Chapter 1

What a Mess!

In This Chapter

- Understanding the current energy situation
- Identifying problems in the current system
- Looking at alternatives

For the most part, producing energy and consuming energy is a very dirty business. Although you all may have a sense of this, the extent of the problem seems to be a political question open to debate. What should be done about energy consumption? Use less? Use different resources? How can new energy sources be best invested in? And perhaps of most importance, what types of new energy sources should be invested in? And what about global warming? Can anything really be done about it? What will new energy sources and the combating of global warming cost both the society as well as individuals?

A lot of solutions are being tossed around, but it's nearly impossible to separate the wheat from the chaff. And to make matters worse, political fringes screech from the sidelines in preachy tones that tend to turn people off to the point where they just plain don't want to listen any more. This is a system guaranteed to create gridlock and partisanship, and that's been the norm for so long that everyone is just plain used to it.

Leaving the important questions up to the politicians hasn't worked too well, and so it's incumbent on everybody to understand the issues so that informed decisions can be made when voting for candidates with varying views concerning both the problem and the solutions. Informed decisions also help you to decide, on a micro basis, what's best for your homes and your families. This chapter gives an overview of energy use — as well as the system's problems — from the past and present as well as what can be done in the future.

Understanding Where Society Is and How It Got Here

The fact is, energy is a critical component of your lives and your economy as a whole. You use energy in virtually every endeavor you engage in, whether you're aware of it or not. Life expectancy in the U.S. has increased 66 percent over the last century (from 47 years in 1900 to 78 years today). Americans are living longer, healthier lives, and for the most part Americans are more secure and knowledgeable about their world. Life is just plain better than it used to be, and this has been made possible by advances in medicine and technology — advances that all took a great deal of energy.

To make any kind of claim that energy consumption has been anything but advantageous to humanity completely misses the point. The problem is not with energy, it's with the way energy is used and which types are used.

It's only becoming evident now that energy use is a zero-sum game: You pay every bit as much as you gain, but the terms under which you pay are still not clear. Of course, you pay for each gallon of gas you use, but we're also learning that we are paying in environmental costs and health costs. The most fundamental concept that this book can teach is this: The U.S. (and by extension, the world) does not have an energy crisis. Rather, it has an *environmental energy policy crisis.* The U.S. has as much energy as it wants to use. The question is how to use it and what kinds of limitations should be set in terms of how the environment is affected through that energy use. To answer that question, you need to get a handle on energy use in the past, present, and future.

Historical trends of energy use

Humans have evolved in step with the sophistication of their energy consumption. Human populations, quality of life, and life expectancy have increased as energy sources have become more sophisticated.

Think about it: Early man couldn't even light a fire. Many froze in the winter, with only wooly mammoth skins to keep them warm, and the quality of life was not much different than that of animals. Once fire was discovered and humans were able to create flames at will, humanity began a gradual but consistent climb from savagery to what it is today. Upon the advent of fire, humans could warm themselves and cook their food. This began the consistent push toward bigger and better cultural and material gains, and it lead to healthier, happier lives.

Throughout time, the human population remained steady for the first 1,500 years and then began a steep, consistent climb. The increase is due largely to the availability of versatile, convenient energy. As controlled, or useable, energy became more prevalent, the population expansion accelerated.

Table 1-1 shows how population and energy consumption per capita have increased through the ages. Continue this trend out a hundred years, and it suggests that the only thing humans will be doing a century from now is consuming energy, 24/7. Regardless whether you're willing to take that leap intellectually, the fact is, humans use more and more energy every year. This growth can't be supported, unless society comes up with alternative sources and consumption habits; otherwise, fossil fuel reserves will be depleted by the year 2050.

Table 1-1 Population and Energy Consumption over Time

Date	*Population (in billions)*	*Consumption in kWh/day*
5,000 bc	0.1	9.4
0 ad	0.3	10.1
1850	1.3	12.0
1980	4.4	51.0
2000	6.0	230
2050	9	1,000?

