

# GREEN INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) : A WAY TO ACHIEVE ENVIRONMENTAL SUSTAINABILITY

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## ABSTRACT

*This paper discusses ideas and concepts of information and communications technologies (ICT) in ecological sustainability. It provides a preliminary idea about Green IT. The paper endeavors to create awareness among the IT professionals and entrepreneurs for Green IT, and suggests for the actions that they and their organizations should undertake. The paper analyses a few case studies and working papers pertaining to the subject and shows that most IT professionals are concerned about climate change and recognize the dual role of IT in causing and resolving environmental sustainability problems. More than 70% of IT professionals and entrepreneurs believe that they can play significant roles in leading Green IT changes. An equal percentage believe that Green IT should be a core part of an organization's overall environmental sustainability strategy and IT management should take the responsibility for reducing IT's environmental footprint. Only about 30% of respondents are aware of ICT policy. IT professionals are either sceptical or unaware of their organization's commitment to Green IT. However, a minority of organizations are taking initial steps in terms of putting green IT on their agenda, allocating budget and implementing Green IT projects.*

**KEY WORDS:** Carbon footprint, Green IT, eco-sustainability, ICT lifecycle, virtual server, energy efficient PC, Colud computing

## 1.0 INTRODUCTION

All over the world, IT is playing an increasingly important role - in both business and individuals' private lives. It is also consuming ever greater amounts of energy and is therefore the source of significant CO<sup>2</sup> emissions. Did we know that IT now causes the release of as much carbon dioxide into the atmosphere as nearly 320 million cars? According to calculations by consultants A.T. Kearney, worldwide IT now generates CO<sup>2</sup> emissions of about 600 million metric tons a year. And if the sector continues growing at the current rate, emissions in Germany alone are expected to increase by another 60% by the year 2020. Green IT can help curb this alarming trend. Simply by consistently implementing known energy-conserving approaches, the CO<sup>2</sup> emitted by IT systems can be nearly halved.

Another study shows that nearly two (2%) of global carbon emissions come from the manufacture and use of Information and Communication Technology. Research by Gartner (2007) showed that this is much as the aviation industry. A significant part of the emissions come from inefficient use of ICT equipment and too little consideration of environmental effects when manufacturing, buying or replacing ICT equipment. And the industry is expected to continue to grow fast, with a corresponding higher level of (unnecessary) carbon emission.

"Green IT" is what analysts, manufacturers and providers call all IT solutions that save energy at business organizations. These include hardware, software and services. Where hardware is concerned, energy-efficient desktop PCs, thin-client architectures and data-center hardware offer answers, and so do energy supply and cooling systems. In the software and service area, there is significant potential in virtualization, in solutions for dynamic capacity management and data-center planning, and in storage-system offshoring. We cannot purchase or order Green IT directly, but intelligent solutions are available that contribute to sustainability. And with the increasing convergence of IT and telecommunications, it is possible to take the Green concept a step further.

Green or eco-sustainability is "the ability of one or more entities, either individually or collectively, to exist and thrive (either unchanged or in evolved forms) for lengthy timeframes, in such a manner that the existence and flourishing of other collectivities of entities is permitted at related levels and in related systems" (Starik and Rands, 1995). It often refers to meeting the needs of present generations without compromising the ability of future generations to meet their needs and involves pollution prevention at the end of a product's use, product stewardship to minimize the environmental footprint during use and use of clean technologies to reduce the use of polluting materials and develop environmentally friendly competencies (Hart, 1997). The construct of ICT is equally broad and can best be approached from an ICT infrastructure perspective. Previous ICT research distinguishes between the ICT technical infrastructure and the ICT human and managerial capability infrastructure. The ICT technical infrastructure refers to "choices pertaining to applications, data and technology configurations" (Broadbent and Weill, 1997). The human infrastructure pertains to "the experiences, competencies, commitments, values and norms of the ICT personnel delivering the ICT products and services" (Byrd and Turner, 2000). The managerial capability comprises the management of all ICT activities including strategic foresight concerning changes in the business, ICT and wider environment.

