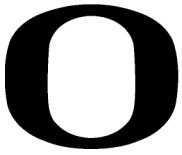

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CAPSTONE REPORT

Managing Energy Consumption of Office Equipment in Small To Mid-Size Companies for Economic Viability

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Abstract

This study examines the proposition that sustainable business practices can decrease the use of energy for office equipment and have a positive impact on profitability, productivity and performance (Hitchock and Willard, 2006). Literature published between 1992 and 2008 are analyzed. Industry terminology is presented, along with recommended sustainable business practices for management of selected equipment. Management systems incorporating sustainable concepts include Smart Management System Automation, data center design techniques and energy efficient office equipment applications.

Table of Contents

Literature Review Introduction

Topic

This paper provides an examination of the economic impact of environmental sustainable business practices in relation to energy consumption of office equipment and equipment consumables, on a small to mid-size company. Included is an analysis of management systems that govern and facilitate the operations of environmentally focused practices and equipment. And while management systems that incorporate sustainability concepts are often only examined in the context of moral responsibility (Capell, Carey, Engardio and Hall, 2007), business managers are concerned with growth and innovation in relation to existing practices and company bottom line profitability.

Research Problem

Information and Communication Technologies (ICT) have a great potential to support sustainable development (Arnfalk, Erdmann, Goodman, and Hilty, 2006). Referenced by Hilty et al., (2006), environmental sustainability is defined by the following set of environmental indicators:

- Greenhouse gas emissions,
- Energy intensity of the economy,
- Volume of transport to gross domestic product,
- Urban air quality,
- Amount of municipal solid waste land-filled or incinerated.

The goal of this literature review is to identify potential benefits of sustainable business practices, when implemented in small to mid-size companies, in relation to energy consumption of office equipment. The pursuit of environmental sustainable action often saves money, (Hitchcock and Willard, 2006) thus increasing profitability. According to 2003 projections by the Department of Energy, annual energy use by personal computers is expected to grow 3% per year, and energy use among other types of office equipment is expected to grow 4.2%; this growth is in spite of improvements in energy efficiency (UC Berkeley, 2004). The U.S. Environmental Protection Agency predicts that power consumption in data centers and small offices will double over the next four years unless companies become more energy efficient (Thibodeau, 2007). The argument to be made, as put forward by Capell, Carey, Engardio and Hall (2007), is that management systems that incorporate sustainability concepts in relation to energy consumption of office equipment are economically viable when compared to existing systems. One such management system, for example, examines cost management techniques (Capell, Carey, Engardio and Hall, 2007). Those working in the field of sustainability generally all envision sustainability as having three realms: economic, social and environmental. Businesses have long referred to this as the "triple bottom line." Instead of trading these realms off against one another, sustainability aims to optimize all three (Hitchcock and Willard, 2006). Of the three aspects of sustainability as mentioned by Hitchcock and Willard, this inquiry is focused on the economic realm in regard to impact on small to mid-size companies

Environmental sustainable business practices in the context of this paper are defined as business practices that reduce energy consumption costs, waste costs, and improve image with shareholders, which increases profitability (Hitchock and Willard, 2006). According to Hilty et

al. (2006) an analysis of the positive and negative environmental effects of sustainable business practices is useless if it ignored the “impacts on the socio-economic system and its interactions with the environment” (Hilty et al., p.1).

The topic of sustainable business practices falls within the field of change management processes "which seek to ensure the successful transition from the old form to the new form" (Galliers and Leidner p. 446). As noted by Hitchcock and Willard (2006), "Virtually everyone is willing to take steps towards sustainability if someone would just explain, in clear and understandable language, what can be done" (Hitchock and Willard p. xi). Business Systems or Business Systems Planning are methodical procedures used in the analysis of processes of organizations’ needs (Galliers and Leidner, 2003). Business systems are a powerful indictor of organizational priorities but they often hold back the organizational change effort (Hitchcock and Willard, 2006). Hitchcock and Willard (2006) suggest making sustainability one of the key trends to consider in strategic planning, operational planning, budgeting and incorporating into policy statements. Kawamoto, Mizuno and Shimoda (2004) describe office equipment power management techniques as one example of a management system that incorporates sustainable business practices. They argue that reducing the energy use of office equipment is effective in improving profitability, as well as restraining electricity demand growth.

Audience and Significance

The audience for this literature review is intended to be department and office managers for small to mid-size companies (SME) who make decisions on company budgets and technology implementation, such as IT Managers, CEOs and CFOs, or managers who aim to create a

bottom-line impact through the use of sustainable office technology (Bowes, 2005). These professionals need to know about both office equipment and management systems. For example, according to UC Berkeley's Energy Analysis Department, the Energy Star program is "designed to curb the growth of CO2 emissions by labeling the most energy-efficient electronic products for the mutual benefit of manufacturers, consumers, and the environment." (p. 6). Companies in the U.S spend as much as 10% of their total IT budgets on power and cooling (Perkins, 2007). "Smart management systems", such as Apple's Energy Saving software feature, can control a variety of different systems, such as monitor brightness, printer output, and cooling requirements. The software can automatically manage electrical consumption of Apple products, thus reducing the cost of electricity by shutting down or using a power saving techniques without human intervention (Gowan, 2007).

The research questions posed in this inquiry for the needs of this audience are:

(1) What types of office equipment are available for companies to purchase, that promise to reduce energy consumption? According to the Energy Information Administration (2003), the most rapid increases in demand of commercial energy are projected for computers, office equipment, telecommunications and miscellaneous small appliance use. The identification of energy efficient equipment show the potential to reduce operating costs;

(2) What existing technologies are accessible to allow existing office equipment to become more power efficient, and potentially thus reduce operating costs? The emphasis on power management of existing assets to capitalize current

infrastructure is a key focus for organizational policy development (Hitchcock and Willard, 2006); and

(3) According to selected literature, can companies implement sustainable business practices in this area and stay within current budgetary parameters? Capell, Carey, Engardio and Hall mention "to many U.S. business leaders, sustainability just meant higher costs" (2007). The area of sustainability and profitability is "…littered with lofty intentions that don't pay off. As a result, many CEO's are unsure what to do exactly" (Capell, Carey, Engardio and Hall, 2007).

Examination of these questions in the selected literature is expected to result in "translating the abstract concepts of sustainability into tangible actions," (Hitchcock and Willard, 2006) for development of business strategies, technologies, and techniques for small to medium-size enterprises (SME) when aligning business systems and planning. Additionally, since the topic addressed in this review is relatively new, the audience should benefit from careful consideration of the Definitions section of this paper, which is developed to establish a common lexicon of terminology used in the arena of sustainable business practices and management systems.

Research Limitations

Literature Sources

The literature reviewed in this paper is limited to the following sources: peer reviewed journals; government publications; trade journals; text books; case studies performed by university researchers; and academic research such as study proposals and thesis and dissertations which include in-depth discussions and careful documentation of the evidence

(Lester and Lester, 2005). Literature that does not directly relate to sustainable business practices are excluded from this review to help narrow the focus. Press releases and advertisements are excluded due to bias claims and data which would only support the profits and benefit of the author or publisher. Trade journals are referenced due to a lack of current data on the recent development of this topic, and because they often contain a high number of citable statistics and technologies not yet available for in-depth peer-reviewed analysis.

Literature Focus

Regardless of the definition, those working in the field of sustainability generally all envision sustainability as having three realms: economic, social and environmental (Hitchock and Willard, 2006). Literature examined in this paper primarily focuses on power management, energy efficient office practices and the cost of implementation, energy conservation and use of office equipment (Kawamoto, Mizuno and Shimoda, 2004) and the potential to enhance the corporate bottom line (Aigner, Hopkins and Johansson, 2003). Social responsibility is not within the scope of this literature review but is embedded in most discussions as an intangible benefit in the argument in support of sustainable business practices (Capell, Carey, Engardio, and Hall, 2007).

