

WHITE PAPER

Measuring the Business Value of Green Datacenters

Sponsored by: HP

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GREEN TECHNOLOGY MEANS BUSINESS VALUE

Today, policy and business leaders are reaching a consensus that industry must address rising greenhouse gas (GHG) emissions. Leading enterprises are now turning to the practical challenge of determining how, how much, and at what cost to reduce emissions. Many are quickly realizing that their information and communication technology infrastructure offers a means to both abate GHG *and* reduce costs with the right incremental capital investments. That is, unlike investments in alternative transportation or power generation options, investments to develop higher performance and utilization of information and communication technology abate GHG at a negative cost. The process of improving information technology and datacenter efficiency not only reduces GHG emissions but also reduces cost for the enterprise. This means that the savings or business value derived from improvements far outstrips the incremental capital costs of "greening" the datacenter. Green IT means business improvement. Firms that rank highest among the "Global 100 Most Sustainable Corporations in the World," such as Amazon, Toyota, and Nike, have realized that focusing on limiting energy calories in the datacenter and elsewhere pays profitability dividends on the financial side. IDC research indicates that companies reducing their metric tons of carbon per datacenter workload by a factor of 55% also incurred 35% less cost per user session on a server.

What's Changing the Game?

A number of phenomena are coming together now to heighten the focus on energy savings in the datacenter. IDC research has shown that:

- Server energy demand doubled from 2000 to 2005.
- Power used by servers, cooling, and ancillary infrastructure in 2005 accounted for about 1.2% of the United States' electrical usage.
- Servers, cooling, and ancillary infrastructure used the equivalent in capacity terms of about five 1,000MW power plants.

Despite feeling concern over energy use and environmental impact, IT managers in these times must prioritize on reducing operational expense and managing the escalating costs of infrastructure and IT staff. Cost reduction and better protection from the risks posed by downtime take precedence over environmental motives.

But the evidence from IDC's Business Value research indicates that efforts to reduce energy use do help companies save money and improve IT service levels. Datacenter energy efficiency improvements such as consolidation through virtualization have delivered strong value for businesses, helping them not only reduce energy use but also reduce server costs per user by almost 40%. In addition to allowing firms to decrease the number of servers they need by over 50% — providing attractive "consolidation" savings — virtualization as a green solution reduces energy consumption and GHG emissions and also provides companies with the means to avoid application shutdowns when and if servers fail, reducing server outage hours per year by over 35%. Virtualization eases the backup process, which in turn allows IT staff to back up more databases. This then results in more applications with restart and recovery capabilities. In fact, all of these goals interrelate and correlate.

The first part of this paper presents our findings on both the green and the business dividends that consolidation via virtualization delivers. The second part presents a view of more advanced green and business value solutions, including more efficient power and cooling solutions from HP.

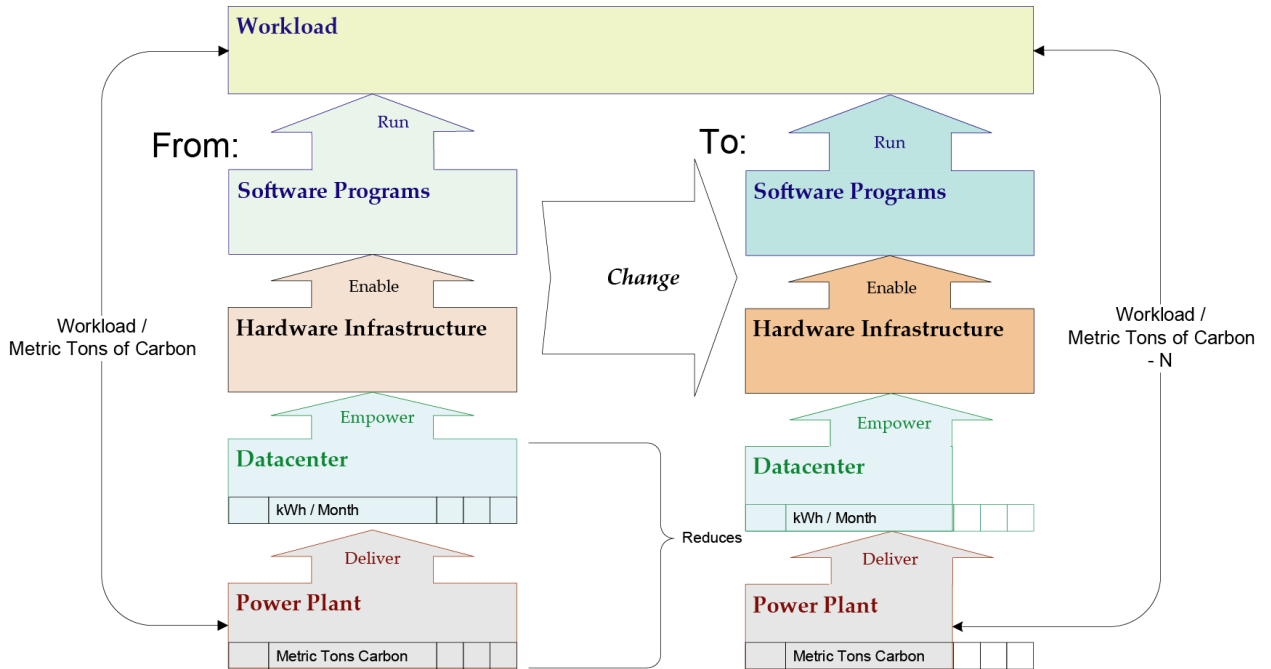
The Full Picture: Returns on Green Datacenter Investments

