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The Co-Production of Ethanol and Electricity From Carbon-based Wastes

A Report from BRI Energy, Inc.
Regarding a New Technology that Addresses
Multiple Energy and Waste Disposal Solutions

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BRI ENERGY, INC.

THE CO-PRODUCTION OF ETHANOL & ELECTRICITY FROM CARBON-BASED WASTES

Carbon-based wastes represent one of the America's most promising and virtually untapped domestic renewable energy sources. More than 1.5 billion tons of municipal solid waste, bio-solids, agricultural, forestry and other waste products are generated in the United States each year.

During the past 25 years, government and private industry in the United States have spent some $9 billion attempting to develop economic and environmentally sound methods for the production of electricity and liquid energy from these resources.

Despite this effort, less than 2% of the electricity generated in America now comes from biomass. Coal-fired power plants, on the other hand, represent the nation's largest single source of industrial air pollution.

Further, the United States today imports some 58% of its liquid fuel requirements, severely impacting the nation's balance of payments and its national security–and its dependence on foreign oil is projected to grow to 68% in 2025. Increased domestic oil production cannot possibly keep pace with the nation's growing demand for liquid energy.

A report by the National Academy of Sciences states that hydrogen-powered vehicles won't be readily available for another 25 years, and before that time, the Natural Resources Defense Council estimates that Americans will buy 450 million new cars and trucks.

Ethanol, however, is already being used around the world in gasoline blends of 10-85% (in Brazil, many automobiles run on ethanol alone). It improves octane performance and reduces automobile emissions and CO_2 when produced from biomass—and it is already integrated into America's liquid energy distribution system.

The nation produced 2.8 billion gallons of ethanol in 2003, less than 2% of its total liquid fuel requirements. This is but a small fraction of the market potential, because today's automobiles can operate efficiently on blends of 20% or higher.

However, ethanol, to date, has been produced chemically from ethylene or biologically from the fermentation of sugars from carbohydrates found in agricultural crops like corn kernels. Sugar fermentation has been the only process to commercially produce ethanol from biomass. However, it is inefficient and uneconomic. Not a single gallon would be produced in the United States today without state and federal subsidies (a 52-cents per gallon federal subsidy, plus additional incentives ranging from five to 28-cents per gallon in the corn-producing states).

Further, the quantity of ethanol that can be produced from available cropland without impacting America's other uses for corn has been estimated to be 4-6 billion gallons annually, approximately 4% of the nation's current demand for fuel.

If electricity and ethanol could be produced profitably from biomass, it could help to stabilize the nation's supply of electrical energy, supplement gasoline, convert vast quantities of the nation's waste stream into energy, and significantly reduce the nation's dependence on foreign oil.

This BRI Renewable Energy Process makes these goals achievable.

The BRI Renewable Energy Process

A new gasification/fermentation process developed for BRI Energy, Inc. ("BRI") by a team led by Dr. James L. Gaddy of Fayetteville, Arkansas, makes possible the co-production of electricity and ethanol from any carbon-based materials, including:

- Municipal Solid Waste
- Biosolids
- Corn Stover and other agricultural residues
- Timber and Wood Waste
- Used Tires or Plastics
- Coal, natural gas and other hydrocarbons

Efficient and highly profitable, the BRI process utilizes an enzyme from patented bacteria, which ingests synthesis gas (gasified wastes) and emits pure ethanol at a yield of 75 gallons or more per dry ton of biomass. From used tires or hydrocarbons it can yield 150 gallons or more per ton.

Unlike combustion processes, thermal gasification decomposes organic materials into their basic molecular structure at temperatures of up to 2,200°F in a reducing, oxygen-starved atmosphere.

Before being introduced to the bacteria in a fermentation tank, the synthesis gases (CO, H_2 and CO_2) must be cooled to approximately 97°F—a process that generates an enormous amount of waste heat that can be used to create high temperature steam to drive electric turbines.
In the fermentation step, the patented bacteria ingest the syngas and emit ethanol and water, which is then distilled away to produce pure industrial or fuel-grade ethanol. Contrary to current sugar fermentation technologies, the process is odorless.