You can see how greater populations results in higher energy consumption. You can also get a feel for how daunting and necessary it is to find a workable solution for energy consumption.

Energy use today

Today, Americans consume around 100 Quads (quadrillion Btus, or British thermal units; head to Chapter 3 for information about energy measurements) of energy per year. (This number includes only sources of thermal energy, such as gasoline, natural gas, coal, and so on, and not the vast carbohydrate network that supplies our food chain.) So is that a lot? Here's 100 Quads worth of energy in units that resonate: Fifteen large horses labor, day and night, 24/7, for each U.S. citizen.

The breakdown of U.S. energy consumption is roughly 40 percent electric, 30 percent transport, and 30 percent for heating. While we burn most of this energy, only about 30 percent goes to direct heating. The rest is used to turn shafts to make electricity, and to turn shafts to move our cars. Eventually, all of this energy makes it back into the environment in the form of heat. In fact, there is far more heat pollution from energy consumption than any of the chemical types of pollution emitted, but Mother Nature can absorb all of this heat without the problems that chemicals create.

Figure 1-1 shows how primary energy sources are used in the American economy. As you can see, coal, oil, gas, and shale (the fossil fuels represented in Figure 1-1) are the most commonly used energy sources today and the root of many of our current problems. Mineral fuels like uranium are used for nuclear fission and fusion.

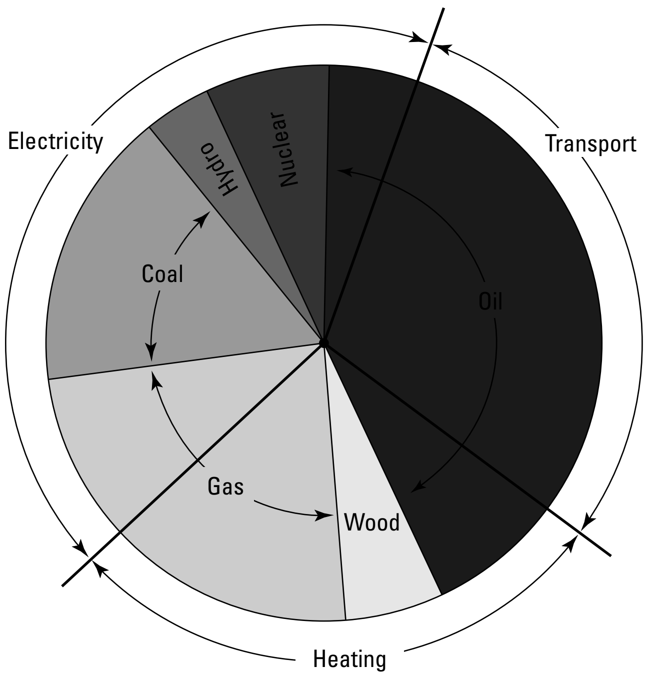

Figure 1-1: Primary fuel uses in the American economy.

For more information on the current state of affairs of our energy use, head to Part II.

Looking ahead to more energy use and waste

As the human population grows, the total consumption of energy grows even faster. Bottom line? We humans seek comfort and consistency in our lives. Energy provides this, and so humans seek energy. The reason so much more energy is being consumed per capita is that ordered energy (go to Chapter 2 for an explanation of this concept) takes a lot of raw energy to create. Raw forms of energy, like firewood, give way to more sophisticated forms, like electricity. That's evolution, in a nutshell.

Humanity strives for consistency. Consistency is order, and that's what energy gives us. If we want more consistency, it will take more energy. And more and more all the time. Human history suggests that our energy consumption is only going to increase, and when impediments to this growth occur, problems follow.

The following sections delve into some of those problems.

The cost of energy producing processes versus raw energy

As more sophisticated energy-consuming processes are developed, the cost of those processes has less and less to do with the cost of the raw energy required and more and more to do with the equipment that creates the finished energy product. You have to consider the total effect of the energy-consuming process. The order achieved from an energy-consuming process is important, not the actual raw energy that is being consumed.

