SUSTAINABLE IT

REDUCING CARBON FOOTPRINT AND MATERIALS WASTE IN THE IT ENVIRONMENT

LECTURE FOUR

DATA CENTRES AND HP CASE STUDY

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hp invent

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The Natural Edge Project (TNEP) is an independent non-profit Sustainability Think-Tank based in Australia, administratively hosted by Griffith University and the Australian National University. TNEP operates as a partnership for education, research and policy development on innovation for sustainable development. Driven by a team of early career Australians, the Project receives mentoring and support from a range of experts and leading organisations in Australia and internationally, through a generational exchange model. TNEP's initiatives are not-for-profit. All support and revenue raised is invested directly into existing initiatives and development of future initiatives.

EDUCATIONAL AIMS OF LECTURES

Lecture 1: Drivers and Benefits of Sustainable IT

The aim of this lecture is to discuss the drivers and benefits of *Sustainable IT*, particularly for the customer. Drivers and benefits range through business, economic, environmental and legislative domains.

Lecture 2: Product Service Systems and the Product Cycle

The aim of this lecture is to discuss *product service systems*, their barriers and lessons from past implementations, as well as the opportunities to reduce energy and materials consumption in packaging and equipment through end-of-life processing.

Lecture 3: Client Equipment

The aim of this lecture is to discuss a four-step process for reducing energy consumption, materials consumption and materials toxicity in client equipment.

Lecture 4: Data Centres and HP Case Study

The aim of this lecture is to discuss a seven-step process for reducing energy consumption in data centres and to present a *Sustainable IT* case study of IT vendor HP.

Lecture 5: Roadmap and Success of Sustainable IT

The aim of this lecture is to discuss the strategies, activities and actions upon which customers and vendors should focus in order to successfully transition to, maintain and promote their *Sustainable IT* solutions at the organisation and industry level.

Sustainable IT

Lecture 4: Data Centres and HP Case Study

Educational Aim

The aim of this lecture is to discuss a seven-step process for reducing energy consumption in data centres and to present a *Sustainable IT* case study of IT vendor HP.

Required Reading

Reference	Page
Smith, M., Hargroves, K., Stasinopoulos, P., Stephens, R., Desha, C. and Hargroves, S. (2007) *Energy Transformed: Sustainable Energy Solutions for Climate Change Mitigation*, 'Lecture 5.3: Opportunities for Energy Efficiency in the IT Industry and Services Sector', The Natural Edge Project (TNEP), Australia. Available at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx. Accessed 30 May 2008.	pp 15-24
Hargroves, K., Stasinopoulos, P., Desha, C. and Smith, M. (2007) *Engineering Sustainable Solutions Program: Industry Practice Portfolio – E-Waste Education Courses*, 'E-Waste Curriculum Development Project - Phase 1: Literature Review', The Natural Edge Project (TNEP), Australia. Available at http://www.naturaledgeproject.net/EWasteHome.aspx. Accessed 30 May 2008.	pp 4-8, 13-16, 24-27, 37
Hewlett-Packard Development Company (2007) *Energy Efficiency Setup Guide*, HP Development Company. Available at http://h50281.www5.hp.com/tawpost/presentations/9607_Energy_Efficiency_Whitepaper.pdf. Accessed 30 May 2008.	pp 2-16

Learning Points

Data Centres

1. Data centres physically house various types of IT equipment and uninterruptible power supplies (UPS), and thus have critical requirements for security and reliability.[1] They generally incorporate specialised computer room air-conditioning (CRAC) units to cool the equipment, which is densely arranged.[2] Data centres consume a large amount of energy. If data centres are not effectively managed, service can be degraded and energy and material resources can be consumed unnecessarily. This Lecture presents a seven-step process for creating and maintaining a data centre that provides high quality service while minimising the energy consumption.[3]
2. *Step 1: Determine the required services*: determine the client environment's required services. The current requirements mainly depend on the total number of users, the maximum number of simultaneous users and the usage profile. Estimating the future requirements can be more difficult and quite uncertain. This uncertainty is best accommodated by adopting infrastructure architectures that can adapt to changing requirements rather than by oversized architectures.
3. *Step 2: Consolidate and virtualise*: turn off unused equipment and incorporate virtual server technology to consolidate the amount of server hardware required.
4. *Step 3: Invest in low-energy IT equipment*: incorporate IT technologies that have low energy consumption. There are many server computer technologies – power management technologies, processors, power supplies and storage memory. The efficiency of double conversion uninterruptable power supplies (UPS) (the most commonly used in data centres) is 86-95 percent. This efficiency can be increased by 5 percent. Flywheel systems are more efficient than a conventional UPS and do not require air-conditioning.
5. *Step 4: Optimise the layout*: optimise the layout of data centre components to reduce unnecessary cooling load by using equipment to enhance cooling and arranging equipment accordingly.
6. *Step 5: Optimise airflow*: optimise airflow around data centre components to reduce cooling load by orienting and spacing equipment accordingly.
7. *Step 6: Invest in low-energy cooling technologies*: incorporate cooling technologies that have low energy consumption. At the rack level, a recent innovation in cooling is direct liquid cooling technology, which circulates chilled water rather than air. Water carries about 3,500 times more heat per unit volume than air. At the room level, cooling is usually by computer room air-conditioning (CRAC) units. There are several ways to reduce CRAC unit energy consumption.
8. *Step 7: Practise energy conscious management*: maintaining low energy consumption requires allocating accountability for energy consumption and costs, and providing feedback to those accountable.

HP Case Study

9. HP is the world's largest IT company. HP has committed to reducing the lifecycle environmental impact of products and operations, and the lifecycle environmental impact of HP's customers,

[1] Lawrence Berkley National Laboratories cited in Big Switch Projects (2004), p 2.
[2] Lawrence Berkley National Laboratories cited in Big Switch Projects (2004), p 2.
[3] Hewlett-Packard Development Company (2007) *Sustainable IT – Section II Un-Sustainable Data Centres*.

partners and suppliers. HP's product and service offerings cover both *product service systems* and *sustainable IT products*.

