. Natural Gas Marketing.
15. Project Management.

Park Greenhouse Construction:

1. Will Be Minimum Of Four (4) Stories High.
2. Will Be Designed To Add Additional Stories As Desired.
3. Will Be Constructed To Withstand Tornados, Category Five (5) Hurricanes, And Maximum Seismic Events.

Park Greenhouse Features Will Always Include:

1. Biodiesel Fuels Retail Marketing.
2. Compressed Natural Gas (CNG) Fuels Retail Marketing.
3. Liquefied Natural Gas (LNG) Fuels Retail Marketing.
4. Mercury-Free Fish Retail Marketing.
5. Organic Foods Retail Marketing.

Future Park Greenhouse Features May Also Include:

1. Assisted Living Facilities.
2. Automobile and Diesel Truck Engine Repair And Maintenance Services.
4. Bookstores.
5. Business Offices.
6. Convenience Stores.
7. Day Care Facilities.
8. Education Programs.
10. Freight Storage And Distribution Facilities.
11. Library Facilities.
12. Medical Clinic Facilities.
15. Retail Clothing Marketing Facilities.
16. Recreational Facilities
17. Traveler Lodging Accommodations.
18. Trucker Lodging Accommodations.

Future Park Features:

1. Will Create Additional Construction Jobs.
2. Will Create Additional Service Jobs.
3. Will Create Additional Park Jobs.
4. Will Create Additional Park Revenues.

Biowaste Energy Industrial Park May Be Promoted:

1. As Just Another Industrial Park, or
2. As An Environmentally and Consumer Friendly Greenhouse Mall.

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Wastes-to-Energy
Design-Build-Own-Operate
Green Energy & Fuels Marketing

With Enormous High Quality Permanenent Jobs Creation Potential
Kyoto Protocol Compliant Producing CO2 Mercury NOx SOx, and Renewable Energy Credits

100% Renewable Energy, Food, Fuels, and Water Independence Technologies

North America Requires 5,000
Massive Greenhouse Gas Emission Credible

Model 1

Model 2

Business

Wastewater
Biowaste energy

Supergrid 7% Connected

Biowaste energy

Wastes-to-Energy

Design-Build-Own-Operate

Green Energy & Fuels Marketing

Business

Wastewater
Biowaste energy

Supergrid 7% Connected

Biowaste energy

Wastes-to-Energy

Design-Build-Own-Operate

Green Energy & Fuels Marketing
Application: Renewable Energy, Fuels, Food, and Water Independence Technologies

These renewable technologies all begin by managing wastes as a valuable resource rather than an oppressive and onerous burden on society. They all finish with creating maximum value added products and services. Everything in between consists of applying the sciences of agriculture, biology, chemistry, and power engineering while capturing nutrients and recycling water. A critical component of each technology is a super efficient anaerobic digestion process which is capable of producing twice as much methane gas as other anaerobic digesters.

BioWastEnergy™ Regional Industrial Parks are being proposed for municipalities and counties for the commercial purpose of supplying all of the community’s base load and emergency electricity requirements. The electricity is generated by using methane gas, a near equivalent of natural gas. The methane gas is produced by the super efficient anaerobic digestion of the community’s trash, food wastes, yard wastes, and sanitary wastes. Many other types of wastes can also be digested. In addition to methane gas other valuable co-products consist of organic fertilizer, liquid fertilizer concentrate, carbon dioxide gas, and high quality reverse osmosis water. The parks generate no wastes that require landfill disposal. This is because the parks generate no wastes.

The parks generate income by charging fees for providing waste management services and by marketing the several co-products generated. The technology is marketed on a build-own-operate basis. Communities become a zero waste-to-landfill society while obtaining their electricity at a lower price than the local utility charges.

Providing electricity at a lower price than the local utility is made possible by:

- Using methane to generate electricity with a gas turbine while using its waste heat to produce steam.
- This steam, in turn, is used to generate additional electricity with a steam turbine thus achieving cost effective combined cycle generation.

Coal fired power plants are scientifically incapable of combined cycle generation and thus their production costs per kWh of gray electricity are always higher than those kWh of green power electricity produced by the regional BioWastEnergy industrial park combined cycle generation.

By adopting this technology, communities may aggressively promote economic development knowing that the regional industrial park can supply required utilities to a relocated or new business at discounts from retail while managing the associated wastes at an affordable price.

Major industries such as pulp & paper mills and sugar cane plantations may also adopt the BioWastEnergy industrial park technology to achieve 100% energy independence while eliminating substantially all environmental problems. Regarding paper:

- Most pulp & paper mills worldwide use the highly versatile Kraft Process and a black liquor recovery boiler. These mills are well known for their stinky air due to the gasification of sulfur containing organics as well as the discharge of sulfur containing non-condensable gasses from a variety of sources. The BLRB enables a mill to generate some 40-60% of its electricity requirements depending on its design while recovering pulping chemicals for reuse. Most of these mills would decommission their inherently dangerous and malodorous BLRB if they had the requisite economic justification. Virtually all of these mills desire to achieve 100% energy independence and 100% water recycling, i.e., zero liquid discharge. Each mill would like to permanently rid itself of the ever present odors and their associated environmental liability. All of these several preferences may easily be accomplished by implementing the following.

- Change #1 decommissions the BLRB. #2 introduces the use of inorganic membrane technology to separate the black liquor lignins and hemicellulose in the concentrate and the recovery chemicals in the permeate. #3 sends the wood wastes, lignins, hemicellulose, sawdust, condensates, sludges, and all wastewaters to the anaerobic digester. The methane gas generated is used to fuel a gas turbine to generate electricity. The waste heat from the gas turbine is used to make steam. The steam is used to generate additional electricity from the mill’s existing steam turbine thereby achieving 100%+ of the electricity and steam requirements through efficient combined cycle generation. The sulfur containing compounds are converted into insoluble iron sulfides in the anaerobic digester. Non-condensable gasses may also be removed by utilizing modern biofiltration technology. Since high quality reverse osmosis water is one of the several co-products of the waste-to-energy process, the mill obtains 100% of its water requirements through recycling. The mill thus achieves 100% energy independence, 100% water reuse, and an odor free environment.
Regarding sugar cane:

- Raw sugar production is likely the largest government subsidized agriculture on earth because of permanent jobs creation and export profits. The rise of the sugar beet and artificial sweetener industries over the last 25 years have put the skids on sugar cane production because of the ever present marketplace realities of supply and demand. In order to augment operating profits, many raw sugar production facilities have decided to use bagasse as a fuel to make high pressure steam. The steam is then used to power a steam turbine generator to make and thereafter sell simple cycle electricity to the local grid. Since bagasse is about 50% moisture, its use as a fuel is extremely inefficient. The production of electricity from bagasse is therefore also extremely inefficient.

- As an industry, sugar cane production and processing generates more organic wastes per unit of raw sugar produced than all other industries. If the waste-to-energy principles of the BioWastEnergy industrial park are applied, all of the bagasse and high strength wastewaters are sent to the anaerobic digester. The resulting methane gas generated is used to fuel a gas turbine to generate electricity. The waste heat from the gas turbine is used to make steam. The steam is used to generate additional electricity with a steam turbine thereby achieving 100% of the steam and electricity requirements of the mill through highly efficient combined cycle generation. In addition, the amount of potential electrical energy that could be generated is likely 25 times that required by the mill itself. Since the conversion of waste-to-energy leads to such dramatic results, it make economic sense to add value to the raw sugar by further purification to a refined white sugar which requires energy intensive processes. Adding value activities also adds local jobs while increasing export profits without jeopardizing energy use. The SAT Process is one such raw sugar refining process. The additional energy required is easily provided by the processing wastes generated.

Massive Greenhouses represent but a process extension of the BioWastEnergy industrial park concept. In the production of crops and foods significant quantities of organic wastes are generated. These wastes are again sent to the anaerobic digester to produce methane gas and other co-products. Combined cycle electricity generation is again achieved. It also makes economic sense to add value by engaging in food processing activities which, of course, generate additional wastes which are also anaerobically digested. It is quite fortunate that nutrients are never destroyed when undergoing anaerobic digestion. One nutrient, namely ammonia nitrogen, is actually produced under anaerobic digestion from the organic nitrogen contained in the waste feedstock.

Because one can control all of the growth variables of nutrients, moisture, temperature, soil pH, weeds, plant diseases, and photosynthesis intercropping may be successfully practiced. Since the earth is quickly running out of horizontal arable land, the only scientific option left is vertical farming. Massive greenhouse technology may be implemented in each and every country on earth without regard to geographic location, climate, form of government, culture, population, religion, or size.

