GREEN IT READINESS: A FRAMEWORK AND PRELIMINARY PROOF OF CONCEPT

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ABSTRACT

Businesses are under increasing pressure from customers, competitors, regulators and community groups to implement sustainable business practices. Balancing economic and environmental performance to be green and competitive is therefore a key strategic issue. The information technology (IT) sector is one of the pioneer sectors which started working on the sustainable development model. However, it is only lately that researchers and organisations have begun to consider the role of IT, not only in contributing to a businesses environmental footprint but also in tackling climate change problems. Usually coined as, "Green Information Technology", the role of IT in causing and resolving ecological sustainability, in maintaining low cost IT shops, in building green reputation capital and in supporting corporate green strategies has hardly been researched. This paper identifies five main areas of Green IT capability and describes the main pillars of a G-readiness framework to help organisations evaluate their maturity for Green IT. The utility of the framework is demonstrated through a desk-based research case study of four organisations. The paper argues that just as e-readiness has been, and continues to be, a critical capability in the digital economy, G-readiness is an equally critical capability in the low carbon digital economy. Without a clear understanding of G-readiness, organisations would approach Green IT initiatives on an ad hoc and somewhat reactive basis, which is undesirable.

Keywords

green IT, digital business, G-readiness index, IT strategy, sustainable business.

INTRODUCTION

The advance of information and communications technology (ICT) based business and social practices in the last few decades have transformed many, if not most, economies into e-economy and businesses into e-business. For economies, ICTs are increasingly playing critical roles in transforming and generating economic opportunities through automotive, informative and transformation capabilities (Chen et al. 2008; Elliot and Binney 2008). The expansion in the use of ICTs in the context of global warming, climate change and sustainability portends two major issues. On the one hand, estimates indicate that the ICT industry accounts for 2% of global CO_2 emissions, which is equivalent to the amount generated by the aviation industry (Goasduff and Forsling 2007). Each stage of the IT resources lifecycle from manufacturing to usage and disposal can pose environmental damages (Elliot and Binney 2008; Murugesan 2007). In addition, the use of ICTs might have had an

undesirable consequence of increasing the expansion of environmentally polluting business undertakings (Chen et al. 2008).

On the other hand, ICTs can be deployed to tackle the environmental footprint of a business. This role of ICTs can range from a carbon foot print analysis and reporting capability through supplanting traditionally carbon emitting and eco-unfriendly business practices, to deploying computerized models to reduce energy consumption. For example, in 2005 IBM USA's work-at-home program enabled by ICT, involved over 20,000 employees, saved more than 5 million gallons of fuel and avoided more than 50,000 tons of CO_2 emissions. Thus, telecommuting offers an important means by which traffic congestion and pollution can be addressed (Chen et al. 2008). A second example is the increasing number of utility companies that are moving to electronic billing, which has a potential to reduce paper consumption.

The above implies that as much as organisational IT infrastructure can contribute to carbon emission, effective and smart use of IT can help organisations to reduce their emissions. This paper refers to this dual role of IT as Green IT. Green IT poses two challenges to organisational IT strategy and governance which thus far has focused on the economical value of IT and the ethical conduct of IT professionals (Marshall et al. 2005; Ridgley 2009). First, organisations are likely to apply environmental and sustainability considerations in IT governance decisions. For example, Aronson (2008) recognised the increased environmental demands of ICT and proposed power efficiency as the most significant way of reducing ICTs environmental impacts. Second and perhaps more importantly, IT managers are expected to provide new tools and capabilities to support a business's carbon reduction and sustainability strategy (Chen et al. 2008). As companies come under increasing regulatory scrutiny to reduce their carbon intensity, IT initiatives can deliver some of these reductions.

Green IT, however, requires new organisational capabilities. Strategies in Greening IT have to start with a clear assessment of where the organisation is, its intended state and how far along the Green IT path it has progressed. The speed with which environmental sustainability impacts IT activities and economics requires a framework that not only accounts for factors enabling the spread and usage of Green IT but that also explicitly considers the roles played by key stakeholders, such as vendors, IT professionals, business executives and the government.

To date, few frameworks have emerged to serve as reliable guides for organisations and researchers alike on their Green IT practice and investigation respectively. As a result, there is a lack of understanding and tool to assess the Green IT maturity of organisations. This paper has produced a Green IT Readiness framework and case examples that demonstrate the utility of the framework. The paper aims to answer the following question: how can businesses assess their Green IT readiness?

The contribution of this paper to both IT theory and practice are manyfold. First, the paper addresses a critical research area that has received little academic research attention. This paper is, therefore, one of the first attempts to provide a theoretical lens to research Green IT. Second, the framework offers a common platform for practitioners to assess and benchmark their Green-IT initiatives and progress. Third, researchers can use this framework to understand important issues such as the drivers, values and antecedents of Green IT.

RESEARCH METHODS

The conceptual G-readiness framework described in this paper was developed by applying understanding from extant literature on E-readiness and Corporate Social Responsibility (CSR), along with extant literature and practitioner publications investigating issues surrounding Green IT, such as the adoption of green supply chain practices. Extant academic Information Systems (IS) literature is

used where available – although an extensive literature review of top IS journals has revealed that little academic research has occurred on the topic over the last 30 years (Elliot and Binney 2008). In order to demonstrate the utility of the "G-readiness" framework, desk-based research utilising secondary data from case studies of ANZ, Telstra, Australia Post and BHP are presented. These organisations were selected because they report to be proactive market leaders in the practice of CSR, e-business and the green movement as summarised in Table 1.

Company	**Description**	**Key CSR, E-business and Environmental Activities**
ANZ Bank	One of the largest Australian companies and a major international financial services organisation. ANZ offers a comprehensive range of financial services to individuals and small and large organisations (ANZ 2009).	• Ranked as the Number One bank globally on the Dow Jones Sustainability Index • Employs strategies to reduce direct and indirect negative impacts of the organization on the environment • Employs a strategy to improve the technology levels used by banks globally
Australia Post	Australia Post is a government business enterprise (GBE). Australia Post offers a range of traditional mail and courier services for individuals and corporations, along side a suite of electronic services such as bill payments (Australia Post 2009).	• Developed policies and strategies for CSR including for the environment incorporating substantial commitments to minmising its environmental footprint • Provides support for a range of community sustainability initiatives such as "Green PC"
BHP Billiton	A large resources company operating in aluminum; energy and metallurgical coal; copper; manganese; iron ore; uranium; nickel; silver and titanium minerals; diamonds; and oil, gas, liquefied natural gas (BHP 2009).	• Has extensive policies for Health, Safety, CSR and the Environment • Sets specific targets for greenhouse gas emissions and has had greenhouse gas reporting processes in place for some time
Telstra	Australia's largest telecommunications company offering mobile and home phone, internet and TV-based services (Telstra 2009).	• A range of environmental and CSR policies covering issues such as carbon emissions; resource efficiency and waste; and energy efficiency. • Measurement of greenhouse gas emission in place for several years

Table 1 Company Backgrounds

CONCEPTUAL BACKGROUND

Although the term "Green IT" is becoming more common in discussion, there is still little common understanding of what Green IT actually means. As Green IT is a nascent field, there is very little academic research on the topic. In order to develop the conceptual foundation of the framework proposed here, we undertook review of practitioner oriented Green IT publications and literature on the adoption of green process technologies, green supply chain practices and e-readiness.

