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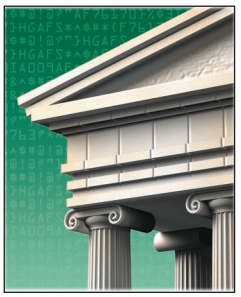

Green IT — More Than a Three Percent Solution?

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IT infrastructure is definitely going green. From significant new regulations for IT equipment disposal to stringent energy-efficiency specifications for PCs and monitors to national standards for data center power savings, Green IT is an "in" topic. But many problems are unsolved. Will telecommuting make a difference or is it too difficult to manage? Will cloud computing reduce the number of large data centers? Can legislation diminish e-waste challenges?

Information and communications technology (ICT) infrastructure accounts for roughly 3 percent of global electricity usage and the same percentage of greenhouse gasses (GHGs),[1–3] but it seems to have a far greater role in the green debate than that. Many of the solutions being introduced for reducing the carbon footprint via more efficient energy use worldwide are heavily dependent on IT — for example, improvements in the power grid, "energy-smart" buildings and cities, and so on. Here, I examine green issues and solutions in IT infrastructure with a brief history behind green computing.

Green Computing Development

The "green computing" idea started in 1992 when the US Environmental Protection Agency (EPA) launched Energy Star, a voluntary labeling approach to recognize electronic equipment's energy-efficiency characteristics. Energy Star has now become an important certification, with significant name recognition in the US and beyond. Today, servers, laptops, gaming systems, and many other IT equipment offerings include Energy Star compliance in their product descriptions. EPEAT — another popular green IT benchmark — is associated with compliance with IEEE standards for monitors, PCs, and laptops and offers highly coveted bronze, silver, and gold ratings for compliance. Vendors take these standards seriously in product development and advertising. Apple's current Macbook Pro advertising prominently mentions high ratings from Energy Star and EPEAT along with other green features, such as recyclable aluminum and glass structures, mercury-free LED-backlit displays, arsenic-free glass, and PVC-free internal cables (www.apple.com/macbook/environment.html).

E-Waste

Used-equipment dumping is perhaps the most legislated and litigated green IT issue. Many states now regulate electronic-waste disposal, including computers, printers, video gaming systems, monitors, television sets, and so on. Seventy percent of all hazardous waste is e-waste, which is bulky, complicated to recycle, and sometimes contains unsafe levels of heavy metals and other dangerous chemicals. The laws enacted so far range from simple prohibition of e-waste in landfills to detailed requirements for collection, transportation, and recycling. The current US congressional session is considering significant legislation aimed at a uniform approach that would unscramble the various e-waste regulations already implemented in nearly half the states. The proposed bill's opening statement lays out the challenge: "The EPA estimates that over 25 billion computers, televisions, cell phones, printers, gaming systems, and other devices have been sold since 1980, generating 2 million tons of unwanted electronic devices in 2005 alone, with only 15 to 20 percent being recycled."[4] The Silicon Valley Toxics Coalition estimates that there are 500 million obsolete computers in the US and that

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130 million cell phones are thrown out every year (www.etoxics.org/site/PageServer?pagename=svtc_global_ewaste_crisis). Where does the recycled e-waste from the US go? Mostly to developing nations with more relaxed environmental regulations, especially China, India, and Pakistan.[5] Pending the enactment of this legislation, 18 states plus New York City have mandated e-waste recycling, and all but California require manufacturers to pay for the recycling. Electronic equipment manufacturers and distributors are concerned that the states' differing regulations could bring uncertainty into their business plans (www.electronicstakeback.com/legislation/state_legislation.htm).