The bacterial culture is anaerobic and dies when exposed to air. It has a Biosafety Level 1 health hazard rating (the lowest possible for microorganisms). The process creates no environmental or health hazards, ground or water contamination, and minimal air emissions. Its residue is a non-hazardous ash.

When biomass is used to co-produce ethanol and electricity, significant reductions in greenhouse gas emissions can be achieved.

The BRI process will gasify any carbon-based material whose moisture content is less than 40% (by weight). Validation tests have shown that feedstocks need not be chipped, shredded or sorted to remove metal and glass, and that they can be blended. Any mixture of plastics, tires, manure, paper or yard wastes, construction debris, furniture, hazardous wastes, crop residues, timber slash, etc., can be converted into synthesis gas, and then to ethanol. Only the inorganic fraction is not converted. For example, sewage sludge and used tires could be blended to reduce the average moisture content to 40% or less.

BRI's plants will also operate on natural gas, petroleum and coal--and these hydrocarbons can be blended with biomass to increase by up to 100% the overall gallon-per-ton output of the plant.

With nominal ash content of five-to-ten percent of the organic fractions, the process will normally convert more than 90% of the waste it receives. The remainder, which is non-hazardous, is discharged from the gasifier to be landfilled or recycled in products like cement blocks or paving. The net effect is that the BRI process can extend substantially the effective life of a landfill. This will significantly reduce the amount of valuable and potentially productive land that must be set aside for this purpose.

The utilities used in operating a BRI plant, with the exception of water, are supplied internally from the plant's waste heat.

The entire process, from the time the waste material is fed into the gasifier to the creation of ethanol, takes less than seven minutes. Current biomass ethanol technologies that use corn kernels or sugar cane as their feedstocks require 36-48 hours for sugar fermentation alone.

This is one of the great strengths of the BRI technology, because this rapid biochemical conversion, plus the fact that the process creates three revenue sources, makes the technology highly profitable, even without subsidies. Ethanol futures trading began in May, 2004.

If and when fuel cells become available to power automobiles, the BRI process can also be used to create hydrogen.

A Typical BRI Renewable Energy Plant

Plant design is governed by the maximum size of today's gasifiers, Therefore, BRI's plants will be modular and their capacities can be readily expanded. A single module will combine two gasifiers, each with a capacity of approximately 125 tons of waste per day, and two fermenters. Each module will process some 85,000 tons of biomass annually to produce 7.0 million gallons of ethanol, also generating 5MW of power. The amount of ethanol and electricity to be produced by any module can be varied according to energy demand.

Among other configurations, a mid-sized BRI Renewable Energy Plant could process 1,000,000 tons of municipal solid waste, waste tires and/or biosolids per year, producing 80 million gallons of ethanol and generating 50 MW of power, 35 MW of which is excess to the operation of the plant. The plant would require ten modules and approximately 30 acres.

The combination of electrical generation and low-priced ethanol production (even if federal subsidies were to be phased out) makes possible long-term firm and stable contracts for the generation and sale of "green power" to utilities at rates as low as 4.5 cents per kWh. On the ethanol side, the feedstock costs for corn kernel-based sugar fermentation technologies are approximately $1.00 per gallon. BRI's feedstock costs could actually be negative (receiving tipping fees for the disposal of waste products) or as high as 40-cents per gallon if its plants were purchasing agricultural wastes from farmers. The technology's advantage over prior sugar fermentation technologies could range from 60-cents to $1.40 per gallon on the feedstock alone. Ethanol is currently selling at around $1.50 per gallon. The tipping fees from waste disposal and revenues from power generation will essentially cover the operating costs of the plant, leaving ethanol sales as the upside.

History of Technology

The first bacteria culture to convert synthesis gas into ethanol was isolated by Dr. James L. Gaddy and his technologists about 15 years ago. Worldwide, some 50 patents have been awarded or are pending for the microorganisms, process and methods.

Extensive research has been conducted to optimize fermentation conditions such as pH, nutrient requirements, etc. Various reactor designs have been developed and tested to maximize reaction rates and mass transfer. Further, using syngas from operating biomass and coal gasifiers, tests at the BRI laboratory and pilot plant in Fayetteville, Arkansas, have successfully demonstrated that syngas with various impurities can be used.

