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# Green IT adoption: a process management approach

Green IT  
adoption

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## Abstract

**Purpose** – To better understand and assist business managers to deal with green IT adoption, this paper provides a step-by-step process management approach.

**Design/methodology/approach** – By drawing on the process management to investigate the green IT adoption, the paper analyzes and discusses four different phases: plan, design, implement, and measure the performance of the process.

**Findings** – The likelihood that companies will successfully adopt green IT initiatives depends on several organizational and environmental factors. The primary factor is the Champion Support. Lack of implementation barriers is another important factor among others.

**Research limitations/implications** – By comparing behavioral and technological changes derived from green IT initiatives and unveiling possible factors associated with the adoption process, this paper provides an opportunity for academics to conduct applied research based on the issues discussed.

**Practical implications** – The paper can be an extremely useful and practical source for top-level managers, particularly IT managers, to bring greener technologies and more environmentally responsible strategies and practices to their organizations.

**Originality/value** – The paper contends that the green IT adoption process is an ensemble of four phases: plan, design, implement, and measure the performance of the process. This paper serves as a guide and offers practical measures in terms of understanding how green IT initiatives could be more effectively and efficiently adopted by organizations.

**Keywords** United States of America, Information systems, Process management, Change management, Information strategy, Green IT, IT adoption

**Paper type** Research paper

## Introduction

In recent years, increasing interest in the environmental impacts of business sustainability and information technology (IT) has become the catalyst for the emergence of green IT, which has piqued growing interest among information systems (IS) researchers, business practitioners, and politicians in recent years (Chwelos *et al.*, 2010; Dedrick, 2010; Harris, 2008; Liu *et al.*, 2008; Melville, 2010; Molla *et al.*, 2009a, b; Watson *et al.*, 2010). Green IT, also known as green computing, is defined as the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems – such as monitors, printers, storage devices, and networking and communications systems – efficiently and effectively with minimal or no impact on the environment (Murugesan, 2008, 2010). Thus, green IT encompasses hardware assets, software assets, tools, strategies, and practices that help improve and foster environmental sustainability.

According to a 2009 green IT report surveying 426 companies in North America and a total of 1,052 worldwide, 86 percent of companies stated that it is somewhat/significantly important that their IT organization implement green IT initiatives. The report also



found that 97 percent of companies are at least discussing a green IT strategy (Symantec, 2009). In addition, a recent CIO magazine survey of IT executives revealed that cost-cutting and social responsibilities are the two main factors driving green IT initiatives (CIO, 2008). At the same time, CIOs are considering how to best undertake green IT initiatives, especially in times of shrinking IT budgets and increasing environmental compliance requirements in terms of ensuring socially responsible, environmentally friendly, and fiscally sound IT investments and practices.

Coupled with soaring energy prices and increased consumer awareness of the danger to the environment, organizations realize the need to get serious about migrating to green IT and demonstrate a better and more responsible corporate accountability. Corporate social responsibility is of a central concern to executives of almost every corporation (Azzone and Bertel, 1994; Berger *et al.*, 2007; Caldelli and Parmigiani, 2004). In early 2010, the ISO 26000, a standard for corporate social responsibility based on the United Nations Global Compact, provided executives with the directions and measures for demonstrating social responsibilities. In this standard, businesses are required to take a precautionary approach to protecting the environment, to promote greater environmental responsibility through business practices and encourage adopting environmentally friendly information technologies. Identifying and implementing enterprise-wide information technologies and practices that will allow for efficient environmental management is thus a challenge for many companies (Bansal and Roth, 2000; Brown *et al.*, 2005; Burton-Jones and Gallivan, 2007; Dascalu *et al.*, 2010; Murillo-Luna *et al.*, 2007).

In spite of the substantial and growing importance of green IT in recent years to advance environmental sustainability and business efficiency, there currently exists a gap of knowledge in the research literature dedicated to enriching our understanding of the role and potential contribution of IT in the domain of environmental sustainability to advance sustainable practices. This research attempts to offer important contributions to both the management practices and research literatures of green IT. The study takes a necessary first step towards enriching our understanding of the role of IT in environmental sustainability by proposing a process management approach to green IT adoption and practices in organizations. The purpose of process management in this context of green IT adoption is to clearly identify and document all the phases and the actions to be taken within each phase to effectively complete the adoption process. Additionally, the process management would involve analyses of efficiency, bottlenecks, and overall adoption process effectiveness in order to make continuous improvements across the process lifecycle.

