SUSTAINABLE IT

REDUCING CARBON FOOTPRINT AND MATERIALS WASTE IN THE IT ENVIRONMENT

LECTURE ONE

DRIVERS AND BENEFITS OF SUSTAINABLE IT

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INTRODUCTION

Sustainable IT, also known as *Green IT*, is a multi-component approach to establishing and sustainably operating an IT business function. *Sustainable IT* is becoming increasingly important in the eyes of many organisations. A survey[1] of organisations of all sizes across both the government and corporate sectors found that 80 percent of IT decision makers believe that implementing *Sustainable IT* in their organisations is important and 49 percent cite positive reputation as one of the greatest benefits. However, 51 percent of IT decision makers cite cost as a barrier to implementing *Sustainable IT* technologies, 25 percent cite complexity of implementation and maintenance, and 21 percent cite potential disruptions to current IT systems.

This Lectures Series offers a solution that addresses many barriers to *Sustainable IT* while optimising costs and minimising negative environmental impact. The focus is on the product and service provision components of *Sustainable IT*. Specifically, these lectures describe a holistic, end-to-end solution for IT systems of medium and large enterprises. This solution consists of:

- *Product service systems*: also known as *sustainable services and systems* and *eco-efficient services*.[2] There are several *product service systems* topologies. These Lectures describe the *use services* topology[3] as applied to IT products and services. In this topology, customers purchase the services of some or all IT hardware and software products through leasing, renting, sharing or pooling while the vendor maintains the ownership, responsibility and stewardship of the products. The aims are to remove aged technology with minimal environmental impact while customers maximise their investment on their IT systems. Vendors can be either an external company or the customer's IT business function, operating largely independently.
- *Sustainable IT products*: i.e. those items of client and data centre equipment that are resource efficient to manufacture, transport and operate, and have low-to-no adverse health impacts on people and the environment throughout their lifecycles.

These lectures draw from information regarding *product service systems* and *sustainable IT products*. They also draw from information regarding the development and implementation of several previously and currently popular IT service models that are relevant to successful *product service systems*, including: *IT service management* (ITSM),[4] also known as *service-oriented IT management* (SOITM); *service-oriented architecture* (SOA),[5] also known as *service-oriented computing* (SOC); and *IT leasing.*[6]

Since an IT system is a large and heavily integrated system with many components, a change in any component of the system will impact on several other components. Thus, it is important that decisions are informed by an accurate understanding and assessment of the impacts on the whole IT system. Hence, readers may be interested in learning about the business components of *Sustainable IT*,

[1] CDW (2008).
[2] Centre for Sustainable Design website; Heiskanen, E. and Jalas, M. (2003).
[3] Hockerts, K. (1999) and Schrader, U. (1999) cited in Centre for Sustainable Design website.
[4] In ITSM, vendors help customers manage their IT resources, usually through a framework for IT activities. ITSM can be more effective through a vendor since many customers lack the expertise to manage large, complex IT systems.
[5] SOA is a software architecture in which software services are accessible to customers over a network, usually the Internet, while being hosted externally. Customers specify the software services required and vendors make them available.
[6] In IT leasing, customers lease IT products from vendors. The vendors maintain ownership and responsibility of the products.

which are beyond the scope of these lectures. The business components are particularly relevant to decision makers in enterprises and include:

- *IT business function governance:* Corporate Social Responsibility (CSR), sustainability Capability Maturity Model (CMM), change management, supply chain management.
- *IT business function management:* revenue, cost minimisation, asset utilisation, risk minimisation.
- *Environmental management systems:* ISO 14000 family, Eco-Management and Audit Scheme (EMAS).
- *Resource audits:* energy and waste.
- *Developing projects:* scoping, goals, objectives and targets.
- *Measurement:* Balanced Scorecard, key performance indicators (KPI), metrics, lifecycle analysis (LCA).
- *Reporting:* Triple Bottom Line (TBL), Global Reporting Initiative (GRI), carbon footprint.
- *IT industry maturity and trends:* emerging technologies, regulations, Emissions Trading Scheme (ETS), carbon offsets.