Audience Selection

Getting into the perspective or "mindset" of the intended audience helps to focus the literature chosen for examination. According to Hitchcock and Willard (2006), top management must juggle the competing interests of different stakeholder groups: customers who want good value, shareholders who want quarterly profits, employees who want meaningful work and

regulators who want safety for employees and the environment. Sustainability concepts can help management come up with creative strategies that meet multiple needs (Hitchcock and Willard, 2006). Hitchcock and Willard (2006) address factors that affect bottom line profitability of an SME, which should be important to company management. Following this line of thought, this literature review is directed to assist management of SMEs to address factors for investments in sustainable programs and new types of environmental markets and to "help organizations perceive the unsustainable nature of current business practices and the inherent benefits of converting to sustainability" (Fields, 2002, p. A114).

Publication Dates

Literature published over a decade ago may not have as much relevance as more recent publications; therefore, date of publication is a factor in resource selection. Technological changes in the past 11 years have been implemented to comply with the introduction of the Environmental Protection Agency's Energy Star program.

Writing Plan

The thematic style of literature review (UNC, 2007) organizing the research around the central topic or issue, rather than (for example) the progression of time, is used as a way to structure ideas in the examination of sustainable business practices in relation to the economic viability of energy consumption of office equipment and equipment consumables, for a small to mid-size company. Sources chosen are arranged according to selected categories (Lester and Lester, 2005). For purposes of organizing resources, literature is examined based on the following themes:

Theme 1: *Energy efficient office equipment in relation to energy consumption.*

For example, about 19% of electricity use in Japanese offices is dedicated to office equipment. Reducing the energy usage of office equipment is effective in restraining electricity demand (and cost) (Kawamoto, Mizuno and Shimoda, 2004).

Theme 2: *Smart management system automation in relation to energy costs.*

For example, using 'power save features' and other resource saving technologies in the form of software or sensory equipment may result in costs savings (Gowan, 2007).

Theme 3: *Impact of sustainable business practices on profitability.*

For example, Engardio, Capel, Carey and Hall (2007) note that embracing sustainability can help avert costly setbacks from environmental disasters (and) political protests. They state, "Nobody has an idea when such events can hit a balance sheet…" (Capel, Carey, Engardio and Hall, 2007, par 5).

Definitions

The purpose of the definitions section of this paper is twofold. The first purpose is to provide a specific framework to this review of literature. The second purpose is to contribute to the establishment of a common lexicon of terminology used in the arena of sustainable business practices and management systems. Definitions are retrieved from literature selected for use in this paper.

Bottom line: For example, the bottom line of an Income Statement. The bottom line shows the Net Income Available to Shareholders. When a company talks about increasing the bottom line, they mean doing things to either increase the revenue or decrease expenses so the company's income increases (Reh, 2007). In this study, the phrase 'bottom line profitability' is used; referring to an organization's break even point for attaining positive revenue after all costs have been subtracted from revenue earnings.

Energy consumption: Consumption of primary and secondary energy sources at the end user (industry, transport sector, households and small consumers) (Steag, 2007).

Energy efficiency: Saving energy and natural resources through the reduction of energy used to operate office equipment such as computers, monitors, and other electrical devices (Gowan, 2007). The term "energy efficiency" also relates to the connection between energy use and emission of greenhouse gases (Hitchcock and Willard, 2006).

Equipment consumables: For the purpose of this inquiry, equipment consumables are items such as toner cartridges, inkjet cartridges, drum/imaging units, disks, paper, etc. (Australian Government, Department of Environment and Heritage, 2006).

Green business practices cost: The financial effects associated with environmental sustainable actions and equipment. Also included are intangible items such as the quantification of environmental, social or labor practices, which "aren't found on a corporate balance sheet, yet can be powerful indicators of future performance." (Capell, Carey, Engardio and Hall, 2007).

Management systems: For the purpose of this paper, the focus is on sustainable management systems, which refer to processes to routinely set priorities for sustainable improvements, monitor the results and institutionalize best practices (Hitchcock and Willard, 2006).

Power management: "Power management (PM) is a built-in function that reduces the power use of office equipment when it is idling" (Kawamoto, Mizuno and Shimoda, 2004).

Office equipment: For the purpose of this inquiry, office equipment is a generic term that refers to all supplies regularly used in offices by businesses and other organizations, who work with the collection, refinement and output of information (colloquially referred to as "paper work") (Wikipedia, 2007). This includes equipment that consumes energy.

Small to mid-size enterprises (SMEs): Small and Medium-sized Enterprises, are defined as enterprises which employ fewer than 250 persons (European Commission, 2003).

Smart management systems: Automated management systems, which manage devices like workstations, UNIX, Netware servers, PC s, printers, routers (and office equipment) (Lin, 1998).

Sustainable business practice: Sustainable business practice is defined as "adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future." (International Institute for Sustainable Development, 1992).

Sustainable development: The concept of sustainable development marries two important insights: that environmental protection does not preclude economic development and that economic development must be ecologically viable now and in the long run (ORD-U.S. EPA, 2007). Concepts used in various arenas and how they pertain to sustainable business practices.

Sustainability: For years, the term 'sustainability' has carried a lot of baggage. It's a favorite cause among economic development experts, human rights activist, and conservationists, but to many U.S. business leaders, sustainability just means higher costs. Put simply, it's about meeting humanity's needs without harming future generations (Capell, Carey, Engardio and Hall, 2007).

Virtualization: A general term for "enhancing a computer's ability to do work. Partitioning the computer's memory into separate and isolated "virtual machines" simulates multiple machines

within one physical computer. It enables multiple copies of the same or different operating systems to run in the computer and also prevents applications from interfering with each other." (TechWeb, 2008).

Research Parameters

The goal of this section is to document the research methods used to develop the literature review, including search terms used in online databases and search engines, hits received, and relevance based on number of occurrences of search terms appearing in search results. Criteria for literature collection are presented. A description of the writing plan for the Review of the Literature is included.

Search Strategy Report

The search strategy for identification of information for use in this study begins by compiling a list of terms related to the chosen topic (see below). Although at first the search terms are haphazard in nature, more viable terms developed from the content of the found resources. Resources used for previous University of Oregon coursework are also referenced for this literature review, including most notably The Business Guide to Sustainability; Practical Strategies and Tools for Organizations (2006) by Darcy Hitchcock and Marsha Willard.

Search Terms

The search terms are listed below and organized by order of creation:

- Sustainable business practices
- Information Technology environmental sustainability
- Environmental office sustainability
- Environmental sustainability business practice
- Sustainable business solutions
- Energy consumption in business
- Office equipment energy consumption

- Office facilities energy consumption
- Sustainable business practices cost
- Green business practices cost
- Sustainable business practices cost

The keywords and search terms are entered into the following online databases: University of Oregon OneSearch, JSTOR (Journal Storage) from U O Libraries, ArticleFirst, Business Source Premier, Lexis Nexis Academic and Academic Search Premier. The search topics yield a vast amount of resources from these databases. Following the guidelines provided by Hewitt (1998), relevance of the sources for collection purposes is determined based on the following:

- Occurrence of search term in the text of the search results
- Credibility of writer based on government, academic or business affiliation
- Bibliography and abstract content relevance

Search Summary

The search summary is documented in Table 1, which is sorted by the search terms used, online database (labeled as *data source*), total hits per search term, relevant hits and a brief description of the search results based on relevance to the literature review topic.