To measure both total energy usage and datacenter efficiency — to calculate a workload per ton of carbon ratio — we need to evaluate four key variables as depicted in Figure 1:

- ☒ **Datacenter workload** — an operational definition of datacenter workload that establishes consistent workload volume metrics that allow comparisons across different enterprises and different types of datacenters
- ☒ **Power efficiency changes implemented** — the types of green investment improvements — virtualization and consolidation, power management, selective cooling — implemented and at what cost
- ☒ **Effects of the power efficiency changes** — the hardware assets and inventory reductions that the changes accommodated
- ☒ **Carbon impact** — the reduction in GHG emissions, especially carbon, which the power efficiency changes enable

FIGURE 1

Measuring Green Benefits and Business Value



Source: IDC, 2009

Green Efficiency Improvements

The change symbolized by the arrow that points from the left stack to the right stack in Figure 1 can involve a wide variety of green IT programs to reduce power consumption in the datacenter. These power reduction changes may include the virtualization of server operating environments to allow their consolidation on fewer and more powerful servers.

As Moore's law continues to outpace the life expectancy of datacenter equipment, organizations are finding that replacing older IT equipment with newer models can reduce power and cooling requirements and free up valuable floor space. Recent IDC research on currently available generations of server platforms shows more than 15 times performance throughput at one-half the electricity usage when compared with a similarly priced unit available two technology generations (three-plus years) earlier.

New power management technology also enables datacenter managers to dynamically allocate power based on the specific requirements of individual workloads. As described on the following pages, new technologies enable managers to measure and allocate power based on the equipment's actual power usage with the ability to cap its consumption to an acceptable level.

Cooling reductions play another significant role in datacenter energy efficiency improvements. Room layout redesign, airflow management, facilities improvements, and variable cooling delivery can play significant roles in reducing overall energy consumption.