Invested energy is the energy that's used to manufacture a product (in the literature, you may see this referred to as *embodied energy,* or grey energy, but it all means essentially the same thing). Most people don't consider invested energy when they're analyzing energy-consuming processes; they only consider the raw fuels that are used by the machines that use energy. But a complete energy picture requires consideration of invested energy.

Decreasing costs, increasing demand

When more efficient machines are devised, the cost of operating those machines decreases, and demand goes up. This is simple economics referred to as *cost elasticity:* The cheaper a commodity becomes, the more it is consumed. For example, more fuel-efficient cars result not in less consumption, but more consumption, because people can afford to drive their cars more.

The inevitability of waste

Waste is a necessary part of every single energy process. It's a simple fact of physics. Therefore, the pursuit of eliminating waste is fruitless, and misses the point. In fact, the more ordered energy becomes, the more waste that is inherent in the process of creating that order. Chapter 3 has more on this topic.

Putting Society Over a (Oil) Barrel: Problems in the Current System

Over the last century, humankind experienced an unprecedented expansion of industrialization. Here's a perspective: Only 100 years have passed since autos have even existed, and electrical power didn't exist in a majority of the country until 50 years ago. Now consider:

- Industrialization is a global phenomenon so energy resources are being consumed at an unprecedented rate the world over.
- Japan is the world's second largest economy, and China is growing into a tremendous world power, consuming resources faster than any country the world has ever seen.
- U.S. consumption of petroleum has risen steadily since 1950, and promises to continue unabated.
- In 2000, the U.S. consumed 20 million barrels of crude oil per day. That's a lot of crude.
- U.S. net fossil fuel imports fell during the '70s as a result of the OPEC oil embargo, but have risen sharply since the mid 1980's. In 2005, over half of the crude oil consumed in the U.S. was imported, and it's projected that this number will increase to over 65 percent within 20 years.

Overreliance on fossil fuels

All of the growth and expansion has been shouldered by fossil fuel energy sources, which creates all sorts of havoc: Politically it makes us beholden to foreign nations. Economically it creates uncertainty in markets, and wild price fluctuations result. Economies need consistency in order to thrive, and there is no telling how much the fossil fuel price fluctuations have cost the U.S. economy in terms of lost growth potential.

Declining supplies

While consumption has skyrocketed, U.S. domestic supplies of crude oil have declined in the last half of the century, and after checking out the following facts, you can see that at some point U.S. domestic supply will simply run dry:

- **At present, U.S. production of crude is only 1.9 million barrels a day.** Current estimates put U.S. domestic reserves of crude petroleum at 21.3 billion barrels. But current production rates are around 8 percent of the reserves per year. This means the U.S. will run completely out of domestic crude in about 12 years
- **Current estimates of U.S. natural gas reserves are 192.5 trillion cubic feet.** But production from these reserves is growing at a rate four times that of new discoveries so the situation is only growing worse. At present, production represents around 4 percent of proven reserves per year, which suggests that the U.S. will run out of domestic supplies in 25 years.

Even if ANWR is opened up to drilling; even if offshore drilling platforms are allowed to proliferate around the coastlines; even if new domestic reserve discoveries exceed the wildest expectations; and even if future generations of extraction and processing equipment exceed expectations, the U.S. will run completely out of domestic supplies for its most basic forms of raw energy.

The U.S. has two options in the face of declining reserves:

- Seize foreign reserves, by war if necessary. Although this may sound outlandish, when the U.S. economy starts to grind to a halt, things will get truly serious.
- Develop alternative energy sources.

Getting better at finding and using fossil fuels

The supply of energy is not determined by how much is available, or what's out there, but by humankind's ingenuity in getting to it, and using it. Semiconductors and computers have made oil-drilling machines infinitely more intelligent and effective than they were 100 years ago. And semiconductors and computers now account for nearly 15 percent of all the electrical consumption in the U.S. Energy begets energy. In short, we have grown much more efficient at extracting raw energy.

A word or two about global warming

I don't take a definitive position on global warming one way or another in this book. My opinion is that it's not really relevant in encouraging people to conserve and practice efficiency. The fact is, the world uses too many resources, and in the process ends up altering the planet in material ways that will affect future generations in one manner or another. Global warming is just one way that humans might be affecting the planet, and in my view the overwhelming attention placed on this one aspect of our environmental defamation does a disservice to the other aspects, and the overall balance and harmony that mankind should be striving for. What if it turns out that there is no global warming? Should society then go right back to the old days of unlimited exploitation of resources? Of course not.

I also find it frustrating that most people seem to believe wholeheartedly that global warming either does or does not exist. There seems to be no middle ground. The fact is, the data, while compelling, is still inconclusive, and both sides have valid arguments. The earth has always warmed and cooled. There have been over 600 warming and cooling cycles, and none of these have been attributable to manmade pollutants. It is theorized by some that the dinosaurs' demise was brought on by a meteor that hit the planet earth, causing tremendous densities of airborne particulates that changed the environmental ambient in catastrophic ways. Warm-blooded creatures thrived in the new world order, and this brought on mankind's ascendance. So within this theory, humankind is a product of a natural global warming event. It would be ironic if mankind ends up ensuring its own demise by a manmade global warming event.

Here's an interesting question for those who believe that mankind should strive to neutralize its effects on the planet. Suppose NASA determined that a large meteor was going to strike the earth. And further, it would be possible to launch a rocket with a massive nuclear bomb that could destroy the meteor. Should we do it, or should we simply let nature take its course?

In conjunction with this trend, technology has provided the means to refine energy to the point where it can be controlled for even the most precise uses, like resurfacing the human eye so to see without eyeglasses, or creating microprocessors so precise and controlled that even microscopic variations in the semiconductor substrates are smoothed over, resulting in ever faster and better computers, that in turn, make it possible to harvest even more energy, and with more efficiency.

Imagine if all of this ingenuity and inventive spirit were channeled into the pursuit of alternative-energy sources. Most of the advances in technology come from the U.S., and if the country were to focus on developing alternative-energy sources, a huge boost to the economy would result. The U.S. could lead the world in exporting alternative-energy know-how, and the equipment to achieve the desired end results.

Rising to the Challenge: Balancing Fossil Fuel Use with Appropriate Alternatives

You solve energy problems by expending even more energy, not less. You need to devise alternatives that offset fossil fuel addictions, and invention and development take a lot of energy. Infrastructure takes energy. All human advancement requires energy in increasing amounts. Because the only consensus seems to be that fossil fuels are not the answer, you have to wonder what form this energy will take in the future. The following sections provide an overview of the alternatives as well as factors to consider when choosing alternative sources of energy.

REMEMBER

This book is all about alternatives to the status quo. Alternatives are not the end all; they will never displace fossil fuels. The solution lies in a combination of doing better with fossil fuel use and developing alternatives when that's appropriate. In Parts III and IV, I describe the alternative technologies in detail, explaining when these technologies are useful and when they're not. Alternatives will require sacrifices not only in terms of monetary costs but also in terms of changing lifestyles.

Looking at the local impact

In addition to the pollution mitigations and political desirability of alternative energy sources, there are attractive local impacts:

- Local jobs
- Sustainable economy
- More money stays local, instead of moving to the Mideast
- Less air pollution, lower health burdens
- Diversification of the energy-supply options
- Security to the U.S. economy — the economy is more controllable if it doesn't rely on foreign countries for energy supplies.
- Increasing supply of energy options reduces costs by increasing competition, making inexpensive energy more widely available

REMEMBER

Economically, none of the alternatives can compete price-wise with fossil fuels, but that all depends on one's accounting system, for fossil fuels are subsidized in many ways by the governments of the world.

Adding up the alternatives

As stated earlier, energy is not running out, nor will it ever run out. The problem is not that less energy resources are available, but that the political and environmental consequences of the current energy consumption, well, stink. Hence, the drive for alternatives. The following sections introduce the alternative energy candidates. You can find out more about these options in Parts III and IV.

Solar power

Solar power, discussed in detail in Chapter 9, uses sunshine to create both heat and electricity, as well as passive heating and cooling effects in buildings. Although there are other ways to take advantage of solar power (think photosynthesis, for example), the one I focus on in this book is the direct conversion of radiation. This includes photovoltaic panels and solar liquid heating schemes. Large scale solar farms can provide entire communities with enough electrical and heating power to make the communities self-sufficient.

Nuclear power

Nuclear power harnesses the tremendous energies from both the splitting and fusing of atoms. In some books, nuclear is not considered an alternative energy source, but my interpretation is that alternatives are those that do not emit the fossil fuel pollutants that are causing so much environmental harm. So I include nuclear energy in the alternative energy pantheon. Find out more about nuclear power in Chapter 8.

Solar's role in other energy sources

Solar power is a key component in other energy sources:

- **Photosynthesis (a plant's ability to convert sunlight into useable energy):** Plants grow and may be combusted as biomass (like ethanol, or wood). Animals eat plants, humans eat animals and plants. There is also energy available from fermentation and anaerobic decay of biomass.
- **Oceanic.** Waves may be harnessed for energy production. Currents are capable of driving hydro turbines. The thermal differences between different regions may be tapped with heat exchange mechanisms.
- **Hydropower.** Solar radiation evaporates water, which becomes rain, which becomes rivers and streams that can be dammed up and outfitted with turbines and generators. See the section "Wind and hydropower" and Chapter 10 for more on this energy source.

Wind and hydropower

Wind power derives from windmills placed in locations with a lot of wind. Luckily for the U.S., there are plenty of suitable sites.

Hydropower comes from dams which provide high pressure water flows that spin turbines, thereby creating electricity. It can be exploited on both a macro level (huge dams can be built to create statewide electrical power on America's biggest rivers) and on the micro level (people can put hydropower generators in backyard rivers and streams). For more info on both of these energy sources, head to Chapters 10 and 11.

Geothermal

Geothermal power, the topic of Chapter 12, takes heat from the earth and redistributes it into a building, or uses the heat to generate electrical power. It's available in tremendous quantities, but it's difficult to extract and takes a lot of capital equipment. On a more general level, heat pumps (the kind in many homes) are a source of geothermal energy, so geothermal energy can be practical and effective on a micro level.

Biomass and wood

Biomass is sawgrass, mulch, corn, and so on. These materials are either burned in their raw form, or processed into liquid fuels or solid fuels. Wood, the most common biomass, is used to heat homes throughout the country. (***Note:*** Some books distinguish wood from biomass, but I don't make that fine a distinction.) Chapters 13 and 14 explore these topics in more detail.

Hydrogen fuel cells

Hydrogen fuel cells, in a nutshell, produce electrical power from nothing more than hydrogen, which is completely free of carbon. The exhaust is water, and what can be more natural than that?

Hydrogen fuel cells combine oxygen and hydrogen to produce water and electrical energy. Sounds simple, and there's an amazing potential to solve a lot of the world's environmental problems, should fuel cells pan out like some people think they will. The technologies are years off, however. And there are some major difficulties that may never be overcome. But the promise remains bright, and a lot of development money is now being invested in fuel cells. Go to Chapter 15 for more information.

Electric vehicles

Electric vehicles use only electricity to power the drive train. The electricity comes from batteries, which are heavy and cumbersome, but battery technologies are getting better and all-electric vehicles are now becoming economically competitive with conventional, internal-combustion vehicles. It should be mentioned that electric vehicles need to get their electrical power from somewhere, and that "somewhere" is likely the power grid, which itself consumes a lot of coal, and emits a lot of pollution. Chapter 18 has more info.

Hybrid vehicles

Hybrid vehicles are a combination of electric and internal-combustion powertrains. When power requirements are low, the vehicle operates in electrical mode. When more power is needed, or when the electrical batteries are near depletion, an internal-combustion engine provides power. Hybrids, discussed in Chapter 19, offer much higher MPG ratings than conventional transportation.

Biofuels

Biofuels, discussed in Chapter 17, are made of biomass products such as corn. Corn ethanol is now being added to most gasoline supplies in the United States. Despite the high energy consumption in the refining process, biofuels allow the U.S. to import less foreign oil, and so the political effects are desirable. Biofuels may either be used in their pure form or mixed with fossil fuels.

Evaluating the alternatives

There is no such thing as a free lunch. Every energy source has pros and cons, and trying to decide how best to provide the power an economy needs is a complex problem. Many believe that the current energy predicament will be solved by weaning society away from petroleum consumption, but even as people develop new alternative sources, the problems don't go away; they simply change in nature.

In evaluating alternative energy sources, here are some important factors to consider.

Combustion versus noncombustion

The majority of our energy sources produce power through combustion processes (burning) that require a burn chamber, oxygen, and exhaustion capacities. From time immemorial, humans have burned wood for fires, and the process was simple: Pile some wood, light it on fire, hang around nearby. Modern combustion processes are engineered to be more efficient (modern wood-burning stoves are around 100 times more efficient than open fires, for example), but the combustion processes, regardless of how efficient they are, are notorious pollution sources.

Noncombustion processes, such as solar power and nuclear, don't exhaust pollutants the same way that combustion processes do, but they entail their own problems. For instance, solar photovoltaic (PV) panels require a lot of energy to manufacture, and most of this energy comes from electrical power which mostly comes from coal combustion. So while solar is pollution free in its on-site implementation, it entails a lot of pollution in its manufacture. Other noncombustion energy sources such as wind and hydropower also require a great deal of energy to manufacture the capital equipment needed to make things work.

Raw material issues

Every energy production plant, whether solar or a woodstove, needs raw materials. In the case of solar, the raw materials are free. In the case of a nuclear power plant, the raw materials are uranium rods, which must be meticulously refined and manufactured. In fact, the total cost of an energy process has less and less to do with the raw fuels. Capital equipment is expensive, and is usually the most influential component in a cost/analysis equation.

The degree of refinement of the energy

Woodstoves provide heat, and in a rather coarse fashion. Solar PV provides high-grade electrical energy. Wind power also provides high-grade electrical energy. In the case of the woodstove, the heat is the desired end product, and heat is very coarse yet effective. Electrical energy is very refined and convenient. Every energy-consuming process requires a certain degree of refinement of the energy, and the refinement itself takes energy. If it's possible to adopt policies that promote less refined energy, everyone is better off.

The level of current technology

It takes time for new technologies to reach the market, and it takes even more time for wide-ranging acceptance and use of a new technology. People don't simply discard their current systems because a radical new technology is developed. They wait until their current equipment breaks down, or is no longer economical to use before they invest in new systems.

Pollution and environmental impacts

Every energy-producing and -consuming process leaves a residue of some kind on our planet. Alternative-energy schemes are not all pollution mitigation marvels. Wood stoves, for instance, can be one of the most polluting energy sources if the wood is burned inefficiently. And different types of pollution cause different types of problems.

Economics

Let's face it; most people are concerned exclusively with economics and are only interested in seeing their net costs decrease for energy consumption. Because of this, the government steps in with taxes, rebates, and other forms of subsidies in order to achieve in the market what they deem desirable, namely lower pollution levels and freedom from foreign oil. If the government didn't mandate economic changes to the playing field, fossil fuels would never yield to alternatives.

Politics

And of course, since government is going to lead the way into the alternative energy future, politics plays a very large role in which alternative solutions get the most play. Green politics is becoming an increasingly powerful and influential part of every government operation.