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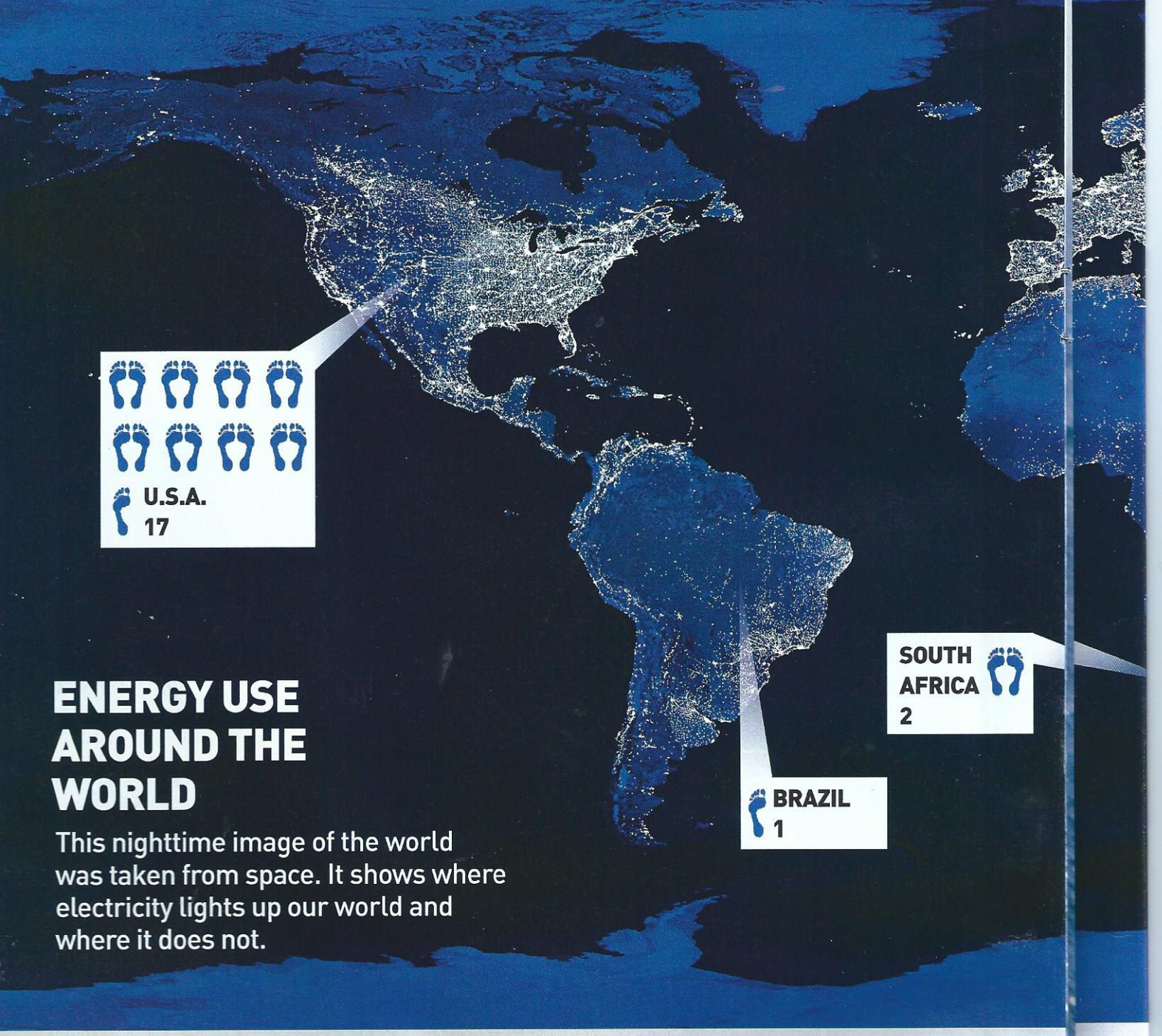
Earth Science
HUMAN IMPACT ON EARTH
As you read, think about how people can help protect Earth's resources and environments.

