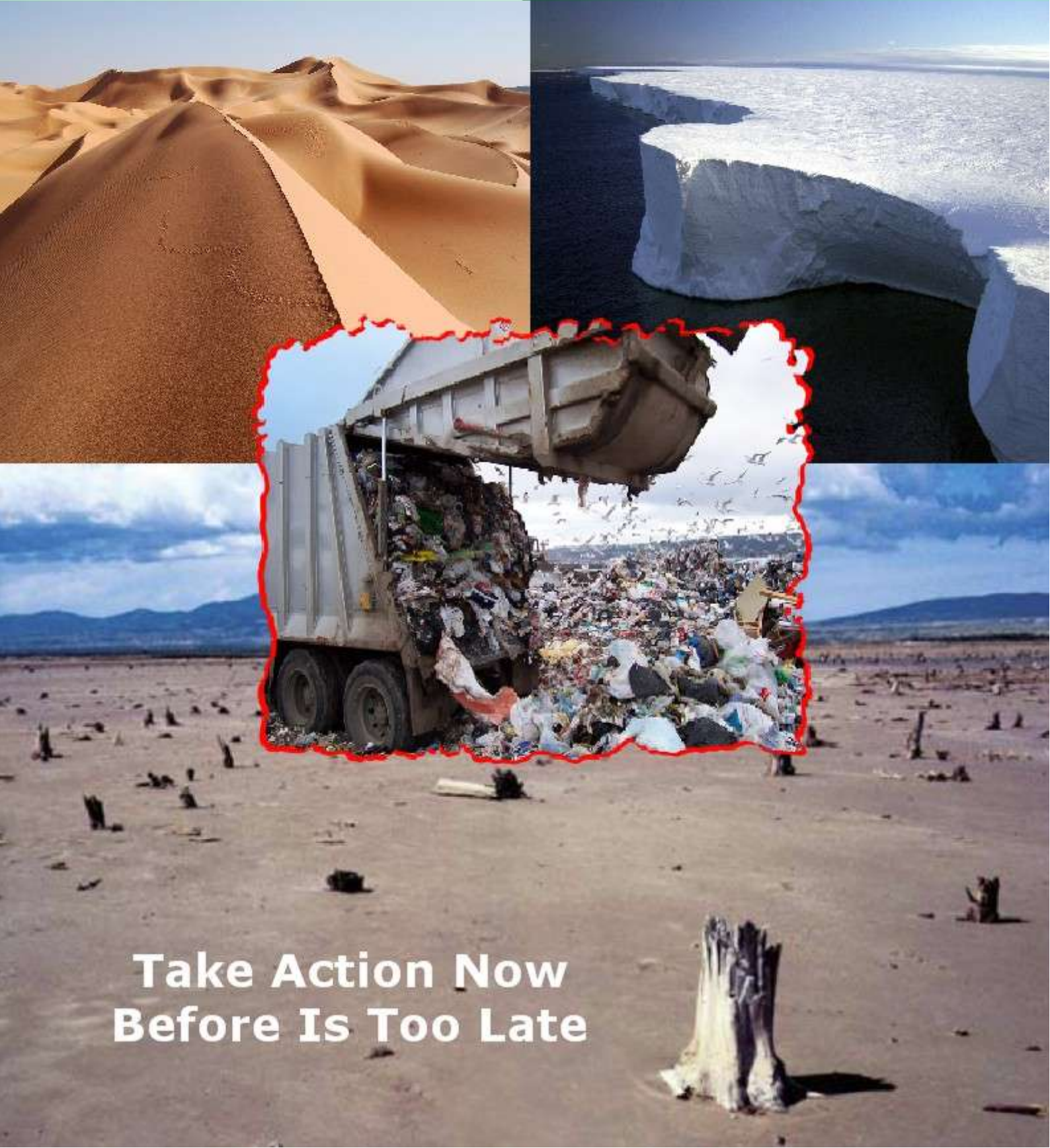




Solutions To Reverse Global Warming



## Waste 2 Energy cum By-Products Plasma System



**Take Action Now  
Before Is Too Late**

# Business Overview

Significant unalterable events are driving demand for Plasma Converter. They are:

- Rising populations in most nations
- General increases in generated waste levels
- Current waste disposal and remediation techniques such as landfills and incineration becoming regulatory, socially and environmentally unacceptable
- A need for critical resources (i.e. power and water) to sustain local economies
- The emphasis being placed upon the production of distributed power and the need to provide alternatives to fossil fuels

Plasma technology addresses these waste and resource issues by offering remediation solutions that are integrated with a range of equipment solutions and services. This solution add value to business so they can now realize revenue streams from tipping fees, as well as from the sale of resulting commodity products and services. Alternatively, this will allow them to generate the product they need while at the same time using a zero cost basis, or revenue generating, source of raw material (waste).

In 2000, recognizing the increasing importance of alternative energy and power sources in general, and hydrogen in particular. Plasma provides a green and renewable source of hydrogen to accelerate the hydrogen economy. In addition, the plasma converter produce methanol from the Plasma Converted Gas (PCG™).

Their business model and its market development strategies arise from the Company's mission, which is to change the way, the world views and employs discarded materials; what many would now call waste. This objective is achieve by strategically marketing a series of products and services emanating from the core Plasma Converter technology, resulting in saleable energy & recycle material while providing a safer and healthier environment. This paradigm-shifting strategy will be implemented through the use of an enhanced business model that provides for engineering services and direct equipment sales with after sales support and service.

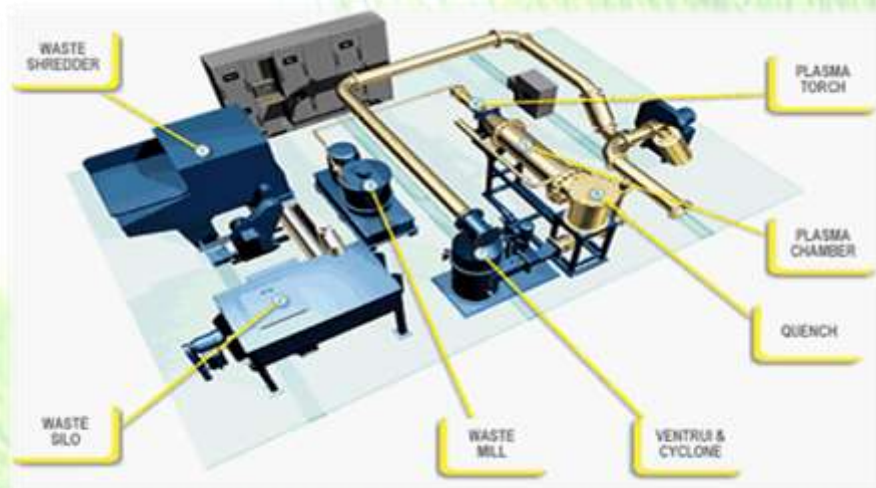
# Waste to Energy

## Plasma Technology



**Plasma torches.**

At the most basic level, a plasma waste converter is a plasma torch applied to garbage. A plasma torch uses a gas and powerful electrodes to create **plasma**, sometimes called the fourth state of matter. Plasma is an **ionized gas**; in other words, it's a gas with free-roaming electrons that carries a current and generates a [magnetic field](#). On [Earth](#), we can see natural displays of plasma fields in [lightning](#). The temperatures generated by a plasma torch can be hotter than the surface of the [sun](#) (more than 6,000 degrees Celsius).



