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Carol Baroudi

Green IT FOR DUMMIES®

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Dedication

Carol dedicates this book to Josh, my parents, Brian, and Sucia, with all my love.

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Introduction

We have passion, conviction, urgency, and necessity. We know that most people don't understand what's in their power to change. Our explicit goal is to enable you to better understand the basic issues around green information technology (IT) and to equip you to take those initial steps. We were changed by writing this book and hope reading it changes you. Time is short; the subject desperately important.

Whether yours is a small organization trying to cut costs, a medium-size organization fighting for your survival in harsh economic times, or a larger organization face to face with power constraints and industry regulations, we hope this book will ground you with what you need to know and empower you to move forward. The folks we've met who've already begun this journey are passionate about what they're doing and proud of what they've done. Many of them are working overtime because they too feel the urgency.

Whether you're an IT manager, a C-level executive, a facilities/operations person, or just someone who wants to understand the implications of information technologies in consumption of power, in finding more efficient processes and cutting costs, and in impacting the planet, we hope you find this book useful.

About This Book

Information technology (IT) is an enormously complex field. It's amazing enough that your applications run, that people can actually use them to get their work done, and that your systems stay up 24 hours a day, 7 days a week, 365 days a year. Green considerations add another layer to that complexity and bring new disciplines that IT people normally don't study in depth.

In this book, we bring the basic information you need to find more efficient and environmentally responsible ways to meet your IT business goals and to leverage IT to move your entire organization in a greener direction. Green IT isn't just about energy efficiencies but also about operational efficiencies that can improve the whole of your IT.

This book was created for IBM to highlight areas that IBM can help you with in your green journey. To a great extent, it is a subset of the full-length trade book, *Green IT For Dummies*. The full-length edition goes into greater detail and provides more direct step-by-step help, but this minibook gives a broad overview and helps you identify areas that may make good starting points for your Green journey. It matters less *where* you start than *that* you start, and we wish you the best.

Icons Used in This Book

Here's a list of the icons you find in this book and what you can expect from the text they highlight.

The Tip icon marks green suggestions that you can implement directly, such as "Turn out lights when rooms aren't in use."

Remember icons mark information that's especially important to know. To siphon the most important information in each chapter, skim through these icons. For example, "Computer room air conditioning can consume more power than all the electronics in your data center."

The Warning icon tells you to watch out! It marks important information that may save you headaches. For example, "Check building and electrical codes before making major wiring changes."

Chapter 1

Greening IT

In This Chapter

- Seeing that green IT can work for you
- Discovering green business drivers
- Making green journeys

Information Technology — IT — is the central nervous system not only of our businesses but also of our governmental and social infrastructure. It depends on electricity, and available electricity is finite. As IT continues to grow, people depend on it more. Its unchecked consumption of power is threatening the financial resources of the organizations it serves, and, quite literally, is putting an ultimately unsustainable burden on the earth.

IT must find a way to be green, but you can't throw a switch and suddenly be green. *Going green* is a process and just the beginning of what's needed for true sustainability. Going green may also be the shortest path to economic savings and the overall health of an organization.

Recognizing the Basic Green Concepts

Awareness of climate change, energy crises, rising energy costs, and the dangers of hazardous materials, is growing. Being green encompasses a set of related issues:

- **Environmental responsibility:** The need to consider the well-being of the environment and protect the health, balance, and diversity of human and natural resources.

- **Global climate change:** The concern that a buildup of greenhouse gases in Earth's atmosphere is slowly increasing the average temperature near Earth's surface.
- **Sustainable development:** Defined by the United Nations' Brundtland Commission as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
- **Corporate Responsibility (CR):** Business' sense of responsibility to society and the environment.

Greening of IT is attractive to businesses for several reasons:

- **IT uses a lot of resources.** IT is often the biggest consumer of electricity.
- **IT equipment produces heat.** This heat must be removed by special air conditioning and cooling equipment, which in turn needs more electricity.
- **IT turns over its equipment every three to five years.** Capital equipment in other departments lasts much longer, so greening new investments in IT have impact sooner. If you truly need to replace a computer, look for more energy efficient equipment.
- **Technology is IT's second name.** IT folks navigate complex technical criteria and make informed decisions. Green is just one more factor for them to consider.
- **IT can help green other processes in an organization.** Virtual travel, virtual client visits, telecommuting, and so on take relatively little energy.

Greening the IT Ecosystem

Greening your IT ecosystem includes networks, the Web, and interconnected and dynamic relationships. The *green IT ecosystem* represents a way of thinking holistically about what, how, and why IT operates — and about who and what those operations impact. The components include

- All computer hardware, software, and networks used inside an organization

- All specialized facilities, such as data centers and computer rooms, that house equipment, including facilities infrastructure equipment that provides power to the computer equipment as well as specialized air conditioning and cooling equipment
- Management strategy responsible for purchasing, running, and responsibly disposing of IT assets
- The staff and organizational culture that makes all the infrastructure and activities possible
- The systems and networks that connect with the organization's suppliers, customers, and partners

Green business drivers

For many organizations, going green is all about the explicit business drivers:

- **Energy costs:** IT can dramatically reduce energy costs. According to the Global e-Sustainability Initiative (GeSI, `www.gesi.org`), the IT industry could save global industry $800 billion dollars in energy costs by 2020 by implementing energy-efficient policies.
- **Energy availability:** In some locations, new power feeds are difficult if not impossible to obtain. The efficiencies inherent in green IT can delay or avoid the need to expand or relocate data operations. One such location is the borough of Manhattan in New York City.
- **Equipment costs:** Greening IT optimizes business processes by consolidating servers and storage, which often results in needing less equipment, which in turn uses less power and require less cooling.
- **Data center costs:** Current trends show that for data center capacity to keep up with escalating demands, data center capacity needs to double every five years. Greener IT can slow the need for expansion as well as reduce the demand for floor and rack space and air conditioning.
- **Business process optimization:** Optimizing business processes such as supply chain management represents a huge opportunity for managing carbon emissions with solutions like shipping logistics planning, among others.

- **Performance and efficiency:** Many, if not most, of the steps you take toward greening IT yield a more efficient, better performing IT.

Focusing on business optimization can help IT reduce energy demands and keep growth in check. Areas to target include

- Server and storage utilization and consolidation
- Server, storage, and application virtualization
- Technology and information life cycle strategies
- Energy measurement and management

You can use software applications to help in your green journey. Areas you can explore include

- Optimizing business process
- Optimizing decision support so that you use information you have to make greener decisions
- Using data management technologies, including de-duplication to reduce requirements for storage, thereby reducing energy use and data center space
- Using data compression technologies so data takes up less storage, which uses less energy and data center space

Add to your business case these advantages associated with using Web collaboration for business communications:

- Savings on travel costs as well as the time savings associated with travel
- Savings on the cost of shipping documents or physical media, such as tapes, CDs, and DVDs
- Reducing the cost of business partnership enablement
- Optimizing relationships with suppliers

Sustainability and green initiatives have a positive impact on the value and reputation of brands. This is true across the board for both service and product-focused organizations, large, small, and midsized organizations, in all regions around the globe, and in all industries. One in four customers say they'd switch brands for a given product or service if provided with more ethical alternatives. No kidding.

Environmental drivers

Beyond corporate responsibility, new legislation may likely prove a strong incentive to curb carbon emission, and organizations need to consider environmental drivers when devising green IT strategies. Some of these drivers include the following:

- **Carbon dioxide** is one of the major human-generated greenhouse gases that the Intergovernmental Panel on Climate Change (IPCC) has concluded is likely responsible for observed increases in temperature over the last 60 years.
- **Coal** provides more than 50 percent of electrical power in the U.S.

Legislation, such as *Cap and Trade,* or *emissions trading,* refers to a strategy to control and reduce carbon emissions by limiting or capping the total amount of greenhouse gases that an entity can emit. Trade in carbon credits provides financial incentives for organizations to lower emissions while working toward reducing overall emissions to the capped total.

In addition, discarded electrical components and electronics (to be distinguished from recyclable units which, properly handled, are considered a commodity) become *e-waste*. (Find out more in Chapter 9).

Emerging Standards for Green IT

Standards play a central role in modern information technology. Such standards allow users to mix the best solutions from multiple sources, instead of locking them into proprietary products from a single vendor.

Before blindly adopting new equipment or practices, just because they're green, IT departments must verify, test, and work changes into their budgets. Standards — and products that meet those standards — provide tested solutions that IT organizations can adopt quickly, relying on the work of the standard-setting and certifying organizations.

The Green Grid unites for green

The Green Grid is a worldwide group of corporations pushing for higher energy efficiency in data centers and business computing. Members include hardware and component manufacturers, data center operators, manufacturers of the facility equipment used in data centers, software providers, and other interested parties. These members are developing metrics, measurement methods, processes, and new technologies aimed at reducing the power needed for data processing. IBM is a founding member of The Green Grid.

Many current standards for green IT are voluntary. They're guidelines that a company can choose to implement, or not. Even so, concerns about power consumption, climate change, energy conservation, and energy security have caused governments around the world to scrutinize energy use and propose guidelines that will eventually become mandates.

The idea that if you can't measure it, you can't improve it ought to govern IT energy use. To understand how well any IT infrastructure, for example, a data center with its individual components and processes, is performing, you need ways to measure it.

Get good ideas about how to take these measurements by visiting `www.ibm.com/ibm/green` — look under the Green IT tab.

Going on a Green Journey

Green isn't a destination. What's evident in the stories that follow is the ongoing process and the growing involvement and commitment of the folks who are on the journey.

Big Blue goes green

IBM, the original IT giant, has been involved in green IT for decades, so its experience is worth a closer look. IBM sounded the keynote for green IT when it published its first

environmental-protection goals in 1971. Tom Watson, Jr.'s corporate policy statement called for IBM to

> *. . . be continuously on guard against adversely affecting the environment. This effort must include constant attention not only to the waste incident to producing the product but also to the consequences of the processes established during product development.*

IBM then developed a comprehensive global environmental management system:

- Between 1990 and 2007, IBM saved 4.6 billion kWh of electricity consumption, avoided nearly 3.1 million metric tons of CO_2 emissions (equal to 45 percent of the company's 1990 CO_2 emissions), and saved over $310 million through its annual energy conservation actions.
- IBM's procurement of renewable energy and renewable energy certificates (RECs) increased from 11 million kWh in 2001 to 455 million kWh in 2007 accounting for 8.5 percent of IBM's total 2007 global electricity purchases.
- IBM reduced its nearly 200 data centers to fewer than ten.

In IBM's 1994 Annual Environment Report, then-CEO Lou Gerstner renewed the commitment:

> *In the past two years, we in IBM have had to rethink much about the way we do business. In the process, it has become clear that there are certain things that should not change. One of them is our responsibility to run a business mindful of the world in which that business operates. When it comes to the environmental well-being of that world, this responsibility takes on added weight for a company such as ours: a multinational organization whose technology represents a powerful engine of change.*

Keeping the commitment

Today IBM's environmental and energy commitments are part of its larger commitment to corporate citizenship and social responsibility, including these important areas:

- **Maintaining environmental awareness:** IBM has published an annual environmental report since 1990; at the end of 1997, it became the first major multinational to

earn a single global registration to ISO 14001, covering all its manufacturing and hardware development operations around the world — which it's maintained ever since.

- **Working smarter to save energy:** IBM saved $250 million in energy costs between 1990 and 2005. In 2007, in its efforts to green itself, IBM saved $97 million in travel costs by using online collaboration — saving itself considerable expense as well as avoiding putting more carbon in the atmosphere from business travel.
- **Mandating responsible product design:** In 1992, IBM established its Product Stewardship program, which focuses on corporate environmental affairs — including the development of products whose design and performance are environmentally friendly. Goals include
  - Extending the life of products
  - Designing products with reuse and recylability in mind
  - Minimizing environmental impact by choosing more environmentally friendly materials
  - Recycling existing equipment

  IBM GARS (Global Asset Recovery Services) works to recover, reuse, and responsibly dispose of electronic equipment.
- **Maintaining consistent environmental effort:** In IBM's case, this means not only establishing a track record but also planning for future improvements:
  - Between 1990 and 2007, IBM avoided energy-use-CO_2 emissions equivalent to 45 percent of the company's own 1990 energy use.
  - Since 1987, IBM has decreased its generation of hazardous waste by 94.7 percent.
  - Since 1995, IBM has reduced its PFC emissions from chip manufacturing by 32.7 percent.
  - From 2007 to 2010, IBM expects to double the computing capacity of its IT centers without increasing energy use.
- **Embracing transparency:** IBM has reported its greenhouse gas (GHG) emissions under the U.S. Department of Energy voluntary reporting program since the inception

of the program in 1995, and has reported through the Carbon Disclosure Project (CDP) since that program's inception in 2003.

IBM looks at how to not only green *itself* but also at how to help its customers go green. To this end, IBM created a framework that identifies starting points for organizations ready to begin their green journeys. IBM applies green thinking to eliminate waste, conserve energy, and optimize business processes by

- Virtualizing applications, storage, and servers
- Improving facilities management including heating, cooling, lighting, and power consumption
- Using more online collaboration and messaging solutions to reduce business travel and engage remote workforces
- Using intelligent management of business information and business processes to lower energy costs
- Designing for reuse and providing customers easy ways to resell or recycle their unwanted computer equipment

RackForce rents out green machines

RackForce, a fast-growing hosting-service provider, started its green journey about seven years ago. RackForce rents servers wholesale to e-businesses, application providers, and hosting resellers. Their green strategy involves rethinking business process and coming up with innovative ways to save energy while doing green-savvy IT. RackForce VP Brian Fry puts it this way:

> *"We didn't start out with a full understanding of green or green strategy. In 2001, we understood that we were very inefficient with our servers, adding 20 servers a day, with low utilization on every server. We also understood that if everything from one customer is linked to one server, failure could be catastrophic."*

RackForce decided to look at virtualization to do more with what they had. They used virtualization strategy to address

server consolidation as well as overall efficiencies of the data center, the ability to make changes on the fly, the ability to move things when they need moving, maximizing utilization.

They innovated from within, switching to hardware that was more power efficient. They added space to the data center to create a major data center (150,000 square feet), and addressed data center efficiencies. They learned not to allow cold air to mix with warm.

Today's chilling systems below 50°F can use cool air without using a chiller at all. RackForce chose to locate where cooling is part of the environment, which was part of making the decision on where to site the new data center. RackForce used a modular design for the data center, a big part of their efficiency. They use water to cool, which is many times more effective than air cooling.

"The carbon impact from IT is getting to be as bad as the airline industry," warns Brian, "Is your data center running on coal? Data centers need to be put where they have the least impact on the environment — in colder locations. With hydropower, the only carbon footprint comes from the dam." Hydropower is very, very clean compared to coal. Using the right engineering and power source is equivalent to reducing 100,000 cars to 1,000 for a 150,000 square foot data center.

