

Introduction

For years, Kara Culpepper and her family held season tickets to the Denver Broncos, attending every home game, like tens of thousands of avid fans. Those were good times, despite the fact that the family often had to endure some of Colorado's most bitterly cold winter weather to watch their favorite team. But after taxpayers built the team a new stadium and ticket prices went through the roof, Kara and her family decided to give up their season tickets. It was just too costly. They didn't give up on their team, however. They decided to watch games on TV at home. Trouble is, their modest suburban home, which was built in the 1970s, was an icebox in the winter. Their home was woefully under-insulated and full of leaks that allowed cold air in on blustery winter days — like

millions of similar residences throughout North America, indeed the world. To watch the games, Kara and her family had to bundle up in jackets and sweaters or huddle under blankets. Ironically, it wasn't a whole lot different than a cold December game at the stadium. "The only difference was that in the stadium, you could actually get sun rays," remarks Kara. So they were a bit colder at home.

Fortunately, those days have ended. Today, Kara and her family watch the Broncos games in comfort, no longer bundled up like the Inuit on a cold Arctic night. Their home is no longer just bearable, it has become quite comfortable thanks to an extensive home energy retrofit. The energy retrofit was made possible by a generous grant from their local utility (Xcel Energy)

and a nonprofit organization, the Colorado Energy Science Center, a leader in wise energy use in Colorado.

This all happened because Kara and her family qualified for a complete energy makeover, worth over \$25,000. Her home was selected as one of two winners in a statewide competition. Among an applicant pool of 10,000, her home was judged to be one of the two most energy-inefficient homes. The judges believed that retrofitting her home would provide significant energy and cost savings. Being voted as owners of one of the most energy-inefficient homes in the state of Colorado is not a great distinction, but Kara and her family were able to look past that dubious honor. The extensive energy retrofit they received has dramatically cut their heating bills and increased their comfort levels beyond their wildest imaginations.

In short order, the family witnessed dramatic changes. Air sealing, improved insulation, and a host of other energy upgrades slashed their natural gas bill in half, saving the family \$150 per month in the dead of winter. New energy-efficient appliances that replaced older, less frugal models, saved the family hundreds of dollars a year on their electrical bills.

Besides saving energy and money, their home is now much more comfortable — a priceless benefit. Their home is much warmer in the winter and much

cooler in the blisteringly hot Colorado summers. All told, the energy retrofit has reduced the family's emissions of carbon dioxide by about eight tons a year! "That's roughly equivalent to removing one and a third vehicles from the highway every year," writes Amanda Leigh Haag in *Smart Energy Living*.

If you are like most of your neighbors, you're being hammered by high fuel bills — at home, at your business, and at the gas pump — and you want to do something about it. Like Kara Culpepper's family, you can reduce your energy consumption dramatically — but you don't have to pay \$25,000 to do so! An investment of three or four hundred dollars, in fact, can result in amazing energy savings that are good for your wallet and good for your future — as well as the future of your children and theirs, and the many species that share this planet with us. A few thousand dollars will bring even greater benefits!

You can increase your energy independence by joining the growing number of homeowners and business owners in urban, suburban, and rural settings the world over who are not only using energy more efficiently, but also producing some — or in many cases all — of their own energy from renewable resources like the sun or wind. With knowledge, careful planning, and a little money, you can also free yourself from ever-rising fuel bills by turning to efficiency

and clean, reliable, and affordable renewable energy technologies. If this is your dream, this book is for you. The previous edition has sold about 40,000 copies to date. Like its predecessor, this edition will help you pursue your dreams of greater energy self-sufficiency and a comfortable and affordable life.

The revised edition of this book will, first and foremost, help you understand *all* of the renewable energy options at your disposal. It will help you develop a sensible, cost-effective strategy to slash energy use and increase your reliance on renewable energy.

RENEWABLE ENERGY AND ME

I have a long-standing love affair with renewable energy. In fact, I fell in love with this clean alternative to mainstream energy in the summer of 1977 while visiting Arches National Park in Moab, Utah. It all occurred in the most unlikely spot — in the parking lot in front of the visitors center. There, park officials had placed the single solar electric module shown in Figure 1.

