While Achieving Energy, Food, Fuels, And Water Independence By Utilizing Already Existing And Individually Profitable Holistic Component Technologies

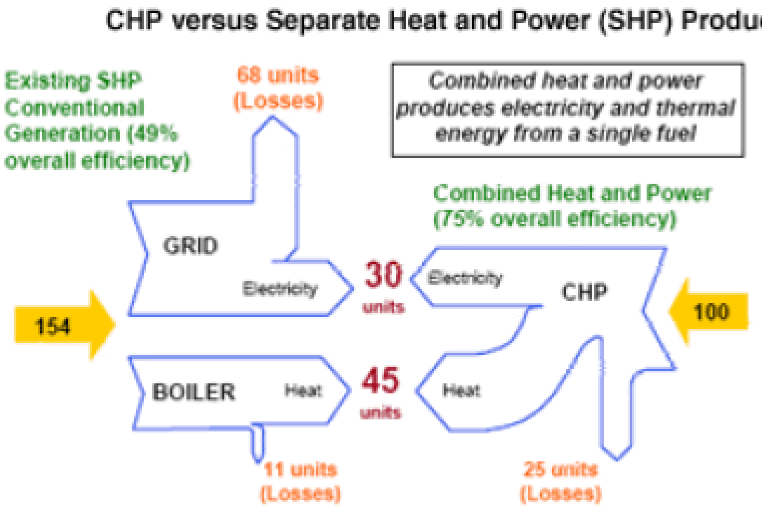
Reversing Global Warming
Through A Worldwide Waste-To-Energy Policy

C. G. (Chuck) Steiner, WaterSmart Environmental, Inc.

From popular mythology, the ostrich is quite famous for hiding its head in the sand at the first sign of danger. In a New York Times story covering the jury instructions in the recent Enron case, the trial judge specifically permitted the jurors to find Messrs. Lay and Skilling guilty of “deliberate ignorance". In legal circles deliberate ignorance is called the “ostrich defense".

In its inaugural 1990 annual report on the inventory of U.S. Greenhouse Gas Emissions and Sinks" the United States Environmental Protection Agency (USEPA) listed but a few of the perceived principal sources of carbon dioxide and methane gases. Through perhaps deliberate ignorance the USEPA did not include carbon dioxide emissions from some 15,000 wastewater treatment plants. In its most recent 1990-2004 450 page annual report (EPA 430-R-06-002, April 15, 2006), there are over 40 sources of greenhouse gas emissions listed including wastewater treatment plants and even animal farts (scientific term = enteric fermentation). The implication that global warming (climate change) is entirely caused by greenhouse gases represents an ostrich defense by past and present administrations to protect the current energy policy that includes both coal fired and nuclear power plants.

Combined heat and power (CHP), also known as cogeneration, is an efficient, clean, and reliable approach to generating power and thermal energy from a single fuel source. CHP is not a specific technology but an application of technologies to meet an energy user's needs. CHP systems achieve typical effective electric efficiencies of 50% to 70% - a dramatic improvement over the average efficiency of separate heat and power. Since CHP is highly efficient, it reduces traditional air pollutants and carbon dioxide, the leading greenhouse gas associated with climate change, as well. As seen below, the CHP system can produce the same electrical and thermal output at 75% fuel conversion efficiency as compared to 49% for separate heat and power. This is a 50% gain in overall efficiency, resulting in a 35% fuel savings. Whenever and wherever higher efficiency is achieved lesser global warming is always realized.



Fueled by electric industry regulation, environmental concerns, unease over energy security, and a host of other factors, interest in CHP technologies has been growing among energy customers, regulators, legislators, and developers. CHP is a specific form of distributed generation (DG), which refers to the strategic placement of electric power generating units at or near customer facilities to supply on-site energy needs. CHP enhances the advantages of DG by the simultaneous production of useful thermal and power output thereby increasing the overall efficiency. Whenever overall efficiency is improved in the marketplace there is always a reduced impact on global warming. Through its CHP Partnership program, the USEPA claims that CHP technology can be applied at both central (i.e. coal fired and nuclear power plants) and DG generation applications. Many DG applications have already been implemented in the marketplace but conversion of coal fired and nuclear power plants to cogeneration has yet to be realized. The associated high cost of electricity production at CHP coal fired power plants has been estimated by the USEPA at $1,400/kW, some $400 higher than conventional coal fired power plants. Converting nuclear power plants to CHP has yet to be considered in the marketplace. Because of high costs and other factors there is little likelihood that either coal fired or nuclear power plants will be converted to more efficient CHP technology notwithstanding it's quite favorable impact on climate change. Consequently these central generation plants will continue to increase global warming for many years to come due to the existing US energy policy.

For starters, the seemingly innocuous Polar Bear Club contributes to global warming, perhaps only minimally, but in two distinct ways to disclose the science:

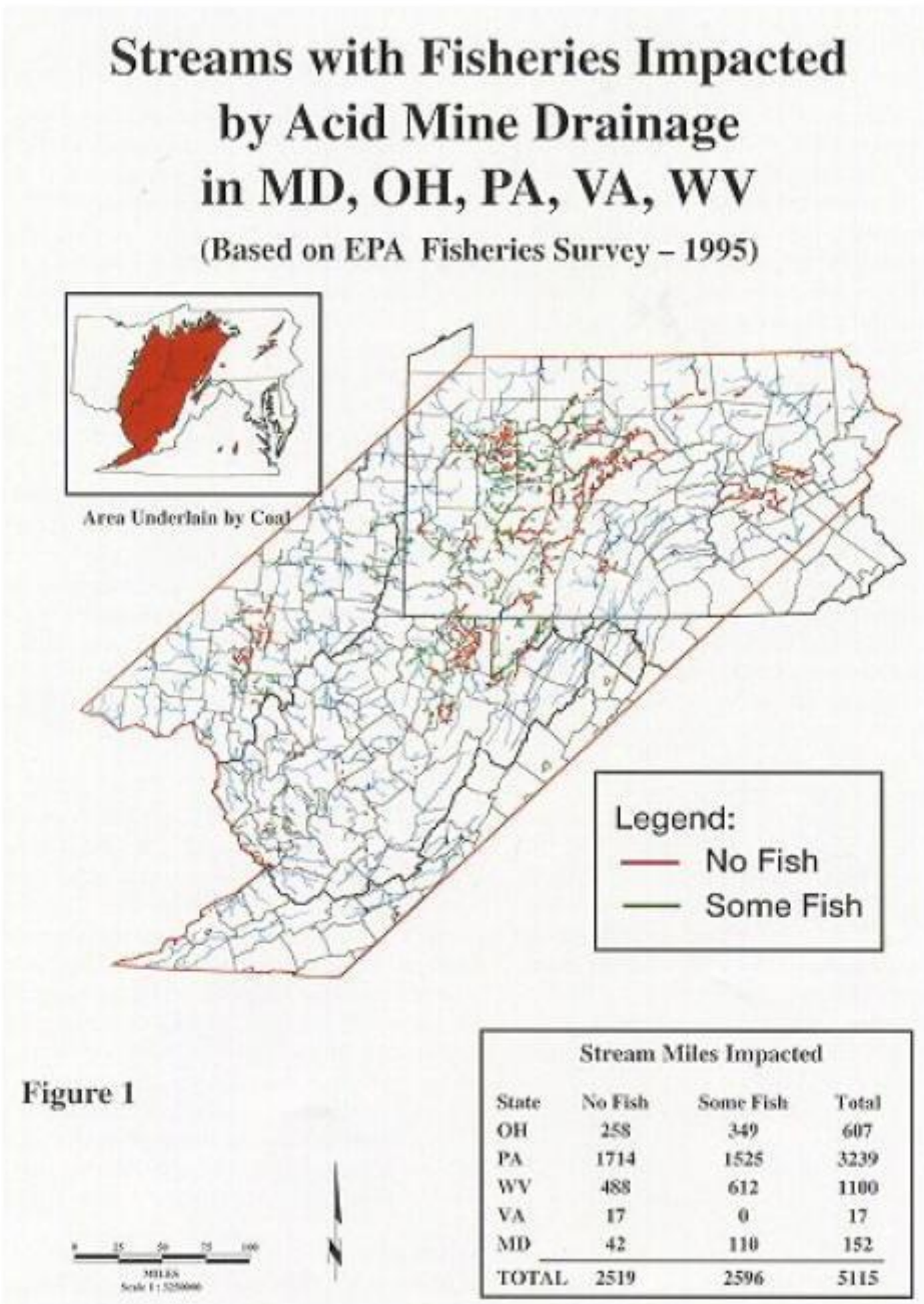
1. By releasing Btus to the environment during their annual outdoor outing to be sure, but including all their outdoor outings throughout the entire year whether wearing clothes or not, and
2. By exhaling more carbon dioxide than the amount inhaled through normal breathing.

In fact, all humans and animals contribute to global warming by exhaling excess carbon dioxide (front and rear end) and methane gases (rear end) while also releasing Btus to the environment.

The somewhat plentiful coal fired and nuclear power plants contribute significantly to global warming in the following ways:

1. Coal fired power plants release carbon dioxide gas (CO2), NOx gases, and SOx gases from their discharge chimneys, and Btus from their cooling towers.
2. Nuclear power plants do not release any significant gases but do release massive amounts of Btus to the environment from their large cooling towers.

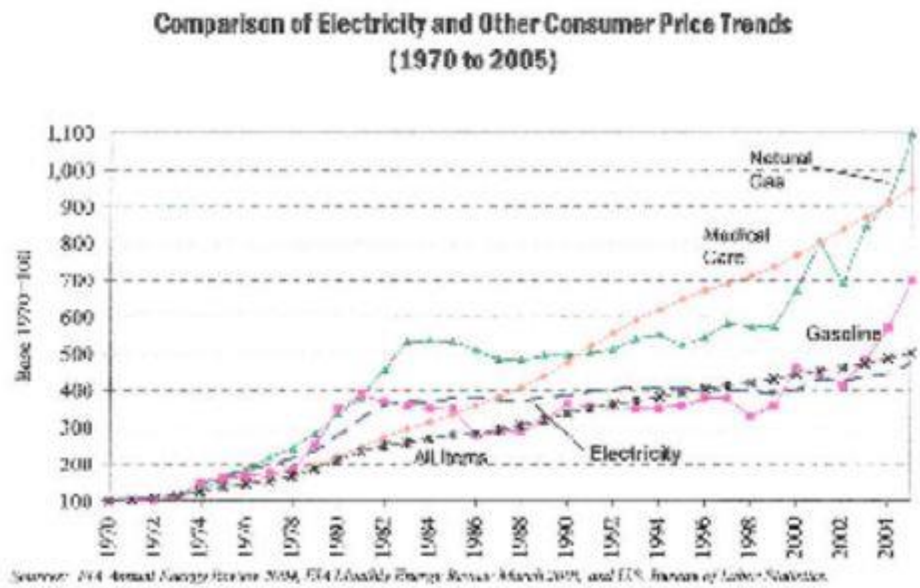
Btu discharges from humans, animals, coal fired power plants, and nuclear power plants are not accounted for in the EPA reports because gases only are listed. The release of Btus by humans, animals, and power plants has not been quantified by any organization but can be scientifically estimated quite easily by making a few conservative heat loss assumptions. Heated buildings also release Btus to the environment as do holding tanks, elevated pipelines, and a myriad of other structures, none of which have yet been quantified. The total quantity of Btus released to the environment represents a quantity that ought not be ignored in searching for a comprehensive climate change solution. This would be a good task for the USEPA to quantify should it ever be asked to change from a United States Energy Policy Protector Agency (USEPPA) to that of an actual United States Environmental Protection Agency (USEPA). One only needs to know that there still remain several thousands of acid mine discharges from coal mining activities that have been allowed to continue their discharges over the last 50 years without a single stream undergoing effective treatment. Repeat, not a single stream.



The USEPPA (aka USEPA) would be happy to correct this assertion if incorrect. According to the United States Geological Survey (USGS), the U.S. Environmental Protection Agency has singled out acid mine drainage as the number one water-quality problem in Appalachia. Estimates place cleanup costs in Pennsylvania alone at around $5 billion. For the last 50 years mercury, sulfur dioxide, nitrous oxide, and carbon dioxide emissions have been permitted at all of our nation's hundreds of coal fired power plants without a single power generation facility having been shut down. Not a single one. It is obvious that the United States Energy Policy Protector Agency (USEPPA) (aka USEPA) is doing an excellent job. Gaseous emissions to the environment from coal fired power plants are now being closely monitored. Btu releases to the atmosphere directly contribute to global warming but heretofore have not yet been considered in the climate change landscape equation.

