Waste-to-Energy Systems

By Mrs. Rebecca C. Wingfield

One of our newest resources is common, everyday trash. "Basic" science tells us that all objects have energy, whether they are trash, scraps, or treasure. Therefore, with the energy situation we are in, many have begun—or already had been—looking at our newest resource for energy. After all, a British thermal unit (BTU) of trash is the same as a BTU of petroleum. This idea has the potential to make companies a lot of money if they can solve some of the problems associated with turning waste (trash) into clean energy.

Clean energy is the crux of the problem. In former times when it was common, open burning of trash was smelly, dirty, and not very efficient. The Environmental Protection Agency (EPA) was created in 1970 with a mandate to clean up and protect the environment, so open trash burning in dumps in the United States became a thing of the past.

". . . [President Nixon] and Congress worked together to establish the…EPA…in response to the growing public demand for cleaner water, air, and land. Prior to the establishment of the EPA, the federal government was not structured to make a coordinated attack on the pollutants that harm human health and degrade the environment. The EPA was assigned the daunting task of repairing the damage already done to the natural environment and to establish new criteria to guide Americans in making a cleaner environment a reality."[1]

The next phase was to burn trash in special incinerators to produce heat energy, which was done on several college campuses and some military installations. Many of these incinerators shut down in the 1980s due to tougher air pollution regulations. Now, we are considering using municipal solid waste (MSW) (trash) to produce energy (electricity) for cities and elsewhere.

Systems Under Development

Technology is advancing, and several types of systems for producing energy are being tested:

Tactical Garbage to Energy Refinery

Last summer in Iraq, a system was tested called "Tactical Garbage to Energy Refinery" or TGER (pronounced "Teeger").

"TGER is small enough to fit into a CONEX [military shipping] container, but . . . [powers] a standard 60-kilowatt generator. TGER works by turning the solid [mixed waste] trash into fuel pellets which are fed into a down-draft gasifier. The gasifier [another word for a pyrolysis system] then heats the pellets, and breaks them down into a synthetic gas [syngas] composed of simple hydrocarbons that resembles low-grade propane. TGER processes the liquid and food waste into a hydrous ethanol, which is blended with the syngas to create usable energy. It takes TGER six hours to fully power up, during which time the amount of diesel fed into the machine slowly drops, until the generator is powered by less than one gallon of fuel per hour, as compared to five per hour without TGER."[2]

TGER's fuel is a mixed waste stream of sorted MSW of papers, plastics, and food-slop garbage. TGER, as it was tested, does not process glass, metals, or hazardous waste streams like medical wastes. This waste must still be processed some other way, but TGER is a step in the right direction.

Swearing in of the first Environmental Protection Agency administrator in 1970.

Biotechnologies

The Army has seen the opportunity to use biotechnologies to solve real problems to provide energy to power generators, and so forth, which provide about half of all the energy used at most forward operating bases (FOBs).[3] A new biorefinery from the United States Army Research, Development and Engineering Command (RDECOM) could cut down on the need for some of the fuel convoys during deployments. *"The two 4-ton machines were designed to fit into standard ISO [International Organization for Standardization] containers, bringing the technology down to a size that is easily transportable."*[4] According to RDECOM, the technology itself is not new:

"What's new about it is the way we put together two different technologies to have a hybrid. First, all the garbage is fed into a chute . . . ground . . . pelletized and gasified. . . Advanced fermentation is used for the food slop and field rations, which get converted into hydrous ethanol. We take those two streams and we blend them, and it gets aspirated into a standard Army generator set . . . a TGER unit can handle about a ton of garbage a day," creating a potentially significant alternative fuel source for the military. *"So if we can keep some of the convoys off the roads . . . drastically cut down on fuel use, it's a good thing all around. The only other byproducts from the TGERs are ash . . . a benign soil additive, and water . . . Once the TGER is ready for prime time, there's likely to be plenty of need for the units, and not just in the Army. The potential for their use at something like a post-Katrina event is huge, because there was plenty of garbage, plenty of trash, but no power.* [Other uses for them could be] *. . . at campsites, at hospitals, at schools,"* or wherever there are people creating masses of trash.[5]

