Part One

THE WORST-CASE SCENARIO

Living without electricity is visceral, maybe even surreal. You begin to feel the difference in everything you do, in almost every step you take. In a very real sense, the lack of electricity drains the lifeblood out of you. You certainly begin to feel a loss of control, and for good reason. The vast majority of us are not in control of our electricity service. It's bad enough to recount your movements in an electricity-less world. Most of us have been through a recent and lengthy outage. It feels like the worst-case scenario. But when you envision a future influenced by the issues that I mentioned in the preface, you begin to realize that the worst case in the years ahead could be *worse*.

In this section, we walk through what happens in an outage so that you can experience how electricity pervades modern existence. Then we learn how today's system works, from the extraction of the raw energy source to the electricity-consuming appliances in your home. After that, we experience more than a century of colorful industry history condensed into what I hope is an engaging and fun approach. Finally, we return to the worst-case scenario theme and show how a system that is breaking can be fixed.

Chapter 1

Night of the Living Dead

You are into day three without electricity at your residence. The heat wave is scorching and you have no air-conditioning. Friends up the street who really can't stand the heat booked what they claim was one of the last rooms available at a hotel still connected to the grid. All the food in the refrigerator is fast becoming fodder for the dumpster. The security system has exhausted its last electrons of backup battery power.

The line last night at the only Mickey D's still able to serve up burgers was brutal. The land-line phones in the house have been down since the storm blew through because they are all remotes that require an electrical connection. You've resorted to burning gasoline in your car to keep the cell phone charged up and your body cool, but you are wondering if you can refill the automobile's tank because half the local stations can't run their pumps. You're taking quick showers, careful to use as little hot water as possible, knowing that the water heater's controls are also electronic and don't work without power.

In the initial hours of the outage, you learned to live without Internet and cable television. These aren't essentials, you think to yourself, although your kids have a different opinion and have spent most of the day moving from one Wi-Fi hotspot to another. Meanwhile, more gasoline is consumed.

You go upstairs to use the bathroom and discover that the water tank on the toilet isn't filling back up. That's weird. The cold water supply to the sink and the bathtub are also low. Check with the neighbors. Same issue. Is there a connection to the electrical outage? Perhaps. The city water system may have lost one or more of the pumps that keep the water pressure high enough to reach the upper floors of homes. Or the water flows had to be redirected because of pump outages, a water main broke from being overloaded, and less water is now in the system. Indeed, in the morning you read that a water main broke less than a mile from your home.

Many of the neighbors have fled to relatives or friends who live in outlying areas. They've been told of the news reports presaging no relief from the heat wave. On the first night or two, there was some comfort, even gaiety, as neighbors gathered on front porches to share storm stories while curious others walked by with their dogs and kids. You were busy keeping chins up in the face of adversity and just thankful that no one in the neighborhood was hurt. Now, it's the third night without power. The neighborhood is eerily quiet. No lights, no security systems. The city's a mess, with thousands of trees down. Police, firefighters and even the National Guard are working to locate individuals who may be at risk of heat stroke. You live in a historic city neighborhood where gang-related petty crime is always an issue, but now everyone's talking about looting. How long before the frustration turns to anger, anger turns to opportunity, and gangs of marauding youth begin plundering the homes?

At the office the next day, power is available. The high-rise office building has a backup generating system in the basement and is connected to the grid in such a way that it can get electricity from more than one source. You do some Internet research on your local utility or electricity service provider. You find that the utility's customer satisfaction indices have slipped this year compared to last. You also discover that there have been controversies between the utility and the

Public Service Commission (PSC), which regulates the utility, about expenditures for distribution system improvements. Not sure how all this relates to your particular situation, you push it to the back of your mind.

You leave work early. Even though the air-conditioning works fine at the office, the last time you slept without air-conditioning on such hot evenings was when you first got out of college and had no money. You can barely type or write in between yawns.

At 3:30 in the morning of day four, you wake to the blaring siren of your security alarm. The power's on—at least on your side of the street. Lights all over the house are on, ceiling fans are whirring, the siren is still screaming and you are completely disoriented. The whole scene is jarring. But the lights are on! Once daylight breaks a few hours later, you move on to the tasks of cleaning up and throwing out. Things begin to return to normal, although it will be another four days of darkness for your friends right across the street.

But for now, it's over. That's it. The worst-case scenario is behind you, isn't it? You wish.

Lurking in the Shadows

Most of us don't think about electricity at all unless it isn't there. But your service, whether at home or at your business, is merely the last link in a long electricity production and delivery "value chain" that is getting longer, going global, governed by vacillating regulations, and subject to all sorts of new threats and vulnerabilities.

Your electricity comes through a distribution circuit, connected to other distribution circuits, which are fed by the transmission system (those long high-voltage wires that go off into the horizon), which is fed by the power plant, which gets its energy from either water in the form of a hydroelectric dam, wind, coal, natural gas or uranium, which can come from places as close as America's heartland or as distant as Iran, Nigeria, Russia, Australia, Venezuela, or Kazakhstan. The large power stations that generate electricity serve various classes of customers: industrial, commercial, and residential. After electricity is first generated, it is greatly increased in voltage to make the long trek over the transmission line more efficient, and then stepped down in voltage as it is taken off the grid for delivery to an end user.

Coal, uranium, and natural gas account for more than 90 percent of the electricity generated in the United States. Renewables make up the rest—with hydroelectric at around 8 percent, wind at 1 percent, and a variety of other sources making up the rest. Today, most of this raw energy is sourced in North America. However, over the next 20 years, things are likely to be different. I like to portray the production and delivery value chain as a "supply line." Unlike in the past, your electricity doesn't really come from a nearby utility. It can come from hundreds, or even thousands, of miles away. These supply lines can be fragile.

Twenty years ago, a worst-case scenario blackout was a much simpler event because the supply line was tighter. A vertically integrated electric utility, highly regulated, was responsible for the entire electricity supply and delivery chain of events. In many cases, these electric utilities also had some control over the coal, natural gas, and nuclear fuel used in their power stations.

In the 1980s, the nation began a protracted experiment with deregulation of the electricity industry. Deregulation was a social, political, and economic trend that affected trucking, telephones, airlines, banking, natural gas, and health care. In the 1990s, under the banner of globalization, large swaths of the rest of the world also began to dismantle state-owned energy enterprises, such as electric utilities, and began to create market-oriented businesses.

Today, and for the last five years, the electricity industry is in what I've called in my speeches to the industry a "quasi-deregulatory quagmire." Depending on where you live, and how vigorously your state pursued competition and deregulation, the vertically integrated supply chain has been busted apart. Some states imposed no competition in the first place. Some started down the path but reverted to regulation. Other states went so far down the competition path that no amount of political maneuvering can "put the genie back in the bottle." In many other countries, deregulation proved to be little more than political rhetoric or window-dressing.

The triple forces of deregulation, market-oriented institutions, and globalization have resulted in many of the consequences that will be described later in this book. However, one of the most important is that the transmission function in this country somehow got lost and ignored during most of the deregulatory fervor. As a result, this country now has what many transmission experts call a "third-world" grid. It's a clever sound bite, but most people will understand the phrase. Certainly, after two major outages this year, my friends and neighbors get it loud and clear.

We have to be careful about how we use the word *grid*. Some industry experts use it to refer only to the transmission function. To others, the grid means all the lines, wires, and circuits between the power station and the electricity meter attached to your home. In other words, it includes the transmission and the distribution functions. In this book, we use it to refer to the latter—all transmission and distribution functionality—and use the phrase *transmission grid* to mean only the transmission assets.

Thirty years ago, we in the industry described our transmission grid system as "gold plated." That means that utilities usually spent more than they needed to ensure that the system was robust and probabilities of massive failures were as close to zero as possible. The reliability of your service used to be something akin to a social guarantee. Regulators benchmarked, or compared, their utilities to others, based on reliability. Today, utilities are trying to maintain some semblance of reliable service on the backs of a deteriorating transmission grid and in the face of a more competitive world for electricity supply.

Many of the much-vaunted positive benefits of deregulation, like lower electricity prices, more reliable service, and new consumer and demand-management technologies, could only have occurred with improvements, constant upkeep and greater integration of the transmission system. Ironically, just the opposite has occurred. Transmission has become the weak link in the supply chain, and many of those positive benefits have yet to materialize. All those ultra-modern, next-generation services deregulation was going to bring to your front door were, unfortunately, dependent upon an increasingly "brittle" transmission grid. Imagine driving a brand-new Maserati over a road littered with potholes.

We're supposed to be balancing electricity supply with electricity demand nationwide, or at least regionally through competition. Low-cost power in the Midwest is being shipped to New England where costs are typically higher. Areas with great reserves of coal, prime sites for new coal-fired units, could generate power economically, and it could be shipped to high-cost regions.

However, because the transmission grid got lost in the deregulatory shuffle, the ability to move this power around to meet these market-oriented expectations did not expand. And, because the utilities and regulators were focused on other parts of the system, the basic infrastructure was actually allowed to deteriorate.

Are you one of those people who would like to see coal-fired generating plants shut down, replaced with renewable energy? One reason you won't see this happen in a big way is that the country lacks the transmission infrastructure to bring wind energy from high-wind areas (usually where few people live) to the places where electricity demand is highest (such as big cities).

So the number one vulnerability in our electricity system is *a deteriorating transmission grid*. While the government and industry have studied the problem and have been taking steps to fix this, progress is slow, and too few of the industry's resources are focused on it.

At the Heart of It All

When you are in the middle of an electricity outage, it's easy to understand how interconnected is our infrastructure. Phones don't work, trains don't run, elevators stop between floors, water pumps quit pumping, compressors that move fuel like natural gas stop turning, computers no long whir, and so on (see Figure 1.1). Electricity is to modern society like blood that runs through the body. It touches everything. It powers everything in some way. If you viewed our infrastructure as a pyramid, electricity would be the base, the bedrock, the foundation upon which everything else depends.

To understand the predicament we may find ourselves in a decade or two from now, imagine inverting that pyramid to where everything from the base down is dependent on the unstable apex.

Fear at the Heart of the Future

Once you thoroughly survey the entire supply chain, transmission isn't the only weak link. When was the last time you thought long and hard

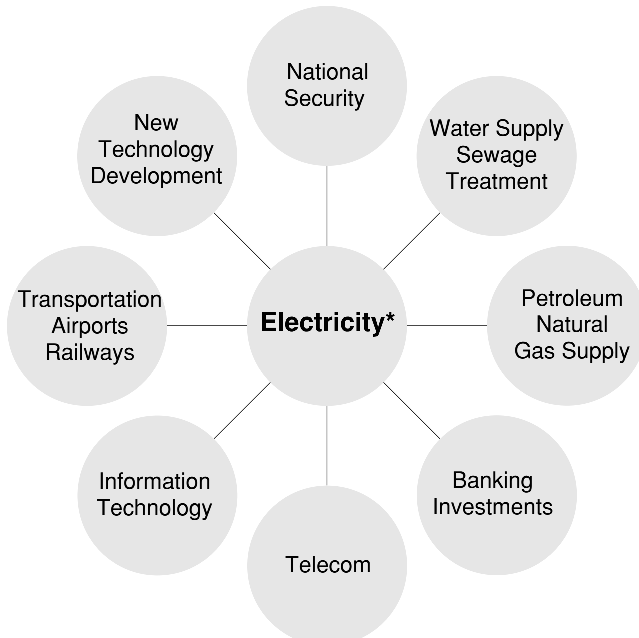

Figure 1.1 Electricity is fundamental and central to modern life.
Note: There is no Strategic Electricity Reserve as there is for oil upon which to draw in case of a true national emergency.

about freight trains? Many Americans believe that our era of dependence upon the railroads ended long ago. But today, more than 50 percent of our electricity comes from the conversion of coal at power stations, and much of that coal is shipped over long distances by rail—from Wyoming to Georgia, for example. Electric utilities east of the Mississippi have been complaining about poor rail service, and are therefore having a difficult time maintaining coal inventories.

Several decades ago, these fuel supply lines were shorter. There are two reasons why coal is hauled greater distances today. Coal from the western United States, primarily the Powder River Basin (PRB) in Wyoming and parts of Utah, is cheaper and has less sulfur than coal from traditional eastern sources concentrated in Kentucky, West Virginia, Illinois, and Ohio. The tradeoff is, however, that it is also a poorer quality coal that burns less efficiently and increases the discharge of carbon dioxide and other pollutants.

Most of our coal-burning plants are getting old. Over the last 10 years, almost all of the new power plants built are fueled by natural gas. That's because the natural gas industry was working off of a supply surplus, or "bubble," created, in part, when natural gas use was banned from power stations between 1979 and 1986. That bubble has been depleted (it took close to 15 years), and now immediate supply is scarce and prices have skyrocketed. In fact, prices have gone up so much that many gas industry experts believe that market forces will force us to import substantial quantities of natural gas from overseas as liquefied natural gas (LNG). Forecasts by the Energy Information Administration (EIA) and others show that we could be importing up to 25 percent of our natural gas consumption by the year 2025.

The list of our potential major LNG suppliers around the world doesn't match up to this country's "best friends" in the rarefied air of geopolitics. Many are our arch enemies, like Iran (the world's second largest holder of natural gas), our former Cold War adversary Russia (with by far the world's richest natural gas holdings), or countries that have given us trouble over the years (Algeria, Indonesia, Libya, and others) and those that are becoming more worrisome by the day such as Nigeria.

If you haven't been keeping up with the electricity industry, you wouldn't know that we're in the permitting stages for a fresh round of construction of large nuclear power units. The dirty secret of nuclear power isn't unsafe reactors, catastrophic accidents, or the potential for nuclear grade materials to find their way into terrorist hands. Those are controversial aspects, to be sure. It is that most of our nuclear fuel is imported. Thankfully, it has largely come from two long-time friends, Canada and Australia. As we'll see later in the book, a significant amount also comes from converting fuel-grade nuclear material from Russia.

With these examples, let's summarize the second vulnerability to the electricity metered into your home or business: *lengthening supply lines.* Under the old regulated electric utility model, the route from energy source to electricity meter attached to a building probably averaged a few hundred miles. In 20 years, if it continues to be more economical to import energy sources, a large fraction of our electricity supply will be "sourced" several thousand miles away, even halfway around the globe. We're even starting to talk in this industry about importing coal, even though we sit on the world's richest coal reserves, enough to generate all of our electricity for several hundred years. It's all about short-term economics, unless we change our national will.

As the supply lines lengthen, it is best to understand them as a taut rope being pulled on both ends. The forces pulling on one end are global economics and geopolitics. The force on the other end is like a powerful vacuum cleaner: Our insatiable demand for energy of all forms has been sucking the supply out of the world. This is okay as long as we're the premium destination for this energy, the ones who can pay the best price or guarantee long-term contracts. This is a global game of tug-of-war that we're playing, and the rules and the players are rapidly changing.

It's Not Just about Us

The economies in China and India have been growing at 7 to 15 percent annually for years. Those two countries represent one-third of the people on the planet. The United States represents 3 percent of the world's population and our businesses cheer and applaud when economic growth tops 3 percent per annum. "That giant sucking sound," the celebrated description by Ross Perot referring to the probable movement of labor to Mexico following passage of the North American Free Trade Agreement (NAFTA), is, in the world of energy, moving away from North America and toward Asia.

There is going to be tremendous competition for the planet's energy resources in the coming years. One thing is certain: We're going to have to pay much more for our share, or our share is going to go where the demand is much higher. However, one sentiment I do not share is this half-baked notion that we're running out of energy. I've been at this business for 25 years. As long as I can remember, we've been "running out." During that entire time, we've had a "10-year supply of natural gas," a "250-year supply of coal," a "30-year supply of petroleum." While I recognize that our planet inherently has a finite amount of resources, in the energy business it's not a matter of resource availability, it's a matter of what price the market will bear to extract those resources.

Resource availability isn't the problem and it isn't going to be—at least for a very, very long time. Our problem is the fragility of our supply lines. Whether energy for electricity is sourced as LNG from the Middle East, uranium from Australia, coal from Wyoming, or electricity from thousands of miles across the country, electricity supply lines are extending beyond the horizon. It is more than shortsighted to think that what happens in China or India has no effect on your electricity.

Just-in-Time Inventory

The number three vulnerability of our electricity system stems from a peculiarity of electricity as an energy form: It cannot be stored; at least, not as electricity. Actually, it can be stored in tiny quantities as electrons in devices called capacitors, which, thanks to advancing technology in microelectronics, are getting larger (called *ultracapacitors*) and more robust. However, for large quantities, it must be stored in another form, such as the chemical energy in a battery, the mechanical energy in a flywheel, or the hydraulic energy of a reservoir of water at a high elevation.

As a country and as an industry, we store vast quantities of petroleum in what is known as the Strategic Petroleum Reserve (SPR). Large volumes of natural gas are stored in underground caverns around the country to balance seasonal demand and supply. Vast reserves of coal are located in mines, a natural means of energy "storage."

We have nothing like this for electricity. We do have facilities called pumped storage hydroelectric plants, which function as bulk electricity storage. However, only 2 percent of our electricity-generating assets are represented by such facilities. In other countries, such as Japan, the United Kingdom, Europe, and South Africa, the percentage is more like 4 to 10 percent.

It seems odd, doesn't it, that we have so little storage for that part of the infrastructure that supports and enables the rest of it? Odd, shortsighted and, I believe, dangerous. Storage technologies are under development rapidly; but so far, few in the industry or in the political arena have given them much attention.

Whither the People

While stored electricity is in short supply, it's in much better shape than our supply of trained and skilled workers. At least for now. And while electricity storage is an issue of physics (a topic scientists and engineers can get their minds around), the supply of workers is an issue of people (a topic even scientists and engineers can't figure out). The supply of trained and skilled workers depends on the creation of incentives.

Electricity is often viewed as a mature or "smokestack" industry. Some have called it a dying industry. Whatever you call it, you can't call it popular. Recent graduates are eager to begin glamorous careers in higher-paying fields such as computer science, electronics, bioengineering, pharmaceuticals, and health care. Meanwhile, the electricity-sector worker is aging and getting ready to retire. The numbers are staggering. For every two workers about to retire, the industry has *less than one* to replace them with. Ninety percent of the engineers and scientists around the globe will come from India and China, according to recent speech by a high-ranking official from the Department of Energy. I just read a report that states the nuclear power subsector alone will require 90,000 trained workers and engineers in the coming years. Ninety thousand! I don't know where those workers are coming from, and neither does anyone in the industry. They are not yet loitering in the halls of academia, judging from reports on college majors.

The fourth major vulnerability, then, is *the lack of specialized workers to maintain and operate the infrastructure.* In the end, this will primarily prove to be an issue of escalating cost, but it will still greatly impact affordable, reliable service. Like energy resources, labor shortages are temporary dislocations, not a situation of "running out." The question is, will we have the right people at the right time? Right now, it doesn't look good.

National Security

During the run-up to year 2000, we learned a great deal about the vulnerabilities of the infrastructure given the impending year 2000 (Y2K) crisis. Experts analyzed and very capably planned for and prevented massive computer failures resulting from the "date" issue affecting a good deal of computer code. The electricity industry, in particular, performed in stellar fashion.

Y2K taught us about how everything is interconnected. That knowledge is now providing the foundation for understanding and protecting ourselves from security threats, which can range from the catastrophic (terrorist attacks) to the mundane (disgruntled workers who hack into the system and do mischief—or windstorms that blow through the neighborhood).

Not only is our electricity grid "third world" in quality, it actually is weakly interconnected. What this means is that the grid is not built to move large increments of electricity long distances. Instead, it is interconnected primarily to move emergency levels of power from one region to another in the event of a widespread outage.

In some ways, a weakly interconnected grid may be beneficial when it comes to security. Disconnected systems cannot all fail together. However, the Y2K studies revealed that there are a handful of major substations in our "national grid" that, if taken out, could likely cause the entire eastern or western parts of the U.S. electricity system to falter. We had a taste of this during the great Northeast Blackout of 2003. The root cause of the failure turned out to be tree limbs along important grid supply lines near one of the substations critical to the systems in the Northeast and Midwest.

Because electricity is the life blood that flows through the rest of the infrastructure, the security of these substations, as well as other parts of the grid, are paramount to national security. Much of the work in this area has "gone underground" since 9/11, and isn't available for public scrutiny. However, it is clear that the gears of the federal government are grinding painfully slowly to take steps to protect such vital facilities. *The fifth vulnerability, therefore, is the interconnection of the grid from a national security perspective.*

Degrading Our Surroundings

Every segment of the electricity production and delivery value chain has associated environmental and ecological impacts. When you think through them, there seem to be no good options for supplying electricity, only less bad ones. Minimizing the impacts on our surroundings adds substantially to the cost of the product and the service.

Today, the most troublesome impact of coal-fired power stations is the massive amount of carbon dioxide (CO_2) that is discharged, contributing to global climate change. Nuclear power's "Achilles' heel" is the safe long-term management (disposal or recycle) of what is known as high-level nuclear waste. The renewable energy sources wind and solar seem attractive until you acknowledge the intermittent nature of those sources. The wind doesn't always blow and the sun doesn't always shine. Long transmission lines require right-of-ways that often must cut through pristine areas. Even many long-time environmentalists are against some of the planned wind farms because of either the NIMBY (Not in my backyard!) effect or because of concerns for bird migration patterns, offshore ecosystems, or just because the 100-foot-tall turbines might ruin their view. It is ironic that large wind farms now may suffer from NIMBY just like nuclear power plants. Finally, there's that lingering EMF (electromagnetic field) issue that slid off the radar screen. That will probably reemerge as soon as new or upgraded transmission lines start being proposed.

Today's natural-gas-fired power plants are typically more efficient than other types of power stations, but they still emit substantial quantities of CO_2. An interesting, little-known aspect of natural gas is that it is almost completely composed of methane (CH_4). Methane is known to be a global warming agent that is more than 20 times as potent as CO_2. Natural gas pipelines, extending hundreds, even thousands of miles, supply the fuel. Leakage occurs along these lines. They are small leaks to be sure, but not insignificant when you consider that every CH_4 molecule that leaks into the atmosphere is like 20 molecules of CO_2! Estimates are that anywhere from 2 to 10 percent of the methane escapes as natural gas is being delivered to the consumer.

So far I've briefly touched on only the most pressing long-term environmental issues associated with each option. Many others, shorter term in nature, are described in later chapters devoted to these options. Nevertheless, it is clear that *our sixth vulnerability is environmental impact.*

Never Say Never: The Worst Case Could Always Be Worse

Let's return to the scenario that we opened with. It's day four and no electricity. The storm has not only damaged distribution equipment, but also caused one or two power stations to shut down. A utility one state over did not experience the storm and has reserve capacity. However, only a minimal amount of that reserve could be transmitted to your location because the transmission lines are weak and are not even able to safely carry the load for which they were originally designed.

Your local utility has two "reserve" power stations that are fueled by natural gas. However, it has contracted to have those plants supplied by LNG under short-term contracts under which the utility has to pay the highest market prices for the fuel because the long-term economics are better. Plus they need those plants so infrequently. The supplier included provisions in the contract that allow the price to escalate based on demand at the time of shipment. An LNG tanker bound for your utility suddenly reverses course when the shipper learns that a firm in China is willing to pay more for the LNG. Either pay up or lose the shipment. The utility decides it will not be held hostage to the vagaries of the global LNG market because that will ruin its balance sheet that quarter. And while the global LNG market may be uncertain, there are some sure things in this life: Wall Street does not like ruined balance sheets.

In the meantime, supply is dwindling at the utility's primary coal-fired power plants. Inventories held in the coal yard adjacent to the power units have been allowed to run low because the financial planners see little need for tying up money in excess inventory when it could be put to better use in other short-term investment instruments. With few alternatives, the utility runs the coal units even though there are some maintenance issues that need to be addressed. It is less efficient than usual and so is consuming even more coal, drawing down the inventories that much further. The next unit train of coal destined for the plant is held up by electrical issues along the railroad. Because the units are being "run harder," one of them experiences a "forced outage."

The utility issues warnings, sanctioned by the state and local government officials, about how much electricity each household can use over the next several days. Run the refrigerator, but unless it is a health emergency, do not run the air conditioners.

Because your utility now competes directly with the utilities adjacent to it, they no longer come to each other's aid in emergencies like this outage. The utility contemplates "airlifting" skilled workers from Asia, but finding ones that speak enough English (so that they understand our safety criteria, for example) is difficult. Plus, the expense is staggering, to say nothing of the bureaucratic challenges of getting security clearances and visas. In exploring this solution, the utility finds that many skilled American workers are now employed in Asia because the money is better and the work, designing and building new infrastructure with advanced technologies, is more gratifying than operating and maintaining the antiquated systems in the United States.

Day four becomes day five, the day that the looters showed up in your neighborhood. Day five becomes day six, when a voltage surge caused by an inexperienced worker cascades to create new equipment failures. Day seven begins a long week during which brownouts are frequent and electricity use is rationed on a daily basis—as it is in third-world countries.

I am only imagining what it might be like in the future, but you can easily get the point. It's getting to be a perilous journey between the source of energy and the electrons at your meter. The trained and expert professionals needed to assure that it's all done safely may not be around. You may think that I'm taking liberties in conjuring up these scenarios. But in December 2000, no one would have believed that Enron could implode by December 2001. On September 10, 2001, few people believed that two 110-story buildings could be felled by airplanes commandeered by hijackers armed with box cutters.

The economic costs of electricity outages are astronomical (see Table 1.1). That's why the most vulnerable businesses maintain sophisticated capability to recover from electricity service disruptions (a field called *business continuity*). The cost to you and I may be more difficult to estimate, but we know it is high, whether gauged by pain in the wallet or psychological damage.

Table 1.1 The Costs of Outages for Selected Commercial Customers

Industry	Average Cost of Downtime Per Hour
Cellular communications	$41,000
Telephone ticket sales	$72,000
Airline reservations	$90,000
Credit card operations	$2,580,000
Brokerage operations	$6,480,000

In later chapters, we'll spend more time on the frequency and severity of electricity outages. There are good reasons why *Power* magazine, one of the industry's most prominent trade publications, reported late last year through its Power News service that one of the largest grid operators in America, PJM, calls the need for new transmission an "emergency," and that "time is of the essence to avoid reliability problems." The North American Electric Reliability Council (NERC), now responsible for the reliability (and reliability standards) for the nation's grid, reports that "the transmission system in North America requires additional investment to address reliability issues and economic impacts." In fact, you almost can't read a report on the U.S. electricity industry that doesn't decry the state of the nation's transmission grid either overtly or covertly.

It does seem like we'll be experiencing more nights of the living dead without electricity. As the issues become clearer, a better strategy also comes into focus. This is what we'll see in following chapters.