

THE BURNING MAN

Can radical Berkeley artist Jim Mason solve the developing world's power problems with a temperamental machine that runs on garbage?

By Josh Dean
Photographs by
Justin Maxon

All Power Labs
founder Jim
Mason at the
company's
headquarters

IT IS A CHALLENGE just to find the door to All Power Labs, an upstart alternative-energy concern in the industrial wastelands of far west Berkeley, California, and it's not unusual for visitors to circle the block several times before realizing that the only way in is through a rolling gate with a small sign. Beyond that is what appears to be a scrap yard filled with old shipping containers and rusty hunks of metal. Welding torches spark and flare; walnut fragments litter the ground. And all around are iterations of APL's main product, the Power Pallet, a contraption consisting of a large silver barrel on top of various other metal parts, all connected with pipes and hoses. It looks like something you'd use to cook meth. In reality, the Power Pallet is a small refinery, which converts biomass (nutshells, wood chips, corncobs) to hydrogen-rich gas, attached to a four-cylinder engine, which burns the gas to generate electricity. The weirdest part: It is, potentially, the most important and transformative energy product that no one has heard of.



Much of APL's Berkeley headquarters consist of repurposed shipping containers.

The Power Pallet was born in the brain of Jim Mason, a 46-year-old engineer-anthropologist and Burning Man installation artist who has been rabble-raising in the Bay Area for the better part of two decades. It is based on an arcane and mostly forgotten process known as gasification, which turns organic junk into gas. It's basically the same idea as the Mr. Fusion that powers Doc Brown's time-traveling DeLorean in *Back to the Future*, which is why APL's logo is an exact rip-off of the one you'll see if you freeze and enlarge frames from the movie.

Last summer, APL sold its 500th gasifier system, five years after the first, and in its brief and colorful life, the company has evolved from a gang of metal fetishists seeking to answer the question "What would power look like if it were art?" into a \$5-million-per-year (and growing) business sustained entirely by sales, with the potential to be much higher.

On this warm October day, Mason arrives just in time for lunch. APL's founder is not an early riser; he keeps the schedule of a college student, working into the wee hours and then sleeping in. Today his body clock is even screwier than normal because he has just returned from a week in Italy dealing with reliability issues on the first of many Power Pallets ordered by Italian farmers, who were drooling over the prospect of generating cheap power by burning old grapevines.

Mason has the hair of an off-duty clown, a floppy mushroom of curls that parts at the center of his forehead, and when he pulls it back behind his ears, he bears a slight resemblance



Mason got interested in electricity when authorities cut power to his industrial art-studio complex.

to the actor Jeff Daniels. Right now he is in one of his semiregular couch-surfing periods, homelessness being a lifestyle decision and not a sign of economic peril. He often bunks in a live-work unit at APL, a situation that's frowned upon by zoning authorities and also feared by employees who already think he spends too much time on the site obsessing over reactor dimensions.

In a few days, Mason will leave on another service call, this time to Haiti. He is currently focused on final tests for version five (or "V5") of the gasifier that's at the heart of the Power Pallet, which weighs 1,200 pounds, sells for \$27,000, and is roughly the size of a commercial refrigerator. The V5 will resolve problems that some early adopters are having, as well as dramatically improve efficiency as Mason steps toward his dream machine—an appliance that someone with no experience could basically plug and play.

The current Power Pallet is far from that; it is sensitive and balky and runs well only at the hands of a well-trained operator. But it puts out 12 to 20 kilowatts of electricity and can easily be connected to a small grid. As far back as 2008, Mason was pushing APL to redefine the concept of energy from a "centralized, top-down commodity" to something "participatory" and ripe for hacking. Today, he's even more convinced of the need for a "PC or Internet" for energy, and he thinks the Power Pallet could be it, once he eliminates complexity ("I consider it a design error that it requires expertise") and lowers the cost. "We're operating at car price points, which I'm very upset about," he says. When I ask what this ideal version would look like, he fumbles around on his laptop for a sketch. It's just a box with a button. "Jim is a wide-eyed optimist," says his APL cofounder, Jessica Hobbs. "He thinks everything is possible." What if this time, he's actually right?