Vertical farming can easily be implemented with zero emissions to the environment and zero wastes to landfill. The exhaust gasses from electricity generation are discharged to the greenhouse where both carbon dioxide and NOX gases are beneficially used by the crops. In addition, excess water vapor associated with the combustion products can be captured with dehumidification equipment and beneficially used. Because of the multiple effects of several stories, multiple harvests per year, and intercropping 50 story greenhouses are capable of producing about 500 times as much food per square foot of horizontal footprint as existing horizontal farming.

The vertical production of vegetable oil crops permits the refining of biodiesel which can be used to power airplanes, barges, boilers, ships, trains, and trucks while providing home and industrial heating. Because the greenhouse always uses its own inexpensive utilities for both production and processing, its costs will always be substantially less than its commodity marketplace competitors thereby creating inherent sustainability.

If vertical farming becomes accepted technology throughout the world, each nation becomes food, energy, fuel, and water independent. This condition would tend to greatly diminish or even eliminate world trade in food, energy, fuel, and water along with all of the associated conflicts which always accompany world economic imbalances. It therefore strongly promotes world peace. See WSE engineering drawing S-2004-2.

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

From the Engineering Department of WaterSmart Environmental, Inc.

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Technology: Sustainable Agricultural Farming Utilizing The OAT™ Process, Massive Greenhouses, And Holistic Waste Management.

Executive Summary

According to Population Action International, the earth is rapidly running out of farm land and the use of additional fertilizers and pesticides offer, at best, but a small extension of time. A truly sustainable solution has yet to be found and none of prospective solutions proposed to date offer much hope for an economically viable and scientifically achievable answer. A viable solution must be found very soon in order to stave off future starvation, localized civil conflicts, and ever increasing world turmoil (see www.populationaction.org/).

Vertical farming consisting of massive greenhouses represents the only sustainable solution to continuously decreasing farm land availability. Every crop that is now grown outdoors may be grown indoors as each of the growth variables of photosynthesis, humidity, temperature, macronutrients, micronutrients, soil pH, plant diseases, pests, and weeds may be precisely controlled. The same is likewise true for all fruits, vegetables, flowers, herbs, and seasonings.

Food processing at each and every greenhouse achieves added value to each food product. All of the wastes associated with harvesting and food processing are then anaerobically digested producing methane gas, carbon dioxide gas, organic fertilizer, liquid fertilizer concentrate, and reverse osmosis permeate water. Fortunately, all macro and micro nutrients fully survive anaerobic digestion and therefore are never lost with the value added food products. The organic fertilizer, liquid fertilizer concentrate, and reverse osmosis permeate water are then 100% recycled back to the greenhouse on a forever sustainable basis.

Some of the methane gas produced is converted into electricity to power the fluorescent lights and HVAC system. Excess methane can be converted into power and sold to the grid or converted into urea fertilizer and sold to the marketplace, or both such activities.

Food processing at each and every greenhouse achieves added value to each food product. All of the wastes associated with harvesting and food processing are then anaerobically digested producing methane gas, carbon dioxide gas, organic fertilizer, liquid fertilizer concentrate, and reverse osmosis permeate water. Fortunately, all macro and micro nutrients fully survive anaerobic digestion and therefore are never lost with the value added food products. The organic fertilizer, liquid fertilizer concentrate, and reverse osmosis permeate water are then 100% recycled back to the greenhouse on a forever sustainable basis.

Fresh fish farming is another food production activity that addresses the continuing decrease in ocean fish inventory. The finished fish would, of course, be fully processed with all associated wastes managed by anaerobic digestion.

The carbon dioxide gas generated during the anaerobic digestion of wastes can be utilized within the greenhouse as a refrigerant, for processed food packaging, and for dry ice production thus enabling necessary preservation during transportation to the marketplace.

Intercropping, the agricultural practice of growing two or more different crops within the same soil matrix side by side, can easily be achieved because of the total control of all growth variables. Each square meter of soil matrix in the proposed greenhouse becomes about 10 times as productive when compared against outdoor single crop farming.

To avoid ever present agricultural tariffs, greenhouses can be built in each of the agricultural product use countries rather than pursuing a policy of product export. This practice also lowers the cost of product transportation to the marketplace, particularly if they are located on a distributed basis.

Greenhouse construction labor and subsequent permanent farm employees provided by the use country ought to make these massive greenhouses most welcome, everywhere. Sharing some of the operational profits with the greenhouse employees and the nearby municipality should remove any remaining barriers that otherwise might exist against the rapid adoption of this technology throughout the world. Providing necessary food while sharing the operational profits creates a quite sustainable economic development activity from a political purview.

In countries too poor to pay for the finished food product, it may be wise to provide the technology on a build-own-operate-transfer basis. In some few selected instances the technology may be simply donated.

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Application: Renewable And Sustainable Energy Independence For North America
Holistic Business Model And Plan

Some seven years ago a highly efficient anaerobic treatment process was developed and patented (U.S. Patent No. 5,630,942). By highly efficient is intended to mean the added capability to degrade lignins thus producing about twice as much methane gas as traditional digesters. Waste-to-energy designs were thereafter developed for municipal solid wastes (MSW); dairy, beef, swine, broiler, layer, and turkey production wastes; food processing wastes; agricultural solid and liquid wastes; and high organic strength industrial liquid and solid wastes. In each and every instance, the five co-products of methane gas, carbon dioxide gas, organic fertilizer (digestate), liquid fertilizer concentrate, and reverse osmosis permeate water are produced for subsequent marketing to the commodity marketplace. The methane gas can be used in whole or in part to generate electricity for use by the waste generator with the excess sold to the grid. In the case of MSW, steel and aluminum cans are separated out and marketed to the ferrous and non-ferrous metals commodity marketplace. In each and every instance 100% of the several feedstocks end up in co-products or separated products that are sold to the marketplace. 0% requires landfill or other disposal as no waste products remain. These excellent results are directly attributable to the inherent efficiencies of the above referenced digester process.

The above renewable and sustainable waste-to-energy applications represent an excellent first start towards electricity independence but hardly achieves total energy independence. Total energy independence includes both electricity and transportation/heating fuels.

Biodiesel may be used for both transportation and heating fuels. It may also be used as a fuel to power reciprocating engine and turbine generators. Additionally, biodiesel may be further refined into both lubricants and greases. It may thus be considered as a total theoretical replacement for all gaseous, liquid, and solid fossil fuels on both renewable and sustainable bases. In short, biodiesel represents a fully acceptable future fuel from a scientific purview. Whether it can be produced on an economically viable basis is the current challenge. Ethanol, solar, hydrogen, biomass, and wind all require substantial governmental subsidies for their continuing existence. Biodiesel, however, can be produced in a manner which totally obviates the need for governmental or other assistance.

Today’s US soybean farmers currently grow perhaps 1% only of the vegetable oil necessary to produce sufficient biodiesel to completely replace the fossil fuels used for US truck, car, plane, train, and ship transportation and home heating. Soybean farming is practiced in a growing environment which includes pests, droughts, plant diseases, weeds, acid rain, and frequent deficiencies of micro and macro nutrients. Soybean prices fluctuate widely and are now at a six year high. Buying marketplace soybeans can only lead to non-competitive and unstable biodiesel costs. A different approach for producing a massive amount of inexpensive vegetable oil on a consistent basis must therefore be developed.

One such approach is the use of massive greenhouses on a distributed basis. By massive is meant 1.5 km x 1.5 km x 50 stories high. By distributed is meant some 3,500 massive greenhouses located on about 80 million acres. In a greenhouse environment one may control pests, droughts, plant diseases, weeds, acid rain, and deficiencies of micro and macro nutrients. Additionally, greenhouse farming can produce four+ perfect crops/year every year.

In order to maximize the square foot value of each greenhouse, the several waste products associated with vegetable oil farming and subsequent biodiesel refining consist of the harvested soybean crop residuals and glycerine. These waste products are anaerobically digested to produce methane gas, carbon dioxide gas, organic fertilizer, liquid fertilizer concentrate, and reverse osmosis permeate water.

The square foot value may be further increased by growing several below ground crops simultaneously with growing above ground soybeans. These other crops may consist of onions, beets, and potatoes. The technology of growing two or more crops within the same soil matrix is called intercropping.