### **PyroGenesis Plasma Arc waste disposal system**

At these temperatures, garbage doesn't stand a chance. Molecules break down in a process called **molecular dissociation**. When molecules are exposed to intense energy (like the heat generated by a plasma torch), the molecular bonds holding them together become excited and break apart. What's left are the elemental components of the molecules. With cyanide, for example, you'll end up with atoms of carbon and nitrogen.

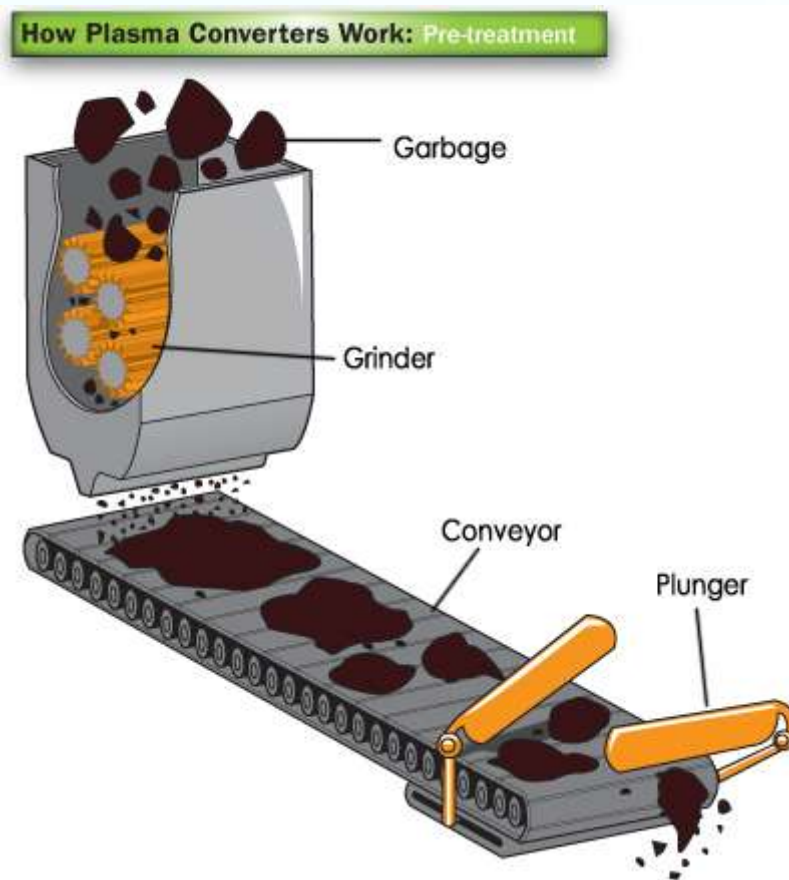
Organic molecules (those that are carbon-based) become **volatilized**, or turn into gases. This synthetic gas (**syngas**) can be used as a fuel source if properly cleaned. Inorganic compounds melt down and become **vitrified**, or converted into a hard, glassy substance similar in appearance and weight to obsidian. Metals melt down as well, combining with the rest of the inorganic matter (called **slag**).

Unlike incinerators, which use **combustion** to break down garbage, there is no burning, or **oxidation**, in this process. The heat from plasma converters causes **pyrolysis**, a process in which organic matter breaks down and decomposes. Plasma torches can operate in airtight vessels. Combustion requires oxidization; pyrolysis does not.

Plasma waste converters can treat almost any kind of waste, including some traditionally difficult waste materials. It can treat medical waste or chemically-contaminated waste and leave nothing but gases and slag. Because it breaks down these dangerous wastes into their basic elements, they can be disposed of safely. **The only waste that a plasma converter can't break down currently is heavy radioactive material, such as the rods used in a nuclear reactor. If you put such material in a plasma furnace, it would probably catch on fire or even explode.**

Municipal Solid Waste  
This article focuses on the plasma gasification of **municipal solid waste (MSW)**, the industry term for what we normally refer to as garbage or trash.

## Plasma Converter Parts



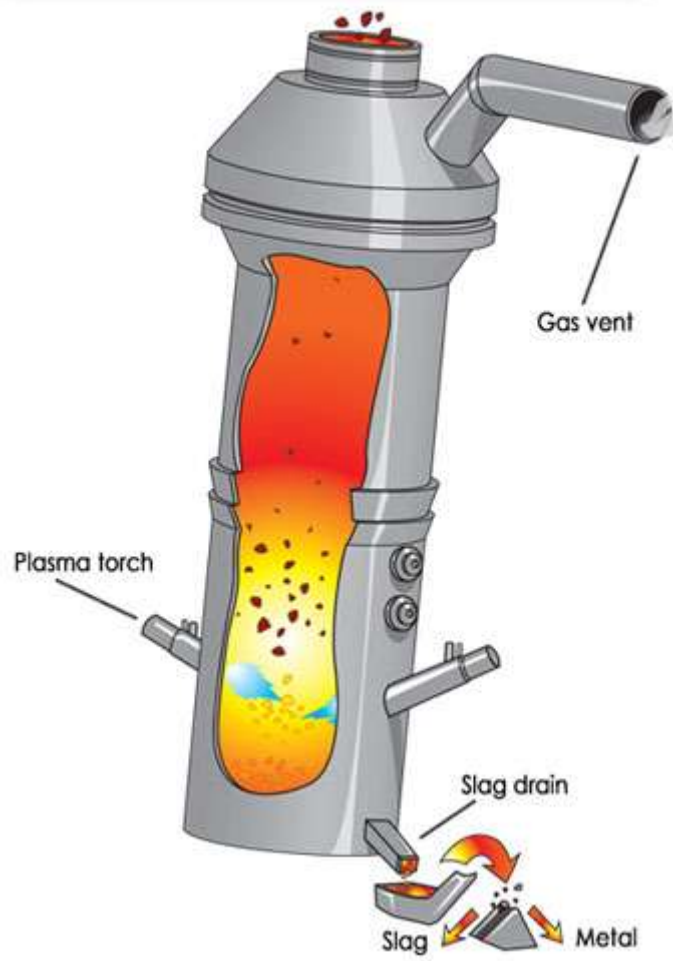
### Conveyor system

In order to feed garbage into the converter, almost all plasma facilities have a conveyor system. Garbage is loaded on the conveyor and is pushed into the furnace (or pre-treatment system if the plasma facility uses one) by a plunger.

### Pre-treatment mechanism

A plasma torch can break down waste without any special pre-treatment. To be more efficient, most plasma facilities employ simple pre-treatment process. Such as the use grinders or crushers to reduce the size of the individual pieces of garbage before moving in to the furnace. The plasma torch can break down the smaller pieces faster.

## How Plasma Converters Work: Plasma furnace



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### Furnace

Here's where the magic happens. Furnaces have an airlock system to allow garbage to come in while preventing the hot gases in the furnace from escaping into the atmosphere. The furnace houses at least one plasma torch; many furnaces have multiple torches to break down all the matter. These torches are usually placed a little lower than halfway down the furnace. The furnace also features a drainage system to tap off the slag as it accumulates and a vent system to vent out the gases. In order to withstand the intense heat, furnaces are lined with refractory material and often have a water-cooling system as well.