The first time the government shut off Jim Mason's power was in February 2001, not even three months after he opened the Shipyard, an

experimental scrap yard-cum-art collective on the same Berkeley property that now houses APL. The Shipyard was born out of Burning Man, the annual sex, drugs, and art bacchanal that draws tens of thousands of people to Nevada's Black Rock Desert, where Mason had developed a reputation as one of the most ambitious and outlandish installation artists on the Playa. A Stanford-educated anthropologist who fell in love with installation art while studying indigenous people in Papua New Guinea, Mason was known for such contextually confusing works as the *Veg-o-matic*, a tractor with an industrial drill rig that spits fire from a pressurized-liquid flamethrower in its snout; *Temporal Decomposition*, a 45,000-pound, 13-foot-wide ball of ice that, as it melted, revealed 100 embedded clocks; and the *Impotence Compensation Project*, a "phallic cataclysm of 300-foot columns of flame" built as a commentary on male-female fertility symbols.

Much of Mason's work depended on massive scale and intense pyrotechnics, but there just wasn't a good place around San Francisco to build gigantic metal things that belched flames. Eventually, he found a plot of land near the Berkeley waterfront and decided to use old shipping containers as studio space. They were also perfect transport vehicles for getting art projects out to the Nevada desert.

Mason stacked 50 containers two high and two wide around the perimeter of the lot, leaving a 100-by-100-foot space in the center for collaborative work. Artists could create there at scale, sharing expensive tools such as plasma cutters and arc welders, and then retreat into their private containers for design or rest. Mason thought that he could circumvent the city's building code by asserting that the units were the equivalent of temporary construction-site offices. "Berkeley very quickly disagreed with my aspirational claims," he says.

Practically overnight, the Shipyard was besieged by bureaucrats, who saw not an industrial artists' utopia but an anarchic Gomorrah of pyromaniacs. When Mason—who had accumulated huge amounts of metal, tools, and machines on the site—opted to fight eviction, the city cut the power. Mason staged a rally in support of his imperiled art space, gathering 400 supporters at Berkeley's city hall. But the power stayed off. So while he endeavored to legalize his space—a process that was certain to take years—Mason and his mates set out to build their own mi-

crogrid. They powered lathes and mills and welders by patching together a mishmash of equipment that they constantly tinkered with and improved upon. At a Mendocino County sheriff's auction, they bought a large diesel generator (confiscated from pot growers) and filled it with biodiesel from a DIY mini refinery known as the apple-seed processor. To store electrons, they constructed a "powertainer" system using an old telecommunications switching station and 17,000 pounds of 48-volt batteries that Mason bought on eBay for \$3,000. They stacked inverters and hacked the machines together.

Mason had a day job as the director of the Rosetta Project language archive, which sought to create a digital archive of all documented human languages, but he presided over the Shipyard at night and by email, keeping an eye on his patchwork power utility via a home-made remote monitoring and control system. He was frustrated with the unreliability of the power supply—and with all the alternatives, especially the slightly damaged solar panels he picked up cheap but found to be underwhelming.

Then he came around to biomass. Mason has an insatiable hunger for information, and he tends to fall into rabbit holes. He found himself drawn to biomass gasification, which he stumbled upon deep in an online thread about internal combustion engines. It struck him as an elegant solution: You take the waste of photosynthesis, which is abundant and free, and convert it to a form compatible with internal combustion engines, which are abundant and very cheap. When done cleanly, gasification's only by-products are exhaust and a degraded charcoal that is easily sequestered back into the ground—where it happens to be a great fertilizer.

Mason read everything he could find on gasification. He bought the entire book collection of an engineer named Tom Reed—gasification's most

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HOW DOES THE POWER PALLET WORK?