10. *Product service systems*: HP offers *End-User Workplace Solutions*,[4] a type of *product service system* for enterprises, and has demonstrated favourable results in terms of reducing energy and materials consumption, reducing cost, reducing complexity, and improving productivity. HP offers established equipment end-of-life services.[5] Since 2007, HP has offered a number of equipment end-of-life services within 52 countries and territories. HP recovers, inspects, evaluates, tests, refurbishes and recycles IT equipment[6] in every product category[7] from any manufacturer.[8] HP designs packaging to eliminate toxic substances, incorporate recycled materials and reduce mass.[9] HP designs its equipment and packaging for reuse and recyclability, which makes end-of-life processing simpler and more cost-effective,[10] and hence increases equipment salvage value and reduces environmental impact.

11. *Sustainable IT products*: HP designs its equipment for low energy consumption during operation and manufacture[11] and has developed several low-energy technologies that feature in its equipment.[12] HP designs its equipment for: low materials consumption and hence improved transportation efficiency;[13] low environmental impact; and enhanced end-of-life materials value.[14] HP has developed several low-materials, high-recycled-content, low-toxic items of equipment.[15] HP has several products that reduce energy consumption in data centres[16] and has operational expertise in reducing data centre energy consumption available through several offerings.[17] More than 1000 HP *sustainable IT products* have become qualified for international eco-labels in North America, Europe and Asia.[18]

[4] Hewlett-Packard Development Company (2006) *HP End-User Workplace Solutions*.
[5] Hewlett-Packard Development Company (2004); Hewlett-Packard Development Company (2005); IDC (2006); Thoughtware Worldwide (2006).
[6] Hewlett-Packard Development Company (2006) *2006 Global Citizenship Report*, p 28.
[7] Hewlett-Packard Development Company website – *Product return and recycling*.
[8] Hewlett-Packard Development Company (2006) *HP expands global recycling program*.
[9] Hewlett-Packard Development Company (2007) *Global Citizenship*; Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 111.
[10] Hewlett-Packard Development Company (2006) *Responsible practices for a happy earth*.
[11] Hewlett-Packard Development Company (2006) *Responsible practices for a happy earth*.
[12] Hewlett-Packard Development Company (2007) *Global Citizenship*; Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 80-82,88,109.
[13] Hewlett-Packard Development Company (2006) *2006/7 Global Citizenship Report: HP's contribution to the Australian community, environment and employees*, p8.
[14] Hewlett-Packard Development Company (2006) *Responsible practices for a happy earth*; Hewlett-Packard Development Company – *Material use*.
[15] Hewlett-Packard Development Company (2007) *Global Citizenship*. Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 109.
[16] Hewlett-Packard Development Company (2007) *Global Citizenship*. Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 81.
[17] Hewlett-Packard Development Company (2007) *Chill your cooling costs and energize IT*; Hewlett-Packard Development Company (2007) *HP Data Center Services: Infrastructure*; Hewlett-Packard Development Company (2007) *HP Dynamic Smart Cooling*.
[18] Hewlett-Packard Development Company (2006) *Eco-labels*.

Brief Background Information

Data Centres

Data centres physically house various types of IT equipment and uninterruptible power supplies (UPS), and thus have critical requirements for security and reliability.[19] They generally incorporate specialised computer room air-conditioning (CRAC) units to cool the equipment, which is densely arranged.[20]

Data centres consume a large amount of energy. In Australia, data centres typically contribute to 15-40 percent of an office building's energy consumption, which equates to 0.11-0.48 percent of total greenhouse gas emissions.[21] Estimates from the US suggest that total electricity consumption in data centres more than doubled between 2000 and 2006,[22] and is 25-50 times that of office environments,[23] or 10-30 times on a power per unit area basis.[24] About half of the energy consumed in data centres is for IT equipment,[25] while the rest is primarily for air-conditioning and lighting.

If data centres are not effectively managed, service can be degraded and energy and material resources can be consumed unnecessarily. This Lecture presents a seven-step process for creating and maintaining a data centre that provides high quality service while minimising energy consumption:[26]

Step 1: Determine the Required Services

Step 2: Consolidate and Virtualise

Step 3: Invest in Low-Energy IT Equipment

Step 4: Optimise the Layout

Step 5: Optimise Airflow

Step 6: Invest in Low-Energy Cooling Technologies

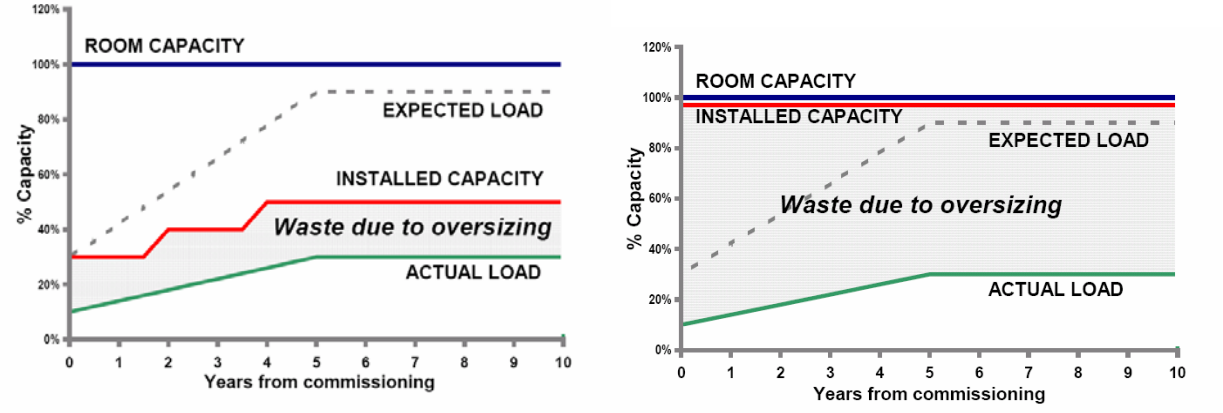
Step 7: Practise Energy Conscious Management

There are several data centre features and technologies that reduce energy consumption. A report by Big Switch Projects[27] identifies 22 such features and ranks them in order of impact. Another report by Rumsey Engineers[28] reviews the energy efficiency innovations in major technologies relevant to data centres. Based on these reports, this Lecture summarises the features and technologies with the greatest impact.