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 1: Drivers and Benefits of Sustainable IT

Educational Aim

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Required Reading

Reference	Page
Lane, J.C. (2001) 'Leasing can Maximize IT strategies', *Financial Executive*, June. Available at http://www.allbusiness.com/technology/790816-1.html. Accessed 10 June 2008.	
Hochstein, A., Zarnekow, R. and Brenner, W. (2005) 'Evaluation of service-oriented IT management in practice', *International Conference on Services Systems and Services Management*, pt.1, vol. 1, pp. 80-84.	pp 80-84
Vosicky, J.J. (1992) 'Capturing the benefits of high-tech leasing', *Financial Executive*, July-August. Available at http://www.allbusiness.com/technology/computer-software-management/332405-1.html. Accessed 10 June 2008.	

Learning Points

1. *Sustainable IT* solutions are holistic, end-to-end solutions for IT systems of medium and large enterprises and comprise of two main components: *product service systems* and *sustainable IT products*.
2. In *product service systems*, customers purchase the services of some or all IT hardware and software products through leasing, renting, sharing or pooling while the vendor maintains the ownership, responsibility and stewardship of the products.
3. *Sustainable IT products* are those items of client and data centre equipment that are resource efficient to manufacture, transport and operate, and have low-to-no adverse health impacts on people and the environment. It is important that changes to an IT system are informed by accurate assessments of the impacts on the whole IT system.

Drivers of Sustainable IT

4. Increasingly, customers are relying on the latest IT technologies, e-business applications and mobile technologies to improve competitiveness.[7] However, without in-house expertise or facilities, these tools and strategies also complicate and increase the cost of IT asset management, add substantial cost and increase system downtime.[8] A solution for many companies is outsourcing the procurement, maintenance and upgrading of IT products and services, or even the operation of the entire IT business function through *product service systems*, which can also free up human and financial resources while streamlining the business structure.

5. *Product service systems* involve procurement, maintenance, upgrading, and retirement of IT products and services. They can standardise the operations, release human and financial resources and significantly streamline information access, storage and support operations, while also eliminating the risk related to pollution and waste regulations and market expectations.

6. There are several market trends supporting *product service systems*, including: *product service systems* being preferred over un-serviced product ownership; a maturing market with new and commoditised technologies and new employment models that complements *product service systems*; competitive advantage being sought ahead of compulsory compliance; and growing pressure to reduce product end-of-life impacts on the environment, as well as pressure to reduce the impacts from each stage of product processing.

7. E-Waste is a serious problem. Worldwide, 20 to 50 million tons of e-waste are generated annually,[9] with 75-80 percent of end-of-life computers being land filled.[10]

8. Most electrical and electronic equipment (EEE) is toxic, increasing health risks to both humans and other organisms. Furthermore, with the exception of some plastics, the recycling rate for almost all of these substances is zero,[11] leading to possible contamination of both the soil and water surrounding the landfill sites.

9. Many countries are adopting or proposing legislation that encourages *Sustainable IT*, the aims of which are to: reduce e-waste volumes; reduce EEE toxicity; increase EEE end-of-life take back and recycling; and reduce transportation of e-waste internationally.

10. Australia is one of few developed countries that do not have these types of legislations. Voluntary product stewardship initiatives are currently in development by Australian Electrical and Electronic Manufacturers Association, Consumer Electronic Suppliers Association and Australian Information Industry Association. However, legislations that encourage *Sustainable IT* will not be in place in Australia for some time, which gives early adopters an extended period of competitive advantage.

Benefits of Sustainable IT

11. *Product service systems* offer customers several economic benefits, including: a spread out investment, which free financial resources; the flexibility to upgrade products and services at low immediate cost; reduced investment costs; and a high return on investment.

[7] Lane, J.C. (2001).
[8] Lane, J.C. (2001); Macquarie Group website – *Equipment life-cycle management;* Vosicky, J.J. (1992); Davey, N. (n.d.) quoting Melvin James.
[9] United Nations Environment Program (2006).
[10] Bingermann, M. (2008); Environment Victoria (2005), p. 6
[11] Environment Victoria (2005) pp. 8-9.