With virtualization, you can replace 20 servers with one. Overall, RackForce got a 300-percent performance and reliability increase and a 30-percent power-consumption reduction by implementing IBM System x3550 servers.

Being green On Line in Brazil

Service and hosting provider, On Line do Brasil in Sao Paolo, Brazil provides IT and services for small and midsize companies. They rent space within a larger data center and populate it with *blade servers* — slim, compact servers on individual circuit boards. Switching from racks to blades reduced the space and energy each server consumes. Thinking about 1,000 servers, the difference between racks and blades is huge. On Line do Brasil was running out of both room and energy; now they have room to grow.

On Line do Brasil's growth plans required good operational efficiency. They approached this need in several ways:

- They developed a good knowledge of virtualization and used VMware with their blades.
- They engaged IBM to consolidate its existing systems onto three IBM BladeCenter HS21 XM servers, housed in an IBM BladeCenter E chassis.
- IBM implemented an IBM System x3550 server to manage the new environment. The System x platform lowers power consumption and increases performance.

Beyond reducing energy and space requirements, On Line do Brasil has gone from an organization of 23 employees with revenues of $1 million to an organization of 33 employees, revenues of $4 million, and hosts 120 customers.

A smarter planet

Something meaningful is happening . . . every human being, company, organization, city, nation, natural system, and man-made system is becoming interconnected, instrumented, and intelligent. This is leading to new savings and efficiency — but perhaps as important, new possibilities for progress.

Business has been at the center of the converging pressure to "go green." Government regulation and laws are becoming stricter. Stakeholders (investors, employees, customers) are increasingly expecting operational consideration of the environment. Energy costs are rising. In many regions around the globe, the availability of energy, waste disposal, water, and raw materials is uncertain.

IBM believes that a shift in societal thinking forces a new code of conduct and demands corporate social responsibility. IBM suggests that "smart systems" are dramatically more efficient and reliable and therefore enabled to save energy and resources. Further, IBM suggests that companies of all sizes can find value in going green through cost savings resulting from decreased waste (energy, water, manufacturing, materials, employee commuting time, business travel time) and/or by tapping new markets and consumer segments that demand environmentally preferred products.

IBM and its Business Partners can help companies of all sizes assess their data center or server room efficiency and carbon footprint to identify cost savings and other environmentally sensitive improvements. For more information visit `www.ibm.com/green` or `www.ibm.com/expressadvantage`.

Chapter 2

Getting Ready to Green

In This Chapter

- Considering what eats energy
- Knowing carbon, both friend and fiend
- Making a green plan and getting started

In this chapter, we explain why IT needs so much power, where it all comes from, the different ways its use impacts the environment, and the basics on how to get started with green IT.

Figuring out Where the Energy Goes

Computers break down problems into many simple, logical decisions; tiny electronic circuits called *gates* or *logic elements* make these decisions. A modern computer processor chip has hundreds of millions of these gates and each make these decisions billions of times every second. Each of these decisions requires a minute amount of electrical energy. All these minute electrical sips add up to big gulps of energy.

Speed increases energy consumption. Applying more power to gates in a processor chip switch makes them faster. Higher-frequency signals generated in a fast computer's operation leak across the thin insulating layers in a chip more easily, using still more power. All that power going into the chip gets turned into heat. A typical processor chip uses roughly the same amount of power as a medium-size incandescent light bulb — and the chip can get just as hot. Getting heat out of the chip affects how fast processors can go.

By definition, the fastest chips on the market can do the most calculations per second, but they generally don't perform the most calculations per unit of electrical energy. If computations can be spread among more than one processor, and that happens in most data centers, using two or three energy-efficient chips instead of one super-fast chip may get the same work done with less electricity and less wasted heat.

In addition to chips, power systems in the data centers consume a lot of power. Everything from UPSs to PDUs to the power supplies in the servers are sources of inefficiency. The power supplies convert incoming voltage to the voltage needed by servers. The power supplies in the servers again convert voltage to that needed by the chips along with AC to DC conversions. Each of these steps leads to losses of energy.

The storage and network devices are responsible for about 6 percent of the power consumption each. And cooling systems consume about 50 percent of the power in the datacenters.

When purchasing new devices or consolidating processing loads to fewer servers, take advantage of servers and devices that do the most work/computation per kilowatt-hour.

Attributing consumption

Your job is to determine how much electricity IT uses. You may go about determining your consumption by following the steps in this section.

Step 1: How much power goes to your data center

First you need to know how much power goes to your data center. If the data center has its own dedicated electric meter, you can use the power reading directly. If other users are on your power meter, such as office areas or manufacturing areas, you need to determine the data center's power usage. There may be current meters built into your switch gear. Ask your facilities people to show you this equipment or ask an electrician to take power readings for you. If you have the right kind of power switching equipment, you will be able to utilize energy management tools to collect this information directly from the equipment.

Step 2: Determining how much electricity devices use

The best way to determine electrical output is to take actual measurements. Newer equipment has power measurement probes built in. The power consumption can then be collected regularly by energy management tools directly from the equipment.

Step 3: Adding up the power of each device

When determining the overall power of each device, you have two options:

- The first option is to use the nameplate ratings of the device, which often reflects the maximum rating of the power supply instead of the actual peak power draw of the specific equipment. The result is that the nameplate values tend to drastically overestimate achievable power draw.
- The other option is to use management software, such as IBM Systems Director Active Energy Manager which details specific power usage at the server level. You can then cumulate the energy draw.

Step 4: Powering equipment versus distribution overhead

Finally you calculate how much of the electricity you buy goes to powering your IT equipment versus cooling and power distribution overhead. After you know this, you should adjust the cost of the electricity supplied to IT equipment upwards to reflect the fact that the heat produced costs money to extract.

For example, if you use 1,200 watts of cooling for every 1,000 watts of power that goes to IT equipment, you should multiply the billed cost of power by (1,200 + 1,000) ÷ 1,000 = 2.2 to get a better measure of the true cost of the energy the equipment uses.

The uncool cost of cooling

All the chips in a computer use electricity and produce heat, as do peripheral devices such as disk drives, video displays, printers, scanners, and modems. Even the fans that move hot air away from all that electronics use electricity and add heat to the room. Servers would burn up if heat isn't removed by large air conditioners — a major expense in data centers.

Air conditioners pump heat from inside a building to the outside, and air conditioners require lots of electrical power. For every 1,000 watts of power used by the computers the air-conditioning often needs another 1,000 watts or more.

Because cooling represents such a large fraction of IT energy consumption, improving air conditioner efficiency is one important road to green IT. In datacenters with multiple cooling systems, it's possible to align cooling system operation to the actual needs of the space. Cooling systems that are responsible for a sparsely populated part of the datacenter, for example, can be set to run less frequently than cooling systems focused on areas full of equipment.

Understanding the Carbon Cycle

Before you can reduce your carbon footprint — the total greenhouse gas emissions caused by an individual, organization, event, or product — you must know how and when you generate carbon dioxide and other greenhouse gases.

Carbon is an element on which all life on Earth depends. All the chemicals that people are made of are built on chains of carbon atoms. The carbon in fossil fuels (like oil) is the remnant of organisms that died millions of years ago.

Burning fossil fuel adds net CO_2 to the atmosphere. CO_2 tends to trap heat much like the glass windows on a greenhouse — sunlight gets through, but longer wavelength infrared radiation from the heated Earth doesn't get back out and is trapped, warming the planet.

Almost half of the electricity used in the U.S. (49 percent) comes from coal. Reducing the electricity used or using cleaner electricity (like hydropower) can reduce your organization's carbon footprint.

Making a Green Plan

Getting your green journey underway isn't difficult and doesn't even have to cost a thing before you start seeing great benefits. When you begin a new venture, there's always tension between planning and action. Taking action too soon

risks bogging you down in minutiae and missing the big picture. But overly ambitious planning can be risky.

Begin sound planning for a long-term commitment while getting started on easier green tasks. Remember to distribute your planning documents electronically, which saves on paper and can improve your process. (See Chapter 8 for details.)

Establishing a baseline

As you build a green program, you'll want to measure your progress. And to do so, you need baseline data on the various parameters you will be measuring. Measure and monitor because you need to establish both your goals and the progress you make toward them. ***Note:*** Showing progress helps ensure that your green program takes root and continues to grow.

Figuring facility power usage

Reducing power consumption, or at least controlling its growth, is one major way a green IT initiative can reduce your organization's environmental footprint. The cost savings that come along with reduced power demand can be either a side benefit or the main justification for your green efforts. Be sure you can quantify the savings.

Start figuring your baseline by determining your data center's current total electric power usage. Consider these suggestions:

- **Find out what the electric bills show as the amount of power used.** If your organization sports a separate data center facility, getting the required information may be as simple as obtaining copies of recent utility bills. When figuring your facility power usage baseline, try to get records for the past 12 months (24 months is best).
- **Find the utility meters and know how to read them.** You would be surprised how many data center managers have no idea of their electricity consumption. As a start, find out which, if any, departments are sharing the meter.
- **Measure daily power usage room by room.** If you have a smaller IT shop with just a computer room (or closet), find a way to measure power on some typical days.

For datacenters, you probably want to leverage systems management tools that can help you assess and monitor power usage automatically and give you real-time power measurements. And the sooner you get baseline data, the more clear-cut the differences that you report will appear.

Measuring IT power utilization

Quantifying total power consumption for a data center or computer room is relatively easy. Quantifying the useful work that gets done with that power is much harder.

To make the process a bit easier, do the following:

- **Inventory all the equipment in your data center.** If you don't have an asset management system, this may require walking around and writing down each piece of equipment. You want to know how many and what kind of blades are in each server. This data helps you estimate how much of the data center power is used by IT equipment versus cooling and other overhead uses. Discovery tools can discover your IT assets and how they relate to business applications, which help identify unused or underutilized equipment.

  If you have an asset tracking system that can give you an inventory report covering the data center, compare the report to reality, even if you just check an aisle or two. Remember, IT equipment using power includes office computers, both desktops and laptops.

- **Note the data center temperature and humidity.** You can use this data to look for potential savings on the power used to regulate the data center environment. Many computer room air conditioners are equipped with panels that display temperature and humidity, but an independent check is always a good idea. Note that temperature and humidity can vary significantly across the data center. So, take measurements across multiple locations. Also consider deploying sensors that can report the temperature and humidity information to energy management tools on an ongoing basis.

- **Measure the power being sent to the electronic equipment in your data center.** Measure or estimate the power consumption for each type of equipment in your data center inventory. An electrician may be able to make spot measurements and provide you with a figure

for power consumption. Ask for a power factor reading (which tells you how close your systems are to an ideal resistive load) as well. If you can't get a reading on the power transmitted, you can compute a power total from your equipment power-consumption estimates. Be wary of the power consumption ratings on the back of your equipment. Often these are overstated by large amounts. Taking actual measurements either with probes or built-in instrumentation is the best approach.

- **Get figures of server and storage utilization.** Many popular operating systems log information related to server utilization. The equipment inventory you took in Step 1 shows you how much storage your data center includes, so you just need to find out how much of that storage is occupied by data of some sort. Eventually you will want to closely tie the energy consumption to actual processing needs.

  After you gather and record all the data, figure a baseline for power consumption and utilization for the IT equipment in your data center. Newer servers can report their own power usage that can be automatically used by energy management software.

Don't forget to include power consumption of equipment besides servers. Storage arrays can use as much power and more. Also include communications equipment, such as switches, routers, and line terminations.

Data centers consume (and expel) more than power

Figuring out the total power consumed by the data center is important, but other factors of IT operations also affect your green IT plans:

- **Getting a handle on storage:** Knowing how much storage you have and how much you use is a good start. We tell you more about green storage in Chapter 3.
- **Getting the big picture of facility operations:** Have your facilities people give you a tour of your data center power switchgear, UPS (uninterruptible power supplies), and cooling systems. Diagram the plant, noting the make and model of chillers, pumps, and other major equipment.

Avoiding political land mines

As you probably know, IT operation folks live and die by service-level agreements. Make sure that you embrace a broad perspective when you set your baselines and decide on where to start with your green activities. Consider the following:

- **Make sure operations management is represented on your green IT steering committee.** Understanding operational concerns will keep you from stepping on a corporate land mine. Be sure to review your security, continuity, and disaster recovery plans.
- **Start small.** First select projects that will allow you to successfully demonstrate the returns. Once you have gained credibility with demonstrated returns, you will have the authority to take on more ambitious projects.
- **Gather information on regulatory requirements.** For example, healthcare organizations in the United States must comply with provisions of the Health Insurance Portability and Accountability Act of 1996 (HIPAA). Any green initiative must take into account the stringent privacy provisions when consider reusing IT equipment.
- **Understand which applications and outputs are most important for your colleagues' everyday work.** An IT manager we know intercepts a regularly printed report every so often and keeps it on his desk. If he receives an angry call from its intended recipient, he rushes the report to him. But if he receives no complaint, he reduces that report's print frequency, from daily to weekly or from weekly to monthly. He saves tons of paper that way.

Picking a Direction for Starting

After you collect the data and devise a baseline for comparing your results, pick some short-term projects that will produce measurable benefits. Deciding which projects you start with depends on what *greenable* areas your survey discovers and your assessment of what related activities are possible.

Measuring to manage

Most IT organizations don't know their energy consumption. Energy Management tools can collect data, determine trends,

and threshold energy consumption across the datacenter and take automatic action to help reduce energy consumption.

Chilling on cooling systems

If you have good data on overall facility power usage and IT equipment usage, divide the first number (overall usage) by the second (IT equipment usage) to get your power usage effectiveness (PUE) score. Data centers often fall into the *2-to-3 range,* meaning that the air conditioning, UPS, and power distribution systems take two or three times as much power as do the data center electronics. That leaves a lot of room for improving the efficiency of the plant equipment.

One way is to raise the temperature in the data center. New guidelines from ASHRAE, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, have widened the allowable temperature and humidity ranges for data and communications equipment. Save in energy consumption simply by adjusting the set-point for the computer room air conditioners, but be sure to get buy-in from those in charge of operations. The new ASHRAE guidelines are available at `www.ashrae.org/publications/page/1900`.

Often entire computer rooms are cooled to address a few hot spots that are caused by things like concentrated workloads or poor airflow. Although running the entire room at a cooler temperature can provide a buffer for these hot spots, a much more efficient approach is to eliminate them altogether so that the temperature can be consistent across the room instead of icy cold in some places and blistering hot in others.

The virtue of virtualizing

Virtualization uses servers more effectively by enabling them to support multiple independent operating systems. If your server or storage utilization is low (most distributed environments average only about 20-percent utilization), you have huge savings in store for you by adopting this technology. If the hardware utilization can be driven up by virtualizing machines and consolidating them onto fewer physical machines, you can reduce energy demands dramatically — not only for the servers and storage, but for all the associated power distribution and cooling costs. End users will see benefits too because virtualization allows for more

graceful redeployment of computing hardware to meet ever-changing demands.