[19] Lawrence Berkley National Laboratories cited in Big Switch Projects (2004), p. 2.
[20] Lawrence Berkley National Laboratories cited in Big Switch Projects (2004), p. 2.
[21] Lawrence Berkley National Laboratories cited in Big Switch Projects (2004), p. 6.
[22] US EPA Energy Star Program (2007) *EPA Report to Congress on Server and Data Center Energy Efficiency – Executive Summary*, p 4.
[23] Rumsey Engineers (2006), p. 2.
[24] Tschudi, W., Mills, E. and Greenberg, S. (2006), p. 45.
[25] Eubank, H. *et al* (2003), p 15; Lawrence Berkley National Laboratory cited in US EPA Energy Star Program (2007) *Handout – Load Density*, p 7; US EPA Energy Star Program (2007) *EPA Report to Congress on Server and Data Center Energy Efficiency – Executive Summary*, p. 4.
[26] Hewlett-Packard Development Company (2007) *Sustainable IT – Section II Un-Sustainable Data Centres*.
[27] Big Switch Projects (2004), pp. 12-16.
[28] Rumsey Engineers (2006), pp. 3-60.

Step 1: Determine the Required Services

Step 1 involves determining the client environment's required services. The current requirements mainly depend on the total number of users, the maximum number of simultaneous users and the usage profile. Estimating future requirements, however, can be more difficult and quite uncertain. In addition to the aforementioned factors, future requirements also depend on whether the trends for each service requirement are increasing or decreasing, whether the customer plans to expand or consolidate, and whether the customer will maintain or change its core capabilities. This uncertainty is best accommodated by adopting infrastructure architectures that can adapt to changing requirements (see Figure 4.1(a)) rather than by oversized architectures (see Figure 4.1(b)). Most data centres are grossly oversized to accommodate a capacity that will never be required.



(a) (b)

Figure 4.1. Comparing actual capacity and installed capacity in a data centre with (a) an adaptable infrastructure architecture, and (b) an oversized infrastructure architecture

Source: American Power Conversion (2004)[29]

Step 2: Consolidate and Virtualise

Step 2 involves turning off unused equipment and incorporating virtual server technology to consolidate the amount of server hardware required. Rather than individual server applications requiring dedicated server computers, multiple virtual servers can co-reside on a single server computer by incorporating software that dynamically allocates resources. However, it is important to compare the reduction in server energy consumption from virtualisation with the increase in air-conditioning energy consumption from denser data centres.[30]

Step 3: Invest in Low-Energy IT Equipment

Step 3 involves incorporating IT technologies that have low energy consumption. There are many server computer technologies – power management, processors, power supplies and storage memory – that were discussed in Lecture 3. This Lecture adds uninterruptable power supplies (UPS) to the list. The double conversion UPS (the most commonly used in data centres) is 86-95 percent

[29] American Power Conversion cited in Big Switch Projects (2004), p. 12.
[30] Taylor, P.W. (2008), p. 14.

efficient. Increasing the efficiency by 5 percent can reduce energy costs by over US$38,000 per year in a 140m^2 data centre. Some new technologies, such as flywheel systems, are more efficient than conventional UPSs (see Figure 4.2), and do not incorporate lead-acid batteries, thus do not require air-conditioning to maintain battery life nor do they present replacement and disposal issues. Uptake of low-energy IT equipment can be facilitated by energy consumption criteria in the customer's purchasing and procurement policies.

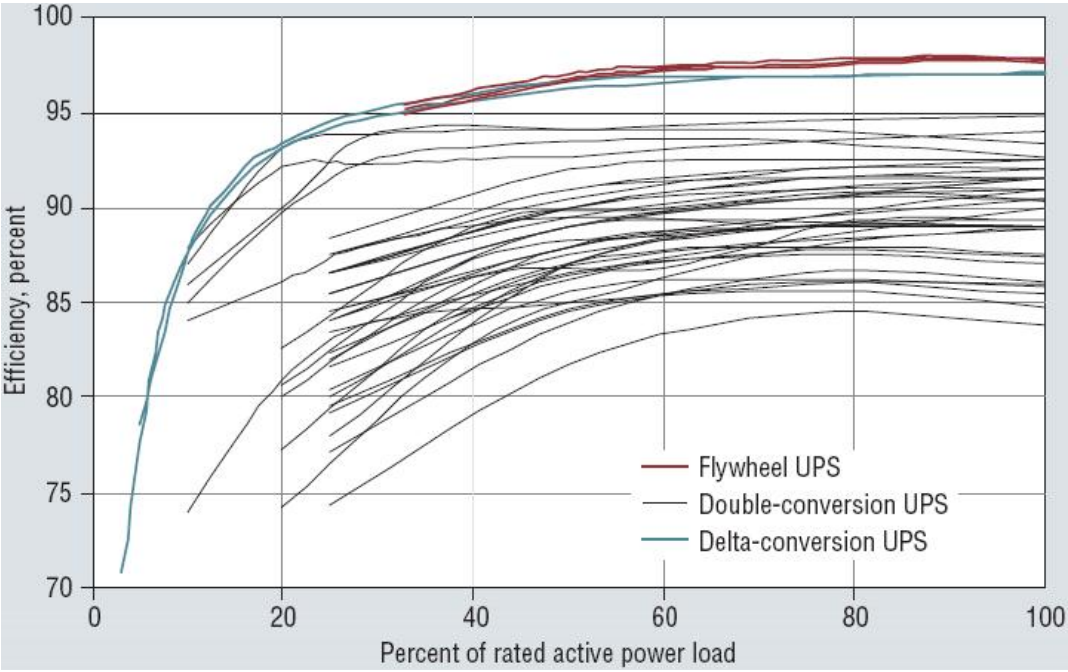


Figure 4.2. Comparing the efficiency profiles of various types of UPS (tested using linear loads)

Source: Rumsey Engineers (2006)[31]

Step 4: Optimise the Layout

Step 4 involves optimising the layout of data centre components to reduce unnecessary cooling loads through features such as: locating data centres within the office space away from exterior walls and heat sources such as kitchens; incorporating insulation for floors, ceilings and walls; sealing leaks and cable cut-outs; using zoned, energy efficient lighting controlled by occupancy sensors; removing airflow obstructions; and locating equipment and air vents to optimise cooling efficiency for the whole data centre, such as the hot isle/cold isle architecture (see Figure 4.3), which can double cooling efficiency.