Green IT

A review of practitioner publications as summarised in Table 2 indicates that Green IT is usually associated with technologies and techniques for improving the energy efficiency of data centres (ACS 2007; Mitchell 2008; Pettey 2006); for reducing the environmental impact of IT operations (Nunn 2007); and the use of IT as an enabler of organisational-wide green initiatives (Gartner 2008; Mines and Davis 2008). It encompasses not only hard technological solutions but also soft business practices and managerial actions to make IT-decision making as eco-friendly as possible (Info~Tech 2007a).

From a process technology perspective, green process technologies can be classified as *end of pipe technologies* and *clean technologies* (del Rio Gonzalez 2005). End of pipe technologies reduce the environmental impact of emissions without necessarily changing the production process. On the other hand, clean technologies cause significant changes in the production process and their adoption is intended to reduce the level of environmental impact along a product's life cycle from design to consumption. From a supply chain perspective, green supply chain refers to integrating environmental thinking into the product design, sourcing, manufacturing, warehousing, distributing and end of life product management aspects of a supply chain (Rao and Holt 2005; Srivastava 2007).

Reference	**Conceptualisation of Green IT**
ACS (2007)	Concern "about energy consumption and subsequent carbon dioxide emissions from commercial ICT equipment".
Mines & Davis (2008)	"Green IT is part of a fundamental change in the economy and society. It is a subset of the larger green (sustainable) business trend, which reconciles sustainable business practices with profitable business operations".
Info~Tech (2007a)	Identified 11 technologies and initiatives as indicators of green IT. These include "equipment recycling, server consolidation and virtualisation, optimizing data centre energy efficiency, print optimisation, data centre airflow management, rightsizing IT equipment, green considerations in sourcing and RFPs, hot aisle/cool aisle data centre layout, budget allocation for green IT projects, liquid cooling for IT equipment, DC powered IT equipment, airside/waterside economizer, carbon offsetting".
Gartner (2008)	Defines green IT based on the role of CIOs. "For most CIOs greenhouse gas emissions and getting IT's own house in order are the main issues. Their more important role, though is to help the enterprise address its enterprise wide environmental sustainability issues… [by playing] one or more of three roles: provide analytical tools, provide analytical/technical insight [and] lead change".
Nunn (2007)	For IT hardware suppliers, green IT is "running IT assets and services in a more energy-efficient way… how to limit and hopefully reduce the organisation's overall carbon foot print".
Mitchell (2008)	In the data centre, going green is about energy efficiency first and foremost. Fortunately, efficiency is a natural by-product of solving the cooling, power and space challenges that today's data centres face.

Table 2 Examples of Green IT Conceptualisation

E-readiness

One of the key challenges following the introduction of the Internet has been how to successfully transform from traditional business models and practices to e-business models. A number of national and international initiatives have been undertaken to assess the e-readiness of countries (Choucri et al. 2003; Mia and Dutta 2007). The aims of such initiatives at macro levels are to benchmark and

monitor the progress of countries to capture the opportunities enabled by the Internet and other forms of ICTs. From organisational specific e-readiness frameworks, we understand that e-readiness can be a source of competitive advantage in the networked economy and the prerequisite for successful e-business (Hartman et al. 2001; Molla and Licker 2005). Likewise, e-readiness assessment helps an organisation to pinpoint some of the hurdles that it might face in its trajectory towards e-business. It facilitates determining an organisation's capacity for e-business and serves as a tool for guiding strategic planning processes in developing e-business. Having resources such as skilled manpower, technology, appropriate organisational culture, organisational capabilities and learning, and overall organisational commitment in the form of management and administrative support, staff involvement and championship have been identified as constructs of e-readiness (Mia and Dutta 2007; Molla and Licker 2005). The insights from e-readiness studies highlight not only some of the variables but also the importance of e-readiness as a critical capability required to execute in the e-economy successfully. We draw a parallel from e-readiness and argue that Green IT readiness (G-Readiness) could be an equally critical quality required to execute e-business or e-government successfully in the low carbon e-economy.

THE G-READINESS FRAMEWORK

The development of the G-readiness framework proceeds in two steps – defining Green IT and explaining the constructs that make up the G-readiness. Based on the review in section 3.1, Green IT can be considered as a holistic and systematic approach to address the challenges surrounding the *IT infrastructure* such as data centre energy efficiency; *IT's contribution* to reducing the environmental impacts of business IT activities (such as through adopting green technologies), *IT's support* for environmentally sustainable business practices (such as in enabling green supply chain management through carbon foot print monitoring and building tools for energy management options) and *IT's role* (such as supplanting high CO_2 emitting business practices) in the low-carbon economy. Thus conceptualised, Green IT covers four different but interrelated perspectives – *sourcing*, *operations*, *services* and *end of IT life management*:

- From a *sourcing perspective*, Green IT implies the practice of environmentally preferable IT purchasing. This involves adoption of sourcing practices such as analysis of the environmental foot print of an IT hardware supply chain, evaluation of the green track record of software and IT services providers, incorporating green issues (such as recyclable design and packaging) in vendor evaluation, and inclusion of social concerns (such as the presence of harmful materials in IT supply chain) in IT procurement decisions.
- From an *operations perspective*, Green IT implies improving energy efficiency in powering and cooling corporate IT assets and reducing IT induced greenhouse gas emissions. Two types of energy consumption reduction can be identified – *temporary* and *structural consumption avoidance*. While temporary avoidance refers to optimisation of energy utilisation without reducing the installed power base, structural avoidance results in reduction in installed power capacity. A number of green technologies, information systems and practices related to the two categories can be used as indications of the adoption of Green IT operation.
- From a *systems perspective*, Green IT refers to the role of IT in supporting a business's overall sustainability initiatives – Green IS. Green IS therefore includes adoption of analytical information systems for green supply chain management, environmental management and carbon foot print analysis. It also includes ICT based low carbon business solutions such as telecommuting, video-conferencing, thin client and web based business services, virtual collaboration and IP telephony.
- From an *end of IT life management perspective*, Green IT refers to practices in reusing, recycling and disposing IT hardware.