Esty and Winston (2006), in their popular book, have provided the essential knowledge necessary for every business executives in order to manage the environmental challenges facing today's society at large and corporations in particular. They provide suggestions on how an organization can generate lasting values such as cutting costs, reducing risks, increasing revenues, and creating strong brands by building environmental thinking into its practices. Hence, there exist both the increasing needs and opportunities for organizations today to capitalize on the green IT movement to reduce their environmental impacts. Businesses today can reduce their carbon footprint by pursuing a green strategy that includes adopting common-sense best practices for improving energy efficiency, improving the utilization of existing IT equipment, and as budgets or regular upgrade cycles allow, investing in new,

innovative technologies (Cooper and Zmud, 1990; Daly and Butler, 2009). However, it is often unclear to IT managers how to adopt green IT in a way that will maximize their energy efficiency and achieve business goals. Primarily, it is due to the complexity and scope of green IT adoption process, the availability of a large set of technologies and strategies to select from, and its governance. The phase-by-phase process management approach to green IT adoption presented here is intended to assist the business executives to better understand and deal with green IT adoption.

### Background and literature aspects

In recent years, the magnitude of ecological sustainability has stimulated increasing research interests on green IT/IS (Chen *et al.*, 2008; Watson *et al.*, 2010, 2008). A variety of methods have been employed to conceptualize green IT, understand the potential adoption issues of green IT in organizations, and define and gauge energy consumption and the greenness, etc. (Chan and Reich, 2007; Chau and Tam, 1997; Haigh and Griffiths, 2008; Jenkin *et al.*, 2010; Overby, 2008; Ruth, 2009; Sisaye and Birnberg, 2010; Vouk, 2008). The congruence of prior green IT studies sheds light on the direct and negative effects of the IT industry and the IT artifacts on the environment. Conceptually referring to the using of IT resources in an energy efficient and cost-effective manner (Dedrick, 2010; Watson *et al.*, 2010), green IT is environmentally friendly IT that is manufactured and used in a way that conserves natural resources and the environment. Green IT is simply applying eco-friendly standards through the use of IT and is guided by the following four broad goals:

- (1) sustain the environment by using natural and renewable resources;
- (2) recycle and reuse the manufactured IT products;
- (3) reduce waste and pollution by changing patterns of production and consumption; and
- (4) ongoing innovation of standards to utilize resources that are not damaging to peoples' health or the environment.

These important goals are reachable under the assumption that IT may enhance efficiency via substitution for more costly labor and regular capital and enable new processes and services toward sustained competitive advantage (Chwelos *et al.*, 2010; Fuchs, 2008; Piccoli and Ives, 2005).

The extant studies on green IT research and practice have indicated that three different yet critical areas need organizations' involvement, including asset management, energy efficiency, and enabling green practices through the utilization of IT (Murugesan, 2008). Since preserving the world's natural resources, such as energy resources, is the responsibility of all its citizens, now every business organization to some extent is either contemplating or has just started to adopt green IT for the following important reasons:

- setting a positive example for employees that help boost morale and company loyalty;
- gaining competitive advantage by differentiating the business from its competitors;
- improving efficiency and lowering operating costs; and
- providing a cleaner and healthier work environment.

Companies today have started joining the movement to go green despite the economic situation that exists around the globe. Since all companies are dependent on IT for efficient operation, the incentive to make their IT operations more efficient provides an opportunity to also reduce energy use. They realize that the best way to get started with energy efficiency is to develop a strategy for green IT adoption. Servers, laptops, and other IT equipment are nowadays typically refreshed every three to four years in most business organizations to keep up to date with technology. Owing to this refreshment need, companies have the opportunities to buy new energy efficient equipment and implement server and data storage using the virtualization technology. Virtualization provides significant IT flexibility, reduces data center space requirements, and lowers system management costs (Greengard, 2008; Overby, 2008). Therefore, for these businesses, improving energy efficiency requires focusing on a number of areas such as their IT equipment, their data center facility, and their energy management strategy and practices.

