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The Prophet of Garbage

Michael Behar

It sounds as if someone just dropped a tricycle into a meat grinder. I'm sitting inside a narrow conference room at a research facility in Bristol, Connecticut, chatting with Joseph Longo, the founder and CEO of Startech Environmental Corporation. As we munch on takeout Subway sandwiches, a plate-glass window is the only thing separating us from the adjacent lab, which contains a glowing caldera of "plasma" three times as hot as the surface of the sun. Every few minutes there's a horrific clanking noise—grinding followed by a thunderous voomp, like the sound a gas barbecue makes when it first ignites.

"Is it supposed to do that?" I ask Longo nervously. "Yup," he says. "That's normal."

Despite his 74 years, Longo bears an unnerving resemblance to the longtime cover boy of *Mad* magazine, Alfred E. Neuman, who shrugs off nuclear Armageddon with the glib catchphrase "What, me worry?" Both share red hair, a smattering of freckles and a toothy grin. When such a man tells me I'm perfectly safe from a 30,000˚F arc of man-made lightning heating a vat of plasma that his employees are "controlling" in the next room—well, I'm not completely reassured.

To put me at ease, Longo calls in David Lynch, who manages the demonstration facility. "There's no flame or fire inside. It's just electricity," Lynch assures me of the multimillion-dollar system that took Longo almost two decades to design and build. Then the two usher me into the lab, where the gleaming 15-foot-tall machine they've named the Plasma Converter stands in the center of the room. The entire thing takes up about as much space as a two-car garage, surprisingly compact for a machine that can consume nearly any type of waste—from dirty diapers to chemical weapons—by annihilating toxic materials in a process as old as the universe itself. Called plasma gasification, it works a little like the big bang, only backward (you get nothing from something). Inside a sealed vessel made of stainless steel and filled with a stable gas—either pure nitrogen or, as in this case, ordinary air—a 650-volt current passing between two electrodes rips electrons from the air, converting the gas into plasma. Current flows continuously through this newly formed plasma, creating a field of extremely intense energy very much like lightning. The radiant energy of the plasma arc is so powerful, it disintegrates trash into its constituent elements by tearing apart molecular bonds. The system is capable of breaking down pretty much anything except nuclear waste, the isotopes of which are indestructible. The only by-products are an obsidian-like glass used as a raw material for numerous applications, including bathroom tiles and high-strength asphalt, and a synthesis gas, or "syngas"—a mixture of primarily hydrogen and carbon monoxide that can be converted into a variety of marketable fuels, including ethanol, natural gas and hydrogen.

Perhaps the most amazing part of the process is that it's self-sustaining. Just like your toaster, Startech's Plasma Converter draws its power from the electrical grid to get started. The initial voltage is about equal to the zap from a police stun gun. But once the cycle is under way, the 2,200˚F syngas is fed into a cooling system, generating steam that drives turbines to produce electricity. About two thirds of the power is siphoned off to run the converter; the rest can be used on-site for heating or electricity, or sold back to the utility grid. "Even a blackout would not stop the operation of the facility," Longo says.

It all sounds far too good to be true. But the technology works. Over the past decade, half a dozen companies have been developing plasma technology to turn garbage into energy. "The best renewable energy is the one we complain about the most: municipal solid waste," says Louis Circeo, the director of plasma research at the Georgia Institute of Technology. "It will prove cheaper to take garbage to a plasma plant than it is to dump it on a landfill." A Startech machine that costs roughly $250 million could handle 2,000 tons of waste daily, approximately what a city of a million people amasses in that time span. Large municipalities typically haul their trash to landfills, where the operator charges a "tipping fee" to dump the waste. The national average is $35 a ton, although the cost can be more than twice that in the Northeast (where land is scarce, tipping fees are higher). And the tipping fee a city pays doesn't include the price of trucking the garbage often hundreds of miles to a landfill or the cost of capturing leaky methane—a greenhouse gas—from the decomposing waste. In a city with an average tipping fee, a $250-million converter could pay for itself in about 10 years, and that's without factoring in the money made from selling the excess electricity and syngas. After that break-even point, it's pure profit.