Pyrolytic Gasification

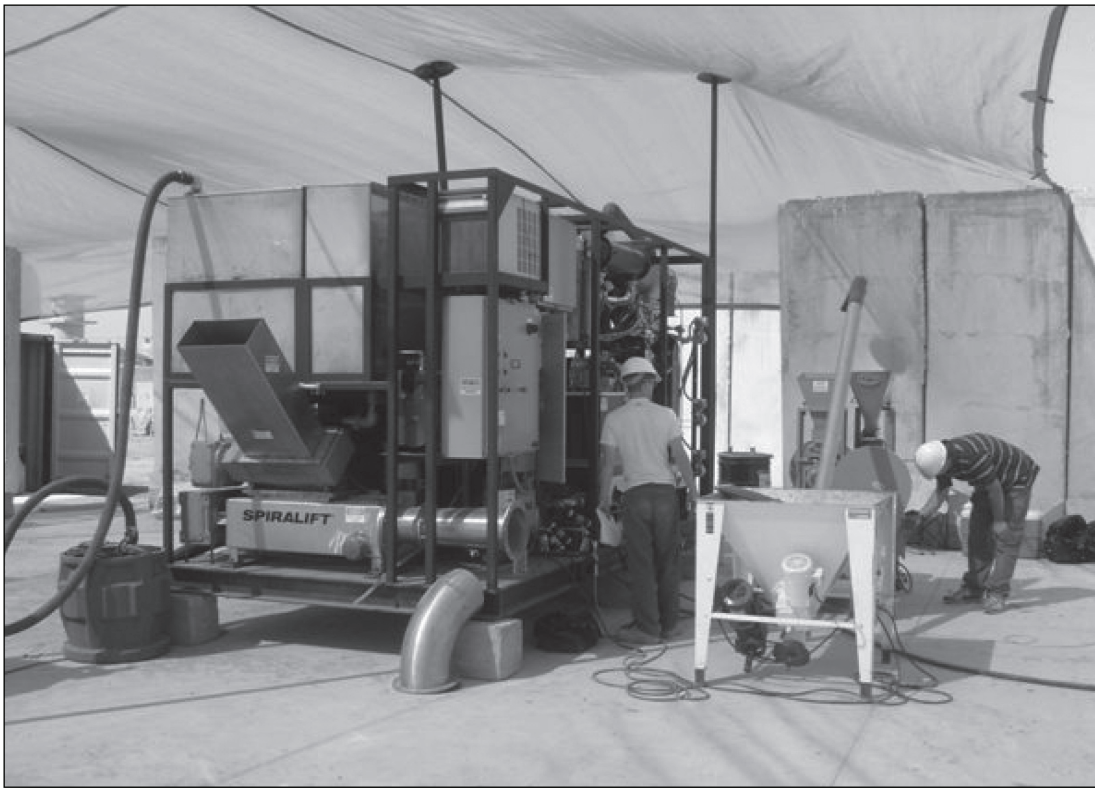
Pyrolytic gasification is not a new term. *"The principles were first brought forth in 1958 at Bell Laboratories within the United States. . . . Thereafter, a number of universities and organizations around the world started R&D [research and development] programs. The word pyrolysis, meaning chemical change brought about by heat, is widely used— even by incineration technologies, which have tried to escape their roots in oxidation and combustion because of the problems prevalent with both. Gasification is . . . the chemical reaction and molecular breakdown or degradation of materials.*

The first pyrolytic gasification systems were brick ovens that used indirect heat/low oxygen.... Waste was placed into the unit, the unit was sealed, and heat applied. After the process of degradation was completed, the oven was opened and emptied to make room for the next batch. Therefore, these systems were known as batch-by-batch systems. This format was first introduced commercially in the early 1970s."[6]

Across the pond, the Royal Navy is using technology to produce energy from waste with pyrolysis technology from QinetiQ.® *"As landfill sites become increasingly overloaded and refuse disposal an escalating problem, engineers have perfected a technology that not only breaks down waste to just a fifth of its previous volume, but generates energy at the same time."*[7]