12. *Product service systems* offer customers several business benefits, including: reduced risk to the customer by sharing it with the vendor;[12] the ability to upgrade and expand quickly and regularly; simplicity and effectiveness by providing a single-source, end-to-end, product and service solution; and better service performance and security.
13. *Product service systems* are favoured by economies of scale because IT product and service provision is the main cost – most activities are targeted towards optimising this cost.
14. *Product service systems* allow relatively low total costs for product end-of-life management, which includes costs for collection, remanufacturing, recycling and disposal activities.
15. *Product service systems* improve resource productivity by: providing more services throughout their life because service intensity is usually higher for shared products, and recovery and reuse is enhanced;[13] addressing the compromise between product longevity and obsolescence through higher service intensity; and providing economic incentives to improve product longevity because the products and services costs and, often, operation costs are absorbed into the compensation to the vendor.[14]
16. The key features of *product service systems*, including leasing and sharing, have been robustly demonstrated with services other than those of IT equipment. Products include carpet,[15] cars,[16] laundry,[17] skiing equipment,[18] power drills[19] and books.[20]

[12] Charles, C. and Holmes, B. (n.d.); Macquarie Group website – *Equipment life-cycle management*.
[13] Heiskanen, E. and Jalas, M. (2003); Ness, D. *et al* (2005).
[14] Bulow (1986) cited in Heiskanen, E. and Jalas, M. (2003); Ness, D. *et al* (2005); Kent, J. and Buchhorn, M. (2001).
[15] Filar, J. *et al* (2005).
[16] Heiskanen, E. and Jalas, M. (2003).
[17] Heiskanen, E. and Jalas, M. (2003).
[18] Hirschl *et al* (2001) cited in Heiskanen, E. and Jalas, M. (2003).
[19] BMBF (1998) cited in Heiskanen, E. and Jalas, M. (2003).
[20] Mäki (1999) cited in Heiskanen, E. and Jalas, M. (2003).

Brief Background Information

Drivers: Business Competitiveness and Asset Complexity

Drivers for *Sustainable IT* are particularly compelling for customers with upwards of 500 workstations. Customers require their IT systems to support their operations by providing the right services as well as having the flexibility to adapt to new demands. Increasingly, customers are relying on the latest IT technologies, e-business applications and mobile technologies to improve competitiveness.[21] However, without in-house expertise or facilities, these tools and strategies also complicate and increase the cost of IT asset management, add substantial cost and increase system downtime.[22] In fact, a survey of companies revealed that 55 percent of respondents were unable to undertake business improvement projects because their IT systems were too rigid and complex.[23] A solution for many companies is outsourcing the procurement, maintenance and upgrading of IT products and services, or even the operation of the entire IT business function through *product service systems*, which can also free up human and financial resources while streamlining the business structure.

> *Constant technological advances, rendering yesterday's innovations obsolete, require companies to continually update technology to remain competitive. Today's mobile lifestyle has moved more technology out of the controlled office environment, making asset management progressively more difficult. Combined with an endless number of expansions, mergers and acquisitions, many organizations are left with a concoction of diverse technologies, making effective asset management even more difficult*.[24]

Product service systems involve procurement, maintenance, upgrading, and retirement of IT products and services. *Product service systems* can standardise the operations, release human and financial resources and significantly streamline information access, storage and support operations. It can also eliminate the risk related to pollution and waste regulations and market expectations.

Drivers: Market Forces

There is evidence that the market, in general, is maturing so as to favour *product service systems*. There are several market trends supporting *product service systems*:

- There is a growing tendency for IT business customers to prefer *product service systems* over un-serviced product ownership.[25]
- The market, in general, is maturing so as to favour *product service systems*[26] and other market-ready sustainable products and services. New and commoditised technologies that complement *product service systems* include server and storage virtualisation, online storage and desktop productivity tools. New employment models that are well supported by *product service systems* include the mobile workforce, where services provision is beyond the traditional working environment and hours, and the merging of work and home life where work is on personal equipment.