The square foot value may be further increased by adding the production of swine, broilers, layers, beef, dairy, fresh fish, and turkey food products. The associated production facilities would add little incrementally to the massive greenhouse while adding significantly to the waste load. The wastes generated from these several activities would be anaerobically digested to produce additional methane gas, carbon dioxide gas, organic fertilizer, liquid fertilizer concentrate, and reverse osmosis permeate water.

The square foot value may be further increased by subsequently processing the onion, beets, potatoes, swine, broilers, layers, beef, dairy, fresh fish, and turkey food products. The processing produces a value added product while significantly increasing the waste load. These food
products would be 100% organically produced thus maximizing their flavor, safety, and marketplace value. The processing waste load would be anaerobically digested to produce additional methane gas, carbon dioxide gas, organic fertilizer, liquid fertilizer concentrate, and reverse osmosis permeate water.

Since electricity, pork, chicken, eggs, beef, milk, fish, and turkeys are consumed on a distributed basis, it makes economic sense to produce these products on a distributed basis to reduce distribution costs thus maximizing the marketplace competitiveness of each such product. The production of each of these food products may be shifted as desired in order to respond to ever changing marketplace demands.

The square foot cost of each massive greenhouse may be minimized by utilizing slip form construction which has been further developed since its first use on building the Hoover Dam. The use of foam concrete further reduces construction costs. Lastly, the use of inorganic waste materials such as bottom and fly ash from distributed coal fired power plants may further reduce construction costs.

The net products produced from each massive greenhouse consist of high quality reverse osmosis permeate water, processed food products, biodiesel, aqueous ammonia, methane, and electricity. If the fats from the processing of food were used for increased biodiesel production, the amount of excess methane gas and associated co-products would be reduced. Electricity generation can be entirely eliminated if 100% of the methane can be otherwise marketed. The commodity marketplace will ultimately determine the optimum mix of food production and in turn the optimum mix of co-products produced. All of the co-products produced are considered equal. Their individual marketplace pricing depends entirely on ever changing marketplace conditions. The idea is to make each value added product as competitive as necessary to move each product as it is produced. Long term storage of food and other co-products is not desirable. Because of the tremendous value generated, the sell price of each product may be adjusted as necessary to make all of the products extremely competitive and therefore easy to move into the marketplace.

InterGen is a quite new IPP which was formed in 1995 as a result of joint venture between Shell Generating (Holding) B.V. and Bechtel Enterprises Energy B.V. This entity has raised over $20 billion in non-recourse project financing in building some 16,000 MW of electricity generating capacity worldwide. This is strong marketplace evidence that qualifying project feasibility studies will attract inexpensive investor interest on a continuing basis. For ease of financing, the format of the renewable and sustainable energy independence project will be that of an IPP even though many more products other than green electricity will be marketed. If the local grid won’t buy the electricity at their true avoided cost, each IPP location will build its own power transmission lines to service the nearest municipality at a sell price which will force the local grid to either wheel the electricity to the final customer or to purchase the output. This approach will may require some pull from the local municipality. Attractive pricing should generate the necessary pulling force.

The economic principles of Natural Capitalism, pioneered by the Rocky Mountain Institute, are applied throughout the entire energy independence business model. These principles consist of the more productive use of resources; to redesign production on biological lines with closed loops, no waste, and no toxicity; to lease or sell a continuous flow of services that meets customers’ evolving value needs; and the reinvestment of ordinary profits to further expand the business. Multinational DuPont, Franco-I Italian chipmaker STMicroelectronics, Michigan based Steelcase, and the now wonderful Brazilian city of Curitiba are implementing the principles of Natural Capitalism with absolutely phenomenal success.

The United States consumes 25% of the world’s total oil production but owns just 3% of the world’s known oil reserves. The rapid development of renewable and sustainable energy independence is absolutely necessary for our national security as well as the continuation of inexpensive energy for the USA as well as all North America. Our border with Canada doesn’t exist as a practical matter and our border with Mexico is rapidly dissolving. The proposed technology can actually be implemented in each and every country on earth. Making all countries energy, food, fuel, and water independent over time will have a compelling favorable impact on human health, economic prosperity, and world peace.

The engineers and scientists at WaterSmart Environmental welcome your inquiries with enthusiasm.

1 Rocky Mountain Institute, www.rmi.org
Process: Holistic Biodiesel Refining Utilizing The OAT™ Process

Executive Summary

A gasoline engine is about 25% efficient in converting Btus into work (joules). A diesel engine, by comparison, is about 43% efficient. When converted into actual distances, each and every 100 gasoline miles is the near equivalent of 172 petrodiesel or biodiesel miles. These facts are ever present driving forces which favor the use of far more efficient diesel engines.

As a diesel engine fuel biodiesel is an environmentally preferred and a performance equal to petrodiesel. If refined from waste vegetable oils and fats it is price competitive with petrodiesel and consequently is now being sold in the marine, transportation, and mining industries as well as for heating oil. If refined from virgin vegetable oils, however, it is not price competitive and therefore not being sold as a 100% replacement of petrodiesel. It is, however, currently being used as a blend component of petrodiesel because of its extremely positive influence on environmental emissions. A blend as low as 2% biodiesel provides a dramatic positive effect on the overall performance of a diesel engine which is a strong reflection of its extremely favorable fuel characteristics.

The production cost of biodiesel consists of the cost of vegetable oil acquisition or production plus the cost of its subsequent refining. There is not a great deal of improvement possible with vegetable oil acquisition or production as most of the some 50 vegetable oils marketed are already fully established worldwide commodities. The cost of biodiesel refining, however, is susceptible to significant improvement if the associated refining biowastes are converted into energy through anaerobic digestion technology.

Biodiesel is efficiently produced by a chemical process called transesterification whereby raw glyc erine is removed from vegetable oils. Raw glyc erine must then be further purified before it can be marketed. Because of a continuing worldwide glyc erine glut, raw glyc erine may be better managed as a biowaste residual of biodiesel refining rather than a salable commodity. And whether the vegetable oils are obtained by crushing or steam extraction there are always additional biowaste residues all of which may be anaerobically digested to produce methane gas. Methane gas can be efficiently converted into steam and electricity, both of which can be holistically and beneficially used in the refining of biodiesel. In addition to methane gas, the OAT™ process generates carbon dioxide gas, organic fertilizer, liquid fertilizer concentrate, and reverse osmosis permeate water, all of which are salable commodities and therefore added value co-products in the refining of biodiesel.

Biodiesel is a pure 100% fuel conforming to ASTM Specifications D 6751. It is referred to as B100 or “neat” biodiesel. A biodiesel blend is pure biodiesel blended with petrodiesel. Biodiesel blends are referred to as BXX. The "XX" indicates the amount of biodiesel in the blend. A B20 blend, for example, is a 20% volumetric blend of biodiesel with 80% petrodiesel. B20 easily meets ASTM Specifications D 975. Biodiesel and biodiesel blends have excellent solvent properties. In some cases, the use of petrodiesel, especially No.2 petrodiesel, leaves a deposit in the bottom of fuel lines, tanks, and delivery systems over time. The use of biodiesel can remove this deposit or sediment which results in the need to change filters more frequently when first using biodiesel until the entire fuel delivery system has been cleaned. This same phenomenon is frequently observed when switching from No.2 to No.1 petrodiesel.

B20 raises the pour point, cloud point, and cold filter plugging point (CFPP) cold weather properties of petrodiesel at least 1.67°C (3°F). Biodiesel anti-gel products are available that can efficiently and effectively lower the CFPP of B20 as low as -40°C (-40°F). Fuel filter and line heaters can also be used to lower the CFPP even further. Neat biodiesel should be transported and stored at temperatures above 10°C (50°F) to guard against gelling.

