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- Understand the components and configurations of home wind-electric systems

**Ian Woofenden**
*Wind-electricity user, consultant, and instructor*

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# Wind Power FOR DUMMIES®

by Ian Woofenden


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# About the Author

**Ian Woofenden** began exploring renewable energy as a preteen growing up in the Midwest, where he built a solar greenhouse, used a clothesline, and walked, ran, and bicycled extensively. Later, when he was a teenager in New England, his parents had a solar hot water system, and he read widely on sustainability, renewable energy, and country living.

After marrying his college sweetheart and going on a 1,200-mile honeymoon on a tandem bicycle, Ian lived in a tipi in Maine and on an island in Lake Michigan before settling on an island in the inland waters between mainland Washington state and Vancouver Island, Canada. There, he and his wife bought 10 acres of off-grid property and began an experimental life with country living and renewable energy that has now spanned almost three decades.

Raising a large family off-grid had many lessons to teach, and running a production woodcraft business for 14 years was challenging and instructive, too. Starting with an automobile battery and a few taillight bulbs, Ian's renewable energy systems have grown to include three wind generators, multiple solar-electric systems, two solar hot water systems, wood heating, extensive gardens and orchards, and again, clotheslines. Ian's favorite mode of transportation is a bicycle, and a solar recumbent tandem trike may be in his future.

Ian comes to renewable energy first and foremost as a user and abuser, an experimenter and active learner. In the early 1990s, Ian decided to pursue this passion as a career and began to take workshops offered in Colorado by Solar Energy International (SEI). A year later, he was coordinating workshops in the Northwest for SEI. Three years later, he landed a job as an editor with *Home Power* magazine, his all-time favorite publication. Today, Ian is one of the senior editors at *Home Power* and is Northwest and Costa Rica Coordinator for SEI, organizing and co-teaching 8 to 10 weeks of workshops per year.

Ian is author of numerous articles on wind energy and other renewable energy topics for *Home Power* and other publications, and he is one of the supporting coauthors of *Power from the Wind* by Dan Chiras. He also teaches wind-energy workshops for other organizations and does private consulting for individuals, businesses, and organizations. He particularly enjoys teaching and consulting in Central America, where he spends several weeks each winter.

With his family mostly grown, Ian is excited to see some of his kids involved in renewable energy and environmental education. His family homestead is still an experimental lab where new products are tested and new lessons are learned. If he hasn't already overcommitted himself, Ian likes to correspond with readers at `ian.woofenden@mindspring.com`.

# Dedication

This book is dedicated to my seven children, who have the capacity to change the world they live in by changing themselves and the way they live; my wife, who has lived with my wind-energy addiction for lo these 31 years; my parents, who taught me by example to think for myself, read, write, and care about the important things in life; and my many friends, supporters, readers, and students, who have discussed, laughed, cried, critiqued, and ranted with me over the years.

# Author's Acknowledgments

As an editor, I have been intimately involved in shaping others' writing, and I know from experience that no one is an island. Anything produced is the result of collaboration on many levels. I stand on the shoulders of others who have been working in the field much longer than I and on those I have shared space with in foundation holes and on top of towers in 25 mph winds.

In particular, I'd like to recognize the following:

Hugh Piggott has been a source of much information, experience, and perspective for many years. I appreciate not only his technical savvy but also his humility and generosity. Having him as technical reviewer on this book is another high point in a long trail as friends and colleagues.

Mick Sagrillo is gradually leaving huge shoes to fill, and I appreciate his willingness to share his knowledge, his recommendations, and his time. As mutual thorns in each other's sides, being around the two of us has been said to be "worth the price of admission."

Paul Gipe is a model of straight-up journalism, and he knows more about more wind generators — large and small — than anyone else I know. He calls a spade a spade, and for that I have great respect.

Other renewable energy colleagues who have helped in my education are my earliest renewable energy guru Windy Dankoff, Christopher Freitas, Richard Perez, Joe Schwartz, Michael Welch, Johnny Weiss, Robert Preus, Dan New, Ed Kennell, Mike Klemen, Dan Fink, Dan Bartmann, Randy Brooks, Kelly Keilwitz, Rose Woofenden, Bill Hoffer, Brent Summerville, E. H. Roy, Roy Butler, Steve Wilke, Tod Hanley, Darren Emmons, Chuck Marken, Megan Amsler, Conrad Geyser, Tom Wineman, Randy Richmond, Victor Creazzi, Eric Eggleston, Jason Lerner, Dana Brandt, the crews at *Home Power* magazine and Solar Energy International, and many others.