### Plasma Torch

The plasma torches used in some facilities are custom-built. The amount of energy they consume, the lifespan of the electrodes it uses, the gas used for ionization (most torches just use ordinary air), the downtime it takes to replace an offline torch and the size of the plasma field it generates all depend on the specific manufacturer. Plasma torches are water-cooled.

## Slag Drainage and Afterburners

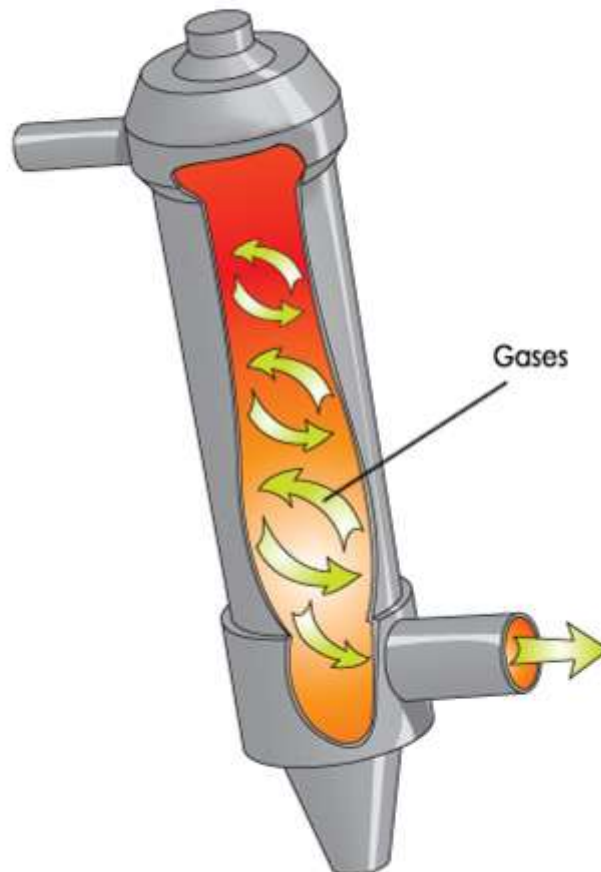
Molten slag pools at the bottom of the furnace and helps maintain the high temperature inside the gasification chamber. Occasionally slag must be drained from the furnace. Some furnaces have drains positioned at a certain height, others use a tap system. Either way, slag drains away from the furnace and cools in a separate chamber.

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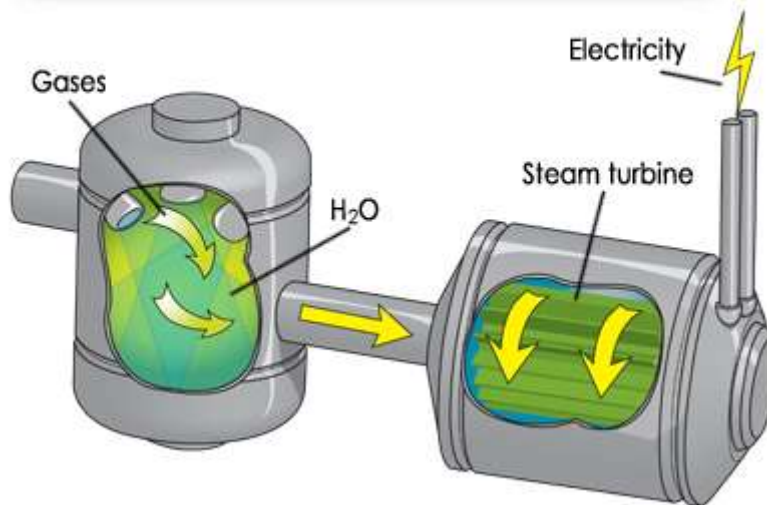
## Gas Ventilation

The furnace also has a vent system to allow gasified components to pass into another part of the system (either an afterburner or a gas cleaning chamber).

### How Plasma Converters Work: Afterburner



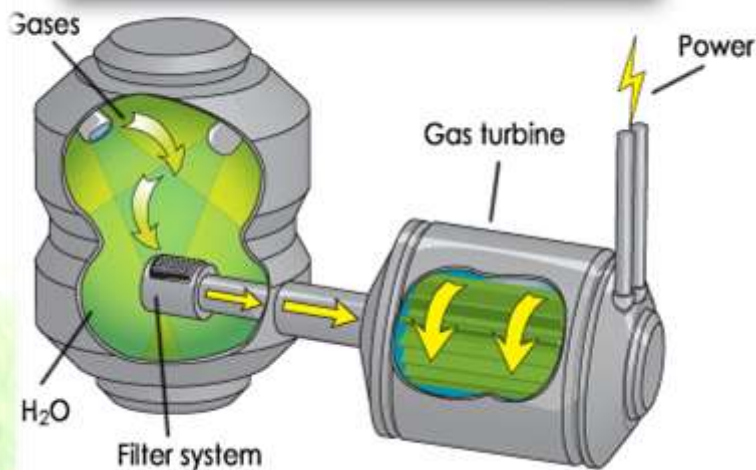
### How Plasma Converters Work: Steam turbines



### Afterburner

Gases can pass through a secondary chamber where natural gas flames combust any remaining organic material in the gases. These extremely hot gases then pass through a **Heat Recovery Steam Generator (HRSG)** system, where they heat water to form steam. This steam then turns a steam turbine to create electricity.

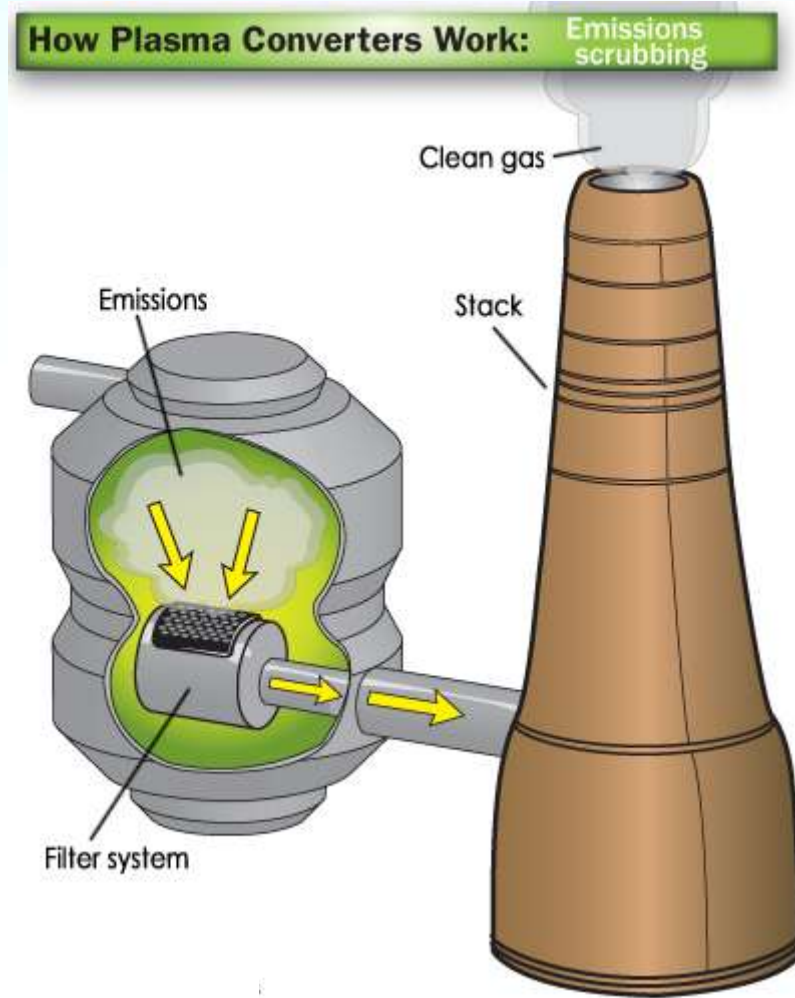
### How Plasma Converters Work: Syngas cleaning tank



