

# INTRODUCTION

*What if I could harness this energy?*

**F**or many of us the question arose during a long stint on an exercise bike or treadmill. Sweating, straining, generating heat, we felt our bodies as engines. Yet the engine's output was wasted. Surely our effort was worth something! What if we could direct it toward a useful purpose, such as generating electricity, blending a smoothie, or turning a piece of wood? Besides keeping us fit, wouldn't it also help to reduce our dependence on polluting fossil fuels?

Most of us probably didn't follow the idea beyond supposition. If we'd made the calculations we would have discovered that the maximum power we could generate during our 1-hour workout would equal about one penny's worth of electricity, or the same potential that's in roughly 2 teaspoons of gasoline. We might have given up on the idea of human-powering our TV or blender. As it can't save much money or greatly reduce fossil fuel emissions, why bother?

The answer, given the enthusiasm of the dozens of human-power inventors and fans I've interviewed, centers on one vital notion: empowerment. People like Rob Roy, who

pedal-powers his home's water pump, aren't beholden to the electric company. If the power goes out in Rob's area, he can still fill his water tank, and his family can still bathe and drink from the tap. Anne Kusilek, who operates a quilt finishing business using only treadle sewing machines, continues working and doesn't even notice when her home loses power. The band Shake Your Peace toured Utah on bikes and used pedal-powered amplifiers, freeing themselves of engines and extension cords. Human power is portable and available on demand. No matter how small the output, it's empowering to discover how much we can do without the utility company, or the noisy, smelly motor, or the plug.

Also striking was the number of people who described the unique connection to their processes or products that resulted from using human power. For instance, a chef realized that he could better gauge the quality of his chutneys and sauces when he mixed them in a bike-powered blender, because he could sense their thickness from the resistance to his pedaling. The same goes for Frederick Breeden of Just Soap, who mixes soaps and

salves in a large bicycle-powered blender. He told me if the soap is mixed too long, it will be spoiled, and as long as he's pedal-powering a batch he can feel when it's time to stop. An electric machine wouldn't offer such control. Similarly, a potter told me he never used motorized wheels because he valued the way that operating a kick wheel connected him to the pot he was throwing.

Using human power, our exertion makes visceral what we take for granted from the grid. It raises our awareness. Some science museum exhibits allow visitors to pedal-power a 60-watt incandescent light bulb. Feeling what an effort this takes teaches us that real work — by something, somewhere — has occurred to light our rooms when we flip the switch. Museums might also allow visitors to pedal-power a compact fluorescent bulb that's just as bright as a 60-watt incandescent bulb but requires only 14 watts. Noticing the comparative ease in our quadriceps, we understand how much less power a compact fluorescent bulb uses.

Replacing motors with muscles can even be considered a political act. Gandhi urged his fellow Indians to spin and weave their own cloth, endorsing local self-reliance as a means to defy the British textile industry, which had crushed cottage industries and changed the nature of Indian society. He called this self-sufficiency “swadeshi.” Through swadeshi he believed India could gain its independence. Each day he sat at his spinning wheel and practiced it himself. Perhaps we can claim hand-cranking our coffee mill each morning or pedal-powering our laptop in the evening as our personal swadeshi.

Others, like David Butcher, human-power their appliances partly to improve their health. David began tinkering with pedal-powered devices 30 years ago. In the last 2 years he's made riding his Pedal Powered Prime Mover — which can drive virtually any appliance, from a bread-making machine to a washing machine — part of his daily routine. As a result, he's lost 30 pounds, lowered his resting heart rate, and quadrupled his power output. He plans to continue developing human-powered devices and his muscles.

Not surprisingly, researchers have discovered that countries in which people use the most labor-saving devices also have the highest obesity rates. One study concluded that by not washing our dishes by hand, hanging our laundry to dry, and walking up stairs rather than taking the elevator, for example, we burn about 111 fewer Calories per day.<sup>1</sup> Another study compared all activities typical of a mid-1800s lifestyle to a sedentary 21st-century lifestyle and calculated a 500–1,000 Calories per day difference. These researchers suggested that the currently prescribed 30 minutes of daily aerobic exercise might actually be  $\frac{1}{3}$  of the exertion our body needs to remain healthy.<sup>2</sup>

I confess that none of these reasons — empowerment, awareness, politics or health — drew my partner David and I to making human-powered devices initially. Instead, it was the challenge of figuring out what we could cobble together in a pinch.

