

Greening your IT infrastructure: Save money while saving the planet

Being 'green' was once merely a sign of virtue that earned a badge of good corporate citizenship. Today, a number of factors have converged to the point where being green is an essential part of smart business. Energy costs are skyrocketing just as we are coming to understand how profound an effect our energy use has on our environment. At the same time we are being pressed to deploy more and more servers to deliver more and more applications, we're running up against the space, power, and cooling constraints of our data centers. Our Information Technology (IT) staff is faced with supporting and maintaining an ever-growing farm of servers and storage. Even our employees are facing challenging personal trade-offs because of the rising cost of energy.

It turns out that the way to resolve many of these dilemmas is to make choices that lessen the impact of our IT infrastructure on the environment — going green makes good business sense because it cuts costs in many areas.

No longer just for the crunchy Boulderites

Over the next five years, we will all experience a massive increase in the impact of environmental variables in purchasing and operational decisions. This shift has already begun, and is driven by large-scale factors such as energy security, global warming, and geopolitics, and also by local influences of economic convenience and regional environmental factors.

Many forward-thinking organizations have already developed strategies to incorporate green IT factors into their everyday business decision-making processes. Stretching far beyond just facilities and information technology, leading companies are creating holistic green IT plans that include the Finance, Purchasing, and even Human Resources departments. Most green IT plans emphasize conservation as the highest priority, followed by the management of waste and other outputs.

At any scale, from the home to government to the global enterprise, individual actions are the critical linchpin in conservation. There are lots of technology levers to pull and knobs to turn to improve energy conservation and reduce waste, but none of them can compete with the impact humans can have on the equation. It is possible to reduce the emissions of a car, but that effort is wasted if the driver leaves the car idling when she runs in for a cup of coffee. Lights that turn off with a motion detector can save tons of energy but still waste much more than a person who is responsible about flicking the switch on the way out the door. Duplex printers (that print on both sides of a page) can literally save trees, but not if users print manuals or big

documents rather than reading them online. We all have to be part of the solution.

The low-hanging fruit

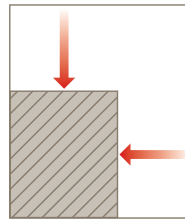
Where to start? The range of choices can be broad and sometimes bewildering. Chances are that your IT department is directly and indirectly one of the largest power consumers in your company. It's also one of the areas where changing practices can have the biggest impact. Because the churn rate in IT equipment is so high, changing the way in which you make IT-related choices can improve your efficiency every time you deploy a new device. The benefits range from lower costs to happier employees:

- **Lower capital costs.** Doing more with less improves efficiency by reducing costs. For example, with today's servers delivering more performance per watt, using a single server to support multiple applications can reduce capital costs.
- **Lower operating costs.** Maintaining a smaller number of servers results in lower power and administration costs. When you consider that every watt of power dissipated in your data center turns to heat, and that it takes roughly another watt for your cooling system to remove that heat, you can double every savings you make on server, storage, and network infrastructure choices.
- **Improved morale and workplace health.** When you make changes that directly affect your employees' work environment, such as using appropriate lighting and low-power LCD monitors, your employees are happier and healthier. Give your employees the infrastructure they need to telecommute, and you improve their lives and increase their dedication — all while helping to save the energy it would take for them to commute to work.
- **Improved company image.** When your employees are happy and healthy, word gets out. Your company becomes a place where people want to come to work and suddenly it's not as hard as it once was to recruit the best talent.
- **Reducing environmental impact.** Reducing energy and other consumption helps to reduce your environmental impact, from reducing your carbon footprint that contributes to global warming to reducing the pollutants that arise from improper IT-related waste disposal. Taking all of these steps helps to leave a better planet for our children.

The five principles of green IT

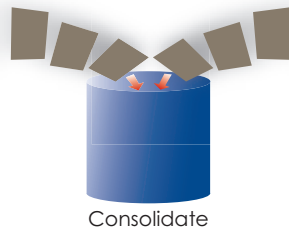
There are five principles that can help guide you along the way to running a more green IT department. Applied Trust uses these principles when providing its EcoInfrastructureSM services to clients. The key idea is to design and operate your IT infrastructure for maximum efficiency, minimizing your ecological impact along the way.