The Bush Administration defends its unrestricted CO2 gaseous emissions policy as helpful to increased crop production. This assertion is scientifically correct and works each and every time there is sufficient rain during the crop growing season. In other words, not a sustainable policy. CO2 gaseous emissions not utilized by crops due to an ever increasing insufficiency (due to climate change) of timely rainfall (called droughts) automatically accumulate in the atmosphere to further increase global warming. Increased irrigation practices cannot make up for insufficient rainfall as the supply aquifers are drying up due to excessive long term withdrawals witness the rapidly depleting Ogallala Aquifer (aka High Plains Aquifer) located beneath the eight Midwestern states of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, and Texas. Recently, and rightfully so, CO2 gaseous emissions from cars, trucks, trains, barges, and ocean going ships have come under global warming scrutiny. The problems keep on coming. Enough mention of these several and growing global warming/climate change problems. Many United States senators, congressmen, individual state governors, and individual city mayors (most notably the Honorable Greg Nickels of Seattle, Washington) have jumped ship from the Bush administration in support of a more effective energy policy. Virtually all of the remainder of the nations of the world already support the concept of a more effective climate change policy and are looking towards the United States for guidance and direct participation, both of which have been and continue to be sadly lacking. Combating global warming also has trans-Atlantic appeal as Britain and California are preparing to sidestep the Bush administration and fight global warming together by creating a joint market for greenhouse gases. British Prime Minister Tony Blair and California Gov. Arnold Schwarzenegger now plan to lay the groundwork for a new trans-Atlantic market in carbon dioxide emissions. Such a move could help California cut carbon dioxide and other heat-trapping gases scientists blame for warming the planet. President Bush has rejected the idea of ordering such cuts.

The administration's very simple energy policy consists of the continuation supply of inexpensive electricity and transportation fuels both of which enable continued expansion of the gross domestic product (GPD) and associated tax revenues. Coal is the highly favored energy source for electricity generation because of its abundant supply and low cost. Nuclear power is also highly thought of but continuing inability to manage nuclear wastes retards further development of this industry. For many years the energy policy has achieved its objective as indicated in the following chart:



In 2002 the policy began to fail due to the combined forces of higher crude oil prices coupled with the disappearance of domestic supplies of inexpensive natural gas. Since 2002 coal prices have increased substantially and climate change considerations have risen dramatically. The energy policy that has worked very well since 1970 is now dead. Although the US still has significant deposits of natural gas, it is far more expensive to extract than the natural gas extracted to date. In other words, all the cheap gas is now gone. Natural gas comes from:

- Most (84 percent) of the natural gas consumed in the United States is produced in the U.S. Canada provides much of the rest (13 percent), with 3 percent imported as liquefied natural gas (LNG).
- Production from the lower-48 states will remain the largest component of U.S. natural gas supply, but producers will be challenged to keep production between 18 and 19 quadrillion Btus per year. Canadian exports are expected to fall from 3.3 quads annually to 2.3 quads by 2020.
- In Alaska, huge quantities of natural gas found in the North Slope region are only the tip of the iceberg in terms of the state's total natural gas resources, but these supplies will remain stranded there until an Alaskan natural gas pipeline is built.
- Imports of LNG will continue to rise - growing from 3 percent of U.S. natural gas supply in 2003 to 22 percent in 2020.

Since 1999, residential natural gas prices in the United States have exhibited an overall increasing trend. The 2004 national average residential price of $10.74 per 1000 cubic feet (Mcf) exceeded the 1999 average price by more than $4/Mcf. The price of natural gas will continue to increase because of the reliable marketplace laws of supply and demand. The price of coal historically follows in lock step with other energy sources. Since 1999 its price has also increased proportional to the corresponding increase in natural gas prices. The administration plans to import significant liquefied natural gas (LNG) from Asia to help the natural gas supply situation in the United States. Additional LNG terminals are now being built as we speak. Inexpensive natural gas disappeared about 5 years ago. At that time 100% of anhydrous ammonia fertilizer was produced within the United States. In 2005, imports from Asia accounted for over 85% of the anhydrous ammonia during which time continuing price increases of the fertilizer have occurred in the agricultural marketplace. Higher prices of natural gas caused the disappearance Farmland Industries, the largest cooperative in the world, because of their total reliance on inexpensive natural gas in their business model. Because of the limited worldwide supply of crude oil its cost will continue to increase because of the ever reliable laws of supply and demand. Perhaps our Asian friends won't notice the laws of supply and demand…duh.

There are a multiplicity of other factors that, when considered together, can do nothing to change the existing trend of increasing energy and fuel costs. In addition, our national electrical grid system (total of 4 grids) has already reached its practical capacity much like an intra-city freeway during rush hour. This year's record hot weather stressed the grid to its maximum because of the increased consumption of electricity for air conditioning.

Notwithstanding the sit-on-your-hands approach by the United States Government, effective climate change can still be achieved by implementing a recently developed worldwide waste-to-energy policy. Here come the several step solutions. Hold on to your hat, tie your shoes, and take a deep breath.

One of the required component technologies is waste-to-energy. Since there are several such technologies let's find the right one. For the last 25 years municipal solid waste-to-energy plants have been built and operated in the United States, Japan, and Europe. These plants incinerate municipal solid waste (MSW) to produce steam. The steam, in turn, is used to spin a steam turbine in the generation of electricity. The MSW-to-energy plant operator makes a profit on:

1. The MSW tipping fee,
2. The sales of ferrous and non-ferrous metals, and
3. The sales of electricity to the grid.

About 5 years ago the worldwide number of these plants began declining for a number of reasons including:

1. Substantially lesser profit from sales of electricity to the grid,
2. Only slightly increased revenue from MSW tipping fees, and
3. Only slightly increased revenue from the sales of ferrous and non-ferrous metals, and
4. Greatly increased costs related to the required installation of emissions control equipment.

As a result, there has been about a 15% reduction in the number of these incineration plants worldwide. The two principal reasons for the diminished profitability of MSW-to-energy plants are:

1. The reduced price paid by the grid for the electricity generated,

2. The Department of Energy (DOE) would not qualify this technology in the United States as "biomass renewable energy" thereby eliminating the associated government subsidies,
3. The ever continuing increased cost of gaseous emission control equipment, and
4. The ever present high moisture content of MSW that automatically reduces the electricity output potential.