### Syngas Cleaning

Alternatively, the gases from the furnace enter a chamber where they are cooled and scrubbed, usually by water. The gases pass through a spray of water, which scrubs the gases of pollutants and particulates. A filter system containing a base filter neutralizes acid gases. The acids in the gases and the bases in the filter combine to form inert salts. The cooled and clean gases continue through the system, which in most cases involves a [gas turbine](#)

connected to an [electricity generator](#). Some systems also harness the heat from these gases to generate steam, similar to the afterburner method mentioned above.



If the plant uses an afterburner, the remaining gases must be cleaned thoroughly to get rid of any hazardous material. Many designs include a dry scrubber system. In this system, powdered carbon is injected into the gases to strip away **mercury**, a poisonous element. Gases also pass through a fabric or bag filter to remove any other dangerous particulates, like **lead**. Once the gases have been cleaned they move to the stack, where they are released into the atmosphere.

### Plasma Converter Byproducts

There are three main byproducts that are a result of the plasma gasification process: synthetic gas (syngas), slag and heat. Let's look at each of these byproducts in more detail. **Syngas** is a mixture of several gases but mainly comprises hydrogen and carbon monoxide. It can be used as a fuel source, and some plants use it to both provide power for the plant and sell excess electricity to the [power grid](#). Garbage contains a great deal of potential energy; the gasification process enables engineers to convert the potential energy into electrical energy.

How much gas is generated by a plasma converter? That depends on what you put into the furnace. If the garbage contains a lot of carbon-based material (in other words, organic waste), then you'll get more gas. Waste with a lot of inorganic material won't yield as much gas. Because of this, some plasma facilities sort through garbage before feeding it into the system.



**Molten slag draining from a plasma furnace**

The solid byproduct from the gasification process is called **slag**. The weight and volume of the original waste material is dramatically reduced.

- The weight of the slag is about 20 percent of the weight of the original waste
  - The volume of the slag is about 5 percent that of the original waste's volume
- The slag can take different forms depending on how you cool it.



**Metal nodules can be separated from the sand**



**Water-cooled slag forms sand**

If slag is air-cooled, it forms black, glassy rocks that look and feel like obsidian, which can be used in concrete or asphalt. Molten slag can be funneled into brick or paving stone molds and then air cool into **ready-to-use construction material**.

The compressed air is blow through a stream of this molten material and form **rock wool**. Rock wool has the appearance of gray cotton candy that is light and wispy. **Rock wool is a very efficient insulation material, twice as effective as fiberglass. It's also lighter than water, but very absorbent.** Because of this, it could potentially be used to help contain and clean oil spills in the ocean. Cleanup crews could spread rock wool over and around an oil spill. The rock wool would float on the water while soaking up the oil, making collection a relatively easy process. Hydroponic growing systems can also use rock wool -- farmers can plant seeds in slabs or blocks of it.



**Air-cooled slag forms rocks like this**

Currently rock wool is produced by mining rocks, melting them down and then streaming the molten material onto spinning machines. The spinning machines fling strands of molten material in the air. Today, the price of rock wool is over a dollar a pound. Since rock wool is a byproduct of the plasma gasification process, it could be sold for as little as 10 cents a pound. The price of insulation would decrease, efficiencies in energy-saving techniques would increase and plasma gasification plants would have another substantial source of income apart from selling electricity back to the grid.



**Rock wool**

The heat created by plasma facilities is considerable, measured in thousands of degrees Centigrade. Heat from the molten slag helps maintain the temperature within the furnace. Some of the heat from gases can be used to convert water into steam, which in turn can turn steam turbines to generate electricity.

Waste treatment through gasification is unique in that it not only gets rid of garbage and generates electricity, it also produces byproducts that are valuable commodities themselves.

## Plasma Gasification Facilities

Currently, there are two commercial plasma plants that process MSW in Japan. In 1999, Hitachi Metals commissioned a pilot plant in Yoshii, Japan. This plant was modest, processing less than 30 tons per day of MSW. The successful operation of the plant spurred the development of two other plants within Japan. The pilot program ended in 2004, and Hitachi Metals decommissioned the plant.

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**The Mihama-Mikata plasma facility**

The plant at Mihama-Mikata industrial park began operations in 2002. This plant can process up to 24 tons per day of MSW and four tons per day of wastewater treatment plant sludge. Because the plant is relatively small, it doesn't produce syngas for fuel. It does produce steam and hot water, however, which is used both for power and heat generation in the industrial park. The plant uses a water cooling system for the molten slag and separates the metal nodules to sell as scrap. The sand is mixed with concrete and used in paving stones.



Photo courtesy [Westinghouse Plasma Corporation](#)  
**Eco Valley Utashinai Plasma Facility**

The plasma gasification plant in Utashinai, Japan also began processing MSW in 2002. The original design of the plant factored in a capacity of around 170 tons per day of MSW and **automobile shredder residue (ASR)**. Today the plant processes approximately 300 tons per day. The plant generates up to 7.9 megawatt-hours (MWh) of electricity, selling about 4.3 MWh back to the power grid.

### Megawatt-Hours

The megawatt-hour (MWh) is a unit of measurement for energy. It's equal to 1,000,000 watts operating for 1 hour. A typical clothes dryer requires about 5.6 kilowatt-hours (or 5,600 watt-hours). One megawatt-hour could power that dryer for more than 178 hours without stopping.

### Future Facilities

A demonstration facility in Israel is scheduled to be converted into a commercial waste treatment facility. Russia has also expressed an interest in plasma gasification facilities, and currently uses plasma plants to treat low level nuclear waste in a plant outside of Moscow.

In the United States, St. Lucie County in Florida is also building a plasma gasification plant. This plant would process all of the incoming waste for the county and begin to mine the existing landfill for waste. Once it is built, the facility will be able to process up to 1,000 tons of garbage per day and generate 67 MWh a day, with a net output of 33 MWh.

### Plasma Converter Challenges



**A typical landfill**

Environmental concerns often take a back seat to economic realities, and it wasn't until **tipping fees** (the fee you have to pay to have garbage hauled to landfills) increased and landfill space decreased that plasma plants became economically feasible. Even in an ecologically-concerned culture, some companies don't focus on the environmental aspect for their business model but positions itself as a power facility that uses a renewable resource for fuel by focusing on the ability to produce electricity for low costs makes it a viable operation.