APL's main product takes waste and transforms it into energy.



1. Raw biomass, such as coconut shells, corncobs, and wood chips, is dumped into a 55-gallon stainless-steel hopper on top of the machine.
2. Biomass is burned and stripped of oxygen to create hydrogen gas, which moves through filters to spin out particles and cool via convective heat loss.
3. The hydrogen gas powers a 10- or 20-kilowatt engine that enables the creation of electricity (just as gasoline does in a typical generator).
4. Electricity flows to a terminal that can be hooked up directly to appliances or power a small grid. On average, 26 pounds of biomass creates enough juice to power three homes for an hour.

PRACTICALLY OVERNIGHT, THE SHIPYARD WAS BESIEGED BY BUREAUCRATS, WHO SAW NOT AN INDUSTRIAL ARTISTS' UTOPIA BUT AN ANARCHIC GOMORRAH OF PYROMANIACS.

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prominent advocate and founder of the Biomass Energy Foundation. He couldn't get over what he was learning. "You could use this as a tool to transform waste into something you run engines on," he thought. "It shouldn't be possible."

Converting biomass to gas inside a high-temperature, low-oxygen vessel isn't a new idea; in fact, the practice was widespread in the late 19th century. Paris got its nickname "the City of Light" because it was the first city in Europe to get streetlights, which burned gas created using similar technology. During World War II, much of Germany's war machine was powered by fuel from gasifiers: The Nazis built 17,000 wood-gas refueling stations, and by the war's end, about 800,000 vehicles were puttering around on the stuff.

What happened? "You put up with a lot to make a gasifier work," says Tom Miles, an Oregon-based consultant who is one of the leading authorities on gasification. The systems that have persisted tend to be either massive refinery-size machines that gasify mostly coal, or small and messy and extremely dirty ones, because the chemical process creates tar. Tar is nasty stuff, typically mitigated using water filtration, which creates toxic slurry ponds. Those kinds of inefficient, pollution-spewing machines are widespread in India and other parts of Asia, but increasingly, countries such as Myanmar and Cambodia are cracking down.

In the developed world, the concept has been basically lost, save for a few enthusiast projects. "I like to say you amortize [gasifiers] on their entertainment value," says Miles. But to Mason, gasification had great potential. The world's big brains had just given up on it too soon.

Mason wanted to reimagine the gasifier for individual use, fixing its technological problems to create an alternative to generators. The impetus, at first, was to power the Shipyard. But as he got going, he began to see a bigger picture.

Mason was raised in the Inland Empire of Southern California, in a fundamentalist Christian family. His favorite hobbies included riding motorbikes in the desert and then taking them apart. "I grew up with engines and the general arts of pyrotechnics," Mason tells me. "Gasification is fascinating in that it's a process of pulling apart fire into its constituent components and being able to control them. It should be thought of as the operating system of fire."

Mason was certain that pollution issues were solvable. "We set out on the process of how we can get these to a form of cleanliness and automation that approximates Mr. Fusion," he says, referring to the machine from *Back to the Future*. "You dump bullshit in and good things come out. The problem is that everything it takes to actually make that work is fairly involved and delicate. You are running a small-scale petroleum refinery at the point of the engine. There are many variables."

His original vision was to use the gasifier as the foundation for an open-source energy movement that he called the All-Power Network. He wanted to build an online community for energy hacking and imagined makers around the world working together to solve the problems of not just gasification but other alternative-energy concepts—in the way that chefs and locavores had transformed food. "The strong-form thesis," he says, "was that we could solve the energy problem by email." It never happened. "Gasification is fascinating, and I never got beyond it. We started building gasifiers."