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My editors at Wiley, Mike Baker, Danielle Voirol, Megan Knoll, and especially Georgette Beatty, have been professional, patient, and insightful. They have formed my rough book into a saleable creature. The many people behind the scenes at Wiley also have my appreciation.

I am blessed with many friends inside and outside of the renewable energy world who give me support, feedback, and encouragement in following my chosen paths in life, with its struggles and triumphs. In particular, I'd like to mention Clay Eals, Andy Gladish, Juby Fouts and clan, Heather Isles, my sister Laura, Susan Miller, Doug Moser, and Steve Dyck, among many, many others.

My immediate and extended family has been an inspiration and a blessing. Several writers are among them, including my father and mother; my favorite and only surviving uncle, George; my brother Lee; and my terribly missed father-in-law, Dave Gladish. My children and future grandchildren are a big part of my inspiration. My hope is that this book reduces wasted resources, time, and money and helps people use one of our abundant natural resources more wisely.

While I'm appreciative of all that these many people have contributed to my life and ultimately this book, responsibility for errors, missing info, and my ever-present personal biases is mine, all mine. Life is imperfect and short; take what you like and leave the rest.

## Publisher's Acknowledgments

We're proud of this book; please send us your comments through our Dummies online registration form located at http://dummies.custhelp.com. For other comments, please contact our Customer Care Department within the U.S. at 877-762-2974, outside the U.S. at 317-572-3993, or fax 317-572-4002.

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# Contents at a Glance

# Table of Contents

# Introduction

Wind energy is without a doubt the most difficult renewable resource to capture. At the same time, it often ends up being the most attractive. Should you be discouraged by the difficulty of the job? No! But if you don't take the difficulty seriously, you will be disappointed. In my many years of working with wind-electric systems, I've seen many, many problems and failures. Some of these were due to equipment design flaws or freaks of nature, but most were due to poorly designed systems and poor maintenance.

This book doesn't sugarcoat the technology or the industry. This is to your benefit! I suspect that your goal is the same as mine: a *successful* wind energy system that gives you electricity that's cleaner and perhaps less costly than what you're using now. Getting to that goal requires looking seriously at what it takes to generate electricity with the wind for the long haul.

Whether you come to this technology with environmental, financial, independence, or hobby motivations, you can get some or all of your home's electricity from the wind. The wind, driven by natural cycles, originating from the sun, is an abundant and renewable resource. Although you still have the capital and maintenance costs of any energy-generating system, you'll never pay a fuel cost on a wind-electric system. (And a *system* is what you need — not a single component but a wisely designed collection of components that work together to capture wind energy, condition it, perhaps store it, and make it usable to you and your neighbors.)

If you do your homework, find good partners, and design, install, and maintain a robust system, you'll be set up for years of satisfying energy. When the wind blows, you'll smile, knowing that it's working for you.

## About This Book

Many people have written books about wind electricity, several of which I use and recommend. This book focuses on a real-world, nontechnical approach to designing and installing wind-electric systems. I didn't write it to turn you into a wind-generator designer, a tower contractor, or an electrician. It's for homeowners who want to explore the possibility of using wind energy and want straight advice from someone with nothing to sell and a great deal of experience with what does and doesn't work.

You don't have to read this book from cover to cover; it's designed so you can dip into and out of any topic at any time. Read what you want, put the book back on your shelf, and bring it down again whenever you need.

If you decide to install your own system, you'll need more than this book. If you decide to hire the job out, you'll be well positioned to ask the right questions, scrutinize the answers you hear, and make wise choices about contractors and system design.

# Conventions Used in This Book

To help you navigate this book, I've established the following conventions:

- **Boldface** text emphasizes the key words in bulleted lists and actions to take in numbered lists.
- New terms in this book appear in *italics* and are explained in the text (and often in the glossary in Appendix A).
- All Web addresses appear in `monofont`.

Some Web addresses may break across two lines of text. Where that happens, rest assured that I haven't put in any extra characters (such as hyphens) to indicate the break. When using one of these Web addresses, just type in exactly what you see in this book, pretending that the line break doesn't exist.

# What You're Not to Read

Please don't read anything that you think is boring or pushes your buttons. If my writing or opinion or the topic doesn't capture your imagination, move on! Each chapter is written to stand on its own, and there's no requirement to read it all or read in sequence. Also, any text preceded by the Technical Stuff icon or included in a sidebar (a shaded gray box) is extra, and you don't need to read it in order to understand the subject at hand.