In the baking hot summer sun, this amazing little device was cranking out electricity that powered a small fan. Park officials had attached streamers to the fan to dramatize the effect. My immediate interest in this amazing, quiet device was sparked partly because I'd been studying

the impacts of generating electricity from conventional sources, notably coal and nuclear fuels. I'd heard about solar electricity and seen pictures of various solar technologies, but had never seen a solar electric module in operation. And there it was, this elegantly simple alternative to messy fossil fuels and dangerous nuclear

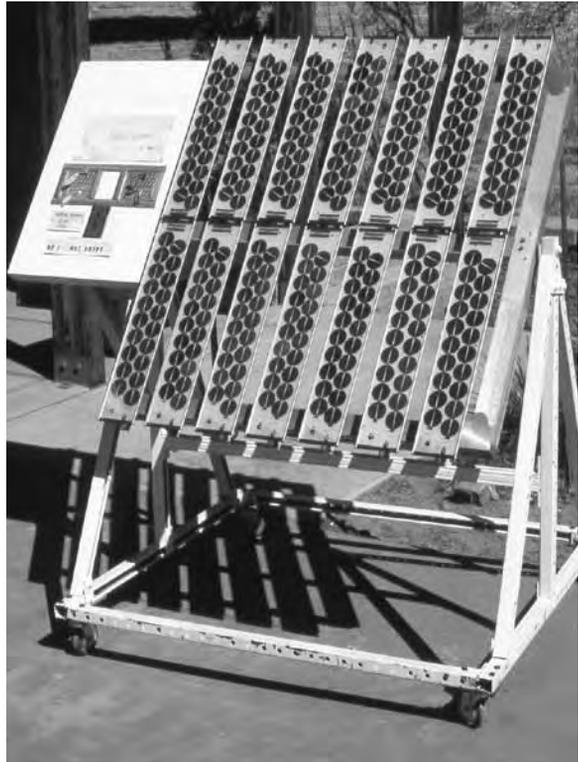


Fig. 1: *This small display of solar electricity turned my head and started a lifelong commitment to renewable energy. Unfortunately, you can't see the fan and streamers that dramatized the PV's remarkable ability to convert solar energy into electricity.*



DAN CHIRAS

Fig. 2: A PV array at *The Evergreen Institute* provides the electricity that powers a classroom and the author's office. Similar systems could be used to power homes throughout the world, providing clean, renewable energy for decades.

power plants. It struck me as a perfect way to live in harmony with nature.

I remember thinking that if solar electric modules like these were placed on millions of roofs throughout North America, they could power the entire world (Figure 2). Sure, it would require resources to make solar systems, but a lifetime of free fuel — solar energy — certainly makes this a much better resource than conventional fuels.

Today, sitting in my wind-turbine-and-solar-module-powered office, I'm living my dream. Out in the field next to my office is a quiet solar array, gleaming in the bright sun, converting solar energy into electricity. I never cease to marvel at the fact that the energy that's powering my lights and my computer is solar energy that jetted

through space, covering 93 million miles in 8.3 minutes. My simple, reliable PV array has no moving parts — like the module I first encountered in Moab, which was cranking out electrical energy in the hot desert sun and sending those streamers and my heart into paroxysms of delight.

Since that day, I have devoted my life to the study of renewable energy, including solar energy, wind power, hydropower, geothermal energy, tidal power, biofuels, and hydrogen. I have written about renewable energy in several books, including college textbooks. I published a bestselling book titled *The Solar House* that describes how to heat and cool a home passively — without costly heating and air conditioning systems and the polluting fossil fuels or dangerous nuclear fuels that power them. My other books include *Power from the Wind*, *Power from the Sun*, *Wind Power Basics*, *Solar Electricity Basics*, *Solar Home Heating Basics*, and a book on sustainable transportation, *Green Transportation Basics*.

I've done more than research and write about the many potentially liberating renewable energy technologies; I have put my knowledge into practice. In the 1970s, I retrofitted my very first home with solar hot water panels for domestic hot water, virtually eliminating my hot water bill. I packed my attic full of insulation to save energy and built a small solar greenhouse

on the house's south side to warm it. I installed a wood stove (and gathered wood for free from a nearby national forest). Together, the insulation, greenhouse, and wood stove virtually eliminated my heating bill.

My second home, purchased many years later, was a passive solar house. Although it worked pretty well, I found ways to improve its energy performance, reduce my family's energy bills, and achieve greater self-sufficiency. In 1995, I built a super-efficient solar home from scratch. This energy-miserly house generates 100 percent of its electricity from a solar electric system and small wind generator, freeing me from those nagging monthly utility bills (Figure 3). (I haven't paid an electrical bill since 1996!) I also have the satisfaction of knowing that I'm dramatically reducing my family's impact on the environment. Our home is passively heated by the sun through south-facing windows, and it is cooled naturally as well. I burn a cord of wood a year as backup heat; all in all, it costs me about \$150 per year to supplement the sun's free heat. I plan to install a solar hot water system that will heat the house, which will eliminate the need for the wood stove.