CLEAN ENER

By Judy Elgin, with T.H. Culhane



ENERGY USE AROUND THE WORLD

This nighttime image of the world was taken from space. It shows where electricity lights up our world and where it does not.

Life on the Grid

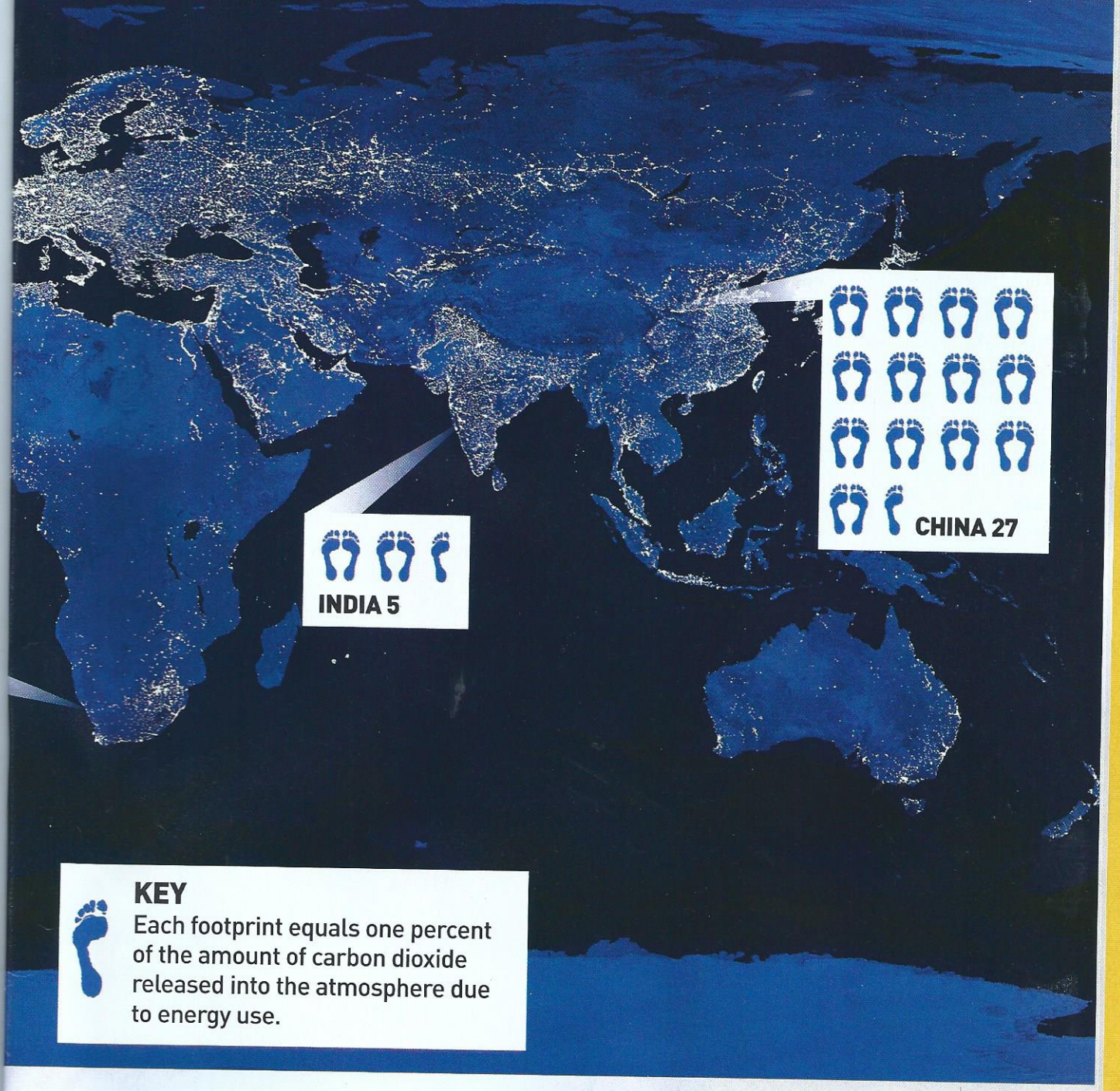
Remember that grid? The bright lights on this map show areas where people live on the grid and rely heavily on fossil fuels. In the United States, over 80 percent of our energy comes from fossil fuels. In China, that percentage jumps to 93 percent.