Biofuels include ethanol, hydrogen, methane, and biodiesel. All are derived from renewable biological sources. All directly support local agricultural economies on a sustainable basis. All generate less pollution than petroleum-based fuels. Compared with petrodiesel, biodiesel:

- Is cleaner burning
- Is odor free, non-toxic, and biodegradable
- Is free of sulfur
- Is safer for people and the environment
- Reduces EPA targeted emissions
- Achieves more complete fuel combustion
- Is safer to handle, transport, and store
- Has higher lubricity
- Reduces black smoke
- Eliminates the nauseating smell
- Has a flash point above 150°C (302°F) and therefore exhibits a lesser potential for explosion
- Reduces greenhouse emissions
- Is a plant-based fuel replacement
According to the USEPA, biodiesel has additional and multiple benefits as follows:

<table>
<thead>
<tr>
<th>Emission benefits</th>
<th>Biodiesel reduces particulate matter, carbon monoxide, sulfur dioxides, and total hydrocarbon emissions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine power</td>
<td>Is virtually the same as petrodiesel (128,000 vs. 130,500 Btus). Therefore, engine torque and horsepower remain virtually the same.</td>
</tr>
<tr>
<td>Conversion and engine adjustments</td>
<td>None required. A changeover to biodiesel or biodiesel blends does not require any engine conversion or adjustments.</td>
</tr>
<tr>
<td>Cetane number</td>
<td>Higher than petrodiesel (49-62 vs. 42 for No.2 diesel fuel) that contributes to reduced engine knocking and smoother running.</td>
</tr>
<tr>
<td>Fuel consumption</td>
<td>Similar to petrodiesel.</td>
</tr>
<tr>
<td>Lubricity</td>
<td>Much higher and compensates for the loss of lubrication with the new low-sulfur and CARB (California Air Resources Board) petroleum diesel fuels.</td>
</tr>
<tr>
<td>Winter conditions</td>
<td>Existing diesel fuel winterizers can be used with biodiesel and biodiesel blends.</td>
</tr>
<tr>
<td>Handling and storage</td>
<td>Is safer than petrodiesel to handle and store. Biodiesel does not produce dangerous vapors at normal ambient temperatures, and can be stored in the same containers and tanks as petrodiesel.</td>
</tr>
<tr>
<td>Environmental</td>
<td>Is safer for the environment than petrodiesel. Is also less toxic than table salt, is as biodegradable as sugar, and contains no carcinogenic aromatics.</td>
</tr>
<tr>
<td>Availability and supplies</td>
<td>Biodiesel is available now. Currently, North America produces a surplus of 22 billion total pounds of vegetable oils, lard, and tallow that is available for biodiesel production.</td>
</tr>
<tr>
<td>Lifecycle carbon dioxide</td>
<td>Is reduced by 78%.</td>
</tr>
<tr>
<td>Energy security</td>
<td>Biodiesel produced from domestic renewable resources supplements the world’s petroleum supplies and helps ensure America’s energy security.</td>
</tr>
</tbody>
</table>

Politically, The Energy Policy Act (EPAct) of 1992 requires most federal, state, and public utility companies to have certain percentage of alternative fuel vehicles (AFVs) in their fleets. Since biodiesel works in any diesel engine with few or no modifications, CPAct was amended in 1998 to allow fleets to gain AFV credits through biodiesel use. Every 450 gallons of biodiesel purchased counts as one AFV credit. Fleets are, however, limited to using biodiesel for 50% of their credits. This 50% restriction is now under review. In addition to the EPAct provision, the Senate’s energy package includes a provision that would give a one percent reduction in the fuel excise tax for every one percent of biodiesel blended into standard diesel fuel up to a B20 blend for three years. Also, biodiesel would be an eligible fuel to participate in a program that calls for the nation to increase use of renewable fuels. This provision calls for the United States to use 5 billion gallons of renewable fuels by the year 2010. There exists a strong petroleum industry lobby opposed to the promotion and usage of alternative fuels. Despite this, use of biodiesel in the United States is increasing, particularly in urban bus fleets. Production costs for biodiesel are currently about 2.5 times that of petrodiesel.

Fuels derived from renewable biological resources for use in diesel engines are known as biodiesel fuels. Animal fats, virgin and recycled vegetable oils derived from crops such as soybeans, canola, corn, sunflower, and some 30 others can also be used in the production of biodiesel fuel. Tall oil produced from wood pulp wastes is yet another possible feedstock source. Biodiesel was used as a diesel fuel as early as 1900 when Rudolf Diesel demonstrated that a diesel engine could be run on peanut oil.

Chemically, biodiesel is the methyl or ethyl alkyl esters of long chain fatty acids derived from renewable lipid sources. It is generally produced in a several stage batch process. The process begins by dissolving the catalyst (sodium or potassium hydroxide) with methyl or ethyl alcohol using a standard agitator. The alcohol/catalyst mixture is then added to a closed reaction vessel and the vegetable oil (or fat, or beef tallow, or pork lard) is/are then added. The reaction process from this point on is closed from the atmosphere and kept around 71°C (160°F) for 1-8 hours. Once the reaction is considered complete, two major products exist namely biodiesel and glycerine. Each has an excess amount of alcohol previously used in the reaction phase. The glycerine phase is much denser than the biodiesel phase. After these two products are separated the alcohol is removed by distillation. The glycerine is neutralized with an acid and sent to storage as crude glycerine. Once separated from the glycerine the biodiesel is purified by washing with warm water (referred to as the methyl ester wash) to remove residual catalysts or soaps, dried, and then sent to storage.

The National Biodiesel Board (NBB) is a trade association of the soybean industry located at PO Box 104898, Jefferson City, MO 65110-4898, Phone: 800.841.5849, Fax: 573.635.7913, URL: [www.biodiesel.org](http://www.biodiesel.org). NBB serves as the product development team for biodiesel within the United States coordinating the research, regulatory, and market development programs needed to commercialize biodiesel. Its membership base includes fuel marketers and related feedstock producing and marketing associations. NBB’s research is focused on biodiesel fuel, its characteristics, its economics, and diesel engine testing for emissions and non-emissions work. NBB’s market development program is focused on federal and state regulatory work and market development through the education of the industry and end users.

The United States, Europe, New Zealand, and Canada have conducted tests of biodiesel on trucks, cars, locomotives, buses, tractors, and small boats. Testing has in-
cluded the use of pure biodiesel and various blends with conventional diesel engines. Results indicate significantly reduced engine wear while performance remains virtually unchanged. Many tests have concluded that the best overall results are obtained with a B20 blend.

**Economics of Biodiesel and Petrodiesel Production**

The prices of feedstock used in the production of biodiesel relative to petrodiesel is a key determinant in the price competitiveness of biodiesel. The economics of biodiesel production have deteriorated since 1994 for two main reasons: First, low agricultural commodity inventories (notably corn and wheat), drought conditions in some production areas and increasing demand for grains and oilseeds has resulted in a significant increase in commodity prices in the last few years. While there is expected to be some price moderation in the short-run, it is not anticipated that grain prices will decline in the foreseeable future to the levels prevailing a few years ago. Second, petroleum prices have declined several dollars per barrel in late March 1996 to just under US$16/barrel. Much of the impetus for the decline resulted from the recent agreement between the United Nations and Iraq, which allows that country to reenter the market as a supplier. Other petroleum producing nations have indicated they will not be reducing their output to compensate for Iraq's production. Therefore, total oil market supply will increase and prices could decline even further. Over the long term, however, agricultural inventories and the price of petroleum will both likely increase because the ongoing trend for both points upward. Currently, biodiesel is a technically acceptable substitute, replacement, or blending stock for conventional petrodiesel, but that its cost may only make economic sense where alternative fuel vehicle purchases are required by federal law and where alternative fuels are required by law to be used by certain regulated fleets. The cost of using biodiesel is quite economical when compared to the total cost to use other alternative fuels.

**Some existing suppliers** of biodiesel using only virgin soybean oil are:

Ag Environmental Products (AEP)  
9800 Pflumm Road  
Lenexa, KS 66215  
Phone: 800.599.9209  
Fax: 913.599.2121  
URL: [www.soygold.com](http://www.soygold.com)

Columbus Foods, Inc.  
800 North Albany  
Chicago, IL 60622  
Phone: 800.322.6457  
Fax: 773.265.6895  
URL: [www.columbysfoods.com](http://www.columbysfoods.com)

NOPEC Corporation  
1316 G. Jenkins Boulevard  
Lakeland, FL 33815  
Phone: 888.296.6732  
Fax: 941.683.1058  
URL: [www.nopec.com](http://www.nopec.com)

World Energy Alternatives  
1 Broadway, Suite 600  
Cambridge, MA 02142  
Phone: 617.621.1522  
Fax: 617.621.1523  
URL: [www.worldenergy.net](http://www.worldenergy.net)

**Some existing suppliers** of biodiesel using only recycled cooking oil are:

Pacific Biodiesel, Inc.  
285 Hukilike Street, B-103  
Kahului, Maui, HI 96732  
Phone: 808.871.6624  
Fax: 808.871.5631  
URL: [www.biodiesel.com](http://www.biodiesel.com)

Griffin Industries  
PMC Marketing Group  
4221 Alexandria Pike  
Cold Spring, KY 41076-1897  
Phone: 703.256.4497  
Fax: 703.256.8585  
URL: [www.griffinind.com](http://www.griffinind.com)

CytoCulture International, Inc.  
249 Tewksbury Avenue  
Poinrt Richmond, CA 94801  
Phone: 510.233.0102  
Fax: 510.233.3777  
URL: [www.cytoculture.com](http://www.cytoculture.com)

For all practical purposes, the performance of the virgin and recycled oil biodiesel products are identical. The marketplace price of the recycled oil is, however, significantly less than the virgin oil product. If all the existing production of virgin and recycled oil were made into biodiesel and sold, the sales would replace less than 2% of petrodiesel sales. Virgin soy oil costs about 20¢/lb which translates into a soy biodiesel price of about $2.00/gallon whereas virgin mustard seed oil, a low value waste product, costs about 10¢/lb which translates into a mustard biodiesel price of about $1.00/gallon. If the waste or recycled oil is free to the producer, the final price of the biodiesel is about $0.83/gallon utilizing existing technology.