Search Terms	Data Source	Hits	Relevant Hits	Relevance to Topic
environmental office sustainability	U of O OneSearch / Core Research	76,646	3	Results from OneSearch include anything from Google Scholar. This adds tens of thousands useless hits based only on if one of they key terms shows up in an article. Relevance was determined based on the number of occurrence of search terms appearing in a single hit.
	Google Scholar	75,400	2	Relevance was determined based on the number of occurrence of search terms appearing in a single hit.
small office business environmental sustainability	U of O OneSearch / Core Research	45,217	None	
	Google Scholar	43,500	None	
environmental sustainability business practice	Google.com	3,460,000	4	Mostly information websites from businesses.
environmental sustainable business practices	U of O OneSearch / Core Research	35,456	6	Many sources had recommendations for the cost savings of sustainability.
small business environmental practices	LexisNexis - Academic	739	10	Majority of directly related articles were news snippets and low academic relevance.

environment business bottom line	LexisNexis - Academic	978	3	Few articles pertaining to small business budgets in relation to environmental sustainability.
	U of O OneSearch / Core Research	580,597	1	
Information Technology environmental sustainability	LexisNexis - Academic	984	4	Many good articles.
	Google Scholar	2,110,000	2	Some duplicates, a few good website portals for future investigation.
	U of O OneSearch / Core Research	116,989	3	
Office equipment energy consumption	U of O OneSearch / Core Research	70,720	8	Many valuable resources.
Office facilities energy consumption	U of O OneSearch / Core Research	68,209	3	Several good case studies.
Information Technology Equipment Energy Consumption	U of O OneSearch / Core Research	128,754	4	High relevance in relation to providing statistics and numbers for equipment energy consumption.
Energy Consumption Information	U of O OneSearch / Core Research	439,046	2	High relevance in relation to providing statistics and numbers for equipment

Technology				energy consumption.
Sustainable business practices cost	Google Scholar	34,700	2	High relevance pertaining to cost of energy savings.
Green business practices cost	Google Scholar	20,400	1	High relevance pertaining to cost of energy savings.

Table 1: Search results for applicable material

Documentation Approach

Search results are documented using Microsoft Excel and Microsoft Word programs based on online databases including ArticleFirst, Lexis Nexis, and University of Oregon Library OneSearch. The collection of potential references is aided by the use of a range of bibliographic tools such as online databases including but not limited to ArticleFirst, Lexis Nexis, and University of Oregon Library OneSearch. The references are then assessed for relevance and quality (see Evaluation Criteria below) in anticipation of final selection. Finally, the process is documented in the form of a structured report (Hewitt, 1998). The documentation approach for is as follows:

1. Search terms used in each search engine and online database are documented. Such databases were ArticleFirst and Lexis Nexis.
2. Initial search results are documented in a graphical format (Table 1) which then became a primary tool supporting the search process, from start to finish.
3. Full versions of the electronic text of perspective sources are downloaded, as available.
4. A collection of available abstracts is collected and compiled into a Word document and scanned for relevance.
5. Potential sources are grouped based on literature review theme categories.
6. Results selected for use in the study are recorded in either in the literature review bibliography or in the full references list, in APA format.

Evaluation Criteria

Selection of literature was established through examination of two key criteria: literature relevance of the subject matter and quality of the source. Relevance was determined by scanning references with abstracts for search terms relevant to the literature review themes, as suggested by Hewitt (1998). Copies of articles and original articles were collected (Hewitt, 1998). Quality was also determined, based on a list of criteria proposed by Hewitt (1998), including the credentials of the author(s), peer review and the journal in which an article was published. Articles were reviewed and if un-researched opinions or private promotion was found, the article was deemed of low quality and discarded from the review.

Writing Plan

According to Leedy and Ormrod (2005), a "review of the related literature section is a discussion of the studies, research reports and scholarly writings that bear directly on your own effort…a careful consideration of the problem should suggest relevant areas for discussion and the order in which they should be addressed" (p. 79). The goal of this review of literature is to provide CEOs and company mangers of SMEs a reference of methods, tools and relevant resources (Hitchcock and Willard, 2006) for assessment and implementation of sustainable business practices. Using search terms based on this goal, themes emerged from the preliminary assessment of the literature in relation to the literature review topic. Themes emerging from the research included office equipment energy consumption, management systems for energy consumption in conjunction with resource allocation impact of sustainability on profitability. In conjunction with Leedy and Ormrod's (2005) guideline for a review of literature, this composition follows Lester and Lester's (2005) "paradigm for advancing your ideas and theories" (p. 136); first establishes

the significance of the relevant problems, examines expert studies and concepts, and offers directives for a plan of action. The outline below presents a way to organize the ideas in the Review of the Literature by category and addresses three relevant themes in a successive arrangement by grouping sources by topic (Lester and Lester, 2005).

Writing Plan Outline

1. Literature that addresses energy efficient office equipment in relation to energy consumption and focuses on the following:
    1.1. Statistics and documentation of energy consumption of office equipment (Biello, 2008), (Energy Information Administration, 2003) and (Perry, 2007).
    1.2. Sustainable business practices for the reduction of energy consumption (Gowan, 2007) and (UC Berkeley, 2004).
2. Smart management system automation in relation to energy costs
    2.1. Literature that addresses smart management system automation in relation to energy costs (Webber, 2006) and (Kawamoto, Mizuno and Shimoda, 2004).
3. Literature that addresses factors influencing the Impact of sustainable business practices on profitability (Hitchcock and Willard, 2006).
    3.1. Government Regulations (Capell, Carey, Engardio and Hall, 2007), (Dizon, 2007), (Office of Research and Development, U.S. Environmental Protection Agency, 2007) and (Wotherspoon, 2007)
    3.2. Legal and Insurance Risks (Hitchcock and Willard, 2006)
    3.3. Impact of sustainable business practices on stock value (Capell, Carey, Engardio and Hall, 2007) and (Fields, 2002).

3.3.1 Impact of sustainable business practices on productivity and performance (Abdou, 1997).

3.4. Environmental protection agencies

3.4.1. Environmental regulations (Office of Research and Development, U.S. Environmental Protection Agency, 2007) and (Energy Information Administration, 2003).

Annotated Bibliography

Twenty-three references are selected to form the basis of the Review of Literature. Literature in this section are grouped according into three themes, each framed to address a specific research question. Within each thematic category, references are organized alphabetically by last name of the author or institution responsible for the creation of the reference. Included in each Bibliography entry is the title and author, publication date, journal volume if applicable, or website and retrieval date, an abstract, an explanation of criteria used to select the reference and a brief description of how the references is used in this paper.

Theme 1: Energy Efficient Office Equipment and Energy Consumption

Abdou, O. A. (1997). Effects of Luminous Environment on Worker Productivity in Building Spaces. *Journal of Architectural Engineering* (pp. 124-132).

ABSTRACT: This paper is based in part, on the results of a survey undertaken by the writer for an industrial client. The purpose was to collect and systematize information on quantitative relations between the indoor environment and worker productivity. Office workers strongly believe that lighting conditions are an extremely important aspect of their workspace environment. Unfavorable conditions may hamper productivity. Day lighting is of particular importance. It is further shown that lighting conditions have a strong impact on worker performance in industrial facilities. Certain lighting strategies can contribute to an enhancement in worker productivity while cutting down on energy consumption. The influences on worker productivity of different characteristics of illumination are described. These include spectral distribution, color rendition, glare,

daylight versus artificial light, and others. The presence or absence of windows on worker comfort and perception is also discussed. It is shown that improving lighting conditions is a highly cost-effective method of increasing worker productivity in office spaces as well as in manufacturing facilities. Although this information is over a decade old, it is relevant in this Review of Literature for the purpose of providing the early strategies of sustainable business practices.

Australian Government, Department of Environment and Heritage. (2006). *Environmental purchasing checklist – Office equipment consumables.* Retrieved November 17, 2007, from http://www.environment.gov.au/settlements/publications/government/purchasing/office-consumables.html#specification

ABSTRACT: This article discusses the environmental impact of office products and services, and includes testimonials and links to further information. Taking into account governmental policies relevant to environmental legislation including the implementation of purchasing policies for recycled goods, tips and checklists are provided for purchasers when considering office equipment consumables. This text provides environmentally sustainable business practices suggested by the Australian Government, and are used in this inquiry to provide fundamentals that are also adaptable for American business standards.

Biello, D. (2008). Digital diet: Computing industry gets serious about energy conservation. *Scientific American*. Retrieved June 15, 2008, from

http://www.sciam.com/article.cfm?id=digital-diet

ABSTRACT: The technology computing industry's shifting focus from power consumption to power conservation. This article summarizes current technology trends and resources to help reduce energy use. This publication features renowned writers including Nobel laureates, and includes insights about developments in science and technology from subject experts. This article is cited in this Review of Literature for current energy usage statistics and industry developments.

