ENVIRONMENT (/TOPICS/TOPIC/CATEGORIES/ENVIRONMENT.HTML)

The afterlife of plastic

With more energy than coal or wood, plastic could become a new global energy source

November 11, 2014 5:00AM ET

by **Luba Ostashevsky (/profiles/o/luba-ostashevsky.html)**

Chemical engineer David Wilson holding a sample of waste plastic and oil reclaimed from plastic at BP's feedstock recycling pilot plant in Grangemouth, Scotland. James King-Holmes / Science Source

BRIDGEPORT, Conn. — For the past few weeks, Moinuddin Sarker has been driving up and down the Connecticut coast looking for a large warehouse facility. He needs it to commercialize a chemical process he has pioneered. A material chemist who was born in Bangladesh and educated at the University of Manchester, Sarker wants to go from being a bench scientist (http://www.collinsdictionary.com/dictionary/english/bench-scientist) to an entrepreneur.

In late October, he signed a lease on a 57,000-square-foot facility in Bridgeport where, with the help of $15 million from an investor, he plans to open the doors of his oil plant in January.

But he won't be drilling in the waters of the nearby Long Island Sound. Instead, he has been negotiating with local sanitation companies to buy their plastic waste and plans to use it to produce 20 million to 30 million barrels of fuel a year, enough to heat all Connecticut households in the winter months.

Sarker's company, Waste Technologies, seeks to convert plastic to oil through a process known as pyrolysis, which melts plastic in the absence of oxygen and turns it into petroleum. In the first week of November, Sarker received a patent for his version of the process. There are other U.S. companies that are trying to commercialize a similar technology, including Agilyx in Beavertown, Oregon (where Richard Branson is an investor); RES Polyflow in Akron, Ohio; JBI in Niagara Falls, New York; and HighWave Energy in Summit, New Jersey, as well as Cynar in England.

By processing the plastic that cannot be recycled — flower pots, bottoms of plastic cups, plastic wrapping around jars, styrofoam containers and even fiberglass — these companies are emulating northern European countries such as Germany, Denmark and Norway that have long viewed garbage as a gold mine.

> **"I grew up believing that plastic was the bane of our existence and that I had to find a solution for it."**
>
> **—Karin Kauffman**
> founder of company that developed thermal cracking

They are also part of an emerging industry that, according to a July study (http://chemistrytoenergy.com/new-study-columbia-university-highlights-significant-potential-recover-energy-waste-united-states) from the Earth Engineering Center at Columbia University, can revolutionize the U.S. economy and energy sources. By mining the plastic currently in U.S. landfills and converting it to oil, the study projects, it would by possible to produce enough fuel to drive 9 million cars or generate enough electricity to heat 14 million homes for a whole year.

“Plastic is considerably higher in energy than coal and wood,” says Charles Mussche, one of the authors. “[But] the companies are still in their kids’ shoes,” Mussche warns, borrowing a metaphor from his native Dutch. “They are getting into their teen years, but it is not a developed industry.”

And the chemical process is not without controversy. Environmental advocates have questions about the process’s possibly toxic by-products, how much energy is needed to run the plants and whether it’s a tacit endorsement of plastic production at a time when Hawaii, California and other states have outlawed single-use plastic bags and Rhode Island, New Jersey and Massachusetts have similar legislation pending.

But plastics-to-oil producers say they share the public’s concerns. “I grew up believing that plastic was the bane of our existence and that I had to find a solution for it,” says Karin Kauffman, who in 2003 founded the research company where Sarker developed his version of pyrolysis, with $5 million of her own money. “As a practicing Buddhist, it was a religious calling for me to figure out how to ease the pollution of plastic on our planet,” she adds.

Sarker came on board in 2005, and by 2010, he had refined the pyrolysis-like process he calls “thermal cracking.” Now with the help of a new investor he is striking out on his own to put this process into action. The technology is based on a little-known fact about plastic: that it is originally made from oil. Converting it back to oil is not difficult, according to Phillip Savage, professor of chemical engineering at Penn State University.

Garbage as a gold mine

Plastic is usually made by heating crude oil, cooling it and adding preservatives so it is able to hold its shape. It can then be molded into light, flexible forms for use as shopping bags, takeout containers or plastic toys. The great benefit of plastic — and perhaps the reason why since its development in the mid-20th century more than 6 billion tons have been manufactured (http://www.nytimes.com/2014/06/10/science/earth/future-fossils-plastic-stone.html?module=Search&mabReward=relbias%3As%2C%7B%221%22%3A%22RI%3A8%22%7D) — is that it does not react with other agents. At room temperature, plastic containers can store alcohol, water and even fuel.

To turn plastic back to its original state requires subjecting it to heat of about 707 to 752 degrees Fahrenheit in an oxygen-starved environment. It is different from burning since there's no combustion with oxygen. The plastic is literally turned to vapor, which can be captured and turned to liquid, producing kerosene, gasoline or diesel fuel, which, according to Sarker, is ready to be put straight into any machine with an engine.

"'[Oil from pyrolysis is] no different from what you buy at a gas station. It's even a higher quality. It can power cars, generators, anything with an engine.'"

—Moinuddin Sarker
developer, thermal cracking

Sarker says that it costs only about $1 to produce a gallon of oil through pyrolysis, which is "no different from what you buy at a gas station — it's even a higher quality," he says. "It can power cars, generators, anything with an engine." Sarker's investor owns an oil refinery and several gas stations and plans to combine the oil from the new plant with his oil and sell it, Sarker says.

Plastic waste makes up 13 percent of all solid waste in the United States. According to figures from the Environmental Protection Agency (http://www.epa.gov/osw/conserve/materials/plastics.htm), out of the 200 million tons of plastic produced each year, 32 million tons are thrown away after a single use. Nine percent of all plastic can be recycled, but the rest goes straight into landfills. Some of that ends up in the ocean.