One of the primary questions following such a broad understanding of Green IT is therefore: What does it take for organisations to succeed in Greening their IT? Drawing from the background review presented above, this paper argues that as much as e-readiness has been and still continues to be a critical capability to succeed in the digital, web-centred and e-economy, G-readiness is a critical capability to succeed in the low carbon and green digital economy. G-readiness is conceptualised as an organisation's capability to implement holistic Green IT practices. It demonstrates the comparative levels of Green IT development among businesses and serves as a benchmark for measuring an enterprise's progress to participate in the global low-carbon e-economy.

Greening IT naturally starts with IT and business leaders' sentiments towards climate change and the role of business in environmental sustainability (Rao and Holt 2005). The literature review on climate change shows that there are two main positions, one dominant and mainstream and another minority and sceptical, about the causes and issues of climate change. Most submit that the climate is changing at an alarming rate and human (including business) activities are the main causes of the change (IPCC 2007; Stern 2008). On the other hand, there are a minority of scholars who are skeptical about the causes and impacts of climate change (Royal Society 2007). This group maintains that the climate is always changing and its impact is not as severe as the other side would have liked us to believe. They believe that human and business activities have nothing or very minimal to do with the changing environment.

Info~Tech's (2008a) global Green IT attitude and action survey of 1260 IT professionals indicates that only 50% of participants are concerned about climate change. The survey further found that attitudes towards Green IT vary from region to region where the rest of the world (Africa, South America and Oceania) leads Europe, Asia and North America in terms of positive opinion towards climate change. The attitude of managers and business leaders towards environmental sustainability is a key factor in understanding not only the challenges of Green IT but also the opportunities associated with it (Gartner 2008). Organisations that are concerned about their social and environmental responsibilities, business sustainability and Green IT can start by articulating policies to tackle those issues. Green IT policies can cover areas such as PC power management (Info~Tech 2007b; Velte et al. 2008), environmentally preferable purchasing (Info~Tech 2007c; Velte et al. 2008), IT architecture and data centre design (Rasmussen 2006) and end-of-life disposal (Velte et al. 2008).

Attitude and policies demonstrate the necessary but not sufficient capability for Greening IT. Although, open standards such as Advanced Configuration and Power Interface (ACPI) provide PC power management capabilities, in practice, few organisations utilise these capabilities (Info~Tech 2007a; Velte et al. 2008). There are also variations in the practice of how aggressive an organisation can be in its power management regime and in terms of user education and user compliance (Info~Tech 2007a; Velte et al. 2008). In a similar fashion, despite showing concerns for the environment and having Corporate Social Responsibility (CSR) policy statements, only limited numbers of businesses actually consider green issues in data centre design, sourcing IT hardware, adoption of green technologies, and end of life IT management (Info~Tech 2007a, 2008a; Mitchell 2008; Velte et al. 2008). This implies two things – disconnect between policy and practice, and variations in the actions and practices of Green IT. There are also issues surrounding the organisational arrangement on who should lead Green IT initiatives. Existing governance arrangements vary from IT playing a role of tool provider to leading changes (Gartner 2008).

Based on the review, we argue that there are at least five important properties for success in greening IT – *attitude*, *policy*, *practice*, *technology* and *governance* – which together create the critical capability we call "G-readiness" (Figure 1).