While this study focuses on enhancing our understanding of the role and potential contributions of IT to advance sustainable business practices through green IT adoption, several leading businesses in their respective industry have demonstrated their role as a change agent toward the environmental sustainability movement. Wal-Mart, for example, through its green supply chain initiatives aligns one of its key goals, low cost leadership in retailing, with environmental sustainability (Watson *et al.*, 2008). This initiative helps Wal-Mart make progress in the direction of sustainable business practices by reducing emissions, wastes, and costs. Strategically, Wal-Mart decided to minimize packaging. The main idea is to reduce the size of products to save energy, shipping costs, and shelf space. It wants its vendor to think “small and mighty” by aggregating goods in the minimal space. It has, for example, convinced vendors to replace bulky plastic jugs with condensed, slimmed-down containers for liquid laundry detergents. Toilet paper manufacturers, likewise, have made their products more compact so that a greater quantity can fit in a given volume. Wal-Mart can use its IS to measure and monitor the costs, emissions, and waste of each phase of a supply chain and packaging alternatives. Wal-Mart’s IS could also be a tool for coordinating and aggregating the many activities in a supply chain to minimize overall emissions. Similarly Sun Microsystems Inc., a global provider for network computing infrastructure solutions, have created an “open work” initiative, which expands the definition of local to make it global, to enhance its employees’ abilities to work locally while competing globally. This initiative reduces the need for employees to travel to work locations and reduce Sun’s employees’ overall carbon footprint (Watson *et al.*, 2008).

The green IT strategy, design, and practice initiatives within organizations have recently emerged into an active research area in the IS discipline. However, the extant green IT literature is heavily based on case studies, anecdotes, and the survey of current practices and thus quite fragmented and scattered. A major gap that exists in the literature today is the absence of a research finding that can assist organizations to develop strategy for their green IT adoption and practices. The emphasis of this research is therefore tailored towards the practitioners of green IT given the aforementioned primary need and urgency for green IT implementations within businesses.

The current literature on green IT research and practices suggest that there exists several opportunities and challenges for undertaking green IT initiatives in organizations. The three primary drivers of green IT initiatives according to the literature are:

- (1) reducing costs due to budget cuts;
- (2) reducing consumption due to resource restrictions; and
- (3) complying with the local law (Velte *et al.*, 2008).

In particular, a 2009 study based on a survey of 143 organizations from USA, Australia, and New Zealand reported the current drivers and inhibitors of green IT adoption (Molla *et al.*, 2009a, b), which are summarized in the following table (Table I). The number inside the parentheses represents the percentage of respondents who agree.

The current literature on green IT research and practices additionally suggest that businesses can become involved in shaping green IT policies and reducing their organizations' carbon footprint in three critical areas:

- (1) asset management;
- (2) energy efficiency; and
- (3) enabling green practices through the utilization of IT (Capra and Merlo, 2009).

Furthermore, studies have shown that IT's environmental impact can be significantly reduced by:

- technological changes; and
- behavioral changes.

Technological changes focus on improving IT and business infrastructures to make them environment friendly. Behavioral changes can be realized by acting in an environmentally responsible manner and by developing and enforcing organizational policies aligned with the green IT strategy undertaken by an organization. In Table II we summarize the research literature to capture the technological and behavioral changes needed to make green IT happen. The rows of the table, respectively, focus on increasing material and energy efficiency of an organization's IT infrastructure, its business activities, and its IT-related product and services choices to reduce environmental impact.

Opportunities/drivers of green IT	Challenges/barriers of green IT
Reducing cost of IT (80%)	Cost of green IT solutions (71%)
Corporate strategy (79%)	Unclear business value of greening IT (48%)
Environmental consideration (77%)	Lack of government incentives (44%)
Social acceptance (71%)	Lack of business leadership on green IT (43%)
Maturity of green IT industry (64%)	The extent of IT sophistication (41%)
Government regulations (57%)	Inadequate skills and training (36%)
Government incentives (54%)	The extent of green IT adoption in the industry (34%)
Clients'/consumers' pressure (48%)	Absence of enforceable government regulations (33%)
Industry associations (29%)	
Competitors' actions (20%)	
IT vendors' pressure (14%)	
Green IT uptake by more organizations (46%)	