- **Rightsize.** Choose the right tool for the job so that you spend energy in places that matter. The loading dock's shipping application probably doesn't need anything more than a thin client to run. Use the fastest quad-core processor and four gigs of memory to help your engineers run their CPU-intensive computer-aided design program instead. Rightsizing is an important principle to apply on a temporal basis. If you can predict workload cycles, take advantage of them by applying computer power to them on a just-in-time basis. If your Web site needs 10 front-end servers to handle the business day's workload, but only five at night, schedule them to power on and off as needed to best match your computing power to the need. Better yet, build your infrastructure so this happens automatically.



Rightsize

- **Consolidate.** Whenever possible, use devices that perform more than one function so that you only have one device to power. Consolidate multiple applications onto one server. Consolidate multiple office functions into one machine — that multi-function printer saves you energy by combining a printer, scanner, fax, and copier into one device.



Consolidate

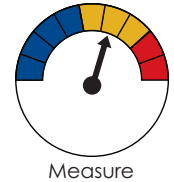
- **Virtualize.** Although virtualized computing environments have been around since the 1960s, the technology is experiencing a resurgence today as a way to better manage workloads across servers. Virtualization is one tool you can



Virtualize

use to consolidate multiple workloads onto a single server while making it easy to move them from server to server in order to balance workloads or take systems offline for maintenance or replacement.

- **Measure.** There is nothing like hard data to convince management that an improvement is worth making. Measurements give you the eyes to see what your energy consumption is today, and how you've changed it through the improvements you've made. Measuring more than just energy consumption is essential; your monitoring strategy should help you find the server that continued to run for two years after the last application was migrated off of it.



Measure

- **Manage your waste stream.** As you purchase new equipment, retire old equipment, and go through consumables, consider the waste stream you're generating. Do the right thing and recycle computer equipment in order to keep the heavy metals and other contaminants in them from our landfills and water supply. A growing number of manufacturers are taking back your old equipment — from toner cartridges to servers — as you purchase new products from them.



Manage Your Waste

An EcoInfrastructure tour

If you imagine your IT infrastructure as everything that connects to your network, you have something that looks like an upside-down tree (Figure 1). Your network connections (and power) come in at the top, meeting a core router that's probably in your data center. (You may have a data center, or you may have a closet, but you probably have some place with a set of central switches, servers, storage, and backup devices). The tree gets wider as your network fans out to your offices, where you may have an IP phone and workstation in each office, plus copiers, fax machines, and printers in common areas. Follow the network connection through your IT infrastructure and consider how you can apply each of the five principles in every area.

Incoming power and networks

Your power infrastructure is a great place to rightsize. You can reduce the impact of what you purchase with carbon offsets or by choosing wind power.

A heavy emphasis on conservation isn't only justified by lofty-minded environmentalism — in fact, conservation provides the best return on investment of any energy management approach. Consider, for example, a company that purchases 200 units of energy every month. Increasing the energy budget by 100 units would result in a 33% surplus in energy (100 of 300 units). However, cutting energy consumption by the same amount would yield a 50% surplus (100 of 200 units)! This example consistently holds true across all kinds of energy consumption and for individuals and large businesses alike. Even marginal short-run energy savings can have a tremendous impact over time. ■