BRI has proven the process and bacteria culture, and has been producing ethanol at its pilot plant for the past three years. The waste-to-electricity elements of the process have been in commercial operation for a number of years. <u>The technology is now at the point</u>

of commercialization. In excess of $12 million in investment, DOE grants and internally generated funds have supported its development.

Status of Technology

Until late 2003, the synthesis gas being utilized in the pilot plant had been formulated by testing a variety of gasifiers that were processing municipal solid wastes, wood wastes and coal. BRI required its own gasifier to prove conclusively in steady state operations that the bacteria culture and the technology would handle the significant variations in gas composition that would be encountered in a commercial operation.

Last November, BRI added a prototype Consutech gasifier to the pilot plant—enabling the complete production of ethanol, from waste gasification through ethanol production in a single integrated process.

In June, BRI completed for Sealaska Corporation a successful 180-day steady state test that included wood waste that had been immersed in salt water for twelve months or longer. As the feedstock qualities and feed rates were varied during the tests, the synthesis gas created from this timber slash validated the robust nature of the bacteria. The tests also validated the company's scale-up estimate that 70-80 gallons of ethanol per ton should be produced from this wood waste feedstock by commercial gasifiers.

With the support of the Department of Energy, the company is now proceeding to test the BRI fermentation technology together with a commercial gasifier that is processing municipal waste in Baltimore. Equipment installation will be completed in time for these tests to commence in October.

In addition to conclusively confirming the commercial viability of the technology, the use of a commercial-scale gasifier in Baltimore will provide important sizing and design information for BRI's commercial plants.

Merrick & Company, the Denver-based engineering firm that constructed an ethanol plant for Coors, independently recommended the BRI process to Sealaska over all other available technologies and has been actively involved in the testing process.

Sealaska's objective is to construct a plant that will use wood wastes to produce all of the ethanol required in the state of Alaska.

In July, the U.S. Department of Energy announced a grant in the amount of $2.4 million, which will enable Bioengineering Resources, Inc., to implement a program for the testing of corn stover as a feedstock to create electric power and ethanol using the BRI Process. The specific tasks in this project will include the definition of the best feedstock conditions and gasifier temperatures, as well as enriched oxygen concentration, to maximize gasifier efficiency and throughput; fermentation of the stover syngas to gather data for design scale-up, emissions measurement for permitting and by-product utilization; and the preparation of a detailed design and energy balance for projection of the economics of combined stover/corn plants. In so doing, the study will investigate the feasibility of locating a corn stover ethanol facility next to a conventional grain alcohol plant in the corn belt, and the synergies involved with such co-location, such as the utilization of waste heat and power from the stover plant. Chippewa Valley Ethanol, a Minnesota corn producer cooperative, and the engineering firms of Katzen International and Burns & McDonnell are also participants in the project.

In steady state operations, BRI's pilot plant is continuing to test various feedstocks as requested by potential licensees, and validating past findings and plant performance. Over the near term, these tests will include municipal solid waste, biosolids, auto fluff, waste tires and used railroad ties. Potential users, including sanitation districts, have offered to provide feedstocks, and in some cases like Sealaska, to pay for these tests.

The Parsons Corporation, one of the world's leading engineering firms, will design, construct and operate BRI Energy's plants. They bring to the process a worldwide reputation and expertise well developed over sixty years. Having studied the technology in depth under full non-disclosure, Parsons has offered to performance guarantee the waste-to-syngas and the electric power components of any BRI plant they design, build, and operate. These two parts of the three-part process are accomplished from the implementation of technologies well proven over time.

Katzen International, a Cincinnati-based engineering firm that is renowned for the efficiency of their ethanol separation and distillation technologies, has been closely involved with the BRI process during its entire pilot plant phase. Katzen has designed 70 ethanol plants around the world. Their technology and expertise will be utilized to extract commercial grade ethanol from the fermentation tanks. Katzen will be responsible for the process design for BRI's plants.

The combination of Parsons and Katzen provides BRI Energy significant depth in the design, construction and operation (design-build-operate/DBO) of its plants.