Source: Molla *et al.* (2009a, b)

**Table I.**  
Opportunities and challenges of green IT

	Technological changes	Behavioral changes
Increase material and energy efficiency of an enterprise's IT infrastructure	Dynamic IT infrastructure with cloud computing Server virtualization and consolidation Storage consolidation Desktop virtualization and thin clients	Develop policies for virtualization and consolidation of data processing and storage Manage, measure, and regulate how your technologies consume energy Server room upgrades, new buildings
Increase material and energy efficiency of an enterprise's business activities	Remote conferencing and collaboration Telecommuting Printer consolidation PC power management	Develop policy for reducing desktop printers and the amount of material that is printed Develop policy for powering down equipment when not in use
Enterprise makes IT-related product and service choices that reduce environmental impact	Moving from CRTs to LCDs New IT purchases conform to functionality standards Asset disposal to include IT equipment recycling	Develop policy for disposing IT equipment in a sound and environmentally friendly manner Make energy conservation an acquisition objective for how you evaluate and procure technologies

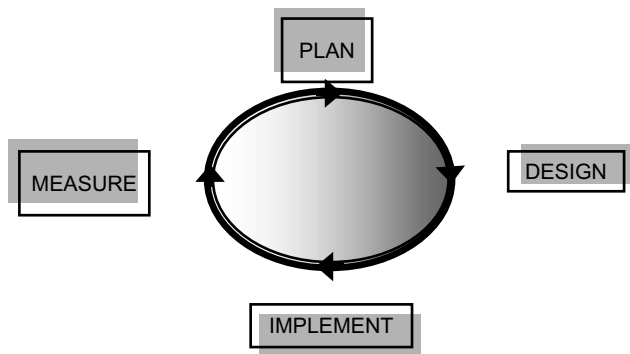
**Table II.**  
Changes required for enabling enterprise actions toward a green IT

**Green IT adoption process**

We contend that the green IT adoption process is an ensemble of four phases:

- (1) plan;
- (2) design;
- (3) implement; and
- (4) measure the performance of the process.

Figure 1 shows this process. Note that the green IT adoption process is cyclical in nature, characterized by a continuous improvement lifecycle.



**Figure 1.**  
Green IT adoption process



Process management can be broadly defined as the application of knowledge, skills, tools, techniques, and systems to define, visualize, measure, control, report, and improve processes with the goal to meet organizational expectations. Therefore, the green IT adoption process management involves the management of all four aforementioned phases so that they are all performed effectively.

As stated earlier, the current literature on green IT research and practices point to three critical areas:

- (1) asset management;
- (2) energy efficiency; and
- (3) enabling green practices through the utilization of IT – to focus on for developing green IT strategies.

We therefore use these three critical areas here to analyze each of the above four phases of the adoption process.

#### *Plan phase*

Making an organization eco-friendly requires the development of a detailed plan that would include:

- determining where an organization is currently in terms of being green;
- defining the organization's green IT objectives both for the short and long term; and
- developing an organizational environmental metrics to assess and measure the progress of its green IT adoption process.

In other words, the plan phase attempts to answer the following three questions: Where are you now? Where do you want to go? How would you measure progress?

The first step of the plan phase is to determine an organization's current impact on the environment from an IT perspective. From the asset management perspective, this would involve cataloging the asset acquisition practices and expected lifecycle/span of assets such as desktops, servers, storage disks, and other peripheral devices. Whether or not the organization gives any consideration to green manufacturing practices during the purchasing process should also be taken into account. The next step is to catalog the current asset/hardware disposal practices. This includes identifying whether there is a recycling process that is used for the assets to ensure that their toxic and hazardous materials are disposed of properly. If so, whether everyone in the organization is aware of and is properly trained to follow the process properly.

The next step is cataloging the energy consumption of each hardware asset. This inventory is used to create an estimate of annual energy use. Additionally, it is important to take into account the heating, cooling, and ventilation requirements necessary to operate the organization's IT infrastructure in general and data centers in particular. Finally, the utilization rate of each asset needs to be cataloged. Included in this would be system uptime, performance indicators, application usage, storage capacity, and any other relevant data necessary to determine the value each asset has to the organization. At this point, the current state of greenness of the organization is documented, which will help develop the next steps of the plan phase to further reduce energy consumption, catalog improvements and plan for future energy needs.