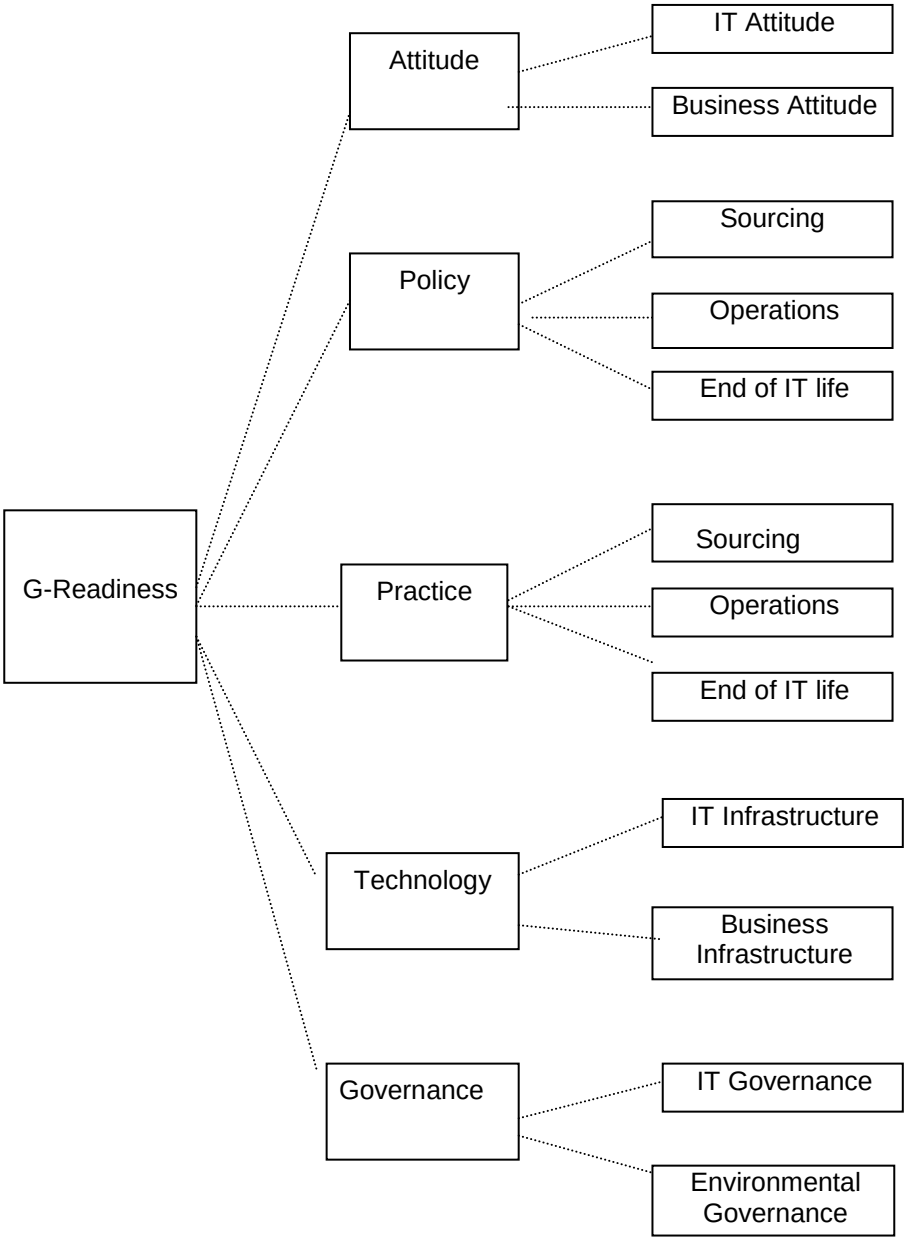

Figure 1 The G-readiness Framework

ATTITUDE

Attitude refers to the affective characteristics of both business and IT leaders and professionals. It can define the level of ICT professionalism (Boughton 2009) and has been found to be one of the major factors in influencing the acceptance and use of technologies (Handy et al. 2001). In this paper, attitude refers to the extent to which both IT and business professionals are aware and interested about the environmental concerns related to the use of IT and the role of IT in resolving environmental problems. While investigating the relationship between environmental attitudes and behaviour, Chan and Yam (1995) found that to encourage people to act environmentally, emotional appeal has a stronger impact than logical reasoning or factual description of harmful effects from environmental pollution. This is because the knowledge of an individual is weakly related to self-reported actual environmental behaviour. On this basis, whether or not an organisation takes Green IT issues seriously will be (at least partially) dependent on IT and business leaders' sentiment to environmental concerns. Existing surveys (see Table 3) indicate that not only could opinions for Green IT might vary from organisation to organisation, they might vary from region to region. Table 4 provides a preliminary proof of concept of the relevance of assessing Green IT attitude.

Item	Europe	North America	Asia	Others	Reference
Environmental concerns in planning IT operations are: Very important Somewhat important Not important	 48% 45% 6%	 33% 52% 15%	 NA	 NA	Mitchell (2008)
I am concerned about climate change: (strongly agree percentage); n= 1260	59%	52%	55%	59%	Info~Tech (2008a)
The issues of Green IT is on my company's radar (strongly agree percentage); n=1262	16%	16%	15%	18%	Info~Tech (2008a)
I am concerned about reducing IT's power consumption (strongly agree percentage); n= 1264	45%	35%	39%	38%	Info~Tech (2008a)

Table 3 Survey Evidence on Green IT Attitude

POLICY

Policy readiness measures the extent to which green and sustainability policies are developed throughout an organisation and permeate the value chain. For example, while some companies have clear Green IT policy others do not. Three value chain areas can assess the extent of policy readiness – IT sourcing, IT operations and services and IT end-of-life management.

IT sourcing policy – refers to the extent to which an organisation has adopted an environmentally preferable purchasing policy (EPP) (Velte et al. 2008) and articulated clear green guidelines for buying IT equipment and services. EPP is a policy choice that encourages purchasing decisions with minimum environmental impacts. Some of the negative environmental impacts of IT equipment include energy-intensive production methods, wasteful packaging, poor recycling practice and heavy

use of hazardous materials and practices (Elliot 2007; Info~Tech 2007c). EPP enables organisations to adopt a more sustainable sourcing strategy. For example, a policy that favours acquiring laptops over desktops demonstrates a commitment to Green IT. Estimates indicate that selecting an efficient laptop and operating it efficiently can reduce energy use by 98 - 99% (Commonwealth Government of Australia 2001). The extent of green guidelines might cover both modern and traditional IT equipment. For instance, the Commonwealth Government of Australia published a green office guide in 2001 which covers the acquisition and use of office equipment – desktop, monitors, photocopiers, printers, fax machine, scanners, and multifunction devices.

Company	**Preliminary evidence of concept**
ANZ	ANZ's Top management attitude towards Green IT is highlighted from statements in its Carbon Disclosure Project (ANZ, 2007). The CEO opined "*While we are on the earth today, our primary responsibility is to leave the planet in a better state than when we inherited it*". This sentiment to environmental concerns from the use of IT is further strengthened by the involvement of top management through the initiatives of ANZ CIO, who's intention was to remove a total of 400 servers from the bank's infrastructure by the end of 2008 both to reduce electricity cost and carbon emissions. The CIO opined "*we have an obligation and an opportunity to take the lead in our organisations about reducing at least the IT impact on the environment that our organisations have".* ANZ has expressed a commitment to become carbon neutral in Australia and New Zealand by using renewable energy by 2009. The above offers an initial insight as to ANZ's top managements interest, commitment and involvement towards Greening IT.
Australia Post	In Australia Post's 2002 Greenhouse Challenge report, the organisation has identified that it has been a participant in the Greenhouse Challenge program since 1997/1998 and has since accumulated greenhouse gas emissions savings of some 200,373 tons of CO_2.
BHP	BHP's Green IT attitude can be gauged indirectly from its commitment in reducing its greenhouse gas emissions using advancements provided by technology and improving the recycling of its waste products. BHP is looking into energy efficiency improvements and alternative energy for its operations; setting greenhouse gas emission reduction plans and energy targets and measures; investing in research and development of low carbon emissions technologies; and has shown a commitment to the design of effective national and international climate change policies through active participation.
Telstra	Telstra has set an international precedent among the telecommunications industry by finding ways that the industry can contribute towards a national shift to a low-carbon economy. It has spearheaded the commissioning of a study called *"A High-Bandwidth, Low-Carbon Future: Telecommunications-based Opportunities to Reduce Greenhouse Gas Emissions*." This study proposes that telecommunications networks can help reduce Australia's greenhouse gas emissions by almost five per cent by 2015 and deliver up to $6.6 billion a year in financial savings for Australian businesses and households. As such, Telstra is aware as well as concerned about environmental issues and the impact of Green IT to the environment.

Table 4 Example indicators of Green IT Attitude

IT operations and services policy – encompasses the extent to which the services provided by the IT infrastructure support issues encapsulated in business sustainability. Some of the policy considerations include PC power management (Info~Tech 2007b); policy on staff computer usage

(Commonwealth Government of Australia 2001) and environmental policy (Goasduff and Forsling 2007).

IT end of life policy – refers to the policies and regulations related to the disposal and settlement of IT equipment/machineries in organisations. In certain regions, end-of-life recycling is required by the provisions of law (Elliot 2007; Info~Tech 2008b). For example, the Japan Ministry of Trade and Industry promotes recycling policy to create a sustainable society that strikes a balance between the environment and the economy (Ministry of Economy, Trade and Industry, Environmental Protection and Recycling 2008). However, in general, there are still no mandatory policies to enforce the rules in most regions.

The G-readiness of businesses in terms of policies can be assessed on the basis of the extent to which the three areas of Green IT polices are developed. This policy reflects an organisation's commitment to technology redundancy and to the roll-over of equipment in order to gain the benefits of each technological advance. Table 5 offers a preliminary proof of concept of the relevance of assessing policy.