[31] Rumsey Engineers (2006), p. 56.

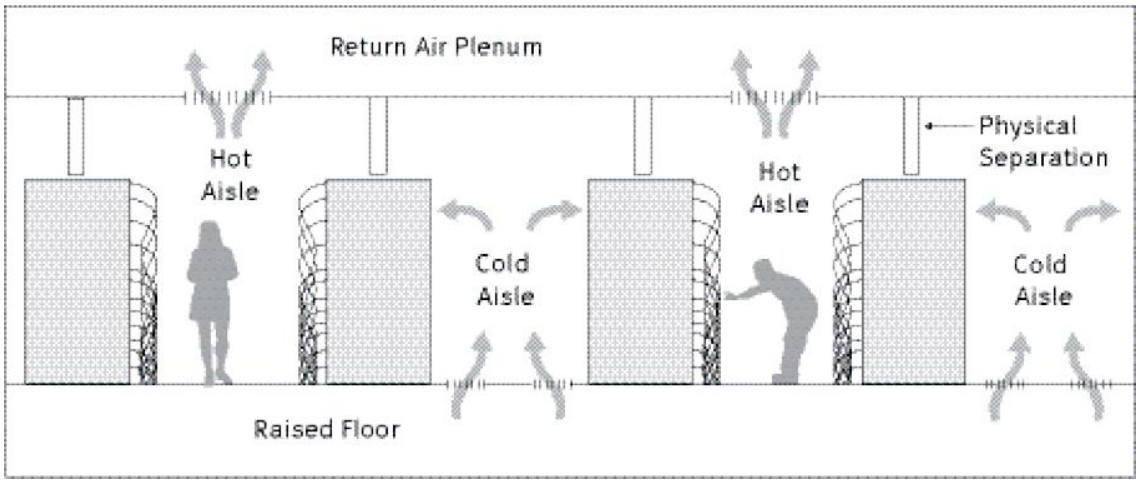


Figure 4.3. Hot isle/cold isle architecture for optimising air flow in data centres

Source: Rumsey Engineers (2006)[32]

Step 5: Optimise Airflow

Step 5 involves optimising airflow around data centre components to reduce cooling load through features such as: orienting equipment such that hot exhaust air from one item is not transferred directly to the intake of another item; allowing sufficient space between equipment to avoid excessive localised temperatures (hot spots) and accommodate adequate air distribution; and placing the most heat-intensive and heat-tolerant equipment at the top of racks where temperatures are usually highest. Optimising airflow is aided by modelling tools such as Computational Fluid Dynamics (CFD) software packages.

Step 6: Invest in Low-Energy Cooling Technologies

Step 6 involves incorporating cooling technologies that have low energy consumption. There are two main cooling levels in data centres:

- *Rack cooling*: A recent innovation in rack cooling is direct liquid cooling technology, which uses chilled water in cooling coils to locally cool small volumes of air in a closed circuit around the rack (see Figure 4.4). By comparison, traditional fan-air cooling acts to carry away large volumes of air from server racks and mixes the air with ambient air and air-conditioned air. Direct liquid cooling can potentially eliminate the need for air-conditioning because water carries about 3,500 times more heat per unit volume than air.

[32] Rumsey Engineers (2006), p. 3.

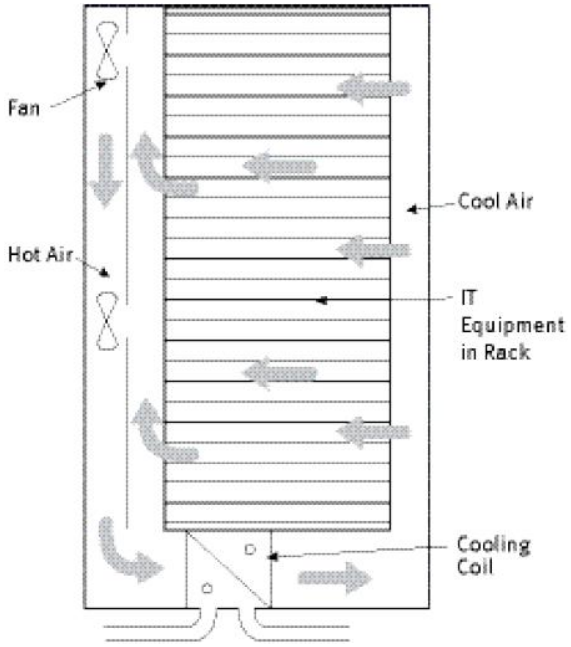


Figure 4.4. Schematic of an integrated direct liquid cooling system in a server rack

Source: Rumsey Engineers (2006)[33]

- *Room cooling:* Room cooling is usually by computer room air-conditioning (CRAC) units. CRAC unit energy consumption can be reduced by: using outside air when appropriate, which can reduce energy costs by over 60 percent; incorporating multistage systems; accurately monitoring room temperatures; networking CRAC units such that they do not compete; and setting a higher temperature set point, nearer that of the surrounding office space rather than the standard 20°C – ICT equipment is far more heat-tolerant than is generally assumed.