Mason built his first gasifier on New Year's Eve 2006. He and Jessica Hobbs (his girlfriend at the time) and the Shipyard artist Matt Snyder worked through that night into the next morning, taking turns using a hair dryer to dry coffee grounds they planned to use as fuel. The machine was rough and ugly and fashioned from a scrap air-compressor tank. But it worked, and the sight was thrilling. "The flames were blue and interesting," Hobbs recalls. "We celebrated by ending up in the woodstove-heated hot tub."

Early iterations were crude, but Mason worked at a furious pace. "Fear perfection," he wrote in one of many manifestos. "Accept mistakes and fix them quickly." To spread the word about his new obsession, Mason built a gasifier that used cigarettes as biomass and the Café Racer, a truck powered by a gasifier that ran on coffee grounds.

Then an email arrived from a professor in Ottawa who had been following Mason's travails in online forums. He asked if he could buy one of the gasifiers Mason had been making from junk compressor tanks and plumbing parts. "That's what got Jim going," says Hobbs. Mason painted one racing red and shipped it off, then decided to start making kits of unassembled parts. He proposed the idea online and expected maybe 10 people to want one. Instead, hundreds of requests flooded in.

Faced with the prospect of delivering these kits—which were called the GEKs (Gasifier Experimenter's Kits) and started at \$1,700—Mason had to rethink his concept; junk parts didn't

make for a scalable model. He taught himself CAD and set about drawing up modular components, standardizing the basic design into digital plans that could be emailed, while also refining kits with precut metal parts. Early customers were mostly universities, labs, and backyard tinkerers, along with some doomsday preppers, who saw gasifiers as the only viable solution for power in a postapocalyptic world (added bonus: the machines are also immune to electromagnetic pulses).

All the while, Mason and his growing cadre of makers were tinkering with the design. "The discipline of the Burning Man—maker world is that you have no money and huge ideas," says Mason. "It teaches you how to realize things with limited resources."

To that point, Mason had mostly been looking at the GEK as a starting place for hackers—a kind of Linux for energy. "These kits were the opportunity to get that conversation started," he says. They also created a revenue stream that allowed APL to sustain itself as a business-in-progress. But the more kits APL shipped, the more demand they attracted, increasingly from the developing world. These buyers weren't hobbyists. They wanted a complete unit that refined gas and put out electricity cheaply, to enable a modern life, and that sparked a paradigmatic shift in Mason's thinking. It wasn't enough to be the pied piper of an energy-hacker movement. He needed to build a reliable, fully realized product that could change the world. He needed to make the Power Pallet.

You access the corporate-office portion of APL, such as there is one, via some unpainted wood stairs in the back corner of what everyone calls "the Pickle Factory," because that's what it used to be. It's one of two structures on the site that actually has a roof and walls, though typically the sides are open to the outdoors, to vent the heat and screeches of various power tools (not to mention the deafening metal or hip-hop that tends to play on the shop stereo).

Up the stairs you'll find a room shared by Tom Price, APL's director of strategic initiatives (and chief evangelist), and Dusty Schwartz, the director of sales and the only guy on the site whose clothing would pass muster at a company that wasn't founded by squatters. There's also an office for Mason that has sometimes doubled as his home, and which for a long time was only accessible via a hole in the wall that you reached from a ladder on the shop floor. Now it has a proper door out into a common room with a painted plywood floor that holds a large table, a projector screen, and three

desks for people who have taken on the difficult challenge of transforming Mason's passion project into a company that actually sells, builds, and ships things. On one wall is a 2012 proclamation from Berkeley mayor Tom Bates "in recognition of the fifth anniversary of All Power Labs," ironic given the city's early eviction efforts.

Alejandro Abalos is APL's chief operating officer. A cheerful, soft-spoken native of the Philippines who came to APL from the solar industry, Abalos is, in Price's words, "the designated adult." Abalos spotted a posting on Craigslist, came by, and, he says, "almost left, like everyone else." He started as a consultant in 2011 but joined full time in 2012, attempting to make a company out of the mess. The books, to the extent that anyone kept them, were in shambles. There was little inventory, or schedule, and the order in which Power Pallets shipped tended to be dictated by which customers were most impatient. "The innovation was apparent," Abalos says. "But we couldn't predict when we'd actually get things done."