***One Particularly Effective Green Efficiency Example:
Virtualization and Consolidation***

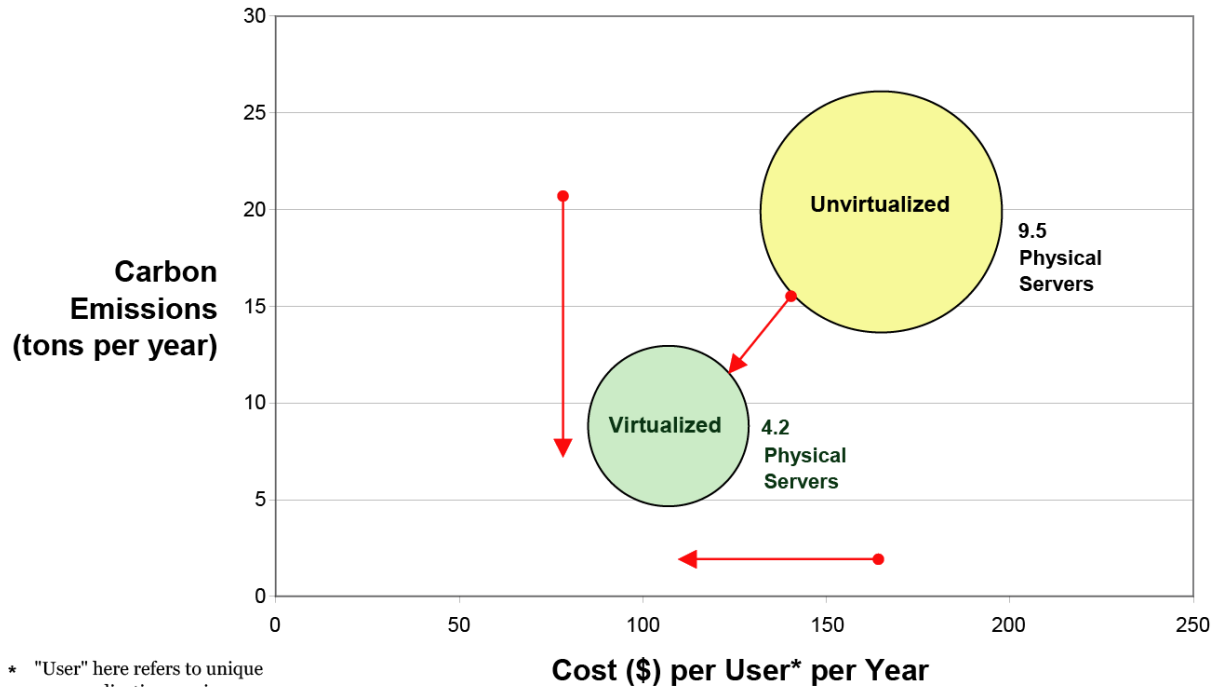
IDC's Business Value of Green research team has been tracking the positive effects of virtualization and consolidation on datacenter sustainability. A closer look at the consolidation of workloads through virtualization from multitudes of underutilized servers onto fewer, more efficient systems illuminates the business value of green dynamic effectively.

As depicted in Figure 2, IDC found that virtualization and consolidation exerted a combined effect, delivering both GHG reduction improvements and cost savings. IDC research across a wide variety of firms showed that to support 1,000-user application sessions — that is, unique application launches against a server — virtualization on average reduced the number of servers required and consequently cut carbon emissions in half from 20 metric tons to about 9 metric tons of carbon per year for that workload. The efficiency change also results in substantially reduced (35% less) cost per user session on a server. Figure 2 illustrates the reduction in number of servers (size of circles) and the reduction in carbon emissions (left-hand axis) to support 1,000-user application sessions.

FIGURE 2

Virtualization and Consolidation as a Green Improvement Reduce Carbon Emissions and Hardware Costs per User by over 50%

**Consolidation's Effect on:
Number of Servers, Cost per User*, and
Carbon Emissions per Year to Support 1,000 Users**



* "User" here refers to unique user application sessions launched against the server.

Source: IDC, 2009

Research indicates that the business value elements accrued from this green improvement went beyond carbon savings. It resulted in a series of ancillary benefits to the entire datacenter, especially in the reduction of downtime hours on an annual basis and the significant reduction in time to launch applications. Factors that customers particularly noticed included:

- ☒ More standardized configurations of servers allowing fewer managers to manage more servers — from 17 servers per manager before virtualization and consolidation to 26 servers per manager after virtualization and consolidation
- ☒ Ability to migrate workloads to other platforms more easily, resulting in less downtime experienced by users — from over 14 hours per year to between 6 and 12 hours per year based on the maturity of the implementation
- ☒ Ability to snapshot and replicate operating systems for test and configuration purposes

By combining all of the benefits — green savings and the ancillary reductions in downtime and datacenter labor — we found organizations reaping financial benefits such as those highlighted in Table 1.

TABLE 1**Business Value of Green and Virtualization (All Values per User*)**

| Category | Effects of Green Solution (Virtualization) |
|----------------------------|--------------------------------------------|
| Total benefits | \$287 |
| Total investment | \$45 |
| Discounted benefits | \$225 |
| Discounted investment | \$38 |
| Net present value (NPV) | \$187 |
| Return on investment (ROI) | 498% |
| Payback | 6.60 months |
| Discount rate | 12% |

*Total value (costs, investments, benefits) divided by total number of intraenterprise users equals "per user" values.