The second step of the plan phase is defining the organization's green IT objectives both for the short and long term. Every organization is different, therefore, there is no "one-size-fit-all" strategy available or is even practical to consider. The green IT objectives of an organization is defined based on identifying where in the three areas:

- (1) asset management;
- (2) energy efficiency; and
- (3) enabling green practices through the utilization of IT – individually and collectively costs can be reduced, adhering to regulation and/or legislative requirements, and aligning with meeting the social responsibility expectations of the organization's stakeholders.

For these objectives, clear goals both for the short and long term need to be established to ensure that all implementations will bring quantifiable value to the organization. These goals would be for power consumption reduction, regulatory compliance, decreased carbon footprint from asset management, and operational cost savings. The scope of these goals should also be established. That is, for example, setting the power consumption reduction target or setting the cost savings target for both short and long terms. An organization can set a target of 10 percent reduction in power consumption across their data centers within the next two years, for example.

The final step of the plan phase is developing the organization's environmental metrics to assess and measure the progress of its green IT adoption process. Beyond measuring the organization's carbon footprint, the environmental metrics should focus on assessing its energy use, asset selection, supply chain compliance of green practices, and the engagement of employees in the green IT practices (Kumar and Mieritz, 2007; McKinsey, 2009). It is also crucially important for the organization to communicate the environmental metrics to its stakeholders which include the customers, shareholders, employees, and regulators.

#### *Design phase*

The design phase of the green IT adoption process is involved in designing – developing a blueprint or carving out a path/plan – to achieve the target – meeting the goals set in the plan phase. There are many different tactics available for greening an organization's IT and IT-related practices. Choosing the appropriate tactics to meet the short and long terms goals that were set in the plan phase for the three areas:

- (1) asset management;
- (2) energy efficiency; and
- (3) enabling green practices through the utilization of IT – as well as developing "green" practices and policies that align with the chosen tactics are the primary focus of this design phase.

The design blueprint would therefore include both the technology use and application along with the areas for reduction, as well as the green policies and procedures necessary to carry out the plan.

Asset management includes the design, procurement, operations, and end-of-life management of IT equipments or products with the goal to reduce the burdens that these products have on the environment (McKinsey, 2009). IT products have a significant

impact on the environment. They contain chemicals known to threaten human health and the environment – lead, mercury, cadmium, and brominated flame retardants among them. They create e-waste at the end of their lifecycle. Achieving the highest return on IT assets is a balancing act. Asset managers tend to find an optimal solution juggling four key variables/constraints:

- (1) achieving highest levels of reliability;
- (2) at the lowest cost;
- (3) within a compliance framework; and
- (4) with limited resource.

Asset management thus aims to maximize the value of critical assets over their lifecycle while following eco-friendly business practices.

Optimizing the energy efficiency of an organization and its IT infrastructure is critical to demonstrate the value of being green. The optimization functions used are firm-specific and are determined based on their IT readiness and infrastructure. Desktop and enterprise computer equipment require significant energy to operate, leading to increased greenhouse gas emissions. Recently, large consolidated data centers alone use more than 5 percent of all electricity consumed in the USA. The Green Grid, an industry consortium dedicated to improve energy efficiency within data centers and business computing systems, help define and promote the most effective energy efficiency practices in data centers – including their operations, construction, and design – to help solve the problems related to power consumption that are plaguing data centers worldwide. Energy efficient IT infrastructures consequently reduce costs, resolve space, power, and cooling constraints that impact growth, improve flexibility and responsiveness, and help achieve green IT objectives.

Recently, many businesses are considering a new computing paradigm, called cloud computing, to optimize utilization and minimize cost of their IT infrastructure. Cloud computing leverages shared infrastructure to deploy and balance IT resources to cater to the computing needs in real-time. It can help organizations of all sizes go green by providing a shared infrastructure with virtualization capabilities. Thus, organizations can access services and infrastructure on an as-needed basis, and promote the ability to maintain distributed workforces. Virtualization is an energy efficient consolidation technology found in cloud computing centers today. Virtualization help reduce energy consumption and costs by increasing utilization and decreasing the number of servers and physical floor space in the data center. It has been reported that virtualization has been shown to reduce floor space by 80 percent and energy consumption in data centers by 40 percent (Capuccio and Craver, 2007).