Data Centers and Servers

Data center energy and emissions costs are a major concern in green IT analysis because more than half of all IT-related electrical costs are generated there, from small installations to massive facilities with thousands of servers and tens of thousands of associated workstations. In 2005, the power and cooling cost for servers worldwide was US$26 billion, and that cost is forecasted to top $40 billion by next year (http://whitepapers.zdnet.com/abstract.aspx?docid=327188). A Gartner study found that data centers, with their associated servers, air conditioning, fans, pumps, UPS (uninterruptible power supply), and so on, use 100 times the energy per square foot of an office building.[6] Reducing server electrical needs is definitely part of manufacturers' competitive position. Two years ago, Sun Microsystems Coolthreads servers (advertising "sips power, gulps data") claimed fivefold increases in performance at one-fifth the power and one-fourth the space (www.sun.com/servers/coolthreads/overview) as earlier models. Both IBM and HP, significant manufacturers of servers and other IT equipment used in data centers, have major commitments to reducing energy costs internally as well as for their clients and customers. HP's annual global citizenship report describes the footprint for all major production processes in terms of annual emissions; for example, 2008 CO2 emissions (www.hp.com/hpinfo/globalcitizenship/gcreport/intro/ceoletter.html), measured in tons, were from

- operations — 1.442 million;
- manufacturing (including first-tier suppliers) — 3.5 million;
- product transport — 1.8 million; and
- employee business travel — 425,000.

IBM, with 8 million square feet of data centers, has drawn some inferences from its own energy use experiences. The company found that whereas data centers occupied only 6 percent of the total allocated floor space, they constituted more than 30 percent of IBM's total electrical expense. Non-IT machinery, such as cooling systems, fans, pumps, UPS, and so on, account for more than half of data centers' electricity bill. IBM consults extensively with its clients to reduce the total data center cost and claims that, in some consulting engagements, the savings approach 40 percent.[7] General Electric has a 29,000 square foot installation in Ohio housing nearly 4,000 IT systems, which annually consume 24 million kilowatt hours (kWh). By using many of their own products, they've reduced the cost for cooling the center by 11 percent; 2 to 3 million gallons of water will be saved — a 20 percent reduction — and water treatment chemicals reduced by half (www.genewscenter.com/Content/Detail.asp?ReleaseID=5653&NewsAreaID=2&MenuSearchCategoryID=). The Department of Energy (DOE) maintains a Web site with success stories on data center energy management. For example, Lucas Films estimated savings of 3 million kWh in energy by selectively investing in energy-efficient equipment and software — leading to bottom-line reductions of $343,000 in the first year and full investment return in 1.2 years (www1.eere.energy.gov/industry/saveenergynow/pdfs/43651.pdf).

The $787 billion stimulus bill passed in March 2009 included significant funding for technology upgrades and improvements — $7 billion for broadband, especially to rural areas; $19 billion for health IT; $4.5 billion for an improved electricity grid, and so on. It also included $50 million in tax incentives for projects that promote IT energy efficiency. This funding, part of $16.8 billion awarded to the Department of Commerce's Energy Efficiency and Renewable Energy division for spurring IT growth, can be used directly for data center projects, improved telecommunications hub operations, and many other green IT needs (www.forbes.com/2009/03/10/data-center-legislation-technology-cio-network-data-center.html).

PCs, Monitors, and Workstations

PCs on average use only about 100 watts of power, but there are well over a billion of them in the world, so the combined electrical requirement is large. HP claims that their latest Energy-Star-qualified PC with full power-management features uses only one-fourth the power of a PC without these features (www.hp.com/sbso/solutions/pc_expertise/energy-efficient-computing.html). Thin-client approaches, which rely on "dumb" data terminals that do minimal computing and use very little electricity, are also capable of energy savings, especially in large systems. Thin clients reduce hardware and maintenance costs, and they can also reduce total energy

expense. Monitors are also coming under increasing scrutiny for green compliance. The EPA's fifth upgrade in Energy Star requirements for monitors — released on 1 April 2009 — requires a 20 percent increase in electrical efficiency. The EPA estimates that, if all monitors comply, this upgrade alone will achieve savings of roughly $1 billion per year in energy expenses and avoid GHG emissions equivalent to 1.5 million cars (www.fmlink.com/News/Articles/news.cgi?display=article&id=25660). Almost 500 different monitors currently show either silver or gold EPEAT certification, indicating success in meeting dozens of energy criteria (www.epeat.net).