Company	**Preliminary evidence of concept**
ANZ	ANZ has a sustainable sourcing policy with its suppliers to reduce the amount of greenhouse gas emissions within its organisation. ANZ has clear guidelines in place with its IT suppliers in the use of green technology. For example, in the area of IT sourcing, ANZ has an obligation and a clear-cut policy with green guidelines to identify energy efficiency opportunities within its organisation and report progress towards implementation of this to the federal government under the Energy Efficiency Opportunity Act (2006).
Australia Post	Australia Post has participated in the Federal Government's co-operative Greenhouse Challenge program since 1998 and has internal initiatives for energy-saving; waste-management; vehicle fleet fuel efficiency and providing advice and assistance to other large fleet operators.
BHP	BHP intends to have greenhouse gas management and energy conservation programs at all of its sites that have annual emissions greater than the equivalent of 100,000 tons of CO_2. BHP also has in place an health, safety, environmental responsibility and sustainable development (HSEC) policy.
Telstra	Telstra has undertaken a project to investigate how telecommunications networks and digital products can enable business enterprises, households and governments to reduce carbon emissions within Australia. Telstra has a Green Purchasing Environmental Policy that was launched in June 2002. Some of the objectives of this policy are to "consider environmental issues in the purchasing of all products and services; purchase environmentally preferable products and services; contract with vendors that demonstrate responsible environmental performance; and establish a purchasing framework that encourages vendors to improve their environmental performance and/or the environmental performance of their product or service".

Table 5 Example indicators of Green IT Policy

PRACTICE

The policy dimension of G-readiness captures the intellectual dimension of G-readiness. However, not all policies are implemented smoothly. Indeed, organisations might vary in the actual

implementation of their policies. A business's green practice along its value chain from inbound to reverse logistics influences G-readiness (Rao and Holt 2005).

Green IT sourcing practice captures the extent to which environmental considerations are factored in IT and other purchasing decisions. This practice might vary from one where there is no environmental consideration to a case where environmental considerations are given higher weight (Info~Tech 2007a; Snege et al. 2008). As noted earlier, consumer buying habits are increasingly driven by ethical concerns. Green issues may not only have an impact on consumer buying power, but also affect how both the public and private sector award competitive tenders (Whitby 2007). Generally though, green sourcing revolves around evaluating the environmental behaviour of suppliers and partnering with suppliers to improve their performance (Rao and Holt 2005). Green sourcing practices also include advocating the use of green technologies during request for proposal processes and shortening IT equipment refresh periods to gain access to energy efficient equipment (Info~Tech 2007d). The involvement of suppliers is a critical element of Green IT sourcing practice (Rao and Holt 2005).

Green IT operations and services practices – Green IT operation practices can involve people, clients, servers, and the network critical physical infrastructure (NCPI). At the client level, using Advanced Configuration and Power Interface (ACPI), IT managers not only can reduce power consumption by "slowing down processors, spinning down hard disks and shutting off monitors" but also reduce a firm's environmental footprint (Info~Tech 2007b). However, few businesses implement this. Other operational actions to reduce power consumption include retiring systems, operating existing systems in an efficient manner and migrating to more energy efficient platforms (for example using blade servers) (Rasmussen 2006). In addition to supporting Green IT by purchasing green hardware equipment and software to reduce energy cost and consumption, companies can also cultivate Green IT practices – the way employees use IT (Velte et al. 2008). At the NCPI level, techniques such as "right-sizing the NCPI system to load, using efficient NCPI devices and designing an energy-efficient system" can be used (Rasmussen 2006).

Green IT end of life management practices – this refers to the compliance of IT equipment/machinery manufactures, users, and resellers in Green IT end of life management. In terms of IT manufactures, issues concerning Green IT end of life management would be whether the IT equipment and/or packaging is reusable because to crush and/or burn these IT equipment/materials could harm the environment (Alsever 2008). For example, when a customer purchases an Apple computer or monitor, the company will provide free recycling services to handle the customer's old computer or monitor, regardless of the manufacturer (Apple 2008). IT users would refer to practices taken in handling the broken and unwanted IT equipment. For example, users are encouraged to consider selling their unwanted equipment through the CellForCash.com for recycling, whereby unwanted items will be refurbished and resold (Alsever 2008). Many organisations have encouraged donation of unwanted IT equipment/machinery to non profit organisations and schools.

Overall, the extent to which IT has addressed the following issues can provide an indication of the practice dimension of G-readiness:

- Data collection on vendors' green rating
- The extent of contacts awarded to suppliers that use green technology
- Auditing the power consumption of existing systems
- IT projects implemented to reduce power consumption requirements
- IT projects implemented to maximise power utilisation (PC power management)
- The extent of enforcement of PC power management
- The energy rating of implemented technologies
- Actions taken to reduce IT's carbon footprint
- Projects implemented to monitor enterprise carbon footprint

- The extent that equipment/machinery is recycled.

Based on both the secondary evidence (Table 6) and our analysis, practice readiness indicates to what extent an organisation has translated its concerns and policies into actions.

Company	Preliminary evidence of concept
ANZ	The ANZ Supplier Sustainability Assessment Tools is a requirement for all tenders and includes specific questions relating to greenhouse gas emissions. ANZ's goal was to increase the number of suppliers (including IT suppliers) undergoing detailed social and environmental screening by 50% in 2008. So far ANZ has conducted social and environmental screening of major 32 suppliers in Australia and New Zealand. It also uses life-cycle assessment to evaluate the greenhouse gas emissions associated with electronic transactions and to reduce its greenhouse gas emissions.
Australia Post	In disposing its old computers, Australia Post has partnered with GreenPC and Technology for Schools to refurbish and recycle old computers and donate them to schools and charities that can't afford such technology. In recycling ink and toner cartridges, Australia Post has partnered with Cartridges 4 Planet Ark, and this partnership enables customers to drop off their used ink and toner cartridges for recycling. It has also conducted a company wide staff environmental awareness survey covering everything from their recycling practices to switching off lights.
BHP	BHP has the world's first power plant fuelled by coalmine ventilation air that powers extensive business operations including IT operations. This A$30 million plant generates some six megawatts of electricity per hour while reducing greenhouse gas emissions. At BHP Billiton Illawarra ventilation air containing dilute methane is being used to generate electricity commercially.
Telstra	Telstra has reduced vehicle fuel consumption by 5 per cent and increased productivity by 15 per cent by installing GPS; used energy management programs that are IT inclined to save the equivalent annual greenhouse gas emissions of 2,225 Australian homes; reduced office paper consumption from 9 to 7.4 reams-per-staff-member; and has replaced its 36,000 colourful screensavers with black screens.

Table 6 Example indicators of Green IT Practice.

