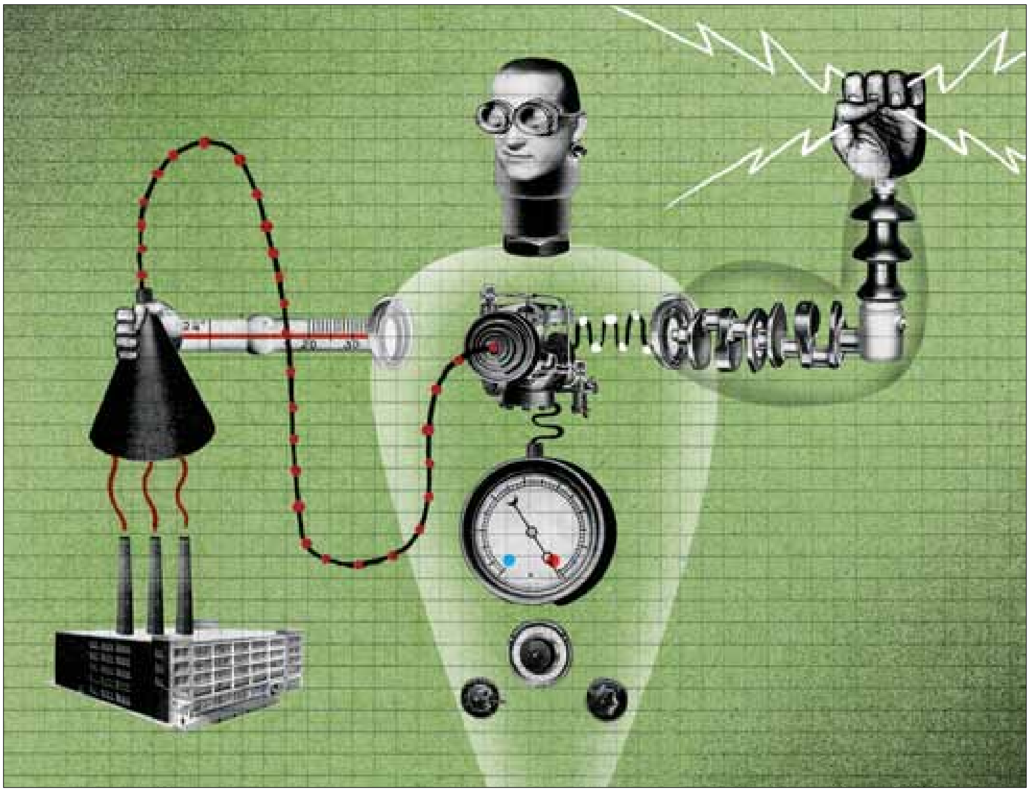

HEAT + NEW GIZMO = POWER

We generate huge amounts of energy, which produces excess heat, which gets wasted. Recover 3 percent of it and you offset half the nation's electricity needs. Cool.

BY SCOTT DODD

IN 1882 THOMAS EDISON BUILT THE NATION'S FIRST POWER PLANT IN LOWER Manhattan, selling electricity to New York City's rich and powerful. Edison himself flipped the first light switch in the Wall Street offices of J. P. Morgan. But Pearl Street station, equipped with six 27-ton dynamos, also produced tremendous amounts of heat. Edison, always the problem solver, used that heat to make steam, which he then sold to nearby businesses, where it was used to power factories and warm buildings during the winter.

When we convert energy from one form to another, as we do when we burn fuel to make wheels spin and electrons flow, invariably some is lost along the way. Since Edison's day those losses have risen precipitously: today scientists at the Department of Energy's Lawrence Berkeley National Laboratory estimate that nearly two-thirds of the energy generated in the world is lost as heat. If we could reclaim just 3 percent of our waste on a daily basis, they say, we could offset half the nation's electricity needs.

How we go about doing that is no small task, but over the past few years, technology startups, uni-

SCOTT DODD *is OnEarth's online news editor. This is his first assignment for the magazine.*

Whales to the Rescue

WHAT DO YOU GET WHEN you cross a whale with a Wall Street trader? A carbon credit. Or at least that's what one oceanographer's latest research indicates. Andrew Pershing, an oceanographer at the University of Maine, says that nursing whale populations back to their pre-industrial levels could help mitigate climate change.

"Whales are like the redwoods of the ocean," Pershing says. Blue whales can live for a hundred years or more—and they're huge: a 100-ton blue whale contains nearly 10 tons of carbon. When a whale dies naturally, it tends to sink, locking the carbon away in the cold depths of the ocean. Commercial whaling releases carbon into the atmosphere, through the consumption of meat and oil as well as the decomposition of cast-off body parts.

Rebuilding the Southern Hemisphere's blue whale population from 1,000 to 325,000 (its pre-industrial size) would lock up as much carbon as a forest the size of Los Angeles, Pershing argues. Selling carbon credits for whale conservation could be used to fund monitoring initiatives and marine park management, he adds. "We need to use the markets creatively."