The marketplace future of this technology appears to be all downhill. Over the last 10 years the grid has gradually concluded it isn't in its best long term financial interests to pay premium prices for MSW-to-energy produced electricity thus departing from its former willingness to do so. In the background the electrical generation/distribution industries are trying to cope with the deregulation of the entire market. Beginning in the late 1990s, corruption has been commonplace of the likes of Enron to include hundreds of other energy players. As the non-regulated energy industry emerges from its legal troubles it will likely be unwilling to pay a premium for energy from MSW-to-energy generation facilities.

There is another MSW-to-energy technology that uses anaerobic digestion technology to produce methane gas. The methane gas, in turn, is used as a primary fuel in the generation of electricity using either internal combustion engines or gas turbines.

Waste Management, Inc. is the world's largest waste management services provider. It is the leading provider of comprehensive waste and environmental services in North America. The company is strongly committed to a foundation of financial strength, operating excellence and professionalism. Waste Management tailors its services to meet the needs of each customer group and to ensure consistent, superior service at the local level. Headquartered in Houston, the company's network of operations includes 413 collection operations, 370 transfer stations, 283 active landfill disposal sites, 17 waste-to-energy plants, 131 recycling plants, 95 beneficial-use landfill gas projects and 6 independent power production plants. These assets enable Waste Management to offer a full range of environmental services to nearly 21 million residential, industrial, municipal and commercial customers. The company is engaged in a Cooperative Research and Development Agreement (CRADA), a joint research effort with the EPA to determine which practices best promote the safe operation of large-scale bioreactor landfills. Through our Maplewood and King George County Landfills, we are also participating in the EPA's Project XL, an initiative that uses pilot projects for achieving superior environmental performance from Bioreactor Landfill Technology. The company's goal is to make Waste Management's many landfill gas-to-energy programs even more efficient while making landfills last longer. Waste Management owns traditional MSW-to-energy incineration plants and much newer landfill gas-to-energy plants. Landfills produce methane gas due to the anaerobic digestion of MSW. Anaerobic digestion is deemed more effective than incineration because it is a wet rather than a dry process. The inherent moisture content of MSW therefore increases methane gas production and its corresponding ability to generate electricity. Both active and retired landfills can produce electricity using anaerobic digestion notwithstanding the fact that landfills are regarded by process engineers as quite inefficient anaerobic digesters.

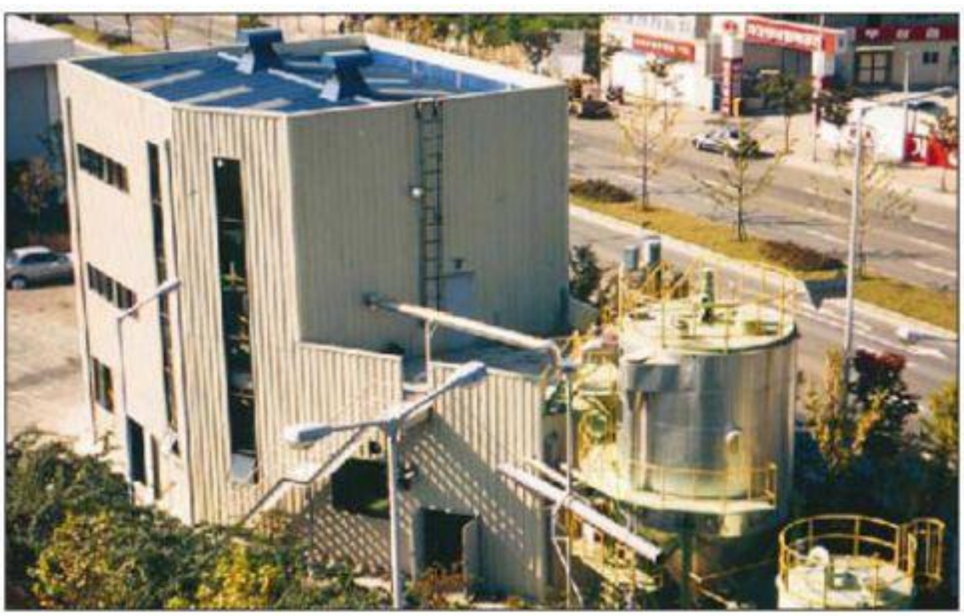
Traditional digesters used throughout the world are therefore quite capable of digesting municipal solid wastes in the same manner as landfills witness the continuing success of Waste Management, Inc.

Traditional digesters are single compartment (one phase) process vessels that are frequently called conventional high rate (CHR) anaerobic digesters. They normally operate at the mesophilic temperature of 37ºC (98.6 ºF). In the last 10 years more efficient digesters are being manufactured that operate at the thermophilic temperature of 60ºC (140ºF). During this same time frame there has been another anaerobic digester marketplace trend, namely the gradual switch from single phase digestion (CHR digesters) to two-phase digestion. CHR digesters operate at a single pH around 7.0 and a single oxidation reduction potential (ORP) whereas two phase digesters operate at two distinct pH ranges, the first phase being acidic and the second phase being basic. The acidic phase operates at a positive ORP whereas the basic phase operates at a negative ORP. In every CHR digester there are two simultaneous microbial digestion reactions that produce gas. One reaction produces carbon dioxide gas whereas the other produces methane gas. If these reactions were permitted in two separate digester reactors, called phase I (one) and phase II (two), the production of carbon dioxide gas and methane gas would be significantly more efficient because they could each proceed at the optimum pH and optimum ORP preferred by their respective anaerobic digestion bacteria. The bacteria that produce carbon dioxide gas prefer an acidic pH (less than 7.0 pH) whereas the bacteria that produce methane gas prefer a basic pH (greater than 7.0 pH). Two-phase digesters that operate at a thermophilic temperature are easily capable of producing twice the gases (carbon dioxide gas and methane gas) at twice the speed as CHR anaerobic digesters. The longest running United States based thermophilic two-phase anaerobic digester has been operating in DuPage County, Illinois at its 12 million gallon per day (MGD) treatment plant (located within Woodridge). It was process designed by the distinguished Dr. Sam Gosh, formerly of the Gas Technology Institute with Consoer Townsend Consulting Engineers providing the overall treatment plant design. The DuPage facility has been operating successfully since 1991. Full marketplace credit for developing highly efficient two-phase anaerobic digestion technology goes to the Gas Technology Institute, a United States based trade association of the natural gas industries. This was a 10 year program that was terminated about 15 years ago due to significant new discoveries of natural gas. When the program was initially created it was believed that the United States was running out of natural gas. The just referenced new discoveries of natural gas have already been mostly used up. Apparently an energy policy decision has been made to simply import natural gas from Asia in the form of liquefied natural gas (LNG) to make up the shortfall. Rather than conserving its supply of natural gas for US markets, the natural gas providers are selling it to

Mexico at record profits. Sales to Mexico are expected to continue for some time to come.