**Crop Vegetable Oil Yields:**

<table>
<thead>
<tr>
<th>Crop</th>
<th>kg oil/ha</th>
<th>L oil/ha</th>
<th>lbs oil/ac</th>
<th>gal oil/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>corn</td>
<td>145</td>
<td>172</td>
<td>129</td>
<td>18</td>
</tr>
<tr>
<td>cashew nut</td>
<td>148</td>
<td>176</td>
<td>132</td>
<td>19</td>
</tr>
<tr>
<td>oats</td>
<td>183</td>
<td>217</td>
<td>163</td>
<td>23</td>
</tr>
<tr>
<td>lupine</td>
<td>195</td>
<td>232</td>
<td>175</td>
<td>25</td>
</tr>
<tr>
<td>kenaf</td>
<td>230</td>
<td>273</td>
<td>205</td>
<td>29</td>
</tr>
<tr>
<td>calendula</td>
<td>256</td>
<td>305</td>
<td>229</td>
<td>33</td>
</tr>
<tr>
<td>cotton</td>
<td>273</td>
<td>325</td>
<td>244</td>
<td>35</td>
</tr>
<tr>
<td>hemp</td>
<td>305</td>
<td>363</td>
<td>272</td>
<td>39</td>
</tr>
<tr>
<td>soybean</td>
<td>375</td>
<td>446</td>
<td>335</td>
<td>48</td>
</tr>
<tr>
<td>coffee</td>
<td>386</td>
<td>459</td>
<td>345</td>
<td>49</td>
</tr>
<tr>
<td>linseed</td>
<td>402</td>
<td>478</td>
<td>359</td>
<td>51</td>
</tr>
<tr>
<td>hazelnuts</td>
<td>405</td>
<td>482</td>
<td>362</td>
<td>56</td>
</tr>
<tr>
<td>euphorbia</td>
<td>440</td>
<td>524</td>
<td>393</td>
<td>57</td>
</tr>
<tr>
<td>Commodity</td>
<td>Yield (units)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>--------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumpkin seed</td>
<td>449 534 401 57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oriander</td>
<td>450 536 402 57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mustard seed</td>
<td>481 572 430 61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camelina</td>
<td>490 583 438 62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sesame</td>
<td>696 828 622 88</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safflower</td>
<td>790 940 705 100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td>800 952 714 102</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rung oil tree</td>
<td>863 1026 771 110</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunflowers</td>
<td>890 1059 795 113</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunflowers</td>
<td>978 1163 873 124</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapeseed</td>
<td>1000 1190 893 127</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olives</td>
<td>1019 1212 910 129</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Castor beans</td>
<td>1188 1413 1061 151</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pecan nuts</td>
<td>1505 1791 1344 191</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jojoba</td>
<td>1528 1818 1365 194</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jatropha</td>
<td>1590 1892 1420 202</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macadamia nuts</td>
<td>1887 2246 1685 240</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil nuts</td>
<td>2010 2392 1795 255</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avocado</td>
<td>2217 2638 1980 282</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coconut</td>
<td>2260 2689 2018 287</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil palm</td>
<td>5000 5950 4465 635</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vegetable oil yields x 0.8 = approximate biodiesel yields

**Biodiesel NOX Control Technology** already exists with more under development. In the fossil fuel power industry ammonia is added to the hot discharge gas under catalytic influence to convert NOX to Nitrogen Gas and Water. In a worst case scenario the same technology can be successfully used to reduce biodiesel NOX emissions to acceptable levels. One can also retard the timing to achieve acceptable NOX results at the expense of diesel engine performance if absolutely necessary.

**Current Biodiesel Production Plants** have directed their marketing efforts at the blend business with some B100 from used vegetable oil (with lard, fat, and tallow sometimes added) being sold to the marine and mining industries. The blend business plants are focused almost entirely on existing commodity crops of soybean and rapeseed (canola in Canada) for their feedstock. It is common practice to crush the crop to separate as much vegetable oil as is possible. The remaining pellets and/or mash is then beneficially used as animal feed. On the surface, these practices seem efficient but from chemical engineering and nutrition standpoints are highly inefficient. Far too much oil is left in the crop and the utilization of crop residuals as animal feed, or feed supplements, in fact represents but a solid waste disposal activity rather than a scientifically preferred animal nutrition diet. Additionally, virtually all existing vegetable oil crops are commodities in the marketplace subject to ever present intermittent droughts, diseases, and governmental subsidy influences. Consequently, the marketplace prices of the produced biodiesel are dependable.

Lastly, the majority of existing biodiesel production facilities are rather small which adds another level of marketplace price sensitivity.

**B100 represents a potential replacement fuel** for petroleum diesel on a global basis if all of the following holistic production procedures are implemented in their entirety:

1. The use of steam to maximize vegetable oil extraction followed immediately by transesterification of the already hot oil.

2. The OAT™ process anaerobic digestion of glycerine and vegetable oil crop residuals in the generation of methane gas, electricity, steam, organic fertilizer, and liquid fertilizer concentrate all of which support biodiesel production. The organic fertilizer and the liquid fertilizer concentrate are always captured and recycled back to the cropland.

3. The planting of new crops on massive acreage with access to irrigation water or an acceptable climate to maximize consistent mass production. The farm implement equipment will, of course, use economical B100.

4. The selection of the crop(s) which produces the greatest oil yield/acre/climate as the farmland can always be nutritionally prepared to satisfy crop nutrient uptake requirements.

**Biodiesel - the dominant fuel of the future**

As limited fossil fuels disappear, replacement fuels and/or renewable energy sources will have to be developed according to the USDOE. The major renewable fuels under consideration are hydrogen gas, ethanol, and biodiesel. The infrastructure for using Hydrogen gas must still be developed. This renewable fuel has an inherently low Btu value which adversely impacts on its resulting fuel economy. Ethanol is produced by a highly inefficient fermentation process. The infrastructure for using ethanol (pure, not mixed with gasoline) must still be developed. This renewable fuel also has an inherently low Btu value which adversely impacts on its fuel economy. Biodiesel, by comparison, is already being produced by an efficient refining process that can be made even more efficient. The infrastructure for using biodiesel is already in place. Biodiesel also possesses a high Btu content when compared with either hydrogen gas or ethanol.

Biodiesel can be used as jet fuel, heating oil, and diesel fuel. It can also be refined as lubricating oils and greases.

As biodiesel begins to replace petroleum diesel (and other kerosenes) and as the political pressure to increase the miles-per-gallon efficiency of automobiles, gasoline and gasoline engines will both disappear as diesel engines are far more efficient than gasoline engines.
The use of biodiesel will permanently and completely eliminate foreign oil imports and therefore maximize our national security. The fuel has no technical, political, or environmental downside. Agricultural job creation is fantastic. American dollars will stay here as all associated production requirements of this fuel are accomplished domestically. The Kyoto requirements will automatically be achieved as the biodiesel refining process as well as the fuel itself both reduce carbon dioxide emissions. One can actually end up selling CO₂ credits to other countries, including Japan, which has no oil or coal of their own.

Total time to accomplish the dominance of biodiesel – perhaps 15 years, maybe sooner, depending on the technology provider(s).

Somewhat amazingly, neither governmental subsidies nor petroleum industry cooperation are even necessary. Other biofuels of hydrogen, CNG, LNG, and ethanol cannot effectively compete because of the inherent high Btu content of biodiesel. Because the B100 production technology is so strong, downstream petroleum industry participation would be expected, welcomed, and even encouraged.