Mason had reached the limits of his knowledge about manufacturing. ("I'm terrible at all of the Republican values that we associate with a successful business," he told me at one point.) "Inventing something is easy for Jim," Abalos says. "Repeating something over and over and scaling is a different thing. We work on product now. The word is *productizing*."

Abalos stepped in, giving workers more distinct responsibilities and creating deadlines. He devised an inventory system so people weren't running out to the hardware store every time they needed a lug nut or pipe joint. And he began a process to farm out as much manufacturing as possible, to free up Mason and his engineers to do what they do best: tinker and improve the product. There's been progress, but "we're not even close to where we need to be," Abalos says. Especially if they want to meet the growing demand from overseas.

There is immediate need for the Power Pallet in places where the only other option is diesel-fueled generators. Though diesel generators are much cheaper, a \$27,000 Power Pallet would theoretically pay off the cost difference in 15 months—and then keep chugging on as long as there are coconut shells or corn-cobs to stuff into the hopper. The trick is making sure it works consistently enough that you don't scare away buyers. "We're driving without a map," says Price, who, in recent months, had been to Myanmar, Liberia, Nigeria, and Mexico to promote the Pallet. "We're creating a product that doesn't exist for people who don't know

they need it." His phone vibrates, and he picks it up. "The Malians have initiated the wire transfer," he says after hanging up, and laughs at how absurd that sounds. A development group in Mali, he explains, had bought diesel generators for 250 villages, and a year later, three-quarters of them weren't working because those villages have no reliable access to fuel. The area does have plenty of biomass, and when they heard about APL, their interest was piqued. This wire transfer is for the first two of 10 trial units. "If it works, they plan to roll out to 250," Price says. "That's one country."

With 35 full-time employees, APL's current capacity is about 20 units a month, a number that could become woefully inadequate if one of a few test projects in Mali, Myanmar, or Liberia works out. APL is also in early discussions with a major Indian manufacturer looking to replace the dirty gasifiers currently in service. Abalos predicts sales will double in 2014. "We have done so much with so little," he says.

"In terms of lean manufacturing and design, we've figured out how to do this as a Zen fasting retreat," Mason jokes. And there's steady cash flow to go with that capital efficiency. "It's not speculative value at this point; this is an operating endeavor," he says, with a customer base that is potentially vast. "It's the energy market. It's near-unlimited." But APL will need to grow fast to take advantage.

Port-au-Prince, Haiti, looks bleak, even four years after the earthquake that nearly leveled the place. "You can never rely on the national grid here," says Duquesne Fednard, a local entrepreneur, driving along a broad coastal road that was once the city's grand promenade but is now lined with shanty homes and trash piles. "If you want 24-hour power, you create it." It's been two weeks since I first met Mason in Berkeley, and he invited me to Haiti to see how a Power Pallet might actually be used by people like Fednard. A Haitian in his mid-thirties who moved back from New York after the 2010 earthquake to help his people, Fednard founded one company to make inexpensive, efficient cookstoves and is now partnering with two Americans on a pilot project that aims to bring small-scale electricity to rural areas of Haiti that currently rely on diesel generators.

Known as Limyè Pa w ("Your Light" in Creole), Fednard's startup won a business-plan competition that provided enough seed money to purchase a Power Pallet. The machine arrived in Haiti last spring, ran just long enough to prove the concept to the funders, then conked out. Since then, it's been sitting in a dusty, open-air

work space with a poured-concrete floor on the grounds of Haiti's largest technical school (founded and still operated by Fednard's family), waiting for Jim Mason to come fix it.