Remove barely used resources

A significant number of IT resources that consume energy aren't associated with any useful work. That server that was purchased for a project six years ago, long since forgotten, may still be powered up with a spinning disk. Or how about a server that was purchased for testing that's on 24/7, but is utilized only .01 percent of the time? In fact, it's not unusual to find that 10 to 20 percent of all IT hardware in a given organization falls into this category.

Finding and eliminating energy-wasters provides incredible bang for the buck — because every piece of equipment that can be eliminated also saves the associated space, power, and cooling. Although it's impossible to ascertain the usage of a machine by looking at the outside of the box, there are automated tools that are capable of identifying those with low utilizations or scanning an environment to identify the ones that aren't connected to any useful applications.

New data center planning

If your organization is planning to construct a new data center, getting green mandates into that planning process should be a high priority. After all, the operational cost to provide power and cooling to that new data center may ultimately eclipse the capital spent to build it. You can find many opportunities to make a new data center more efficient and lower its environmental footprint, from selecting more efficient cooling systems to selecting an environmentally optimal site.

Seek guidance from folks who do green IT for a living. Optimize what you already have, save money on power, and potentially curb new expenditures on equipment and facilities. If you're faced with inadequate power availability or are pushing the boundaries of your data center now, you may want to get help sooner rather than later. You may be able to avoid costly build-outs and improve your overall efficiency at the same time.

Chapter 3

Green Information Strategy

In This Chapter

- Collecting, classifying, and archiving your information
- Understanding best practices for managing and retaining your information
- Optimizing storage for greener results
- Going green through outsourcing

How do you know what information to keep and for how long, what to delete, and where should you put it all? Some kinds of storage are greener than others; some allow quicker access than others. Deciding what to keep and what goes where takes thought, planning, and policy. This chapter looks at ways to optimize storage to gain efficiencies in capacity management, power and cooling — all important green considerations.

Not all Information Is Equal

With more and more information generated every second, saving every bit of it makes no sense — it costs money, power, and materials and it actually makes finding and using the information that *is* important harder.

Green information strategy involves several key steps:

- **Understand the requirements for information retention and availability.** Staff at all levels of your organization needs to understand what information is valuable for business, what types of information must be kept for how long, and how easy it must be to access. For some kinds of information, legislation dictates both how long and the degree of ease of access.

- **Determine infrastructure requirements.** What do you need for servers, storage, networking, archiving, backup, and disaster recovery systems and the software to manage it all?
- **Conduct continual strategic planning to meet economic and business conditions and demand.** Hold strategic review at least once a year with line of business representatives, IT, compliance officers, and representatives from your legal department.
- **Measure progress and adjust your strategies.** Plan periodic measurements of the amount of data you store.

Managing Information Lifecycles

Information Lifecycle Management (ILM) is a set of concepts critical to formulating IT policies. ILM enables organizations to build processes and implement best practices for creating, storing, archiving, and ultimately disposing of data that no longer has any value to the organization. ILM enables an organization to match the storage costs of the information to the business value of the information, and to adjust the levels of storage costs as the value of information changes.

ILM is important to your green strategy because it helps you identify your actual storage needs. This model classifies data according to its value so you aren't using electricity to power storage devices for information that's not currently needed, and helps eliminate obsolete data so you can reuse storage and avoid or delay buying additional storage.

The ILM model identifies five stages in the lifecycle of data:

- **Creation:** This phase pertains to generating documents in a word processor, filling a spreadsheet with data, or using a Customer Relationship Management (CRM) system to input customer information. New information might also include scanned paper correspondence, drawings created on a computer-aided design (CAD) system, PowerPoint presentations, recorded video conferences, and so on.
- **Distribution:** After someone generates a document, it usually needs to go somewhere beyond the computer it's created on. For example, an e-mail message to a coworker leaves your computer and is distributed to

your coworker's desktop through a company network and a mail server, but you may also send a copy to a customer. The distribution stage encompasses delivery of data both within a company and externally.

- **Use:** After the document, e-mail, presentation, or other type of data arrives at its intended destination, something happens to it. Maybe the presentation is delivered to an outside salesperson for a meeting tomorrow morning, or six people read the document and add their comments, and then some unfortunate, long suffering soul has to integrate all those contentious comments to create a final version in time for some deadline. Whatever the case, the data is used as part of a business activity.
- **Maintenance:** The data is managed in this phase. For example, an e-mail may be kept in an e-mail inbox, which is one form of filing it. It may also be backed up, forwarded, or archived. What happens to data depends in part on its *currency* (how readily available it needs to be) and how valuable the data is considered to be by the organization. The notion of currency takes into account the fact that data can (and does) lose its value over time. From a cost-effective standpoint, data should be indexed and moved to less expensive storage or even offline as its value fades. If the IRS conducts an audit or a lawsuit requires data to be provided, that data again acquires currency and needs to be recovered.
- **Disposition:** Faced with increasing regulatory pressure to keep certain kinds of data, some companies have responded by trying to "keep everything." Such a strategy creates an indexing nightmare and the continual need to buy more storage capacity to respond to unbridled demand. Companies that analyze their data use and storage needs can better determine which data needs to be retained and for how long.

Each organization needs to first decide what types of data it needs to keep, classify that data according to how readily available it needs to be, and move the data to appropriate types of storage. Different organizations have different requirements around what's important to them and for how long. Knowing what you need to keep, keeping only what you need to keep, and keeping it only as long as you need to keep it allows you to use the fewest resources and the least power, furthering your green efforts.

Requirements vary by country, industry, and organizational policies. Moving less frequently accessed information to archives that can be kept off line means you aren't using power for access that's seldom used. It's like turning the lights on only when you need them.

Each organization needs to decide what types of data it needs to keep, classify that data according to how readily available it needs to be, and move the data to appropriate types of storage. (See the section "Using tiered storage," later in the chapter.) The guidelines are covered in the following sections.

Identify

The organization first needs to determine all types of data to be stored, the source of that data, and its long-term value to the organization. For example, as e-mail is a dominant form of communication between companies and their customers and suppliers, companies need policies concerning how e-mail is classified and stored. Changes made in 2006 in the Federal Rules for Civil Procedure (FRCP) — the rules governing non-criminal litigation in the U.S. Federal court system — allowed penalties to be assessed against companies that could not produce electronic documents in a timely fashion during the discovery phase of a lawsuit. (Discovery is a step in civil litigation where each side is required to produce all relevant documents requested by the other side.) In several high-profile cases, companies were penalized for failing to produce electronic documents in what became known as *e-discovery* cases.

If your organization keeps all incoming e-mail, use an e-mail security service that keeps spam off your network.

Classify

You should categorize or index the various types of data, and as the data loses its currency, move it to appropriately less expensive storage. You can use automated classification to separate information that has business value from information that can be discarded. We discuss less expensive and less power-consuming storage options in the section "Using tiered storage."

Move

Where possible, move the data to data archive systems, such as tape, for permanent storage. If you don't already archive, begin archiving now. Archiving has operational benefits and saves energy and money.

Optimizing Storage

You can use a variety of technologies and methodologies to optimize your storage utilization. Together they can reduce the amount of storage you need, and thereby the energy you use to power and cool it.

Using tiered storage

Using storage tiers helps companies think in terms of storage efficiency. Moving data from one tier to the next uses progressively less energy and supports a green data strategy.

To grasp the idea of tiered storage, think of data descending a staircase along its lifecycle, with each tier reflecting how the data is currently being used (or not used) and how accessible it needs to be. The number of tiers varies, but most companies recognize five tiers.

Tier 1 — mission-critical data

This tier involves highly transactional data that needs to be accessed frequently. Examples of Tier 1 storage include Web servers that support the Web site your customers use and accounting databases.

Tier 1 data is the most expensive to store, both in monetary and environmental costs. This data occupies space on spinning disk drives and may be duplicated on user machines, particularly laptops, as access may be needed when the network is not available. If you have the option, store this data at data centers that are powered by renewable sources.

Tier 2 — high value but not mission critical

In this tier, data needs to be accessed less frequently, so performance is less of an issue than it is with Tier 1 data. This storage is less expensive. Sample Tier 2 data may include documents stored on a collaboration server, or databases that are accessed infrequently. Data de-duplication can ensure that Tier 2 data is stored only once.

Tier 3 — transitional storage

Tier 3 data is valuable data that needs to be accessed infrequently. Examples may include an indexed e-mail or document

repository. Tier 3 data is a candidate for *MAID (massive arrays of idle disk)* storage. Such systems save energy by keeping disk drives powered down until the data on them is needed.

Tier 4 — disaster recovery

This tier serves as a repository for applications and data that need to be available to restore continuity of operations in the event of a business interruption, such as a power outage.

Disaster recovery systems can often be powered down or kept in standby. Periodic testing can be scheduled at a time when power is more available, keeping load off less efficient "peaking" generators.

Tier 5 — archive

Tier 5 is the repository of data that needs to be retained but doesn't need to be online. Here are some suggestions for being green with your archiving:

- Archive off-site in a secure, protected location. Any data can be put into an archive, but it's most likely data that the company intends to keep for a long period of time.
- Compress data, which allows two to three times as much information to be stored in the same amount of space.
- Tape offers better cooling and power consumption than disk and has a longer life span lasting 10 to 20 years.

Storing information by policy

The work to keep all information where it belongs and to move it where it needs to be moved, when it needs to be moved, can be greatly simplified by automating the process, defining policies about what needs to happen when, and allowing software to do the job for you. IBM Tivoli Storage Manager and System Storage Archive Manager helps provide hierarchy and storage media management functions by moving content between different pools or tiers of storage. Information can be moved from disk to tape and from generation to generation. You define the rules that identify what

should be moved to what type of storage and how long to keep it there, automatically optimizing storage.

Implementing a records management policy can help ensure that information you determine to have business value is retained according to corporate, government and industry guidelines. For example, organizations need policies to define rules about how long e-mail is retained.

IBM provides a variety of disk storage appropriate for every tier. For long-term information retention, SATA (Serial ATA is a storage interface for connecting host bus adapters to mass storage device) drive based disk offerings are a good choice. IBM midrange disk systems provide a secondary storage system for information retention. A high-end disk system such as IBM XIV Storage System or IBM System Storage DS8000 Turbo is ideal for Tier 1 as it is designed to support the most demanding business environments. To retain information and records to address regulatory compliance, consider IBM System Storage DR550 or IBM System Storage N Series with Snaplock. These disk systems support policy-based data management capabilities.

SOA you wanna green

Service Oriented Architecture (SOA)—a business model with the idea of reuse built in — is hot today. SOA can be helpful in developing green enterprise solutions because it combines environmentally friendly concepts with good business sense. SOA can make it easier to adapt IT to changing business conditions therefore increasing agility. The challenge of transforming business processes and operations to include environmental consideration is simply another business requirement that can be defined as a business policy.

For example, in managing the carbon footprint of an enterprise, some calculations occur repetitively, such as estimating carbon emissions or assessing carbon trade-offs based on current carbon offset market conditions. With SOA, when you create software services, you can use them in business applications across your enterprise, perhaps adding green calculations to accounting systems, travel expense systems, and supply chain management.

Outsourcing: Going Greener with Hosted Data Center Services

Your company has a choice when it comes to building your information infrastructure: You can build a physical infrastructure that you staff and maintain, or you can outsource these services totally or partially. You can still categorize your data according to the tiered storage architecture. You can store your data for some or all tiers with an off-premises provider. Here are some reasons to consider using a hosted data center provider:

- **Greener:** Dedicated data centers consolidate the operations of many organizations and gain economies of scale, reducing the amount of power and equipment that those organizations would gobble up individually.
- **Cheaper:** Acquiring and maintaining data center equipment, and powering and cooling it is expensive. Hosted services provide a cheaper alternative to running all these systems in-house.
- **Physical plant:** Locate data in buildings designed to support IT. Data centers need power and cooling. Some cities restrict the amount of power available for powering data centers, and data centers are being relocated to areas near cheaper, cleaner power and cooling.

Some companies prefer to use the services of a provider that has expertise in archiving. Some use remote services to complement in-house IT staff. IBM Remote Infrastructure Management Services provides a flexible, affordable suite of services to help monitor and manage infrastructure either on site or from an IBM facility.

Disaster recovery and business continuity

Disaster recovery systems are designed to hold a "snapshot" of all critical applications and data that a company needs in the event of a business interruption. Using virtual servers to host disaster recovery is a greener strategy than having redundant physical systems.

All businesses need disaster planning

A business interruption may be more catastrophic to a small business than to a large one. Large businesses frequently have more than one location and often back up critical applications and data to these locations as well as to their headquarters. You have only to remember the devastation wrought on the Southeastern coast of the United States by Hurricane Katrina to realize how badly the physical infrastructure of cities and towns can be damaged and how long it can take to bring it back to some semblance of normal.

This said, small and large businesses can benefit from outsourcing their disaster recovery infrastructure. One compelling reason is that the service provider's data centers are *hardened* (built to withstand events such as hurricanes and tornadoes), are located away from big cities and in meteorologically "neutral" areas, and are also *redundant* — that is, the data center is replicated in one or more geographically dispersed locations.

Data center replication

Replicating the data center involves duplicating the functionality and services of a data center in a different location. Data center replication is done for several reasons:

- To serve as a backup for a primary data center. The secondary data center provides the ultimate backup and recovery mechanism in the event of business interruption.
- To provide a way of decreasing the load on a primary data center during periods of increased business demand.
- For companies whose business operations are dispersed through numerous countries, additional data centers are used to bring services closer to the user of those services.

Replicating data centers is standard practice for data center hosting providers to ensure that they provide uninterrupted service to their customers. Branch offices can act as redundant backup sites, and many companies replicate their critical data and applications.

Co-locating data centers

Co-location is a computer industry term that refers to sharing space — for instance, multiple companies sharing space and resources in a data center. Each company owns its physical equipment in the shared data center.

The chief distinction between co-location and hosting is that the co-location center provides power, cooling, security, and facilities management while you continue to manage your own servers and storage. By way of contrast, data center hosting providers also provide the equipment and services.

For small- and medium-sized data centers, co-location provides an alternative to building and managing your own facilities. Co-location providers charge by the amount of rack space provided, bandwidth used, and power consumed. Choosing efficient equipment can save power. Some co-location firms offer green design and power.

Relocating to the Cloud

Cloud computing may be a green solution for some organizations. Cloud computing provides information infrastructure capabilities as a service. Users access technology-enabled services "in the Cloud" without knowledge of, expertise with, or control over the information. Cloud computing is a pay-as-you-go service that includes network charges, storage charges, and access charges. Cloud computing allows users to access information and services from whatever device they wish — laptops, desktops, iPhones, BlackBerries — any IP-enabled device.