TECHNOLOGY

Green IT is also about acquiring more environmentally effective (greener) technologies. A key driver of G-readiness success in the area of technology is to build a green technological infrastructure. This includes both NCPI, such as power supplies and IT infrastructure (Rasmussen 2006; Valte et al. 2008). Some of the commonly adopted green technologies include server virtualisation, data centre energy optimisation and rightsizing IT equipment (Info~Tech 2007a; Velte et al. 2008). Further, Rossi (2007) highlights that businesses and countries spend billions of dollars each year to power computers. This creates a bad image for IT as being energy-consuming and bad for the environment. RMIT University, which claims to be leading Australian universities in green electric power consumption, is incrementally moving to buy more green power from 2% in 2007 to 15% in 2008 to 20% in 2010 (RMIT 2007). To measure G-readiness along the technology dimension, organisations can look at the following indicators:

- The extent to which an organisation has a green business infrastructure (such as green rated buildings) and green power sources
- The development of Green IT standards across the enterprise

- Server consolidation and virtualisation
- The extent that applications and technologies are retired for greener technologies
- The extent of solutions development to support enterprise wide green initiatives.

Based on the secondary evidence (Table 7) our analysis identifies that the four organisations investigated in this study have undertaken a range of Green technology initiatives.

Company	Preliminary evidence of concept
ANZ	ANZ uses solar-powered ATM's, new building to achieve a 6 star Green Star environmental rating and has decommissioned 192 servers to date with an estimated saving of AU$120,000 in electricity and about 2,500 tons of CO_2 emissions. Future plans include the decommissioning of 400 servers with estimated electricity savings of AU$250,000. Replacement of approximately 12,000 higher energy intensive CRT monitors to more greenhouse friendly LCD screens is also planned, with an are expected reduction of more than 1000 tons of CO_2 emissions. ANZ has 'PC Snoozer Branches' where PCs are automatically powered down overnight.
Australia Post	Australia post has implemented a new building management system (BMS) in its largest mail facility in Sydney. This was done to control the air handling units and the lux levels of the dock lighting. The introduction of this facility is expected to result in a 4.3% reduction in energy consumption, with a greenhouse gas emission saving of 477 tons of CO_2 equivalent. Australia Post is currently working with the CSIRO and the Queensland Government to establish a trial of a fuel cell.
BHP	BHP uses an emissions inventory system throughout the Group that meets evolving best practices. The company has a US$300 million financial commitment to invest in energy efficiency improvements and alternative energy for its operations. The company also supports research and development and demonstration of low emissions technologies with relevance to its businesses, customers and communities.
Telstra	Telstra makes use of new "in-person" video-conferencing in place of many face to-face meetings. Telstra has implemented successful systems in its directories business, Sensis, to encourage recycling and has installed a renewable energy center in one of its Melbourne buildings. Telstra recommends the use of text messaging to public transportation using wireless broadband, of real-time allocation systems for better freight management.

Table 7 Example Indicators of Green IT Technology

GOVERNANCE

Governance is a key consideration of the dimension of G-readiness and refers to the management infrastructure to implement Green IT. Governance offers a framework for defining the complex set of relationships and activities in organisational relationships (Davies 2002). It is the operating model that defines the administration of Green IT initiatives. Gartner's (2008) case study reveals that Green IT requires "sound management infrastructure to understand impacts, prioritise actions and manage the enterprise's responses". Roles, responsibilities, accountability and control for Green IT initiatives need to be clearly established. Should a business assign the responsibility for Green IT initiatives to CIO's, or should it come under environmental managers? Should IT organisations be held responsible for electricity costs and accountable for energy efficiency? Answers to these and similar questions define the governance dimension of Green IT.

How a business as a whole manages its environmental and social responsibility influences the role of CIOs in Green IT initiatives. Existing practices vary. In the ANZ, IT leads Green IT initiatives (Gartner 2008). In others, IT's role is restricted to providing either tools or insights (Gartner 2008). In some companies in Asia, and in very few in Europe and North America, electricity costs are the responsibilities of IT (Info~Tech 2008a). Governance also includes allocation of budget and other resources to Green IT initiatives and defining metrics for assessing the impacts of Green IT initiatives. For example, Info~Tech's (2008a) global survey reveals that out of 1257 respondents, about "65% to 70% in Asia, Europe, Africa, South America and Oceania agree that their companies will have Green IT budget". Further, the survey reveals that only one fifth of enterprises in Europe and 15% in North America, have developed metrics for measuring IT power consumption efficiency. Businesses need to develop a standard administrative process to develop Green IT. Currently, such frameworks come in the form of six-sigma, ISO 14001; ISOI 9000 and World Business Council for Sustainable Development (WBCSD) standards (Gartner 2008; Rao and Holt 2005). In the US, data centres are beginning to get LEAD (Leadership in Energy and Environmental Design) certified, a certification from US's Green Building Council (Dunn 2008). Overall, the governance dimension of G-readiness can be measured using the following indictors:

- Clearly defined roles, responsibilities, accountability and control for Green IT initiatives
- Existence of standard administrative processes for developing Green IT initiatives
- Establishment of metrics for assessing the impact of Green IT initiatives
- Allocation of budgetary and other resources for Green IT
- The role of CIOs in enterprise wide green initiatives
- The responsibility of IT in electricity costs.

Based on the secondary evidence (Table 8) the four organisations investigated in this study have approached Green IT governance in a variety of ways.

Company	**Preliminary evidence of concept**
ANZ	CIO plays a key role in enterprise wide Green IT initiatives. Operations, Technology and Shared Services has overall responsibility for developing and implementing ANZ's energy efficiency program, including aspects pertaining to meeting ANZ's carbon neutral commitments.
Australia Post	Australia Post has an environment manager in charge of PC refurbishment and recycling. It partners with GreenPC and InfoXchange, with the assistance of Infotech Research, in leading the development of a supply chain program to help maximize recycling and minimize waste.
BHP	Manages environmental sustainability as part of its health, safety, environmental responsibility and sustainable development portfolio. Has a vice president of sustainable development and community relations but its reign over IT issues is not clear.
Telstra	Telstra has a management infrastructure led by its CIO in implementing and advocating for Green IT.

Table 8 Example Indicators of Green IT Governance

DISCUSSION AND CONCLUSION

The Green Movement has been identified as a significant social movement and a general reaction to the malfunctioning of the Western social formation (Galtung 1986; Mathur and Mathur 2000). It incorporates many aspects of everyday life such as politics, consumerism, technology, product purchases and consumption, marketing, manufacturing and resources (Mathur and Mathur 2000). The Green Movement differs from many other social movements in that it denies that basic social problems can be solved by addressing a single factor and argues that a holistic approach is needed (Galtung 1986). As identified earlier, whether an individual joins the Green Movement or not, is said to be based on subjective motivation and subjective capability (Galtung,1986). Motivations for joining the Green Movement have will have important implications for organisations considering "Green IT" and sustainable business practice.