Someday very soon, cities might actually make money from garbage.

Talking Trash

It was a rainy morning when I pulled up to Startech R&D to see Longo waiting for me in the parking lot. Wearing a bright yellow oxford shirt, a striped tie and blue pinstriped pants, he dashed across the blacktop to greet me as I stepped from my rental car. A street-smart Brooklyn native, Longo was an only child raised by parents who worked long hours at a local factory that made baseballs and footballs. He volunteered to fight in Korea as a paratrooper after a friend was killed in action. He's fond of antiquated slang like "attaboy" and "shills" (as in "those shills stole my patents") and is old-school enough to have only recently abandoned the protractors, pencils and drafting tables that he used to design his original Plasma Converter in favor of computers.

Today, Longo is meeting with investors from U.S. Energy, a trio of veteran waste-disposal executives who recently formed a partnership to build the first plasma-gasification plant on Long Island, New York. They own a transfer station (where garbage goes for sorting en route to landfills) and

are in the process of buying six Startech converters to handle 3,000 tons of construction debris a day trucked from sites around the state. “It’s mostly old tile, wood, nails, glass, metal and wire all mixed together,” one of the project’s partners, Troy Caruso, tells me. For the demonstration, Longo prepares a sampling of typical garbage—bottles of leftover prescription drugs, bits of fiberglass insulation, a half-empty can of Slim-Fast. A conveyer belt feeds the trash into an auger, which shreds and crushes it into pea-size morsels (that explains the deafening grinding sound) before stuffing it into the plasma-reactor chamber. The room is warm and humid, and a dull hum emanates from the machinery.

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Startech's sample fuel

Caruso and his partners, Paul Marazzo and Michael Nuzzi, are silent at first. They’ve seen the demo before. But as more trash vanishes into the converter, they become increasingly animated, spouting off facts and figures about how the machine will revolutionize their business. “This technology eliminates the landfill, which is 80 percent of our costs,” Nuzzi says. “And we can use it to generate fuel at the back end,” adds Marazzo, who then asks Lynch if the converter can handle chunks of concrete (answer: yes). “The bottom line is that nobody wants a landfill in their backyard,” Nuzzi tells me. New York City is already paying an astronomical $90 a ton to get rid of its trash. According to Startech, a few 2,000-ton-per-day plasma-gasification plants could do it for $36. Sell the syngas and surplus electricity, and you’d actually net $15 a ton. “Gasification is not just environmentally friendly,” Nuzzi says. “It’s a good business decision.”

The converter we’re watching vaporize Slim-Fast is a mini version of Startech’s technology, capable of consuming five tons a day of solid waste, or about what 2,200 Americans toss in the trash every 24 hours. Fueled with garbage from the local dump, the converter is fired up whenever Longo pitches visiting clients.

Longo has been talking with the National Science Foundation about installing a system at McMurdo Station in Antarctica. The Vietnamese government is considering buying one to get rid of stockpiles of Agent Orange that the U.S. military left behind after the war. Investors from China, Poland, Japan, Romania, Italy, Russia, Brazil, Venezuela, the U.K., Mexico and Canada have all entered contract negotiations with Startech after making the pilgrimage to Bristol to see Longo’s dog-and-pony show.

Startech isn’t the only company using plasma to turn waste into a source of clean energy. A handful of start-ups—Geoplasma, Recovered Energy, PyroGenesis, EnviroArc and Plasco Energy, among others—have entered the market in the past decade. But Longo, who has worked in the garbage business for four decades, is perhaps the industry’s most passionate founding father. “What’s so devilishly wonderful about plasma gasification is that it’s completely circular,” he says. “It takes everything back to its fundamental components in a way that’s beautiful.” Although all plasma gasification systems recapture syngas to turn into fuel, Startech’s “Starcell” system seems to be ahead of the pack in its ability to economically convert the substance into eco-friendly and competitively priced fuels. “A lot of other gasification technologies require multiple steps. This is a one-step process,” says Patrick Davis of the U.S. Department of Energy’s office of hydrogen production and delivery, which has awarded Longo’s company almost $1 million in research grants. “You put the waste in the reactor and you get out the syngas. That’s it.”