The combination of the ICT infrastructure and the eco-sustainability perspectives can lead to the following definition of Green ICT. Green ICT is an organization's ability to systematically apply environmental sustainability criteria (such as pollution prevention, product stewardship, use of clean technologies) to the design, production, sourcing, use and disposal of the ICT technical infrastructure as well as within the human and managerial components of the ICT infrastructure. [1]

This paper puts an endeavor to provide ideas and concepts about Green ICT, and it tries to create awareness among the users, professionals and entrepreneurs about the role of ICT in maintaining the echo sustainability. The paper also puts forward some suggestions as to the actions the ICT professionals, entrepreneurs and organizations should undertake to maintain a sustainable environment.

## **2.0 THE CONCEPT OF GREEN ICT.**

The origin of the concept of Green ICT or Green Computing dates back in 1992 when the U.S. Environmental Protection Agency launched Energy Star, a voluntary labeling program which is designed to promote and recognize energy-efficiency in monitors, climate control equipment, and other technologies. This resulted in the widespread adoption of sleep mode among consumer electronics. The term "green computing" was probably coined shortly after the Energy Star program began; there are several USENET posts dating back to 1992 which use the term in this manner.[1] Concurrently, the Swedish organization TCO Development launched the TCO Certification program to promote low magnetic and electrical emissions from CRT-based computer displays; this program was later expanded to include criteria on energy consumption, ergonomics, and the use of hazardous materials in construction.[1]

Green computing or green ICT, refers to environmentally sustainable computing or ICT. In the article *Harnessing Green IT: Principles and Practices*, San Murugesan defines the field of green computing 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." [1] Green ICT can include hard technologies as well as soft systems and business policies and practices spanning the ICT lifecycle from production, through sourcing, building and use to disposal. Environmental considerations can be embedded in policy frameworks, in operational routines, in ICT design features and information

systems as well as in the values and norms of the ICT human infrastructure and managerial considerations and practices. Greening ICT can be undertaken in order to address two overarching and interrelated goals. On the one hand Green ICT can help businesses to mitigate ICT's direct contribution to emission, that is solving ICT's contribution to environmental problem. On the other hand, Green ICT can be used in order to help businesses tackle their overall footprint that is using ICT as part of the solution to reduce a business's environmental footprint. Of course within these two objectives are the needs to satisfy the business case for reducing cost and/or increasing revenue. Green ICT is relatively new and most ICT green efforts amount to little more than wiping carbon's footprints on a doormat.

Murugesan lays out four paths along which he believes the environmental effects of computing should be addressed:[1] Green use, green disposal, green design, and green manufacturing. Green computing can also develop solutions that offer benefits by "aligning all IT processes and practices with the core principles of sustainability, which are to reduce, reuse, and recycle; and finding innovative ways to use IT in business processes to deliver sustainability benefits across the enterprise and beyond".[4]

Modern ICT systems rely upon a complicated mix of people, networks and hardware. As such, a green computing initiative must cover all of these areas as well. A solution may also need to address end user satisfaction, management restructuring, regulatory compliance, and return on investment (ROI). There are also considerable fiscal motivations for companies to take control of their own power consumption; "of the power management tools available, one of the most powerful way still be simple, plain, common sense."[4]

### **3.0 Why Green ICT?**

The need for green ICT is evident and new sector groups are springing up constantly, but despite a number of green initiatives, the impact has been tiny. Data centres are turning green more because of energy costs than conviction. Energy reduction through better equipment engineering, better data centre design, and better work management is the easy answer; it is an obvious way to reduce the carbon footprint and it cuts costs, so no one objects. Still, there is enormous waste in the sector that is not quite as obvious.

The goals of green computing includes : reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of defunct products and factory waste. Research continues into key areas such as making the use of computers as energy-efficient as possible, and designing algorithms and systems for efficiency-related computer technologies. The appropriate use of ICT can provide a significant contribution to green House Gas (GHG) reductions. How to eliminate other forms of waste is a somewhat harder question. Digging deeply into the question and eliminating less obvious sources of waste is not yet popular with most of the environmentally engaged ICT players. Various approaches are being prescribed by the researchers, and are being practiced by ICT professionals and entrepreneurs in an effort to achieve environmental sustainability.

### **4.0 GREEN IT THROUGH GREEN SOFTWARE**

These days, with bigger, faster, processors, CPUs are idle a good part of the time while I/O operations are going on and information swapped between memory and disk storage. Although the time it takes to execute code or the constant execution of extra lines of sloppily written code is not very important to programmers or to data centre managers, it does keep machines humming needlessly.