From an organisational perspective, references to CSR and "sustainability" have become commonplace (Hendry and Vesilind 2005). The literature on sustainable business practice and CSR indicates that organisations' capability to comply with the mounting demands of different environmental groups and government regulations and practice socially oriented moral management is a major concern and an issue that might affect competitiveness (Carroll 1991; Gartner 2008; Rao and Holt 2005). Businesses use sustainability and CSR initiatives such as green supply chain management, environmentally preferable business practices; environmentally friendly technologies, and an aggressive stance towards CO2 emissions, to demonstrate their commitment to the environment (McWilliams et al. 2006).

This paper presents a framework to understand Green IT. As green issues continue to entice global debate, IT is expected to play a crucial role in both greening its operations and services and supporting a business's overall environmental sustainability objectives. Most CIOs and IT managers are facing two conflicting demands. On the one hand, the growth of digital business has led to increasing demands for data centres and related technology in general. On the other hand, the rising cost of energy, its cleanliness and its availability are limiting the supply of energy to those data centres and other technologies. This requires IT management to turn to Green IT solutions. In this paper, four dimensions of greening IT – sourcing, operations, systems and end-of-IT life management have been identified. For a business to operate successful in one or all of these dimensions, it needs to demonstrate G-readiness.

The framework can relate to implementing green business practice in general. However in this paper, G-readiness is conceptualised as a measure of a company's IT preparedness to be environmentally responsible and competitive. The five dimensions that make up G-readiness can be combined in a variety of permutations to separate organisations that are successful in building Green IT from those that are less successful. Separately, the low level development of the five attributes can represent barriers to Green IT success. In this paper, we have also explored secondary sources of four large well-known Australian organisations to demonstrate the practical relevance of each of the dimensions of the G-readiness framework. The organisations explored in this paper are reportedly forward thinking, with respect to CSR and environmental issues and we anticipate that future studies will reveal that the components that make up G-readiness are well developed at a handful of companies, in their infancy at a few more, practically nonexistent in most. Further research investigating potential levels of sophistication within each dimension and potential relationships between the dimensions of the G-readiness framework would also be valuable.

G-readiness doesn't come easily. It might come easily for "born-green" (Backer 2007) companies. By virtue of being created green, these companies might avoid much of the digital age inertia with which their more-established counterparts must contend. For others, however, it requires a concerted effort

from attitude to technology from policy through practice to governance. Disparities in the level of G-readiness could translate to disparities in the sustainability of businesses and hence could influence a business's performance. Understanding and leveraging Green IT is critical for businesses' continued progress. Without a clear understanding of G-readiness, companies will approach Green IT initiatives on an ad hoc, somewhat reactive basis insufficiently supported by the structural requirements to execute competently. This may lead to sinking resources into Green IT initiatives without seeing results anywhere near expected returns. As green issues continue to impact strategy, business operations and IT itself, lack of G-readiness may translate to missed opportunities for competitiveness and success.

REFERENCES

ACS 2007. "Australian Computer Society Policy Statement on Green ICT", retrieved on 19 December 2009 from www.acs.org.au.

Alsever, J. 2008. "The 'Green' Way to Dump Electronic Junk", retrieved on 23 June 2008 from http://www.msnbc.msn.com/id/24163506/.

ANZ 2007. "Carbon Disclosure Project (CDP5) Greenhouse Gas Emissions Questionnaire", retrieved on 19 December 2009 from http://www.anz.com/Documents/AU/Aboutanz/ANZ_CDP5_Response_FINAL.pdf.

ANZ 2009. "ANZ About Us", retrieved on 19 December 2009 from http://www.anz.com.au/ about-us.

Apple 2008. "Apple and the Environment", retrieved on 24 June 2008 from http://www.apple.com/environment/recycling/program/index.html accessed.

Aronson, J. 2008. "Making IT a Positive Force for Environmental Change", *IT Professional*, IEEE Computer Society, (January/February), pp. 43-45.

Australia Post 2009. "Australia Post – About Us", retrieved on 19 December 2009 from http://www.auspost.com.au/CAP/0,1469,CH2007%257EMO19,00.html.

Backer, L. 2007. "When Oil and Wind Turbine Companies Make Green Sense Together", *Business Strategy and the Environment*, (18:2), pp. 43-52.

BHP 2009. "BHP Billiton Resourcing the Future", retrieved on 19 December 2009 from http://www.bhpbilliton.com/bbContentRepository/docs/sustainabilitySummaryReport2009.pdf

Boughton, C. 2009. "What is an ICT Professional Anyway", *Australasian Journal of Information Systems*, (16:1), pp. 149-163.

Carroll, A. 1991. "The Pyramid of Corporate Social Responsibility: Toward the Moral Management of Organisational Stakeholder", *Business Horizon*, (July-August), pp. 39-48.

Chan, R. Y. and Yam, E. 1995. "Green Movement in a Newly Industrializing Area: A Survey on the Attitudes and Behaviour of the Hong Kong Citizens", *Journal of Community and Applied Social Psychology*, (5), pp. 273-284.

Chen, A. J. W., Boudreau, M., and Watson, R.T. 2008. "Information Systems and Ecological Sustainability", *Journal of Systems and Information Technology*, (10:3), pp. 186-201.

Choucri, N., Maugis, V., Madnick, S. and Siegel, M. 2003. "Global e-Readiness - for what?", retrieved on April 1 2004 from http://ebusiness.mit.edu.

Commonwealth Government of Australia. 2001. "The Green Office Guide", retrieved on 19 December 2009 from http://www.energyrating.gov.au/library/pubs/greenofficeguide.pdf.

Davies, J. 2002. "Models of Governance - A Viable Systems Perspective", *Australasian Journal of Information Systems*, (9:2), pp. 57-67.

del Rio Gonzalez, P. 2005. "Analysing the Factors Influencing Clean Technology Adoption: A Study of the Spanish Pulp and Paper Industry", *Business Strategy and Environment*, (14:1), pp. 20-37.

Dunn, D. 2008. "Building to be Green All Over", *ComputerWorld*, retrieved on 23 August 2008 from http://www.computerworld.com/pdfs/LFG_green_IT_2008.pdf.

Elliot, S. 2007. "Environmental Sustainable ICT: A Critical Topic for IS Research?", in F. Tan and J Thong (eds) Proceedings of PACIS 2007, AIS, 4-7 July, Auckland New Zealand.

Elliot, S., and Binney, D. 2008. "Environmentally Sustainable ICT: Developing Corporate Capabilities and an Industry Relevant IS Research Agenda", Proceedings of PACIS 2008, 4-7 July Suzhou, China.

Galtung, J. 1986. "The Green Movement: A Socio-historical Exploration", *International Sociology*, (1:1), pp 75-90.

Gartner 2008. "Going Green: The CIO's Role in Enterprise-wide Environmental Sustainability", *Gartner EXP premier*, May 2008.