Waste management is big business. Any major revolution in waste management faces critics and opposition from those that benefit from the status quo. As environmental pressures increase (both from the perspective of waste management and that of renewable sources

for fuel), city and county governments are more willing to explore alternate strategies to handle waste.

## Profitable Plasma Plants

Plasma waste treatment facilities are becoming more cost effective, however. Because a plasma plant can generate revenue beyond tipping fees, they can competitively price tipping fees to make it cheaper to ship garbage to the facility than a landfill. As plasma facilities are standardized, tipping fees will continue to decrease.

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With the right capacity, a plasma plant can generate enough syngas to run an engine or gas turbine and generate electricity. A 1,000 ton per day plant can generate enough electricity to power the plant itself and still have plenty of power to sell back to the grid.

The hot gases can be used to generate steam, which can turn steam turbines for electricity or be used to generate heat for the plant and other facilities.

Slag can be sold in any of its forms. The rock form can be used as gravel or molded into bricks. Sand can be mixed with concrete and used in various paving and construction projects. Rock wool can be used for insulation or to contain dangerous oil spills. The St. Lucie County plant will produce 12 tons per day of vitrified slag (from 1,000 tons of waste). If the molten slag is cooled by water, metal nodules can be separated from the slag and sold for scrap. The St. Lucie facility is expected to produce about 4 tons per day.

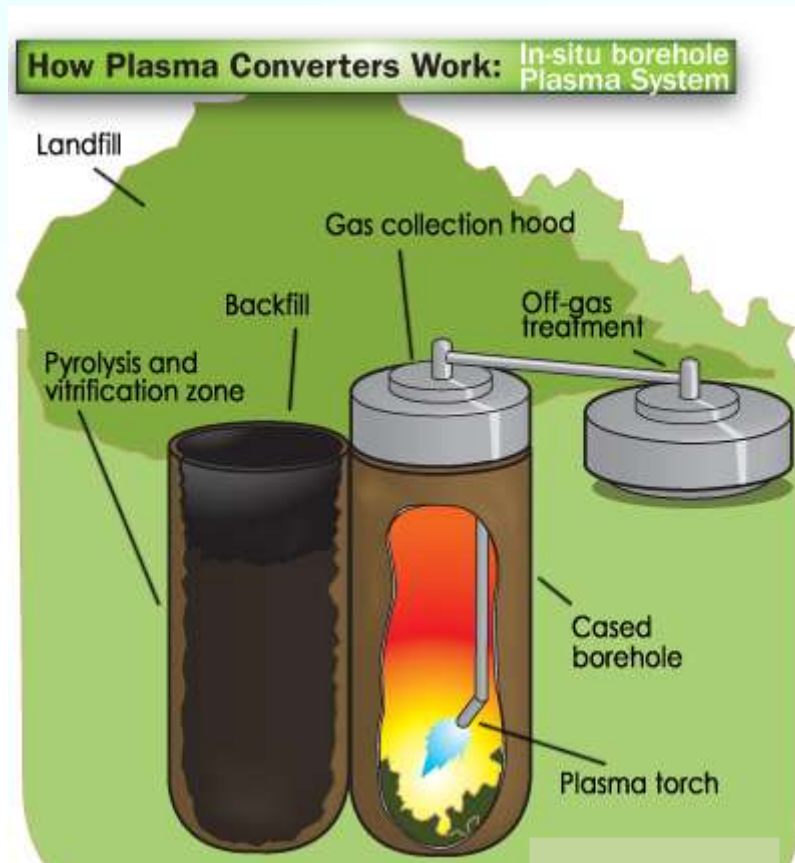
## Plasma Waste Converters is the Solution to the Future

With focus increasing daily on mankind's environmental impact and the growing concern to look to renewable energy resources, plasma plants are well positioned to become an important part of how we generate power and deal with waste.

Potential uses for this technology (apart from new plasma waste treatment plants) include:

- **In-situ facilities**

A portable plasma gasification system to treat existing landfills without building an entire plant. Instead of a stationary furnace and gas treatment facility, boring holes into existing landfills, sticking a plasma torch into the hole, and capping the hole with a gas capture system. The landfill itself would act as the furnace vessel. Since plasma gasification is not a combustion process, the landfill contents would either gasify or vitrify, with no danger of fire.



- **Co-location with existing power plants**

Another option that would significantly reduce the price of a plasma plant is the co-location of the plasma gasification chamber with a pre-existing power facility. Because the amount of gases produced by plasma plants is relatively small when compared to coal or oil-fired power plants, the power generators in plasma plants are smaller and less efficient (larger generators require much more gas). Coal and oil power plants use the same processes as plasma plants to treat gases and generate power. By connecting a line from a plasma gasification furnace to a coal or oil furnace, it eliminates the need for a plasma plant's gas treatment equipment, which make up approximately 50 percent of the overall cost of building a plasma waste treatment facility. The gases from the plasma furnace would combine with the gases in the coal or oil furnace. The relatively clean gases from the plasma furnace would help boost efficiency and reduce the amount of coal or oil needed to generate power.

- **Decontamination**

The intense heat from plasma torches can completely neutralize the hazardous components found in diseased livestock or contaminated soil. Engineers could transport modular, portable plasma facilities to dispose of animal carcasses or treat soil on site. Incineration of such hazardous material doesn't always destroy all the contaminants, or produces ash that is also hazardous waste. Plasma gasification would destroy or render inert any harmful material.

## FAQs

**Q: What types of waste can the Plasma Converter process?**

A: All types of waste; solids, liquids, and gases, can be processed separately or simultaneously.

**Q: How much pre-preparation is necessary before processing?**

A: None. The Converter processes all materials without sorting. In some cases it may be desirable to volume reduce waste materials through the use of a shredder to achieve optimal processing efficiencies.

**Q: How effectively does the Plasma Converter process medical waste and other troublesome hazardous waste streams such as PCB's?**

A: The Plasma Converter can process all such hazardous wastes safely and efficiently. Temperatures in the Plasma vessel reach in excess of 30,000° F at the core of the Plasma field. All wastes fed into the vessel are irreversibly destroyed and converted, through the process of molecular dissociation, into a safe synthesis fuel gas called Plasma Converted Gas (PCG).

**Q: What type of feed systems can the Plasma Converter accommodate?**

A: All types; ram, auger, rotary valve, top gravity feed, and others. In addition, liquids and gases are fed into the vessel simultaneously through their own dedicated ports.

**Q: What volumes of waste can the Plasma Converter process?**

A: The Plasma Converter vessel is manufactured in several standard industrial sizes; 5 tons per day (tpd), 10 tpd, 20 tpd, 50 tpd, and 100 tpd. Resource Recovery Facilities of 500 tons per day and larger are under proposal, utilizing multiple 100 tpd vessels and centralized gas scrubbing.

**Q: What are the principal by-products of the system?**

A: The two principal byproducts of the Plasma Converter are a synthesis fuel gas called PCG and an obsidian-like stone, which is non-toxic and non-leachable. Both are commodity products that offer the customer revenue potential. The PCG can be directly used for plant heating or cooling, to make electricity, or to desalinate water, as well as other uses. Additionally, the PCG can be used to make hydrogen or methanol. The obsidian-like stone can be sold to the construction and abrasives industries.