While there aren't exact figures for just how much, cases of marine animals that have died from ingesting plastic have made it into headlines. This summer and fall, two sei whales washed up on shore in Virginia and off the coast of Washington state, near Seattle.
A necropsy of one of the whales (http://blog.oceanconservancy.org/2014/08/26/plastics-are-a-whale-of-a-problem-for-our-ocean), a female, revealed that a piece of plastic that looked like a DVD case was lodged in her stomach. The one in Seattle had plastic bags and golf balls in its stomach.

Jay Schabel, the chief executive officer of RES Polyflow, has similar plans for processing solid waste. With a functional plant, he is further along than Sarker; Schabel is currently working out the kinks of the industrial process. RES Polyflow plans to process, on average, 5,000 pounds of waste an hour to produce 3 million gallons of fuel a year.

A technician holding a handful of shredded waste plastic at a recycling facility, BP's Feedstock Recycling Pilot Plant, Grangemouth, Scotland.
James King-Holmes / Science Source

He has worked closely with waste companies and used to think that large chemical companies would be the first to these emerging pyrolysis technologies, but "big petrochemical companies have dabbled with it as a way to get rid of the plastic they produce," he says, "but they couldn't make it work financially, so it's left to smaller start-ups to try.

Polyflow is working with the agriculture sector to collect heavy farm-related materials such as the plastic sheets used to line crop beds and the large, heavy-duty bags used to move crops, fertilizer and soil. "And if we can make plastic waste a valuable material, the benefit is that it's less likely it'll continue to pollute the environment," he says.

Environmental benefit?

Sarker and Schabel both hope that turning plastic waste into a commodity will be good for their companies and good for the environment.

But Keith Weitz, an environmental scientist at RTI International, a nonprofit research institution that tracks waste management, says the technology is not quite there: “We’re a good few years out before we see how well the first-generation facilities work in real-world settings.” Plus, there are significant barriers, such as federal rules and requirements governing the quality of transportation-grade fuel. This means that “the synthetic oil produced by pyrolysis will likely require additional refining if it is to be used as a vehicle fuel. This increases the cost to facilities and consumes energy resources,” he writes in an email.

Some energy experts also worry about pollutants and that sending more carbon into the atmosphere will cause further damage to the ozone, fueling climate change.

“It all depends on the problem you want to solve,” says John DeCicco, an energy expert at the University of Michigan. “If your objective is to lower carbon dioxide in the atmosphere, pyrolysis is not necessarily a benefit. If plastic is landfilled, you’re as ahead of the game as you’re going to be by keeping the carbon out of the air.”

A worker transports discarded plastic bottles imported from Australia, at a plant in Hong Kong's rural New Territories, August 24, 2011, before a process which separates plastic waste from them. Bobby Yip / Reuters / Landov

Environmentalists have a similarly measured response. Charles Moore, an oceanographer who in 1997 discovered a large mass of plastic in the Pacific Ocean (dubbed “the great Pacific garbage patch (http://education.nationalgeographic.com/education/encyclopedia/great-pacific-garbage-patch/?ar_a=1)” by the media) and who leads a foundation dedicated to keeping plastic pollution out of oceans, says that pyrolysis “doesn’t stop the generation of plastic to begin with, which should be the goal.”

His preferred solution would be finding an alternative to plastic that is biodegradable. He would, however, endorse pyrolysis as an interim solution if there were a way to stop plastic waste from washing into the ocean. “I just came back from an expedition in the Pacific and I’ve never seen so much plastic out there,” Moore says.

But environmental agencies such as National Resource Defense Council say more pragmatism is needed. “Every category of waste has its best ecological route. And converting the plastic that can’t be recycled to liquid fuel is a good path,” says Allen Hershkowitz, a senior scientist and waste expert at the NRDC.

“‘Producing oil from waste at home should be considered better than using energy to bring petroleum from halfway round the world.’”

—Jay Schabel
CEO, RES Polyflow, a plastics-to-oil company

Regarding the concerns about environmental damage from pyrolysis, Schabel argues that “producing oil from waste at home should be considered better than using energy to bring petroleum from halfway round the world.”

Yet environmental groups are also concerned about the end product of pyrolysis. When plastic is first made, preservatives such as talc, sawdust and hazardous additives such as lead and arsenic are added to help the material hold its shape. When the plastic melts, the additives end up as black char.

RTI's Weitz says the only studies on what gets left behind after plastic is converted to oil so far have been reports from the companies themselves. Sarker and Schabel both say the char constitutes 2 percent of the weight of the original plastic waste (for every 5,000 pounds of plastic their companies process they're left with 100 pounds of char) and that it's nonhazardous. Both their companies are in the process of figuring out a use for it.

The two men are making plans to bring this emerging technology to market. Sarker is currently negotiating to provide oil to the company that runs the ferry from Bridgeport to Montauk, New York. And Schabel's RES Polyflow is scheduled to be operational by early 2016.

Sarker already plans to open plants all across the northeast: New Jersey, New York and a second plant in Connecticut. Schabel says Polyflow has received a $1 million dollar grant from the Ohio state government but that he has also had to round up additional investor support of about $7 million. "We want to be seen as an alternative-energy fuel. Awareness is the biggest challenge."

RELATED NEWS

TOPICS
Energy (/topics/topic/issue/energy.html), Oil (/topics/topic/issue/oil.html), Pollution (/topics/topic/issue/pollution.html)

Senate may force vote to approve Keystone XL in lame duck session

US and China reach agreement on climate change, greenhouse gases