The Garbage Man

After his tour of duty in Korea, Longo put himself through night school at the Brooklyn Polytechnic Institute. In 1959, engineering degree in hand, he got a job at American Machine & Foundry (AMF)—the same company that today runs the world’s largest chain of bowling alleys—designing hardened silos for nuclear intercontinental ballistic missiles, such as Titan and Minuteman. “There was never a time I can remember when I didn’t want to be an engineer,” he says.

For years, Longo tried to convince his bosses at AMF to go into the garbage business (as manager of new product development, he was charged with investigating growth areas). “I knew a lot about the industry, how backward it was,” he says. The costs to collect and transport waste were climbing. He was sure there had to be a better way.
In 1967 Longo quit his job at AMF to start his own business, called International Dynetics. The name might not be familiar, but its product should: Longo designed and built the world’s first industrial-size trash compactors. “If you live in a high-rise or apartment building and dump your trash down a chute,” he says, “it’s probably going into one of our compactors.”

When Longo started his company, it was still easier and cheaper to just haul the loose trash to the dump. But gas prices climbed, inflation increased, and soon, business boomed. In a few years, there were thousands of International Dynetics compactors operating around the world. The machines could crush the equivalent of five 30-gallon cans crammed with trash into a cube that was about the size of a small television. “Our purpose was to condense it so it would be easier and cost less to bring to a landfill,” he says.

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Longo's Plasma Converter is built in part from off-the-shelf components. The plasma torch contained in the vessel at left above is borrowed from the metal-fabrication world.

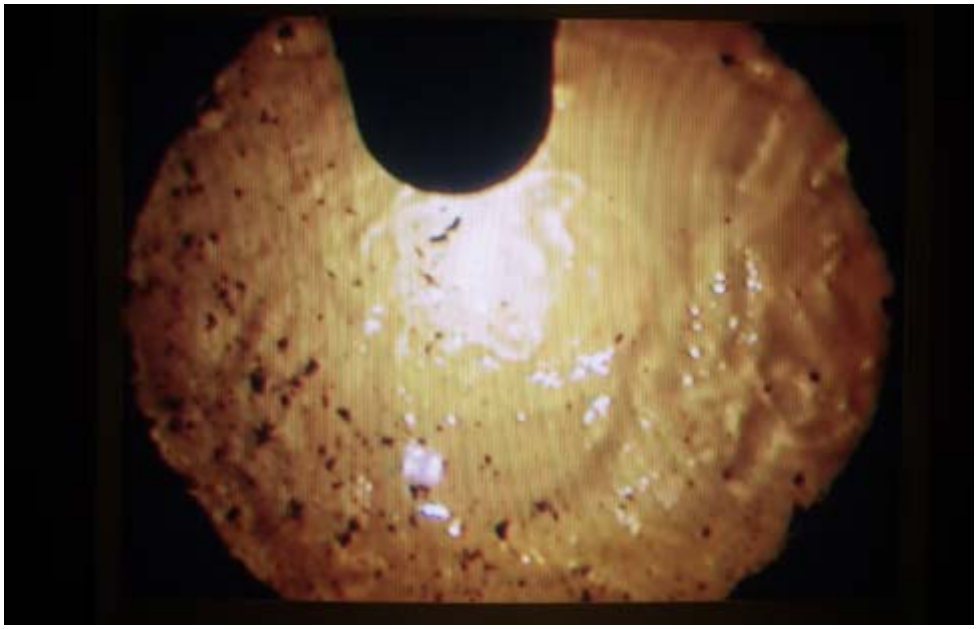
Then, in 1972, Longo read a paper in a science journal about fusion reactors. “The authors speculated that plasma might be used to destroy waste to the elemental level someday in the future,” he recalls. “That was like a spear in the heart, because we had just got our patents out for our trash compactors, and these guys were already saying there’s a prettier girl coming to town,” he says. “It would make obsolete everything we were doing. I resisted looking at the technology for 10 years. But by 1984, it became obvious that plasma could do some serious work.”