I have no air conditioner. I don't need one. The house stays cool through the hot summer months thanks to high levels of insulation, energy-efficient windows,

earth sheltering, and other features I'll explain later in this book.

In the fall of 2008, I purchased a 50-acre farm in Missouri, which has been converted to an educational center, The Evergreen Institute Center for Renewable Energy and Green Building. Here, I teach numerous classes on all sorts of renewable energy systems and green building. The classroom and faculty residence have been retrofitted to make them super-efficient; they are equipped with two solar hot water systems, two solar electric systems, and a wind turbine on a 126-foot tower. We have even converted a small pickup truck to electricity. Our goal is to produce as much energy as we consume.

You too can dramatically reduce your energy use. You can even achieve near total

Fig. 3:
The author's passive solar/solar electric home in Evergreen, Colorado obtains energy from a solar electric system and a small wind generator.



energy independence, eliminating the sting of high monthly fuel bills and greatly reducing your environmental impact. This book will show you how. I'm not going to dwell on the world's energy problems — peak oil and natural gas, the high cost of fuels to our economy, the plethora of environmental consequences of conventional fuel use, global climate change, etc. I discussed those in the previous edition. With this edition, I'm going to push forward, immediately delving into clean, reliable, and affordable solutions that you can use to reduce energy consumption and gain greater self-sufficiency at home and in your own business.

ORGANIZATION OF THE BOOK

My goal with this book is to show you that it is possible for you to incorporate renewable energy into your daily life. Chapter 1 will give you an overview of renewable energy, examining the many options available to homeowners. I also present a summary of the pros and cons of renewable energy, so you can enter into this venture with eyes wide open.

In Chapter 2, I'll explore efficiency and conservation, the cornerstones of personal energy strategies. You will see why I consider energy conservation and efficiency efforts to be extremely valuable forms of renewable energy. You will also see that you can save lots of money through

home energy efficiency and conservation efforts, and that there are a host of other benefits. This chapter concludes with a simple, cost-effective home energy efficiency and conservation strategy that will save you and your family thousands of dollars, perhaps tens of thousands of dollars, over your lifetime. These ideas can even be applied to your business.

In Chapter 3, we'll focus our attention on solar hot water systems for providing domestic hot water. We will examine the types of systems on the market today, and explore how they work. I'll provide information, including costs, that will help you decide which system is best for your home. As in other chapters, we'll explore important home energy savings that will reduce your demand for hot water. We'll also look at the pros and cons of solar hot water systems.

In Chapter 4, I explore some solar space-heating options, that is, how you heat your home and business using renewable energy. I discuss one of my favorite strategies, passive solar heating: heating homes without costly nonrenewable fuels or expensive mechanical systems. I'll also look at a popular technology referred to as heat pumps; these could become a mainstay of American home heating in the not-too-distant future.

Two technologies that you will be seeing more of in the future, covered in

Chapter 5, are solar hot water and solar hot air systems used to heat homes.

In Chapter 6, I will examine wood burning as a home heating strategy. Fireplace inserts, wood stoves, pellet stoves, and masonry heaters are covered in this chapter. I'll also tell you where you can find lots of free wood, even in cities and towns.

Chapter 7 tackles the enormous challenge of cooling a home without costly fossil fuels. I offer some general strategies as well as specific tools of the trade, and I explain how they can be applied to different climate zones.

In Chapter 8, I will explore solar electricity, an amazing technology that converts sunlight energy into electricity. I will describe the options that are available to you as well as the costs of these systems and ways to help offset the costs, sometimes substantially, through efficiency measures and local, state, and national incentives.

How you can produce electricity from wind power is examined in Chapter 9. Although wind generators are not for everyone — certainly not those who live in urban or suburban neighborhoods — you will see that there are even ways that you can tap into wind energy *without* installing a wind generator in your back yard.

In Chapter 10, I explore microhydroelectric systems, a technology that allows rural residents in some areas to tap into the power of flowing water. Although few residential sites in North America are appropriate for this approach, those who are lucky enough to live on one will find microhydroelectric to be an excellent choice.

At the end of the book is a list of important resources — websites, books, articles, magazines, videos, organizations, and so on — that can provide additional information and support.