Step 7: Practice Energy Conscious Management

Maintaining low energy consumption requires allocating accountability for energy consumption and costs, and providing feedback to those accountable. Allocating accountability provides an incentive to reduce energy consumption and perhaps invest in green power. Feedback is acquired through sub-metering and itemising energy bills. Feedback assists in establishing performance benchmarks and raising awareness of energy issues.

Benefits to Reducing Energy Consumption in Data Centres

There are several benefits to reducing energy consumption in data centres, including:[34]

- Reduced energy costs and associated greenhouse gas emissions.
- Reduced capital costs, particularly for air-conditioning equipment.
- Reduced thermal stress on equipment from excessive heat.

[33] Rumsey Engineers (2006), p. 34.
[34] Lawrence Berkley National Laboratory website – *Data Centre Energy Management: Economics*; Lawrence Berkley National Laboratory website – *Data Centre Energy Management: Non-Energy Benefits*.

- Increased server density for any given energy consumption.
- Increased free space and reduced construction costs from incorporating new generation back-up energy systems.
- Reduced noise and vibration, and increased server productivity (fewer errors, rewrites and retries) from requiring fewer fans.
- Increased reliability from requiring fewer devices that can fail.
- Reduced operations and maintenance costs.

Results of Incorporating Energy Efficient Features and Technologies in Data Centres

Incorporating energy efficiency features and technologies into data centres can cost-effectively reduce total energy consumption by 70-90 percent. For example, in 2003, a 3-day data centre design charrette showed that energy consumption in a data centre can, compared to conventional practice at the time, be reduced by 89 percent by incorporating advanced technologies and concepts, most of which are now available.[35] Another example is the US Environmental Protection Agency's exploration of three scenarios for improving energy efficiency in data centres. The most aggressive improvement scenario can reduce energy consumption by more than 70 percent compared to projections of current practice.[36] A final example is a review of energy-efficiency improvements in 36 data centres of a telecommunications company.[37] The total capital investment of about US$500,000 reduced operating energy costs by more than US$2,000,000 per year.

HP Case Study

HP is the world's largest IT company. HP's Global Citizenship is based on three pillars – corporate accountability and governance, environmental responsibility, and community investment and involvement. HP's environmental responsibility pillar commits to reducing the lifecycle environmental impact of products and operations and the lifecycle environmental impact of HP's customers, partners and suppliers.

HP's product and service offerings are consistent with many of the recommendations and discussions in this Lecture Series. These offerings cover both *product service systems* and *sustainable IT products* (see Figure 4.5).

- *Product service systems*: HP offers *End-User Workplace Solutions* for enterprises and has established equipment end-of-life services. HP equipment and packaging is also designed to be easily reused or recycled.
- *Sustainable IT products*: HP's equipment and packaging are designed under the *Design for Environment* program, which was developed in 1992 to focus on three priorities: design for recyclability, energy efficiency and materials innovation.[38] The program covers all HP equipment, from consumables such as ink cartridges and packaging, to client equipment such as computers,

[35] Eubank, H. *et al* (2003), p. 14.
[36] US EPA Energy Star Program (2007) *EPA Report to Congress on Server and Data Center Energy Efficiency – Executive Summary*, pp 5-7.
[37] Lawrence Berkley National Laboratory website – *Data Centre Energy Management: Economics*.
[38] Hewlett-Packard Development Company website – *Design for Environment*.

as well as integrated systems such as data centres. Through the program, more than 1000 HP products have become qualified for international eco-labels in North America, Europe and Asia.[39]