—CRYSTAL GAMMON

ILLUSTRATION BY DAVID PLUNKERT

versity labs, car companies, and even the Defense Department have begun to take on the challenge in earnest. Researchers are now working furiously to create devices that will skim waste heat on every scale, from the tiniest microprocessors to the largest power plants. Many of these devices will be powered not by boiling water to create steam, as was done in Edison's day, but by taking advantage of the simple fact that electrons will flow from a hot metal surface to a cold one. Connect the device to a wire and a new source of electricity is born.

"The potential is vast," says David Cahill, a professor of materials science and engineering at the University of Illinois at Urbana-Champaign. "What's really exciting about thermoelectrics"—as the technology is called—"is that it scales beautifully."

> *Researchers envision cell phones with double the talk time and cars that go farther on a gallon of gas—all powered in part by waste heat*

Along with wind turbines and solar panels, the next clean energy frontier could take the form of an array of tiny semiconductor chips wrapped around anything from a smokestack to a computer server, turning heat into usable energy. Imagine a laptop that runs twice as long, powered in part by the heat generated by the microprocessor. Researchers envision cell phones with double the talk time and cars that go farther on a gallon of gas—all powered in part by heat that would otherwise be wasted.

The basic concept has been around for some time. NASA has been using thermoelectric devices to power deep-space probes for decades; even after 32 years, Voyager 1 is still beaming back radio signals from 10 billion miles away. During the oil embargo of the 1970s, when every kilowatt counted, the Department of Energy started doling out grants to companies and research labs trying to develop heat-scavenging devices for earthbound situations. A 1979 *Popular Mechanics* story on a related waste-heat capturing technology known as thermionic conversion declared: "Complex engineering problems remain. But there is considerable optimism that thermionic generators may one day play an important part in the country's energy picture."

However, the 1970s were followed by decades of cheap energy and, not surprisingly, a lack of interest in spending money on new ways to collect waste heat. But the cost of fossil fuels has risen sharply in recent years. Today, as the federal government aims to improve the nation's energy efficiency, the Department of Energy is one of the biggest funders of current thermoelectric research.

Before Matthew Scullin became the CEO of a thermoelectric startup called Alphabet Energy, he was a doctoral student at Lawrence Berkeley, where he helped create a device that his company aims to commercialize. Scullin's company is one of a dozen or so that have received government grants or private investments to improve the efficiency of thermoelectrics and bring down their cost by creating new materials, new manufacturing methods, or both.

"We have a core technology—a chip—that can be inserted into a wide variety of technologies and applications," Scullin says, adding that his goal is to make Alphabet Energy the "Intel of waste heat." Just as Intel makes silicon computer chips that are used by other companies in a wide variety of devices, Scullin wants to manufacture thermoelectric chips that could be used to recycle waste heat in anything from home appliances to airplane engines.

The concept is simple: a device made of a semiconducting material is sandwiched between two strong conductors. When one side gets hot, electrons begin to flow toward the cooler side. The semiconductor channels them into a wire, creating a flow of electricity that can be directed back into the original gadget, engine, or other heat-generating device, acting as an additional power source.

The first large-scale application of thermoelectric devices could emerge from the auto industry, where the push for higher fuel efficiency is driving car manufacturers to look for anything that can pull another mile or two out of each gallon of gas.

The Michigan–based company Amerigon has been honing its expertise in thermoelectric technology by making seat warmers for cars since the 1990s. Today it receives federal funding for its effort to produce electricity from the temperature differential between the hot gas in a car's exhaust pipe and the chilly fluids in the car's coolant system. That surplus electricity is enough to improve fuel efficiency by 2.5 miles per gallon, according to the Department of Energy's estimates.

Ford and BMW are scheduled to deliver test vehicles equipped with Amerigon's prototype thermoelectric generators to the National Renewable Energy Laboratory in Colorado later this year.

"People have been futzing with this for 180 years," says Dan Coker, Amerigon's CEO, hopeful that his own thermoelectric dreams will finally pay off.

Tricky Seals Do Science

DAVID HOLLAND, A PROFESSOR of mathematics and ocean-atmosphere science at New York University, has been looking for a better way to measure the flow of ice from land to sea. He needs that information to predict sea level rise over the next century, and he thinks he's found a research partner who can help: the ringed seal.

In August, Holland's team will travel to Greenland to tag four seals in the Jakobshavn fjord with tiny monitoring devices that include a GPS receiver, a radio transmitter, and a thermometer. As the seals dive up and down in the water column, the monitoring devices will record temperature and salinity. When the seals come up for air, the transmitters will automatically send the results back to Holland's lab in New York City.

"Seals will go where no man will go," Holland says. Ships can't get close enough to calving icebergs to take the temperature of the currents that well up under the ice: the warmer the water, the faster the glaciers crumble.

Holland and his team are hopeful that the seals won't wander too far from home—and the study area. If all goes as planned, the researchers may put more seals on the payroll in the near future.

—JOANNA FOSTER

ILLUSTRATION BY TIM BOWER