The engineers and scientists at WaterSmart Environmental welcome your inquiries.
Distributed Biodiesel Refining

Made possible by the OAT™

Optimized Anaerobic Treatment Process

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United States Fossil Fuel Annual Sales

- Consisting of heating oil, jet fuel, natural gas, diesel fuel, LP gas, and gasoline total about 300 billion gallons according to the American Petroleum Institute.
- 100% of these sales may be theoretically and technically replaced by biodiesel.
Existing US Vegetable Oil Production

- Can produce but 0.2% of the 300 billion gallon biodiesel demand.
- Land required to produce 100% of the demand is approximately 80 million acres or about 1-1/2 times the size of the state of Rhode Island.
- Additional vegetable oil farming is therefore required to satisfy the sustainable and renewable biodiesel market.
Inexpensive Land Sources

- Closed landfills.
- Active landfills.
- Closed + active landfills and their ancillary buffer zones add up to about 80,000,000 acres.
Inexpensive Land Or A Liability?

- The OAT™ process permits the total elimination of closed and active landfills.
- If owned or leased by WaterSmart, these landfills represent a significant resource rather than a significant liability.
- Once eliminated, the former landfill site may be developed as a vegetable oil farm.
- It is entirely possible that WaterSmart can be paid to accept a landfill site or its lease.
Soybeans

- Are already the most widely grown protein/oilseed crop in the world.
- Can be grown in a controlled environment or greenhouse similar in appearance and structure type to a twelve story concrete parking garage.
- Require a two meter deep soil to establish a one meter plant height for maximum oil production.
- Under a controlled environment four harvests per year can be achieved which would reduce the stories from twelve to two. Additional stories can always be added to satisfy future growth.
A Controlled Environment

- Requires irrigation water for plant growth and boiler water make-up.
- Requires electricity for the fluorescent lights.
- Requires a soil amendment to provide micronutrients.
- Requires carbon dioxide gas to enhance plant growth.
- Requires phosphates and potash for maximum plant growth.
- Requires heating and cooling to optimize plant growth.
- In short, requires all of the co-products of the OAT™ process.
A Controlled Environment

- Can significantly reduce plant insects.
- Can significantly reduce plant disease.
- Reduces or completely eliminates pesticides.
- Reduces or completely eliminates weeds.
- Completely eliminates drought conditions.
- Completely eliminates excessively wet soils.
- Completely eliminates loss of moisture due to transpiration.
- Can significantly increase vegetable oil yields.
Vegetable Oils

- Can be extracted by crushing.
- Can be extracted with hexane.
- Can be extracted with steam (recommended).
- Leave solid residues after extraction.
- Leave glycerine and fatty acids after refining.
Biodiesel Refining

- Requires energy in the forms of steam and electricity.
- Energy requirements add to refining costs.
- Use of solid residues can reduce refining costs by marketing as animal feed (common practice).
- Use of solid residues, glycerine, and fatty acids can significantly reduce refining costs by conversion into energy through anaerobic digestion (not yet attempted).
- If converted into energy would **more than satisfy** biodiesel refining steam and electricity requirements thus reducing production costs.
Fate Of OAT™ Process Co-Products

- Digestate (digester solids) are returned to greenhouse soil thereby accomplishing 100% recycling of micronutrients.
- Phosphorus and Potassium salts returned to greenhouse soil thereby accomplishing 100% recycling of macronutrients.
- Carbon dioxide used to enhance soybean plant growth.
- Methane converted into steam and electricity for biodiesel refining process.
- Reverse osmosis permeate water used for plant irrigation.
- Stripped ammonia sold as fertilizer thus further reducing biodiesel refining costs.
Distributed Electricity Generation

- Can be accomplished using excess methane gas.
- Can be accomplished using biodiesel fuel.
- Should be accomplished using combined cycle generation technology for increased efficiency.
- Can utilize steam turbine discharge for vegetable oil extraction steam (common practice in palm oil industry).
- Beneficial use of steam turbine discharge for extraction steam further reduces biodiesel refining costs.
A 100 Acre Two-Story Soybean Greenhouse

- Can produce about 38,000 GPY or 100 GPD of vegetable oil.
- This amount oil production can support about 40 kW of simple cycle electricity generation from biodiesel at an 80% yield.
- Anaerobic digestion of the crop residuals and biodiesel refining wastes to methane gas further increases the electricity generation potential to over 210 kW.
- Converting from simple to combined cycle increases electricity generation output to over 250 kW.
- Adding 10 stories further increases power output potential to 1.5 MW and biodiesel yield to 225,000 GPY.
- Some or all of the biodiesel may be used for domestic air and ground transportation, domestic heating requirements, and as a quite valuable fuel export product.
- Building a several thousand acre multi-story greenhouse is technically achievable utilizing currently available reinforced concrete construction technology.
Each Greenhouse

- May be expanded to increase distributed biodiesel production.
- Distributed biodiesel generation reduces biodiesel market costs.
- Landfills are located on a distributed basis.
Each Greenhouse

- May be expanded to increase biodiesel production for the purpose of increasing distributed electricity generation.
- Distributed electricity generation reduces distribution line losses due to conductor resistance.
- Generated electricity fully qualifies as green energy.
Biodiesel Refining Process

- Produces biodiesel for sale to the marketplace.
- Produces aqueous ammonia fertilizer for sale to the marketplace.
- Can produces electricity for sale to the marketplace.
- Can produce CNG for sale to the marketplace.
- Can produce steam for sale to the marketplace.
- Generates zero wastes.
A Holistic Biodiesel Refining Processes Which Uses The OAT™ Process

- Is competitively capable of completely replacing fossil based fuels worldwide.
For Project Feasibility Studies and Proposals

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Executive Summary

According to Population Action International, the earth is rapidly running out of farm land and the use of additional fertilizers and pesticides offer, at best, but a small extension of time. A truly sustainable solution has yet to be found and none of prospective solutions proposed to date offer much hope for an economically viable and scientifically achievable answer. A viable solution must be found very soon in order to stave off future starvation, localized civil conflicts, and ever increasing world turmoil (see www.populationaction.org/).

Vertical farming consisting of massive greenhouses represents the only sustainable solution to continuously decreasing farm land availability. Every crop that is now grown outdoors may be grown indoors as each of the growth variables of photosynthesis, humidity, temperature, macronutrients, micronutrients, soil pH, plant diseases, pests, and weeds may be precisely controlled. The same is likewise true for all fruits, vegetables, flowers, herbs, and seasonings.

Food processing at each and every greenhouse achieves added value to each food product. All of the wastes associated with harvesting and food processing are then anaerobically digested producing methane gas, carbon dioxide gas, organic fertilizer, liquid fertilizer concentrate, and reverse osmosis permeate water. Fortunately, all macro and micro nutrients fully survive anaerobic digestion and therefore are never lost with the value added food products. The organic fertilizer, liquid fertilizer concentrate, and reverse osmosis permeate water are then 100% recycled back to the greenhouse on a forever sustainable basis.

Some of the methane gas produced is converted into electricity to power the fluorescent lights and HVAC system. Excess methane can be converted into power and sold to the grid or converted into urea fertilizer and sold to the marketplace, or both such activities.

Fresh fish farming is another food production activity that addresses the continuing decrease in ocean fish inventory. The finished fish would, of course, be fully processed with all associated wastes managed by anaerobic digestion.

The carbon dioxide gas generated during the anaerobic digestion of wastes can be utilized within the greenhouse as a refrigerant, for processed food packaging, and for dry ice production thus enabling necessary preservation during transportation to the marketplace.

Intercropping, the agricultural practice of growing two or more different crops within the same soil matrix side by side, can easily be achieved because of the total control of all growth variables. Each square meter of soil matrix in the proposed greenhouse becomes about 10 times as productive when compared against outdoor single crop farming.

To avoid ever present agricultural tariffs, greenhouses can be built in each of the agricultural product use countries rather than pursuing a policy of product export. This practice also lowers the cost of product transportation to the marketplace, particularly if they are located on a distributed basis.

Greenhouse construction labor and subsequent permanent farm employees provided by the use country ought to make these massive greenhouses most welcome, everywhere. Sharing some of the operational profits with the greenhouse employees and the nearby municipality should remove any remaining barriers that otherwise might exist against the rapid adoption of this technology throughout the world. Providing necessary food while sharing the operational profits creates a quite sustainable economic development activity from a political purview.