To address the corporate commuting and office space issues, and to offer flexibilities to both employees and employers, telework has become an important contributor to green practices (Ruth and Chaudhry, 2008). This environmentally friendly practice provides a multitude of benefits that include increased productivity, lower cost due to reduction in office space requirement, reduced business travel, and enables a virtual collaborative work environment.

To pursue sustainable practices that are appropriate and practical to meet the green IT goals, an organization needs to develop policies that minimize the use of hazardous materials, maximize energy efficiency, and encourage recycling and/or use

of biodegradable products among others. Green IT governance – the management infrastructure to administer green IT initiatives – must be considered to be the operating model. In this model, the roles, responsibilities, accountability, and control of green IT initiatives need to be clearly established. Green IT governance thus puts structure around how an organization aligns its green IT strategy with business strategy, ensuring that the organization stay on track to achieve its strategies and goals, and implement good ways to measure IT's performance. Simply put, green IT governance enables the design and institutionalization of good organizational practices to fit an organization's green IT initiatives to its business strategies.

Table III summarizes the best practices in the three areas:

- (1) asset management;
- (2) energy efficiency; and
- (3) enabling green practices through the utilization of IT – for managers to be aware of and choose from for adopting greener IT practices that meet their organization's green IT goals and objectives.

#### *Implement phase*

The implement phase of the green IT adoption process is involved in putting the design plan to practice. This includes institutionalizing the technical solutions and the green IT practices that were designed through green IT governance in the design phase.

In this phase the IT managers apply a few common practices to implement the chosen technology solutions. One such practice is called consolidation. If an organization is currently using a number of servers that are not being utilized to their storage and performance capacity, they would be consolidated to a fewer number and the excess servers would be retired. However, the IT managers must ensure that the consolidated servers are able to handle peak loads for the combined services they will support. The servers that are chosen to retire are the ones that are the least power efficient. It is also a common practice to use blade servers to provide even greater power efficiency in a large consolidation situation. Another practice for maximizing server utilization is to allow computing services to be distributed across available servers. Again, unused servers will be retired and new servers will not need to be purchased unless absolutely necessary.

Another practice, mentioned earlier, is creating virtual environments, which utilize common operating systems and application components, thereby reducing the overall storage and processor requirements along with their associated power utilization. Like server virtualization, storage virtualization is performed to reduce the sheer number of disk drives in the data center. The use of intelligent SANs enables such an environment, which can save considerable amount of money. Beyond the servers and storages in the data center, virtualization techniques can be applied to client desktops to obtain the same functionalities and benefits accrued with server and storage virtualization. Additionally, extremely energy efficient desktops with little or no disk capacity (e.g. thin clients) can take advantage of virtualization and streaming technology to further significantly reduce desktop power consumption.

Another common practice is to use a network power management system to reduce power consumption. Energy Star, an environmental initiative run by the US Department