Chemineer, the manufacturer of the fermentation tanks, has guaranteed the ability to sustain the same environment that was successfully achieved in the pilot plant in their commercial-sized tanks. All of the equipment utilized in the BRI process is "off-the-shelf."

BRI is now in discussions regarding projects throughout the United States, as well as potential international joint venture relationships. These projects involve such feedstocks as MSW, auto fluff and the conversion of combustion-to-electricity plants.

It is expected that the first commercial demonstration plant will be constructed as a joint venture with Ross Management, LLC, a family owned solid waste collection and disposal business located in Goldendale, Washington. Ross Management currently has contracts for the disposal of waste streams totaling 150,000 tons per year and a permitted site in Dallesport, where it is expected that a plant producing nine million gallons of ethanol annually will be in operation by the fourth Quarter of 2005. The feedstocks for this plant will involve 50% municipal solid waste and 50% used tires and auto fluff.

The company has positioned itself to commercially validate the technology, and ultimately to provide the nation with much-needed relief from the escalating costs of electric power and liquid energy, and its dependence upon foreign oil.

Biomass Feedstock Resources

The United States annually creates some 240 million tons of municipal solid waste, about one-third of which is recycled or composted, leaving 160 million tons of trash to be managed. On average, 82.5% of these wastes could be consumed in the BRI Process. Only the inorganic fraction (metal, glass, ash) is not converted.

Taking into consideration such other waste products as agricultural residues, forest thinnings and wood wastes, plastics and biosolids, there is enough readily accessible biomass in the United States to produce 22.5 billion gallons of ethanol and a meaningful portion of America's power requirements each year.

California, for example, generated 72 million tons of solid waste in 2003. After recycling and diversion, some 37 million tons were buried in landfills. Further, California must dispose of 33 million used tires every year, one-third of which are chopped up and placed in landfills.

Utilizing these waste products, the BRI process could turn states like New York and California into net exporters, rather than importers, of ethanol. Last year, California consumed some 600 million gallons of ethanol, only 8 million gallons of which was locally produced. Its projected need for the current year is 900 million gallons or more.

The technology could bring a new ethanol industry to non-farm states. A typical 50 million gallon ethanol plant will create additional employment and $30-40 million in economic activity for the local economy each year.

And in so doing, it will enable these states to qualify for millions of dollars of federal incentives that otherwise would have been limited to the Midwest. In addition to the 52-cent per gallon federal ethanol subsidy, which will remain in place through 2008, the tax provisions of the energy bill, now under consideration in Congress, provide a 1.8-cent per kWh tax credit for waste-to-electricity generation.

Municipal Solid Waste (MSW) as the Feedstock

Approximately 80% of municipal solid waste is carbon-based and can be used in the production of ethanol and electricity. The unconverted portion, which consists of inert materials like glass and metals, would continue to be landfilled. However, the useful lives of landfills could be extended by five times, and it is possible to recover wastes from existing landfills for use in the process.

By entering into long-term contracts to make their wastes available for the co-production of ethanol and electricity, cities could significantly reduce their waste transport and disposal costs and substantially lengthen the useful lives of their landfills.

The combination of 1) the technology rights, 2) cities seeking to dispose of their wastes, 3) utilities attempting to achieve mandated goals for the production of electricity from renewable resources, 4) refiners seeking a low-cost and guaranteed flow of ethanol, and 5) the ability to take advantage of the tax credits, federal grants and loan guarantees for plant construction in the current energy bill provide a business model that can be implemented throughout the nation.

Biosolids as the Feedstock

5.6 million dry tons of biosolids are disposed of annually in the United States, and roughly 60%--or some 3.4 million metric tons--is spread on agricultural land, according to the Environmental Protection Agency.

Although these disposal practices have improved in the past decade, resistance to their use has been growing due to perceived adverse human health effects. Each year, sanitation districts are being ordered to cease these practices, even while the biosolids waste stream is dramatically increasing.

The benefits of disposing municipal wastes through gasification rather than land application, landfilling and incineration are clear. The BRI Process finally makes this solution economically viable.