Moving to the cloud has the potential to greatly simplify IT management by providing scalable resources on demand, including systems management, virtualization, and security. IBM is a trusted partner for organizations interested in the rewards from Cloud Computing.

Cloud computing can be supportive of green and sustainability as long as the computing services being delivered by providers who've optimized their data centers. Certainly moving to the cloud can help minimize energy consumption on premises and likely reduces carbon emissions as well.

Chapter 4

Maximizing Data Center and Server Room Efficiency

In This Chapter

- Measuring and maintaining data center efficiency
- Racking up green servers
- Cooling your data center (or server room)

Everybody has data, but not everyone has a data *center*. For many organizations, most of their IT equipment lives in what they might describe as their server room, or server closet, as the case may be. In this chapter we help you understand the basics of those elements under your control that contribute to data center and server room efficiencies and inefficiencies.

Designing a data center for maximum efficiency is complex and requires input from many disciplines not normally associated with IT. You must consider myriad factors as well as plan for growth and technological and economic change.

Smaller organizations might have a dedicated server room — the room where most servers are kept to facilitate the care and feeding of said servers. Designing a server room typically means you're operating on a smaller scale. You still need to contend with such issues as "Is there enough power, space and cooling available in this location for us to operate?" You can and should think about ways to improve efficiency. Money saved by more efficient server room usage is just as welcome as money saved in the data center.

Planning for Green Efficiency

What your data center will need ten years from now is almost impossible to know. Stakes are high; if you under-provision, much that went into the data center might be scrapped early. If you over-provision, resources will be underutilized and less efficient. Air conditioning equipment, for example, generally works most efficiently when you match it to the heat load. Systems with excess capacity often waste power. Luckily for new data center builders, vendors such as IBM provide modular data centers that can be rolled out as needed.

Raised floors versus solid

Raised floors have been the norm in computer rooms since the vacuum tube era; however, it's now possible, using newer technologies, to build computer rooms anywhere. Not having to create raised floors can save bundles.

Variable speed drives

Fixed-speed motor controls run at the same speed all the time, even if the heat load on the system doesn't require full power. Variable speed motors and controls are more expensive to purchase, but they can tailor cooling power usage to need, producing substantial savings, and may prove less expensive in the long run. The obvious green choice is variable speed.

Power distribution

Power distribution encompasses all the equipment and cabling needed to bring electrical power from your building's power connection to the utility company's lines to the racks containing your IT equipment. This includes transformers, *switch gear* (similar to the breaker panel in a home), backup power systems, and the like. In many data centers, 10 to 15 percent of total electrical power is lost in these systems. Best practices can cut those losses by up to half.

Thermal density

The trend in servers is to pack ever more CPUs into a single rack. More CPUs means more power, which means more heat. When power densities get above 200 watts per square foot, blowing cold air through a false floor isn't effective because too much air is needed to remove the heat. Approaches, like racks (19-inch EIA-310-D standard) with built-in chillers or even water-cooled servers, become preferable.

Modular, Green Server Rooms

IBM's Scalable Modular Data Center (SMDC) has inherent scalability and flexibility to help cut upfront costs by as much as 20 percent by using standardized modules, is designed to be 15 to 30 percent more energy efficient, and can be deployed, typically, in just 8 to12 weeks. Data centers smaller that 500 square feet to over 2,500 square feet (approximately 50 to 250 square meters) can be targeted to meet the needs of a wide range of clients.

Consolidating IT Infrastructure

One of the most effective ways to improve the power consumption and cooling requirements is by consolidating parts of the IT infrastructure. Reducing the number of physical servers will almost always result in power savings, and as system maintenance costs decrease, less staff is required to manage the physical infrastructure.

In traditional server architecture, most servers run a single application for better performance, which is wasteful. You can consolidate your servers in the following ways:

- **Use a larger server.** A server with faster processors and increased memory capacity replaces several servers.
- **Replace physical servers with virtual servers.** Each application runs in its own virtual "machine." The virtualization manager allocates resources to each running application so to maintain performance.

Having fewer physical resources to manage saves rack space, floor space, and reduces cooling and power needs. Replacing several physical servers with *blade* servers may not reduce power or cooling at all because of the concentration of processors and memory within each blade server.

Storage is often allocated to specific applications, like databases, that require space to be reserved for tables and indices. Rather than calculate the amount of storage to be reserved, most IT administrators allocate the largest amount available, which results in capacity that often goes unused.

Estimates are that only 30 percent of storage capacity is used at any given time, meaning companies should attempt to use their current storage more efficiently before buying more.

Just as servers can be virtualized, so can storage. Storage virtualization allows you to combine storage capacity from multiple disk systems into a reservoir of capacity that can be better managed, saving energy and simplifying IT.

Rack space and floor space

As you consolidate servers you can reduce the number of racks needed. Increasing hard drive capacity has a similar effect on storage racks: more capacity in less space. Fewer racks mean reducing total floor space as well as reducing power consumption and cooling.

In the past, the entire data center was cooled uniformly. Cooling is increasingly being applied at the rack-level now instead. Moving the cooling closer to the source of the heat — the servers or drives in the rack — means that the cooling system can be much more efficient.

Measuring Efficiency

You can't manage what you can't measure. This section covers some key metrics you need to track.

Power usage effectiveness

Power usage effectiveness (PUE) is likely the best overall industry metric of data center energy efficiency. PUE is the total power the data center is using divided by how much power goes to all the equipment racks. Lower PUEs are better. For existing data centers, PUE's range from 2.3 to over 3.0, leaving plenty of room for improvement.

Both the Environmental Protection Agency (EPA) and The Green Grid (see Chapter 1 for more info) say 1.2 is the ideal — achievable with the best available technology and data center practices for newer data centers with less stringent requirements for availability.

Data Center infrastructure Efficiency

The Data Center infrastructure Efficiency (DCiE) is 1/PUE. Divide 1 by a PUE of 2.0, to get a DCiE of 50 percent. Many prefer using DCiE as a metric because it's easier to understand. A DCiE of 50 percent means that 50 cents of every dollar is spent on the productive use of IT. Improvement to 70 percent means more efficient use of power, which saves power and cost.

Power cost at the rack

Although you may pay 10 cents per kwH, taking the cost of cooling and power distribution into account may mean you should use 30 or 40 cents per kwH in choosing systems.

Picking Greener Servers

Servers generate the most heat and consume the most power in the data center. Servers are becoming greener, but some new developments offset some of the gains:

- Increased density of processors on a single chip raises power requirements and produces more heat. A single processor may be more energy efficient, but more processors mean each chip uses as much or more power.

- Network and storage controllers use more power for faster I/O.
- As drive prices fall and demand for storage rises, organizations add drives, boosting power consumption.

As the amount of computing power has increased, so has the power requirement and the amount of heat generated. Energy management is increasingly important as the price of energy increases — greater amounts of energy aren't always available, and system deployments grow beyond the capacity of current facilities to supply their power and cooling needs.

Some of IBM's solutions include the following:

- IBM Systems Director is energy management technology that monitors and control energy usage for energy efficiency, performance, reliability, and availability. Systems use less power, generate less heat and use less energy to cool systems.
- IBM's POWER6 architecture with EnergyScale provides power trending, power-saving, capping of maximum power and thermal measurement, allowing you to measure the energy of the system and direct policies toward energy-efficiency.
- IBM POWER6 processor-based servers deliver outstanding performance per watt as well as virtualization technologies. Live Partition Mobility allows you to move running partitions from one POWER6 server to another, conserving power by moving workloads off underutilized servers. They can work together to optimize system utilization, improve application availability, balance critical workloads across multiple systems and respond to ever-changing business demands.
- The IBM Rear Door Heat eXchanger removes heat generated from the back of computer systems before it enters the room. The Rear Door Heat eXchanger reduces up to 55 percent of the heat load coming from any IBM enterprise rack. It requires no fans or electricity and its design allows systems to air-cool without opening or removing the door. It attaches to the back of the rack without taking extra space and prevents condensation.

Green Power Using Blade Servers

Blade servers put each processor, memory, and hard drive on a single card called a blade. Blades plug into a *backplane*. Blade servers offer a real opportunity for green efficiency because the power and cooling is shared among all the blades plugged into the backplane. These common services include

- **A single power supply:** A larger supply is generally more efficient, so the blade packaging uses less power for the same amount of computation.
- **A shared cooling system:** The concentration of blades in one chassis allows the server designers to use fewer but larger and more efficient fans and to engineer the air flow for better effectiveness.
- **A shared network interface:** In place of individual network interfaces, which frequently use considerable power, the blade server case provides a common network backplane with a port for each blade server.

Because of the concentration of blades within the blade server case, manufacturers often supply software to control the power usage of individual blades or the system as a whole.

Replacing multiple 1U "pizza box" servers with blade servers generally saves power and space. Designed to address thermal concerns without sacrificing performance, IBM BladeCenter infrastructure uses energy-efficient components and a shared infrastructure architecture. Calibrated Vectored Cooling capabilities enable dual paths of air to each component, improving uptime and longevity while reducing wasteful air movement. The optimized airflow, the blade form-factor and power-efficient processors provide thermal management without more fans, allowing more servers. The IBM Power Configurator tool helps estimate building and electrical costs.

Energy Efficiency for Servers

What you monitor, you can begin to manage. Getting a thermal view of server and facilities together helps you to identify both hot spot and wasteful cool spots so you can make adjustments to your energy management policies.

Another important goal is to use servers at full capacity. Experts estimate that as much as 60 percent of all servers are underutilized. If application loads are more evenly distributed, the number of servers can be reduced. Average x86 server utilization is said to be between 10 and 15 percent, and x86s are proliferating. Rightsizing IT equipment can reduce energy consumption by as much as 50 percent. To ensure that you're using your servers efficiently, follow these steps:

- Use virtualization to increase server utilization.
- Update your organization's software because more efficient software can reduce server loads.
- Use less efficient servers to provide peak capacity, and power them down when not needed.

IBM's Active Energy Manager, an extension of IBM Systems Director, can help you with

- Platform monitoring and reporting of energy usage across all IBM server platforms within the IT infrastructure
- Measuring and reporting server energy consumption
- Understanding how energy is used within the data center so you can optimize servers and their workloads

The graphical user interface monitors and displays the collected power measurement data for individual servers or the entire rack. It provides analysis of long-term power trends for all servers that have Active Energy Manager. More accurate power-consumption predictions can help you to

- Reduce the infrastructure required for redundancy
- Allow more servers to be installed on smaller power feeds
- Lower overall data center capital and operation costs

Active Energy Manager lends a hand in reducing energy consumption by automatically varying fan speeds based on ambient temperature, turning off unused processor cores and allowing you to set energy usage limits.

Gathering up the data

IBM has partnered with leading data center facility and wireless monitoring vendors to collect data and provide alerts on the status of air conditioning units, uninterruptible power supplies (UPS), power distribution units (PDU), and even legacy systems that don't have energy monitoring sensors. These systems allow you to be aware of issues with electrical power supplies and cooling systems so you can take appropriate actions to avoid service outages.

Performance per watt

Performance per watt is a measure of a computer's energy efficiency. Applying a similar metric to a group of machines from different manufacturers, or a product line from one manufacturer, results in a ranking of energy efficiency.

Power-capping to cut waste

Power-capping refers to the practice of limiting the amount of energy supplied to a server at various times during the server's operation. Power capping is generally implemented in a software management tool that uses policies set by IT to limit power consumption when the server in question isn't being heavily loaded. This practice, in essence, allows managers to trade power for performance.

Computers consume large amounts of electrical power. Essentially, all that power is converted to heat, which must be removed from the equipment in case equipment fails. IBM offers solutions that enable clients to cool just the equipment.

Power for cooling accounts for 65 percent of the energy use in many data centers. The good news is that if you follow best practices, you can reduce that number substantially to as low as 20 percent of the total energy consumed. After virtualization, improved cooling represents the biggest opportunity for IT energy savings.

Improving Cooling

Data centers are paramount to IT operations, running mission-critical operations 24 hours a day. Any changes must be carefully planned. Cooling systems require quite different expertise from traditional IT systems. Many decisions concerning data center cooling require input and approval from other professionals, electricians, HVAC (heating, ventilation, and air conditioning) consultants, and even architects. Electrical and building codes must be followed.

Some ways to improve efficiency are quite simple, such as identifying and sealing air leaks or finding places where cool and warm air mix unnecessarily. Other solutions, such as adding water-cooling aisles, are more complex. Still others are best implemented when new data centers are built.

What Makes Computing Hot?

Sometimes as much as half of the electricity spent in a data center or server room is used to cool the facility, because when equipment gets too hot, it fails. Here's the problem.

Electrical power is fed to the individual integrated circuits that do the computing your business depends on. All that power is eventually converted to heat. Fans speed the heat away from high-power chips, such as CPUs and graphics processors so the chips don't get too hot and fail. The fans can be arranged to blow outside air into the chassis, to suck the heated air out of the enclosure, or both. Fans consume power that also gets converted into heat. The power all those little fans use is often comparable to the power consumed by the chips themselves.

Both in data centers and server rooms, space is always at a premium. Servers and equipment that take up as little rack space as possible help conserve space. However, cramming more power-consuming chips into a smaller space requires more fans to keep the air moving fast enough to dissipate all the heat. Disk drives are also packed into racks, so they, too, need armies of fans to keep them cool.

Everything that happens adds to the heat load that those air conditioners must pull out of the building. Even the people produce heat, averaging some 100 watts each.

The Basics of Cooling Systems

The development of the practical steam engine in the 18th century led to the industrial revolution. But what you may not remember is that it also inspired a revolution in physics: the theory of thermodynamics. The second law of thermodynamics says that the efficiency of a steam engine can never be 100 percent, and the maximum efficiency depends on the difference in temperature between the input steam and the exhaust. The greater the difference, the greater the efficiency.

Air conditioners are essentially steam engines operating in reverse. Rather than use a difference in temperature to create power, they use power to create a difference in temperature. The same second law of thermodynamics governs their efficiency as well, but with a happy twist — air conditioner efficiencies can be greater than 100 percent. In other words, an air conditioner can move more energy in the form of heat than the electrical energy supplied to the unit.

Moving cold air long distances is difficult. In most large building air conditioning systems, the evaporator extracts heat from a flow of water instead of air. The chilled water is pumped to heat exchangers throughout the building, where it cools air in the building's ventilation system.

Here are a few more basic principles to keep in mind:

- Heat flows from hot to cold at a rate proportional to temperature difference.
- Warm air rises.
- Creating cold air or cold water costs money, so if you cool air, use it before it mixes with warm air.