	Best practices	Comments
Asset management	<p>Design of green IT by the manufacturers</p> <p>Companies buying green IT – energy efficient and environmentally friendly equipments</p> <p>Companies using a range of green IT equipments from desktop to data center</p> <p>Recycling of used and unwanted computer equipments</p> <p>Use of environment-friendly methods for disposing end-of-life computer equipments</p>	<p>Energy Star (<a href="http://www.energystar.gov/">www.energystar.gov/</a>) provides support for energy efficient products and practices</p> <p>EPEAT (<a href="http://www.epeat.net/">www.epeat.net/</a>) helps evaluate, compare and select computer equipments based on environmental attributes</p> <p>Green Grid (<a href="http://www.thegreengrid.org/">www.thegreengrid.org/</a>) focus on improving energy efficiency in data centers and business computing ecosystems</p> <p>eCycling – guidance provided by Environmental Protection Agency (EPA)</p>
Energy efficiency	<p>Reducing the use of imaging devices – printers, photocopiers, fax machines, and scanners to save energy, trees and operational costs</p> <p>Using network power management systems to lower power consumption, reduce costs and eliminate waste</p> <p>Consolidating servers, as well as storage to optimize server and storage needs and capabilities</p> <p>Improving air flow and temperature regulations in data centers</p>	<p>Shift to networked laser printers and multifunction printers and copiers</p> <p>Power down PCs at night and enable power management features</p> <p>Upgrade to a newer and efficient uninterruptible power supply</p> <p>Use virtualization technology to consolidate servers</p> <p>Consolidate storage with SAN/NAS solutions</p> <p>Optimize data center design</p>
Enable green IT practices through the utilization of IT	<p>The enterprise network is capable of supporting business collaboration and wireless technologies</p> <p>Use of anytime-anywhere technologies – teleworking, mobile and wireless – make 24/7/365 possible</p> <p>Data center virtualization – enables multiple virtual servers to run on a single physical server, promoting efficient utilization</p> <p>Use of storage area network (SAN) or network-attached storage (NAS) to reduce cost and increase efficiency of the storage system</p> <p>Use cloud computing to improve the way IT services are delivered by a company</p>	<p>The ability of a network to handle all – voice, data and multimedia traffic and applications – eliminates duplication of bandwidth, networking equipment and network management resources</p> <p>Telework and videoconferencing replace energy- and time-intensive activities such as commuting by personal vehicle or air travel</p> <p>Examples of virtualization software – VMware's vSphere and Microsoft's Hyper-V</p> <p>Cloud-based IT services are delivered on demand in a way that lets one easily scale the capacity up or down based on their need</p>

**Table III.**  
Three areas of green IT implementation and their best practices

of Energy and the EPA, estimates that using a network power management system, which automatically powers down computers when they are not being used can save \$25-\$75 a year per desktop.

Additionally, the designed organizational green IT practices are formally institutionalized in this phase in terms of operating procedures. The employees are trained to follow and to log (document) the usage of these procedures properly and timely.

### *Measure phase*

The measure phase of the green IT adoption process is involved in measuring and monitoring the performance of the green IT that has been implemented against the organization's environmental metrics to assess whether the target goals for each objective are met. CIOs and sustainability team at large companies have used spreadsheets in the past to track carbon emissions. More recently, environmental sustainability tracking software such as Enterprise Carbon Accounting (ECA) software is being adopted by large companies because of the multi-dimensional tracking and reporting functionalities that are available in them compared to plain spreadsheets. The measure phase thus determines the on-going success of the implementation. If the implementation does not fully pass the test for effectiveness, the green IT adoption process would then need to revisit the plan phase to make adjustments to the plan based on the feedback received in the measure phase. The adjusted plan would most likely require adjustments to the design and subsequently to the implementation. Thus, the green IT adoption process is cyclical, characterized by a continuous improvement lifecycle.

### **Conclusion**

With the absence of one in the current green IT research literature, this study attempted to provide a workable, best-practice-based roadmap for organizations to follow to adopt green IT. Going green is an incremental process. As with many other business efforts, there currently are, and will be in the future, easily attainable action steps and more advanced requirements. However, a focused and systematic effort, such as the one presented through the process management approach here, can have a meaningful impact both in the short and long term. Cloud computing will increasingly serve as a good player in the current green IT adoption movement, especially for:

- those companies who are looking to avoid upfront costs associated with building their own IT infrastructures;
- IT departments that do not have the internal resources to maintain an enterprise-level data center and associated services; or
- companies that want to add supplemental computing capacity or services that are not already built into the company's infrastructure.

This is primarily because cloud computing leverages shared infrastructure to deploy and balance IT resources for computing tasks in real-time and it can significantly reduce carbon footprints while maintaining the levels of service (Greengard, 2008).

The likelihood that companies will successfully adopt green IT initiatives depends on several organizational and environmental factors as well. The primary factor is the Champion Support. Having the support of Champion is critical to success of any project but, particularly for green IT adoptions as they require education and a shift in attitude and behavior. Lack of implementation barriers is another important factor among others. Companies adopting green IT initiatives may face barriers that inhibit the successful approval and implementation of these initiatives. Some of these potential barriers could be:

- lack of buy-in from all levels of an organization;
- inadequate funding;
- inadequate skill sets to execute the initiatives;

- unclear or poorly defined objective;
- undefined linkage between the adoption objective to business objective;
- unknown impact of the adoption initiatives on the overall business; and
- inadequate infrastructure to support the technical requirements of the initiatives.

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