DuPage County, Illinois Two-Phase Thermophilic Anaerobic Digestion Facility

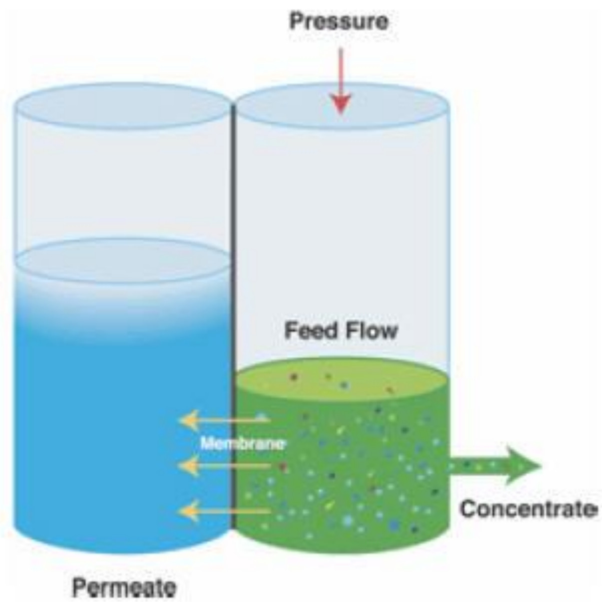
Two-phase thermophilic anaerobic digestion technology converting food waste into energy was demonstrated in Korea in 1998 as shown below.



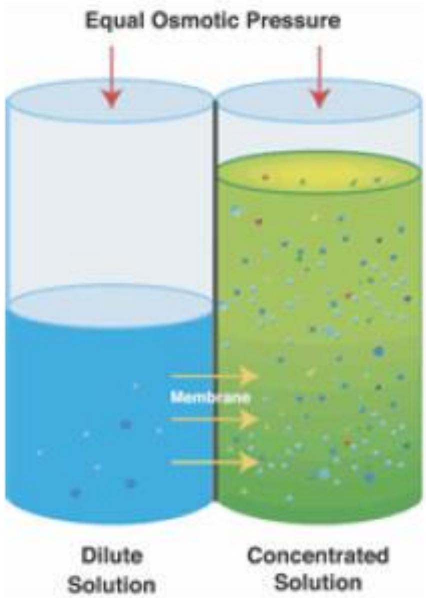
From CADDET Technical Brochure No. 66

Having now identified two-phase thermophillic anaerobic digestion of MSW and other wastes as one of the waste-to-energy component technologies, the task to identify additional required technologies still exists.

The term reverse osmosis comes from the process of osmosis, the natural movement of solvent from an area of low solute concentration, through a membrane, to an area of high solute concentration if no external pressure is applied. In simple terms, reverse osmosis is the process of pushing a solution through a filter that traps the solute on one side and allows the pure solvent to be obtained from the other side. More formally, it is the process of forcing a solvent from a region of high solute concentration through a membrane to a region of low solute concentration by applying a pressure in excess of the osmotic pressure. The membrane here is semipermeable, meaning it allows the passage of solvent but not of solute.



The membranes used for reverse osmosis have no pores; the separation takes place in a dense polymer layer of only microscopic thickness. In most cases the membrane is designed to only allow water to pass through. The water goes into solution in the polymer of which the membrane is manufactured, and crosses it by diffusion. This process requires that a high pressure be exerted on the high concentration side of the membrane, usually 2 - 14 bar (30 - 200 psig - pounds per square inch - gauge) for fresh and brackish water, and 40 - 70 bar [(600 - 1000 psig)] for seawater, which has around 24 Bar [(350 psi)] natural osmotic pressure which must be overcome.



In the late 1940s, researchers began examining ways in which pure water could be extracted from salty water. During the Kennedy administration, saline water conversion was a high priority technology goal-"go to the moon and make the desert bloom" was the slogan. Supported by federal and state funding, a number of researchers quickly advanced the science and technology of sea water conversion, but UCLA made a significant breakthrough in 1959 and became the first to demonstrate a practical process known as reverse osmosis (RO). The first viable reverse osmosis membrane was made from cellulose acetate as an integrally skinned asymmetric semi-permeable membrane. This membrane was made by Loeb and Sourirajan at UCLA in 1959 and patented in 1960. The current production of reverse osmosis (RO) membrane materials are based on a composite material patented by FilmTec Corporation in 1970. FilmTec's FT30 membrane is known as a polyamide thin film composite membrane. It was subsequently acquired by Dow Chemical Company. During the period 1995-2005 the cost of membranes decreased over 50% due to increased acceptance of the technology coupled with increased competition in the marketplace. From a technology that one couldn't once afford, the technology ascended to the level one couldn't afford to do without.

Maximum membrane sizes have but gradually increased over time from 2"Ø to 13" Ø. With its introduction of a whopper 18"Ø membrane, Koch Membrane Systems has become the worldwide leader of this increasingly important technology.

KOCH MEMBRANE SYSTEMS

MegaMagnum®
Water Treatment Systems

Koch Membrane Systems, Inc. has grown through the internal development of superior filtration products, as well as through acquisitions of leading companies in the field. KMS is headquartered in Wilmington, Massachusetts, with offices throughout the world and manufacturing plants in Wilmington, Massachusetts, and San Diego, California. Among the acquisitions of Koch Membrane Systems, Inc. were Romicon, Inc. in 1991, Fluid Systems Corporation in 1998, and Puron AG in 2004, all three of which had closely related products and technology. Romicon's outstanding reputation was based on hollow fiber membranes and membrane systems.