[21] Lane, J.C. (2001).
[22] Lane, J.C. (2001); Macquarie Group website – *Equipment life-cycle management;* Vosicky, J.J. (1992); Davey, N. (n.d.) quoting Melvin James.
[23] Davey, N. (n.d.) quoting Melvin James.
[24] Lane, J.C. (2001).
[25] Alexander (1997) cited in Heiskanen, E. and Jalas, M. (2003); Vosicky, J.J. (1992).
[26] Heiskanen, E. and Jalas, M. (2003).

- In Australia, *product service systems* can provide a competitive advantage for enterprises ahead of legislation that mandates strict management of waste IT hardware products (equipment).

  > *Compliance is another driver that is making IT more service-centric. Not only do companies have to deliver excellent customer service, but they often have to rise to the challenge of meeting the regulations imposed on their industry at the same time.*[27]

- There is pressure from consumers to reduce adverse environmental impacts from their end-of-life equipment. Currently, 75-80 percent of end-of-life computers are landfilled,[28] with very few of the 1000 toxic substances, other than plastics, being removed first.
- There is pressure to reduce adverse social and environmental impacts. The toxic substances in IT equipment can be released into the industrial and natural environments at all stages of processing, operation and retirement,[29] and can result in an array of negative impacts on humans and other organisms.[30]
- Vendors, with their expertise and experience, have much better control over environmental and social impacts than customers.

In addition, a review of the link between *product service systems* and eco-efficiency highlights several current economic and market trends that support the wide-spread adoption of *product service systems*:[31]

- saturated markets
- the information economy, disintegration of industry boundaries, blur between products and services
- post-material lifestyles
- customer orientation, relationship marketing, customer retention
- mass customization
- lean production, efficient use of capital
- core competencies, outsourcing
- increased importance of shareholder value and stock market value

Drivers: Environmental Pressures and Legislation

- *The Pressures of E-Waste*: Waste electrical and electronic equipment (e-waste) imposes a substantial strain on waste management and the environment. Worldwide, 20 to 50 million tons of e-waste are generated annually,[32] with this figure growing, especially for short-life IT equipment. In 2008, it is estimated that 302 million computers will be sold worldwide,[33] bringing the total

[27] Davey, N. (n.d.) quoting Marina Stedmann.
[28] Bingermann, M. (2008); Environment Victoria (2005), p. 6
[29] Brigden, K. *et al* (2005), p. 3.
[30] Brigden, K. *et al* (2005), p. 3; Environment Victoria (2005) pp. 8-9; Schmidt, C.W. (2002).
[31] Heiskanen, E. and Jalas, M. (2003).
[32] United Nations Environment Program (2006).
[33] IDC (2008).

number of computers in use to more than 1 billion after 27 years.[34] It is estimated that 2 billion computers will be in use by as soon as 2015, with 775 million of the new computers arising in Brazil, Russia, India and China.[35] The increasing e-waste resulting from the increasing computer sales is compounded by decreasing computer operating life. The operating life of a modern computer has decreased from 4-6 years in 1997 to 2 years in 2005.[36] E-waste is the fastest growing component of municipal trash streams, growing three times faster than any other type of waste in the European Union.[37] E-waste also represents valuable materials being made unrecoverable in landfill.

Most electrical and electronic equipment (EEE) is toxic.[38] In fact, EEE can contain up to 1000 different toxic substances, many of which can be released into the industrial and natural environments at all stages of processing and operation,[39] and thus can result in an array of negative health impacts on humans and other organisms.[40] Furthermore, with the exception of some plastics, the recycling rate for almost all of these substances is zero,[41] so there is a good chance that they will contaminate soil and water bodies near landfills.

- *E-Waste Solutions*: Many countries are adopting or proposing legislation that encourages *Sustainable IT*,[42] including the United States, Canada, Mexico, China, Taiwan, Japan, Korea[43] and the European Union.[44] The legislations, which also affect companies in other countries, aim to:

  - reduce e-waste volumes;
  - reduce EEE toxicity;
  - increase EEE end-of-life take back and recycling; and
  - reduce transportation of e-waste internationally.