Agricultural Waste as the Feedstock

Current ethanol production requires corn kernels. Corn is selling at $2.60 per bushel, a single bushel of which creates 2.6 gallons of ethanol. In other words, its feedstock costs one dollar per gallon. With biomass, BRI's per gallon feedstock cost can run from -$.40 per gallon, if it is being paid $30.00 per ton or more as a tipping fee to take the wastes it processes, to $.40 per gallon, if purchasing corn stover from farmers at $30.00 per ton. Herein lies the technology's most obvious competitive advantage over current sugar fermentation technologies.

By blending feedstocks, BRI plants could afford to pay for agricultural wastes, creating an entirely new revenue source for farmers from their existing crops and significantly strengthening the economics of American farming. BRI plants that utilize agricultural residues could afford to pay farm cooperatives for collecting and transporting these feedstocks. Further, organizations that enter into long-term contracts to supply agricultural residues for the BRI Process will be given a participation in the plant's net profits.

Today, corn stover is often left in the field and plowed under. In many states, other agricultural residues are subject to open-field burning. (In California, the legislature has banned the practice and farmers have no viable disposal alternatives. BRI is working with the California Agricultural Council to provide a solution.) All of these activities contribute substantially to greenhouse gases—emissions the BRI process could eliminate.

Blending Coal with Biomass

It is estimated that America has a 400-year supply of coal, oil shale and other hydrocarbons. Coal is one of the nation's most abundant energy resources, and when combined equally with biomass, it will increase by 50% the amount of ethanol produced by the blended feedstock.

Rather than combusting coal (one of the nation's most destructive sources of industrial pollution), the BRI Energy process gasifies it. The method is environmentally clean.

Summary

In summary, the BRI Renewable Energy Process will:

- Make possible the consistent, low-cost generation of electrical energy, while providing municipalities with economic alternatives to the disposal of municipal solid wastes and biosolids and the proliferation of landfills.
- Respond to federal and state mandates that call for the introduction of renewable fuels and the generation of green power.
- Utilize several of America's most abundant resources to produce fuel-grade ethanol, a truly sustainable fuel source, priced competitively with gasoline, even if government subsidies for ethanol were phased out.
- Help reduce America's dependence on foreign oil.
- Improve the economics of farming by providing additional income for farmers from their existing crops (through the sale of agricultural wastes like corn stalks, corncobs, cotton plants, rice straw, etc.).
- Create a genuine economic stimulus for our farm communities and cities, including jobs for the domestic work force.
- Make an important and lasting improvement to the environment by disposing of a sizeable portion of the nation's waste stream, and doing so without harmful ground, air or water emissions.