**Q: Does the system create any kind of emissions?**

A: When the gas is used as a feedstock, no stack is necessary as all commodity byproducts are recycled for further use. PCG is similar to natural gas when used to generate steam (ie. Boiler) or energy (ie. Microturbine).

**Q: Can the Plasma Converter generate its own power for processing?**

A: Yes, for most carbonaceous waste streams, enough PCG is produced to run a motor generator set or turbine to produce the electricity needed to run the system plus some residual electricity

that can be put back into the electrical grid or sold to others. This electric generation capability is especially important for remote areas or where the cost of electricity is particularly high or availability is limited.

**Q: What equipment is included in the Plasma Converter System ?**

A: The system includes the Plasma Converter Vessel with feed system, Plasma Torch and Power Supply, A High Pressure Cooling Water System, Central Computer Control Station, and Gas Polishing System. The system delivers a cleaned, cooled, scrubbed synthesis gas ready for use. The customer will need to supply PCG storage and use equipment such as compressors, motor-generator sets, turbines, and boilers to employ the PCG.

**Q: Is performance insurance available and can AEL provides financing?**

A: Yes, performance insurance is available to qualified buyers. The insurance provides coverage for a buyer's intended waste stream as well as for the successful permitting of the Plasma Converter system for the specific application.

AEL can arrange project financing for creditworthy buyers and will consider taking an equity position in a joint development arrangement for those projects that offer an attractive financial return.

### FAQ's Relative to Homeland Defence

**Q: Can the Plasma Converter process and destroy Anthrax?**

A: Yes, the Plasma Converter will irreversibly destroy many hazardous contaminants including anthrax, mad cow disease, and foot and mouth disease.

**Q: How would a Plasma Converter get to a ground zero site in the event of a terrorist hazardous attack?**

A: Truck-mounted mobile Plasma Converter systems that could be rapidly deployed to process and destroy hazardously contaminated materials at ground zero.

**Q: How are anthrax and other hazardous contaminants irreversibly destroyed?**

A: The intense radiant energy and super high temperatures created by the plasma arc will cause the actual molecules that make up the viruses and bacteria to break apart through a process called "molecular dissociation". No hazardous organisms or agents that go into the Plasma vessel survive.



## LOCATION

### PLASMA/GASIFICATION

#### PROJECT DEVELOPMENT – COMMERCIAL PROJECTS

The Plasma torch systems are proven in metallurgical and waste-to-energy (WTE) commercial applications. In Japan, the WPC plasma gasification system has been used to process municipal solid waste (MSW) for more than five years. Plasma torches have been used in cast iron foundry melting at a General Motors Plant in Defiance, Ohio since 1989

<b>WPC Plasma Torch Installations</b>	<b>Application</b>
2001 Hitachi Metals Ltd. Utashinal, Japan-Eco-Valley Waste-to-Energy Facility	Commercial Gasification of Auto Shredder Residue & MSW
2002 Hitachi Metals Ltd. Mihama, Japan	Commercial Gasification of MSW & Waste Water Sludge
1995 Ishkawajima-Harima Heavy Industries Co. (IHI) Kinuura, Japan	Commercial Vitrification of MSW Incinerator Ash
1992 Aluminum Canada Ltd. (ALCAN) Chicoutimi, Quebec – Canada	Commercial Aluminum Dross Recovery Furnaces\
1989 General Motors Corporation Central Foundry Division Defiance, Ohio, USA	Commercial Cast Iron Production
2008 SMS Infrasturce Nagpur, India	Commercial Gasification of Waste (Currently being commissioned) 72 Tons per day
2008 SMS Infrasturce Pune, India	Gasification of Hazardous Waste 72 Tons per day
1999 Hitachi Metals Ltd. Yoshi, Japan  City of Madison Madison, Pennsylvania US50 – US\$100 Million	Gasification of MSW Plant  Commercial Demonstration Facility capable of up to 1 TPH feed . WPC has completed more the 100 pilot tests on a multitude of feedstock. Proprietary IP with 22 active patents worldwide. Processing 48 tons per day

Summerset Power Plant State of Massachusetts, USA	The largest Plasma retrofit energy project in Massachusetts
Miranmar Air Force Base Miranmar, California	4,000 tpd plasma gasification plant (Restricted Site)
City of Jacksonville Jacksonville, Florida	1,000 tpd plasma gasification plant (Under construction)
St Lucie	3,000 tpd WTE Plant – one of the largest Plasma Gasification facilities. Produces 60MW of energy (Under Construction)
New Orleans	2,500 tpd garbage to electricity using Plasma technology
Somerset, Massachusetts	Gasification plasma technology used in retrofit of coal fired power plant
Muhlenberg County Kentucky, USA	WPC plasma gasifier using coal feed stock levels to 500 tpd
Tallahassee, Florida	Installing a WPC designed plasma gasification system to convert municipal solid waste into clean energy, including will produce 30 MWH

The use of plasma torches has been known since the 1930's and primarily used in metallurgy and the destruction of hazardous waste. High prices for oil and the realization that the amount of oil is limited has put focus on the conversion of organic matter into synthesis gas (Syngas), which in turn can be used for the production of transportation fuels or injected into a typical combustion turbine for the production of electricity. Organic matter, which is ordinarily disposed of in landfill can now be converted to biofuels and/or electricity. This process has many advantages over the typical combustion of fossil fuels.

In Plasma Gas Vitrification (PGV) there is no ash residue, no toxic or leachable product. Water and air quality is vastly improved in comparison to incineration of fossil fuels. Hundreds of thousands of tons of waste materials can be diverted from landfill disposal to electric generation.

Plasma Gasification Technology, offers an environmentally responsible solution for older plants and works with numerous feedstocks including: Solid & biomass, coal, construction and demolition waste. Feedstock such as biomass can be co-gasified with coal in retrofitted plants, reducing non-renewable resource use.

Over 1,200 Plasma Ignition Systems in operation worldwide.



## Overall Emission Rate Reduction

HG (Mercury)  
**95% REDUCTION**

SO<sub>2</sub> (Sulfur Dioxide)  
**95% REDUCTION**

NO<sub>x</sub> (Nitrogen Oxide)  
**60% REDUCTION**

CO<sub>2</sub> (Carbon)  
**Capture Compatible**

## Other On-Going Projects

### Plasma Fuel Systems



Working on a research grant provided by the United States Air Force, the R&D team developed some of the theoretical models for the use of plasma to supersaturate metal hydrides with Hydrogen. It was able to show to the satisfaction of the Air Force that with the use of specially tuned plasma and quenching systems they could increase the amount of hydrogen that could be stored in lithium hydride, magnesium hydride and especially aluminium hydride.

The scientists were able to triple the storage capacity of these metal hydrides and keep them stable at far higher temperatures than had been previously possible.

The applications that are currently being researched include rocket fuel, military munitions and a canister based hydrogen storage system for automobiles.

The team is vigorously engaged in securing grants from NASA, the Department of the Air Force and DARPA to continue with the research.

### Plasma Synthesis



The scientists have expertise in the use of plasma to synthesize compounds at much lower cost than conventional methods. They constructed a plant that produces Titanium Oxide using plasma technology.

It is currently in operation. Titanium Oxide is used in cosmetics, the production of white paint and in the manufacture of capacitors.