Source: IDC's Business Value Research, 2009

How Green Technology Works: Electro-Motive Diesel

Electro-Motive Diesel (EMD), a 2005 spin-off from General Motors, is the world's largest builder of diesel-electric locomotives. EMD has been striving to improve efficiencies and reduce GHG emissions for nearly two decades, beginning with the goal of improving its locomotives' fuel efficiency to reduce its customers' fuel costs. The company currently pursues a green corporate strategy, spearheaded by its director of green. "The industry has reduced its carbon footprint by about 80% in the last 20 years, and with 60% of the market, we have been leading the charge," said Anuraag Bhargava, vice president and CIO. "Thinking green is ingrained throughout our processes, which includes IT."

Upgrading Infrastructure While Reducing Costs

Following the spin-off from GM, EMD's IT organization faced a number of challenges. The company had nearly doubled its business over the previous several years, with demands on IT rising severalfold. What had previously become a 9-to-5 computing environment transformed into a global, follow-the-sun design and manufacturing environment. The business demands increased the pressure on IT even as the global operations collapsed its windows for maintenance and backup to zero.

Further, as a standalone entity, EMD needed to independently implement a number of services it once received as a subsidiary of a larger organization. For example, the company needed to build a second datacenter to meet higher availability and failover requirements. Managers required that the IT group meet all these new objectives

within a corporate-mandated budget reduction of 15%. To meet these combined challenges, EMD IT managers needed to examine every possible method of increasing efficiency and reducing costs. "We needed a paradigm shift," stated Bhargava. "We ended up using more green IT, virtualizing everything from servers to storage to save every penny we could."

Implementing Virtualization and Consolidation in Partnership with HP

Already a long-standing HP customer, EMD approached HP and laid out its dual goals of upgrading the overall fabric of its IT infrastructure while bringing down costs dramatically. HP and EMD worked closely together to design and implement a four-pronged approach:

- ☒ Virtualizing and consolidating EMD's servers, reducing its count of approximately 180 physical servers by about 75% (Using HP Integrity servers and other technology for this consolidation, EMD moved from a 100% physical server environment to a 95% virtual environment.)
- ☒ Consolidating its storage infrastructure, using other IT partners, and freeing up about 80% more space in the datacenter
- ☒ Virtualizing its network, implementing technology to identify servers with low utilization and better manage bandwidth usage
- ☒ Rearchitecting its approach to power and cooling by moving from a nearly redundant design in uninterruptible power supplies (UPS) and cooling units to a more efficient, multimodule "N+1" standby approach, reducing the footprint by about 30%

Results: Reduced Costs, Reduced Carbon Emissions

These changes exerted a significant impact. Energy costs per server instance were reduced by 50%. This means that even after EMD nearly doubled the number of server instances — to support the increased business and application workload — kilowatt-hours used per month dropped 30% below previous levels.

EMD experienced its most dramatic savings in server management and maintenance. The simplified and improved datacenter infrastructure environment meant that costs for these activities dropped by 40%. Ultimately, the team not only met but also exceeded its budget reduction goal, reducing the IT budget by over 15%. It continues the pace, currently aiming to further reduce the IT budget by an additional 5–10%. It expects to meet this goal using the same principles.

"Going green and reducing cost go hand in hand," observed Bhargava. "As things get consolidated into tighter virtual groups, they are more easily manageable, and that lowers my costs. When we started going green and reducing the footprint, we automatically saw the cost reductions."

Next Steps

EMD is planning to widen this green/efficiency initiative. Having virtualized the datacenter, it is now targeting its users' more than 2,000 desktops and laptops. These

client devices currently consume more power than the datacenter. EMD plans to implement virtualization of the desktop, which should benefit:

- ☒ Users, who will experience less downtime and fewer help desk requirements
- ☒ IT, which will enjoy a greatly reduced desktop support burden
- ☒ The environment, which will experience less GHG emissions as lower energy-consuming thin clients replace relatively high energy-consuming desktop PCs and the more energy-efficient datacenter takes on the user's client workload

GETTING TO GREEN BUSINESS VALUE — THE NEXT STEP: HP THERMAL LOGIC SOLUTION

While virtualization and consolidation are delivering substantial benefits across the board, IT executives consistently rank power and cooling as their top item of continuing concern in IDC surveys. This is in stark contrast to several years ago, when the thermal characteristics of datacenters were often treated as an afterthought. Today, the rising cost of energy, combined with the increased energy requirements of IT equipment, is presenting significant operational challenges. Proper energy management is becoming a requirement to avoid the conflict between the ability to scale IT to match business demands and controlling costs. IDC has observed an increased focus on green IT solutions due to the beneficial impact, not only to the environment but also to the business.