Your cooling system's efficiency

A heat pump can be more than 100 percent efficient. But rather than talk in terms of efficiency, air conditioning engineers use the term *coefficient of performance* (COP), which is the heat change per unit time at the air conditioner output divided by the input power. So, for example, a COP of 3.5 would correspond to an efficiency of 350 percent.

Getting Cool

To improve your power usage effectiveness (PUE) and Data Center infrastructure Efficiency (DCiE), consider these steps:

1. **Assemble a team to review current approaches to data center cooling and to evaluate alternatives.**

   Include data center mangers, the facilities department, and consultants for expertise not available in-house.

2. **Identify vendors with promising approaches.**
3. **Develop a proposal with cost saving estimates, including benefits like reduced carbon.**
4. **Develop an implementation plan that allows changes to be made with minimal disruption.**
5. **Take baseline measurements that allow you to quantify benefits after the changes have been implemented.**

Restyling your aisles

In traditional data centers, equipment racks face in one direction with computer room air conditioners (CRACs) around the perimeter of the room. Air conditioning keeps the air within an acceptable range for the equipment to operate reliably. This process is inefficient because the cold air mixes with hot air from the equipment, and the lukewarm mixture cools the racks. Mixing cold and warm air needlessly wastes energy.

A more efficient arrangement is *cold aisle/hot aisle cooling,* where you arrange the racks holding your servers in alternating cold and hot aisles so that the intake side of the equipment always faces a cold aisle and the exhaust side faces a hot aisle. No cold air is allowed to enter the hot aisle.

The cold aisle/hot aisle approach is most suitable for data centers with enough racks to organize this way, but you can apply the principle to smaller centers by ducting the cold air to a location near the intake side of the equipment racks.

Maintaining the temperature

The power required to cool your data center depends on the temperature you set; the cooler you want it, the more you pay. Many data centers are run cooler than they need to be. This wastes energy and money. Raising the temperature one degree Fahrenheit can save 1.6 percent of the energy bill.

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE, `www.ashrae.org`), in consultation with computer manufacturers, recently lowered its recommendations for data center air temperature and computer room humidity. The new recommendations for maintaining IT equipment safely are as follows:

- **Maximum temperature:** 80.6°F (27°C)
- **Minimum temperature:** 64.4°F (18°C)
- **Maximum relative humidity:** 60 percent
- **Maximum dew point:** 59°F (15°C)
- **Minimum dew point:** 41.9°F (5.5°C)

The new maximum temperature is a big increase over the 2004 maximum, which was 68°F and 55 percent relative humidity. Using the new guidelines can save a lot of energy.

Tips for smaller data centers

Although many organizations have smaller operations, IT often consumes large amounts of energy. Here are some suggestions aimed at smaller data centers:

- Check your air conditioning system's manuals for required maintenance.
- Change air conditioner filters and clean coils regularly.
- Inspect refrigerant piping to ensure that insulation on the cold leg is intact.
- Arrange the CRAC output so it's near server inputs.
- Consider using outside air during the cooler times of year.
- Use waste heat to heat the rest of the building.
- Increase computer room air temperature per ASHRAE 2008 guidelines.
- Shade outside air conditioning units from direct sunlight where feasible.
- If fan motors require periodic lubrication, do this regularly.
- Make sure tower servers aren't shoved up against a wall or other obstacle.

Chapter 5

Green Storage

In This Chapter

- Exploring green storage
- Cutting the fat with thin provisioning and data deduplication
- Backing up more with less

Storage systems are among the most conspicuous consumers of power and cooling. To be usable for data storage, drives must be fully powered and running. Storage manufacturers are working on ways to reduce the amount of power and cooling required by redesigning storage systems and by managing the use of storage capacity more carefully. However, every year "knowledge workers" create more stuff that has to get stored. And now in many places, laws or policies require that every e-mail be kept around in the event that it's required in a lawsuit. The kinds of files getting created are getting bigger too. Video files, for example, take up huge chunks of storage, and their usage in every day business is growing by leaps and bounds.

Successful green strategy goes beyond formal planning and implementation and involves actively managing all the components of the IT infrastructure. Storage management includes capacity planning, regularly scheduled maintenance, backup, failover, and business continuity. Deploying tiered storage, using thin provisioning, storage virtualization, and deduplication can reduce the amount of storage and its growth rate, saving energy and cost.

Exploring Green Storage Gear

For most companies, making storage greener is a progression along a path: Storage systems are retired or redeployed when

their capacity becomes too small to support their intended use or when they become defective. Replacement storage systems have more capacity (because component disks have become larger) and consume less power (because continuing advances in technology make arrays more efficient). Newer systems are more likely to have power management features built into the array, instead of added on after the fact.

RAID Arrays: Necessary but not necessarily green

Redundant Array of Independent Disks (RAID) technology was developed to combat sudden disk failure. Even though most companies also back up data regularly, data recovery can take time and (depending on the method used) may present its own problems. The basic principle behind RAID is to write data simultaneously to two or more hard drives but in a manner transparent to servers and applications. If a drive fails, redundant information on the other drives enables data to be recreated and so avoids an outage. Protecting against failure does have a green cost: more disk drives are used than are required just to store data and so more energy is used. Modern RAID technologies, however, can keep this to a minimum.

Tackling Storage Sprawl

The tendency to dedicate an individual server to a specific application caused servers to proliferate. As more and more servers are deployed, the complexity of attaching storage to servers has been a challenge. Many companies have responded by dedicating storage to individual applications to help simplify the infrastructure. One storage system might be used for e-mail while another is used for a database system. As a consequence, *server sprawl* (the unchecked proliferation of servers) drives *storage sprawl* (the unchecked proliferation of storage) and storage may be used inefficiently since spare capacity on storage dedicated to databases can't be used to satisfy a growing e-mail system. Companies are forced to add capacity for separate applications, contributing to poorly used, but still powered and cooled, sprawling racks of storage devices.

Virtualization helps tame the monster of server sprawl by allowing companies to consolidate applications and run them on a single server simultaneously, eliminating the need for dedicated servers. Storage virtualization provides similar benefits to help tame storage sprawl.

Contributors to storage sprawl

The need for additional storage capacity continues unabated. The appetite for storage is fueled by many factors:

- **Nearly every person in every organization has a PC — and sometimes more than one.** All those PCs create a veritable blizzard of documents of all kinds: e-mails, letters, drawings, spreadsheets, PDF files, and so on. For most companies, these documents comprise the organization's intellectual property and need to be stored in some fashion against the risk of data loss.
- **Many company documents may need to be retained for regulatory reasons.** For example, healthcare agencies are required to retain patient's medical records for a period of time following treatment. Also, stringent guidelines exist about how those records are stored and eventually destroyed. In some government agencies, records of all transactions, including e-mail, must be kept for 15 years. Records of deeds and real estate titles need to be kept indefinitely, and as these records move to digitized formats, cities and towns need more storage capacity. Banks, already the keepers of massive amounts of data, now get to store digital images of every check.
- **Paradoxically, server virtualization creates a greater need for storage.** Virtualization makes it easier to deploy new virtual servers to support growth and new applications. Each virtual server requires storage. As companies adopt server virtualization in their efforts to eliminate servers and build a more dynamic infrastructure, their need for storage capacity increases.

The burgeoning need for storage is great for companies that sell storage, but not so good for corporate budgets, power consumption, or the planet in general. Storage sprawl leads to increased power and cooling consumption.

Minimizing storage sprawl

To minimize the unchecked proliferation of storage, establish a formal storage plan that takes into account current and new application requirements, the number of users, the number of branch offices — in short, a current picture of your storage infrastructure. After you create a snapshot of your storage infrastructure, determine whether these strategies can help you green your storage system:

- **Understand how you're using storage today.** Before you make changes to improve the energy efficiency of your storage, it's important to know how you're using storage today. Then you can proceed in the most cost-efficient manner. Surprisingly, many companies don't have a clear idea of how much storage they have or how well utilized it is.

  IBM Global Technology Services performs a study powered by IBM Novus Storage Enterprise Resource Planner (SERP) software to help users understand what storage they have, where it is located, how well it is being used, and what business units are using that storage. Armed with this information and more, you can make informed decisions and improve energy efficiency.

- **Use existing storage capacity better before adding more storage.** Many companies are surprised to find that they may be using only 50 percent or less of their storage to store data. This poor utilization drives up costs and wastes energy since the unused storage still consumes power. Methods of maximizing your existing storage capacity are covered in this chapter. One example is IBM Tivoli Storage Productivity Center. It allows you to monitor your use of storage and also improve storage provisioning and planning.

- **Buy storage you need for the coming year only.** A formal storage plan together with understanding your storage use should give you guidance about what capacity you need now and what capacity you need a year from now. Buying storage too far in advance commits financial resources early and consumes more energy. Newer technologies inevitably will be better or cheaper or both, and with the focus shifting on making technology more environmentally friendly, using the most recent advances makes good sense.

- **Use storage management tools to help manage how storage is allocated and deallocated.** Many storage manufacturers provide software that helps manage storage. These software tools range from simple wizards to migrate data from an old disk to a new one, to very sophisticated tools that manage how applications use available storage capacity. A mid-priced storage array ($25,000) may have software functions that allow thin provisioning, data deduplication, and overall monitoring of the health and status of the component disks that comprise it.

  Storage management software such as IBM Tivoli Storage Productivity Center provides sophisticated capabilities such as understanding how storage is being used and end-to-end monitoring and management of the storage area network (SAN). The goal remains the same: to increase the efficiency and utilization of storage capacity. These actions cut infrastructure costs, slow the speed at which new capacity needs to be added, and contribute to building greener infrastructure.

- **Consider implementing tiered storage architecture.** In an attempt to simplify storage, some companies deploy just one type of storage — usually enterprise-class storage — for all their requirements. In contrast, a tiered storage approach recognizes that not all data has the same requirements and so uses different types of storage with different cost, performance, and energy use characteristics for different types of data. This approach can markedly reduce cost and energy use. Storage virtualization can make tiered storage easy to implement.

- **Consider consolidating storage systems.** Some companies still use the hard drives inside their servers or storage dedicated to servers, also known as direct attached storage (DAS), as their basic "unit" of storage. DAS storage is more difficult to manage and share among servers than storage attached to a network. DAS may also limit server virtualization strategies because it isn't shared. Network attached storage (NAS) and storage area networks (SAN) are easier to manage than DAS because they're designed to be shared, as well as to be directly accessible and managed from the network.

Data Deduplication

Deduplication is a computer industry term for "removing the duplicates," and, as this strange word implies, it's a process that examines a hard drive or storage system to find and remove duplicate files — effectively reducing the amount of storage required for a given set of data. The "reclaimed" storage is then available for additional data. The net effect of deduplication is to increase available capacity and perhaps forestall the need to buy additional capacity. It's clearly a good green measure to take.

Here's a simple example of how deduplication works. Say you send an e-mail to a customer and to several coworkers, about a delivery that needs to be rescheduled. The customer replies to all the people on the original e-mail and includes the text of your original message. After several rounds of e-mail discussion, your message has to grown to ten pages, as have the copies that went to each recipient. Consider the number of e-mails you receive and reply to every day; then, multiply *that* number by the number of employees in your organization.

E-mail quickly adds up to a great deal of data, all of which passes through (and is stored on) your company's mail server. Don't forget about your calendar appointments, slide presentations, documents, and so on — most of which get sent to several people.

All these individual e-mail events don't need to be stored — in fact, even your original e-mail isn't needed. Only one complete version of the chain of responses and attachments needs to be preserved. Deduplication removes all the unnecessary duplicates and thus reclaims the space formerly occupied by duplicates.

Two products that may be of assistance to you include the following:

- The IBM System Storage TS7650 ProtecTIER Deduplication Appliance is a preconfigured solution of IBM storage, IBM server, and IBM's ProtecTIER data deduplication software designed to improve backup and recovery operations.

- IBM N series systems with Advanced Single-Instance Storage (A-SIS) help provide a data deduplication solution primarily intended for archives and other longer-term retention purposes.

Thin Provisioning

Thin provisioning — allocating just the right amount of storage as you need it — helps eliminate unused capacity. By allocating storage as it's needed and using storage management software to adjust it, all the storage available can be consumed as it's needed. To properly allocate or provision storage capacity for an application, storage management software uses each application's storage requirements to configure the correct amount of storage capacity.

The benefits of thin provisioning are twofold:

- Storage is "dynamically" allocated — it can grow or shrink according to application requirements.
- Storage management software can monitor many applications simultaneously and provision the unused capacity for them all as needed.

Some applications require a certain amount of storage to be reserved, or allocated, when the application is installed. So, how does thin provisioning contribute to green? By helping to increase the overall utilization of storage systems, thin provisioning can forestall the need to add capacity, which means fewer storage disks, less power consumption, less cooling, and less data center capacity.

How thin provisioning works

To understand how thin provisioning works, consider a database application, which typically requires storage to be allocated for tables and indices. How much is allocated is based on an estimation of how many records will eventually be stored in the database. Here are some of the factors:

- Every record has overhead, which means that it requires a certain amount of storage space based on the number of fields in the record.

- Each table, index, form, and so on requires an amount of storage based on the record's overhead.
- Creating an empty database, one with no records in it yet, also requires some space.

Add to this, space for the database application itself. When you start writing records to the database, storage gets used up quickly. Most administrators allocate as much storage as they can during installation. The problem is that it wastes storage space. Unused, allocated space can't be used for anything else.

Thin provisioning functionality can be found in some disk systems, such as the IBM XIV Storage System. XIV is a next-generation high-end open disk storage system, part of a broad spectrum of IBM system storage and SAN offerings. The XIV Storage System is an enterprise disk system architected from the ground up to meet today's information infrastructure challenges. It offers built-in high-performance, space saving functions such as snapshot and thin provisioning. These XIV functions can help reduce direct and indirect costs by allowing users to install capacity only for data actually written, and gradually grow it over time with minimal management effort.

The IBM System Storage SAN Volume Controller (SVC) storage virtualization system provides thin provisioning and other capabilities to all storage that it is managing. In this way, SVC can help improve utilization of existing storage systems that don't have their own thin provisioning function.

Thin provisioning for storage

To use thin provisioning, start by following these steps:

1. **Identify all the applications used in the company.**
2. **Determine how much storage is allocated to the application).**
3. **Use the thin provisioning management software to reallocate storage capacity from the available pool of storage dynamically.**

After you compile a list of the applications that use the most storage, enter these requirements into thin provisioning software to allocate storage for each application. You can use a storage area network (SAN) because it's ideal for thin provisioning. It's literally a network (or pool) of storage that can be assigned to applications by a storage management software. A SAN may consist of a single array of drives in a compact enclosure, or it may be composed of many individual storage systems that are managed as though they were one system, even extending over the Internet.

Thin provisioning depends on managing capacity dynamically in response to application demands. Because a SAN is a storage system whose capacity is managed similarly, thin provisioning is often part of a SAN storage manager.