IT INFRASTRUCTURE

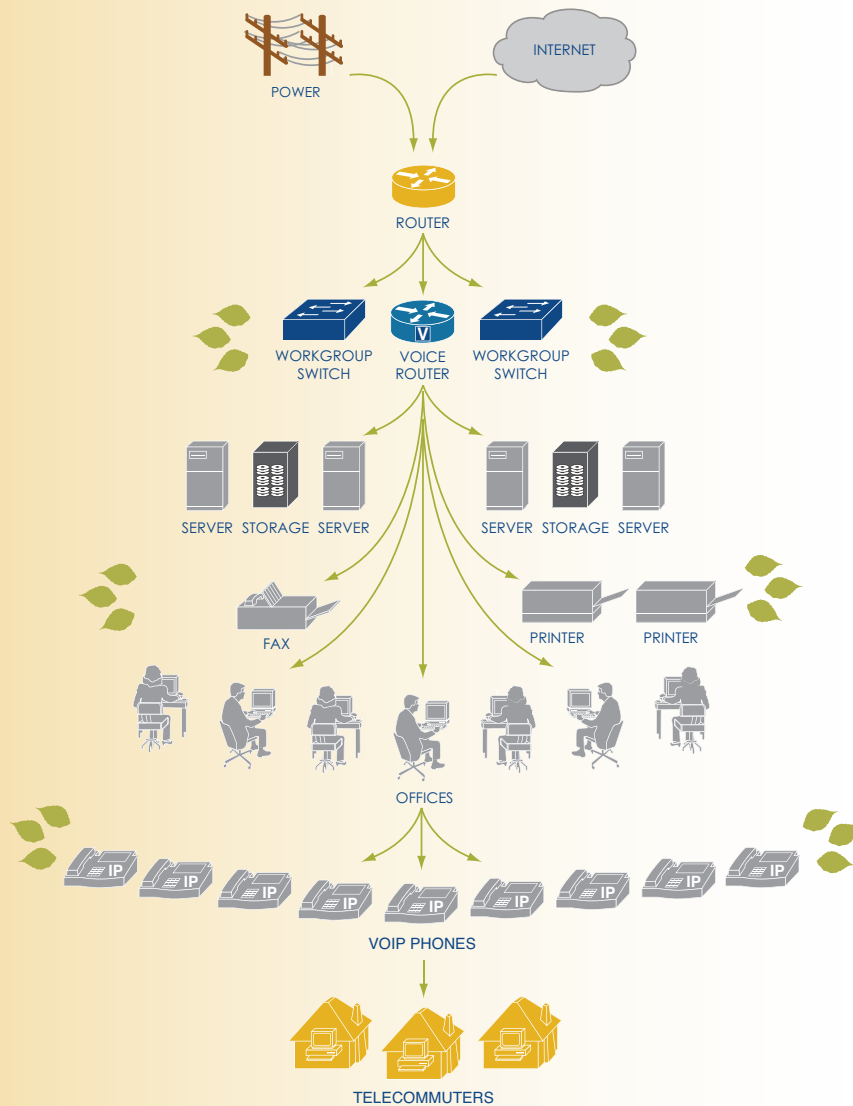


Figure 1: Greening your IT infrastructure means examining everything that connects to your network.

Make sure that you've rightsized your uninterruptible power supply (UPS). From batteries for short-term outages, to cogeneration to survive long-term ones, you can reduce the impact of the waste stream these devices generate by dividing your power consumers into three categories: critical, essential and non-essential. Critical loads are those that can't be interrupted. Essential loads (such as lighting and printers) can be interrupted briefly until a generator comes online. Non-essential loads (such as the coffee pot) don't need a UPS at all.

Put your resources into supporting critical and essential loads, and economize on your UPS and generator. If you have a generator, size UPSs only to cover the gap between commercial power loss and standby power availability — many organizations have a 30-second generator cutover time but 40 minutes of standby UPS, which is an unnecessary cost as well as a source of highly toxic battery waste. Overall, rightsizing your UPS and generator combination reduces the flow of replacement batteries you need to keep your batteries fresh, and it saves on the amount of fuel you must keep fresh and ready to run the generator.

Routing and switching

Consolidation and virtualization can play an important role in reducing the amount of equipment used for routing and switching, simplifying your operations and reducing the amount of energy used. If you have different networks supported by different switches, consider consolidating onto a smaller number of switches and using Virtual Local-Area Networks (VLANs) to support multiple logical networks on a single device. If you have a number of discrete network components such as load balancers, firewalls, encryption appliances, and intrusion detection systems, consider consolidating these into a single router that allows blades to be plugged in to support each of these functions. Blades can use less power than their standalone equivalents, and fewer individual power supplies means fewer points of power-conversion inefficiency. Bladed routers and switches not only give you the ability to scale by adding more blades as needed, but power supplies are more efficient the closer they operate to their power rating.

Telecommunications

Voice over IP (VoIP) piggybacks onto your existing switched

Ethernet infrastructure, allowing a single network cable to carry voice and data to each office. This cuts the amount of copper cabling to each office in half. Then you save even more because you no longer need home runs of copper that traverse multiple floors to reach a central PBX. VoIP phones are typically powered using Power over Ethernet (PoE), where 20% of the power is consumed in your data center but 80% is dissipated in the offices, slightly changing your heating and cooling equation. Make sure your mechanical engineering team is up to speed on the latest heat load equations!

Providing connectivity for your employees to work from home or satellite offices can improve morale and save on the energy needed to get them to work (see “Safe and secure remote access” in the Q4 2007 issue of *The Barking Seal*). Creating a teleconferencing/videoconferencing infrastructure improves your employees’ efficiency when working at home, and it makes it easier for you to reach out to your clients on a more frequent basis without burning fuel to see them in person.

Server and storage infrastructure

Consolidation and virtualization play an important role in doing more with less power in your data centers. Today’s servers deliver more in terms of performance, and performance per watt. This combination of performance and efficiency makes them ideal platforms for consolidating multiple applications through the use of virtualization software.

Server and storage modernization

Simply replacing aging, power-hungry equipment with modern-day, energy-efficient equivalents can reduce power consumption and allow you to reclaim valuable data center space. Modern server infrastructure will give your applications a performance boost. For those horizontally-scaled applications, you may even be able to provide improved performance while reducing the overall number of servers. Consider your storage devices: are you spending energy spinning a large number of aging, smaller disk drives? With disk capacity increasing while prices per gigabyte are constantly falling, the same equation applies to your storage systems.

Server consolidation

Many organizations purchase a new server for each new application they deploy, leading to a proliferation of servers that are typically woefully underutilized. An Internet search for “average server utilization” will lead you to hundreds of different articles citing analysis estimating overall average server utilization levels that range from less than 10% to up to 25%. Every organization’s overall utilization is different, but supporting multiple applications on a single server can help you to increase your overall utilization and thus reduce the number of servers you must purchase, power, and maintain.

Server virtualization

If you need to consolidate applications that require their own operating system instances, virtualization gives your operating system (and applications) the illusion that they own an entire server. This enables you to run many operating system instances

on a single server, allowing you to raise CPU utilization levels and more closely match your processing capacity to your workloads, thus increasing energy efficiency. Most virtualization software allows you to package your virtualized environment and easily move it from server to server, simplifying data center operations considerably. Are you running old applications on outdated, inefficient servers? Some virtualization software emulates old hardware so that, for example, you can move a Microsoft Windows NT environment onto a modern server, gaining a performance boost while saving energy.

Storage consolidation

Storage consolidation offers similar benefits, allowing you to consolidate data onto a centralized storage system, making your data center more efficient. Direct-attached storage, where you have multiple disk drives in every server, results in ‘islands’ of difficult-to-manage storage with low utilization levels. Each isolated disk drive consumes power and contributes to your waste stream when the server is ultimately replaced.

In contrast, centralized storage allows you to manage your storage and servers independently, allowing you to better match your storage hardware to your data requirements. Centralized storage is a requirement if you want to take advantage of some sophisticated features of virtualization software, such as real-time virtual machine migration. It can take the form of Network-Attached Storage (NAS), where storage is allocated to servers a filesystem at a time. It can also take the form of a Storage Area Network (SAN), where a separate Fibre Channel network connects servers to virtual volumes on large storage systems. In between is iSCSI, which provides virtual volumes to servers but uses your IP network to do so. Learn more from “Managing your data performance, availability, and retention” in the Q3 2006 issue of *The Barking Seal*.

Rightsizing in the data center

Server and storage consolidation are both forms of rightsizing, matching your needs more closely with the equipment that you deploy. The following are just a couple of ways in which you can rightsize in your data center:

- If you have a disaster recovery site, does it need an exact replica

SOME KEY SERVER VIRTUALIZATION PRODUCTS

These products vary in the forms of virtualization they offer and what guest operating systems they support.

For x86/x64-architecture servers:

Microsoft Virtual Server
VMware Infrastructure 3
Open-source Xen

For MacOS systems:

Parallels
VMware Fusion

For Sun SPARC® servers:

Logical Domains
Solaris™ Containers

of your primary site, or can it be scaled down and run in a performance-degraded mode in the rare event of a disaster? Having a scaled-down disaster recovery site saves energy every day, and it reduces the waste when you ultimately upgrade your servers.

- If your workloads are cyclical and predictable, can you bring servers online and take them offline at predictable times of the day, helping to match your computing capacity with your workload demands? Virtualization helps with this, because you can automatically move virtualized environments from server to server as your workloads fluctuate.

Data center cooling infrastructure

Every watt consumed in a data center generates heat that then takes roughly a watt to remove. There are lots of ways to change this equation. Data centers have traditionally been kept cold because it's hard to control the random intermixing of hot and cold air, and you need to keep the room cool enough to avoid hot spots. First, address your physical layout to minimize the intermixing of hot and cold air. Then you can increase your overall room temperature without hot spots limiting your freedom. Depending on your climate, consider whether you can use cool, outside air at night or in off seasons to reduce your overall energy impact. In Colorado, a well-grounded data center can safely use direct outside air for cooling year-round (depending on outside air temperature, of course).

Office infrastructure

In terms of square footage, you probably have much more office space than data center space, and managing this space for energy efficiency can contribute to your energy savings and also have a positive effect on your work environment — helping your employees be happier and more productive, and making your company a place where people want to work. Here are some suggestions for your overall office environment:

- *Use energy-efficient lighting and lighting controls.* Fluorescent uplights give a pleasing, even light that allows any surface to be a work surface. Move from incandescents to compact fluorescents, or better yet use even more efficient LED lighting. Read about Applied Trust's use of LED lighting in "Applied Trust thinks and lives 'green'" on page 12. Give employees control over lighting, and use motion sensors to turn off office lights when they're not in use.
- *Address Heating, Ventilation, and Cooling (HVAC) concerns* so that employees aren't using space heaters in the winter (or worse, in the summer!) and opening windows at other times. Comfortable employees are happy and productive ones, so the expense of getting your HVAC right pays off handsomely. Use dedicated cooling for your data centers so that you don't have to freeze your employees in order to keep your servers running cool.
- *Consolidate common infrastructure*, for example combining

your fax, printer, copier, and scanner into only one device that consumes power.

- *Consider your waste stream.* Spend the extra dollars upfront to install a duplexer on your printer and set defaults so that you normally print on both sides, saving paper costs and reducing your waste. Use recycled paper, and consider using recycled toner cartridges.

In each office

Each of your offices presents an opportunity to maximize efficiency, minimize ecological impact, and have happier employees. Follow the principles illustrated in Figure 2, namely reducing direct consumption, managing your output stream, and choosing green technologies:

- *Use one PC per employee, and size the machine to the task being performed.* In many cases, a Windows terminal is sufficient, which saves power and administration costs. Do

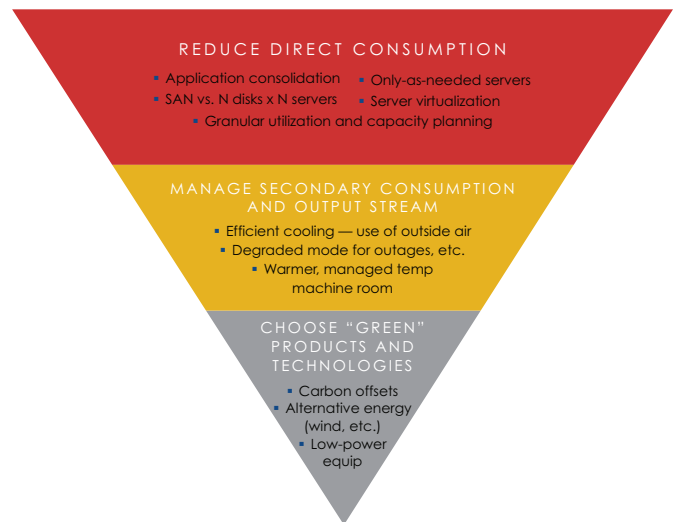


Figure 2: Techniques for greening your office space.

you have engineers with multiple high-power workstations for development and testing? Chances are they don't need to do both at the same time, so one workstation combined with virtualization software can give them the multiple environments they need, but with less energy consumption. Laptops are built with low-power processors. Your employees can use them at home and with external monitors in the office. Using laptops when appropriate can be both a perk and an energy-saving strategy.