# Foolish Assumptions

Some wit once said, "Assumption is the mother of all screw-ups." I state upfront my basic assumptions about you so I can help you avoid making a mess. Here's what I assume:

- You are interested in successful wind-electric systems.
- You want to know whether a wind-electric system is a viable option for your circumstances, and you want a solid grounding in the concepts and components of such a system.
- You want your misunderstandings, myths, and fantasies about wind energy to be corrected. You'd rather hear straight talk than sales hype.
- Your goals include cleaner, cheaper, or more local electricity.
- You know that really valuable things cost — in time, money, and energy. In other words, you know that TANSTAAFL — there ain't no such thing as a free lunch.

# How This Book Is Organized

This book is divided into six parts. As a strong advocate of not coloring between the lines, I encourage you to seek out the parts and chapters that you're interested in and read them first. Here's how the general topics are divided.

## Part I: A Wind Primer: Stuff You Need to Know

This part focuses on key wind energy information. It's important to decide upfront whether you're a good candidate for wind energy and to understand the basic parts of the systems and how those parts fit together. Electrical terminology and concept basics can help you understand how these systems work, and understanding some basic wind energy principles can help you understand the resource you're trying to capture.

## Part II: Assessing Your Situation

This part is perhaps the most important part of the book because it takes a hard look at your home and its energy use and your site and its energy resource. Energy efficiency is a vital strategy that helps reduce your energy load and therefore your system size and budget. Understanding wind site assessment helps you get realistic about your site's potential. How you interact with the utility grid — or don't — is covered here, as is economic "payback" and your options if you decide not to use wind energy.

## Part III: Assembling Your System

After you've decided to have a wind-electric system, you have a number of choices about system design. An early question is whether you'll be doing this all yourself or working with others. You also need to decide on a wind generator, a tower, and the other components. And then you pull the system design together into a unified whole.

## Part IV: Installing and Operating Your System

The culmination of all your design work is the actual installation. Before you start, focusing on safety — with towers, mechanical and electrical aspects, and so on — is step number one. After your installation, you need to learn to live with, maintain, and enjoy your system.

## Part V: The Part of Tens

This part, which is a feature of all *For Dummies* books, starts with ten goals for your wind-electric system. These help you get on track. I then outline ten common mistakes so you can steer around them. And ten stories — of successful and not-so-successful systems — give you examples to follow or avoid.

## Part VI: Appendixes

In this part, you find a brief glossary full of important wind energy terms as well as abbreviations and conversion tables.

# Icons Used in This Book

This book is peppered with the following icons to draw attention to specific concepts:


This icon highlights key theories and practices worth keeping in mind during your design and installation process.


Sometimes I like to show off my technical prowess. You can decide whether to read and indulge me.


Look for text marked with this icon for ways to work or ways to look at things that you may not have thought of.


Safety is the number one priority. Don't ignore the advice you find with this icon.

