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:

- **Wattage:** The rate of energy generation, transfer, or use
- **Watt-hour:** The unit of electrical energy
- **Voltage:** Electrical pressure
- **Amperage:** The flow rate (often called *current*) of electrons (charges)
- **Direct current (DC):** One-way flow of electrons
- **Alternating current (AC):** Two-way flow of electrons
- **Amp-hour:** Battery storage capacity
- **Ohm:** Resistance to the flow of charges
- **Hertz:** The frequency of AC alternation

Perusing Wind-Energy Principles

In addition to having a clear understanding of electrical principles, you want to understand wind-energy principles. Wind is invisible and a bit mysterious. Its power increases with the wind speed cubed (V^3), which is a particularly important concept to understand; it means that a small change in wind speed can have a big effect on how much electricity you're generating.

Capturing wind energy requires a large enough collector on your generator, and air density (and therefore elevation) also has an effect on power. (One wind power formula says that the power in the wind equals $^1/_2$ times air density times the collector area times the wind speed cubed, or $P = {}^1/_2DAV^3$.)

Although this formula helps you understand the comparative power available in the wind, energy (measured in watt-hours) is the prize you seek, so focusing on instantaneous or maximum power (measured in watts) is a distraction at best. And you don't want watt-hours for a day, week, or a year but for years if not decades, so you should seek reliable equipment that churns out the watt-hours for the long haul. Chapter 5 explores these topics and more.

Getting a Grip on Your Energy Situation

Because your goal is undoubtedly to make some or all of the electrical energy for your home, understanding how much energy you use is crucial. The next step is to work on energy efficiency — making the best use of your energy. Your site's wind-energy potential needs careful consideration, too. All these steps improve your chances of generating the amount of energy you need.

Before designing a system, you need to decide how your system will or will not relate to the utility grid. The grid allows you more leeway in how much energy you can use or need to produce, but hooking up does involve getting through some red tape.

After you calculate how much energy your chosen turbine is likely to produce on your site, you can get an idea of the value of your investment. If you decide not to go after wind energy, you have some other options. Read on — this section covers all these energy issues.

Conducting an assessment and increasing your home's efficiency

An energy assessment can give you a big-picture view of the energy use of your family, including specifics about each energy user in your home (by *energy user,* I mean your air conditioner or stereo, not, say, your spouse and kids). The simplest way to get the overall view of your electricity usage is from your utility bill, but getting more specific can help you ferret out the biggest culprits.

Chapter 6 gets down to the nitty-gritty for you. Ideally, you'll end up with a detailed list of all your home's energy users, with an accurate number of kilowatt-hours (kWh) per day attached to each. You'll also figure out which appliances are using energy even when you aren't using them so you can make wise energy-efficiency moves.

If you're motivated to save money or the environment or both, focusing on energy efficiency is your absolute best move. Energy efficiency has a larger return on your investment and a lower upfront cost than any wind-electric system does. Chapter 7 talks you through the details of improving your lighting, appliances, and other energy hogs in your home. The end result may be cutting your energy use by one-third to one-half or more. This means that your wind-electric system — and its budget — can shrink accordingly.

Calculating your home's potential for wind energy

Casual observation of the wind is almost useless as information for your wind-electric system design. Though getting specific numbers may be difficult and costly, you need to work toward getting as accurate an estimate of your average wind resource as possible. Wind is your fuel, and without knowing how much fuel you have, you have no way of knowing how much electricity you can generate.

I describe various subjective and less-subjective methods of estimating your wind resource in Chapter 8. I recommend that you use as many of them as possible and still be conservative with your estimate. Your wind resource is the biggest factor in what you get out of your wind generator, and there's no sense in setting yourself up for disappointment with enthusiastic estimates.

Knowing your home's relationship to the grid

You have a very basic decision to make in designing your system: how the utility grid will be involved. Tying into the grid allows you to buy energy from the utility when the wind isn't blowing and to send energy to the grid when your turbine is making more energy than you can use, usually for an energy credit. You have three basic choices, assuming you aren't already far from the grid:

- **Batteryless grid-tie:** This is the most efficient, effective, and economical system, but when the utility is out of service, your system is, too.
- **On-grid with battery backup:** You have the benefit of using the grid as a "battery" to get credit for your excess electricity, but you also have outage protection.
- **Off-grid:** You have to make all your own electricity all the time.