By then, the principal component of today’s plasma gasification systems, the plasma torch, had become widespread in the metal-fabrication industry, where it is used as a cutting knife for slicing through slabs of steel. Most engineers at the time were focused on ways to improve plasma torches for manipulating metals. But Longo had trash on the brain—whole landfills of trash. He was intent on developing a system that used plasma to convert waste into energy on a large scale. So he jumped ship again. In 1988 Longo sold International Dynetics and founded Startech.

Plasma to the People
“People kept asking me, ‘If this is so good, Longo, then why isn’t everyone already using one?’ ” he says, referring to himself in the third person, a device he relies on frequently to emphasize his point. “We had the technical capability, but we didn’t have a product yet. Just because we could do the trick didn’t mean it was worth doing.” Trucking garbage to dumps and landfills was still cheap. Environmental concerns weren’t on the public radar the way they are today, and landfills and incinerators weren’t yet widely seen as public menaces. “We outsourced the parts to build our first converter,” Longo says. “When we told the manufacturers we were working with plasma, some of them thought it had something to do with blood and AIDS.”

Longo describes the development curve as “relentless.” He teamed up with another engineer who had experience in the waste industry and an interest in plasma technology. “We didn’t have computers. We did everything on drafting boards. But I was aggressive. And the more we did, the more it compelled us to continue.” It took almost a decade of R&D until they had a working prototype.

“I felt like St. Peter bringing the message out,” Longo says of his first sales calls. In 1997 the U.S. Army became Startech’s inaugural customer, buying a converter to dispose of chemical weapons at the Aberdeen Proving Ground in Maryland. A second reactor went to Japan for processing polychlorinated biphenyls, or PCBs, an industrial coolant and lubricant banned in the U.S since 1977 (“really nasty stuff,” Longo says).



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A video screen allows operators to see what's going on inside the burn chamber as the plasma arc rips electrons from the surrounding air.

Longo realized early on that what would make plasma gasification marketable was a machine that could handle anything. Some of the most noxious chemicals, he knew from his decades in the garbage industry, are found in the most mundane places, like household solid waste. Startech has an edge over some of its competitors because its converter doesn't have to be reconfigured for different materials, which means operators don't have to presort waste, a costly and time-consuming process. To achieve this adaptability, Startech converters crank the plasma arc up to an extremely high operating temperature: 30,000˚F. Getting that temperature just right was one of Longo's key developmental challenges. "You can't rely on the customer to tell you what they put in," Longo says. "Sometimes they don't know, sometimes they lie, and sometimes they've thrown in live shotgun shells from a hunting trip. That's why it's imperative that the Plasma Converter can take in anything."

A video camera mounted near the top of the converter at the Bristol plant gives me a glimpse of the plasma arc doing its dirty work. At a computer station near the converter, Lynch taps a few commands into a keyboard, and a loud hiss fills the room, the sound of steam being released from behind a pressurized valve. "You can use that steam to heat your facility and neighboring buildings," he says proudly. Next to him is an LCD monitor with a live video feed from inside the reactor. A vivid magenta glow fills the screen as I watch the plasma torch vaporize a bucket of cellphones and soda cans. A hopper at the top of the vessel dumps another load into the plasma reactor, and seconds later, it vanishes too. "The idea," Lynch says, "is that regardless of what you put in the front end, what comes out will be clean and ready to use for whatever you want." I've watched him operate the converter for nearly an hour, and I'm still stunned to see no smoke, no flames, no ash, no pollution of any kind—all that's left is syngas, the fuel source, and the molten obsidian-like material.