HP Thermal Logic, a core component of HP's Green Business Technology Initiative, answers this customer challenge. It provides a focused strategy to help customers save money and expand their datacenter capacity through more energy-efficient solutions while reducing their environmental impact. HP Thermal Logic includes a range of embedded technologies to provide a holistic approach to driving energy efficiency in the datacenter. The portfolio includes innovations in power and cooling, monitoring, reporting, and adaptive management functionality. With HP Thermal Logic, HP aims to help datacenters address three primary goals:

- ☒ Reduce energy consumption
- ☒ Reclaim datacenter capacity
- ☒ Extend the life of the datacenter

Reduce Energy Consumption

For years, HP has been incorporating innovations into its products that are designed to reduce energy consumption. HP Thermal Logic for Integrity aims to use every watt efficiently, from "chip to chiller," by focusing on the energy efficiency of components, power supplies, and systems:

- ☒ **Energy-efficient components.** HP Integrity servers feature Intel's power-efficient Itanium processors that use demand-based switching technology, which provides the ability for the processor to switch to low power modes, conserving power and requiring less cooling. Additionally, the use of the smaller

2.5" storage drives reduces the power consumption relative to the larger 3.5" form factor. Finally, the servers have internal fans that can dynamically adjust speeds to match IT loads; during low or idle workload periods, the fans will slow to reduce their energy consumption.

- ☒ **High-efficiency power supplies.** The power supply of a server offers opportunities for significant returns in terms of improving energy efficiency. In the past, power supplies lost a significant amount of energy because these components typically run, on average, at only 60–70% efficiency. The low power factor of these systems meant that an increased amount of current was drawn for the same amount of power transferred — thus resulting in a lower performance per watt. According to HP, the Integrity family includes enhanced power conversion technologies that deliver more than a 15% efficiency improvement over their predecessors and reduce the losses in DC to AC and DC to DC conversions. Additionally, the new HP BladeSystem (ProLiant and Integrity) and HP ProLiant servers currently offer common slot power supplies so that customers can choose the power supplies that work best in their environment, including high-efficiency and DC power supplies. The common slot power supplies will become available on rackmounted HP Integrity servers in the future.
- ☒ **Energy-optimized systems.** In the past, server systems were measured mainly by their compute performance and cost. Today, however, the energy efficiency of the server is on par with cost and performance in terms of selection criteria because the power consumption of a server has a significant impact on both the TCO of the system and the efficient operations of IT. The power a system consumes is converted into heat that must be handled by the cooling infrastructure, which requires its own power to operate. Because improving the energy efficiency of a server also reduces its power and cooling load — at roughly a watt-to-watt ratio — each server energy savings actually yields double its value. In the design of the latest generation of the Integrity line, HP paid significant attention to the energy performance of the systems by eliminating the leakage of electrical currents and by using advanced materials in the system design to attain higher performance-per-watt ratings.

Reclaim Datacenter Capacity

The reality is that datacenters are built with specific maximum power capacity budgets and that power and cooling, rather than floor or rack space, is often the limiting factor in datacenter design. The energy budget is a key aspect of determining the compute performance in any given facility. Unfortunately, it is rarely the case that power in the datacenter is efficiently allocated, and the full power budget envelope is most often not used. Additionally, server loads tend to fluctuate by the day (and by the hour and minute), so the amount of power actually used very rarely equals the maximum capacity. The fact is that in most situations, the actual power peak is well below the maximum power budget available in the facility.

This unused capacity represents wasted compute resources that can be reclaimed to enable datacenters to increase their overall capacity within the existing footprint. This can lead to significant savings from costs associated with datacenter infrastructure and future buildout. By offering technologies to better manage power consumption,

HP can actually help companies reclaim additional capacity in their datacenter. HP's Integrity servers deliver power management solutions at both the platform level and the OS level.

HP's Insight Power Manager (IPM) provides customers with visibility into the actual power consumption and thermal output of their IT system. IT organizations are able to monitor and manage the power consumption of an individual server or a collective group of servers and c-Class BladeSystem enclosures. Historical data on energy consumption and thermal output can be collected and graphically viewed to establish baseline benchmarks and to identify trends. With a better understanding of their environments, customers are able to employ the policy-based power management capabilities to more effectively allocate the available power budget.

