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A Portable Refinery Powered by Garbage

Researchers have built and tested for the military a portable machine that efficiently turns waste into electricity.

By Tyler Hamilton

An energy-from-waste project led by researchers at Purdue University is giving new meaning to the term "military power." Scientists from the university's department of agricultural and biological engineering have developed a portable machine that turns a variety of food waste and inorganic trash into electricity, reducing the amount of diesel fuel and garbage that soldiers in the field must carry with them.

Despite being small enough to transport in a 20-foot shipping container, the "tactical refinery" is three technologies in one: a bioreactor that uses enzymes and micro-organisms to turn food waste into ethanol; a gasification unit that turns plastics, paper, and other residual waste into methane and low-grade propane; and a modified diesel engine that can burn gas, ethanol, and diesel fuel in variable proportions. The engine powers a generator that produces electricity on site. "What's unique is the way the system is integrated," says Michael Ladisch, lead researcher on the project.

Diesel fuel is required for the first several hours to get the machine up and running from a cold start. Eventually garbage, such as food waste from a mess tent, is fed into the system. The resulting ethanol and gas gradually displace the diesel fuel, which is reduced to a minimum drip. The main by-product of the machine is a benign ash that needs to be removed every few days.

Two prototypes will be shipped overseas later this year for a six-month demonstration. The hope is that the system can be shrunk down by another 60 percent, making it small enough to fit on a Humvee trailer. Its developers also hope that one day it will be practical to use it in civilian settings, such as in humanitarian- and disaster-relief zones or simply as a supplementary power system for places that generate large amounts of organic and inorganic waste.

"This is the way to go, from a sustainability perspective," says Kartik Chandran, an assistant professor of earth and environmental engineering at Columbia University. Chandran says that systems such as the one designed by Purdue are not only ideal for military applications but also make sense in poor countries that often lack electricity. "The biggest challenge is in separating the fuel after it's been produced and then cleaning it up so you don't mess up your combustion system."

The Purdue project initially studied the typical waste streams that soldiers produce in the field to select the best energy-conversion technologies. A biocatalytic process was chosen to deal with the food portion of the waste. The trick was to get the pH balance and temperature right for the mixture of enzymes and microorganisms the researchers selected. For plastics, wood, and other nonfood waste that can't be broken down in a bioreactor, a gasifier was developed that exposes the material to extreme heat in a low-oxygen environment.

"We were lucky," says Ladisch, pointing out the complex mathematical modeling that was required to make sure all parts hummed in harmony. "We turned the key and it actually started up. That's never happened in my career before."