- *LCD monitors are the norm today.* They consume less power and are easier on the eyes than old cathode-ray tubes. Prices are constantly falling, but don't use that as an excuse to scrimp. A larger monitor makes it more feasible to work with multiple pages on the screen, making it easier to read documents online rather than printing them out to read.
- *Set up sleep schedules* on your PCs and your monitors; consider powering off your PCs completely overnight.

GREEN BUILDING TIPS

The U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) Green Building Rating System™ provides an enormous amount of guidance in the design, construction, and operation of energy-efficient buildings. It provides guidelines and a rating system for new and existing buildings, and for different types of use. Whether you hire a certified consultant to help you certify your efforts, or simply peruse their guidelines for good ideas, it's worth a visit to www.usgbc.org.

- **Consider the waste stream that office equipment generates.** Be sure to properly recycle your old workstations and monitors — remember that even today's LCD monitors contain heavy metals, including mercury, in their fluorescent backlights. Consider extending your equipment replacement life cycle to slow down the rate of disposed equipment coming from your offices. Provide a place where employees can take equipment for proper disposal, rather than leaving it up to them to choose between the trash can and paying for recycling themselves.

Once you have equipment to dispose of, consider your options. Many vendors will take your old equipment when you buy new equipment. Many municipalities have programs for disposing of computer equipment and hazardous materials (including used compact fluorescent bulbs). In Boulder, visit the Center for Hard-to-Recycle Materials (CHaRM).

Where to start

Greening information technology is probably the most formidable change that an organization can undertake. Moving to a model where you design and operate your infrastructure to minimize ecological impact takes the involvement of virtually every part of a company, from the Facilities department that powers and cools the data center to the Human Resources department that makes decisions on telecommuting and work schedules.

This leaves the daunting question: "Where to start?" You start by taking a baseline measurement of where you are today, making incremental improvements, and measuring the impact you've had. It's an iterative process that gains momentum: you show improvements that justify the next round of effort:

- **Measure** your energy consumption at multiple levels so you can build a model that shows you where you're spending the most energy and identifies the low-hanging fruit. Measure your building's power consumption over a repeatable period. Monitor where that power is going — your HVAC, data center, office lighting, office equipment, down to individual servers in your datacenter. Once you've measured your

energy consumption, measure your waste. How much paper do you consume? How much equipment do you dispose of?

- **Set goals** for the various parts of the upside-down tree that comprises your IT infrastructure. Use your energy measurements to guide you to the low-hanging fruit. Chances are that the largest energy consumers are also the most fruitful places to start.
- **Make incremental changes** to your infrastructure. Incremental changes are important because most organizations are in a constant state of flux, and you want to be sure that you are measuring the impact of the changes you've made rather than changes in the organization. You want to be able to measure, for example, the impact of your employees using laptops instead of desktops, not the energy savings because half of them moved to a different site and stopped using energy where you're measuring it.
- **Measure again** to evaluate the cost-benefit of your improvements, and use those measurements to sell management on the next round of improvements in your overall plan.
- **Repeat.** Greening your IT organization is an iterative process, and one that can yield improvement upon improvement in efficiency and ecological impact. Greening your IT organization reduces capital costs, strengthens your bottom line through reduced operational costs, and makes your employees more happy, healthy, and eager to work in a company with the 'green' reputation that yours soon will have.
- **Control.** Make sure that you have control over your IT purchasing, so that you can choose green products for new projects from the get-go.
- **Get Experienced Help.** Companies like Applied Trust can provide independent opinions and assistance with making your IT infrastructure green in a practical way. ■

SITES WHERE YOU CAN LEARN MORE:

- www.greenercomputing.com
- www.green Seal.com
- www.green-e.org
- www.usgbc.org
- www.beclimatesmart.com/programs/REAP.php
- www.thegreenoffice.com
- www.energystar.gov

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