  These legislations directly encourage *Sustainable IT*.[45]

  Australia is one of few developed countries that do not have these types of legislations. For example, Australia is yet to enforce product-take back of EEE,[46] while at the state level, only the ACT currently bans computer waste to municipal landfill.[47] However, voluntary product stewardship initiatives are currently in development by Australian Electrical and Electronic Manufacturers Association, Consumer Electronic Suppliers Association and Australian Information Industry Association, the peak electrical and electronic industry associations.[48]

[34] Forrester (2007).
[35] Forrester (2007).
[36] Jayakody, C.S. (2004).
[37] Europa (2005).
[38] Earth tones (2006).
[39] Brigden, K. *et al* (2005), p. 3.
[40] Brigden, K. *et al* (2005); Environment Victoria (2005) pp. 8-9.
[41] Environment Victoria (2005) pp. 8-9.
[42] Davey, N. (n.d.) quoting Marina Stedmann.
[43] Hewlett-Packard Development Company (2006) *2006/7 Global Citizenship Report: HP's contribution to the Australian community, environment and employees*, p8.
[44] European Union (2003) 'Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE)'; European Union (2003) 'Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment'; European Union (2006).
[45] Davey, N. (n.d.) quoting Marina Stedmann.
[46] Environment Victoria (2005) p. 17.
[47] Environment Victoria (2005) p. 17.
[48] Department of the Environment, Water, Heritage and the Arts website.

The lack of legislation and regulation has likely led to Australia becoming a laggard in *Sustainable IT*. Legislations and regulations that encourage *Sustainable IT* will not be in place in Australia for some time, which gives early adopters an extended period of competitive advantage.

Benefits: Economic and Business Benefits to the Customer

Product service systems offer customers real economic benefits:

- *Free financial resources*: *Product service systems* improve the customer's financial flexibility.[49] Since the investment is spread out over the contract period, no large initial investment is required[50] and thus financial resources are freed for other activities.[51] Spreading out the investment can also yield improved purchasing power, easier financial forecasting, tax benefits, immunity to interest rates, and improved access to loans and overdrafts.[52] Customers have the flexibility to upgrade products and services at low immediate cost while not having to wait to pay off their current products.[53] Alternatively, customers can save 40-70 percent on product costs by leasing used products, the costs of which decrease 20-50 percent annually to make way for new products that perform only slightly better.[54]
- *Reduce investment costs*: *Product service systems* yield lower total cost to the customer. Several practical *product service systems* have demonstrated that customers can expect high return on investment and hence substantial medium- and long-term cost savings.[55]
- *Share the technological and economic risks with vendors*:[56] The IT industry is one of the most rapidly progressive commercial industries. Its dynamic nature presents risks to customers. For example, new technologies are developed so fast that there is rarely time for them to be proven reliable; and, consequently, the IT markets are somewhat unpredictable. *Product service systems* reduce the risk to the customer by sharing it with the vendor.[57] Furthermore, the overall risk is reduced since the vendor's expertise enables more accurate risk assessment.
- *Upgrade and expand regularly*: The rapid innovations in the IT industry require customers to update their products and services regularly,[58] roughly every three years.[59] *Product service systems* make regular upgrades cost-effective[60] and relatively quick and uniform across the customer's facility.[61] They also accommodate business expansions and downsizing, ensuring that the customer only pays for the products and services required at the time.[62] *Product service*