Gowan, M. (2007). 8 Ways to Go Green. *Macworld.com*. Retrieved November 11, 2007, from http://www.macworld.com/article/57689/2007/05/june07workingmac.html

ABSTRACT: The article discusses several ways of creating an energy efficient office that helps in saving energy and natural resources. It is stated that electricity consumption of Macintosh computers can be reduced by setting the energy saver option to turn the monitor black if not used for a long time. Suggestion has been given to turn off the computer once the work is done and not to leave it in sleep mode as it would help in saving 40 watts of electricity in a day. It has been stated that one should use solar chargers for laptops and small electronic devices that use renewable solar energy. The publication is a well-established trade publication and referenced for industry professionals' opinion.

Kawamoto, K. Mizuno, M. and Shimoda, Y. (2004). Energy saving potential of office

equipment power management. *Energy and Buildings* (pp. 915-923). Elsevier B.V. Retrieved November 8, 2007, from Lexis-Nexis database

ABSTRACT: While many studies have estimated the energy saving potential of office equipment power management, there is no recent study about the energy saving potential of shortening the power management delay time. In this paper, we estimated the energy saving potential of the complete saturation of power management, and also the additional energy saving potential of shortening the power management delay time for PCs, displays, copiers, and laser printers in Japanese offices. To obtain key data, we conducted the surveys and field measurements of usage in business hours and the turn-off rate at night. We found that office equipment power management can save as much as 3.5 TWh (Total Watt Hours) per year, which is nearly equal to 2% of commercial electricity consumption in Japan. We also found that the energy use of office equipment in Japanese offices with no use of power management is even lower than that in US offices with maximum use of power management. This is primarily because the portable computer is much more popular in Japan, and also because the manual-off rate at night is more than twice that in the US. One of the main reasons for selecting this article for use in this inquiry is to provide a reference of case study examples for environmental sustainable business practices, specifically perspectives on power management of office equipment.

Perry, L. (2007). *Achieving Environmental Sustainability, Part 1-Executive Thought Leadership*. Cisco Systems, Inc. Retrieved May 20, 2008, from http://tools.cisco.com/dlls/tln/page/cio/detail/cio/2007/environmental-sustainability-part-1

ABSTRACT: Forum focuses on how IT can make business processes more agile. An examination of how IT can help a company be more "green." Cisco IT describes how it has worked toward environmental sustainability using statistical data regarding consumption of materials and equipment, energy efficiency, and reduced electronic and office waste. The text is published by a corporation – Cisco Systems -- and examines the environmental aspects of sustainable business practices. The information is used to support ideas presented in the first theme of this paper, literature that addresses energy efficient office equipment in relation to energy consumption.

Sustainable Business Network of Portland (2007). *Sustainable business practices for locally owned businesses.* Retrieved June 6, 2007, from http://www.sbnportland.org/resources/SustBizPrac.pdf/download

ABSTRACT: A sustainable business strives to achieve high standards by creating value for its customers, suppliers, employees and the communities on which its business depends. It also ensures the preservation of the social and environmental systems it relies on for its resources. This Review of Literature cites information from this online article to demonstrate the information available for businesses on a local level for support on implementing environmental sustainable practices. The Sustainable Business Network of Portland (SBNP) is a non-profit organization that works with other non-profit organization and government agencies, acting a resource on sustainability issues for the local network of Portland, Oregon's community-based businesses. SBNP contributes current data not yet published by peer-review analysis.

Perkins, B. (2007). Ten Energy Savers. *Computerworld,* Vol. 41. Retrieved November 23, 2007, from http://www.computerworld.com/action/article.do?command=viewArticleBasicandarticleId=301286

ABSTRACT: The article discusses ways that could allow reduction of energy costs in information technology organizations in the U.S. It includes quantification and communication about energy costs within the organization, implementation of total system energy, utilization of equipment with which to monitor actual power consumption, consideration of utility rates when locating server centers, installation of modular and scalable uninterruptible power supplies, advancement of cooling systems, utilization of energy-efficient lighting, reduction of data volumes, assumption of utility rebates and tax credits and completion of green association guidelines. Portions of this document identify current trends and statistics that are cited in this inquiry. *Computer World* is an industry trade journal referenced for current data not yet published by peer-review analysis. *Computer World's* website and print publications have been the leading source of technology news and information for 40 years, and have won more than 100 awards in the past five years.

Webber, C. A. (2006). After-hours power status of office equipment in the USA. *Energy*. Vol. 31. Retrieved November 23, 2007, from www.osti.gov/energycitations/servlets/purl/821675-waYRd0/native/821675.pdf

ABSTRACT: Office equipment is expected to be the fastest-growing segment of commercial energy use over the next 20 years, yet many aspects of office equipment

energy use are poorly understood. User behavior, such as turning off devices at night or enabling power management (PM), influences energy use to a great extent. The computing environment also plays a role both in influencing user behavior and in the success of PM. Information about turn-off rates and PM rates for office equipment was collected through a series of after-hours audits in commercial buildings. Sixteen businesses were recruited, including offices (small, medium and large offices in a variety of industries), schools, and medical buildings in California, Georgia, and Pennsylvania. The types and power states of office equipment found in these buildings were recorded and analyzed. This article presents these data for computers, monitors, printers, copiers, fax machines, scanners and multi-function devices. These data can be used to improve estimates of both energy consumption for these devices and savings from energy conservation efforts. The statistical information provided in this text is cited in this inquiry as the data is referenced from the governmental environmental protection agency. This publication was reverence as a credible source as it is found on the U.S. Department of Energy's Office of Scientific and Technical Information website and backed by government funded research.

Theme 2: Smart Management System Automation in Relation to Energy Costs

Arnfalk, A. Erdmann, L. Goodman, J. and Hilty, L.M. (2006). The relevance of information and communication technologies for environmental sustainability – A prospective simulation study. *Environmental Modeling and Software*, Vol. 21. Retrieved October 25, 2007, from http://www.empa.ch/plugin/template/empa/*/51354/---/l=2

ABSTRACT: Information and Communication Technologies (ICT) have relevant positive and negative impacts on environmental sustainability on various levels: First-order effects such as increasing electronic waste streams; second-order effects such as improved energy-efficiency of production; third-order effects such as a product-to-service shift in consumption or rebound effects in transport. In the simulation study described in this article, all known relevant effects on all three levels were modeled using a System Dynamics approach in combination with scenario techniques and expert consultations. The prospective study for the European Union with a time-horizon until 2020 revealed great potential for ICT-supported energy management and for a structural change towards a less material-intensive economy, but strong rebound effects in the transport sector whenever ICT applications lead to time or cost savings for transport. This case study provides a plethora of information incorporated in this inquiry, including key definitions for environmental sustainability. The authors also provide an emphasis on information and communication technologies. This resource is a published academic peer-review and is cited throughout this paper for information on power management and research on energy-efficient practices.

Bowes, D. (2005). On-the-job seasoning of an IT pro. *Computerworld*. Vol. 39. Retrieved November 23. 2007, from www.computerworld.com.my/PrinterFriendly.aspx?articleid=2778andissueid=91andpubid=3

ABSTRACT: In the words of the author . . . . Like most information technology (IT) managers, I always aimed to create a bottom-line impact through the use of technology,

reduce the mystery surrounding IT and adopt standard business management techniques. Unfortunately, these efforts generally didn't have the intended result. Most chief executive officers still don't seem to grasp the potential of business transformation coupled with IT. But this is our fault as much as theirs. What can we do to remedy this situation? The answer lies in training, but I'm talking about something more than a class for your business executives to learn how to use a spreadsheet. I'm talking about a widespread learning environment, a culture of learning. For the purpose of this inquiry, the information in this trade journal text is referenced as a way to provide industry professionals' opinion. *Computer World* is an industry trade journal referenced for current data as the information on new technologies not yet reviewed by academic sources. *Computer World's* website and print publications have been the leading source of technology news and information for 40 years, and have won more than 100 awards in the past five years.