In countries too poor to pay for the finished food product, it may be wise to provide the technology on a build-own-operate-transfer basis. In some few selected instances the technology may be simply donated.

The dedicated scientists and engineers at WaterSmart Environmental welcome your inquiries with enthusiasm.
Elevation Section

Multi-story Greenhouse

Walsam Environmental Inc.

Plan Title: Back Yard

Scale: 1/8" = 1'-0"

15 ft x 15 ft Square

Soil

Beans

Planter/Container Machine

Turf Concrete

Turf Concrete

5 ft x 5 ft
Application: SuperGrid™

Over 2 million miles of pipelines now exist within the United States moving gasoline, diesel fuel, kerosene, aviation gasoline, jet fuel, home heating fuel, natural gas, propane, hydrogen gas, crude oil, propylene, ethylene, anhydrous ammonia, coal slurry, phosphate slurry, water, and orange juice. When compared against rail, barge, and truck modes of transportation, pipeline transfer is considered more expensive from a capital investment standpoint but far more efficient from an operational standpoint. Consequently, pipelines continue to be built for commodity movement. As transportation fuel costs increase, the relative cost of pipeline transport decreases even further.

From a safety standpoint, pipelines are considered rather safe and getting safer. The largest accident to date occurred on the Trans-Alaska pipeline on October 4, 2000 when a single stray bullet from a careless hunter or perhaps a malicious vandal penetrated the 42 inch pipe releasing over 285,000 gallons of crude oil. This incident slowed production of North Slope oil to 5% of the normal one million barrels/day delivery rate for a six month pipeline repair and spill cleanup period. According to the US Office of Pipeline Safety (ops.dot.gov), during the reporting years 1986-2001 there were almost 3,000 accidents with 36 fatalities and 242 injuries from the operation of pipelines carrying hazardous liquids including petroleum products. When compared against rail, barge, and truck modes of transportation on a per/ton-mile of product transferred basis, pipeline transfer easily wins the safety award notwithstanding the Alaskan incident.

Overhead power transmission grids are approaching practical operating capacity resulting in frequent power rationing and occasional power loss. Solar storms and hurricanes also have the ability to trigger power outages. These grids normally experience about 20% line loss due to power transmission inefficiencies. The recent August 14, 2003 Niagara-Mohawk grid blackout manifested the need to greatly improve power transmission capacity and associated operational management of our national grids. One of the greenhouse commodity products distributed is liquefied nitrogen. By enclosing the power distribution cable within the liquefied nitrogen pipeline, the power transmission cable is cooled. By distributing power at the temperature of liquefied nitrogen the power transmission losses are reduced to nearly zero. This extreme efficiency translates into an annual savings of $40 billion for the USA electricity consumer.

Each massive greenhouse produces several products which require distribution to the marketplace. If each of the greenhouses were connected with a distribution conduit to accommodate product transfer, a SuperGrid™ would gradually emerge. Installing two pipes simultaneously in a common conduit is but slightly more expensive than a single pipe. Therefore the installation of several pipelines, power transmission, communication and data transmission cables, and a service subway is extremely efficient and economical in terms of commodity transfer. By placing the distribution conduit below grade utilizing heavy duty reinforced concrete construction, it would become rather safe from terrorist attack.

By constructing several cross-connections between independent terminals, the entire SuperGrid™, as a practical matter, becomes totally immune to both terrorist attacks and random seismic events. The resulting SuperGrid™ thereby achieves economical, permanent, efficient, and secure commodity product distribution on distributed and sustainable bases. Because of its significant operational efficiency, all of the products moved would tend to drive the marketplace price of each lower. This powerful deflationary force would keep all of the distributed products highly affordable to the end user on a profitable and therefore sustainable basis.

The biodiesel product would, over time, completely replace gasoline, petrodiesel, jet fuel, kerosene, heating oil, and associated lubricants. FYI, biodiesel can be further refined into biolubricants which compete with petroleum based lubricants. Natural gas, as we know it today, would also disappear because of its inability to compete in the marketplace. Because of its higher cost of power generation, existing coal fired power plants would gradually become obsolete as the SuperGrid™ grows. The only electricity source that might continue to compete economically is super efficient nuclear power. By super efficient refers to avoided costs prior to the recognition of the significant costs of nuclear waste management. Each massive greenhouse would also be a food production and processing site possessing the potential of gradually replacing existing concentrated animal feeding operations (CAFOs) along with existing food processing facilities. Please refer to Engineering Drawing No. SG-0202.

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

From the Engineering Department of WaterSmart Environmental, Inc.
Buried Supergrid: Elevation Section
Next Generation
BioWastes-to-Renewable Energy
Kyoto Protocol Compliant
Global Cooling Technologies

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Cities become electricity, natural gas, and diesel fuel independent. No more expensive imports from the power grid, natural gas pipeline, and oil companies.

City residents and businesses will be able to purchase electricity, natural gas, and diesel fuel at a 20% discount from existing marketplace prices on a sustainable basis.

City residents and businesses will be able to purchase compressed natural gas (CNG) which burns cleaner than gasoline and will be priced to sell for 20% less on an equivalent miles per gallon basis.

Municipalities automatically become zero-waste-to-landfill communities.
Business Model 1

- The generated electricity is always green and 100% renewable.
- City residents and businesses will be able to purchase electricity, natural gas, and diesel fuel at a 20% discount from existing marketplace prices.
- City residents and businesses will be able to purchase compressed natural gas (CNG) which burns cleaner than gasoline. This fuel will be priced to sell for 20% less than gasoline on an equivalent miles per gallon basis.
- Municipalities automatically become instant zero-waste-to-landfill communities.
Business Model 1
Is marketed and developed as
BioWaste Energy Regional Industrial Parks

- Each park always treats sanitary wastewater, municipal solid wastes, fish processing wastes, and biodiesel refining wastes.
- Many other wastes will also be accepted.
- Each Park is operated by BioWasteEnergy, A Division of WaterSmart Environmental, Inc.
Business Model 1

BioWaste Energy Regional Industrial Park
Operated By BioWastEnergy, A Division Of WaterSmart Environmental, Inc.

Material Flow Schematic

Eligible Biowastes
- Municipal Solid Wastes
- C&D Wastes
- Sanitary Wastewater
- Stormwater
- Green Wastes
- Food Wastes
- Animal Wastes
- Industrial Wastes
- Liquid Organics
- Solid Organics

OAT™ Process
Optimized Anaerobic Treatment
- Organic Fertilizer
- Liquid Fertilizer Concentrate
- Carbon Dioxide Gas
- Reverse Osmosis Water
- Methane Gas

CO-PRODUCTS TO MARKET
- OAT TM Process
- Optimized Anaerobic Treatment
- Gas
- Methane
- Liquid
- Fertilizer Concentrate
- Reverse Osmosis Water
- Methane Gas

POWER PLANT AND UTILITIES
- Carbon Dioxide
- RO Water
- Electricity
- Steam
- Natural Gas

Eligible Park Projects, Typ.
- Ag Processing
- Algae Farming
- Biodiesel Refining
- Brewery
- Cheese Making
- Chemicals
- Distillery
- Ethanol Production
- Fertilizer Production
- Fish Farming
- Food Processing
- Pharmaceuticals

To Park
- To Public

All BioWaste Energy Regional Industrial Park Liquid And Solid Wastes

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Regional Industrial Parks

- Never require tax money for their construction. Project financing is raised from financial markets. Sales and property taxes will never increase due to park construction.
- Always generate significant renewable energy credits because they have a positive impact on global warming. These credits are used in part to secure project financing.
- Always increase farming property worth by creating greater value per acre than existing use.
- Have zero emissions to the environment.
- Have zero wastes that require landfill disposal.
- Always create temporary and permanent jobs.
Regional Industrial Parks

- Generate 100% of a community’s electricity demand thereby permitting a city to eventually disconnect from the grid.
- Generate 100% of a community’s diesel fuel demand since biodiesel is a perfect replacement for petroleum diesel.
- Generate 100% of a community’s demand for natural gas since digester methane gas is a perfect replacement for pipeline supplied natural gas.
- Enable the use of compressed natural gas (CNG) fuel for gasoline powered engines. CNG is cleaner burning than gasoline and significantly extends engine life.
- Have the ability to generate 100% of the local demand for fresh fish through fish farming activities. All fish raised will be Mercury free since they are grown under cover. Additional Mercury-free fish will be exported to the marketplace. Fish farming will be practiced 365 days/year as excess energy from the park will permit effective heating of pond water during winter months.
- Microalgae farming and associated biodiesel production will also be practiced around the clock 365 days/year.
- Fish and microalgae farming generate far greater value/acre than all other food production products. Processing fish and biodiesel refining are “value added” activities.
Regional Industrial Parks