Reducing the complexity of software, its sheer size and the tendency of some software's performance to degrade is one of the ways to achieve green savings. It is time to re-examine the tendency to needlessly complicate software by including functions and features that are rarely, if ever, used. How about an industry-wide standard to rate just how green software is? Let's see how MS Office stacks up against office suite X, how Windows' green compares to Linux or if Oracle is greener than SAP. Kill two birds - bloated software and energy emissions. Better yet, force users of inefficient software to buy carbon offsets - we might end software bloat forever.

No matter how much we improve the energy efficiency of the ICT sector at every level, the real savings from ICT, as the EU rightly emphasises, are likely to come from ICT contributions to monitoring and reducing the emissions of heavy polluters, by monitoring factories and big office buildings to optimize their energy usage profiles. The largest corporate solar panel installation in North America, the 1.6-megawatt array at Google's headquarters saves a lot of energy, but it is a trivial compared to what people can save by using the Internet to work at home. There are many other approaches, like Advanced Configuration and Power Interface (ACPI), being implanted by the top manufacturers of ICT gadgets for reducing energy usage in their equipment and systems.

The answer to the greening of ICT isn't easy; the savings have to come from the whole value chain, from all the equipment, from the software and the way it is used and powered. To do this right, we will need accepted standards for green equipment, software, operations and the like. We will also need a much better idea of the tradeoffs, of the hidden costs down the line - do we use plastic bags or save trees - to make the right decisions. There are no easy answers, but one thing seems certain, there is no way to make a greener world without ICTs.

## **5.0 GREEN IT THROUGH MATERIAL RECYCLING**

Recycling computing equipment can keep harmful materials such as lead, mercury, and hexavalent chromium out of landfills, and can also replace equipment that otherwise would need to be manufactured, saving further energy and emissions. Computer systems that have outlived their particular function can be re-purposed, or donated to various charities and non-profit organizations.<sup>[1]</sup> However, many charities have recently imposed minimum system requirements for donated equipment. Additionally, parts from outdated systems may be salvaged and recycled through certain retail outlets and municipal or private recycling centers. Computing supplies, such as printer cartridges, paper, and batteries may be recycled as well.

A drawback to many of these schemes is that computers gathered through recycling drives are often shipped to developing countries where environmental standards are less strict than in North America and Europe.<sup>[1]</sup>

On Feb. 05, 2010, Hewlett-Packard announced it had surpassed its goals for recycling e-waste: Globally, it recycled nearly 250 million pounds of hardware and print cartridges in 2007-a 50% increase over the previous year. And it announced a new goal: to reuse 2 billion pounds of products by the end of 2010. <sup>[6]</sup>

The recycling of old computers raises an important privacy issue. The old storage devices still hold private information, such as emails, passwords and credit card numbers, which can be recovered simply by someone using software that is available freely on the Internet. Deletion of a file does not actually remove the file from the hard drive. Before recycling a computer, users should remove the hard drive, or hard drives if there is more than one, and physically destroy it or store it somewhere safe. There are some authorized hardware recycling companies to whom the computer may be given for recycling, and they typically sign a non-disclosure agreement.<sup>[4]</sup>

## 6.0 INTERNET USAGE AND SERVICES

The internet has changed our world and the global economy. We are now entering a new stage in its growth. Web 2.0, collaboration, virtual worlds and mashups are all part of it. Also parts of the new Web are the evolutionary moves towards the semantic/ intelligent web, IPv6, the growth in enterprise services that are not a mere extension of existing services and financial services such as mobile cash and credit. The Web is also revolutionizing education, healthcare, government and social services in general. The impact of this upon the world's ICT infrastructure is hard to calculate, but we see and feel the effects wherever we are in the region - or the world.

## 7.0 ANALYSIS OF STUDY REPORT

While carrying out studies in the field of "Green ICT" the author has analyzed a good number of case studies and working papers related to the area of study. However, basing on the analyses of one paper titled "A PRELIMINARY REPORT ON GREEN IT ATTITUDE AND ACTIONS AMONG AUSTRALIAN IT PROFESSIONALS" By ALEMAYEHU MOLLA with VANESSA COOPER, HEPU DENG, STAS LUKAITIS 2009<sup>[1]</sup> some additional information are incorporated in this paper. This study was set out to address the following questions:

- a. To what extent are IT professionals concerned about climate change?
- b. What are the perceptions of IT professionals in terms of IT's contribution to environmental footprint and in IT's role in tackling a business's environmental footprint?
- c. What are some of the processes IT professionals follow to increase their awareness of Green IT?
- d. To what extent they are practicing Green IT in their professional and personal lives?
- e. How do they perceive their working environments' preparedness for Green IT.

## 8.0 SUMMARY OF THE REPORT

The findings indicate that the majority of IT professionals are concerned about climate change and the overwhelming majority believes that IT has a dual role in causing and mitigating environmental problems. However, the way in which IT professionals seek to increase their knowledge of Green IT issues remains unclear as few respondents indicated that they participate in Green IT workshops, discussion forums or seminars. This implies that either IT professionals are using alternative means to increase their knowledge, or that there is a need to promote Green IT education to IT professionals. Importantly, the study has identified that currently there seems to be a discrepancy between the concern for Green IT issues and the actual practice of Green IT in organizations. While IT professionals are taking simple actions towards Green IT such as printing on both sides of paper, more complex behaviours are practiced to a less commonly. Further, IT professionals are largely sceptical of their organization's awareness, policy and practices of Green IT which warrants further investigation.

Info-Tech (2008) conducted the Global Green IT Attitude and Action survey covering 1260 respondents at the end of 2007. The authors of reference [1] carried out survey in Australia among the IT professionals and entrepreneurs in the year 2009 taking ten questions from Info-Tech's (2008) report. The comparison of those ten questions against Info-Tech's published report is summarized in the following table:

**Table 1 : Summary of Study Report**

Items	Regions				
	Australia	Europe	North America	Asia	Rest of world
Concern about climate change	81%	94%	83%	90%	95%
Company action for reducing carbon footprint	50%	45%	35%	47%	41%
Green IT on company's radar (agenda)	47%	72%	71%	71%	72%
Budget for green IT in the next three years	28%	65%	55%	68%	65%
Company's steps to reduce IT's power consumption	41%	48%	48%	54%	47%
Company policy on computers use	42%	56%	36%	74%	56%
Company advocating use of Green technology in sourcing	23%	30%	25%	41%	31%
Adoption of IT Power consumption efficiency metric	14%	21%	16%	40%	25%
IT's responsibility for power consumption	08%	25%	20%	45%	22%
Personal concern for reducing IT's power consumption	64%	85%	85%	85%	88%

Source: Info~ Tech (2008) and Green IT Working Paper No. 2/2009 © Molla, et al., 2009, School of BIT, RMIT

The result in Table 1 shows that, overall Australian respondents are less positive about their company's Green IT commitment compared to their peers in Asia, Europe, North America and the rest of world. Nevertheless, Australian companies appear to have taken more action for reducing their carbon footprint. This result might be interpreted as either that Australian organisations are becoming more environmentally friendly or it could just be the outcome of the time differences between the current and Info~Tech's (2008) survey. Despite an almost one year difference in the data collection time frame between the current (2009) and Info~Tech's survey, Green IT has yet to capture the attention of more than half of Australian respondent organisation's attention. This lack of attention is further reflected in budget allocation. While more than 55 % of Info~Tech's European, Asian, North American and the Rest of World respondents believed that their employer will allocate a budget for Green IT, only less than 30% of Australian respondents expect to see that level of Green IT commitment from their enterprise. Further, even in terms of respondents' personal concern for reducing IT's power consumption, Australian respondents lag the rest of the world by about 20%. In summary, the current findings suggest that Australia underperforms in many of the Green IT attitude and action dimensions. However, this result should be considered as preliminary and more studies are needed to understand the shift in opinions and actions towards Green IT. The author has carried out a limited scale survey among the students (undergraduate level computer science and engineering students), professionals and entrepreneurs of Bangladesh which shows rather far below performance in regards to the awareness on Green ICT. However, further elaborate study is needed in Bangladesh to confirm the findings.