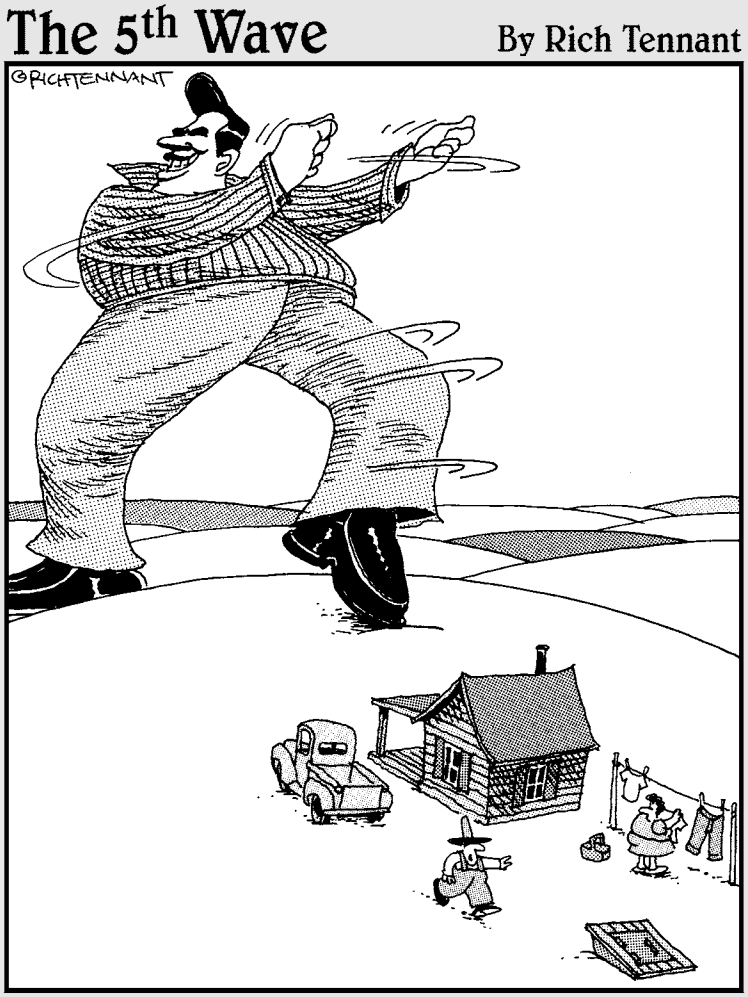
# Where to Go from Here

Scan through the table of contents and see what excites you, and then dive in. If you're determined to be organized, read straight through. But this book isn't entirely linear. As with my teaching style, it's more circular, with recurring themes. This isn't because I forgot I've already said something but because some ideas bear repeating.

If you want a quick overview, read Chapter 1, which summarizes the key concepts in this book. If that's too much, check out Part V, the Part of Tens, where the chapters are bite-sized and pithy. Wherever you start and however far you go, I hope this book will help you become realistic about wind-electric systems. If you follow the advice here, you'll be well positioned to capture an abundant, free, and dynamic resource!

# Part I

# A Wind Primer: Stuff You Need to Know




"Get in the cellar, Ma – twister's heading this way, and it's a big one!"

## In this part . . .

This part gets you off to a good start in understanding wind-electric systems. Chapter 1 gives you an overview of wind energy. In Chapter 2, you look at your motivations and goals, common objections and legal issues, and your chances for success. Chapter 3 identifies the components of a typical wind-electric system and how they can be put together. To wrap up, Chapter 4 gives you a foundation in electrical terminology, and Chapter 5 covers wind-energy principles.

# Chapter 1

# Introducing the World of Home Wind Electricity

### In This Chapter

- Determining whether wind energy will work for you
- Breaking down the components of a wind-electric system
- Understanding electricity and wind-energy principles
- Getting a handle on your energy situation
- Designing, installing, and operating your system

Have you ever watched a wind generator spinning in the breeze and wanted one for your home? You're not alone. Wind generators — big and small — are captivating. Something about capturing the elusive, invisible force of wind excites people. I'm here to help you take that excitement and succeed in making meaningful amounts of electricity from the wind for years to come. Think of this chapter as your introduction to the wide world of wind energy.

## Figuring Out Whether Wind Energy Is Right for You

People chase after wind energy for a variety of very different reasons. Yours may include reducing your impact on the environment, saving money, increasing the reliability of your home's electricity, boosting your social status, or adopting a fascinating hobby. Being clear about your motivation can help you make sure you reach your goals. For example, if wind energy is a hobby, you'll be less concerned about payback; if it's an environmental passion, you'll want to make sure you're actually cleaning up the Earth, not burdening it with more stuff.

To be successful, you obviously need wind, and you need a good site where you can install a tall tower to get up into the good wind. But you also need to please your local bureaucrats, as well as your family and neighbors. Educating yourself about the common objections to wind energy can help you educate others about the reality of a wind-energy system and get them on your side.


If you have the right site and situation, you still need to have or hire the skills to design, install, and maintain a system. Someone — either you or someone you hire — has to be hands-on. Someone needs to be ready to take on a system that isn't easy and may well give you headaches at times. Finding mentors, experienced wind-energy users, and professionals can help. Chapter 2 explores these issues and more in detail.

## Understanding the Components of Wind-Energy Systems


If your goal is to make wind electricity, you need more than a wind generator. A wind-electric system, even at its most basic, includes the following parts:

- **Wind generator:** The spinning device that captures wind energy and converts it to electricity
- **Tower:** The steel structure that holds your wind generator up in the wind
- **Transmission:** Wire and associated equipment
- **Controls:** The charge controller, inverter, and so on
- **Batteries and/or grid interface:** Equipment for energy storage and grid interconnection
- **Metering, disconnects, overcurrent protection, grounding, and more:** Gear to keep track of your system's performance and keep the system safe

Chapter 3 details these system components so you can understand their functions and be ready to think about how to put them together in your system.

## Focusing on Electricity Fundamentals

You can't do a good job of designing, installing, and operating an electrical system without understanding electricity. If you don't know a watt from a volt, Chapter 4 helps you with plain-language explanations of electrical terms, including the following: