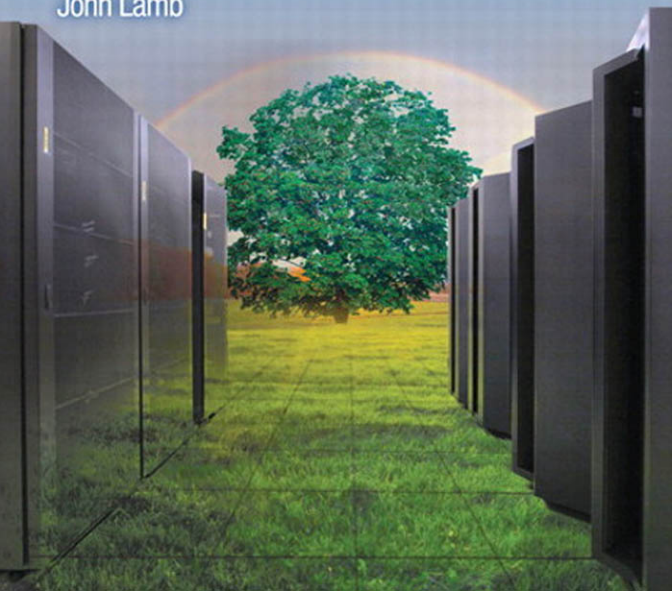
The Greening of IT

How Companies Can Make a Difference for the Environment

John Lamb



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Preface

Info-Tech's 2007 Green Index indicates that one-quarter of IT leaders in the United States are either "very" or "extremely" concerned about energy efficiency and environmental responsibility, yet only nine percent consider themselves to be "very" or "extremely" green. The index surveyed more than 700 people in North America during February 2007. The market research firm said that dedicated green budgets for IT initiatives might, in turn, influence vendors and suppliers to meet similar green mandates. Large players, such as Dell, HP, IBM®, Cisco, and Sun, have jumped on the green bandwagon, and Info-Tech anticipates a significant increase in the amount of green-focused products and marketing collateral as green adoption continues to gain traction. According to the market research firm IDC, by 2010, for every $1 spent on hardware, 70 cents will be spent on power and cooling. By 2012, for every $1 spent on hardware, $1 will be spent on power and cooling.

At this time, most companies are considering the effects that their Information Technology (IT) architectures and installations are having on the environment. This book outlines the major issues they face. It also describes, through case studies, how the green IT experiences of many different organizations can be leveraged for *your* company. Although IT and data centers are inherently technical, this book is intended for the nontechnical audience, as well. That's because data centers and IT in general (including our laptops, PDAs, the Internet, and so on) are significant contributors to greenhouse gas pollutants and global climate change. Recent UN and White House sessions on climate change have emphasized the environmental importance of green projects. Although controversial, Al Gore's film and book, *An Inconvenient*

Truth, have raised awareness worldwide to the effects of emissions on the environment. Other books, such as Thomas Friedman's 2008 *Hot, Flat, and Crowded: Why We Need a Green Revolution—and How It Can Renew America*, continue to sound the wake-up call. Green IT is one significant step in providing a solution to the crisis. As discussed in Chapter 1, "The Importance of Green IT," many companies are emphasizing the Corporate Social Responsibility (CSR) aspect of green IT. In 2009, Google plans to open a data center in Council Bluffs, Iowa, close to abundant wind-power resources for fulfilling green energy objectives and proximate to fiber-optic communications links. Going green also inspires us at the individual level. Because I grew up in North Dakota, I emphasize in Appendix C, "Comparison of Different Power-Generation Methods," that North Dakota is the top wind state (in potential) in the United States. When I visited my small farm community home town in eastern North Dakota in July 2008, I was proud to see the wind turbines springing up around the state. The Great Plains area of the United States has even been referred to as the Saudi Arabia of wind. This overall awareness, sense of responsibility to contribute, and pride in contributing will continue to be very important for our success in driving toward green IT.

Green IT is the study and practice of using computing resources efficiently. Typically, technological systems or computing products that incorporate green computing principles take into account the so-called triple bottom line of economic viability, social responsibility, and environmental impact. This approach differs somewhat from traditional or standard business practices that focus mainly on the economic viability or economic benefits rendered by a computing solution. These new focuses are similar to those of green chemistry: reduction of the use of hazardous materials such as lead at the manufacturing stage, maximized energy efficiency during the product's term of use, and recyclability or biodegradability of both a defunct product and of any factory waste.

A typical green computing solution addresses some or all these factors by implementing environmentally friendly products in an efficient system. For example, an IT manager might purchase Electronic Products Environmental Assessment Tool (EPEAT)-approved hardware combined with a thin client solution. As compared to a traditional desktop PC configuration, such a configuration would probably reduce IT maintenance-related activities, extend the useful life of the hardware, and allow for responsible recycling of the equipment past its useful life.

The U.S. government is going green. President Bush signed an executive order in January 2007, mandating government agencies use of green technology and processes. See http://www.whitehouse.gov/news/releases/2007/01/20070124-2.html. If corporations want to sell to the federal government, they now must have a green plan.

Many technical groups are also now involved in the effort toward green IT and green data centers. Governments, electric utilities, engineering societies, and all IT vendors are involved. For example, in May 2007, IBM unveiled Project Big Green, a redirection of $1 billion USD per year across its businesses to increase the energy efficiency of IBM products and services. The goal is to reduce data center energy consumption and transform customer technology infrastructure into "green" data centers, with energy savings of more than 40 percent for an average data center.

Green IT and green data center technology cover a broad spectrum, from efficient cooling towers and variable speed blowers, to the use of energy-efficient IT systems such as virtual servers, blade servers, and virtual data storage. These topics are covered both as general areas of concern and in more detail in later chapters. This book was written to have a wide appeal to many types of readers (that is, not just a technical group), as it has been written in a more informal writing style than the typical technical book. The target audience consists of CEOs, CIOs, VPs of IT, system architects, and sales and marketing people. Most of this book is on the level of "Here's what you can do" and geared to the target audience. Some of the appendixes and parts of chapters go into additional technical detail and help respond to "Here's how you can do it."

The competition fostered by these global issues has inspired energy-efficient products and energy-efficient technology services across the globe (for example, Sun, Dell, HP, Fujitsu-Siemens, APC, Liebert, and so on). That competition, along with regulation and standards for measuring energy efficiency, will continue to rapidly drive energy efficiency across the board. We will all benefit.

Green IT is an ideal way for most companies to make a significant step toward environmental preservation. Because IT equipment is continually refreshed as a matter of company policy to remain competitive, the opportunity is there to emphasize energy efficiency for the refreshed equipment. Replacing the IT equipment with energy-efficient systems with concepts such as virtual servers, blade servers, and virtual data storage can easily reduce IT power consumption for the replaced equipment

by 50 percent. However, virtual server and virtual data storage technology are methods to enable you to significantly reduce equipment and system management costs for your data center. So, data center green technology is based around a solid business case without even considering the savings due to a reduction in energy costs. Of all the green projects out there, green IT is truly a "win-win" direction for all companies to pursue.

Finally, although the main intent of this book is to examine the business benefits of going to green IT, we should not lose sight that green projects are also socially responsible. Of course, going green also gives a corporation a potential financial benefit. The recent book *Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage* by Daniel C. Esty and Andrew S. Winston shows how companies benefit financially by emphasizing environmental responsibility and following the "green wave" (to use the author's term). In 2009, with Steven Chu as U.S. Secretary of Energy, going green will get another significant boost. Secretary Chu was director of the Lawrence Berkeley National Laboratory and a strong supporter of alternative energy development, along with a strong belief in encouraging energy efficiency and conservation for all our current infrastructure.

How to Use This Book

This book is organized largely around the two basic reader groups for a book of this type: 1) CEOs, CIOs, VPs of IT, sales and marketing people and 2) system architects, IT architects, engineers, and other technical groups. If you're more involved in the business aspects of your company, you might be most interested in the early chapters on "what to do" in the area of green IT. The following bullets give an overview of how this book is organized and will help serve as a guide for your reading.

- Chapters 1 through 5 give a background on green IT and should be of interest to all readers. These chapters give information on the green IT challenge and the importance of collaboration across a wide array of technical and regulatory groups.

- Chapters 6 through 11 look at some of the technical equipment and strategies for saving energy in IT. Chapters 9 through 11, the case study chapters, are intended to emphasize the "lessons learned" aspect of green IT. The case studies include universities, energy utilities, and large and small companies and span the globe to give guidance based on country or regional green regulations and issues.
- Chapter 12, "The Future of Green IT for Corporations," is the summary chapter and also takes a look at the future. This material should be of interest to all readers.
- The appendixes give details on checklists for green IT, tools for power and cooling estimates, emerging technologies such as grid and cloud computing, background information on the pros and cons of different power-generation methods, and information on worldwide electricity average prices for IT. Cloud computing, discussed in detail in Appendix B, is a significant new technology for green IT. The recent push for "private cloud computing" will have an impact on all of our data centers.
- The Glossary following the appendixes will help you with many terms used in green IT.

This book was written to enable you to go directly to a chapter or section of interest and begin reading without having first read all the previous chapters. The intent is to make the content of each chapter as independently intelligible as possible.

Green IT is and will continue to be an interesting and hot topic worldwide. Enjoy this book. It was a pleasure to write.

—John Lamb

1

The Importance of Green IT

"As more and more people understand what's at stake, they become a part of the solution, and share both in the challenges and opportunities presented by the climate crises."

—Al Gore on global warming

Information Technology (IT) is at the heart of every successful modern business. Without it, success is impossible. Yet, the pervasive deployment of IT has had significant, unintended side effects, namely as a significant contributor to the economically unsustainable worldwide dependence on fossil fuels. The awareness of these side effects, though somewhat late in coming, has led some successful companies to turn to a sustainable practice known as "IT greening." IT greening is about using IT more efficiently to achieve reductions in energy consumption, and therefore, considering the acquisition of energy-efficient IT solutions. Within this book, you can find details on the environmental impact of IT, including data centers' consumption of fossil fuel-based electric energy. In addition, we examine many case studies, extracting lessons learned and best practices for implementing green IT.

IT is so pervasive that energy efficiency through the implementation of green IT has moved to center stage for many companies in their pursuit of environmentally helpful practices. This book provides details on the importance of implementing green IT; the significant and growing role of IT and data centers in the world's consumption of electric energy and carbon footprint; and especially the case studies for "lessons learned" and the best-practice approaches for implementing green IT.

As I mentioned in the Preface, green IT is an ideal way for most companies to make a significant step in reducing their carbon footprint for several reasons. First, for competitive reasons, most companies already refresh their computer hardware—laptops, desktops, servers, and storage devices—every three to four years. That refresh cycle provides a recurring opportunity to buy increasingly energy-efficient technology, such as virtual servers, virtual networks, and virtual data storage. Such virtualization can easily reduce IT power consumption for the replaced equipment by up to 50 percent. (For examples, refer to the Environmental Protection Agency's [EPA] "Report to Congress on Server and Data Center Energy Efficiency" or the reports by Jonathan Koomey listed in the Bibliography.) A second compelling reason to move to green IT is that virtualization technology enables you to reduce equipment and system management costs for your data center. Data center green technology is based on a solid business case—even before we consider the savings due to reduced energy costs. A third reason for moving to green IT is that all large companies are moving to such implementation improvements (in IT virtualization, cloud computing, and so on). In addition to information on IT virtualization, this book also includes information on new energy-efficient cooling technologies that support IT, and the impact of electric utility-rate case incentives and government incentives and regulations on promoting IT energy efficiency.

Green IT has many different aspects. In this book, we use the terms **green IT**, **green computing**, and **green data centers**. Green IT—as used here—is the most comprehensive because it includes all computing, inside and outside the data center. The emphasis of our discussion is on the business aspects of green IT, so the focus is on what to do, rather than the details of how to do it. However, several chapters, especially the case studies, do give details on how to implement green IT, using best practices based on recent experience and lessons learned through dealing with many companies and organizations throughout the world.

In the following chapters, we look at the benefits and roadblocks in moving to green IT, including the following:

1. Organizational issues in addressing the problem (for example, CIO doesn't pay the electricity bill).
2. The future of regulations as external factors for change.
3. Overall motivation for executives to move to green IT.
4. Evaluation of product end of life and asset disposal, procurement policies, and supply-chain issues (solutions to avoid climate impact, and such).

Executives have one significant aspect of motivation to move to green IT that is not covered in any depth in this book, and that is the area of corporate social responsibility. A growing body of evidence shows that companies can do well by doing good. In fact, books have been written about this corporate motivation for going green. (See the reference to *Green to Gold* in the Bibliography.) The Internet's ubiquitous connectivity has created new relationships among businesses, customers, employees, and partners. People now have access to massive amounts of information and opinions about products and company practices. This information is available in every part of the globe, every minute of every day. Collaboration over the Internet is taking place during a time of increased visibility of corporate actions, a time when customers' perceptions of companies—and their consequent purchasing behaviors—are fundamentally changing. Thus, having your company become part of the **green wave** (to use a term used in the *Green to Gold* book) should be an additional motivation (besides the standard business case) for companies to pursue green IT.

Although this book emphasizes the business aspects, rather than the technical aspects, of green IT, several chapters give technical details, including the case study chapters (Chapters 9, 10, and 11). I'm an engineer by training, and I'm fascinated by the technical aspects of green IT. The energy used for green IT and green data centers is electricity, so I would like to give a brief review of the familiar electricity concepts and relationship of volts, amps, and watts, which are fundamental in our quest to reduce energy used for green IT. The relationship between volts, amps, and watts is this: watts = volts × amps. A watt is the measure of electrical power. Energy is power over a unit of time. We pay for electricity in terms of energy used with a measure of kilowatt hours or KWH. One kilo watt hour (KWH) of electrical energy is the energy used by having 10 one-hundred-watt light bulbs on for one hour. In the New York City area, one KWH costs about 20 cents, whereas in West Virginia, a KWH costs only about 5 cents. The big difference in cost is due to the big difference in generation costs. With the high cost of electricity, the region of the country is becoming a significant factor in deciding where to locate a new data center.

Besides the cost per KWH, another aspect of basic electricity to consider for your data center is the voltage level. In the United States, we typically have two voltages to use in our homes, offices, and data centers: 110 volts or 220 volts. The actual volts can fluctuate somewhat during the day (as you can discover using a simple voltmeter), and electrical engineers often give the two voltages available as 120V or 208V. If you have an electric range, an electric clothes dryer, or a large electric air conditioner in your home, they'll be

connected to the higher 208V service. The reason is that they need more power; using a higher voltage gives more power and also saves energy. Higher voltage saves energy because the formula for electric losses due to transmission over a wire is $I^2 R$, where I represents amps, and R is the fixed resistance of the wire. Because watts = volts × amps, we can double the power (watts) by doubling the volts or doubling the amps. However, doubling the amps would increase the losses by four times. Thus, to transmit electricity over long distances, the practice is to increase the voltage as much as possible. In high-tension towers, the voltage is often as high as 120,000 volts, and even in the power lines outside our houses, the voltage is often 4,000 volts. That voltage drops to 110V for use in our houses to reduce danger of electrocution. As noted, 220V power is used only for electric ranges, clothes dryers, and so on, although in Europe, the base power is 220V. One easy way to reduce energy transmission losses at data centers is to use 220V (208V) service. Higher input voltage results in more-efficient operation. Most servers (just like our laptops or hair dryers) are capable of either 110V or 220V service. Older data centers often have 110V power sources for servers, but switching to 220V (208V) would provide significant savings. This change in voltage at data centers to reduce energy use is mentioned in several places throughout the book.

The Growing Significance of Green IT and Green Data Centers

Much of the emphasis in the following chapters is on data centers because they almost always represent the starting point for green IT initiatives for companies. Data centers—the facilities that primarily contain electronic equipment used for data processing, data storage, and communications networking—have become common and essential to the functioning of business, communications, academic, and governmental systems. Data centers have been growing and expanding quickly as our economy continues to shift from paper-based to digital information management. The U.S. EPA's 2007 "Report to Congress on Server and Data Center Energy Efficiency" estimated that the energy use of the nation's servers and data centers doubled from 2000 to 2006 to approximately 61 billion KWH. Under current efficiency trends, national energy consumption by servers and data centers could nearly double again by 2011 to more than 100 billion KWH, representing a $7.4 billion annual electricity cost.

Data centers are found in nearly every sector of the economy, including financial services, media, high-tech, universities, and government institutions. Dramatic server growth at data centers is indicated by well-known web services such as Google, Amazon, and eBay. Estimates indicate that Google maintains more than 450,000 servers, arranged in racks located in clusters in cities around the world. Google has major data centers in California, Virginia, Georgia, and Ireland, and new facilities in Oregon and Belgium. In 2009, Google is planning to open one of its first sites in the upper Midwest in Council Bluffs, Iowa, close to abundant wind power resources for fulfilling green energy objectives and proximate to fiber optic communications links. For additional information on the positioning of new data centers close to abundant renewable electric power sources, see Appendix C, "Comparison of Different Power-Generation Methods." Amazon.com and eBay also have thousands of servers. It is estimated that the Second Life Internet-based virtual world launched in 2003 has more than 9,000 servers. Even with these large numbers of current servers, IBM consultants estimates that in the next decade, server shipments will grow by six times and data storage by an amazing 69-fold.

Green energy-efficient data centers can help us reduce greenhouse gases—which, in turn, can help reduce global warming. The recent UN and White House sessions on climate change emphasize the environmental importance of green projects. Although the extent of the global warming danger might continue to be open to debate, implementing green data centers presents a significant opportunity for all of us to help reduce greenhouse gasses.

In many instances—such as building alternative energy sources by implementing solar panels, or wind turbines—going green has not been economical and can be justified only by government or energy utility rebates. Yet implementing green data centers can be quite financially rewarding—especially when you go first after the low-hanging fruit. As I've indicated throughout this book, going to green IT is a win/win for all parties involved. Energy expenditures for IT keep increasing. Figures mentioned previously bear repeating. According to the research firm IDC: By 2010, for every $1 spent on hardware, 70 cents will be spent on power and cooling, and by 2012, for every $1 spent on hardware, $1 will be spent on power and cooling. Green IT has generated significant customer interest throughout the world. Much of the interest comes from the financial return on green data center investment.

Here is a general definition of a green data center: A repository for the storage, management, and dissemination of data in which the mechanical,

lighting, electrical, and computer systems are designed for maximum energy efficiency and minimum environmental impact. The construction and operation of a green data center involve use of advanced technologies and strategies. The strategies and goals include the following:

- Minimizing the footprints of the buildings
- Using low-emission building materials, carpets, and paints
- Creating sustainable landscaping
- Initiating waste recycling
- Installing catalytic converters on backup generators
- Using alternative energy technologies such as **photovoltaics** (PVs) and fuel cells
- Increasing the efficiency of heat pumps, variable speed fans, and free-cooling technology

However, in the following chapters, we concentrate on the ways data centers can become more energy efficient by first exploring the low-hanging fruit. The basic technologies that we should first examine for existing data centers range from the use of efficient cooling towers and variable speed blowers to the use of energy-efficient IT systems, such as virtual servers, blade centers, and virtual data storage. Server consolidation—although initially undertaken to save server hardware capital—is also an excellent way to reduce server energy use. A step way beyond server consolidation is data center consolidation—also done to reduce facility and personnel resource cost; however, a significant side effect is reduced data center energy use. Most data centers have already started to employ newer IT technology such as virtual servers or server consolidation, so this book first explores the technologies that have already started to be employed at your data center for capital cost-saving—and discuss the ways this same technology can significantly reduce energy use. The experiences described in the case studies presented in later chapters are a way to leverage those lessons learned for your data center.

Many consultant reports indicate that data centers are at a "tipping point." Some well-publicized issues supplying adequate electrical power to data centers include Canary Wharf in London and the area south of 14th Street in New York City. In 2006, the financial institutions at Canary Wharf were told that the power infrastructure could not supply power for additional servers at their data centers. In recent years, financial organizations have been

adding significant server power, often with racks of blade servers. The racks of blade servers can greatly increase the power required per square foot in the data center. Each blade server requires about the same energy as larger, older servers, and the data center needs similar levels of electricity to cope with the heat generated. Canary Wharf didn't have the power infrastructure to support the increased demands. A similar limit of the power structure occurred during 2008 for data centers south of 14th Street in Manhattan. Power restrictions to data centers based on inadequate power infrastructure is only a part of the problem. Data center floor space has also become a significant concern for data centers, especially in large cities. Often, a company runs out of data center floor space with no easy capability to expand.

The green IT techniques described in later chapters (such as server and data storage virtualization, and server consolidation), in addition to cutting power requirements by 50 percent, also reduce data center floor space requirements. Using virtual server techniques to replace ten stand-alone physical servers with one large physical box that includes ten virtual servers can easily reduce the data center floor space required by 80 percent. Practicing green IT promotes a "win-win" situation for all aspects of your data center: electric-power reduction, server cost, data center floor space, and management of the physical boxes.

Although building and certifying a green data center or other facility can often be expensive upfront, substantial long-term cost savings can be realized on operations and maintenance. The green data center technologies described later can all be based on the typical business case, where a significant **return on investment** (ROI) would be required before proceeding with a project. Of course, there are also significant nonfinancial returns to consider—because green facilities (including green data centers) offer employees a healthy, comfortable work environment. In addition, we cannot ignore the fact that green facilities enhance relations with local communities.

We are all aware of the growing pressure from environmentalists and, increasingly, the general public for governments to offer green incentives: monetary support for the creation and maintenance of ecologically responsible technologies. Server refresh offers data centers a convenient opportunity to go green, which always makes economic (as well as environmental) sense. IBM estimates that a typical 25,000 SF data center with electrical costs at 12 cents per KWH will cost a company $2.5 million a year in electrical energy costs for IT power and cooling. IBM also estimates that the typical data center can reduce its annual electricity cost by up to 50 percent by going green. Of course, as energy costs continue to climb, so will the savings due to the

installation of energy-efficient IT equipment and optimization of data center cooling techniques.

Recent EPA reports stress that the U.S. data center industry is in the midst of a major growth period stimulated by increasing demand for data processing and storage. This demand is driven by several factors, including the following:

- Increase in electronic transactions in financial services, such as online banking and electronic trading
- Growth of Internet communication and entertainment use
- Increase in online shopping and related transactions
- Shift to electronic medical records for healthcare
- Growth in global commerce and services
- Adoption of satellite navigation and electronic shipment tracking in transportation

Other important trends contributing to data center growth in the government sector include the following:

- Use of the Internet to publish government information
- Government regulations requiring digital records retention
- Enhanced disaster recovery requirements
- Emergency, health, and safety services
- Information security and national security
- Digital provision of government services (for example, e-filing of taxes and U.S .Postal Service online tracking)
- High-performance scientific computing

During the past five years, increasing demand for computer resources has led to significant growth in the number of data center servers, along with an estimated doubling in the energy used by these servers and the power and cooling infrastructure that supports them. This increase in energy use has a number of important implications:

- Increased energy costs for business and government
- Increased emissions, including greenhouse gases, from electricity generation

- Increased strain on the existing power grid to meet the increased electricity demand
- Increased capital costs for expansion of data center capacity and construction of new data centers

For these reasons, there has been mounting interest in opportunities for energy efficiency in this sector. To its credit, the Information Technology (IT) industry is actively investigating and developing solutions, such as power-managed servers and adaptive cooling.

The direct energy use of IT and infrastructure equipment is not, however, the only way that data centers affect energy use. The data-processing and communication services provided by data centers can also lead to indirect reductions in energy use in the broader economy, which can exceed the incremental data center energy expenditures in some cases. For instance, e-commerce and telecommuting reduce both freight and passenger transportation energy use. When we use an electronic bookstore such as Amazon.com, that use of e-commerce can save us from driving to the local bookstore, and, hence, save energy. We can attend a "virtual" conference using a web-conferencing service such as Webex or Microsoft® Live Meeting and thus save the energy expenditure of an airline flight to the conference, use of a rental car, and all the other energy use that travel entails.

The pursuit of energy efficiency opportunities in data centers is especially important because of the estimated continued rapid growth of direct energy use in data centers and the resulting impact on both the power grid and U.S. industries.

To repeat the theme: We're all aware of rising energy costs in today's data centers and the growing concerns over global warming and other environmental issues. These problems have made green IT one of the hottest topics in the IT area. But what exactly is green IT and green computing and how does it affect IT infrastructures? This book provides an outline on the concepts, benefits, and business value of green computing, such as the following:

- A definition/analysis of green computing and its benefits
- An overview of green computing solutions
- The business case for going green
- Implementation of an energy management solution
- Why energy efficiency is so important

All Companies Can Take Basic Steps Toward Green IT

According to Gartner research firm, the green wave has only begun to rise. The research company predicts that in 2009, more than one-third of all IT organizations will place environmental concerns among their top six buying criteria. By 2010, Gartner says, three-quarters of companies will use carbon-footprint considerations in calculating their hardware-buying strategy, and by 2011, large enterprises will develop policies requiring their suppliers to prove their green credentials through an auditing process.

Most companies are talking a good game but not actually going green where it counts. According to a survey of 124 IT operations by Forrester Research in May 2007, some 85 percent of respondents said environmental factors are important in planning IT operations. But only one-fourth of survey respondents have actually written green criteria into their company's purchasing processes. Enterprises that have started the green journey, however, have found that reducing total energy requirements can be accomplished through some fairly straightforward improvements that don't take years to implement or to bring return. The following six tasks are applicable to all green IT projects. Chapter 2, "The Basics of Green IT," gives details on the five steps used by IBM to implement green data centers. Those five green data center steps include the virtualize, cooling, and measure tasks in the following list. Also, Chapter 9, "Green IT Case Studies for Energy Utilities," and Chapter 10, "Green IT Case Studies for Universities and a Large Company," give details on the five steps used for case studies.

1. Communicate Green IT Plans and Appoint an Energy Czar

Measuring the current state of affairs, energy wise, is one of the first steps to take. A baseline on which to start measuring the impact of an organization's energy-saving initiatives in the green IT area is needed. Of course, you must also communicate your proposed energy-efficiency initiatives right away. Inform all employees about the plans and goals to save energy via green IT. Besides communicating with your employees, set up an organization to drive the effort. You may start by making one person responsible; give that person a title (like "Energy Czar"). Details on the importance of communication and collaboration for green IT is the subject of Chapter 3, "Collaboration Is Key for Green IT."

2. Consolidate and Virtualize

Consolidating IT operations, and using virtualization to reduce server footprint and energy use, are the most well-recognized and most-often-implemented efficiency strategies of the past few years. Some of the largest technology organizations in the world—including Advanced Micro Devices®, Hewlett-Packard®, Intel®, IBM, and Sun Microsystems®—have recently (2008) completed major data center consolidation projects. The projects also included server consolidation and virtualization. Details on the significance of virtualization for your IT systems in going to green data centers is the subject of Chapter 6, "A Most-Significant Step—'Virtualizing' Your IT Systems."

3. Install Energy-Efficient Cooling Units

In most cases, traditional data center design called for bulky **computer room air conditioners (CRAC)** units that are placed on the perimeter of the floor to move large amounts of air around the data center. However, in-row or supplemental cooling units have been shown to save energy. The in-row units typically enclose a row or two of servers, and the backs of all the servers are pointed into a single "hot" aisle. Heat in the aisle is contained by a roof and end-row doors, allowing cooling to be applied directly to the heat source, rather than trying to cool after the heat is dispersed into the general data center floor. Details on data center cooling strategies for green data centers are given in Chapter 8, "What About Chillers, Cooling Tower Fans, and All That Cooling Equipment Usually Ignored by IT?"

4. Measure and Optimize

In 2009, several groups (including the The Green Grid) are expected to release important deliverables in the form of metrics that businesses can use to measure the power-usage effectiveness of facilities infrastructure equipment. Most businesses can already readily identify areas where infrastructure optimization can achieve increased efficiency by simply monitoring and measuring their existing infrastructure equipment. The EPA is also working to create metrics. About 100 companies have indicated that they will provide raw power data and other information to the EPA for use in developing its new benchmark. The EPA indicated that the results of the benchmark should be available by 2010.

Until widely accepted metrics become available, businesses should make sure that the utility costs associated with their data center operations are broken out separately from those for other corporate facilities. In addition, metering specific equipment racks or types of equipment such as servers can provide valuable insight into which specific consolidation, virtualization, and optimization projects will yield the best ROI going forward. The status of energy-use metrics is the subject of Chapter 7, "The Need for Standard IT Energy-Use Metrics."

5. Implement Efficient Applications and Deduplicate Data

Software and application efficiency can be significant for green IT. The author has had a recent experience where the procedure for creating a data warehouse report was reduced from eight hours to eight minutes merely by changing the Oracle data warehouse search procedure. (For example, don't search the entire database each time when only a much smaller search is required.) During the eight hours required to create the report, the large server was running at near peak capacity. Sure, that type of significant application inefficiency has been created and fixed many times over the history of programming. But what about the cases where a few application efficiencies can make an application run 20 percent faster? That 20 percent more-efficient application can also result in 20 percent lower energy use. The steps required to improve application efficiency by a few percent are often not easy to determine; however, the added incentive of saving energy—while making the application run faster—is a significant plus.

Data-storage efficiency, such as the use of tiered storage, is also significant. **Data deduplication** (often called **intelligent compression** or **single-instance storage**) is a method of reducing storage needs by eliminating redundant data. Only one unique instance of the datum is actually retained on storage media, such as disk or tape. Redundant data are replaced with a pointer to the unique data copy. For example, a typical email system might contain 100 instances of the same one-megabyte (MB) file attachment. If the email platform is backed up or archived, all 100 instances are saved, requiring 100MB storage space. With data deduplication, only one instance of the attachment is actually stored; each subsequent instance is just referenced back to the single saved copy. In this example, a 100MB storage demand can be reduced to only one MB.

Data deduplication offers other benefits. Lower storage space requirements can save money on disk expenditures. The more efficient use of disk space also allows for longer disk-retention periods, which provides better **recovery time objectives** (RTO) for a longer time and reduces the need for tape backups. Data deduplication also reduces the data that must be sent across a WAN for remote backups, replication, and disaster recovery.

Data deduplication uses algorithms to dramatically compress the amount of storage space needed. Many organizations deal with increased scrutiny of electronically stored information because of various regulations; this need to preserve records is driving significant growth in demand for storing large sets of data. Depending on the type of information compressed, deduplication can enable a compression rate of between 3:1 and 10:1, allowing businesses to reduce their need for additional storage equipment and associated tapes and disks. Many businesses are already using the technology. Application efficiency as part of green IT strategy is discussed in Chapter 2.

6. Make Use of Rebates and Incentives

More utility providers offer rebates or other incentives that encourage businesses to update equipment and adopt efficient operational practices that can help reduce peak and total power demands. Companies doing this include Pacific Gas and Electric in San Francisco and Austin Energy in Austin, Texas.

New electric power-generation stations are very expensive, and power companies are more than willing to avoid building new capacity. Thus, the power companies encourage data center efficiency through rebates and other incentives. Also, the organization's facilities team doesn't have to build as much new data center space. The IT organization and engineering groups get new equipment that is smaller, cooler and faster than before—and everyone ends up happy. The roles of government and energy utility rebates and incentives are the subjects of Chapter 4, "The Government's Role—Regulation and EPA Activity," and Chapter 5, "The Magic of 'Incentive'—The Role of Electric Utilities."

What This Book Covers

This book includes the following topics to help you understand green data centers and your potential role in creating and maintaining them:

- The significant role data centers have in the world's consumption of electric energy and carbon footprint.
- How companies are offering services and products to help reduce data center energy use—for example, IBM's Big Green $1 billion annual investment in green data centers.
- How IT employees (for example, corporate CIOs (chief information officers), IT architects, IT specialists, and IT project managers) can help drive the implementation of green data centers.
- Case studies of organizations implementing green data centers.
- Details on the best ways to measure data center energy use and report to your executives. Because "You can't manage what you can't measure," the first step is to start the measurement process and understand the need to continually improve your measurement process. This is necessary to better quantify the savings due to your energy initiatives.
- Study of the different ways to measure server utilization and look at trends. You need to answer the question: How has customer server virtualization increased server CPU utilization?
- Continuing follow-up on the literature on green data centers because technology is progressing at a fast pace. The U.S. EPA is key to following the U.S. government recommendations and incentives for data center energy efficiency.
- Survey of emerging technology for server and storage enhancement to reduce data center energy use. This includes the following:
  - **Information Lifecycle Management** (ILM), overall storage management, tiered storage
  - Server virtualization enhancements such as PowerVM®, VMware enhancements, and such
  - Active energy management
  - Enhanced cooling technology
- Analysis of emerging technology for server and storage enhancement to reduce data center energy use.

Index

Numerics

3tera, 243
7x24 Exchange, 42

A

accreditation by LEED, 121
active solar energy technologies, 273
AEM (Active Energy Manager), 32, 50, 218, 229
  benefits of, 229-230
  Chicago-area utility case study, 155
  integration with systems management, 231-232
AFCOM (Association for Computer Operations Management), 36, 41
air flow optimization in data centers, 137-138
air-side economizer systems, 139
Alliance to Save Energy (ASE), 37, 41
Amazon, 5
  cloud computing and, 240-242
Amazon Elastic Compute Cloud (Amazon EC2), 240
Amazon Flexible Payment Solution, 243
Amazon Fulfillment, 243
Amazon Simple Storage Services (Amazon S3), 240
American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), 35, 40, 225
amps, watts, volts relationship, 3
Anderson, David F., 71, 215
application developers, cloud computing and, 239
application efficiency, 12, 24-25, 37, 208
application service providers (ASPs), defined, 238
Archimedes, 277
Aristotle, 183
ASE (Alliance to Save Energy), 37, 41
ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers), 35, 40, 225
ASPs (application service providers), defined, 238

assessment of energy efficiency, 21
Chicago-area utility case study, 150-151
Lexington, Kentucky case study, 172-173
Association for Computer Operations Management (AFCOM), 36, 41
Austin Energy, 75
automation tools, India case study, 200
Avista Utilities, 75

B

backup software, server virtualization and, 107
Barker, Lynn, 115
BAS (building automation systems), 42
baseline measurements, 10, 207. *See also* metrics
Bertone, Mitch, 161
blade servers, 34
benefits of, 102-103
combining with virtualization, 104-105
defined, 102
virtualization of, 103
Blue House, 240, 243
border adjustment (in emissions trading), 57
Bourne, Richard, 115
Brin, Sergey, 239
Bryant University case study, 157-163
building automation systems (BAS), 42
building energy management, collaboration with IT energy management, 42-43
building new data centers, 23
Chicago-area utility case study, 151
India case study, 198-199
Lexington, Kentucy case study, 173-174
building rating systems per country, 119-120
business and technology drivers for cloud computing, 241
business continuity, virtualization and, 103-104

C

California Public Utilities Commission (CPUC), 72
cap-and-trade system, 49, 55-58. *See also* carbon trading
capacity factor for wind power, 263
carbon footprint calculator, 225
carbon trading, 49, 120. *See also* cap-and-trade system
case studies
Bryant University, 157-163
Chicago-area utility company, 150-155
assessment of energy efficiency, 150-151
building new data centers, 151
cooling strategies, 153
power management metrics, 153
reporting, 155
virtualization, 152-153
Columbia University, 157, 163-169
HPC (high performance computing), 165-167
planning stage, 164
testing stage, 167-168
green computer manufacturers
HP, 232-233
Sun, 233-234
India, 196-203
automation tools, 200
challenges faced, 196-198
data center build, 198-199
data center consolidation, 199
disaster recovery, 201
future projects, 203
PC conversion to laptops, 201
products used, 200
results, 201-202
server consolidation, 199
virtualization, 200
Istanbul, Turkey, 194-196
Lexington, Kentucky, 158, 169-181
assessment of energy efficiency, 172-173
building new data center, 173-174
cooling strategies, 178-179
future planning, 179-180
power management metrics, 177-178
virtualization, 174-177
Montpelier, France, 187-194
energy-use dashbards, 191-192
live camera, 190
solution-level monitoring, 192-194
thermal camera, 191
PG&E (Pacific Gas and Electric Company), 148-149
World Community Grid, 184-187
certification process for LEED, 117-118
Certified Green testing program, 22
Chapin, Daryl, 274

checklist for green IT, 215-224
Chicago-area utility company case study, 150-155
assessment of energy efficiency, 150-151
building new data centers, 151
cooling strategies, 153
power management metrics, 153
reporting, 155
virtualization, 152-153
chip-level cooling systems, 144
chip technology, green IT and, 234
Chu, Steven, xxvi
Cisco, 20, 82
clean energy costs, projections for, 287-288
Clean Energy Project (grid computing), 186-187
Clean Power Estimator, 225
client virtualization, 95-97
cloud collaboration, 238, 240, 243
cloud computing, 99. *See also* grid computing
advantages of, 239, 247
Amazon and, 240-242
business and technology drivers for, 241
conceptual architecture and infrastructure for, 244-245
defined, 237-238
in FCMG (Fast Moving Consumer Goods) industry, 238
at Google, 239, 243
at IBM, 240
impact of, 248
private cloud computing, 240-241
resource for information, 248-249
types of, 242-243
cloud services, 238, 240, 243
cloud storage, 238-239, 242-243
cluster architecture for server virtualization, 99-101
collaboration, 39
between IT technology vendors, 40
of building energy management and IT energy management, 42-43
carbon trading and, 49
cloud collaboration, 238, 240, 243
within companies, 46
data center energy efficiency groups, 40-42
Al Gore's role in, 52-53
government initiatives, 44, 46
The Green Grid agreements, 48-49
of IT vendors, 49, 51-52
of universities, 47-48
with utility companies, 43-44
Columbia University case study, 157, 163-169
collaboration initiatives, 47
green IT plan, 67
HPC (high performance computing), 165-167
planning stage, 164
testing stage, 167-168
commercial building technical assistance to promote energy efficiency, 61
communication of green IT plans, 10, 207
companies, collaboration within, 46
component efficiency standards, 126-127
computer manufacturers
HP case study, 232-233
Sun case study, 233-234
computer networks, green IT and, 234-236
concentrating solar power (CSP) systems, 276-277
conceptual architecture for cloud computing, 244-245
Confucius, 15
consolidation, 11, 207. *See also* virtualization
India case study, 199
server consolidation, 88-89, 217
Consortium for Energy Efficient Thermal Management, 42
conversion to laptops, India case study, 201
cooling strategies, 11, 22, 207
Chicago-area utility case study, 153
Lexington, Kentucky case study, 178-179
cooling systems
efficiency strategies, 135-136
air flow optimization, 137-138
CRAC unit efficiency, 140-141
economizer systems, 139-140
supplemental cooling, 142-143
vapor sealing, 136-137
emerging technologies for, 143-144
energy saving tips, 131
energy usage statistics, 129-130
liquid cooling systems, 134-135
stored energy, 132-134

coordination of CRAC units, 141
corporate social responsibility, 3
CPP (Critical Peak Pricing), 73
CPUC (California Public Utilities Commission), 72
CRAC unit efficiency, increasing, 140-141
Critical Peak Pricing (CPP), 73
Crosswell, Alan, 163
CSP (concentrating solar power) systems, 276-277

D

data center consolidation, 6
Data Center infrastructure Efficiency. ***See*** **DCiE**
data centers. ***See also*** **green data centers**
barriers to energy efficiency, 60
cooling systems
efficiency strategies, 135-143
emerging technologies for, 143-144
energy saving tips, 131
energy usage statistics, 129-130
liquid cooling systems, 134-135
stored energy, 132-134
defined, 4
energy usage, 4, 18-19, 59-60
cost statistics, 281
energy efficiency recommendations, 30, 62-66
energy ratings, 81
metrics. See *metrics*
statistics, 226-228
fuel cells in, 143
green IT checklist, 215-218, 220-224
incentives for green technology, 77-78
location of, effect of electricity cost on, 251-252
power infrastructure, lack of, 6
productivity metrics, 125-127
recycling IT equipment, 82-83
server usage in, 5
virtualization. *See* virtualization
data deduplication, 12-13, 208
data storage, impact of server virtualization on, 105-108
Database of State Incentives for Renewables & Efficiency (DSIRE), 76
DCiE (Data Center infrastructure Efficiency), 121-122
explained, 122-124
future development, 125
decoupling, defined, 74
Dell, energy efficiency initiatives, 82
Deming, W. E., 109
Department of Energy. ***See*** **DOE**
desktop computers
energy consumption costs, 27
energy efficiency of, 25-26, 28-30
desktop virtualization. ***See*** **client virtualization**
diagnosis. ***See*** **assessment**
Digital Scroll compressor technology, 141
disaster recovery
green IT checklist, 218
India case study, 201
server virtualization and, 107
virtualization and, 103-104
distributed computing, grid computing as, 244-245
DOE (Department of Energy)
DC Pro tool, 225
Save Energy Now Data Center initiative, 45
Web site, 36
Drucker, Peter, 109
DSIRE (Database of State Incentives for Renewables & Efficiency), 76