## 9.0 CONCLUSION

The issues of climate change and environmental protection have been debated for decades. Now they have become part and parcel of day-to-day business reality; companies are accepting responsibility for the CO<sup>2</sup> emissions they cause and are taking action. ICT has, in many ways, a vital role to play. It accounts for about two percent of global CO<sup>2</sup> emissions, which must, and can, be curtailed. In addition, through the intelligent use of ICT solutions to support business processes in other industries, it can help curb the other 98 % of emissions. The deployment of Green ICT makes a valuable contribution to protecting the environment. And businesses themselves benefit. Many of the approaches presented in this document are associated with lower costs, especially those that target energy consumption. They also improve a company's image, and noticeably raise customer and employee satisfaction. And as policymakers increasingly address climate change, new legislation and regulations on ICT can be expected in the near future. So organizations are well-advised to act now.

Some approaches are already being practiced now. According to the German Business Travel Association (VDR), 65% of German enterprises are already using telephone and video conferencing systems to minimize business travel. And according to the Experton Group, 65% of German enterprises are virtualizing their servers. Every organization has its own unique situation, and the first step should therefore be to analyze it. We have already described possible approaches for business processes, data centers and office environments. Quick wins can be achieved by harvesting "low-hanging fruit", for example by encouraging more energy-efficient use of office equipment or duplex printing. Greater potential is available through partnership with an external ICT service provider. For example, an external provider can add value through their expertise in videoconferencing or electronic archiving, or - like in the case of Dynamic Services - its professionally organized and operated data centers. But be warned: It is vital to plan carefully before modifying business processes. When properly implemented, these measures promise excellent, and lasting, improvements. But it is essential to proceed systematically while coordinating and consolidating all of your Green ICT efforts.

Modern IT systems rely upon a complicated mix of people, networks and hardware; as such, a green computing initiative must cover all of these areas as well. A solution may also need to address end user satisfaction, management restructuring, regulatory compliance, and return on investment (ROI). There are also considerable fiscal motivations for companies to take control of their own power consumption.

The answer to the greening of ICT isn't easy; the savings have to come from the whole value chain, from all the equipment, from the software and the way it is used and powered. To do this right, we will need accepted standards for green equipment, software, operations and the like. We will also need a much better idea of the tradeoffs, of the hidden costs down the line - do we use plastic bags or save trees - to make the right decisions. There are no easy answers, but one thing seems certain, there is no way to make a greener world without ICTs.

In order to reduce pressure on scarce energy, larger server centers are sometimes located where energy and land are inexpensive and readily available. Local availability of renewable energy, climate that allows outside air to be used for cooling, or locating them where the heat they produce may be used for other purposes could be factors in green sitting decisions. Some other approaches may be adopted and implemented to reduce the energy usage while computing. This allows a system to automatically turn off components such as monitors and hard drives after set periods of inactivity. In addition, a system may hibernate, where most components (including the CPU and the system RAM) are turned off.

Recycling computing equipment can keep harmful materials such as lead, mercury, and hexavalent chromium out of landfills, and can also replace equipment that otherwise would need to be manufactured, saving further energy and emissions.

IT has a dual role in causing and mitigating environmental problems. Energy reduction through better equipment engineering, better data centre design, and better work management is the easy answer; it is an obvious way to reduce the carbon footprint and it cuts costs

## 10.0 RECOMMENDATIONS

Organizations should take appropriate measures and develop practices of consciousness about environmental sustainability in use, procurement and induction of their ICT gadgets. In this regard the following recommendations are put forward:

- a. Organizations should consider outsourced data centre housing to "share" cooling and power requirements as well as increase data centre processing utilization.
- b. Maximize use of recyclable components (e.g. thin client based technology, energy efficient monitors, forced duplex / multiple page print)
- c. Enact power management policy. Active directory based settings to force minimized consumption during periods of inactivity.
- d. Use software to automatically turn-off and turn-on computers as required. Turn processor based power management ON for efficient utilization of processing.
- e. Take paper reduction measures. (Fax to e-mail, storage area networking etc)
- f. High and low availability disk management. (Archiving and content management, paper and consumables efficiency, consumables re-use arrangements.)
- g. Consider convergence among systems and facilities. For example, VOIP, single infrastructure layer for voice and data. Also emphasis on using multi-function devices like print, scan and copy.
- h. Rationalize and consolidate where possible. Reduce daily reliance on paper and hard copy.
- i. Organizations should take steps to assist with admissibility /authentication of electronic documents.
- j. All should focus on electricity minimization. Less applications used means less servers required leading to lower power requirements. Less physical servers means less cooling and power requirements.
- k. Include appropriate provisions in ICT contracts for environmental purchasing.

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