Storage Virtualization

Many companies have deployed server virtualization to improve the efficiency of their server environments. Multiple workloads from different servers are consolidated onto fewer, more powerful servers that are much better utilized. As a result, infrastructure is simplified and energy consumption is slashed.

Storage virtualization is the ideal complement to a server virtualization strategy. Storage virtualization pools together available capacity from multiple storage systems and so creates the effect of consolidation without requiring a change in storage hardware. This "virtual consolidation" enables capacity in different storage systems to be shared and so helps avoid "trapped capacity" that is available but cannot be used by an application.

Storage virtualization hides the boundaries between disk systems so storage becomes a resource available to meet business requirements. This approach simplifies management and capacity planning and enables administrators to focus more on business priorities.

Using these capabilities, companies deploying storage virtualization have seen improvements in storage utilization

of up to 30 percent and reductions in storage growth of as much as 20 percent. These improvements translate directly into reduced costs for storage acquisitions and a greener data center from less storage capacity being required.

IBM is a leader in storage virtualization technologies. IBM System Storage SAN Volume Controller and SAN Volume Controller Entry Edition provide enterprise-class storage virtualization capabilities in a highly-scalable, high availability clustered system.

Looking at the Basics of Tape

Tape is the de facto technology used to protect and archive data. Tape backup is a key part of the data lifecycle, protecting data on disk and later archiving it for disaster recovery and record-keeping policies. Here are some reasons organizations continue to use tape:

- Tape is relatively inexpensive.
- Tape is the greenest storage available. Tape data consumes power only when it is accessed, which is usually rarely.
- Most companies already have an investment in tape.

Tape is important in high-capacity backup storage. Users can manage storage requirements through tape's unique attributes:

- **Removable:** Store it away to help protect it from viruses, sabotage, and other corruption
- **Scalable:** Add more cartridges, not drives
- **Portable:** Move it to another site to avoid destruction in the event the first site suffers threat or damage
- **Fast:** Up to 160 megabits per second for IBM's System Storage TS1130 Tape Drive
- **Reliable:** IBM servo technology, read after write verification, and advanced error correction systems, help provide reliable and dependable storage

Tape can help address security and compliance requirements with encryption and WORM technologies and costs up to 10 times less than disk.

Chapter 6

Using Virtualization

In This Chapter

- Understanding virtualization
- Building a virtual infrastructure
- Replacing physical servers with virtual servers

Originally most computers came with only one operating system on which to run applications. Through the magic of virtualization, computers use virtual memory technology to run multiple operating systems or applications at the same time. Virtualization originated on IBM mainframe systems in the 1970s, and the IBM System z continues to offer one of the most advanced virtualization architectures. Now IBM Power Systems, System x, and BladeCenter servers all leverage mainframe virtualization strengths.

Virtualization is highly popular for many reasons, primarily because it's a great way to increase the use of any computer. Companies get more bang for their technology buck, which is always a happy result.

Virtualization increases utilization by consolidating applications onto fewer servers, thereby reducing the number of servers needed. This in turn reduces the data center's power consumption and cooling requirements, making virtualization one of the easiest, quickest ways to get a greener data center.

Understanding Virtualization

Believe it or not, the idea behind virtualization dates back to the 1960s. Early mainframe computers had very little random access memory (RAM) in which to run *programs,* the series of

instructions that tell the computer which tasks to perform — what we now call *applications.* Computer designers came up with the idea of tricking the mainframe into thinking it had more memory than was actually present on the machine. They did this by moving parts of a program into a special file on the computer's disk — a process known as *swapping.* When a computer needed some part of a program that was stored on disk, that part was loaded from disk into memory just as though it was always there. Think of someone juggling bowling pins and you've got a good image of what the computer was doing.

That special file on disk is a *swap file* and is still used in computers today, except that operating systems, such as Windows, Mac OS X, Linux, AIX and z/OS manage the swapping process as a matter of course.

This rather simple scheme became known as *virtual memory* because the amount of memory available for applications to use was limited only by the size of the disk (rather than the amount of actual memory) — meaning that it was essentially unlimited.

Although virtualization has been around a long time, it's now integral to computing and a pillar of Green IT. Virtualization means higher utilization of the equipment you have, which translates into needing less stuff, which in turn translates into less energy and fewer materials that need to be manufactured, less energy consumed in running said stuff, and less stuff to dispose of when you need to upgrade your IT equipment.

Virtual memory became virtualization

Original IBM personal computers had very little RAM and no hard drive, and by today's standards, ran very slowly. As computer technology evolved through the 1980s and 1990s, computer chips became faster, memory became increasingly less expensive, and hard drives became indispensible for storing applications that we use all the time.

In 1999, VMware took the idea of virtual memory one step further and applied it to the PC architecture. VMware's initial product, VMware Workstation, focused on the desktop

computer and was rapidly adopted by software developers who wanted to run more than one operating system, such as Windows and Linux, on one machine.

Some applications, such as e-mail, database, and Web servers, typically require all the resources of the server on which they run in order to provide the best performance for multiple users. VMware's product runs not only multiple operating systems but also multiple applications; it put each application in its own virtual machine. A separate program — a *hypervisor* — manages the virtual machines and connects them to underlying computer resources.

IT quickly saw the value of running multiple applications on a single server and started using the Workstation product on servers. Servers that deliver critical business applications — *production servers* — run continuously under heavy use and require industrial-strength operating systems and applications that are optimized for server use. VMware saw the need and developed VMware Server, and more recently, VMware ESX.

The number of virtual machines that can run on one computer is dependent on the computer's resources. The performance of the applications running on the virtual machines is subject to these limitations. They may experience slower than expected performance or the inability to support additional users.

IBM is one of the earliest and most effective suppliers of x86 server virtualization. VMware is the largest supplier of windows-based virtualization today, but at least 25 different companies supply some kind of virtualization in software or as part of hardware devices such as storage appliances.

Why is virtualization green?

Virtualization is one of the easiest paths to green, because when you run more than one application on a server — *application consolidation* — you reduce the number of servers required to support these applications. The reduction in the number of physical servers is *server consolidation.* Fewer servers mean less power consumption and a lower energy requirement for cooling the servers. In a data center, having fewer servers translates to less rack space and thus a smaller footprint for the data center or server room.

Virtualizing your IT infrastructure allows you to adjust your server capacity to your actual needs. Server demands constantly change. With normal peeks and valleys of usage from varying workloads, virtualization allows you to balance usage across all virtualized servers for higher utilization rates. The result is you need fewer servers, and the servers operate more efficiently. Replacing physical servers with virtual servers also reduces the burden of server administration — the attention servers and applications need for maximum performance.

Three kinds of virtualization

Server virtualization is one of the quickest paths to green savings, but you can also apply virtualization to other areas of the IT infrastructure, namely storage and desktops, as follows:

- **Virtual storage:** This type of virtualization differs from server virtualization in that individual storage systems, storage area networks (SANs), or even direct-attached storage (DAS), are *pooled* so that it appears to applications as though all the storage is one large disk. Storage virtualization is often considered to be an essential part of a server virtualization strategy; but storage virtualization works equally well with physical servers as it does with virtual servers.

  The IBM System Storage SAN Volume Controller (SVC) Entry Edition delivers enterprise-class storage virtualization, optimized to meet the needs of mid-sized businesses. It helps simplify management of storage infrastructure and provides a single easy-to-use point of control even as storage needs grow.

- **Desktop virtualization:** End users can take advantage of virtualization by remotely accessing their own computer's resources and applications (their *desktop*), as well as applications, such as word processing, spreadsheet, e-mail, or calendar. Virtualization can even replace the traditional desktop computer with a smaller, less power-hungry device. Desktop virtualization can also be used to extend the life of older equipment. IBM's desktop virtualization solution, IBM Smart Business Desktop Cloud, provides "anytime, anywhere" access to

applications, information and resources. It acts as a "connection broker," seamlessly connecting end user devices with centrally managed applications.

- **Application infrastructure virtualization:** Virtualizing application infrastructure can save energy because it allows applications to be separated from the physical infrastructure on which they run. In a virtualized application infrastructure, you can dynamically allocate or migrate application workloads across a pool of server resources in response to business needs. IBM's Websphere Virtual Enterprise helps companies to increase flexibility and agility to ensure business process integrity, improve service and application performance, and better manage applications.

Building a Virtual Infrastructure

Building a virtual infrastructure, one in which servers, storage, and maybe even desktops use some form of virtual technology to provide services, is surprisingly easy. As with any IT strategy, building a virtual infrastructure requires

- **A thorough understanding of the current infrastructure's architecture:** What applications run on which servers, end user usage patterns, and so on
- **A formal plan to implement virtualization:** Including costs and benefits, a plan to test virtual servers before putting them in production, and making sure that staff is trained to implement and maintain the infrastructure

Application requirements

The first step in building a virtual infrastructure is knowing which applications run on which servers. You must understand every application's requirements for memory and disk usage.

For example, database applications are highly transactional — they read and write records almost constantly. Applications like these require the fastest server and the fastest, most available storage for maximum performance.

Contrast a database application's profile with a server that supports file storage and printing. These servers experience bursts of activity followed by periods of inactivity. Although high performance is nice, it isn't critical to the server's tasks.

Identifying underused servers

Servers that are only lightly used are another likely target for application consolidation. Some applications require that storage space be allocated in advance — for example, a database might require a *minimum* of 25 gigabytes of disk space to hold its tables and indices. Wise administrators know that after an application is installed and configured, it becomes exponentially harder to reallocate more space, so rather than allocate the minimum amount of storage, administrators often allocate 10 times more space than the minimum — 250 gigabytes, perhaps the entire disk.

If this database is the only application running on the server — typical for a database application — it's likely that the server's storage is underutilized. Because this storage was allocated ahead of time, this wasted capacity means that the server can't be used for any other purpose. These servers become good candidates for virtualization because the virtual machine's resources can be dynamically allocated to allow for increasing application requirements.

Building virtual machines on target servers

This part is probably the easiest of the process. In fact, the process is so easy that administrators have been known to put too many virtual machines on a server, causing virtual server sprawl.

Examples include VMware, which provides installation wizards that make building a virtual machine a nearly foolproof process and PowerVM, which provides industrial strength virtualization technologies for AIX, i, and Linux operating systems on IBM Power Systems. PowerVM virtualizes processor and I/O resources for client partitions enabling increased asset utilization, enhanced infrastructure flexibility and reduced costs.

In most cases, the administrator needs to supply only information about what resources the application requires for installation and operation — the same information the administrator supplies for installation on a physical server. This information includes

- **The amount of "memory" required:** Memory in this case really means the amount of drive space (virtual memory) to allocate to the application.
- **The type of network connection:** The administrator needs to determine if the application needs to use the underlying computer's network or can instead use a virtual network connection provided by the virtualization software manager.

After the virtual manager has this information, it builds a virtual machine of the correct size, optimized for the operating system and the application. This virtual container is empty at first, waiting for the administrator to perform these steps:

1. **Install the operating system (for example, Windows XP or Linux) on which the application will run.**
2. **Install the application itself onto the newly installed operating system.**
3. **Restart the virtual machine — which is equivalent to rebooting a physical server.**

That's it. The virtualized application behaves exactly as it would on a physical server.

Testing virtualized applications

An IT best practice is to test a new application on a physical server before placing it into production, and you should treat virtual applications exactly the same way. Because substantial differences exist among virtualization products, operating systems, applications, and so on, here are some of the steps involved:

- **Testing the application's performance under *load:*** Allowing some users to access and use the application to make sure it meets expectations

- **Tuning the application:** Adjusting the application to optimize its performance under use
- **Tuning the virtual machine:** Supporting the application

After the virtual server's test results meet the required performance goals, you can place it into regular service. Remember that end users should see the same performance whether they're accessing a virtual application or an application running on a physical server.

Replacing physical servers with virtual servers

The process of replacing physical servers with virtual servers includes the process of building a virtual server and making some decisions on the greenest way to deal with the servers you replace. We cover both these topics in this section.

Here are the basic steps to replacing a physical server:

1. **Configure virtual machines for the applications that will be installed on the host or target physical server.**
2. **Test the virtual server to make sure that it supports the applications installed on it and that the performance meets expectations under real operating conditions.**
3. **Place the virtual server into production use.**
4. **Retire or repurpose the physical server or servers that the virtual server has replaced.**

Virtual Disaster Recovery

Virtualization has affected both the cost of disaster recovery systems and the way in which backup and recovery are performed. Applications running on virtual servers each run on their own virtual machine. Virtualization software is usually capable of taking a *snapshot,* or *image,* of a virtual machine's current state, just as you'd take a picture of a tree. In the case of the virtual server, the snapshot contains the application and its current data.

This image of a virtual machine has some unusual properties:

- It can be copied or moved.
- The image can be restored to the same or a different virtual server.
- If the image is captured in the right way, it can be restored to any computer, using a *bare metal recovery (BMR)* process.
- You can transfer the image to a remote location, such as a branch office.
- With the right software, virtual machine images can be captured automatically at preset intervals.

  This capability — *continuous data protection (CDP)* — is very useful for protecting applications with a large transactional volume, but a large chunk of drive space is needed for each snapshot.

Green and financial benefits

Taking snapshots of virtual servers is a function of the virtualization software, not the underlying computer. This means it can substantially reduce the cost of building a disaster recovery infrastructure. In fact, disaster recovery is one of the main reasons companies build a virtual infrastructure, after server and application consolidation.

Is a virtualized disaster recovery infrastructure greener than a physical recovery infrastructure? The answer is it depends. If you're incorporating disaster recovery into an existing server and thus replacing a physical server, the answer is yes. Otherwise, the net effect of using virtualization to green your disaster recovery may be neutral. If nothing else, it'll most likely be less expensive to acquire and maintain than a traditional recovery infrastructure.

Replacing physical tape with virtual tape

Physical tape has been the backup medium of choice for decades. Unfortunately, physical tape has some characteristics that can make it undependable, such as incompatibilities between different types of tapes and tape readers. The physical tape itself can degrade over time, rendering it

difficult or impossible to read. Of course, physical tape can be considered an inherently green solution because after a tape is put in the library, it doesn't consume any power. The tape drive doesn't consume any power either, unless it's in use.

Virtual tape technology allows a specially formatted hard disk to emulate a tape drive. The emulation is accomplished by software and drivers that allow traditional backup software to use the same commands and protocols to write to virtual tape as does physical tape. Virtual tape provides an alternative to traditional tape with few of tape's drawbacks. Some significant advantages of virtual tape include

- Virtual tape won't run out of capacity.
- A virtual tape can be scanned for duplicate files or records and removed.
- Virtual tapes aren't susceptible to physical defects, although they are prey to problems that affect hard drives, such as bad sectors and so on.
- Virtual tape is easy to duplicate — simply perform a disk-to-disk copy.
- Virtual tape doesn't require a special, temperature-controlled environment.