TECHNOLOGY SUMMARY

THE BRI PROCESS

Gasification / Fermentation

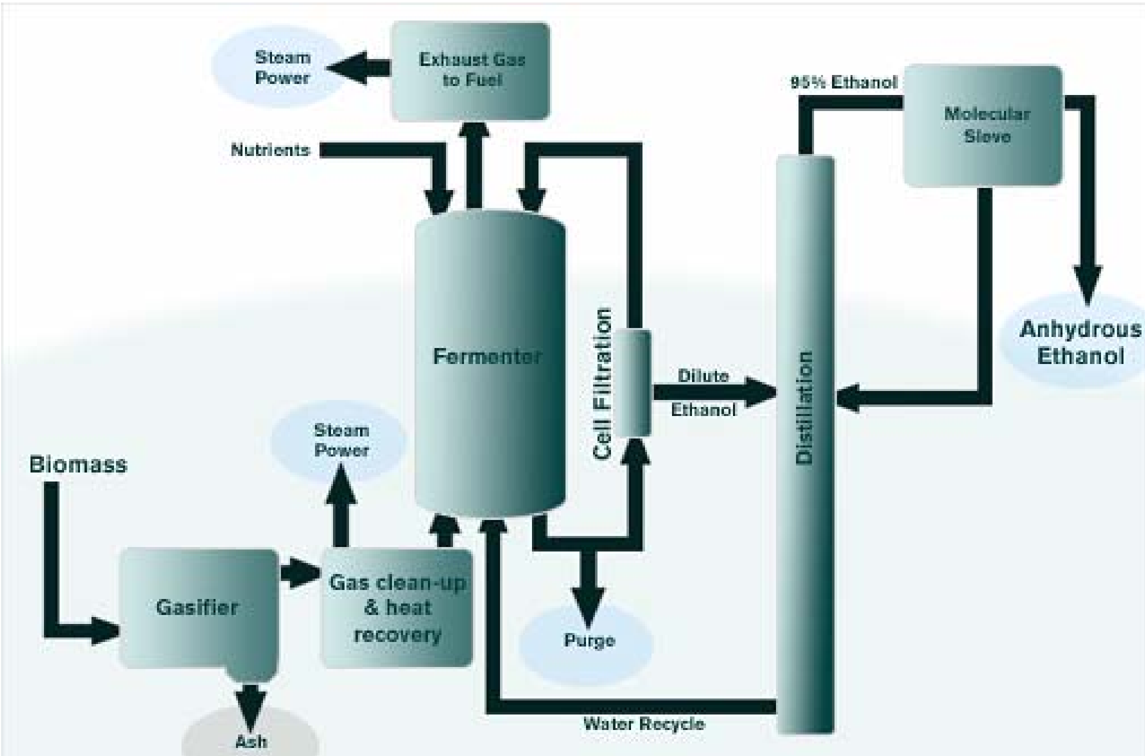
All ethanol processes require two steps: a step to convert raw materials into intermediates, followed by an ethanol synthesis step. Traditional ethanol processes produce sugars as intermediates, followed by fermentation. An alternative involves gasification of the raw material to produce synthesis gas, followed by reaction, either catalytically or biocatalytically. The chemical process has been practiced in large scale in South Africa for many years; but the ethanol specificity of the catalyst is low and a variety of other alcohols and hydrocarbons are produced, resulting in a low ethanol yield. The biochemical process involves fermentation of the syngas, with high specificity and only ethanol is produced.

Today, gasification is a commercial technology that has been applied to coal, biomass and a variety of other carbonaceous materials. Gasification of solids or liquids produces synthesis gases containing monoxide (CO), hydrogen (H_2) and CO_2. BRI has developed a process to convert the syngas into ethanol using a patented microorganism and process. Since all of the carbon and hydrogen in the raw material is gasified and can be converted into ethanol, this process has very high yields (at least 75 gallons per ton and 150 gallons per ton or more for used tires and other high-BTU content feedstocks).

Biological Process for Ethanol Production From Biomass

BRI has selected a two-stage gasifier that raises the syngas temperature to 2000^{o}F in the second stage to enable cracking of any heavy hydrocarbons to CO and H_2, maximizing the ethanol yield. There are hundreds of these units in operation with a demonstrated reliability of 95 percent. The hot gases are then cooled to 100^o F and introduced into the fermenter where ethanol is produced. Nutrients are added to provide for cell growth and automatic regeneration of the biocatalyst. A dilute, aqueous stream of ethanol is continuously removed through a membrane that retains cells for recycle to maximize reaction rates. Anhydrous ethanol is produced by conventional distillation followed by a molecular sieve, using the waste heat from the process. Water, with nutrients, is recycled from the distillation bottoms back to the fermenter.

Any carbon-based raw material can be converted into ethanol, including corn stover, MSW, used tires or plastics, biosolids, animal wastes, coal, oil shale, etc., or mixtures thereof.



Biological Process for Ethanol Production from Biomass

The process is simple and well defined, breaking complex molecules into CO, H_2 and CO_2, and then building back into a single product. Ambient temperature and pressures are used, and capital and energy costs are minimized. The primary disadvantages of most biological processes are slow reaction rates and the requirement for sterilization. For example, the typical sugar fermentation requires 36-48 hours. Reactor design for the syngas fermentation has been studied extensively in our laboratories and fermentation times of a few minutes have been achieved. Also sterilization is not necessary, since the CO in the syngas eliminates most contaminants.