The HP Integrity line of servers also has the capability to manage power at the OS level that works in conjunction with the platform's tools. The advantage of this integration is that all the tools are available without requiring a system reboot to change modes. The OS power management tools are made possible through the new Itanium 9100 series processors and the demand-based power switching technology. The tools enable individual applications to manage power through either policy-based or application service-level objectives.

The Integrity iLO2 management processor, available today on entry-level HP Integrity servers and all HP BladeSystem servers, including HP Integrity blades, monitors and records the power consumption and system temperature. Additionally, iLO2 enables system administrators to set the power modes on the processor for specific servers or a group of servers, either manually or through time-based policies.

Dynamic Power Capping

HP is also planning Dynamic Power Capping features on future HP Integrity servers — a Thermal Logic innovation designed to allow companies to reduce server energy consumption and thereby reclaim unused datacenter capacity by measuring and capping each system's actual energy use. This, in turn, extends the life of the datacenter.

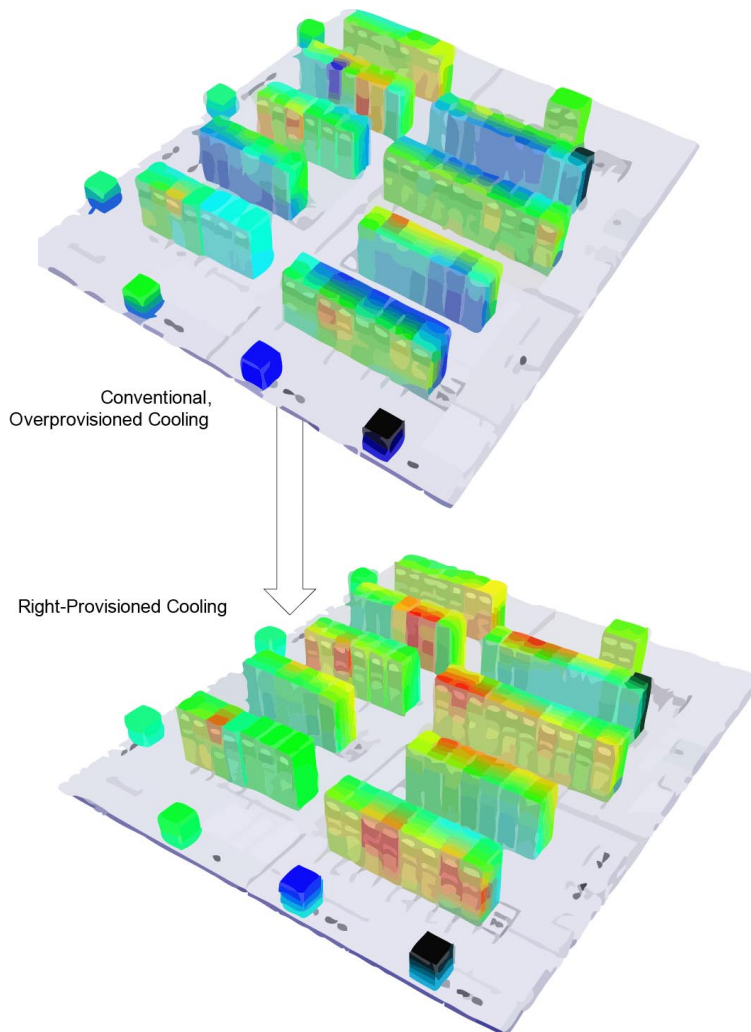
Monitor and Manage Datacenter Environment

As datacenters' electricity and cooling profiles change from moment to moment and month to month, datacenter managers need to ensure that adequate cooling covers the maximal demands and avoids hardware downtime caused by overheating. In trying to avoid this potential failure and sustain consistent temperatures, datacenter managers often "overcool" the datacenter environment, using energy needlessly to excessively ventilate and condition the environment.

HP has designed a means to address this issue with a combination of wireless temperature sensors and modeling software to manage the actual cooling requirements. Measuring the actual cooling, overcooling, and undercooling states, as depicted in Figure 3, allows datacenter administrators to manage the cooling process and assets more effectively.