Dynamic Infrastructures and Image Management

As virtualization continues to grow, dynamic infrastructures are demonstrating increasing customer value. The emergence of cloud computing is the embodiment of these dynamic infrastructures and has clear advantages over older "static" models; however, it has brought some new challenges especially in the management of a vast number of server images.

As a result, a new and growing area emerged called Image Management. Very simply, image management is the set of capabilities required to manage the lifecycle of server images, for both physical images and virtual images. IBM and other vendors will continue to address this need with new products and solutions.

Chapter 7

Collaborating for a Greener World

In This Chapter

- Capitalizing on collaboration
- Telecommuting with panache
- Networking for profit and fun

The Internet has changed the world in countless ways, not the least of which is how and where you work. This network of networks (and the applications now available on it) has freed both organizations and individuals from the ties of any specific work location. That freedom carries with it some profoundly green consequences, including not polluting by commuting and reducing the need for physical media. The Internet is a big enabler of collaboration.

Collaboration covers all the ways that folks work together to create, understand, and accomplish much more than any individual can do alone. Teams inside organizations collaborate whether their teammates sit next to them or in another country. Organizations collaborate to define new standards and share best practices. Companies collaborate to leverage special skills, such as artistic design and translation, to buy supplies, or to sell and distribute products.

Ever-ready E-mail

You may take it for granted, but e-mail was one of the first collaborative technologies to take root. Not everyone use to have e-mail, but it's now the communication mechanism of choice and is mission-critical to most organizations everywhere.

And when you think of the paper and postage saved by using e-mail instead of snail mail or the courier charges and physical media costs avoided by sending files electronically, you know that e-mail has a very green upside.

Here are common business communications done by e-mail that are harder, less efficient, and costlier to do other ways:

- Sending files and messages to more than one person at the same time
- Keeping complete records of the files and messages sent and received
- Sharing the information received with other people
- Carrying on conversations with people *asynchronously* — conversations that span time zones, days, weeks, and months and include as many that want to participate

If folks have access to the Internet, they have access to e-mail, which is a great place to start collaboration.

Most think of e-mail as basically free — it costs next to nothing to send, and sending something to 20 people is no costlier than sending it to one. However, we want to alert you to greener e-mail usage. Here are some things to consider sharing with the e-mail users in your company:

- **Don't print hard copies** of your e-mail messages unless you really, truly need to.
- **Delete e-mail** you don't need and aren't required to keep (by organizational policy or by law). E-mail you keep is archived, and e-mail archives take up constantly growing, digital storage space somewhere — typically, on a disk that, by design, consumes power.

  Keeping less e-mail means that less storage is needed to back up your e-mail and, ultimately, less power is being consumed. Because the amount of information that businesses store can double every 18 to 24 months, do your best to get rid of what you don't need. Here are specific ideas to help you decide what you don't need:

  - When replying to or forwarding e-mail, delete whatever is no longer necessary to the conversation. Remember that most e-mail is being archived. The less you send, the less has to be stored, the less

storage space is needed, and the less power is needed to support it.

- Clean out your often forgotten Sent folder. Delete everything you're not required to keep or won't need.
- Offload old e-mail onto media that's not always on. You may want to keep some messages just in case, but you don't need countless copies and you don't necessarily need them on your computer. Storing to a flash drive, CD, DVD, or other device that isn't always powered on makes a lot of sense.

Sending attachments to a large number of people translates to a large number of copies of the same attachment getting archived and increasing storage demand. Not everyone you send to necessarily wants or needs to see all your attachments, so basically you're doing the equivalent of making a lot of extra paper copies and handing them out whether folks want them or not. You know that extra paper copies are wasteful — extra electronic copies are wasteful, too.

Web Conferencing

Organizations use a host of online conferencing platforms to guide their listeners through PowerPoint presentations, show product demonstrations, and use a virtual whiteboard to brainstorm ideas across the ether. All these tools can be very helpful and are critical in environments that have truly embraced remote employees' full inclusion and enablement.

IBM Web Conferencing helps leverage the Web to minimize the need for travel and to enrich what would otherwise be just an ordinary phone conversation.

Unified Communications

Unifying voice, video, and data transfer is sometimes called *unified communications* (UCC) and refers to moving all the methods of traditional communications to integrated digital communications that are managed together. For some businesses, this integration is a real competitive advantage; for others, it might not be so imperative. For example, a

company that does a lot of video conferencing and voice communications may find that unifying communications saves loads of time and money by bringing the management of these separate systems to one "unified" view.

Integrating communication and collaboration in a rich multi-media experience allows you to reuse IT and telephony equipment, reducing waste and disposal of what otherwise would be considered out dated assets.

Green Document Management

Most teams that collaborate to create business documents — reports, presentations, budgets, and so on — understand that they need some sort of central repository for storing these documents as well as some system for managing versions. But document management systems can obviate the need for paper storage while enabling team members from across the hall (or across the planet) to collaborate without undue cost or constraint.

IBM Lotus Quickr provides efficient document sharing that can help people share information in new ways. For example, by sharing links instead of sending e-mail attachments you can reduce storage requirements. Centralizing document access electronically reduces paper consumption and makes the space-hogging file cabinet a thing of the past.

Collaborating in the Cloud

Cloud computing — computing done in a remote, perhaps hosted environment — is IT being done for you outside your physical environment. Benefits of cloud computing include not actually purchasing equipment, not paying to power, cool and store equipment, and replacing and disposing of physical equipment. When it comes to collaboration, here are some things you can do in the cloud:

- Storage
- Document processing
- E-mail

- Web conferencing
- Super-duper, high-end–processing

IBM offers a host, pardon the expression, of applications in the cloud. LotusLive is a cloud-based portfolio of social networking and collaboration services designed for business. LotusLive.com is now the place to find all of Lotus' cloud solutions including e-mail, collaboration and Web conferencing services. LotusLive is built using open Web-based standards and an open business model allowing it to easily integrate with third party applications. Lotus' "Click to Cloud" seamlessly links on-premise solutions with LotusLive services. Find out more about the LotusLive portfolio at `www.lotuslive.com`.

Discovering Telework

Before diving off into telework for everyone, learn, plan, create policy, and educate everyone about the opportunities, responsibilities, and expectations around telework. The U.S. federal government has put together guidelines for federal agencies that you may find helpful. At `www.telework.gov`, you can find help for how to manage teleworkers and how to be a teleworker. You also find policies and procedures that may or may not be right for your organization, but at least give you a place to start.

Organizations that go beyond sanctioning telecommuting to enthusiastically embracing it understand that in order for workers to be highly productive, they need appropriate tools. Remote workers also need to be actively engaged and feel part of the whole — not like folks relegated to the sidelines. This section covers some tricks of the trade.

Staying connected

Remote employees must be *full* employees in every sense of the word — that you enable their full participation. Create appropriate e-mail distribution lists so everyone's kept in the loop and provide all the access to communications needed to be highly productive from a remote site.

IBM Lotus Sametime

IBM Lotus Sametime instant messaging (IM) reduces the need for sending e-mail (eliminating the need to store and archive e-mail, thereby saving money and energy).

Fully equipping the remote employee

Make sure remote employees have all the productivity tools (hardware and software) they need to do their jobs and that these tools all work over their Internet connections. If your culture embraces instant messaging, Webcams, and other collaboration tools, ensure that all your remote users are fully trained in their use.

Making meetings count

If you call a meeting or participate in a meeting, make sure the meeting stays on track, is punctual, and succinct. As well as everyone's valuable time you're spending, you're likely racking up minutes on your conference call account or hogging bandwidth that may be better used elsewhere.

Check out John Cleese's training videos on how to better run meetings: `www.videomedia.net/catalogjohncleese.html`.

Making good use of office space

Larger organizations make hay from telecommuting by capitalizing on the diminishing demand for office space, which can translate into a huge decrease in operational costs. Effective teleworking programs help organizations avoid costly build-outs or new construction, and over time, prove to palpably reduce costs.

Because employees do occasionally come into the office — we hear "every couple weeks or so, for a day" — organizations do

need space for folks to use on those days. And those spaces must enable the telecommuters to be highly productive when they're not in the meetings they came in to attend. People who are accustomed to working at home complain that coming into the office is a time waster — they often have a hard time making good use of commuting time, and they're much less effective in the office than they are at home.

These tools and practices seem to help:

- **Have phones that go where you go.** Current technologies go beyond simple call forwarding. Making the phone next to you your phone means that when you dial out, you're dialing from your phone. Your credentials appear on the caller ID regardless of whether you're in Tulsa or Taiwan.
- **Know where you can hang your hat.** Some organizations have assigned offices for remote workers but astutely share offices between at least two, the idea being that if each is only in the office every couple weeks, there won't be a lot of conflict over the space. Others have designated areas with plenty of open office space that's unassigned and available for anyone who needs a place to work on a given day. However you arrange the workspace for remote employees, make sure that it's ready to go with a working phone, electrical outlets, and Internet connectivity.
- **Optimize for greener practices.** Newer collaboration tools put more focus on using less energy and disk space. New IBM Lotus Domino and IBM Lotus Notes require less hardware and, in turn, use less energy. The software developers did a lot of work to make these products more efficient. They put a big focus on data compression, which reduces the amount of disk storage needed, the network traffic produced, the backup costs incurred, and the actual physical space (with its attendant facilities costs) needed for data storage.

Green Social Networking

Social networking allows folks to get to know each other and get together *virtually* — without physically traveling to do so. IBM has announced partnerships with major organizations that provide key social networking sites and platforms. These partnerships will deliver integrated collaborative solutions to more than 400 million people worldwide.

LinkedIn

LinkedIn, an online network of more than 34 million business professionals, will work with IBM to connect the LinkedIn network with LotusLive. LotusLive users will be able to search LinkedIn's public professional network and instantly collaborate with using LotusLive services.

Salesforce.com

Salesforce.com is integrating LotusLive services within its CRM solutions, helping to simplify and improve customer interactions. Businesses will be able to extend the customer and opportunity management work done in Salesforce with the collaborative capability of LotusLive.

Skype

Skype integrates its voice and video with LotusLive to create a seamless communications experience.

Telecommuting stars

Many of the IBMers we've met over the last several years work from home full-time. The 42 percent of the nearly 400,000 employees who don't regularly come into an office saves IBM $100,000,000 in real-estate costs every year. They go to real, live, physical (as opposed to virtual) conferences — which is how we can attest to their actual existence — but do their day-to-day work from home. In 2006, in the United States, IBM's work-at-home program, which leverages IBM's collaboration tools, conserved more than eight million gallons of fuel and avoided more than 68,000 tons of CO_2 emissions. By using collaboration, last year IBM was able to save $97 million in travel costs. In addition to the full-time, work-at-home program, IBM has a mobile employee program that enables employees to work from home a designated number of days each week. IBM claims another $16.5 million in cost savings from using instant messaging instead of the phone. And using voice communications over the Internet (technically known as Voice over Internet Protocol, or VoIP) can dramatically reduce phone usage charges as well.

Chapter 8

Going Paperless

In This Chapter

- Digitizing documents
- Bettering your printing habits
- Choosing greener printers and supplies

One huge advantage of the electronic age is that technology can enable, expedite, and make more efficient the processes on which organizations rely. Just as alternative, more sustainable energy is considered, you can replace cumbersome, manual paper-based processes with connected, reusable, easily-enhanced automated processes that rely on digital data.

Going Digital

Look around you. Chances are, the longer you've been in business, the more paper you have stored, the more manual your processes, the more paper and ink you use — unless you've made a conscientious effort to change not only your business processes but also the thinking endemic to your culture. Chances are, you're better off making that effort.

Paper documents are time-consuming and costly to create, process, distribute, file, store, retrieve, reproduce, and dispose of. But why focus just on paper's cons? The positives of digital documents may help you win the minds and hearts of people in your organization. And the benefits of digital documents outweigh the benefits of print in many cases. Consider the following:

- **You can search digital documents electronically.**

- **Digital documents are much more portable.**
- **Audio, graphic, and video counts as digital, too.**
- **A non-paper method not only reduces paper but almost inevitably improves the process itself.**

  For example:

  - When you fill out a form, chances are someone else has to interpret your handwriting and enter it into a computer for you. However, if you register for something online, your registration is fed directly into a database without requiring an additional person to key it in.
  - Service requisition done online allows for easy tracking and response through e-mail — no more physical requests.

When processes change, IT is the critical enabler. Look for ways to cut costs and reduce time by eliminating paper processes throughout the organization. One study at a large commercial bank found a potential return on investment of over $36 million by just using the digital documents rather than printing them to paper. And this was in just six bank departments.

Putting the E in forms

Eliminating paper by turning your paper-based processes into electronic processes greatly facilitates everything from sourcing and procurement, to benefits enablement, to provisioning access and equipment, to bill paying, payroll, expense accounting — you name it.

Electronic forms reduce the costs and waste associated with creating, managing, storing, and disposing of paper forms. E-forms help automate human interaction with processes, reducing the costs and waste associated with common process bottlenecks. E-forms streamline business process automation and leverage existing IT systems, helping to reduce operational costs and paper consumption.

Form creation itself is insufficient, however. You need to actually do the work to understand the business processes

these forms support. *Business process optimization (BPO)* can be very, very green.

For example, processing a college application that's done by paper forms involves creating the original paper form itself and making many copies along the way. Often various forms including letters of recommendation, transcripts, and essays have to be copied to create packets of information that have to be reviewed by many parties.

Consider the same process the e-form way. The applicant fills out the e-form and subsequent copies are all electronic — no paper printed, copied, mailed, and filed. The admissions clerk can easily group and forward e-forms to all necessary reviewers. Personal student information, such as name, address, phone number, social security number, and names and contact information for parents, can all become part of the applicant's record automatically. If the student is accepted and matriculates, all this information can become part of the student's record without filling out new forms. All those important mailings will use information from that original e-form, all with entry done only once by the applicant at the beginning of the process.

IBM Lotus Forms Turbo is part of IBM's Lotus Forms family of products, targeted specifically for non-technical users that need to create simple eForms quickly. IBM Lotus Forms Turbo is easy and quick to deploy, requires no training and is designed to help customers address basic form requirements such as surveys, applications, feedback, orders, request for submission, and more — without involvement from the IT department.

Signing with digital signatures

A big hold-out in the paper-clinging world is the world of contracts. "We need a signature" is the mantra of the legal eagles tasked with safeguarding the organization's interests. Electronic signatures are our answer. Contracts can be exchanged with very high assurance that the sender who digitally signs and sends the documents is actually the person he says he is. What "proof" have you that that signature coming over the fax belongs to the person you spoke with on the phone or that the person you spoke to on the phone is the person they told you they were?