- Require the full privatization of a community’s wastewater treatment plant.
- Require the conversion of the community’s potable water plant to membrane treatment. Membrane treatment is far more secure from terrorist attack than all lesser forms of water treatment. The cost of membrane conversion is included within total project financing. If the water plant is fully privatized the cost of potable water to citizens and businesses decreases by 20%.
- Permit the continuance or elimination of community trash recycling programs. Each park will recycle ferrous and non-ferrous metals (beer and pop cans) and nothing else.
- Will accomplish stormwater treatment by beneficially using it as municipal solid waste dilution water.
- Will be organized as for-profit corporations. Each park will share its annual profits with the city on a 50:50 donation basis to enhance municipal payroll compensation and to help fund routine municipal projects.
There Are Over 50 Existing North American MSW-To-Energy Plants That Use Incineration To Generate Electricity

- Other than scrap metals no other valuable co-products are produced.
- Associated air pollution is always a concern.
- The resulting ash must be landfill disposed.
- The plant’s owner/operator makes very little profit.
- Consequently, existing MSW-to-energy technology is held in low esteem by both investors and environmentalists.
One Major Reason For Low Profits--
The High Moisture Content Of MSW

- The efficiency of incineration technology is Greatly Diminished by the ever present high moisture content of MSW.
- Incineration Technology is a Dry Process.
- Anaerobic Digestion is a Wet Process.
Anaerobic Digestion

- Is already being used by municipalities to generate methane gas to fuel electricity power generators.
- Is already being used by dairies and swine producers to generate electricity.
- Is already being used by the food and beverage industry to generate electricity.
- Can be beneficially used to produce methane gas from municipal solid wastes.
WaterSmart’s MSW-To-Energy Anaerobic Treatment Process

- Has been carefully designed to recycle 100% of its residuals.
- Therefore, no material left over requires landfill or other disposal.
System Design

- MSW is mechanically sorted to remove ferrous and non-ferrous metals (beer and pop cans) which are sold to ferrous and non-ferrous metal buyers.
- Everything else is mechanically reduced in size to about 2.5 mm (approximately 1/10th inch) by mechanical grinding.
- The ground material is then mixed with sanitary wastewater and added to the anaerobic digester.
- Represents *next generation* technology in the marketplace.
Each System Component Is Established Technology

- MSW sorting to remove beer and pop cans.
- Size reduction (grinding).
- Slurry mixing.
- Anaerobic digestion of MSW.
- Carbon dioxide compression.
- Methane compression.
- CNG fuel for gas generators.
- Reverse osmosis membrane treatment.
Digester Co-Products

- Methane gas
- Carbon dioxide gas
- Organic fertilizer (digestate)
- Liquid fertilizer concentrate
- Reverse osmosis permeate water
Methane Gas

- Is dried, compressed, and beneficially used as a fuel to power internal combustion engines or gas turbines to generate electricity.
- Waste heat from power generation equipment is beneficially used to make steam. The steam is used to make additional electricity. When two methods are simultaneously used to make electricity its power generation is referred to as combined cycle. The efficiency of combined cycle generation is about 15% greater than simple cycle electricity generation.
- The compressed methane gas (called CNG) can also be used to fuel transportation equipment.
- The compressed methane gas can also be used to manufacture anhydrous ammonia and urea fertilizers.
- No methane gas from the anaerobic treatment process is released to the environment.
Carbon Dioxide Gas

- Some is liquefied for use in manufacturing dry ice.
- The balance is beneficially used in the photosynthesis of carbohydrates during fish farming and lipids during microalgae farming.
- No carbon dioxide will be released to the environment.
Digestate Solids Composition (From Anaerobic Digester)

- Ground glass, ground sand, ground rubber, ground leather, and ground plastics.
- Highly insoluble sulfides of Cadmium, Calcium, Copper, Iron, Lead, Manganese, and zinc, Chromium Oxides, and Calcium salts. These metals and salts are beneficial, necessary, and valuable micronutrients in soil.
- Approximately 1-1-1 N-P-K (Nitrogen, Phosphorus, and Potassium).
- Qualifies as Class “A” Biosolids in compliance with 40 CFR Part 503.
- Also qualifies as an organic fertilizer.
Solids Management.

- May be sold to the marketplace as an organic fertilizer at 30% moisture content.
- May be sold to the marketplace as a soil conditioner or soil amendment at 30% moisture content.
Liquid Streams
(From Digester)

- Liquid fertilizer concentrate.
- Reverse osmosis permeate water.
Liquid Fertilizer Concentrate.

- Contains about 20-10-10 N-P-K in a concentrated 10% dissolved solids water solution.
- Will also contain soluble aluminum, magnesium, and sodium salts.
- Is sold to the marketplace.
Reverse Osmosis Permeate Water.

- Is used as boiler water make-up in making steam for the steam turbines.
- May be added to MSW to prepare a 5% slurry.
- May also be used for aquifer recharge to repair and replace contaminated groundwater.
- May be used for irrigation.
- Excess may be discharged under an NPDES permit.
Gas Management.

- No digester release of methane gas to the environment.
- No digester release of carbon dioxide gas to the environment.
- Eliminating digester gas releases to the environment accomplishes a 500%+ reduction in greenhouse gas emissions.
- At the same time significant carbon dioxide credits are generated, on the order of 85 grams/kWh of electricity generated.
Business Model 2

- Entire Nations become energy, food, fuels, and water independence through massive greenhouse farming. By massive is 1 mile square (1.5 km square) by 50 stories high.
- North America requires some 5,000 massive greenhouses to achieve energy, food, fuels, and water independence.
- By connecting each of the several greenhouses together to form a SuperGrid, energy, food, fuels, and water can be economically delivered to the marketplace under secure conditions.
- Greenhouse farming results in several harvests per year. By controlling moisture, humidity, carbon dioxide concentration, temperature, nutrient addition, lighting, and other variables, successful intercropping can be practiced. All foods grown and processed result in organic and natural food production. The use of pesticides and weed killers can be totally eliminated. Massive greenhouse farming represents highly efficient land management. Upwards of 500 times as much food can be grown/horizontal acre with this technology.
- Pipeline products consist of electricity, biodiesel fuel, anhydrous ammonia, urea, compressed natural gas, liquefied nitrogen, and water. Foods may consist of anything that can be grown as well as concentrated animal feeding operations. All food products will be processed to achieve value added. All wastes associated with farming, food production, and food processing will be anaerobically digested to produce the same five co-products referenced in Business Model 1.
Business Models 1 & 2

BioWastEnergy
Regional Industrial Parks
(North America Requires 20,000)

SuperGrid™ Connected
Massive Greenhouses
(North America Requires 5,000)

100% Renewable Energy, Food, Fuels, and Water Independence Technologies

Kyoto Protocol Compliant Producing CO₂, Mercury, NOx, SOx, and Renewable Energy Credits

With Enormous High Quality Permanent Jobs Creation Potential

Note 1: Governmental Subsidies Not Required Or Considered.
Note 2: Above Technologies Gradually Replace Coal Fired And Nuclear Power Plants.
Note 3: Above Technologies Gradually Replace Oil Companies.
Note 4: Above Technologies Gradually Replace Old Agricultural Subsidies.
Note 5: Above Technologies Gradually Promote Global Peace While Completely Eliminating World Hunger.
Note 7: Above Technologies Gradually Reverse Global Warming Due To Consumptive Depletion Of Carbon Dioxide.

100% Renewable Energy, Food, Fuels, and Water Independence Technologies

Zero Gaseous Emissions To Environment

Electricity To Market

Enhanced De claimed

Design-Build-Own-Operate

Wastes To Energy

Electrolysis To Market

Wastes To Landfill

Green Energy & Fuels Marketing
Design-Build-Own-Operate
Wastes-To-Energy

BioWastEnergy

Regional Industrial Parks
(North America Requires 20,000)

SuperGrid™ Connected
Massive Greenhouses
(North America Requires 5,000)

Featuring Intercropping With Multiple Harvests/Year

Totally Enclosed Crop & Food Production & Processing

With 100% Water, Soil, And Nutrients Recycling

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SuperGrid™

Buried SuperGrid™ Elevation Section
For Project Feasibility Studies And Other Inquiries

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