FIGURE 3

Datacenter Cooling Visualization: Overprovisioned, Right Provisioned



Source: HP, 2009

The measurement and visualization tools help customers identify and remediate problem areas such as airflow obstructions, overprovisioning, rack overcooling, and floor tile placement. They also allow customers to vary cooling requirements as datacenter usage profiles vary and, in general, link the datacenter and facility managers together to respond more effectively to potential infrastructure issues with minute-by-minute notification of critical changes.

Extend the Life of the Datacenter

One of HP's key objectives for HP Thermal Logic is to help companies extend the life of their current datacenter. Reclaiming trapped capacity can help companies delay the need to build out additional capacity and extend the life of their current datacenters, saving costs and resources and at the same time reducing environmental impact.

This is supported by a broad range of HP products and services, including technologies designed to help companies better measure and manage their datacenter's energy consumption.

HP Energy Efficiency Services

Offered as part of the HP Datacenter Services offering, HP Energy Efficiency Services are designed to help companies better utilize and manage energy, which in turn allows them to maximize capacity, control costs, and extend the life of their datacenter. The portfolio of Energy Efficiency Services includes:

- ☒ Facility and Technology Assessment Services
- ☒ Energy Efficiency Design
- ☒ Thermal Assessment Service for Blades

HP offers a range of Facility and Technology Assessment Services, including power and cooling analysis, computational fluid dynamics (CFD) analysis, thermal zone mapping, and energy efficiency analysis. CFD modeling enables HP to model the probable effects of potential cooling improvements or the addition of new equipment to the facility. Thermal Zone Mapping is a technology that provides a multicolored 3D graphical thermal map of the datacenter to help IT identify air flows and opportunities to adjust air conditioning output settings to improve energy savings and efficiency.

CHALLENGES/OPPORTUNITIES

Any new initiative poses challenges even as it opens doors to powerful new opportunities. The drive to implement green datacenter technologies and the associated tools that enable reductions in watts per workload or "carbon tons per task" faces obstacles, such as the following:

- ☒ **Datacenter managers are still not measuring and focusing on kilowatt-hours.** Legacy building environments and the separation of property and facilities management from datacenter technology management functions at corporations have resulted in a sustained disconnect. Only over time will IT organizations gain more attention and focus on the overall cost of and value of energy savings in the datacenter.
- ☒ **Electricity costs in the United States remain under the radar.** With the relatively very low cost of petroleum and coal energy to U.S. power utilities, energy costs at roughly \$.10 per kWh remain unrealistically low. Though these petroleum and energy costs will change gradually, their minimal price visibility today thwarts economic motivations for green datacenter initiatives.
- ☒ **Power generation and datacenters.** The most powerful green sustainability leverage may exist on the generation and transmission side of the power equation rather than on the usage side. That is, ultimately improving a datacenter's sustainability profile means reducing tons of GHG emissions per workload. Amazon's move to build a datacenter in Boardman, Oregon, alongside

Google's massive datacenter means that both datacenters operate at a workload per ton ratio approaching zero. The electricity feeding both comes from hydroelectric generators powered by the Columbia River; hence, there are no carbon emissions. The use of nonfossil fuels and renewable energy sources to generate electricity avoids the emission of CO₂ that results from the combustion of fossil fuels. In one fell swoop, both organizations radically dropped their "tons per task" ratio to almost zero. Likewise, moving a datacenter from a coal power-dominated state to a natural gas generator state will immediately reduce carbon emissions by over 35%.

Even given these caveats, customers are implementing green datacenter technologies, and they are realizing cost reductions and business value increases because of their implementations. Their environmental sustainability improvements codeliver agility improvements and an overall reduction in unscheduled downtime.

CONCLUSION

Green datacenter solutions deliver compelling business value to organizations today. Organizations consolidating workloads with virtualization increase the number of users supported per server by a factor of 2.5, improve the availability of servers, enable application scalability, improve disaster recovery support, and reduce cost per application. This trend will continue. As newer green technologies and solutions for improved power and cooling efficiencies become available, datacenters can extend and improve on the savings they have realized with virtualization and consolidation.

And as governments and corporations increase pressure on IT to reduce energy demand and greenhouse gas emissions, pressure to improve datacenter energy efficiency will continue. A reliable, high-performance datacenter that meets business needs within strict power, space, and budget limits will need not only consolidation and virtualization but also effective power capping, policy-based power management, and up-to-date and efficient system components. All of these green solutions deliver business value today. The need will only increase as energy costs and calls for reduced greenhouse gases increase.

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