Several years ago we were building a straw bale shed. We'd been mixing earthen plaster by foot in a stock tank, but by this method each batch took at least an hour to make, never

mind how long it took to apply. We thought we'd found the solution in a cheap, old cement mixer we bought at an auction. But even after some repair, the dusty motor smoked and wheezed to a halt. Days later we found an exercise bike marked "Free" on an elderly neighbor's lawn. With some ingenuity we put the two together and made a bicycle-powered cement mixer, which lasted exactly as long as we needed it to plaster the rest of our building. (The exercise bike was never meant to work so hard, and in our final week of work one of its welded joints gave out.)

Making do, or using what's available, drives the use of human-powered devices in many developing countries. For example, pedal-powered electrical generators and LED lights replace kerosene lamps in rural areas of Nepal, where electricity is either unavailable or too expensive. Pumps powered by merry-go-rounds bring clean drinking water to villages in sub-Saharan Africa. In Mexico and Guatemala, bike-powered machines grind corn, depulp coffee beans, and shell macadamia nuts. In Mali and the Philippines, a pedal-powered peanut sheller makes processing and eating peanuts more economical. Human-powered devices are a form of intermediate technology — contraptions more sophisticated than hoes, for example, but simpler and less expensive than tractors. Reducing manual labor, improving nutrition, freeing time for more profitable pursuits, and enabling groups to establish small businesses, they serve real health and economic needs.

As recently as 150 years ago, human-powered devices were the norm in every nation. This book begins by describing the

evolution of human-powered devices from Archimedes' screw to electricity-generating boots. It explains how bicycles influenced woodworking tools and how gun manufacturing related to treadle sewing machines. The book does not, however, explore human-powered transportation. Many other authors have published excellent, thorough works on the history, principles and various uses of bicycles, velomobiles and flycycles.

The second chapter describes the physics and physiology behind human power. You'll learn how many watts one human can practically generate and how our muscles deliver that power. Chapter 2 also examines the drive types, frames and applications of human-powered machines in use around the globe today. It includes tips on maximizing the efficiency and comfort of the device you're building, plus hints on how to scrounge parts. This is the heart of the book for those who want to understand and design their own human-powered devices.

The remaining chapters offer plans for making specific human-powered devices grouped by area of use. For example, in the "Human-Powered Devices for the Kitchen" chapter you'll find instructions for making a pedal-powered blender. Chapter 4, "Human-Powered Devices for Lawn and Garden," includes a plan for making a treadle-powered water pump. In Chapter 6, "Human-Powered Devices for Recreation and Emergency Preparedness," you'll learn how to pedal-power your TV or laptop. For each plan I've provided a list of materials and necessary tools, plus clear, step-by-step instructions and accompanying illustrations to guide you. I've also

noted each design's ease of construction, relative cost to make, time to make, and ease of operation. Finally, because improvisation is so much a part of invention, I've added lists of workable variations to the instructions.

All of the machines in the plans can be built from scavenged materials with common tools and parts from a hardware store. None requires special mechanical or metalworking skills. However, if you know how to weld or own a metal lathe, for example, you can craft more sophisticated versions of any device. I encourage you to improvise and modify the plans to enhance your machine's strength, longevity, aesthetics or personal comfort.

On the other hand, if you prefer to purchase off-the-shelf products, the last four chapters also feature commercially available human-powered devices and, where possible, include reviews of their effectiveness. For

example, in Chapter 4 you'll find a comparison of human-powered push lawn mowers. Chapter 6 features several types of human-powered electricity generators, from costly bicycle-based systems to small hand-cranked mobile phone chargers.

What inspired me most while researching and writing this book was talking with individuals who had that idea — *What if I could harness this energy?* — one day, and then set about making it happen. Each was delighted to describe his or her invention and graciously shared technical details and photos. These are the people highlighted in vignettes interspersed throughout the book. Even if you don't long to construct or operate a human-powered device in your home, I hope you'll be captivated by the creativity and energy that went into making them.