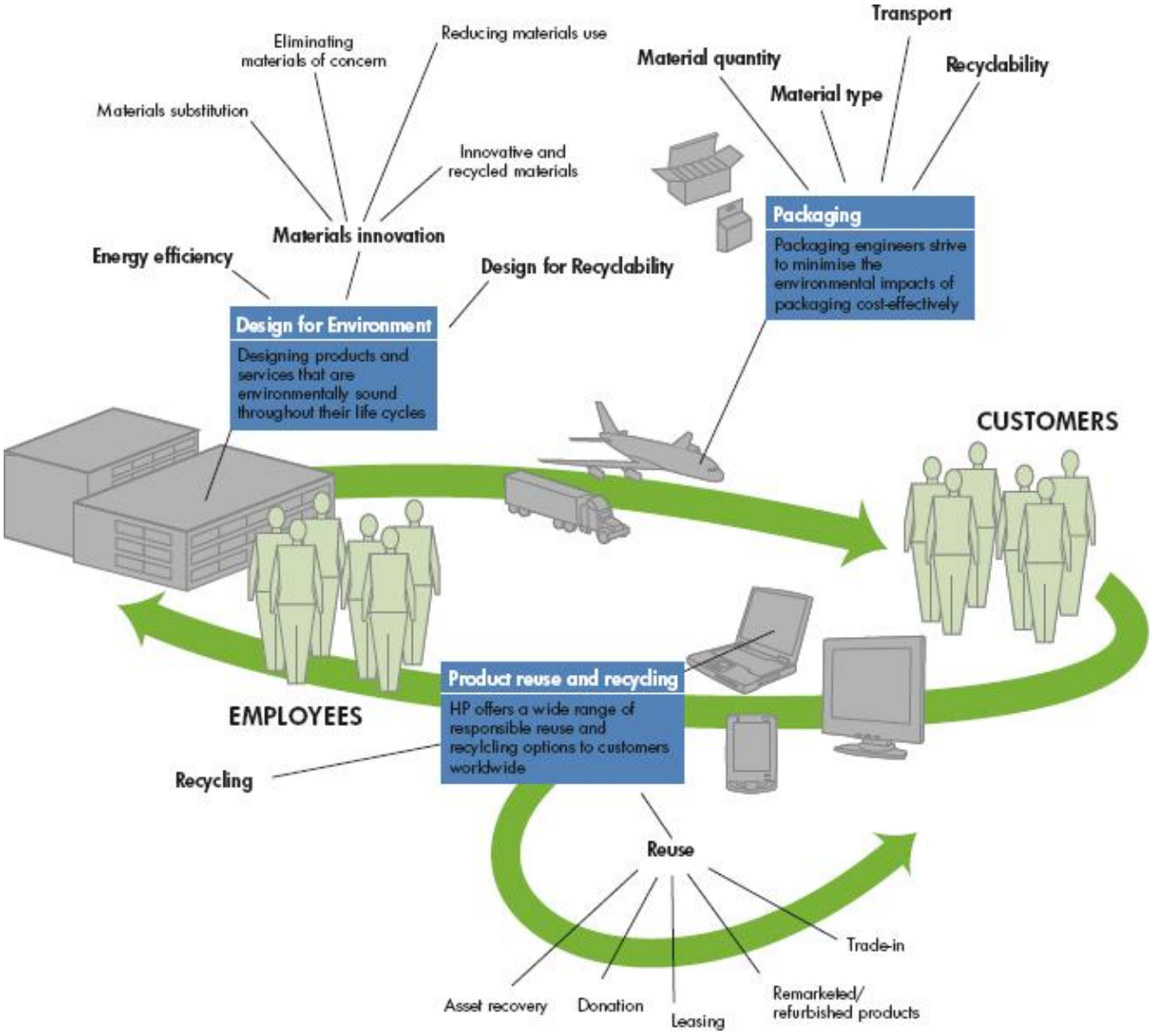


Figure 4.5. HP's activities that contribute to Sustainable IT

Source: Hewlett-Packard Development Company (2006)[40]

Product Service Systems

One of HP's offerings for enterprises is *End-User Workplace Solutions*[41] (*EUWS*), a type of *product service system*. End-User Workplace Solutions demonstrate the cost-effectiveness and performance superiority of *product service systems*. Customers can customise their End-User Workplace Solution by investing in any combination of many offerings, from service desk solutions, desktop solutions,

[39] Hewlett-Packard Development Company (2006) *Eco-labels*.
[40] Hewlett-Packard Development Company (2006) *2006/7 Global Citizenship Report: HP's contribution to the Australian community, environment and employees*, p 7.
[41] Hewlett-Packard Development Company (2006) *HP End-User Workplace Solutions*.

mobility and wireless solutions, to imaging and printing solutions, as well as messaging and collaboration solutions. End-User Workplace Solutions incorporate services for technology and support, consulting and integration, utility, and outsourcing.

HP encourages customers to assess the changes in their work environments as a result of deploying End-User Workplace Solutions:

1. The Universal College of Learning,[42] in New Zealand, invested in End-User Workplace Solutions to improve the IT facilities for its 650 employees. The venture delivered a 133 percent return on investment, which gives a payback period of 15 months. The End-User Workplace Solution also resulted in several measurable improvements:
   - The Help Desk now receives 310 calls per month (down from 573), 80 percent of calls are solved within eight hours, and there are zero unresolved issues carried over to the next period (down from 118 per month).
   - Server downtime, a measure of availability and reliability, now occurs 2-3 times per year, down from 52 times per year.
   - The annual hardware and software product upgrades now take about two person-weeks per 1000 desktop computers, down from 2 man-months.
   - Usage monitoring revealed that more than 200 computers could be, and were, eliminated from the network.
   - The number of computers manageable per full time equivalent IT employee is now 115, up from 53.
   - A user satisfaction survey showed that 89-97 percent of employees were at least satisfied with the new facilities for all four categories surveyed, and the number of IT employees required to maintain the facilities remains flat while demand continues to grow on three campuses.
2. The International Rice Research Institute,[43] in the Philippines, is investing US$2.25 million over three years in End-User Workplace Solutions to improve the IT facilities for its 1000 employees. The investment will save an estimated US$2.46 million over the first three years. The End-User Workplace Solution has also resulted in several measurable improvements so far, with further optimisations planned:
   - PC support time is down by an estimated 34 percent.
   - The number of printers is down, with a goal of reducing total printers from 400 to 200 and thus saving an estimated 360 IT employee hours.
   - Downtime is now eliminated - down from several times per year.
   - Time to deploy a new application is now almost immediate, down from 3-4 weeks.
3. Krung Thai Computer Services, in Thailand, is investing US$4 million over three years in End-User Workplace Solutions to improve its IT facilities (which includes 12,000 PCs).[44] The investment in its first year has so far reduced costs by 17.2 percent, which is comprised of a 25.2 percent saving in direct costs (such as PC acquisitions and services, PC management and

[42] Thoughtware Worldwide (2006).
[43] IDC (2006).
[44] Hewlett-Packard Development Company (2005).

support, and support overhead) as well as a 4.1 percent saving in indirect costs (such as end-user operations and availability).[45] The End-User Workplace Solution has also resulted in several measurable improvements in its first year:

- The call failure rate fell from 12.6 to 2.3 percent
- The number of times the agreed performance targets and response times were not met fell by about 50 percent.

HP was able to provide a true end-to-end solution, offering full business and IT benefits to customers from our portfolio of hardware, software and services, plus the financial management component that no IT vendor has ever offered…

Sanpat Sopon, Managing Director, Hewlett-Packard (Thailand) Ltd., 2005[46]

End-of-Life Management

Since 2007, HP has offered a number of equipment end-of-life services within 52 countries and territories. HP acquires end-of-life equipment through returns, trade-ins, lease terminations and donations,[47] with donated equipment being passed onto disadvantaged individuals, schools and charities.[48] HP recovers, inspects, evaluates, tests, refurbishes and recycles IT equipment[49] in every product category[50] from any manufacturer.[51] Some HP equipment is remarketed with a warranty.[52]

Between 1987 and 2007, HP recycled about 520,000 tons of equipment and has set a goal to reuse and recycle an additional 450,000 tons by 2010.[53] In 2007 alone, HP recycled 113 tons of equipment, and reused and remarketed 28,500 tons (about 3 million items) - which, together, are equivalent to 15 percent of HP relevant sales.[54]