Fednard and his partners, Ben Shell and Dan Bierenbaum, are skeptical of the traditional aid handed out by NGOs. They believe that the only real way to raise the standard of living for Haitians is to use a model that generates income for locals. A microgrid, which would sell power in small batches—100 or 150 watts at a time to power a small TV or some exterior lights—would do exactly that. It would also enable small businesses (a bodega with a refrigerator, a small Internet café) to open. You don't just improve lives by offering power, Fednard says. "You make the community feel part of the system."

Thousands of miles across the Atlantic, an Israeli-American named Yoav Palatnik has established a beachhead for APL in the form of EcoPower Liberia at a vocational school very much like the one Fednard's family owns in Port-au-Prince. There, Palatnik has set up two Power Pallets wired to a microgrid that will soon provide electricity for the school, which currently sinks 40% of its budget into diesel for generators that run only four hours a day. He has trained two young Liberian students, whom he calls the Biomass Boys, to operate and maintain them. Liberia's situation is similar to Haiti's, in that it is a battered nation with limited resources and little hope that there will ever be an electric grid.

"It's an experiment in grassroots electrification, and it's never been done before," says Palatnik. "There is a need for a radical breakthrough in energy in the third world, and what Jim is doing is the very first attempt to point to a new model. Like anything radically new, it may end up going nowhere, but so far he is pulling it off. I think what Jim does is akin to sorcery. It's a fascinating act of sheer will and nuttiness, and it's a beautiful thing to watch. He makes you feel like you're part of something really amazing."

First, though, the Power Pallet has to work. At the school in Haiti, Mason and APL's Bill Bayer—a 33-year-old engineer who drove and serviced a vegetable-oil-powered bus for a traveling clown circus before showing up at the Shipyard because he'd heard about it from some anarchist friends—pull the machine apart to suss out the problem. Bayer wipes his brow with a rag. "It appears we sent a bad electronics system," Mason says, and by his expression I can tell he is disappointed. "People are trying to build a business around them. It has to work."

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That's exactly how Fednard feels; he has spent months staring at a machine he couldn't use. "I love the idea of it, to put energy production in the hands of the people," he says, watching Bayer plug a laptop into the machine's brain. "That's never existed before. Anywhere. But it's really high-tech for a village right now. That's the biggest concern."

Fednard and his partners spent good money on this ornery machine, and they didn't just *want* it to work; they *needed* it to work. "Even at the price, we could make a business out of this," Shell explains. Projections showed they could break even in two to three years. "But the idea wasn't to make money. It's to find a sustainable model. In the big picture, I think if you can show that there's enough waste for fuel, it looks pretty compelling."

Mason shuffles around behind Bayer, making suggestions. "There's tremendous learning by going on these trips, identifying engineering improvements," he says. "Enthusiasts can deal with a machine that works 60% of the time. [But in the commercial market] it's 100% or zero. It has to do a lot more than just be interesting."

Finally, after two hot, frustrating hours, Bayer isolates the problem and, at 5:45 p.m., the engine sputters, rattles, and then starts up. It sounds like a tractor—not deafening, but not quiet either. A white vapor appears at the top of the machine.

"There's something there!" Bierenbaum yelps.

"What is it?" I ask.

"That's the future," Mason replies.

Shell scrambles over to his impromptu mini grid and flicks a switch. All eight bulbs come to life. My iPhone, which I'd plugged into one of the outlets, buzzes to signal that charging has begun. Bierenbaum laughs and high-fives Shell as the two plug and unplug things, tinkering with the load. Fednard adds a refrigerator, and Bayer takes to calling the stifling room—which now has cold beer and Wi-Fi—"Little America."

In a corner, Mason had plopped down onto the massive pile of corn parts that will be the gasifier's fuel in Haiti. He grabs a handful, spreading his fingers apart so that the beige and yellow fragments slip between them, and looks on as a room full of people fuss over his machine, satisfied at last. "The thing that we forget here with all the challenges is that this is running on trash," he says. "We're putting corncobs into a can and energy comes out." ☺

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