Catching the Litter Bug

Low transportation costs, cheap land, weak environmental regulations—these factors help explain why it took plasma until now to catch on as an economically sensible strategy to dispose of waste. "The steep increase in energy prices over the past two years is what has made this technology viable," says Hilburn Hillestad, president of Geoplasma. His company, which touts the slogan "waste destruction at the speed of lightning with energy to share," is negotiating a deal with St. Lucie County, Florida, to erect a $425-million plasma gasification system near a local landfill. The plant in St. Lucie County will be large enough to devour all 2,000 tons of daily trash generated by the county *and* polish off an additional 1,000 tons a day from the old landfill. Of course, the technology, still unproven on a large scale, has its skeptics. "That obsidian-like slag contains toxic heavy metals and breaks down when exposed to water," claims Brad Van Guilder, a scientist at the Ecology Center in Ann Arbor, Michigan, which advocates for clean air and water. "Dump it in a landfill, and it could one day contaminate local groundwater." Others wonder about the cleanliness of the syngas. "In the cool-down phases, the components in the syngas could re-form into toxins," warns Monica Wilson, the international coordinator for the Global Alliance for Incinerator Alternatives, in Berkeley, California. None of this seems to worry St. Lucie County's solid-waste director, Leo Cordeiro. "We'll get all our garbage to disappear, and our landfill will be gone in 20 years," he tells me. The best part: Geoplasma is footing the entire bill. "We'll generate 160 megawatts a day from the garbage," Hillestad says, "but we'll consume only 40 megawatts to run the plant. We'll sell the net energy to the local power grid." Sales from excess electricity might allow Geoplasma to break even in 20 years.

In New York, Carmen Cognetta, an attorney with the city council's infrastructure division, is evaluating how plasma gasification could help offset some of the city's exorbitant waste costs. "All the landfalls around New York have closed, incinerators are banned, and we are trucking our trash to Virginia and Pennsylvania," he explains. "That is costing the city $400 million a year. We could put seven or eight of these converters in the city, and that would be enough." The syngas from the converters, Cognetta says, could be tapped for hydrogen gas to power buses or police cars. But the decision-making bureaucracy can be slow, and it is hamstrung by the politically well-connected waste-disposal industry. "Many landfill operators are used to getting a million dollars a month out of debris," says U.S. Energy's Paul Marazzo. "They don't want a converter to happen because they'll lose their revenue."

Meanwhile, Victor Sziky, the president of Sicmar International, an investment firm based in Panama, is working with the Panamanian government to set up at least 10 Startech systems there. "The garbage problem here is exploding in conjunction with growth," says Sziky, who lives in Panama City. "We have obsolete incinerators, and landfills that are polluting groundwater and drinking water. We've had outbreaks of cholera and hepatitis

A and B directly attributed to the waste in landfills. There are a lot of people in a small country, and there's no infrastructure to deal with it." The project will be capable of destroying 200 tons of trash a day at each location, enough to handle all the garbage for the municipalities involved—and, says Sziky, to produce up to 40 percent of their electrical demand.

Panama's syngas will probably be converted to hydrogen and sold to industrial suppliers. The current market for hydrogen is at least $50 billion worldwide, a figure that is expected to grow by 5 to 10 percent annually, according to the National Hydrogen Association, an industry and research consortium. Analysts at Fuji-Keizai USA, a market-research firm for emerging technologies, predict that the domestic market will hit $1.6 billion by 2010, up from $800 million in 2005. The Department of Energy's Patrick Davis says that when the long-awaited hydrogen-powered vehicles finally arrive, the demand for hydrogen will soar. But he also notes that to have an effect on global warming, it's critical that hydrogen come from clean sources.

That's one more idea that's old news to Longo, who, as usual, is 10 steps ahead of the game, already embedded in a future where fossil fuels are artifacts of a bygone era. For the past several years, he has been developing the Starcell, a filtration mechanism that slaps onto the back end of his converter and quickly refines syngas into hydrogen. As he says, "We are the disruptive technology." Longo has been working in garbage for 40 years, making his fortune by literally scraping the bottom of the barrel. Which is, it turns out, the perfect vantage point for finding new ways to turn what to most of us is just garbage into arguably the most valuable thing in the world: clean energy.

In January, Michael Behar wrote about the world's first undersea resort.