HP aims to offer recycling services wherever HP products are sold[55] and has demonstrated expertise in equipment end-of-life management through several equipment collection and recycling programs. As of 2007, in Australia, HP only has a permanent cartridge recycling program, but has collected and recycled a wider variety of equipment through various partnerships.[56] HP is the sole industry partner in the *Byteback* computer recycling scheme, which is run in partnership with the Victorian State and Local Governments. Through *Byteback*, HP recycles IT equipment free-of-charge for Victorian residents and small businesses. Equipment is transported to a facility for disassembly and the resulting components are transported to domestic and international facilities for final processing. HP also participates in the *Cartridges 4 Planet Ark* program with Planet Ark and other manufacturers. Through *Cartridges 4 Planet Ark*, HP collects and recycles print consumables from printers, photocopiers and fax machines, with all equipment prevented from being landfilled. Finally, HP also initiated a two-day equipment take-back initiative across New South Wales with an IT retailer. HP

[45] Hewlett-Packard Development Company (2004).
[46] Hewlett-Packard Development Company (2005) quoting Sanpat Sopon.
[47] Hewlett-Packard Development Company (2006) *2006 Global Citizenship Report*, p 28.
[48] Hewlett-Packard Development Company (2006) *2006 Global Citizenship Report*, p 28.
[49] Hewlett-Packard Development Company (2006) *2006 Global Citizenship Report*, p 28.
[50] Hewlett-Packard Development Company website – *Product return and recycling*.
[51] Hewlett-Packard Development Company (2006) *HP expands global recycling program*.
[52] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 95.
[53] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 98.
[54] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 92.
[55] Hewlett-Packard Development Company website – *Our commitment to environmentally sustainable development*.
[56] Hewlett-Packard Development Company (2006) *2006/7 Global Citizenship Report: HP's contribution to the Australian community, environment and employees*, p3,9-10.

offered discounts on HP equipment to customers who participated in the initiative.HP is now planning more permanent equipment collection programs in Australia.[57]

Packaging Materials

HP designs packaging to:

- *Eliminate toxic substances*: HP has eliminated PVC[58] and heavy metals.[59]
- *Incorporate recycled materials*: HP has begun using biopolymers (biodegradable materials made from crop wastes), and created packaging from 100 percent recycled polyethylene terephthalate (PET) (used for inkjet cartridge blister packs),[60] as well as using moulded pulp and other recycled content (used in PC packaging).[61]
- *Reduce mass*: HP has replaced wooden pallets with foam plastic pallets, which have a 13kg lower mass (used for shipping notebook computers from China to Europe) and has simplified product documentation and CDs. HP also packages PCs together[62] and has reduced the mass of LaserJet toner cartridge packaging by 45 percent compared to previous designs, which allows 30 percent more cartridges to fit on a single pallet.[63]

Design for End-of-Life Processing

HP's *design for recyclability* focus aims to make equipment end-of-life processing simpler and more cost-effective,[64] and hence increases equipment salvage value and reduces environmental impact. HP has its own design for recycling standards, the features of which include:[65]

- Using modular designs so components can easily be removed, upgraded or replaced.
- Eliminating glues and adhesives by using, for example, snap-in features.
- Marking plastic parts that weigh more than 25 grams to aid materials identification during recycling.
- Reducing the number and types of materials used.
- Using single-plastic polymers.
- Using moulded-in colours and finishes instead of paint, coatings or plating.

HP's design for recyclability standards are reflected in all items of equipment.[66] For example, HP's printing and imaging equipment[67] is typically 70-85 percent recyclable or recoverable by mass. Compared to monochrome HP LaserJet print cartridges in 1992, current cartridges have less than half of the average number of parts and less than two-thirds of the average number of plastic resins.

[57] Hewlett-Packard Development Company (2006) *HP expands global recycling program*; Hewlett-Packard Development Company (2006) *2006/7 Global Citizenship Report: HP's contribution to the Australian community, environment and employees*, p. 5.
[58] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p. 111.
[59] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[60] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p. 111.
[61] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[62] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[63] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p. 111.
[64] Hewlett-Packard Development Company (2006) *Responsible practices for a happy earth*.
[65] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[66] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[67] Hewlett-Packard Development Company (2007) *Global Citizenship*.

Many HP Deskjet printers do not use paint, plating and flame retardants, they do not adhere dissimilar materials, and they use a snap-fit design with a limited number of similar screws. These printers have a mass as low as 2kg. Some printers share a particular platform with common parts that is projected to reduce materials consumption by more than 26,000 tons over four years compared to the previous platform. Another example is computers – the rp5700 desktop computer has a tool-less chassis and contains 95 percent recyclable components, and HP's notebook computers are more than 90 percent recyclable or recoverable by mass.[68]

Client Equipment – Energy Consumption

HP's *energy efficiency* focus aims to reduce energy consumption during operation and manufacture.[69] HP has developed several low-energy technologies that feature in its equipment:

- *Computers*: HP has created low-energy computers for all applications. For example, the rp5700 desktop computer, when coupled with an LDC monitor, consumes up to 80 percent less energy than does its predecessor coupled with a CRT monitor.[70] The Blade computer incorporates a processor that is ten-times more efficient than those in a typical desktop PC.[71] The xw6400 Workstation provides five-times better processing performance per unit energy than its predecessor.[72] HP's thin client technology can reduce power consumption by more than 80 percent compared to a typical desktop system.[73]
- *Computer components*: Three main components that reduce the computer's energy consumption are low-energy processors, the HP BIOS,[74] and power supplies. HP computers incorporate low-energy processors, and HP's computer BIOS provides several power management features, including support for all industry-standard sleep states and processor throttling, as well as thermal and acoustic management. HP ships all computers with power management features enabled on both processors and BIOS. In 2007, power supplies were on average 15 percent more energy efficient than previous power supplies.[75] External power supplies for notebook computers are at least 84 percent efficient and consume less than 0.5W when disconnected from the computer.[76]
- *Printers*:[77] HP LaserJet printers and new HP inkjet printers automatically transition to a sleep mode when inactive for a period of time and consume less than 1W in off mode. The LaserJet P1005 printer series consumes almost 25 percent less energy to print a page than its predecessor through two features: 1) the specific toner placement; and 2) the toner formulation, which requires 15 percent less energy to reach its melting point than conventional toner.
- *Internet communication*: HP Halo Telepresence Solutions,[78] a video conferencing technology, enables face-to-face meetings without the associated travel. Halo provides an environment that looks, sounds and feels much like that of a face-to-face meeting. In one HP project that used Halo, the team improved time-to-market by six months and eliminated 44 international trips,

[68] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, pp 88, 103.
[69] Hewlett-Packard Development Company (2006) *Responsible practices for a happy earth*.
[70] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 88.
[71] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[72] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[73] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 81.
[74] Hewlett-Packard Development Company (2007) *Energy Efficiency Setup Guide*.
[75] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[76] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 80.
[77] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, pp 80, 109.
[78] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 82.

preventing more than 143 tons of CO_2 equivalent emissions – the equivalent of removing 26 cars from the road for one year.