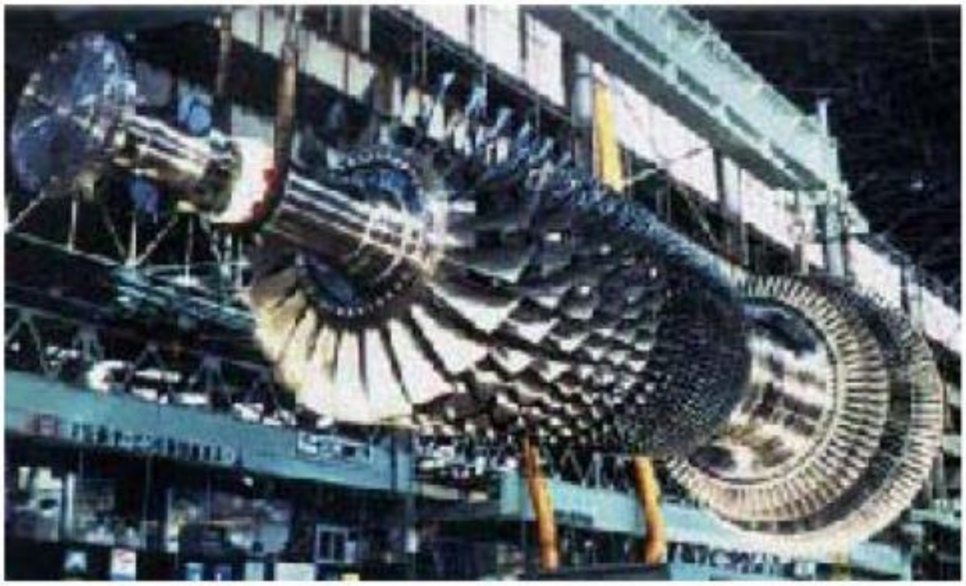
Preliminary list of required component technologies now consists of:

1. Two-phase thermophilic anaerobic digestion of MSW and other wastes, and
2. Reverse osmosis treatment

Another essential technology is the generation of electricity. This can be accomplished using diesel and natural gas (methane) fueled combustion engine generators as well as diesel and natural gas (methane) fueled turbine generators. Both types of power generation systems lend themselves to combined cycle (aka cogeneration) efficiency referenced under the combined heat and power (CHP) section discussed above. The power generated will be used to power the Regional Biowaste Energy Industrial Park as well as the surrounding community. The power generation equipment can be supplied by several worldwide vendors. Typical power generation equipment is shown below:

Deutz Model TCG 2020 Natural Gas Engine Power Generator Source: Deutz Power Systems GmbH & Co. KG

Cummins 1,000 kW Diesel Generator



Two Mitsubishi Model 701F Combustion Gas Turbines Total Power Generation Capacity 526 MW Electricity

The above power generation equipment always produces carbon dioxide gas, oxides of nitrogen (NOx), and water vapor. These gaseous discharges have to be successfully managed in order to prevent additional global warming. 100% gas managed control technology will be disclosed later on.

Another essential technology is the accelerated production of microalgae for the purpose of producing biodiesel fuel. 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 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 lubricity and environmental emissions. A blend as low as 2% provides a dramatic positive effect on the overall performance of a diesel engine reflecting 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 glycerine is removed from vegetable oils. Raw glycerine must then be further purified before it can be marketed. Because of a continuing worldwide glycerine glut, raw glycerine 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 two-phase thermophilic anaerobic digestion 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 petrodiesel 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 antigel products are available that can efficiently and effectively lower the CFPP of B20 biodiesel 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 highly biodegradeable.
- 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 much 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 gas emissions.
- Is a plant-based fuel replacement.

The production of biodiesel from vegetable oil represents an industry that is quickly gaining a worldwide foothold in the biofuels business due to the increased subsidies in the marketplace.

This country's principal effort to develop alternative energies was undertaken by the National Renewable Energy Laboratory (NREL). This laboratory was initially established by the Solar Energy Research Development and Demonstration Act of 1974. Originally called the Solar Energy Research Institute, NREL began operating in July 1977 and was designated a national laboratory of the U.S. Department of Energy in September 1991. NREL has existing partnership agreements with approximately 250 industry partners, 70 universities and 80 not-for-profit organizations. Twenty years of research have yielded significant progress in many renewable energy technologies. The cost of wind energy has declined from 40¢ per kilowatt-hour to about 5¢. Photovoltaic systems can now be manufactured for about $2.20 per watt, down from $4.50 per watt in 1980. And ethanol costs have plummeted from $4 per gallon in the early 1980s to $1.22 today. Yet all of these alternative energy technologies still require governmental subsidies for their application in the marketplace. None yet represents a true scientific (economically competitive) solution.

The closest NREL has come to an economically competitive solution was the Aquatic Species Program (ASP) that consisted of the production of a biofuel called algal biodiesel. Algal biodiesel is produced through the growing of microalgae for their lipid content. The lipid content is then converted into biodiesel through transesterification in the same manner that soybeans and other vegetable oils are converted. Biodiesel produced from microalgae is, as a practical matter, identical with biodiesel produced from vegetable oils. The ASP funding totaled $25.05 million over a 20 year period which began in 1978. Continuation funding was ultimately terminated when it was officially determined that algal biodiesel could not be produced economically. Even though every one of the past NREL success stories still require subsidy support for their marketplace use the ASP program was killed for the same reason-likely due to our nation's energy policy that is intimately and equally committed to the existing coal and oil industries.

The ASP obtained its data from growing microalgae in warm open ponds relying on daylight photosynthesis and micronutrients from rainfall runoff events. If the microalgae is produced under 24 hours photosynthesis conditions with massive amounts of micronutrients added to the culture at about 100 degrees Fahrenheit, production can be significantly enhanced. The micronutrients are provided by the reject (liquid fertilizer concentrate) of the reverse osmosis equipment downstream from the two-phase thermophilic anaerobic digester. By additionally adding the carbon dioxide, NOx, and moisture from the power generation equipment the microalgae production technology becomes compliant with Kyoto Protocol. The resulting final microalgae production is increased perhaps 100-fold in far less space as the NREL open ponds. The produced microalgae may be used:

1. In quite economical biodiesel production.
2. In quite economical fish farming.
3. And as an economical animal feed supplement.