Conry-Murray, A. (2007). Measuring the PC Power Bill. *Network Computing*. Retrieved November 23, 2007, from www.networkcomputing.com/showArticle.jhtml?articleID=196901483

ABSTRACT: Energy costs to power and cool the data center are a top concern for IT. This article examines the costs to power desktops and laptops and the significance of their power consumption. Information from this article is used to support the discussion of environmental sustainable practices in relation to existing practices and company bottom line profitability. *Network Computing* is a subsidiary of *Information Week*, an

organization which conducts research and studies on business technology trends and issues.

Hoenshell, D.J. (2008). Environmental Sustainability: *Green solutions make business sense*. Electronic Data Systems Corporation (EDS) White Paper. Retrieved May 20, 2007, from www.eds.com/about/corporate/downloads/sustainability_whitepaper.pdf

ABSTRACT: EDS recognizes that a healthy environment is the basis for a sustainable global economy and essential for the well-being of our people, our business and clients' success. The key challenge is to enable global business, counter for the human demands on the environment and still safeguard vital ecosystems. It's a balancing act that requires efficient processes and practices within eco-responsible solutions, with results that add business value, lower IT costs and significantly reduce the enterprise carbon footprint. Although this reference is a white paper, the information provides documented "eco-friendly" outcomes for IT related services and technologies, which are addressed in the section of this paper pertaining to smart management system automation and provides examples of power-saving technologies.

Perkins, B. (2006). IT Energy Costs: The Quiet Budget Killer. *Computerworld*. Vol. 40 (p. 62). Retrieved November 23, 2007, from www.computerworld.com/action/article.do?command=viewArticleBasicandarticleId=111171

ABSTRACT: The article focuses on the energy costs which become the burden of the high technology industries. The author points out that most information technology

organizations estimate their standard infrastructure expenses based on servers, telecommunications and desktops but few consider the cost of the electricity required to power and cool their equipment. He adds that with the rising energy prices, companies can no longer ignore the cost of power. He points out some tips for power saving such as, operate the uninterruptible power supply, batteries and power-distribution systems in their most effective load range, design server layouts for cooling and enforce power-saving mode for unused equipment. Information in this article is cited in this inquiry to display techniques and methodologies for reducing power requirements in IT equipment. *Computer World* is an industry trade journal referenced for current data as the information on new technologies not yet reviewed by academic sources. *Computer World's* website and print publications have been the leading source of technology news and information for 40 years, and have won more than 100 awards in the past five years. This article is referenced in this review of literature for information pertaining to expenses of IT infrastructure in relation to energy costs.

Thibodeau, P. (2007). Feds Push if to Expend Less Energy.

Computer World. Vol. 41 (p. 18). Retrieved November 24, 2007, from www.computerworld.com/action/article.do?command=viewArticleBasicandarticleId=300604

ABSTRACT: The article reports on the appeal of the U.S. Environmental Protection Agency (EPA) to Information Technology (IT) managers to adopt best practices for managing power usage. EPA predicts that power consumption in data centers will double over the next four years from 2007 unless companies become more energy efficient.

Vince Delperdang, information technology operations manager of O'Donnell/Atkins Co., cites some burdens which include other aspects of IT. He combines interest in computers and the environment in lessening IT's power consumption. The author is an IT manager with an environmental science degree and is cited for his studies of power usage and IT equipment in relation to government energy usage projection forecasts.

Theme 3: Impact of Sustainable Business Practices on Profitability

Aigner, D. J., Hopkins, J. and Johansson, R. (2003). Beyond compliance: sustainable business practices and the bottom line (General Sessions). *American Journal of Agricultural Economics*, Vol. 85 (pp 1126-1139). Retrieved November 26, 2007, from http://goliath.ecnext.com/coms2/browse_R_A088

ABSTRACT: In recent years, there has been considerable research activity devoted to the relationship between the environmental performance and financial performance or stock returns of publicly traded companies. The examples of environmental impacts on companies' profitability provided in this article are cited in this inquiry. This article was chosen for citation as a credible source as it is found in a peer-review journal and provides focus on the economic impacts of sustainable business practices for SMEs.

Capell, K., Carey, J., Engardio, P. and Hall, K. (2007). Beyond the Green Corporation; Imagine a world in which eco-friendly and socially responsible practices actually help a company's bottom line. It's closer than you think. *Business Week.* Vol. 4019. Retrieved October 25, 2007, from the LexisNexis database.

ABSTRACT: Company impact on community and environment are in the context of moral responsibility. The future of business growth is dependant upon business leaders' putting sustainability at the top of the agendas. This inquiry cites sections of this article to provide insights on financial impacts of environmental sustainable business trends and policies. This resource is a trade article and is cited in this paper as it gives more insight on intangible impacts of sustainable business practices such as public image and shareholder valuation.

Fields, S. (2002). *Sustainable business makes dollars and sense.*

Environmental Health Perspectives, Vol. Retrieved November 23, 2007, from http://www.ehponline.org/members/2002/110-3/EHP110pa142PDF.PDF

ABSTRACT: Reports the corporate investments for sustainable development in the U.S. Public demand for green products; Aims for a green economy; Adjustments by companies on federal environmental regulations. This article is referenced for this inquiry to provide key economic indicators. The author of this article uses research-based statistics and is cited in this review of literature to emphasize the value and benefits of implementing sustainable practices.

Hitchcock, D. and Willard, M. (2006). *The Business Guide to Sustainability.*

London, UK: Earthscan.

ABSTRACT: Sustainability promises both reduced environmental impacts or ecological footprint and real cash savings for any organization, be it a business, non-profit/NGO, or government department. The information provided by this textbook is heavily cited

throughout this inquiry. The authors are highly accomplished and academically recognized for expertise in the field of business and environmental sustainability. The authors are both accredited educators at several Oregon universities, have published a number of popular management books, and are founders and active members in suitability focused organizations. The authors are cited throughout this paper for their insight and expertise in the field of sustainable business practices.

International Institute for Sustainable Development (1992). Business and Sustainable Development: *A Global Guide.* Retrieved May 4, 2008, from http://www.bsdglobal.com/pdf/business_strategy.pdf.

ABSTRACT: Sustainability in the business context represents a progression beyond environmental regulatory compliance, eco-efficiency efforts such as energy efficiency and pollution prevention, and environmental risk management to a business model that gauges performance by a "triple bottom line." The “triple bottom line” adds environmental and social performance to traditional measures of economic performance. Companies attempting to create sustainable businesses are making fundamental changes not only in product design, production and distribution, but also in corporate philosophy and marketing strategies. Few companies are currently considered sustainable, and those that are tend to be small companies serving niche markets. A growing number of companies, however, are taking a leadership role in adopting some level of sustainable business practices as they move on a path towards sustainability. This source is cited for definition of sustainable business practice and referenced for information on the impact of sustainable business practices on profitability. The author is affiliated with a non-profit

organization supported by the Canadian government. This resource is primarily directed toward SMEs and the information is applied to this paper for current international information on the progression of sustainability concepts.

Kefalas, S. A.G. (2001). The Environmentally Sustainable Organization: *A Systems Approach.* Indiana University Press. Ethics and the Environment. Retrieved November 24, 2007, from http://inscribe.iupress.org/doi/pdfplus/10.2979/ETE.2001.6.2.90

ABSTRACT: Few concepts have created more sound and fury than the concepts of development and environment. The difficulty associated with these concepts increases exponentially when one attempts to clarify them by adding some attributes such as concrete definitions and measurements pertaining to the quantity and quality of these concepts. This essay deals with the private, for-profit corporation as the primary agent in the process of satisfying the human struggle for survival. This agent has been the epicenter of the "development-environment" issue for quite some time. Further, this agent has been frequently singled out as the most important, if not the exclusive, contributor to society's inability to achieve the desired "sustainable development," whatever meaning one attaches to it. We present a framework for designing a "new" type of organization which will be environmentally sustainable. This Environmentally Sustainable Organization (ESO) resembles a living organism that pursues its own survival in an environment with finite natural resources and infinite human desires. The author is noted for writing multiple published books on the subjects of systems analysis and

management. This particular work is referenced for this review of literature for insights on the profitability of sustainable development.