Software

Microsoft, the world's largest software company, has clearly made green IT an integral part of its strategy. As described in their annual Corporate Citizenship Report (www.microsoft.com/about/corporatecitizenship/us/default.mspx), new Microsoft facilities must meet Leeds' silver energy-efficiency standards for buildings and reduce electricity costs by 20 percent. In software applications, they claim that Windows Vista saves roughly $50 per year in electrical costs per PC, which reduces carbon emissions by 3 million tons annually. They also expect an additional savings in travel, meeting expenses, and so on, via unified software solutions and working with other companies. The Climate Savers Computing Initiative outlines an additional goal of reducing the carbon footprint due to computer use by 54 million tons in 2009.

Virtualization software manages large clusters of separate, individual servers as if they were a single, virtual computer. In a data center with thousands of servers, there can be considerable idle time as equipment waits for sequentially-assigned tasks using electricity and cooling power while doing no computing. Virtualization harnesses these resources by increasing server sharing and utilization, thereby reducing electrical cost. Advanced virtualization systems can function across single or multiple operating systems — Windows, Unix, Linux, and so on. A downside to virtualization is that its complexity requires frequent maintenance and support tools, but it's a major contributor to electricity efficiency in data centers, and industry now recognizes it as a resource for increasing automation, reclaiming resources (idle virtual machines, for example), and recasting CPU and memory (http://esj.com/Articles/2009/04/14/Virtualization-Benefits.aspx?).

Power-management tools — software for managing electrical systems as complicated as clusters of office or residential buildings or as simple as an individual PC — are delivering multimillion dollar savings. In the Pacific Northwest, the Energy Star power-management tool Portfolio Manager showed potential energy savings of 6 to 15 percent for more than 20 buildings (www.nwalliance.org/ourwork/projectsummary.aspx?ID=89). For individual PCs, power-management tools' effects are equally impressive. Here are some reported savings for several power-management offerings, as reported by Energy Star (www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_ss#ge):

- Verizon — $7 million for 185,000 PCs;
- Yale — $40 per PC;
- Dell — 40 percent on energy costs by using 1E NightWatchman and SMSWakeUp software on its desktop and notebook computers;
- GE — $2.5 million on 75,000 PCs; and
- Fusion Trade — $70 per PC by using EZ GPO and Windows Task Scheduler for overnight system updates.

Spam causes emissions, too. A recent report from McAfee shows spam's electricity profile effect, based on 62 trillion spam messages in 2008: the average spam email causes emissions equivalent to 0.3 grams of carbon dioxide (CO2) per message; globally, annual spam energy use totals 33 billion kWh, or 33 terawatt hours (tWh) — that's equivalent to the electricity used in 2.4 million homes every year, with the same GHG emissions as 3.1 million automobiles using two billion US gallons of gasoline. Spam filtering saves 135 tWh of electricity per year (http://img.en25.com/Web/McAfee/CarbonFootprint_28pg_web_REV.PDF).

Telecommuting

A significant unknown factor in green IT planning is the true effect of telecommuting. One optimistic recent prediction is that, if half the eligible workers would telecommute, it would save, enough oil to free the US of over half its dependence on Persian Gulf sources.[8] The federal government has been relatively unsuccessful in achieving even modest telecommuting goals and is now attempting to legislate a 20 percent telework rate (http://thomas.loc.gov/cgi-bin/bdquery/z?d111:h1722:). Senator Daniel Akaka (D-Hawaii), a cosponsor of the bill, commented that, in previous telework hearings, witnesses reported "agency leadership and management resistance" as the most significant barriers to telework implementation.[9] Companies such as IBM, Sun Microsystems, and Cisco have been routinely using telecommuting for half their workforce for more than a decade, but this experience isn't common. An ITIF report found that, if only 14 percent of existing American office jobs were converted to work-from-home jobs, the savings would be dramatic: estimated at 136 billion vehicle travel miles annually in the US by 2020 and 171 billion miles by 2030.[10]

Green IT savings from telecommuting, for now at least, can only be left to conjecture because we might have already achieved many of the most lucrative opportunities. Success will depend on a combination of skillful management of offsite employees and improvements in current security arrangements, in addition to greater support by public and private sector senior managers.[11]