Associated co-product management consists of:

1. The retail selling of biodiesel at a 20% discount from petroleum diesel.
2. The transfer of all biodiesel wastes to the anaerobic digester to produce more methane gas, carbon dioxide gas, organic fertilizer (digestate), liquid fertilizer concentrate, and reverse osmosis (RO) water.
3. Fish processing and retail selling of processed fish at a 20% discount from retail.
4. The transfer of all fish farming and processing wastes to the anaerobic digester to produce more methane gas, carbon dioxide gas, organic fertilizer (digestate), liquid fertilizer concentrate, and reverse osmosis (RO) water.
5. The methane gas produced will be:
    a. Used to generate combined cycle electricity for internal BioWaste Energy Regional Industrial Park use with the remainder sold to the local marketplace at a 20% discount from retail.
    b. Retail sold to the local marketplace as compressed natural gas (CNG) fuel at a 20% discount on a gasoline gallon equivalent (GGE) basis.
    c. Retail sold to the local natural gas marketplace at a 20% discount from retail.
6. Some of the microalgae will be sold as an animal feed supplement at a 20% discount from retail on a protein content equivalent basis.

The Food Independence technology component may achieved by vertical farming within massive greenhouses. Our planet is rapidly running out of arable land. Those nations which have already run out of arable land are clearing forests (deforestation) for agricultural production. Deforestation causes climate change due to the burning of these forest clearing wastes. The combustion of forest wastes discharges carbon dioxide into the environment. Carbon dioxide is thought to be one of the several gasses that are responsible for global warming. Nations that clear forests for food production, however, have no other choice to prevent food deprivation and in some cases children starvation. Vertical farming (multistory greenhouses) completely solves this tragic problem on a sustainable basis.

Greenhouse farming permits the production of 100% organic foods which are thought by many to be more nutritious. Since precise nutrient and moisture management can be achieved intercropping may be practiced thereby producing more food per acre than horizontal farming. Intercropping refers to the simultaneous growing of two or more crops within a common soil matrix. Greenhouse farming eliminates the necessity to use pesticides, fungicides, and herbicides since greenhouse supply air can be mechanically filtered and sterilized to remove or otherwise sanitize airborne spores. With the next generation technology greenhouse make-up air first passes through power generation combustion engines to produce electricity. The completely sterile products of combustion consist of water vapor, carbon dioxide, and oxides of nitrogen. The carbon dioxide is beneficially used in the photosynthetic production of carbohydrate based food crops. By increasing the carbon dioxide concentration to about 1,200 parts per million by volume (ppmv) (1,200 µL/L) crop growth rates are maximized. By precisely controlling temperature, humidity, nutrients, and artificial lighting crop production can be further optimized. Because the greenhouse weather can be precisely controlled more than one crop per year can be produced. In the case of soybeans, for example, four crops, rather than a single crop, per year are easily achievable. Greenhouse weather control combined with intercropping can achieve 10 times more food production/hectare than traditional horizontal farming.

MSW-to-energy anaerobic digestion plants produce digestate that contains insoluble salts of heavy metals. The digestate will be beneficially used as the granulated soil matrix within greenhouses. Soil scientists list the several micronutrients of Aluminum (Al), Arsenic (As), Barium (Ba), Boron (B), Chloride (Cl), Chromium (Cr), Cobalt (Co), Copper (Cu), Fluorides (F), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Nickel (Ni), Lead (Pb), Selenium (Se), Strontium (Sr), Titanium (Ti), Tungsten (W), Vanadium (V), and Zinc (Zn) as essential for optimum plant growth. It is well known that Hawaii has the most productive soils anywhere found. The productivity is achieved because of the generous content of micronutrients. The soils were initially formed from lava flows which are rich in minerals. The heavy metal content of MSW therefore ends up in a quite productive role within the greenhouse.

For more than 20 years the United States Environmental Protection Agency (USEPA) has permitted the land application of Class B Biosolids. The Centers For Disease Control And Prevention, The Occupational Health And Safety Administration (OSHA), and several additional private groups have recommended against this continuing practice. When Class A or Class B Biosolids that contain heavy metals are applied to cropland, heavy metals uptake occurs mostly within the root system with progressively lesser uptake occurring throughout the entire plant pathway to the food product itself. The uptake occurs at acidic, neutral, and basic (alkaline) pH values as well as other growing conditions such as moisture adjustments and macro nutrient applications.

Using the Class A Biosolids Digestate as a soil amendment for use in landscaping or greenhouse activities is specifically permitted by the USEPA because of its Class A Biosolids Status (Section Three, Par. 3.1 EPA/831-B-93-0026, Land Application of Sewage Sludge, December, 1991). The soil amendment therefore becomes the ultimate fate of the heavy metals. When using the Class A Biosolids digestate as a soil amendment in the greenhouse growing of vegetable oil crops, the vegetable oil can be subsequently refined into biodiesel through transesterification. Heavy metals do not participate in the transesterication process and are therefore left over in the associated wastes. The transesterification process results in soapstock and glycerin wastes. All wastes associated with biodiesel refining are routinely returned to the digester to produce additional renewable energy. The associated vegetable oil crop residues are also routinely returned to the digester to produce additional renewable energy. The soil amendment therefore becomes the ultimate fate of the heavy metals. When using the Class A Biosolids Digestate as a soil amendment in the greenhouse growing of food crops, the organic food products will be marketed at a discount from retail. Evidence that food products produced on sewage sludge applied land are harmful to human health does not exist (Section Three, Par. 3.1 EPA/831-B-93-0026, Land Application of Sewage Sludge, December, 1991, and Food Standards Agency, Research Programme Annual Report, 2001). Using the digestate soil amendment, regardless of the heavy metals content (pollutant load), is specifically permitted by the USEPA because of its Class A Biosolids Status. The soil amendment therefore becomes the fully and automatically permitted ultimate fate of heavy metals. Use of the two-phase thermophilic anaerobic digester organic fertilizer (digestate) for the greenhouse production of organic food crops therefore represents a environmentally proper and agriculturally beneficial use of this co-product of the waste-to-energy technology.