Chapter 9, which delves into the pros, cons, and configurations of these systems, can help you make your decision.

Determining payback on your investment

Everyone wants his or her purchases to make sense. Financial sense is one way to look at what you buy, though actually it's not the most common way. Almost all your purchases include other values — quality, style, the environment, personal tastes, and so on.

Chapter 10 looks at both the financial side and the full value of purchasing, installing, and using a wind-electric system. I challenge you to look hard at your motivations, your decisions, and the alternatives to renewable energy.

Looking at other energy options

Wind energy is not for everyone, and it may not be for you. Consider these circumstances:

- Sometimes you just don't have the right site. You need enough wind, you need legal permission to put up a tall tower, and you need the physical space to do it.
- Sometimes you don't have the right situation. Electricity from the utility may be very cheap in your area, or incentives (such as subsidies, loans, and tax breaks) may be very low or nonexistent.
- Sometimes you're not the right type of hands-on person, or you don't have the dough to hire the right type of person to keep a system going.

In those cases, you don't need to give up on your renewable energy dreams. Chapter 11 presents some other options:

- **Solar electricity:** Photovoltaic (PV) modules — solar-electric cells — provide clean, reliable electricity for decades.
- **Hydro electricity:** If you have a stream falling down your back forty, you can tap it for electricity.
- **Solar thermal applications:** Heating your home and/or water with sunshine are definite options.
- **"Green power" purchases:** Your utility or other providers may offer greentags, renewable energy certificates (RECs), or other ways to use your dollars to support clean electricity projects.
- **Transportation alternatives:** From bicycles to hybrid cars, transportation is a field ripe for energy savings.
- **Simplifying your life:** Tackling this toughest of jobs may reap the largest reward at the least cost.

Designing Your Wind-Energy System

System design pulls together the information from your energy assessment, site assessment, and personal assessment. With this information, you need to find suppliers, contractors, and other team members. Then you actually need to choose the components you'll use — the wind generator, tower, and balance of systems (BOS) gear. Add the team to the gear and work through the process of figuring out how a gang of people and a pile of gear can turn into a working system.

A team of experts to help

Chapter 12 can help you decide where you'll be along the continuum of sole owner-installer to check-writer and observer. In all cases, you'll be dealing with other people; even if you're going it alone on the design and installation, you still need to buy your equipment from someone.

I recommend buying from someone who can supply you not only with gear but also with information about how to design, install, and maintain a long-lasting system. Paying a bit more for the gear is worth it if you end up with a consultant you can turn to when you have questions.

If you're new to this field, you're more likely to be somewhere on the other end of the continuum, where you'll be either working as part of a team or hiring a contractor to do the whole job. Picking your team carefully can mean the difference between a delightful experience and a disaster.

Wind generators

In a wind-electric system, the wind generator is the star of the show. Of course, there are no one-man or one-woman shows in wind energy — you need all the components. So I'd encourage you *not* to turn to Chapter 13 first and drool over your wind generator options. Get a good grounding in the whole system first so that when it's time to look at the star, you understand the whole script and performance.

Being clear about what size of wind generator you need is a good first step. This goes back to your energy *load* — how much energy you use, because the wind generator's diameter will be directly related to how much energy you want to generate. Then looking at the different turbine configurations is worth doing (although most configurations will be similar, and the oddball ones are best left to the crazy experimenters).

Before you make your final pick, look at what kind of an owner you'll be, how harsh your site is, and what your budget constraints are. I discuss all this and more in Chapter 13.

Towers

Wind-generator towers are the most ignored and underrated part of wind-electric systems, but they're crucial for good performance. Because the power available in the wind increases with the cube of the wind speed (V^3), getting just a bit more wind means getting a lot more energy. And the way to get a bit more wind is to put up a taller tower. The standard rule of thumb in the industry is to have the lowest blade *at least* 30 feet above anything within 500 feet.

Your site will help decide what tower style you need, based partly on the *footprint* (the area taken up by tower, anchor, and guy wires). Towers come in three basic styles, with variations on the basic three. Table 1-1 shows how the styles compare.