[49] Kent, J. and Buchhorn, M. (2001); Monash University website.
[50] Lane, J.C. (2001); Sopko, S. (1992); Schroder cited in Dwyer, J. (1995); Monash University website; Hewlett-Packard Development Company (2004).
[51] Macquarie Bank website – *Leasing*; Hewlett-Packard Development Company website – *Learn about the benefits of leasing*.
[52] Sopko, S. (1992); Schroder cited in Dwyer, J. (1995); Hewlett-Packard Development Company website – *Learn about the benefits of leasing*; Monash University website; Lane, J.C. (2001).
[53] Vosicky, J.J. (1992); Schroder cited in Dwyer, J. (1995); Hewlett-Packard Development Company website – *Learn about the benefits of leasing*.
[54] Vosicky, J.J. (1992).
[55] Thoughtware Worldwide (2006); IDC (2006); Hewlett-Packard Development Company (2005).
[56] Charles, C. and Holmes, B. (n.d.); Macquarie Group website – *Equipment life-cycle management*.
[57] Charles, C. and Holmes, B. (n.d.); Macquarie Group website – *Equipment life-cycle management*.
[58] Hewlett-Packard Development Company (2004).
[59] Vosicky, J.J. (1992).
[60] Lane, J.C. (2001).
[61] Monash University; Hewlett-Packard Development Company (2005).
[62] Hewlett-Packard Development Company website – *Learn about the benefits of leasing*.

systems also provide software and consulting services, which are usually the most costly part of an IT system.[63]

- *Simplicity and effectiveness*: *Product service systems* streamline the customer's business operations by providing a single-source, end-to-end, product and service solution, which minimises the delays, administration costs and complexity of engaging multiple vendors or performing those activities themselves.[64] Vendors are responsible for IT asset management and thus have an incentive to simplify their portfolio of products.[65] Monash University in Australia, a *product service systems* customer, has reported that their *product service system* has introduced consistency among its IT products by establishing standard minimum configurations and engaging a small number of product suppliers.[66]
- *Better service performance and security, and hence perform better themselves*: Vendors can manage products and services,[67] while customers can use freed human resources to concentrate on their core business or expansion.[68] Vendors have greater expertise in their products, services and industry than customers. Thus, vendors can more comprehensively manage products and services, resulting in a higher quality of service to customers.[69] In fact, a study of six large companies in the manufacturing, banking, IT and public sectors revealed that all companies enjoyed a higher quality of service, greater efficiency through standardisation, better optimised processes and automated processes.[70] Customers can then use freed human and financial resources to concentrate on their core business or expansion.[71]

Benefits: Economies of Scale Favour Product Service Systems

For individuals or companies that have many costs, it may not be worth optimising a single cost such as that of their IT system. For vendors, however, IT system costs are the main cost and thus inevitably will be optimised, creating greater value for the customer.[72] Scale-related efficiency improvements have also been demonstrated with centralised voice mail, water services and household maintenance services.[73]

Benefits: Lower Total Costs for Product End-of-life Management

Another key economic benefit is relatively low costs for product end-of-life management, which includes costs for collection, remanufacturing, recycling and disposal activities. This benefit is particularly important because it provides an incentive to respond to market pressure to reduce adverse environmental and social impacts from end-of-life equipment.

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[63] Lane, J.C. (2001).
[64] Hewlett-Packard Development Company website – *Learn about the benefits of leasing*; Macquarie Bank website – *IT and Technology Financing*; Hewlett-Packard Development Company (2005).
[65] Lane, J.C. (2001); Macquarie Group – *Equipment life-cycle management*.
[66] Monash University website.
[67] Charles, C. and Holmes, B. (n.d.); Heiskanen, E. and Jalas, M. (2003); Hewlett-Packard Development Company (2005); Hochstein, A., Zarnekow, R. and Brenner, W. (2005).
[68] Davey, N. (n.d.) quoting Ross Altman; Charles, C. and Holmes, B. (n.d.); Macquarie Bank website – *IT and Technology Financing*; Hewlett-Packard Development Company (2005).
[69] Charles, C. and Holmes, B. (n.d.); Heiskanen, E. and Jalas, M. (2003); Hewlett-Packard Development Company (2005).
[70] Hochstein, A., Zarnekow, R. and Brenner, W. (2005).
[71] Davey, N. (n.d.) quoting Ross Altman; Charles, C. and Holmes, B. (n.d.); Macquarie Bank website – *IT and Technology Financing*; Hewlett-Packard Development Company (2005).
[72] Heiskanen, E. and Jalas, M. (2003).
[73] Heiskanen, E. and Jalas, M. (2003).