Nathan, L. (2008). Ecovillages, Values, and Information Technology: *Balancing Sustainability with Daily Life in 21st Century America*. DUB Group, University of Washington. Retrieved May 20, 2008, from http://dub.washington.edu/djangosite/media/papers/chi_1419-nathan.pdf

ABSTRACT: This project seeks to provide a rich account of the adaptive process that occurs as individuals with explicit value commitments interact with information technology. Specifically, ethnographic methods are being used to investigate the information technology adaptive process as it unfolds in the daily life of two ecovillages, communities made up of individuals striving to balance their use of technology with a lifestyle that is environmentally, socially, and economically sustainable. Anticipated research outcomes include: (1) an analytic description of information technology adaptive process; (2) a categorization of technological functionalities which support or constrain certain values, (3) an empirical extension of Value Sensitive Design, and (4) an analysis of the negotiation around tensions which emerge as a community's values influence the use of information technology features and, reciprocally, as information technology features influence a community's values. Most broadly this work contributes to our larger understanding of how the information technology adaptive process influences the human experience. This article is referenced for the difficulties that can be encountered when moving from a legacy infrastructure to a new production environment. This resource is a

project published by the University of Washington and is cited as a peer-review analysis of current environmentally sustainable IT support systems.

Office of Research and Development U.S. Environmental Protection Agency (2007). *Sustainability research strategy.* Report Draft. Retrieved October 25, 2007, from www.epa.gov/sustainability/pdfs/sustainability-research-strategy-draft061307.pdf

ABSTRACT: ORD conducts cutting-edge research and fosters the use of sound science and technology to fulfill the Agency's mission of protecting human health and safeguarding the natural environment. ORD research is a mix of (1) *core research* that seeks to advance fundamental understanding of key biological, chemical, and physical processes that underlie environmental systems, and (2) *problem-driven research* that focuses on specific environmental problems or customer needs. The Sustainability Research Strategy encompasses both core and problem-oriented research, aiming first at understanding biological, physical, and chemical interactions through a systems approach, and secondly at developing effective models, tools, and metrics that enable decision-makers to achieve sustainable outcomes while regarding profitability. This resource is used for definitions and considerations taken by the U.S. EPA with legislation and how it relates to SMEs in the terms of environmentally sustainable business practices

Review of the Literature

The Review of Literature is organized into three parts for the purpose of providing an overview of selected issues of energy efficient office equipment in relation to energy consumption, smart management system automation in relation to energy costs, and the impact of sustainable business practices on profitability. The growing awareness of the rise in energy cost and energy use of office equipment has ignited a plethora of research and literature supporting the movement toward the application of sustainable business practices and potential related benefits. Literature is examined for relevant information including statistics and projections, case study conclusions, current trends and procedures, and economic impacts for adapting sustainable business practices. The Conclusion provides a set of recommendations for practice and suggestions for further research to assist management of SMEs to "help organizations perceive the unsustainable nature of current business practices and the inherent benefits of converting to sustainability" (Fields, 2002, p. A114).

Part One: Energy Efficient Office Equipment in Relation to Energy Consumption

Statistics and documentation of energy consumption of office equipment. Research shows that energy consumption of commercial office equipment is increasing yearly, and accounts for a significant percentage of U.S. energy expenditure. Statistics and data from several sources illustrate this point, including governmental studies, records from industry leaders and in popular journals. The Energy Information Administration (2003) predicted that "Total electricity demand is projected to grow by 1.9 percent per year from 2001 to 2020…Rapid growth in

electricity use for computers, office equipment, and a variety of electrical appliances in the residential and commercial sectors is only partially offset by improved efficiency." In 2007 Perry noted that commercial use of power accounts for 62.5 percent of U.S. electricity consumption, 36 percent of U.S. primary energy use, and 30 percent of U.S. greenhouse gas emissions (Perry, 2007). And just this year, as reported in Scientific American, e-mailing, number crunching and Web searches in the U.S. consumed as much as 1.5 percent of the nation's electricity—half of which comes from coal (Biello, 2008).

By the end of 2005, data centers were consuming approximately 1.2% of all U.S. electricity (Perkins, 2007). Hownshell (2008) notes that perhaps the greatest impact that information technology has on the environment is not just e-waste, but the use of electricity. He writes, "the production of electricity creates carbon dioxide (CO2), by volume one of the leading greenhouse gases that affect climate change" (p. 1). According to Hoenshell (2008) predictions have been made that in 2008 half the world's data centers will have inadequate electricity to meet their energy and air conditioning needs.

Sustainable business practices for the reduction of energy consumption. Hitchcock and Willard (2006) suggest that due to the increase of cost and use of office equipment, a significant amount of resources are available which address sustainable business practices for the reduction of energy consumption. Computers, copiers, faxes and other office equipment represent the third largest electrical use in commercial buildings. Approaches that can be taken by IT management of SMEs to implement sustainable business practices for the reduction of energy consumption,

may include alternative utilization for current equipment and considerations for energy efficiency specifications of future equipment upgrades (Hitchcock and Willard, 2006).

Suggestions for operation of current infrastructures and available supplemental tools for the design of an energy efficient office structure are outlined by Gowan (2007) including the reduction of electricity use for computers, monitors, printers and other electrical devices. He suggests starting with simple practices such as turning computers to low-power mode rather than running at full power which uses 77 percent less energy, and connecting all peripherals to a power strip then turning the strip off at the end of the day which will save an average of two watts per hour per power adapter (Gowan, 2007).

To reduce power consumption of data centers, one company has taken the innovative approach of opening a data center 125 feet below ground utilizing a former mine. This approach recycles unused pre-altered environmental space, while also providing a cool temperature between 60-75°F, thus reducing the negative effects of air conditioning while also reducing the company's cooling costs by as much as 60% less than at ground level (Thibodeau, 2007).

Part Two: Smart Management System Automation in Relation to Energy Costs

Smart Management systems include software for the automation of equipment such as computers, servers, routers and other office equipment, reducing human interaction for maintenance and management (Lin, 1998). Power Management is a facet of smart management systems, and often includes factory installed settings that allow a device to automatically turn off

or reduce power consumption when not in use and is implemented as a "built-in function that reduces the power use of office equipment when it is idling." (Kawamoto, Mizuno and Shimoda, p. 1, 2004). SMEs may want to consider smart management systems such as computer software and network appliances as ways to support power management (Webber, 2006). In a case study conducted in Japan, Kawamoto, Mizuno and Shimoda (2004) discovered that office equipment power management saved as much as 3.5 TWh (Terra Watt Hours) per year, or nearly 2% of commercial electricity consumption in Japan. It should be noted that he also found that the energy use of office equipment in Japanese offices with no use of power management is even lower than that in US offices with maximum use of power management. This is primarily because the portable computer is much more popular in Japan, and also because the manual-off rate at night is more than twice that in the US.

Large amounts of electricity are wasted in off-business hours due to the improper configuration of equipment to either turn off or enter low-power modes within a pre-determined time of inactivity. Utilizing power management systems has the potential for energy savings of up to 60 percent for PC's, 90 percent for copiers and 65 percent for printers, during non-business hours (Kawamoto, Mizuno and Shimoda, 2004). The EPA's Energy Star Program, which was created in 1992, is highlighted by Webber (2006), and focuses on the labeling of equipment that reduce the amount of electricity consumed by either shutting down or entering a low power usage state after a designated amount of inactivity time.

Perkins (2007) suggests using systems that monitor power consumption and airflow to highlight where areas of improvement can be made. Hitchock and Willard (2006) recommend looking at

power reduction for copiers and printers by considering the amount of energy needed for particular units to operate. Power management systems may also include reducing the amount of physical equipment for company production. Examples made by Hitchcock and Willard (2006) include centralized printing devices which can be used to replace individualized printers per employee.

Software is available for the control and automation of large computer network power consumption. Gowan (2007) provides the example of Faronics' Power Save application that can create custom settings to enforce when a computer goes into power saving modes from a centralized console. On a per computer basis, equipment can be scheduled when to startup and shutdown based on working hours to reduce the amount of time wasted waiting for the PC to boot up (Gowan, 2007).