Table 1-1 Basic Tower Styles

Tower Type	*Need to Climb*	*Footprint Size*	*Cost*
Tilt-up	No; all maintenance is on the ground	Largest footprint	Medium cost
Fixed guyed	Yes	Medium footprint	Lowest cost
Freestanding	Yes	Smallest footprint	Highest cost

I discourage you from using homebuilt towers or mounting a turbine on your roof. If you want reliable, safe performance, your best bet is to go with the tried and true, unless you're a crazy inventor who loves to experiment and is willing to take the consequences. Also keep in mind that choosing a tower that's too short and too close to obstructions (such as trees, buildings, and landforms) is the number one mistake that people make in small wind energy today.

Choosing your tower type, height, and overall plan is vital to achieving good results. Your tower is a big chunk of the budget, and tower installation takes a significant amount of time. Turn to Chapter 14 to delve into towers.

Other components

The supporting cast in a wind-electric system may include a charge controller, inverter, disconnects and overcurrent protection, wiring, batteries, and more. Together, these items are called *balance of systems* (BOS) equipment. There's a lot of detail to understand here, and unless you already have experience under your belt, you need support in this realm. Chapter 15 can help you know which questions to ask and how to understand the answers.

Tying everything together

Understanding what each component does is one thing. Designing an integrated system of components that work together well to accomplish your goals is another thing altogether.

Here are some specific decisions about your system and the factors that impact them:

- **Wind generator size:** Your energy load (kilowatt-hours per day/month/year) and your wind resource (average wind speed) determine the size of your wind generator.

- **Tower height:** Your site and its wind shear help you determine the minimum tower height — I recommend going higher than the minimum.
- **Relationship to the grid:** Your situation, motivation, and mindset determine your system type. Choose wisely among off-grid, battery-based grid tie, and batteryless grid-tie. Changing your mind later often isn't easy.

Choose your project team carefully, too. Don't fall victim to the pain of the "best price," which is often attached to the worst service, if not the worst product. Consider the advantages of buying a complete package from a dealer who can support you. I cover these issues and others in Chapter 16.

Installing and Using Your Wind-Energy System

When it's time to get your hands dirty — or someone else's hands dirty — and install your wind-electric system, the first priority should be safety. Wind-energy systems have more dangers than other renewable energy systems and more than a typical home's electrical system.

Installation needs to be done with care, and it requires experience in a variety of fields, from concrete to mechanical construction to electricity. After that, monitoring and maintaining a system can take less technical savvy if you've done a good job of design and installation.

Staying safe

Hazards on wind-energy jobs include gravity, the weather, mechanical moving parts and failure, electricity, batteries, and live (human and animal) hazards. To work safely around these hazards, you need a variety of safety equipment. Tower climbing has its own set of tools that includes harnesses, lanyards, fall-arrest equipment, tool bags, pulleys, lines, and more.

Knowing how to work safely on the tower and on the ground is not optional. You're dealing with life and death here. Falling or dropping something from even 40 or 50 feet can be fatal. Understanding how to work safely around electricity, batteries, and mechanical tools and components is also important.

Chapter 17 gives you a good start on understanding the dangers and the gear, and it sets you up to find out more on the job.

Installing your system

Wind-electric system installation covers a variety of trades:

- You start by laying out the tower, excavating, and pouring concrete for the tower base and anchors.
- Tower installation includes assembling and lifting, with more than one possible approach.
- Wind-generator installation also involves weight, mechanical work, and electrical connections.
- Electrical work spans the distance from the tower top (where you find a whole different set of working conditions) to the power room.

Chapter 18 gives you the big picture on these processes, which vary depending on your specific site, design, and equipment.

Monitoring and maintaining your system

Living with a wind-electric system is a satisfying occupation. A wind generator gives you an eye on the sky and the weather. Your awareness should extend to the instantaneous output (watts) and cumulated output (watt-hours) of your system. Not only will your metering and data-logging systems be fascinating to keep track of, but they'll also let you know how your system is performing.

Wind energy is not a build-it-and-walk-away proposition. These systems require regular maintenance. At least once a year — and maybe twice — someone needs to lower or climb the tower to check the wind generator, do all scheduled maintenance, and address any problems. On the ground, batteries are the primary focus for maintenance, but you need to be aware of other system components and their calibration, too.

Chapter 19 covers these issues and more. If you're aware of your system and treat it carefully, you'll be set up for a long career capturing the energy in the wind.