Goasduff, L., and Forsling, C. 2007. "Gartner Says 50 Percent of Mid and Large Sized Western European IT Organisations will Develop a Green Strategy by the End of 2008", *Gartner*, Egham, 22 May.

Gorard, S. 2001. "Quantitative Methods in Educational Research: The Role of Numbers Made Easy*"*, *Continuum International Publishing Group*, London.

Handy, J., Whiddett, R., and Hunter, I. 2001. "A Technology Acceptance Model for Inter-organisational Electronic Medical Records Systems", *Australasian Journal of Information Systems*, (9:1), pp. 39-50.

Hartman, A., Sifonis, J., and Kador, J. 2001. *Net Ready: Strategies for Success in the Economy*. New York: Mcgraw-Hill.

Hendry J. R., and Vesilind, A. P. 2005. "Ethical Motivations for Green Business and Engineering", *Clean Technologies and Environmental Policy*, (7:4), pp. 252-258.

Info~Tech 2007a. "11 Green Initiatives Your Peers are Cultivating", *Info~Tech Research Group*, (July), pp. 1-14.

Info~Tech 2007b. "PC Power Saving Plans Reduce Costs and Environmental Impact", *Info~Tech Research Group*, (December), pp. 1 -10.

Info~Tech 2007c. "Exercise Environmentally Preferable Purchasing for a Healthier Plant and Pocketbook", *Info~Tech Research Group*, (October), pp. 1-9.

Info~Tech 2007d. "Top 10 Energy-saving Tips for a Greener Data Centre", *Info~Tech Research Group*, (April), pp. 1-11.

Info~Tech 2008a. "North America Underperforms in Green IT Attitudes and Actions", *Info~Tech Research Group*, (January), pp. 1-15.

Info~Tech 2008b. "Use EPEAT to Decrease Equipment Costs and Help the Environment", *Info~Tech Research Group*, (February), pp. 1-3.

IPCC 2007. "Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability. Summary for Policymakers', retrieved on 18 December 2009 from http://www1.ipcc.ch/ipccreports/assessments-reports.htm.

Le Matais, J. 1999. "Approaches to Comparology", *International Electronic Journal for Leadership in Learning*, (3:15), retrieved on 18 March 2009 from http://www.ucalgary.ca/~iejll/volume3/lemetais.html.

Marshall, P., Mckay, J. and Prananto, A. 2005. "Business Value Creation from IT Investments: Towards a Process Theory of IT Governance", *Australasian Journal of Information Systems*, (12: 2), pp. 192-206.

Mathur, L.K., and Mathur, I. 2000. "An Analysis of the Wealth Effects of Green Marketing Strategies", *Journal of Business Research*, (50:2), pp. 193-200.

McWilliams, A., Siegel, D. S. and Wright, P. M. 2006. "Corporate Social Responsibility: Strategic Implications", *Journal of Management Studies*, (43:1), pp. 1-18.

Mia, I. and Dutta, S. 2007. "The Global Information Technology Report 2006/2007", *World Economic Forum*, Geneva.

Mines, C. and Davis, E. 2007. "Topic Overview: Green IT", *Forrester Research*, retrieved on 23 June 2008 from http://www.forrester.com/Research/Document/Excerpt/0,7211,43494,00.html.

Ministry of Economy, Trade and Industry, Environmental Protection and Recycling 2008. retrieved on 24 June 2008 from http://www.meti.go.jp/english/policy/index_environment.

Mitchell, R. L. 2008. "Green by Default", *ComputerWorld*, retrieved on 23 June 2008 from http://www.computerworld.com/pdfs/LFG_green_IT_2008.pdf.

Molla, A. and Licker, P. 2005. "Perceived E-readiness Factors in E-commerce Adoption: An Empirical Investigation in a Developing Country", *International Journal of Electronic Commerce*, (10:1), pp. 83-110.

Murugesen, S. 2007. "Going Green with IT: Your Responsibility Towards Environmental Sustainability", *Cutter Business – IT Strategies Executive Report*, (10:8), pp. 24-33.

NFER (n.d.) "Desk Based Research", retrieved on 18 March 2009 from http://www.nfer.ac.uk/what-we-offer/nfer-research-methods/desk-based-research.cfm.

Nunn, S. 2007. "Green IT: Beyond the Data Centre How IT can contribute to the Environmental Agenda Across and Beyond the Business", *Accenture*, pp. 1- 7.

Pettey, C. 2006. "Gartner Says 50 Percent of Mid and Large Sized Western European IT Organisations will Develop a Green Strategy by the End of 2008", *Gartner Inc*., Stamford, 29 November.

Rasmussen, N. 2006. "Electrical Efficiency Modeling for Data Centers", retrieved on 23 June 2008 from http://www.apcmedia.com/salestools/NRAN-66CK3D_R1_EN.pdf.

Rao, P. and Holt, D. 2005. "Do Green Supply Chains Lead to Competitiveness and Economic Performance?", *International Journal of Operations & Production Management*, (25: 9), pp. 898-916.

Ridgley, C. 2009. "The Decision Disconnect", *Australasian Journal of Information Systems*, (16:1), pp. 185-208.

Rossi, S. 2007, "Australia Spends Millions Each Year Powering Computers", *Computerworld Australia*, 19 September, retrieved on 5 June 2008 from http://www.computerworld.com.au.

RMIT 2007. "RMIT Goes a Deeper Shade of Green", retrieved on 19 December 2009 from http://www.rmit.edu.au/browse;ID=vpusc7o147se1.

Royal Society 2007. "Climate Change Controversies: A Simple Guide", retrieved on November 2009 from http://royalsociety.org/Climate-change-controversies/.

Snege, P., Smith, B., Kruschwitz, N., Luar, J. and Scheley, S. 2008. *The necessary revolution: how individuals and organisations are working together to create a sustainable world*, New York: Doubleday.

Stern, N. 2008. "The Economics of Climate Change", *American Economic Review*, (98:2), pp. 1-37.

Srivastava, S. K. 2007. "Green Supply-chain Management: A State-of-the-art Literature Review", *International Journal of Management Reviews*, (9:1), pp. 53-80.

Telstra 2009. "Telstra – About Us", retrieved on18 December 2009 from http://www.telstra.com.au/abouttelstra/.

Velte, T.J., Velte, A.T., and Elsenpeter, R. 2008. *Green IT: reduce your information system's environmental impact while adding to the bottom line*, New York: McGraw Hill.

Whitby, P. 2007. "The Benefits of Green IT: The Reasons for Adopting a Greener IT Policy Have Become too Good to Ignore', retrieved on 5 June 2008 from http://www.computing.co.uk/computing-business/analysis/2199135/benefits-green-3420872.