Using fossil fuels not only depletes the planet's resources. It also releases a lot of carbon dioxide and other materials, which harm the environment. They create a layer of gases in the atmosphere. This layer traps the sun's energy close to Earth, which warms Earth's overall climate.

Carbon Footprint

As the Earth grows warmer, some environmental problems develop. Sea levels rise and weather patterns change. A country's **carbon footprint** summarizes the amount of fossil fuels a country uses. People in countries with larger carbon footprints use more fossil fuels for everyday tasks—from cooking to driving to running factories.

Countries with smaller carbon footprints use energy, too. The **biomass**—wood, charcoal, dried plants, and animal dung—that people burn for cooking and heat also releases carbon dioxide. Their energy use affects Earth, too.



Simple Solutions

When T.H. Culhane first started thinking about energy use, he was working in remote areas in Borneo and in Guatemala. He saw how the people in these places used every part of their environment to thrive. They live in a sustainable way. This means they lived a lifestyle that doesn't use up Earth's natural resources.

Culhane began traveling around the world to jungles, remote villages, and urban slums to study the way people lived. He wanted to understand what challenges they faced and see what solutions they had come up with.

What he saw inspired him and led him to think beyond people living in remote areas. "These people inspired me to rethink how people living in cities could live sustainably, too," Culhane says.

Culhane believes that many energy problems can be readily solved. "All of the solutions to urban problems are already available—somewhere—just waiting for enough people to put them all together," he says. One solution to developing and using sustainable energy involves natural recycling processes, and it led him to invent something.

Waste Not, Want Not

Culhane used some of the sustainable ideas he learned from other cultures to invent a new device. It provides energy in a different way.

Culhane began with his belief that there is no such thing as "waste" or "garbage." He says that most of what we call "kitchen waste," "toilet waste," "agricultural waste," and "garden and yard waste" have value. They can be reused. They can be a source of clean fuel and fertilizer.

He calls his invention a **biodigester**. The *bio* stands for "living" and *digester* says what it does—digests. The device uses the same microbes that people and animals have in their guts to break materials down.

So, you can put food scraps, used cooking oil, grass clippings, even what you clean out of the cat's litter box, into the biodigester. Your bathroom waste can go into it. People in rural areas can add in manure from cattle and sheep.

How it Works

Once organic materials are inside the biodigester, the microbes get to work. They break down what you put in it in the same way your stomach breaks down food. Over time, the device fills up with biogas. Biogas is a combination of methane, carbon dioxide, and sulfur gas.

When biogas reacts with oxygen, it releases energy when burned. This energy release allows biogas to be used as a fuel. It can be used for heating purposes, such as cooking. It can also be used in a natural gas engine to convert the energy into electricity and heat.

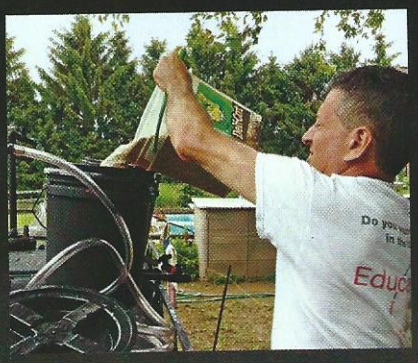
Like all systems, the amount of energy put in relates to how much energy comes out. For a biodigester, the amount of energy released depends on how much organic material is put into it.

Culhane uses a plastic bucket to measure how much energy goes into a biodigester. One full bucket of food scraps a day releases enough gas to light two small rooms for an evening or cook two meals. Through trial and error, Culhane has learned that the breakdown of some materials releases more gas than others.