Slimming with scanning

Just how many filing cabinets does your organization use? Are there more on order? Whether they're full of sales contracts, patient medical records, architectural drawings, x-rays, or marketing collateral, chances are you could go a long way to cut the filing, storage, retrieval, and distribution costs by going digital. Libraries figured this out a long time ago when they started reducing stacks of newspapers to microfiche.

Depending on the legislation that applies to your stored data, you might find electronic systems makes economic as well as environmental sense sooner rather than later. You may find that scanning old paper documents and storing them

- Electronically frees up high-priced office space
- Simultaneously provides better protection and retrieval

Scanning documents is no one's idea of a good time but you may be helping both your organization's economy as well as your local economy by employing some folks who need the work. Of course, capturing and working with the original "born digital" document is even more efficient and also provides all the indexing and retrieval metadata you might need without having to scan paper.

Changing Printing Habits

Too many folks print first, and ask questions later. Help people change their printing habits. Making printing less a part of daily life may take some time, but sending out organization-wide messages that educate, demonstrate, and reinforce the value change you seek can go a long way to expedite the change. That said, helping people become more aware of the costs and waste of unnecessary printing only goes so far. Reinforcing your message with some of the following strategies may help you change old habits.

Inconvenient printing

If you want to help people think about their printing habits, make it a little less convenient to just print everything:

- Have only the number of printers necessary for the task at hand.
- Put all printers in one location — don't distribute convenient printers throughout the building.

When folks actually have to get up and walk a few minutes to retrieve their printout, they may find it more convenient to read something on the screen — it may actually take less time than the round trip to the printer. Others will welcome the exercise. Folks at the IBM Corporation tell us that their printers are in a seldom-visited room, which is kept dark. Lights turn on by motion detector during the rare occasion someone must print.

In addition to reducing paper use, consolidating printers also offers the following benefits:

- **Reducing the number of printers being powered**
- **Reducing energy costs**
- **Taking up less space**

Defaulting to duplex

Duplex printing is printing on both sides of the paper. Some printers are equipped to do this automatically; others allow you to reinsert a page so the printer can print on the second side. You can also set your printing to duplex by default.

Double-sided printing won't help with ink or energy costs per se, but the savings in paper is dramatic.

Paper-free PowerPoint

PowerPoint presentations pervade many processes. Although PowerPoint presentations aren't a bad thing in and of themselves, the wide-spread *printing* and *distributing* of PowerPoint presentations is objectionable.

We're familiar with the popular reasons for printouts, but look for ways to avoid printing. Those copies will likely end up in the trash or, if trees are lucky, in the recycle bin.

Improving data security

Many folks may argue that keeping paper files is a safer practice than keeping e-files, but check out these counterarguments:

- Paper must be filed, and filed correctly.
- Generally speaking, organizations don't have *backups* of their filing cabinets.
- Locking a filing cabinet is a good idea, but if documents are actually sensitive, what levels of protection and trust do you require of the person or persons who hold the key(s)?

Given the increased regulations around data privacy, chances are you're better off creating and protecting digital documents with the myriad tools at your avail, than risking sensitive paperwork finding its way into the wrong hands. Making a physical copy of paper documents leaves no trail — perhaps page counts on the copier, but no clue as to what's been copied. Data protection software can limit who can access what information and can actually limit where information flows, when, and how.

Going green here can help you stay on the right side of compliance and better protect your critical data.

Printers, Paper, and Ink

If you can avoid printing, do so. Using electronic forms and sticking with the digitized document will help. When you must print, make the greenest choices you can. Most printers come under the category of *always-on devices* — like network components, they're turned on and hardly ever turned off, except for changing ink cartridges, clearing paper jams, and periodic service calls.

When thinking about greening your office, take a look at what green printing may look like in your business environment. Examine not only the printer itself but also your paper and ink and how your equipment and supplies match your needs.

Checking out printer specs

Fortunately, most printers of recent vintage have the following green features:

- **Energy Star rating:** A new set of Energy Star specifications for imaging equipment went into effect in 2007. Energy Star–qualified devices cost about the same as standard imaging equipment, but use less electricity. In fact, qualified equipment that meets the new specification (a computer or monitor, for example) can save you $115 over the life of the product. Here are some other attributes Energy Star-qualified devices tout:
  - On average, 25 percent more energy efficient than traditional models.
  - Energy Star printers all print two-sided images, saving paper.
  - Energy Star equipment is designed to run cooler and last longer, so using them may help with your air conditioning costs and replacement cycles.
  - Energy Star imaging products will save billions over the next five years and avert greenhouse gas emissions equal to four million cars.
- **Power saving mode:** In this mode, the printer effectively shuts down into an idle state that uses much less power until it gets a request to print something.

Equally important is matching the printer to your needs. Most people think about printers in terms of *speeds and feeds* — how many pages can the printer print per minute, does the printer handle photo quality printing, and so on.

In considering when to replace existing printers with greener options, you need to consider the frequency and usage your current printers get. Older, less efficient printers that are only used occasionally or only in back-up situations shouldn't be replaced. Older printers that won't print 2-sided copies that are in constant use probably should be replaced on the merits of saving paper alone.

Picking greener paper

Trees are cut down to produce paper, and if not replanted, deforestation has dire consequences. When you clean up your act around paper, you're not just talking about reducing what you use and recycling your waste. You can make better choices about the paper you use.

There's a ton to learn about paper from a green perspective that goes beyond the simplistic moniker of "recycled." Consider the following in your paper purchasing decisions:

- How paper is manufactured
- How the paper is recycled
- What percentage of a paper's content is recycled
- Whether the paper manufacturer works with the Forest Stewardship Council to ensure that forests are maintained

The Forest Stewardship Council (`www.fscus.org`) is a not-for-profit organization focused on maintaining and renewing forest resources. The council certifies paper, paper merchants, and paper manufacturers that align with responsible forest use.

To help you bridge the gap between a neophyte well-intentioned, responsible paper consumer to a well-informed paper purchaser, we recommend "Translating Recycled Paper Lingo into a Language You Can Understand" by Brian J. Cowie, CEO and Founder, The Paper Mill Store, `www.thepapermillstore.com`.

Different papers are appropriate to different usage. There's no such thing as 100 percent recycled paper — you always need some new paper content. Recycled paper that comes from the mill before consumer use reflects efficiencies in the mill's processes. Recycled post-consumer paper saves landfill.

Find the most affordable, environmentally friendly mix that does the job. The percentage of recycled content doesn't tell you whether the paper's right for you. Chances are you'll need to see samples; if you'll be buying in quantity, your supplier should be more than happy to let you sample. Because so many different things get recycled into recycled paper — both pre-consumer waste fiber and post-consumer waste fiber — you don't know what you're getting without closer inspection.

Chapter 9

e-Waste Not, e-Want Not

In This Chapter

- Buying sensibly
- Knowing what you have
- Extending a lifecycle
- Recycling and disposing of equipment safely and legally

The IT industry constantly replaces hardware with new machines, each cooler in concept and hotter in performance (and often in thermal dissipation) than the last. Along with new technology comes a serious problem — what to do with the stuff you don't need anymore. Here's what *not* to do — just throw it away. Computers are full of hazardous material that, if disposed of improperly, creates serious health problems. No organization is too small to do the right thing.

Before you go very far, you need to know what you already have. An electronic asset-tracking system can help you make decisions about old equipment before the cleanout crew arrives. Without a system for tracking the equipment over its life, material will make its way to the dumpster. If you already have a capital-asset management system in place, add a disposal component to automate the process.

Buying Wisely

Take some steps now to ensure a cleaner tech death a few years from now. Consider this before you purchase:

- ✓ Give preference to manufacturers that have a take-back program for their equipment.

- Buy equipment made from materials that are easier to recycle.

  Not all products are designed equally. In 1992, IBM established its Product Stewardship program, which focuses on corporate environmental affairs including product environmental design and performance. The Product Stewardship program helps development groups within IBM apply environmental considerations from product concept through product end-of-life. They pay attention to extending the life of products, designing products with reuse and recylability in mind, and minimizing environmental impact by choosing more environmentally friendly materials.

  In 1990, IBM's Worldwide Distribution organization developed Environmental Packaging Guidelines, which promote the use of reusable, recyclable packaging, minimizing the use of toxic elements and waste.

- Label machines that are covered by a take-back program so when the time comes to dispose of it, the information is at hand.
- Look for equipment you can upgrade without replacing the entire mechanical assembly.
- Consider leasing equipment. When you don't want it any more it goes back to the leasing company

Extending Lifecycles

The best form of recycling is reuse. IT equipment typically has a three-to-five-year working life. Keeping equipment in service for even a year longer reduces — by as much as 33 percent — the environmental cost of manufacturing, transporting, and disposing of new hardware.

Reassigning old equipment

Perhaps the simplest way to extend the life of IT equipment is to find new uses for it within the organization. Here are some ideas:

- Older servers can be kept as standby units for use during periods of high demand. Remember to consider the costs of maintenance contracts or technical support.

- Older desktop equipment can be handed down to users who don't need blazing-fast machines.

Desktop virtualization can greatly extend the service life of older computers as can the installation of Linux, which performs quite well on older PCs.

Donating machines

Offering equipment donations to a nonprofit group — school, library, job-training program, or other charity — that can use your old computers provides another way to extend their life. Here are some things to consider in setting up a donation program

- Nonprofits only want reasonably recent machines in good working order.
- Windows XP or Mac OS X Tiger or later are probably okay.
- Machines with functioning hard drives — minus the previous owner's data — are much preferred.

The U.S. Environmental Protection Agency has a list of organizations that accept used computer equipment. Check out its Web site: `epa.gov/osw/conserve/materials/ecycling/donate.htm`.

Recycling Safely and Legally

All good things must come to an end and that includes the useful life of electronic equipment. What was once a miracle of technology becomes a nasty trash disposal problem.

Trash can take three routes:

- The worst solution is to transfer the equipment to a recycler who ships the stuff to a third-world country, where cheap labor, often children, exposes themselves to hazardous materials to extract valuable materials, and dumps what's left over in an empty field or waterway.
- The bad route is to the local landfill. U.S. and European authorities supervise active landfills. Still, old computer equipment takes up landfill space and dangerous substances, such as lead and mercury can leach out.

- The right way is through a service that recycles as much of the materials as possible.

Finding a green recycler

Many electronics vendors are doing their best to create take-back programs and asset recovery systems. IBM started some 20 years ago and now processes some 41,000 machines a week around the globe. In 2008, it processed more than 77 million pounds of end-of-life products. They don't limit themselves to IBM equipment, and there's no minimum number of assets you need to collect before they'll help you.

IBM's Global Asset Recovery Services (GARS)

One of the world's largest, most efficient reverse logistics organizations, IBM's Global Asset Recovery Services (GARS), enables full remanufacturing capabilities. A broad network of distribution channels provides optimal residual value and asset value recovery for IBM customers, IBM partners, and IBM itself. GARS supports IBM's environmental leadership and high standards by reusing, reselling, and recycling used equipment. It's responsible for all excess and surplus equipment across IBM worldwide and works to recover, reuse, and responsibly dispose of electronic equipment. IBM GARS provides a full complement of services including packing and transportation services.

IBM's environmental management system (EMS) — for the global operational and logistics processes related to the return, remanufacturing, de-manufacturing, remarketing, and disposal of used equipment — was recently certified to the ISO 14001 standard by Bureau Veritas Certification, North America (BVC).

More good starting points for recycling old equipment

To help you get started recycling that old equipment, surf the following sites:

- `epa.gov/osw/conserve/materials/ecycling/donate.htm`.
- `computerhope.com/disposal.htm`
- `ibm.com/financing/us/recovery`

- federalelectronicschallenge.net/resources/docs/select.pdf

The Basel Action Network

The Basel Action Network (ban.org) runs an e-Stewards certification program for recyclers of electronic waste. The program forbids accredited firms from doing the following:

- Dumping toxic e-waste in developing countries, local landfills, and incinerators
- Using prison labor to process e-waste
- Releasing (without authorization) private data contained in discarded computers

Disposing Safely and Legally

Electronic equipment and the batteries that power it are a lot more difficult to get rid of (ethically) than they are to buy. More and more countries are requiring vendors of electronic equipment such as cell phones and other consumer devices be responsible for taking their products back and recycling them.

Batteries

The IT sector generates a constant stream of worn-out batteries: from tiny silver-oxide or lithium cells (used on computer motherboards for battery backup) to large lead-acid units used in uninterruptible power supplies. Lead-acid batteries and older nickel-cadmium batteries contain hazardous materials. Older, disposable cells contained small amounts of mercury, but mercury use has been phased out.

Employee equipment

Your organization is responsible for the computers it buys and eventually disposes of. To increase your organization's environmental standing or to offset some of its impacts, consider extending your recycling umbrella to computers and other electronic equipment owned by your employees.

Data Security and Recycling

Sensitive information stored on hard drives and non-volatile memory presents a major obstacle to reuse and recycling IT equipment. A common solution is to remove the hard drive from each computer before it's allowed out of the building. This makes the computer much less usable and greatly increases the likelihood of it ending up in a landfill. A better solution is to get your organization involved on two fronts:

- Develop a procedure for sanitizing hard drives. Those in charge of security (and your legal department) should find the procedure acceptable.
- Place protocols that ensure that the sanitizing is carried out on all machines transferred out of the organization.

Safely removing files from a computer isn't just a matter of deleting them. When operating systems like Microsoft Windows delete files, they remove information from the file directory to make the space on the hard drive but they don't erase the data. Software utilities, such as Norton Unerase, can recover deleted files if they've just been deleted.

Disposing of business IT equipment without first removing sensitive data can have serious legal consequences. A partial list of U.S. laws that require steps to prevent the unauthorized disclosure of data from IT systems include

- Health Information Portability and Accountability Act (HIPAA)
- Identity Theft and Assumption Deterrence Act
- Children's Online Privacy Protection Act
- Fair and Accurate Credit Transactions Act of 2003 (FACTA)
- Personal Information Protection and Electronic Documents Act (PIPEDA)
- Payment Card Industry standards (PCI)
- Gramm-Leach-Bliley Act (GLBA)
- California Senate Bill 1386
- Sarbanes-Oxley Act (SBA)
- SEC Rule 17a

Transform your IT into a greener operation

Green IT can reduce costs

and the negative impact on the environment, making being green good for all businesses

For reasons both economic and environmental, as well as for reasons of capability, companies of all sizes need to hone in on ways to make their processes greener. Unchecked consumption of power is threatening the financial resources of the organizations it serves, and, quite literally, is putting an ultimately unsustainable burden on the earth. Business can't go on as usual because natural resources are finite, and IT growth left unabated needs more kilowatts than can be supplied. Find solutions inside this book and make your contribution in reducing your carbon footprint!

Discover how to:

- *Reduce costs and meet your IT business goals*
- *Be more environmentally responsible*
- *Leverage IT to head toward greener processes*
- *Identify Green starting points*

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