In *product service systems*, the vendor maintains ownership of products and consequently carries the responsibility of equipment end-of-life management.[74] This cost need not be high and can be offset. Firstly, at least some of the cost can be included in compensation to the vendor. Secondly, collection costs are relatively low since the products are easily traceable and collection is scheduled. Finally, vendors can plan more cost-effective collection, reuse, recycling and disposal activities with a larger volume of products.[75]

In fact, the costs of implementing the European Union's Waste Electrical and Electronic Equipment directive are lower than initially expected, even without the offsets available through *product service systems*.[76] The highest and lowest recycling costs for IT equipment reported in the review are summarised in Table 1.1. Recycling costs in countries that have multiple recyclers are far lower than those that have only a single recycler, due to competition.[77]

Table 1.1: The highest and lowest recycling costs for IT equipment in the European Union

Country	Laptop Computer	Desktop Computer	Inkjet Printer	LaserJet Printer	Flat Screen Monitor	Number of recyclers
Germany	0.07€	0.38€	0.12€	0.43€	0.29€	Multiple
Spain	0.20€	0.50€	0.18€	0.75€	0.81€	Multiple
Belgium	1.65€	2.48€	1.65€	1.65€	4.96€	Single
Switzerland	6.00€	6.00€	3.00€	4.00€	6.00€	Single

Source: Hewlett-Packard Development Company (2006)[78]

Benefits: Improved Resource Productivity

- *Improved resource productivity throughout the supply chain*: In *product service systems*, products will generally provide more services throughout their life because service intensity is usually higher for shared products, and recovery and reuse is enhanced.[79] In fact, the absolute lifespan of some IT equipment can be longer in *product service systems*, despite higher service intensity.[80] Higher service intensity and possible longer lifespan results in improved resource efficiency, not only of input materials, but also of raw materials and transportation resources; and also results in reduced waste and associated environmental damage.[81]
- *Address the compromise between product longevity and obsolescence*: Higher service intensity results in more frequent product failures. Consequently, equipment can be replaced with the latest technologies more regularly without forfeiting useful service life.[82] In addition, resource efficiency improvements can be had more regularly if the vendor has a focus on *sustainable IT products*, particularly resource efficiency.

[74] Hewlett-Packard Development Company website – *Learn about the benefits of leasing*; Monash University.
[75] Heiskanen, E. and Jalas, M. (2003).
[76] Hewlett-Packard Development Company (2006) *Real consumer cost for electronic equipment recycling as low as 1 Eruo cent*.
[77] Hewlett-Packard Development Company (2006) *Real consumer cost for electronic equipment recycling as low as 1 Eruo cent*.
[78] Hewlett-Packard Development Company (2006) *Real consumer cost for electronic equipment recycling as low as 1 Eruo cent*
[79] Heiskanen, E. and Jalas, M. (2003); Ness, D. *et al* (2005).
[80] Mont (2001) cited in Heiskanen, E. and Jalas, M. (2003).
[81] Ness, D. *et al* (2005).
[82] Heiskanen, E. and Jalas, M. (2003); Macquarie Group website – *Equipment life-cycle management*.

- *Economic incentive to improve resource efficiency*: Vendors of leased equipment have more incentives to improve product longevity than vendors of purchased equipment.[83] For example, a study of two large IT vendors' long-term sales and leases indicated that the more the vendor leased their products, the less they invested in new product development.[84] This inverse relationship arises because, in *product service systems*, the products and services costs and, often, operation costs are absorbed into the compensation to the vendor. The vendor thus has an incentive to enhance profits by minimising the need for new products and hence resources[85]; and by providing resource efficient technologies, which are cheaper to operate.[86] Minimising the need for new products is also encouraged by a strong market for used high-tech, wherein vendors can sell or re-lease products to other customers.[87]

Benefits Case Studies: Sustainability Benefits in Non-IT Industries

The *product service systems* model is not new. The key features, including leasing and sharing, have been robustly demonstrated with services other than those of IT equipment, as briefly described in the following familiar case studies:

- *Carpet*: A study of Interface, a carpet manufacturer that provides its products through a *product service system*, compared several performance measures of a conventional purchase system and a *product service system* over four service periods, where a service period is defined as either the product's useful life or the length of the service contract, respectively.[88] Table 1.2 summarises the results, highlighting the performance after 4 service periods compared to a reference of the initial period for the purchase system. The *product service system* outperformed the purchase system in every measured category while costing the customer only moderately more.