Culhane's Biodigester

T.H. Culhane invented a device he calls a biodigester to create energy from waste. Here's how it works:

1. Food scraps, manure, and organic materials are dumped into the biodigester.



2. Microbes break down the contents of the biodigester. Biogas moves out when other materials are put in.

No More Garbage Cans

For example, freshly cut grass clippings produce four times more biogas than the same amount of dried cow manure. And, of course, bigger biodigesters use more organic material and supply more gas.

Culhane has designed biodigesters in different shapes and sizes. Some are just a large hole in the ground lined with concrete. Others are big plastic containers.

Despite the differences in size and design, all of the biodigesters work in the same way. One pipe is used for putting the organic material into the device. A second pipe carries the biogas to be stored. A third pipe is used to drain off the liquid fertilizer that forms in the process. This fertilizer can be used in gardens.

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3 Biogas moves out through this pipe to be burned or stored.

biogas

oils and fats

liquid fertilizer

organic material

4 A rich, liquid fertilizer collects in a bucket to be used on gardens.

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Black paint keeps the inside of the biodigester warm and dark. Light kills microbes.

Culhane collects and stores biogas in balloon-like bags on his rooftop.

Plants that are fertilized with the nutrient-rich liquid from the biodigester can grow without soil.

Positive Effects

Culhane's invention was first installed in countries where many people lived off the grid. And it's had a major impact.

Households using biodigestors no longer need to burn wood for cooking, so air pollution is reduced. That's important because smoky fires can cause health problems for people living around them.

Fewer trees are now cut down for fuel. That means that deforestation—widespread tree removal—has slowed down around areas using biodigesters. That's good news because deforestation threatens wildlife habitats and causes flooding.

Using biodigesters also keeps communities cleaner. Because the biodigestor is fed food scraps and other organic waste, garbage is no longer around to attract flies, rats, or other wild animals. Dumping toilet waste in the biodigester keeps the waste from contaminating water supplies with disease-causing microbes.

Reaching More Homes

Culhane saw how well his machine was working in remote areas. Now he is focusing on areas where most people live on the grid and have large carbon footprints. By designing smaller biogesters, more households can have their own energy-producing systems. This reduces the use of fossil fuels.

Culhane knows that the smaller biodigesters can't produce all of the energy needed by a household in the United States, Europe, or other areas on the grid. But replacing even a small amount of fossil fuel energy with biogas can make a big difference to the environment.

For example, a biodigester might produce just enough gas to cook with. Or it might provide enough energy to heat water for showers and baths. While it doesn't sound like a lot, it still represents a significant savings in the amount of energy that needs to be purchased. So the carbon footprint of a household gets smaller.

'Domestic Dragons'

There's another advantage to using a biodigester. The rich, liquid fertilizer it produces can be used to grow plants. Culhane urges people to use it to grow food plants such as tomatoes and lettuce. These plants can grow without soil if they are nourished by the fertilizer.

Culhane places plants in towers made of recycled scrap materials. He puts netting inside the towers to support the plants' roots. He pours fertilizer over the roots every day or so. Plants begin to grow. These gardens use very little space. People living in cities can put their tower gardens on patios, rooftops, and porches.

Culhane calls the biodigesters "domestic dragons" for the flame they produce. He uses one in his own home. He believes strongly that biodigesters provide an unending and sustainable supply of benefits.

Biodigesters reduce our carbon footprint. They reduce air pollution and deforestation. They are cost-efficient. They are easy and safe to use. They turn every bucket of organic garbage into an hour or two of odorless cooking gas and a bucket of fertilizer for growing food without soil. Culhane says, "It is a win–win solution and explains why I live with such hope and optimism for the future."

WORDWISE

biodigester: a device that uses organic waste to produce a gas that people can use for energy

biomass: plant material and animal waste used as a source of fuel

carbon footprint: the amount of carbon dioxide and other gases released during a given period

grid: a network of wires that carries electricity