Another compound produced from the plasma technology is silicon dioxide that is used in light reflecting paint as well as an admixture for ceramic base substrates.

The scientists have also constructed a plant that produces silicon nitrate using plasma. This material is required for the manufacture of ceramic tools.

Both plants have demonstrated significantly lower operating and production costs than would have been possible using conventional non-plasma technology.

This project is currently engaged in research to produce industrial and gem quality diamonds by plasma.

### Platinum Group Metal Plasma Applications



The team has spent a great deal of time and has clearly the world foremost expertise in the use of Radio Frequency plasma torch technology for the processing of precious metal ore. This expertise has extended to mining, concentrating, assaying, smelting and leaching of these precious metals ores.

A large facility in Los Angeles has constructed six 300Kw units to process up to 12 tons a day of precious metal ore, electronic scrap and base metal recyclables. The team has also designed a plant and supplied their

technology to a large Japanese precious metal processor. That plant is scheduled to go online in January 2010.

AEL is now engaged in negotiations for much larger plants in other Asian countries. They are now in the ending stages of planning for a new facility in the United States in preparation of electronic scrap that will be used as the substrate for both the American and Asian operations.

Further research on the plasma technology use in precious metals recovery from brine generated from oil wells in the Southwest United States. Testing and research has shown initially promising results and will be a focus of the company in the near future.

### Plasma Surface Modification



For the past ten years, exhaustive research on the plasma modification of seed surfaces demonstrating a significantly increased growth rate, brix value, size and weight of crops such as wheat, tomatoes, corn, barley and cowpeas. The plasma changes the surface characteristics of seeds allowing for greater nutritional transfer

from the soil. Currently the project is exploring a joint venture with several large seed companies to continue with ongoing research as well as a start up commercial plant.

On the same token, the project has applied the plasma surface modification technology to paper products finding it ideal for archival protection by making the paper hydrophobic. Conversely by altering the parameters of the technology, it can make the paper hydrophilic resulting in improved ink adhesion and gluing. This same technology has been applied to both plastics for ink adhesion and gluing as well as fabrics where the plasma surface modification can protect clothing in its hydrophobic mode and improve color transfer when made hydrophilic. The project will be ready within the next year to commercialize these processes.

### Plasma Waste Recycling



Medical waste is an international recycling problem as the hazardous waste that emanates from medical testing and treatment can be very dangerous to hospital and sanitation workers. The R&D team has designed a system that is both efficient and safe. Based on the proprietary plasma technology, the equipment can be placed on a mobile platform for use in multiple hospital locations.

Medical waste is also primarily municipal solid waste except for about 25% of the material that is bio-hazardous such as drugs, chemical reagents, disposable instruments and post-surgical waste. This kind of material requires special treatment and plasma is most efficient when processing only these biohazardous items. It is the only technology that has the capability of processing every form of medical waste economically.

The RF Plasma system includes a liquid nitrogen (LN2) generator, a LN2 crusher and mill, a feeding system, a primary nitrogen plasma torch and reactor, a cyclone, a bag house filter, a secondary oxygen RF plasma torch and reactor and a wet scrubber.

A conveyor delivers waste powder to be decomposed by the primary nitrogen plasma torch in the first reactor transforming it into stable carbon black. The carbon black is quenched and collected into container. The off gas that results from the thermal treatment in the primary reactor is directed to a cyclone followed by a bag house filter into a second oxygen plasma torch and finally into the secondary reactor. The exhaust gas is deacidified by weak alkaline water in wet scrubber. This RF plasma system can be designed to be either stationary or mobile with a production rate of 5 tons/day. The total power required is 400 kW.

AEL is currently in negotiation with several Mexican states and is looking to take this technology worldwide.



**Polychlorinated Biphenyls (PCBs)** are a mixture of up to 209 different chlorinated compounds. Efficient treatment of this waste with RF Plasma depends on optimizing the unit's parameters for each individual PCB composition.



The eight current technologies used to treat PCB waste have the same flaw in that they do not achieve a DRE (Destruction and Removal Efficiency) of 99.9999%.

The RF Plasma System addresses this DRE flaw making the technology the most efficient current method for PCB waste treatment. The high ion temperatures and electron energies associated with RF plasma's fast dissociation reactions combine to make the technology capable of reaching the required DREs.

Although the plasma system is compact it has a high throughput. The RF Plasma system consists of a solid/liquid PCB pre-treatment unit, an electrodeless plasma torch that can work in any environment including halogenated gases, a reactor, a gas separation unit, an emission control unit and an RF/DC power supply. Initial PCB wastes are fed directly into the steam plasma torch. The resultant dissociated components are then quenched in the reactor. The exhaust gas can be recycled as fuel gas for a gas turbine after being cleaned by a cyclone/filter system and a wet scrubber.

The R&D team is working in tandem with its medical waste recycling project to present the technology to several Mexican states. The system has application worldwide.

Waste tires are a significant recycling problem. The team has designed a plasma based solution that is both elegant and efficient to deal with the hundreds of millions of tires are scrapped each year that only add to the mounting waste in landfills.

Plasma system recovers the saleable material and generates a marketable syngas.

**Scrap tires** are pre-treated with a shredding system that initially turns the tires into 6-inch strips. These strips are conveyed to a granulating shredder that removes any wire and reduces the shredded tire particles to 3/8 inch or less.

The shredded tire particles are conveyed and fed to the plasma reactor through an air interlock system that controls the plasma reactor's gas environment. Two plasma torches heat the shredded tire. The plasma reactor's average temperature stabilizes in seconds. When the reactor temperature rises to ~ 500F, the reactor begins to generate the vaporized gases methane, ethane, butane and propane. By adding high temperature steam into the reactor we partially oxidize the carbon and generate a synthetic gas consisting of ~ 40 % CO and 40% H<sub>2</sub>. Two tons of waste tires are completely decomposed in ~ 1 hour, producing 740 kg of Carbon Black, 200 kg of steel and ~ 1000 kg of other hydrocarbons. The tires also contain ~ 3.2 percent of Zinc by weight that is trapped in the Carbon Black and not dispersed.

The vaporized gas exits the plasma reactor with an average temperature of ~1500 C. It is directed to the cooling/cleaning system that includes a quenching unit, a water-cooled cyclone and a wet scrubber. The clean, cool gas could be used as fuel for gas turbine electrical generators or could be liquefied. The emission control system includes a final filter, a high-energy oxidizer as well as gas sensors.

The plasma reactor works in a batch mode of ~ 2 tons of shredded waste tires. The synthetic gas yields ~ 2.9 m<sup>3</sup>/kg with a specific heat value ~ 6 MJ/m<sup>3</sup>. The company is looking to install several of these facilities in Mexico.

**Cow manure** is produced in vast quantities in many parts of the world. The bacterial contamination of ground water from the leaching of manure into aquifers and other ground waters are a serious public health issue in both developed and undeveloped nations. This

project has conceived a solution using its plasma technology that eliminates the bacterial pollution of water sources while producing a valuable, safe fertilizer for the regions' farmers.

Cow manure is conveyed to a "pre-treatment disinfection system" where it mixes with a low pH disinfectant in agitator-equipped holding tanks. This sludge moves to a centrifuge or belt-press conveyor based dewatering unit where the material is separated into solids and wastewater. The solids are processed in an atmospheric plasma RF electromagnetic system that bacterially de-contaminates the material while reducing the maximum liquid content to 25%.