Table 1.2: Performance comparison of purchase system and *product service system* for Interface

	Purchase system	**Product service systems**
Probability renewed service period	0.2	0.9
Price/m^2 charged to clients	Moderate	Moderate-high
Cumulative revenue		
Ref: 100%	110%	500%
Cumulative landfill redirection of nylon per 1000m^2 of carpet		
Ref: 100kg	120kg	2050kg
Cumulative landfill redirection of PVC per 1000m^2 of carpet		
Ref:500kg	600kg	8800kg
Cumulative CO_2-equivalent savings during manufacturing (nylon and PVC) per 1000m^2 of carpet		

[83] Bulow (1986) cited in Heiskanen, E. and Jalas, M. (2003); Ness, D. *et al* (2005); Kent, J. and Buchhorn, M. (2001).
[84] Goering and Boyce (1993) cited in Heiskanen, E. and Jalas, M. (2003).
[85] Heiskanen, E. and Jalas, M. (2003).
[86] Ness, D. *et al* (2005).
[87] Vosicky, J.J. (1992).
[88] Filar, J. *et al* (2005).

Ref: 0kg	0kg	71,000kg

Source: Filar, J. *et al* (2005)

- *Cars*: A study of a Dutch car-sharing program with 337 customers showed that, compared to a purchase system, the number of cars in use and the required parking space was 44 percent lower, the cars were 22 percent lighter and 24 percent more fuel efficient, and the average car mileage was 33 percent lower.[89]
- *Laundry*: A review of professional and industrial laundry service performance showed that, compared to household washing and drying, these services can consume up to 80 percent less water, 85 percent less detergent and 77 percent less energy, and emit 33 percent less carbon dioxide.[90] The resource efficiency improvements arise as a result of better cost control of input resources, economies of scale, better equipment, and more skilled and knowledgeable operators.[91]
- *Skiing equipment*: A study on skiing equipment leasing found that, compared equipment ownership, the resource efficiency of the leased equipment is 1.7-fold higher due to shared use.[92]
- *Power drills*: A study compared the material intensity of customer-owned electric drills for 150 households with that of two shared professional electric drills for the same households. The material intensity per hole drilled was ten-fold higher for the two shared drills due to the shared use and higher quality of the drills.[93]
- *Books*: A study of Finland's public libraries found the shared use of books reduces paper consumption by 32,000 tons and carbon dioxide emissions by 13,800 tonnes annually, assuming every book is loan 60 times annually.[94]

[89] Heiskanen, E. and Jalas, M. (2003).
[90] Heiskanen, E. and Jalas, M. (2003).
[91] Heiskanen, E. and Jalas, M. (2003).
[92] Hirschl *et al* (2001) cited in Heiskanen, E. and Jalas, M. (2003).
[93] BMBF (1998) cited in Heiskanen, E. and Jalas, M. (2003).
[94] Mäki (1999) cited in Heiskanen, E. and Jalas, M. (2003).

Optional Reading

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3. Davey, N. (n.d.) *Service with a Smile*, CXO. Available at http://www.cxo.eu.com/pastissue/article.asp?art=26646&issue=162. Accessed 10 June 2008.
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Key Words for Searching Online

Sustainable IT, product service systems, business competitiveness, IT asset complexity, e-waste, WEEE, landfill impacts, toxic substances, product take-back, product end-of-life, technology risk, streamline IT, total cost of ownership, resource productivity, resource efficiency, longevity and obsolescence.