Stopping (or disabling) power management allows for updates and automated tasks to take place after hours as in a Windows NT based operating network. However, according to Webber (2006) disabling power management can increase the cost of energy usage on a company's bottom line by allowing equipment to continue running when not in use. Kawamoto, Mizuno and Shimoda's (2004) study shows that 19% of electricity in Japan is allocated to powering office equipment. Power Management systems combined with smart management systems can help to reduce the cost of power usage in equipment between 20-30% by shortening the power saving delay time from 60 to 15 minutes (Kawamoto, Mizuno and Shimoda, 2004).

Hoenshell (2008) suggests the use of Server Management Services, another facet of smart management systems, to help automate server maintenance procedures through virtualization. Virtualization takes several physical servers and consolidates them onto a single piece of equipment which has a positive effect on company bottom line by reducing the amount of hardware that needs to be powered and maintained. Server management services also reduce energy consumption through improved utilization of hardware (Hoenshell, 2008).

According to Bowes (2005), smart management systems may also include the use of company personnel. This starts with cross training company staff in efficient ways to use computer and email systems. He suggests that by creating a training environment, either through local intranets or human resources, IT leaders for SMEs can help identify areas of increased efficiency where IT can contribute to improved company resource allocation (Bowes, 2005).

Perkins (2007) suggests including smart management systems for the reduction of data volumes as a way to reduce energy costs. Large amounts of data acquire space overtime on hard drives and are often copies of existing documents or information, unused documents, or contain information that is no longer pertinent. Automated archival systems scour old information stored on computers and compress or dispose of unnecessary data, reducing energy consumption by minimizing the amount of data on the physical hard disk (Perkins, 2007).

Part Three: The Impact of Sustainable Business Practices on Profitability

According to Hitchcock and Willard (2006) "One misconception that prevents many executives from pursuing sustainability is the assumption that it will end up costing more "(p. 120). They suggest that the opposite is true; sustainable action has several benefits including saving money for businesses, and improving corporate public image.

Government regulations. A contributing factor of sustainable practices on profitability is governmental regulations. American companies may come under increased regulations if government industries change their policies based on public opinion and perception (Capell, Carey, Engardio and Hall, 2007). The U.S. Department of Energy (2006) states that commercial buildings consume 18% of all electric usage in the U.S. and energy usage growth for the commercial sector will grow 2% annually between 2007 and 2025. One of the top priorities for the Department of Energy is improving energy efficiency for the construction and use of commercial buildings (Department of Energy, 2006).

According to the U.S. EPA (2007), a main goal of their sustainable research strategy is to "employ life cycle assessment and material flow analysis to evaluate environmental releases from industrial systems and nanomaterials" (Office of Research and Development, U.S. Environmental Protection Agency, p. 8. 2007). Perkins (2007) brings to awareness the United Nations' estimate that 20 to 50 million tons of computer equipment and cell phones are dumped into landfills each year worldwide, a negative effect of IT technologies on the environment. Hitchcock and Willard (2006) stress that "electronics are filled with heavy metals, which can

leach into groundwater in a typical landfill (p. 99). They illustrate the proposal that organizations have successfully reduced as much as 90 percent of waste, and in some cases, convert the elimination of waste into a source of revenue; "an Epson plant in Hillsboro, Oregon diverted all of their waste from landfill and saved about $300,000 in the first year" (Hitchcock and Willard, p. 54, 2006). To reduce electronic equipment waste, and combat global warming, Perkins (2007) urges IT leaders to focus on reducing energy consumption, and reuse or refurbish office equipment or dispose of hazardous materials in an ecologically friendly manner. Following the practice of shifting to environmentally preferable materials and eliminating the long-term impacts on the environment in accordance to governmental regulations (Office of Research and Development, U.S. Environmental Protection Agency, 2007), one suggestion for the reduction of e-waste in landfills is to re-use "legacy data center [equipment] into a backup facility" to help mitigate disaster recovery set up costs (Perkins, 2006).

Wotherspoon (2007) discusses civic programs sponsored by Australia's Victorian Employers Chamber of Commerce Industry which help businesses reduce their costs and limit environmental impacts though sustainable means. Dizon (2007) prefers pre-empting governmental regulations (as in the case of The Coca-Cola Company in the Philippines) by actively partnering with regional governments and communities. Potential benefits include a positive public perception and compliance with government regulations (Dizon, 2007).

Another possible influence of governmental bodies on company profitability is regulation on power consumption as illustrated by Perkins (2007). The EPA instituted new Energy Star requirements beginning in January 2007 requiring greater energy efficiency in power supplies

and low-power modes. President Bush gave an executive order that 95% of all electronics bought by Federal Agencies meet new EPA guidelines. State governments have begun to set limits on chemicals permitted in products and instituting Electronic recycling acts. California's Electronic Waste Recycling Act mandates that purchasers of computer systems and displays must pay a $6 to $10 recycling fee upon purchasing equipment. In the European Union, new laws governing restriction of hazardous materials in electronic production and disposal tracking of electronic assets have gone into affect (Perkins, 2007).

Legal and insurance risks. Hitchcock and Willard (2006) emphasize that sustainability can significantly reduce legal and insurance risks associated with government regulations, as well as the loss of insurance coverage or the likelihood of legal action. The Department of Energy is also a controlling factor of energy consumption and "considers the efficiency and eco-effectiveness of the manufacturing process" (Hitchcock and Willard, pp. 56-57, 2006). Focuses of government regulatory enforcement also include equipment disposal, not just energy usage and manufacturing process. Government sustainability-focused regulations will be used to modify public activities in the commercial sector and are often enforced through the form of monetary penalties for failure to comply but also with incentives including tax breaks for compliance (Hitchcock and Willard, 2006).

Impact of sustainable business practices on stock value. "The number of corporate social responsibility (CSR) shareholder resolutions in the US leapt around 800 in 2002 and was expected to increase by 20 percent in 2003" (Hitchcock and Willard, 2006). Companies are becoming more sensitive to public relations in regard to social responsibility, which has become

an important screen for many mutual funds. Companies that shun sustainability risk reducing demand for their stocks and therefore lowering stock prices (Fields, 2002).

Impact of sustainable business practices on productivity and performance. Leading corporations, such as Intel, have conducted research that highlights energy costs. Intel's study from 2007 calculated that a single computer consumes approximately $13.94 worth of electrical power to operate per year while in off business hours or idle periods (Conry-Murray, 2007). Intel offers its methodology as a benchmark for gauging the impact of sustainable practices on energy consumption. (Conry-Murray, 2007). Conry-Murray (2007) discusses Intel's 2007 survey, highlighting the figure of only 26 percent of IT professionals who list energy efficiency as important to their network infrastructure. The increase in the cost of energy creates the need to gauge the power costs of desktops and laptops.

Hilty et al (2006) argue that information and communication technologies have a great potential to support sustainable development when implemented in a systemic approach. They provide research on the beneficial environmental impacts of specific communication technologies such as virtual mobility, telecommuting, teleshopping, virtual meetings and e-business. Environmental benefits include the reduction in travel which in turn reduces not only company expenses but also carbon footprint (Hilty, et al., 2006).

Gowan (2007) highlights energy reducing practices such as turning off computers instead of leaving them in sleep mode when employees leave the office, which can save about 40 watts of

electricity per computer a day. He notes "that adds up to 4 cents a day or $14.00 per year, at the 2005 U.S. average of 9.45 cents per kWh" (Gowan, 2007). Both Hitchcock and Willard (2006) and Gowan (2007) list equipment related suggestions for reduction of energy use including switching to LCD monitors which require only 25 watts per hour versus 'old-fashioned' cathode-ray tube (CRT) monitors which need more energy as "they require constant power to illuminate the phosphors that produce images on screen" (Gowan, p. 2, 2007). Utilizing hard drive storage for keeping documents digital after reading them on screen, rather than printing to hard copy can save time, money and natural resources. This practice can be utilized for documents including e-mail messages, PDF files and online receipts, and not only saves paper and toner, but the creation of a digital filing system saves productivity time for easy and efficient retrieval (Gowan, 2007).