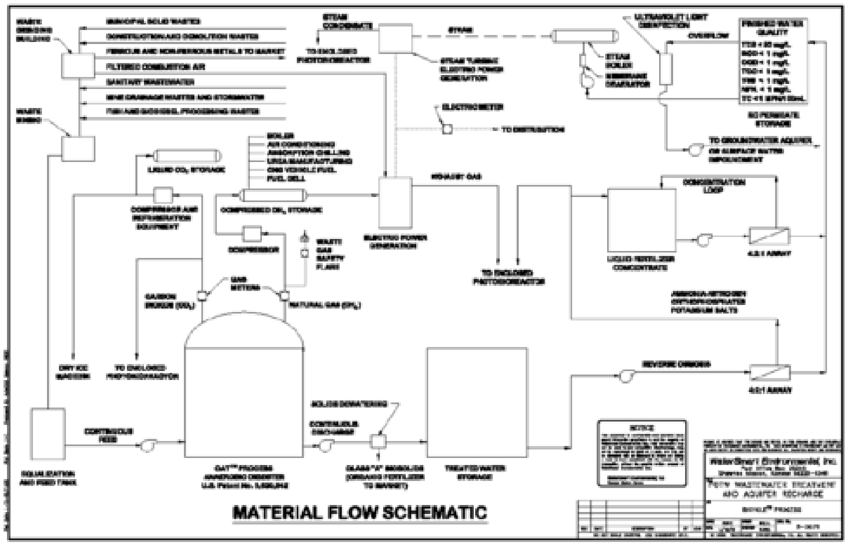
(Author's Note: It has just recently been learned that Beethoven [Ludwig van Beethoven] of Symphony No. 5 fame [Opus 67 In C Minor] died [March 26, 1827] of lead poisoning resulting from his music composing habit of drinking wine from a pewter goblet. Lead is one of the heavy metals. The medical science of determining the harmful effects of heavy metals has been around for well over 50 years. The continuing public debate that All Heavy Metals are automatically harmful to human health appears to be based on rather simplistic non-technical concerns over the general use of chemicals in the agricultural marketplace rather than the systematic application of sound science. For example, the quite popular human vitamin Centrum contains Boron [B], Calcium [Ca], Chromium [Cr], Copper [Cu], Iodine [I], Iron [Fe], Magnesium [Mg], Manganese [Mn], Molybdenum [Mo], Nickel [Ni], Potassium [K], Phosphorus [P], Selenium [Se], Silicon [Si], Tin [Sn], Vanadium [V], and Zinc [Zn] chemicals. There are some 23 heavy metals including Cr, Cu, Fe, Mn, Ni, Se, Sn, V, and Zn [Glanze, 1996]. The environmental and medical communities appear out of sync on the subject of heavy metals. The few heavy metals of Arsenic [As], Mercury [Hg], and Lead [Pb] have indeed caused death [Beethoven] under special circumstances. In general, heavy metals are extremely beneficial micronutrients within the agricultural marketplace.)

While achieving energy, food, fuels, and water independence, the proposed waste-to-energy technology can solve significant major problems such as aquifer depletion and acid mine drainage destruction. Acid mine drainage streams extend over 13,000 miles (Hadley, Snow 1974). Abandoned coal mines now number over 15,000 (many references). The devastation of the fresh water fishing is complete. Not too many fish like a pH of 3 nor do they enjoy iron pyrites. Makes them gag. If the acid mine drainage is managed as a liquid waste similar to, say, sanitary wastewater the proposed technology can convert the drainage into bottled water quality. Acid mine drainage can be used (diverted) along with sanitary wastewater to slurry mix ground up MSW in the production of electricity and other valuable co-products. The resulting RO water is then discharged back into the drainage stream resulting in an environment again suitable for fresh fish and other aquatic growths. Acid mine drainage streams frequently flow past municipalities. Municipalities generate MSW. The proposed site of acid mine drainage treatment is therefore near a community. Perhaps the same community that provides the miners. Just a thought. Acid mine drainage streams look like the following. Fish seem to prefer a better water quality. Maybe better trout fishing in Pennsylvania can be achieved someday with an intelligent global waste-to-energy policy that replaces the administration's current energy policy. A replacement policy that also produces less expensive energy, food, fuels, and water on a sustainable basis.

The effects of Acid Mine Drainage (AMD) on Shamokin Creek approximately 13 miles downstream of the last mine discharge. This location is 3 miles from its confluence with the Susquehanna River.

Successful treatment begins with the construction of a building near the stream and community. The building will house power generation equipment, biodiesel production equipment, fish farming and processing equipment, equipment to compress natural gas, food production and processing equipment, dry ice manufacturing equipment, MSW grinding equipment, and a two-phase thermophilic anaerobic digester on the main floor. The basement of the building will contain fresh fish farming capabilities. The second and third floors will be dedicated to greenhouse farming utilizing the digestate from the digester. The design will permit the addition of more floors over time. Unemployed miners will be solicited for employment.

An engineering drawing showing the entire process of waste-to-energy is shown below:



Integrated And Holistic Waste Processing And Recycling With Associated Value Added Products Production And Marketing

Acid Mine Drainage Wastes
Animal Processing Wastes
Animal Production Wastes
Biodiesel Refining Wastes
Construction & Demolition Wastes
Crop Processing Wastes
Crop Production Wastes
Dead Animal Wastes
Dumpster Wastes
Fish Farming Wastes
Fish Processing Wastes
Food Wastes
Medical Wastes
Municipal Solid Wastes
Stormwaters
Sanitary Wastewater
Unknown Wastes

Two-Phase Thermophilic
Anaerobic Digestion

Carbon Dioxide Gas
Methane Gas
Organic Fertilizer (Digestate)
Liquid Fertilizer Concentrate
Reverse Osmosis (RO) Water

Biodiesel Transportation Fuel To Local Market
Microalgae To Local Market
Compressed Natural Gas (CNG) Transportation Fuel To Local Market
Natural Gas (Methane) Heating Fuel To Local Market
Electricity To Local Market
Processed Fish To Local Market
Processed Crops To Local Market
Processed Animals To Local Market

Carbon Dioxide Gas To Microalgae Production
Combustion Generator Gases To Microalgae Production
Liquid Fertilizer Concentrate To Microalgae Production
Organic Fertilizer To Greenhouse
Reverse Osmosis (RO) Water Of Bottled Water Quality To:

- Aquifer Restoration
- Boiler Water Make-Up
- Chesapeake Bay
- Discharge
- Fish Farming
- Irrigation
- Livestock Drinking Water