These processed solids are fed into a dry extruder that compresses and reduces the volume. This final product can be used as a non-toxic dry fertilizer.

The wastewater is conveyed to a treatment system that includes a pre-filter that removes particles down to 100 microns in size, a 20 micron centrifugal cartridge filter, an automatic or manual backwash controller and multi-coaxial plasma reactor. The resultant industrial grade water can be adjusted by the plasma unit to almost any pH. High pH water can be used in the wet scrubber and deodorizing unit while low pH water can be used as the first stage of the system as a cow manure disinfectant.

The company plans to build several plants for regions of Mexico that have significant cow manure problems.

**Hydrogen Sulfide** gas is produced as an exhaust from refineries. Polymet has designed plasma systems that separate sulfur from hydrogen eliminating the odiferous pollution.

**Hydrogen Chloride** is a dangerous acid that is commonly produced from a number of manufacturing processes. In a co-venture with I. E. Dupont, the R&D team has developed a megawatt scale plasma process to turn Hydrogen Chloride into chloride and hydrogen. This technology, patented by the company's scientists is in use worldwide.

### Plasma Spheroidization



Another project developed a radio frequency plasma torch technique to spheroidize metals for various manufacturing processes. The following is a list of metals already spheroidized and in certain cases nanometerized.

**Molybdenum** micro spheres are used in steel forging and rolling applications as well as thermal spray applications.

**Tungsten** nanometer size spheroids have been applied in military grade bulletproof vests.

**Tungsten Carbide** micro spheres have been used in a multiplicity of high stress situations where it is used as surface protection to guard against excess wear. The material has also been used to protect gas turbine exhausts.

**Cast Tungsten Carbide** micro spheres are used in machined metal parts for surface protection and particularly helpful on the surface of oil drill bits.

**Aluminum Oxide** and **Zirconium Oxide** micro spheres are used extensively in applications requiring high temperature coating Magnesium Oxide micro spheres have been used in the construction of submarines as insulation for various heating elements.

**Ferric Oxide** micro spheres are commonly used to simulate fuel injection experiments.

### Plasma Activated Water



The R&D team has developed a multi-coaxial plasma reactor that that alters the physical properties of water. Common tap water or even drinking water is not a monomolecular liquid, but a clustered liquid. Clustered water consists of water molecules forming small groups or clusters. The other characteristic of clustered tap water is that it has a pH between 7-8 and an oxidation-reduction potential averaging +500 mV. Water with a pH of 7 is neutral. Lower pH levels indicate increasing activity, while pH levels higher than 7 indicate

a more basic solution.

The multi-coaxial plasma reactor produces both low and high levels of pH water depending upon the application. Lower pH levels result in water used for anti-bacterial and sanitizing needs while higher pH levels result in water used for feeding and drinking.

This unique plasma process is a non-chemical method of treatment. The plasma technology breaks the clusters of molecules in the water producing monomolecular water. A gas mixture of oxidizing and/or reducing agents is ionized creating plasma inside of a quartz vessel. This newly created plasma contains ionization properties that include charged particles, ultrasound modulation and ultra-violet radiation.

Tap water crosses an electromagnetic field while exposed to ultrasound and ultraviolet radiation from the RF pulsed plasma decreasing water clusters from 10-24 to 1-3 for the plasma activated water. The activity of the water increases in proportion to the decrease of water clusters.

The monomolecular, activated water's small sized water molecules allow it to penetrate the membranes and pores of produce and animal foods killing most types of bacteria. The monomolecular water increases the effectiveness of the low levels of chlorine already found in tap water making the chlorine much more aggressive towards bacteria. Combined with a lower pH level, the plasma activated water becomes even a more powerful anti-bacterial agent making the water more acidic.

The plasma process transforms the impurities of tap water to a more safe, efficient and effective way of water use. Mineral substances are easily dissolved in the water transforming

it into an ionized form. This makes their assimilation and usage more effective and easy. The monomolecular water is less hard than tap water as carbonates are precipitated in the process. As well, it tastes better containing less chlorine mercury, cadmium, and nitrates.

The company has constructed several commercial sized units for further testing and is currently in negotiations to mass market the technology.

## R&D Team

### Dr. George Paskalov

Dr. Paskalov is the Chief Scientist of this plasma project. He is also a Research Associate in the Department of Physics, Plasma Physics Laboratory at the University of California, Los Angeles and has been from 1999. Dr. Paskalov has been a Senior Scientist with Plasma Plus Inc., located in Los Angeles and was responsible for development of new technology for plasma modification of materials and purification and spheroidization and densification of dispersed powders from 1994 to 2000.

From 1993 to 1994 Dr. Paskalov was Chair of Electrotechnics, Associate Professor with the Technical University St. Petersburg, located in St. Petersburg, Russia and was responsible for lecture on modeling of plasma processes. Prior to this Dr. Paskalov was Senior Scientist in the Electrothermal Installation Laboratory with the Technical University St. Petersburg located in St. Petersburg, Russia from 1982 – 1994 where he worked on the development of high power RF Plasma torches.

Dr. Paskalov holds a M. Sc Electrical Engineering from the Technical University St. Petersburg, located in St. Petersburg, Russia and a Ph.D. Plasma Processing and installations from the Technical University St. Petersburg, located in St. Petersburg, Russia. He is a member of APMI International and the Society of Inventors, has co-authored two books, published 54 articles and is the holder of 6 U.S. patents.

### Mark Gorodkin

Mr. Gorodkin was ex-business director with Plasma Plus Inc., located in Los Angeles and was responsible for technical support, maintenance and marketing research from 1991 to 2000. From 1989 to 1991 Mr. Gorodkin was also an ex-business director with LML Inc., located in Los Angeles, and was responsible for market research.

Prior to this Mr. Gorodkin worked with Plastmass in Bobruysk, Belarus as Business Director responsible for marketing research from 1987 – 1989 and with Fermash in Bobruysk, Belarus as an Electrical Engineer in technical support form 1977 – 1987. Mr. Gorodkin holds a B.Sc Electrical Engineering from the State University of Belarus at Minsk and a Dip. Business Management from the School of Management at Minsk...

## Viktor Sokolov

Mr. Sokolov is in charge of equipment engineering and assembly. He was a Research Engineer with Plasma Plus Inc., located in Los Angeles and was responsible for research on RF power source and plasma modification of materials as well as purification, spheroidization and densification of dispersed powders from 1994 to 2000.

Prior to this, from 1985 to 1994, Mr. Sokolov was a Research Engineer in the Laboratory of Electrothermal Installations working on RF pilot installations for plasma treatment of powders and pulse modulated RF generators for thermal plasma. Mr. Sokolov holds an M.Sc. Electrical Engineering from the Technical University Petersburg, located in St. Petersburg, Russia. He has published 12 articles.

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## CONCLUSION

The Company believes that this will make an excellent investment in environmentally responsible clean technology. By focusing a superior plasma variant technology on a singular problem, scrap tires, they continue to pursue in developing a best practice system for the re-use and recycling of a growing problem and providing all stakeholders with an experienced team and a sound plan.