The implementation of sustainable business practices not only impacts the productivity of office equipment, but also office worker performance (Abdou, 1997). Abdou (1997) recollects the energy crisis of the 1970's which brought to public awareness the consideration of natural light for the reduction of a building's energy consumption. He suggests that natural light in the office environment not only cuts down on energy consumption of artificial lighting, but also influences human well-being, directly affecting productivity and performance. The figures of savings from energy-efficient technologies available in 1997 show a potential value of 50-70 percent. However Abdou (1997) argues that the energy cost savings is small in comparison to the value of improved office worker productivity. He states "energy consciousness has resulted in reduced lighting levels in building spaces. Yet, compared to other amenities in buildings, light is the least expensive and most important component influencing human performance" (p. 131).

Additionally, Nathan (2008) shows that a potential negative impact of change in current computer systems may be the reluctance for employees or support personnel to move off of current systems for support reasons. Usage and usability may decline if new system is technologically intricate (Nathan, 2008).

Conclusions

According to Hitchcock and Willard, (2006) the pursuit of environmental sustainable action often saves money, thus increasing profitability. This study identified potential benefits of sustainable business practices when implemented in small to mid-size companies, in relation to electrical energy consumption of office equipment and corresponding cost management techniques. A 2007 survey shows "more than half [of businesses surveyed] are unaware of how [energy] they use…yet half of the businesses said environmental issues do affect them" (Wotherspoon, 2007).

Hitchcock and Willard (2006) provided a definition of environmental sustainable practices used in this study which refers to practices that reduce energy consumption costs, waste costs, and improve image with shareholders. This inquiry examined first the statistical data of commercial energy consumption and then examined supporting studies which focused on sustainable practice benefits qualified by energy efficiency and economic factors.

The Review of Literature presented a synthesis of selected statistics and projections of commercial energy consumption, and current trends and procedures for adapting environmentally sustainable business practices concerning electrical energy. A lexicon of industry terminology was a direct result of this Review of Literature, to be used as a definition guide for management of SMEs in strategic planning for implementing sustainable business practices. The goal was to assist management of SMEs to address factors related to electrical power usage in order to "help organizations perceive the unsustainable nature of current business practices and the inherent benefits of converting to sustainability" (Fields, p. A114, 2002).

The conclusions of this study are best illustrated by Fields' (2002) commentary and show that sustainable business practices such as implementing energy efficient technologies and "greener" applications of existing technologies "reflect the growing attitude that progressive environmental practices are a competitive advantage rather than a cost" (Fields, p. A145, 2002). According to the conclusions drawn by authors presented in this Review of Literature, SMEs can implement sustainable business practices while maintaining current budgetary parameters. Such practices involve utilizing virtualization techniques to reduce physical equipment needs (Hoenshell, 2007), using existing equipment features to reduce power consumption (Kawamoto, Mizuno and Shimoda, 2004), and altering current usage practices and habits (Gowan, 2007). A summary of recommendations for practice and suggestions for further research is presented below.

Sustainable Business Practices for the Reduction of Energy Consumption

Smart Management Systems

Kawamoto, Mizuno and Shimoda (2004) suggests the use of power management for the reduction of energy consumption. They urge SMEs to utilize power management modes on office equipment stating that "when PM [power management] is built-in and properly functioning, about 90% of the energy use in non-business hours can be saved" (Kawamoto, Mizuno and Shimoda, 2004). Power management enabled devices that are Energy Star compliant come pre-loaded from the factory with power saving modes, generally set in 15-30 minutes of inactivity. Leaving these settings turned on or re-enabled is a quick and cost-efficient way to reduce energy consumption through factory installed defaults (Webber, 2006).

Smart management systems which fully manage web hosting services have the potential to reduce server, HVAC and environmental foot print. EDS and other companies provide services to SMEs that include fully managed web hosting to reduce electrical energy consumption (Hoenshell, 2008).

Software and Equipment

Practices for immediate implementation for the reduction of energy consumption include altered use of standard office equipment. Gowan (2007) recommends simple practices such as unplugging power adapters and chargers not in use as they continue to use energy while plugged in, at an average of two watts per hour per charger. Connecting all the peripherals to a power strip and turning the strip off at the end of the day is a simple solution. This suggestion also pertains to all office equipment and can be automated with the use of Sophisticated Circuits' PowerKey Pro USB 650 (Gowan, 2007).

For long-term planning for sustainable office practices, authors recommend consideration of efficiency specifications as part of purchasing policy for software and equipment upgrades. Focus can be made on specific energy-efficient components such as power supplies (Hitchcock and Willard, 2006), and may also include Energy Star program compliant office equipment that have power management features (Webber, 2006). A number of references cited within this Review of Literature make suggestions for reduction of consumption of materials and equipment through the use of wireless networking devices. The results of the increase of wireless networking technologies include the reduction of physical cabling needed to wire SME

workspaces and data centers. Perry (2007) suggests the use of Connected Workspace, developed by Cisco, which reduces electronic and office waste as well as improves energy efficiency.

Data Centers

The configuration and planning of data centers plays a key role in the reduction of electrical energy consumption by SMEs. Perkins (2006, 2007) repeatedly stresses the importance of gauging power needs of data centers and focusing on total system energy including power and cooling. Utilizing UPS (Uninterrupted Power Supply) hardware that adds capacity incrementally can allow SMEs to match power capacity and costs to current needs, rather than to projections, which will reduce overestimation of power use and costs (Perkins, 2006). Modeling tools such as those available from Aperture and APC may be used to recommend equipment placement that minimizes power and air conditioning requirements by using sensors that monitor actual power consumption and airflow (Perkins, 2007).

Thibodeau (2007) also stresses the importance of positioning IT equipment in a way that maximizes airflow to facilitate cooling. He highlights one company's decision to move away from four direct-attached storage systems to a storage-area network from Pillar Data Systems Inc. This change enabled the company to track power usage levels, triple storage capacity and add new servers without consuming more energy (Thibodeau, 2007).

Information for Further Research

Sustainable Business Practices for the Reduction of E-Waste

To reduce e-waste to landfills, SME managers can examine the end of life practices for equipment by asking the following questions: *Will the manufacture take back the product to recycle? Are all components recycled or disposed of properly? Does the company donate usable equipment to non-profit organizations for use?* (Hitchcock and Willard, 2006).

Products Mentioned by Cited References

- The ENERGY STAR program information and information pertaining to ENERGY STAR approved office equipment can be found at http://energystar.gov/ (Webber, 2006).

- The U.S. Environmental Protection Agency has created environmentally preferable guidelines for computers which can be retrieved online from www.epa.gov/oppt/epp/electronics.htm (Hitchcock and Willard, 2006).

- Faronics' Power Save can be found at www.macworld.com/2570 (Gowan, 2007)

- Sophisticated Circuits' PowerKey Pro USB 650 can be found at www.macworld.com/2571 (Gowan, 2007)

Handbooks and Guides Referenced by Hitchcock and Willard (2006)

Hitchcock and Willard (2006) list numerous resources for further study which may be referenced by management of SMEs in the pursuit of implementing sustainable business practices. A few key references are listed below:

Altomare, M. and Natrass, B. (2002). *Dancing with the Tiger; Learning Sustainability Step by Natural Step*. Gabriola Island, BC: New Society Publishers.

ABSTRACT: Provides an overview of the popular Natural Step framework with case studies from North America.

Carstedt, G. and Senge, P. (2001). Innovating our Way to the Next Industrial Revolution. *MIT Sloan Management Review*, Winter.

ABSTRACT: This article provides an explanation of why sustainability is going to be the real "new economy" and summarizes issues including most of the basic sustainability concepts, differentiates eco-efficiencies from sustainability, and recounts profitability examples.

Hitchcock, D. and Chalfan, L. (2001). Approaching Zero Waste. Portland, OR: AXIS Performance Advisors. Part of the Sustainability Series ™. www.axisperformance.com/sust_series.html.

ABSTRACT: Details the concepts of zero waste and then provides a step-by-step process for achieving it, including quotes and advice and lessons learned by those in the field doing the work. Zero Waste is a critical concept nested within a larger sustainability effort. Approaching sustainability under the banner of "zero waste" since this term emphasizes resource efficiencies and cost savings.

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