E

eBay, 5
Ebbers, Mike, 88
economizer systems in data centers, 139-140
educational institutions, government regulation and, 66-67
EEC (Energy Efficiency Certificate) program, 51-52
efficiency. ***See*** **energy efficiency**
Efficient Power Supplies Web site, 41
electric utilities. ***See*** **utility companies**
electrical energy storage, 132-133
electricity. ***See also*** **power generation methods (renewable)**
costs
clean energy projections, 287-288
CPP (Critical Peak Pricing), 73
effect on data centers, 251-252, 281
per KWH (kilo watt hour), 3
U.S. statistics, 282-284
worldwide statistics, 284-286
data center usage, 59-60
power infrastructure, lack of, 6

voltage levels, 3-4
watts, volts, amps relationship, 3
worldwide usage statistics, 226-228
Electronic Product Environmental Assessment Tool (EPEAT), 79-81, 109
Electronic Waste Recycling Act, 80
embedded cooling systems, 144
emissions trading. *See* cap-and-trade system
EMS (energy management systems), 42. *See also* AEM (Active Energy Manager)
enabling power management features, 28
energy, defined, 3
energy consumption
of data centers, 4, 18-19, 59-60
of desktop and laptop computers, 27-30
metrics. *See* metrics
reducing indirectly, 9
statistics for data center cooling systems, 129-130
energy efficiency
defined, 60
incentives
from electric utilities, 69-78
from EPA, 60-62
from IT vendors, 81-84
ratings for green IT, 78-81
recommendations for data centers, 62-66
strategies for data center cooling systems, 135-136
air flow optimization, 137-138
CRAC unit efficiency, 140-141
economizer systems, 139-140
supplemental cooling, 142-143
vapor sealing, 136-137
Energy Efficiency Certificate (EEC) program, 51-52
energy management systems (EMS), 42. *See also* AEM (Active Energy Manager)
energy potential rankings of wind power, 269-271
ENERGY STAR program, 45, 58-59, 79, 114-115, 180
energy storage, 132-134
energy-use dashboards, Montpelier, France case study, 191-192
energy utilities. *See* utility companies
Enterprise Strategy Group (ESG), 105
environmental impact
of hydroelectric power, 258-259
of utility company data centers, 148
EPA (Environmental Protection Agency), 55. *See also* government regulation
collaboration with The Green Grid, 48-49
data center energy efficiency recommendations, 62-66
energy efficiency incentives, 60-62
ENERGY STAR program, 45, 58-59, 79, 114-115, 180
Web site, 36
EPEAT (Electronic Product Environmental Assessment Tool), 79-81, 109
ESG (Enterprise Strategy Group), 105
Esty, Daniel C., xxvi
European Code of Conduct Web site, 36
European Union Emission Trading Scheme, 56
evaluation. *See* assessment
experimental solar power systems, 277-278

F

Fanara, Andrew, 80
Fast Moving Consumer Goods (FCMG) industry, 238
federal government, data center energy efficiency actions, 64-65
financial incentives to promote energy efficiency, 61
floor space. *See* physical space requirements
fluid-side economizer systems, 139
four-step compressor unloading, 140
France case study, 187-194
energy-use dashboards, 191-192
live camera, 190
solution-level monitoring, 192-194
thermal camera, 191
free-market environmentalism, cap-and-trade system as, 57
freight forwarding, 19
Friedman, Thomas L., xxiv, 215, 281
Fritts, Charles, 273
fuel cells, 143
Fuller, Calvin, 274
future
of green IT, 205-206, 209
challenges facing, 210-212
goals for, 212-213
strategy for, 213-214
of metrics/rating systems, 127

G

Generation Investment Management, 52
geothermal power, cost of generation, 254
Glaser, Peter, 278
global warming, 5
Gloster, Art, 160
Goethe, 147
Google, 5
cloud computing and, 239, 243
Google Apps, 243
Google Data Center in a Box, 162
Gore, Al, xxiv, 1
collaboration role of, 52-53
government
collaboration role of, 44-46
data center energy efficiency actions, 64-65
green initiatives of, xxv
procurement programs to promote energy efficiency, 62
regulation. *See also* EPA (Environmental Protection Agency)
educational institutions and, 66-67
energy efficiency ratings, 78-81
ENERGY STAR program, 58-59
of greenhouse gases, 55-58
Green Building Rating System. *See* LEED
"The Green Data Center: Steps for the Journey" (IBM Redpaper) (Ebbers), 88
green data centers. *See also* green IT
defined, 5
reasons for adopting, 4-9
resources for information, 40-42
steps toward achieving, 20, 172
assessment of problems, 21, 150-151, 172-173
blade servers, 34
building new, 23, 151, 173-174
cooling strategies, 22, 153, 178-179
high-efficiency power supplies, 34
high-voltage power distribution, 35
power management, 22, 153, 177-178
virtualization, 22, 152-153, 174-177
virtualization and standardization, 30
The Green Grid, 40, 121-122, 207
collaboration agreements, 48-49
data center productivity metrics, 125-127
long-term approach, 124-125
short-term approach, 122-124
Web site, 35
green IT. *See also* green data centers
advantages of using, 2-3
case studies. *See* case studies
checklist for, 215-218, 220-224
chip technology and, 234
cloud computing, impact of, 248
collaboration. *See* collaboration
Columbia University, 67
computer manufacturers
HP case study, 232-233
Sun case study, 233-234
computer networks and, 234-236
defined, xxiv, 2
for desktop and laptop computers, 25-30
energy consumption rates, 18-19
energy efficiency programs, 81-84
energy efficiency ratings for, 78-81
future of, 205-206, 209
challenges facing, 210-212
goals for, 212-213
strategy for, 213-214
government regulation. *See* government regulation
metrics. *See* metrics
organizational issues confronting, 17-18
product lifecycle, 20
reasons for adopting, 4-9
resources for information, 35-37, 225
steps toward achieving, 10, 20, 172, 206
application efficiency, 12, 208
baseline measurements, 10, 207
communication, 10, 207
consolidation and virtualization, 11, 207
cooling strategies, 11, 207
data deduplication, 12-13, 208
metrics and optimization, 11-12, 32-33, 207-208
rebates and incentives, 13, 209
supply-chain issues, 19-20
tools for, 225
in utility companies, environmental impact of, 148
virtualization. *See* virtualization
workload optimization, 24-25
greenhouse gases
government regulation of, 55-56, 58
hydroelectric power and, 257-259
reducing, 5

grid computing, 98. ***See also*** **cloud computing**
advantages of, 247
defined, 237
as distributed computing, 244-245
virtualization and, 246-247
World Community Grid case study, 184-187
grid management of wind power, 263-264
Grove Associates, 37, 39

H

Hamilton, Victoria, 163
head (in hydroelectric power), defined, 256
heat removal. ***See*** **cooling systems**
Heiber, Gerald, 115
hierarchical storage, green IT checklist, 219
High Performance Computing (HPC), 47, 165-167
High Tech Energy Efficiency Incentives program, 74
high-efficiency power supplies, 34
high-voltage power distribution, 35
Hind, Rick, 80
history of LEED, 115-116
Hot, Flat, and Crowded: Why We Need a Green Revolution—and How It Can Renew America **(Friedman), xxiv, 281**
HP case study (green computer manufacturers), 82, 232-233
HPC (High Performance Computing), 47, 165-167
humidity, controlling in data centers, 136-137
hydroelectric power, 255-261
advantages of, 257-258
comparison with other generation methods, 260
cost of generation, 254
disadvantages of, 258-259
environmental impact of, 258-259
greenhouse gas emissions and, 257-259
population relocation and, 259
related activities surrounding, 258
small-scale plants, 256-257
storage, 133
worldwide production capacity, 261
hydrogen-power fuel cells, 143