Metrics

Measuring Green IT compliance is difficult, and many other approaches besides Energy Star and EPEAT exist. At the macro level is the United-Nations-approved standard called the "triple bottom line" (economic, ecological, and social outcomes), which is associated with the global ecological footprint and has an IT component. By contrast, the Telecommunications Energy-Efficiency Ratio (TEER) is an equipment-specific metric (www.chloregy.org/opinion/technology/4882-telecommunications-energy-efficiency-ratio). The ITU emphasizes Green IT, too, noting that mitigation of IT emissions has a major multiplier effect: "Although ICTs account for only around 2.5 per cent of total greenhouse gas emissions, they have the potential to be used in reducing the other 97.5 per cent of emissions in other sectors" (www.itu.int/themes/climate/docs/report/08_mitigation.html). Earlier this year, the EU produced its own detailed policy document, describing a 10-year plan aimed at "mobilizing information and communication technologies to facilitate the transition to an energy-efficient, low-carbon economy." Noting that ICT has the responsibility of developing both new approaches to carbon reduction (enabling) and metrics for success (quantifying), the plan is a benchmark for the entire 26-member EU, which has an aggregate gross domestic product and population larger than that of the US (http://ec.europa.eu/information_society/activities/sustainable_growth/docs/com_2009_111/com2009-111-en.pdf). Viviane Reding, director of the European Commission's Information Society and Media group, gives frequent online lectures on the importance of IT as a part of governmental efficiency and has specifically singled out green IT initiatives as a crucial part of overall policy implementation (http://ec.europa.eu/commission_barroso/reding/video/index_en.htm). Metrics can help, but there are traditional management concerns, too. One study found that many companies don't inform the IT unit about its electricity bill, resulting in missed opportunities for goal-setting and attention to IT energy improvements.[12]

Because green IT is a very small segment of the aggregate electrical energy equation, its ecological impact might not be great overall, but it's an integral part of the wider green movement, and many of its manifestations are significant. Here are some green IT markers to keep an eye on. First, as the largest single source of hazardous waste, IT equipment will come under increasing scrutiny and legislation, as more manufacturers must become responsible for the additional cost of equipment disposal after use. Second, the energy costs associated with data centers and their servers, coolers, and so on, as well as workstations and monitors, are becoming increasingly evident. Energy Star has already set up data center energy criteria, and the EU is similarly committed to achieving major green IT goals for the energy-hungry centers. Third, US federal procurement regulations are squeezing contractors to use EPEAT-approved monitors and workstations, which alone should spur the broader market. Fourth, it's possible that several large-scale federal energy carbon offset plans, such as cap-and-trade, tax credits, and so on, will lead to increased green IT initiatives. Finally, as mentioned earlier, the great unknown could be telecommuting because its energy savings goals can be achieved only if there is a minor revolution in how managers operate – a revolution that the federal government itself is so far unable to lead.

Cloud computing – the reallocation of processing workloads from smaller, company-operated facilities to massive computing warehouses – is a possible game-changer in green IT. If it really catches on, many firms and government agencies might send their data center work to Amazon's or Google's warehouses. A recent report cited the example of a global logistics company that had a choice: spending $4 million for 150 new servers plus $1

Further Reading

Here is a list of Web sites that deal with green IT issues.

- Green Review — frequent updates on green IT issues and events worldwide; www.thegreenitreview.com;
- The Green Grid — industry-supported research and commentary site aimed at data center activity with reports about design, energy measurement, and so on; www.thegreengrid.org;
- State e-waste information from electronics takeback.com — maps, updates legislation, and so on; www.electronicstakeback.com/legislation/state_legislation.htm;
- Department of Energy site with data center success stories; www1.eere.energy.gov/industry/saveenergynow/case_studies.html; and
- Energy Star — IT-related reports from the most significant electrical efficiency standards organization; www.energystar.gov/index.cfm?c=new_specs.enterprise_servers.

million in annual license fees or having the same job done by Amazon's cloud service for $131,000 (www.portfolio.com/views/columns/dual-perspectives/2009/03/09/Todays-Weather-Report). If cloud computing's potential is fully realized — many people still have significant questions about its reliability and security — and, as more large customers migrate in that direction, green IT challenges won't go away. They'll become more concentrated in very large facilities. Stay tuned.

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