In this technique of burning waste without oxygen, *". . .pyrolysis as a method of waste disposal provides a host of potential benefits. Unprocessed waste can be treated in a burner to reduce its mass by 80 percent. The end product is an inert ash, which itself is useful and can be bonded to form the lightweight blocks used for building internal walls. Additionally, pyrolysis has the potential to generate 'green'*

HMS Ocean **received a pyrolysis unit in 2008.**



Contractors install the Tactical Garbage to Energy Refinery (TGER) in Iraq.

energy as a byproduct. Pyrolysis yields an 80 percent heat output: if you put 100 kilowatts of energy into the process, it produces 80 kilowatts of heat energy. This heat can be used to power a steam turbine to generate electricity."[8]

Although this process affords the benefits of cutting down numbers of personnel and saving valuable space, *"the pyrolysis system has not been without considerable engineering challenges, however. The system is shaped like a tube, into which the waste is inserted at one end. A screwlike device then pushes waste along the tube at enormous pressure. As the waste passes through, it is heated—without oxygen—to between 800 and 1,100 degrees celsius (C). By the time it reaches the end of the tube, it has been reduced to a grey ash, which can be emptied out. The heat energy by-product of the process is fed back into the system and is used to drive the device so that, once started, it effectively becomes a self-driving process. The ship-based burners are designed to handle 2.8 tons of waste per day—roughly the amount of waste produced by the ship's complement."*[9]

Modular and Containerized Technologies

Several research and development systems have been developed that integrate technologies into modular and containerized systems. These systems usually consist of a solid waste management system, a water purification system, a power generation system, and/or living units. One of the requirements of a modern military force is that it be modular and scalable, which this system is. Approximately 20 ISO containers can carry one system that provides virtual self-sufficiency for a community of 500 people in drinking water and waste management. The plant, which is capable of dealing with about 2 tons of mixed solid waste per day, will destroy wood, paper card, food, plastics, and sanitary, clinical, and oil waste and satisfies the emission requirements of the European Union. This system is supplemented by harvesting water from the air and from the diesel generator exhaust gas stream. When burned, diesel fuel generates a useful amount of water vapor. The exhaust gas stream from the diesel generator is processed to remove the entire water content, which is then sent to the liquid waste plant for purification. As newer technology becomes available, other containers could easily be integrated into the system.

Waste Streams

"A wide variety of waste streams can be used for power production . . . The moisture content in sewage sludge and other toxic liquids or waste materials having high oxygen content will be dehydrated prior to system introduction. A material recovery facility—sometimes referred to as a municipal recycling facility (MRF)—for front-end material handling will be waste-stream specific in design. Liquids will be conveyed by a cavitation pump, whereas solids are generally transported by a conveyor system.

Transportable electrical power that is generated by the process is in the region of 3.8 kilowatt-hours per 7000± BTUs, which is the average value per pound produced by MSW—one of the lowest in calorific value. Higher BTU values of 14,000+ per pound in materials such as rubber or plastics will produce 8+ megawatt-hours. Incineration systems are typically 50 percent efficient, but with [most pyrolysis systems], 75 to 90 percent of the BTU value (depending on the waste stream) is available as an energy source."[10]

Summary

Waste-to-energy is a way to use MSW and other waste streams to produce electricity for use in cities and elsewhere. For the military to use this technology, it must be scalable and modular. Current research in systems such as TGER, biotechnologies, pyrolytic gasification, and modular and containerized technologies is yielding more economical and environmentally protective solutions for clean energy. Waste-to-energy systems are the wave of the future for many reasons, but mostly because they are the smart and right thing to do.

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Endnotes

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[8] Ibid.

[9] Ibid.

[10] Balboa Pacific Corporation, "Waste to Energy," 27 June 2007, <*http://balboa-pacific.com/WasteToEnergy/*>, and website <*http://balboa-pacific.com/WasteToEnergy/WasteToEnergy.pdf*>, accessed 30 January 2009.