I

IBM
cloud computing and, 240
telecommuting at, 84
IBM Active Energy Manager. ***See*** **AEM**
IBM SAN Volume Controller (SVC), 93-95
idle time power usage (SPEC metrics), 110-114
in-row cooling solutions, 133
incentives promoting energy efficiency, 13, 209
from electric utilities, 70-71
for data centers, 77-78
list of, 74-76
PG&E example, 71-72
rate-case incentives, 69-70, 73
from EPA, 60-62
An Inconvenient Truth **(Gore), xxiv**
India case study, 196-203
automation tools, 200
challenges faces, 196-198
data center build, 198-199
data center consolidation, 199
disaster recovery, 201
future projects, 203
PC conversion to laptops, 201
products uses, 200
results, 201-202
server consolidation, 199
virtualization, 200
indirect energy use reductions, 9
infrastructure for cloud computing, 244-245
Insight Control, 33
insolation, 273
installed capacity statistics, wind power, 267-269
intelligent compression. ***See*** **data deduplication**
intermittency of wind power, 262-265
ISPs (Internet service providers), defined, 238
Istanbul, Turkey case study, 194-196
IT costs, 5
IT energy management, collaboration with building energy management, 42-43
IT energy-use metrics. ***See*** **metrics**
IT equipment, recycling, 82-83
IT greening, defined, 1. ***See also*** **green IT**

IT vendors
collaboration of, 40, 49-52
energy efficiency programs, 81-84
IT virtualization. ***See*** **virtualization**
Italiano, Mike, 115
ITherm, 41
IxGreen, 22

J–K

Jacobs, David B., 234
Joyent, 243

kilo watt hour (KWH), cost of, 3
Kleiner Perkins Caufield & Byers (KPCB), 52
Koomey, Jonathan, 81, 226
Kyoto treaty, 56

L

laptop computers
conversion to (India case study), 201
energy efficiency of, 25-30
latent heat removal, 141
Lechner, Rich, 50
LEED (Leadership in Energy and Environmental Design), 109, 115
advantages/disadvantages, 116-117
carbon trading and, 120
certification process, 117-118
history of, 115-116
professional accreditation by, 121
versions of, 118-119
legacy data center case study, 158, 169-181
assessment of energy efficiency, 172-173
building new data center, 173-174
cooling strategies, 178-179
future planning, 179-180
power management metrics, 177-178
virtualization, 174-177
Lehman Brothers, 81
Lexington, Kentucky case study, 158, 169-181
assessment of energy efficiency, 172-173
building new data center, 173-174
cooling strategies, 178-179
future planning, 179-180
power management metrics, 177-178
virtualization, 174-177
liquid cooling systems, 134-135
Litow, Stanley, 186
live camera, Montpelier, France case study, 190
local government, data center energy efficiency actions, 65
logical partitions, 92
Longfellow, Henry Wadsworth, 157
Lotus Sametime Unyte, 243

M

Makower, Joel, 251
Maxwell, James Clerk, 274
measurement. ***See*** **metrics**
Mendler, Sandy, 115
metrics, 11-12, 16, 207-208
building rating systems per country, 119-120
ENERGY STAR program, 114-115
EPEAT, 109
future of, 127
The Green Grid, 121-122
data center productivity, 125-127
long-term approach, 124-125
short-term approach, 122-124
LEED, 109, 115
advantages/disadvantages, 116-117
carbon trading and, 120
certification process, 117-118
history of, 115-116
professional accreditation by, 121
versions of, 118-119
on power management, 22
Chicago-area utility case study, 153
Lexington, Kentucky case study, 177-178
SPEC, idle time power usage, 110-114
tools for, 32-33
Microsoft modular data centers, 162
Microsoft Virtual Server, 92
Miercom, 22
Millman, David, 163
Mobile Measurement Technology (MMT), 43, 149
modular data centers
Bryant University case study, 158-163
Google Data Center in a Box, 162
PUE ratings, 162
Molloy, Chris, 169
monitoring, tools for, 32-33
Montpelier, France case study, 187-194
energy-use dashboards, 191-192
live camera, 190

solution-level monitoring, 192-194
thermal camera, 191
Mouchout, Auguste, 277
multicore processors, 144

N–O

Native Energy, 82
networks. *See* computer networks
Neuwing Energy, 51
New York State Energy Research and Development Authority (NYSERDA), 67, 75
Nirvanix, 242
notebook computers. *See* laptop computers
Nutritious Rice for the World project (grid computing), 184-186
NYSERDA (New York State Energy Research and Development Authority), 67, 75
NYSERDA Clean Power Estimator, 225

O'Neal, Jeff, 134
O'Neill, Molly, 55
offshore windfarms, 266-267
Ohl, Russell, 274
operating system level virtualization, 93
optimization, 11-12, 207-208
of air flow in data centers, 137-138
of workloads, 24-25
organizational issues in green IT, 17-18
Osram Sylvania, 81
outside air systems in data centers, 139-140

P

Pacific Gas and Electric Company. *See* PG&E
Page, Larry, 239
Paladino, Tom, 115
paravirtualization, 93
partitioning servers, 92
passive solar energy technologies, 273
Paypal, 243
PCs
conversion to laptops, India case study, 201
virtualization. *See* client virtualization
peak power capacity statistics, solar power, 275-276
Pearson, Gerald, 274
penetration of wind power, 265-266
penstock (in hydroelectric power), defined, 256
PG&E (Pacific Gas and Electric Company)
case study, 148-149
collaboration with, 43-44
energy efficiency incentives, 70
High Tech Energy Efficiency Incentives program, 74
Utility IT Energy Efficiency Coalition, 71-72
Web site, 37
photovoltaics, 273-275
physical resource requirements
effect of virtualization on, 171
reducing, 7
planning stage, Columbia University case study, 164
population relocation, hydroelectric power and, 259
power companies. *See* utility companies
power generation methods (renewable)
cost of, 254
hydroelectric power, 255-261
advantages of, 257-258
comparison with other generation methods, 260
disadvantages of, 258-259
environmental impact of, 258-259
greenhouse gas emissions and, 257, 259
population relocation and, 259
related activities surrounding, 258
small-scale plants, 256-257
worldwide production capacity, 261
solar power, 272-279
active and passive solar technologies, 273
CSP systems, 276-277
experimental systems, 277-278
peak power capacity statistics, 275-276
photovoltaics, 273-275
storage systems, 278-279
wind power, 261-272
energy potential rankings, 269-271
grid management, 263-264
installed capacity statistics, 267-269
intermittency, 262-265
offshore windfarms, 266-267
penetration, 265-266
small scale generation, 271-272
power infrastructure, lack of, 6

power management, 22. ***See also*** **AEM (Active Energy Manager)**
Chicago-area utility case study, 153
on desktop and laptop computers, enabling, 28
Lexington, Kentucky case study, 177-178
power supplies, 34
Power Usage Effectiveness. ***See*** **PUE**
power usage metrics. ***See*** **metrics**
private cloud computing, 240-241
procurement programs to promote energy efficiency, 62
product labeling to promote energy efficiency, 61
product lifecycle, 20
professional accreditation by LEED, 121
protocols for building management systems, 43
PSSC (Products and Solutions Support Center) Green Data Center of the Future. ***See*** **Montpelier, France case study**
PUCs (Public Utility Commissions), 69
PUE (Power Usage Effectiveness), 121-122
explained, 122-124
future development, 125
ratings for modular data centers, 162
pumped-storage hydroelectricity, 133, 256
PV (photovoltaics), 273-275

Q–R

Q7 (offshore windfarm), 266

raised-floor cooling systems, 142
rate-case incentives, 69-70, 73
rating systems. ***See also*** **LEED; metrics**
energy efficiency ratings for green IT, 78-81
ENERGY STAR program, 45, 58-59, 79, 114-115, 180
future of, 127
PUE ratings for modular data centers, 162
worldwide building rating systems, 119-120
rebates and incentives. ***See*** **incentives promoting energy efficiency**
recycling IT equipment, 82-83
reducing
desktop and laptop computer energy consumption, 27-30
energy usage indirectly, 9
greenhouse gases, 5
physical space requirements, 7
Reed, Bill, 115
refresh cycles, 17
Registration, Evaluation and Authorization of Chemicals regulations, 80
regulation. ***See*** **government regulation**
Remote Data Protection services, 243
Remote Wake, 111
renewable power generation methods
cost of, 254
hydroelectric power, 255-261
advantages of, 257-258
comparison with other generation methods, 260
disadvantages of, 258-259
environmental impact of, 258-259
greenhouse gas emissions and, 257-259
population relocation and, 259
related activities surrounding, 258
small-scale plants, 256-257
worldwide production capacity, 261
solar power, 272-279
active and passive solar technologies, 273
CSP systems, 276-277
experimental systems, 277-278
peak power capacity statistics, 275-276
photovoltaics, 273-275
storage systems, 278-279
wind power, 261-272
energy potential rankings, 269-271
grid management, 263-264
installed capacity statistics, 267-269
intermittency, 262, 264-265
offshore windfarms, 266-267
penetration, 265-266
small scale generation, 271-272
"Report to Congress on Server and Data Center Energy Efficiency" (U.S. EPA), 4
reporting in Chicago-area utility case study, 155
resources for information
on cloud computing, 248-249
on green data centers, 40-42
on green IT, 35-37, 225
Restriction of Hazardous Substances (ROHS) directive, 80
return on investment (ROI) for green data centers, 7

rice research project (grid computing), 184-186
Rohrs, Lynn, 163
ROHS (Restriction of Hazardous Substances) directive, 80
ROI (return on investment) for green data centers, 7
Rosenblum, Matthew, 51
run-of-the-river hydroelectric plants, 256