HP is also working to reduce the energy consumption of its operations.[79] In 2007, HP met its goal to reduce the combined energy consumption and associated GHG emissions of its operations and products to 20 percent below 2005 levels. HP is now targeting a reduction to 25 percent below 2005 levels by 2010, which will require HP to reduce energy consumption and GHG emissions from its facilities to 16 percent below 2005 levels.[80]

Client Equipment – Materials Consumption

HP's *materials innovation* focus aims to reduce materials consumption and hence improve transportation efficiency,[81] and to reduce environmental impact and enhance end-of-life value of materials.[82]

With regard to the first aim, HP actively seeks to reduce equipment mass and incorporate innovative and recycled materials,[83] as evident in HP's equipment:

- *Computers*:[84] Compared to equivalent conventional computers, production of the Consumer Slimline desktop computer over financial year 2006-7 required 8,500 tons less metal, which is about the metal mass in the Eiffel Tower.
- *Printers*:[85] The LaserJet P1005 printer series has the most compact design to-date of any LaserJet printer. These printers use compact cartridges that require 10 percent less plastic by mass than previous generations, and the specific toner placement results in 9 percent less toner consumed per page without compromising output quality.
- *Scanners*: A HP scanner contains materials from recycled print cartridges and plastic drinking bottles.[86]

With regard to the second aim, HP actively seeks to substitute potentially harmful materials and eliminate materials of concern,[87] as evident in HP equipment such as the LaserJet M3035 and P3005 multifunction printers.[88] HP ensures materials safety by requiring suppliers to provide information about their supply chain standards (such as the HP General Specification on the Environment[89]) and management processes that control regulated and restricted materials.[90]

[79] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, pp 71-74.
[80] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 90.
[81] Hewlett-Packard Development Company (2006) *2006/7 Global Citizenship Report: HP's contribution to the Australian community, environment and employees*, p8.
[82] Hewlett-Packard Development Company (2006) *Responsible practices for a happy earth*; Hewlett-Packard Development Company – *Material use*.
[83] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[84] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 109.
[85] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 109.
[86] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[87] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[88] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[89] Hewlett-Packard Development Company (2007) *HP Standard 011 General Specification for the Environment*, Revision K.
[90] Hewlett-Packard Company (2008) *White Paper: HP Green Procurement Guidance*, p 4.

Data Centres

HP has several products that reduce energy consumption in data centres, including:

- *Servers*:[91] A number of servers that incorporate thermal logic consume 33 percent less energy than do conventional rack-mounted servers. The ProLiant 360 G5 server consumes 28 percent less energy than its G4 predecessor while providing three-times more processing power.
- *Storage*: Some disk storage systems and tape drives can reduce storage power and associated cooling costs by up to 50 percent.[92]
- *Network*: The SURVEYOR software helps to reduce network energy consumption through energy measurement and management.

HP also has operational expertise in reducing data centre energy consumption available through offerings such as:

- *Thermal Assessments*:[93] Assessment of data centre power and the cooling environment to determine the optimal layout, including gap analysis and modelling of the thermodynamics (pressure, airflow, temperature) in the data centre, beneath its floor and above its ceiling.
- *Thermal Zone Mapping*:[94] Mapping of the regions serviced by each computer room air-conditioning (CRAC) unit to optimise cooling settings, and match rack-density and server importance with the space cooling profile.
- *Dynamic Smart Cooling*: An advanced hardware and software cooling solution that adjusts air-conditioning to a changing environment.[95] Dynamic Smart Cooling can reduce cooling costs by 25-40 percent.[96]

Legislation and Regulation

HP supports laws and regulations that promote cost-effective energy efficiency[97] and end-of-life programs.[98] For example, in Australia, HP supports the *Australian Information Industry Association*'s national collection and recycling program for all IT manufacturers and suppliers.[99] In Europe, HP, in partnership with other electronics manufacturers, founded the *European Recycling Platform* (ERP).[100] The ERP ensures cost-effective implementation of the European Union's *Waste Electronic and Electrical Equipment* directive through innovative waste management strategies. HP equipment complies with the European Union's *Restriction of Hazardous Substances* directive and HP is taking steps to meet the requirements of the European Union's *Registration, Evaluation, Authorisation and Restriction of Chemical Substances* regulation.[101]

[91] Hewlett-Packard Development Company (2007) *HP FY07 Global Citizenship Report: Web Content*, p 81.
[92] Hewlett-Packard Development Company (2007) *Global Citizenship*.
[93] Hewlett-Packard Development Company (2007) *HP Data Center Services: Infrastructure*.
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Key Words for Searching Online

Sustainable IT, product service systems, data centre, server, server density, computer room air-conditioning (CRAC), virtual server, uninterruptable power supply (UPS), hot isle/cold isle, direct liquid cooling, HP, End-User Workplace Solutions, IT recycling, design for environment, design for recyclability, IT energy efficiency, IT materials innovation, materials of concern, European Recycling Platform, Waste Electronic and Electrical Equipment (WEEE), Restriction of Hazardous Substances (RoHS); Registration, Evaluation, Authorisation and Restriction of Chemical Substances (REACH).