Co-Generation Of Power

In the BRI Process, an enormous amount of waste heat is created from the cooling of the hot syngas (from as high as 2200° to approximately 100°) before it is sent to the fermentation tank. Steam can be generated from this waste heat source and introduced into a turbine to generate electricity. The turbine exhaust steam can then be used as a source of heat for ethanol purification, feedstock drying, air pre-heating, etc.

The quantity of power and waste heat from the process is dependent upon the raw material, the design to meet power requirements in the region and, to a lesser extent, the type of gasifier chosen. One of BRI's plant designs will deliver 75 million gallons of ethanol while generating 141 megawatts of electricity.

Environmental Considerations

Process Emissions. There are three sources of emissions from the gasification / fermentation process: the solid ash from the gasifier, a liquid purge and the emissions resulting from the ethanol fermentation process, which are minimal. Each of these streams will be quantified for each raw material tested in pilot plant experiments to gather the necessary data for permitting. Gasification is not incineration, which has some undesirable environmental characteristics. Gasification occurs in a reducing atmosphere, without production of NO_x, SO_x, dioxins, etc. The gasifier ash (inorganic fraction) is non-toxic, with component concentrations well below EPA requirements, and has been disposed of in non-hazardous landfills for years. The gas produced at the high secondary temperature will be essentially free of hydrocarbons. The synthesis gas is scrubbed to remove any residual components and these gases have been shown to be non-toxic or inhibitory to the biological culture.

The liquid purge stream will contain spent cell components and nutrients, which are non-toxic, below BOD discharge limits and would be treated in conventional sewer or wastewater facilities. Scrubber water will contain chlorides and sulfides, which are neutralized before discharge. The bacterial culture has a Biosafety Level 1 health hazard rating (the lowest possible for microorganisms) and is anaerobic and dies upon exposure to air. In summary, the process creates no environmental or health hazards and minimal air, water and ground emissions.

Environmental Impact. The widespread application of this novel technology can have significant positive environmental impact in many areas. Landfills for MSW are rapidly becoming filled, requiring longer and longer transportation routes and higher costs. Land application of biosolids and animal wastes is coming under increased scrutiny to reduce leaching and runoff. These negative-cost raw materials are ideal candidates for conversion into ethanol and power, eliminating the environmental problems with current disposal methods.

Most electric power and liquid fuel is produced from fossil fuels today, with attendant emissions of CO_2. Landfilling and land application also result in the greenhouse gases, CO_2 and methane. A ton of coal burned to produce electricity produces about 2.4 tons of CO_2. A ton of dry biomass placed in a landfill will produce, over time, about 1.2 tons of mixed CO_2 and methane. The collection and suitable disposal of this CO_2 is the subject of intensive research today. One viable solution, perhaps the only realistic long-term solution, is the substitution of biomass as fuel, with the subsequent re-assimilation of CO_2 as biomass through photosynthesis. For example, if the biomass that is landfilled or plowed under as agricultural residue were diverted to an ethanol plant, one ton would produce 82 gallons of ethanol and about 165kWh of electricity, reducing CO_2 by a net amount of about 40 percent. This comparison does not include the CO_2 re-assimilated as biomass. When added, the result is that each ton of biomass used to produce ethanol results in the net reduction of about one ton of CO_2 produced from coal or gas fired power production, auto emissions, etc.

Ethanol, blended with gasoline has been shown to reduce auto emissions and, as a result, oxygenated fuels have been mandated in most metropolitan areas. The results have been positive, although still disputed by some. Ethanol production has been recently criticized for air emissions from drying of biosolids for animal feed. It should be noted that the gasification / fermentation process does not include such a drying step. It is also argued that ethanol from grain is not renewable and that more energy is consumed than produced, when the energy for farming, production, etc. is considered. The gasification/fermentation process utilizes agricultural residues and other wastes, generates all its own energy and exports electricity and steam.

Ethanol opponents also argue that production is now concentrated in the Midwest and controlled by a few producers. When waste is the raw material, ethanol production becomes universal. Each new plant will generate new jobs and economic stimulus. For example, a typical 50 million gallon ethanol plant would create a total of 450 jobs and add $30-40 million per year to the local economy. When coupled with reduced imports, improved balance of payments, and the environmental benefits, this technology represents a unique opportunity for the nation.