S

Sahin, Serkan, 194
Salesforce.com energy efficiency initiatives, 82
Samudrala, Ram, 185
SAN Volume Controller (SVC), 93-95
Save Energy Now Data Center initiative, 45
schools, government regulation and, 66-67
screen savers, 27
Second Life, 5
sensible heat removal, 141
server consolidation, 6, 46, 88-89
  green IT checklist, 217
  India case study, 199
server power calculators, 225
server usage in data centers, 5
server virtualization
  background, 86-87
  of blade servers, 103
  business benefits of, 103-104
  cluster architecture for, 99-101
  combining with blade servers, 104-105
  impact on data storage, 105-108
  partitioning, 92
  techniques for, 92-93
  utilization diagram, 97-98
Shakespeare, William, 205
Siedzik, Rich, 162
Siemens, Ernst Werner von, 274
single-instance storage. *See* data deduplication
small-scale hydroelectric plants, 256-257
small-scale wind power generation, 271-272
Smartbank, 192-194
SNIA (Storage Networking Industry Association), collaboration with The Green Grid, 48-49
software efficiency, 12, 24-25, 37, 208
solar energy. *See also* solar power
  defined, 272
  storage, 132
solar power, 272-279. *See also* solar energy
  active and passive solar technologies, 273
  as complement to wind power, 265
  cost of generation, 254
  CSP systems, 276-277
  defined, 272
  experimental systems, 277-278
  peak power capacity statistics, 275-276
  photovoltaics, 273-275
  storage systems, 278-279
solution-level monitoring, Montpelier, France case study, 192-194
SPEC (Standard Performance Evaluation Corporation), 110
  feedback on EPA metrics, 115
  idle time power usage, 110-114
spiders, defined, 239
square footage. *See* physical space requirements
Standard Performance Evaluation Corporation. *See* SPEC
standardization, 30
standby power. *See* idle time power usage
state government, data center energy efficiency actions, 65
state rankings for wind power, 269-270
storage of data, impact of server virtualization on, 105-108
Storage Networking Industry Association. *See* SNIA
storage systems
  hierarchical storage, 219
  for solar power, 278-279
storage virtualization, 107
  IBM SAN Volume Controller (SVC), 93-95
  tapes, 95
stored cooling, 132
stored energy, 132-134
Subramaniam, Ravi, 237
Sun case study (green computer manufacturers), 233-234
  energy efficiency initiatives, 82
  telecommuting at, 83
supplemental cooling for data centers, 142-143
supply-chain issues, 19-20
SVC (IBM SAN Volume Controller), 93-95

Swinerton Construction, 78
systems management, integration with power management, 231-232

T

tape virtualization, 95
technical assistance to promote energy efficiency, 61
telecommuting, 83-84
testing stage, Columbia University case study, 167-168
thermal camera, Montpelier, France case study, 191
thermal energy storage, 132
thermal storage systems, 278-279
thin-client computing. *See* client virtualization
tidal hydroelectric plants, 256
tools
for green IT, 225
for monitoring and metrics, 32-33
Turkey case study, 194-196
turning off equipment, 28-29

U

Unilever, 238
Uninterruptible Power Supply (UPS), 34
Chicago-area utility case study, 151
energy usage impact of, 155
Union Bank of California, IT equipment recycling, 83
universities
Bryant University, 157-163
collaboration of, 47-48
Columbia University, 157, 163-169
HPC (high performance computing), 165-167
planning stage, 164
testing stage, 167-168
University of Colorado, green computing, 26
UPS (Uninterruptible Power Supply), 34
Chicago-area utility case study, 151
energy usage impact of, 155
The Uptime Institute, 36, 41
U.S. electricity cost statistics, 282-284
U.S. government. *See* government
utilitization rates, green IT checklist, 217
utility companies
Chicago-area utility company, 150-155
assessment of energy efficiency, 150-151
building new data centers, 151
cooling strategies, 153
power management metrics, 153
reporting, 155
virtualization, 152-153
collaboration with, 43-44
data center energy efficiency actions, 65
decoupling, 74
energy efficiency incentives, 70-71
for data centers, 77-78
list of, 74-76
PG&E example, 71-72
green IT, environmental impact of, 148
rate-case incentives, 69-70, 73
rebates and incentives, 13, 209
PG&E (Pacific Gas and Electric Company)
case study, 148-149
collaboration with, 43-44
energy efficiency incentives, 70
High Tech Energy Efficiency Incentives program, 74
Utility IT Energy Efficiency Coalition, 71-72
Web site, 37
Utility IT Energy Efficiency Coalition, 71-72
utilization diagram for server virtualization, 97-98

V

vapor sealing of data centers, 136-137
VDI (virtual desktop infrastructure), 103
vendors (IT)
collaboration of, 40, 49-52
energy efficiency programs, 81-84
versions of LEED, 118-119
virtual desktop infrastructure (VDI), 103
virtualization, 11, 22, 30, 71, 207
advantages of, 78
Chicago-area utility case study, 152-153
client virtualization, 95-97
cloud computing, 99, 245
defined, 90
effect on physical resource requirements, 171
explained, 85-91
green IT checklist, 216
grid computing and, 98, 246-247
incentives for, 75
India case study, 200
Istanbul, Turkey case study, 195-196
Lexington, Kentucky case study, 174-177

server virtualization
background, 86-87
of blade servers, 103
business benefits of, 103-104
cluster architecture for, 99-101
combining with blade servers, 104-105
impact on data storage, 105-108
partitioning, 92
techniques for, 92-93
utilization diagram, 97-98
SPEC metrics for, 110
storage virtualization, 107
IBM SAN Volume Controller (SVC), 93-95
tapes, 95
VMFS cluster file system, 93
VMotion, 92, 99-101
VMWare, 245
VMWare ESX Server, 92
voltage
high-voltage power distribution, 35
levels, 3-4
volts, amps, watts relationship, 3

W–Z

Waste Electrical and Electronic Equipment regulations, 80
water cooling systems, 134-135
Watson, Robert K, 115
watts, volts, amps relationship, 3
Web sites. *See* resources for information
Whitcomb, Brad, 149
wind power, 261-272
as complement to solar power, 265
cost of generation, 254
energy potential rankings, 269-271
grid management, 263-264
installed capacity statistics, 267-269
intermittency, 262-265
offshore windfarms, 266-267
penetration, 265-266
small scale generation, 271-272
Winston, Andrew S., xxvi
workload optimization, 24-25
World Community Grid case study, 184-187
worldwide building rating systems, 119-120
worldwide case studies
in India, 196-203
automation tools, 200
challenges faced, 196-198
data center build, 198-199
data center consolidation, 199
disaster recovery, 201
future projects, 203
PC conversion to laptops, 201
products used, 200
results, 201-202
server consolidation, 199
virtualization, 200
in Istanbul, Turkey, 194-196
in Montpelier, France, 187-194
energy-use dashboards, 191-192
live camera, 190
solution-level monitoring, 192-194
thermal camera, 191
World Community Grid, 184-187
worldwide clean energy cost projections, 287-288
worldwide electricity cost statistics, 284-286
worldwide electricity usage statistics, 226-228
"Worldwide Electricity Used in Data Centers" (Koomey), 226
worldwide installed capacity statistics, wind power, 267-269
worldwide peak power capacity statistics, solar power, 275-276
worldwide production capacity statistics, hydroelectric power, 261

Xcel Energy, 75
Xen, 93