

Green IT Issues in Engineering and Computing from European and Global Perspective

James Uhomoibhi¹, Bob Crooks², Colin Pattinson³ and Margaret Ross⁴

¹University of Ulster, Faculty of Computing and Engineering, Co Antrim BT37 0QB, Northern Ireland, UK, j.uhomoibhi@ulster.ac.uk (*author for correspondence*)

²Chair of BCS GreenIT SG; Defra CIOD Lead on Green IT; Department of Environment Food and Rural Affairs (DEFRA), Eastbury House, 30 - 34 Albert Embankment, London SE1 7TL, UK bob.crooks@defra.gsi.gov.uk

³Colin Pattinson, Leeds Metropolitan University, Leeds, LS6 3QS, UK, c.pattinson@leedsmet.ac.uk

⁴Margaret Ross, Southampton Solent University, Faculty of Technology, East Park Terrace, Hampshire, SO14 0RD, UK, margaret.ross@solent.ac.uk

***Abstract** - The international awareness of green issues relating to the computer industry and also to the end user and home user is discussed by the paper. Practical approaches at zero or low cost are considered. The growth of interest and actions by the BCS (formerly known as the British Computer Society) are considered. The examinations run by the BCS for end users and general computer users are considered, together with the examination for those involved in running Data Centres and its relationship with the European Community (EC) Code of Conduct for Data Centres. With advancements in the development of increased storage capacity and the use of a combination of emerging technology for information storage, retrieval and use, the paper shows that more needs to be done in engineering and computing education to promote understanding of how these technologies can be integrated for an improved environment. The role of Higher Education in promoting green issues is discussed, together with an example of an Masters course in Green Computing at Leeds Metropolitan University. The growth of the BCS GreenIT Specialist Group, and of increased applications in the sector for end users are considered and reported.*

***Index Terms** - BCS GreenIT Specialist Group, ISEB GreenIT qualifications, BCS Data Centre Specialist Group, EC Code of Conduct for Data Centres.*

INTRODUCTION

Computer usage is now almost essential for many aspects of our lives. Businesses and industry need them for communications with their customers and suppliers as well as for supporting their core business. Universities support their students with learning environments and now most students have their own computers as well as those that they use at their universities or colleges. The growth of computers at home, not only for e-learning, personal use but also as a form of entertainment, has increased considerably in recent years. The usage of computers, whether at work or at home, has now increased to such an extent that the carbon footprint generated from them has been estimated to be approximately the same as that produced by the aircraft industry. In addition, there is further increase in the Carbon Footprint from other electrical equipment used both at home and at work. It has been widely accepted that today there is in need to reduce the Carbon Footprint as well as to reduce power and water usage. Ideally this should be undertaken, if possible, at low or zero cost. To achieve this, there is an need to raise awareness of the simple changes that can be undertaken by home users, managers, their end-users as well as their organisations, whether large or small.

LOW OR ZERO COST ACTIONS

To introduce good practices, it initially needs a sponsor or champion, possibly from the management level in an organisation. It is useful to identify ways to monitor and measure the use of power and water, also of being able to calculate the Carbon Footprint usage, so that improvements can be identified. These would be a major benefit as part of an awareness campaign. Minor changes in everyone's behaviour can lead to major savings.

A survey it was undertaken by Logicalis which indicated that approximately 86% of staff turned off their computers when at home whereas only 66% do so at work. By raising awareness of these simple actions, direct savings can be made at zero cost. By utilising software and motion detectors, both computers and lights can be switched off at low cost when not required.

Non-computing examples of power savings compared with IT and office usage have been provided by the Carbon Trust [1], such as the following:

- “A computer left on 24/7 will cost about £37 a year, whereas by switching off at night and weekends, the charge can be reduced to about £10 a year - and save an equivalent amount of energy to make some 34,900 cups of coffee
- Lighting an office overnight wastes enough energy to heat water for 1,000 cups of tea
- A typical window left open overnight in winter will waste enough energy to drive a small car for more than 35 miles
- A PC monitor switched off overnight saves enough energy to microwave six dinners
- Turning off all non essential equipment in an office for one night will save enough energy to run a small car for 100 miles”

Awareness can be enhanced by the use of visuals such as posters or possibly a stack of used print cartridges showing a typical monthly consumption by the organisation or university. A photograph of possibly the champion can be taken each month with the relevant stack. This can then be repeated each month, providing in time a visual record of the reduction of cartridge usage. A similar procedure can be arranged to show the amount of paper used within one month. Waste computer parts can be turned into art to raise awareness such as with the UK WEEE Man statue [2], standing 7 metres tall, weighing 3.3 tonnes, representing the waste of e-products by the average person in the UK, in their life time.

Practical advice of low-cost actions can be given, such as discouraging the use of screens savers as they use the same power as an active monitor. Staff and students can be encouraged to set their printers if possible for double sided printing. By moving the printers further away from the computer, this can discourage some users from unnecessary printing. The use of recycled paper and of recycling print cartridges can be considered.

Users can be encouraged to remove unnecessary files, such as earlier versions of reports, so reducing the number of servers required and also then the power necessary for cooling them. Some organisations allow time such as the last Friday afternoon of the month for all staff to remove un-necessary files, e-mails, pictures and photographs.

Students can be encouraged to submit their work on-line so allowing easy checking by the students as well as the lecturers for spelling, grammar and plagiarism. The use of track changes can be made by the lecturer to give comments and advice. This reduces the usage of paper, the cost of printing for the students as well as providing fast responses for the students. Savings in power, heating, air-conditioning and security cost can be obtained when a limited number of staff or students work outside the normal hours, such as late into the evenings or at weekends. The additional advantage of utilising only a limited number of rooms rather than the complete building also increases the safety of those working at these non-standard times.

Electronic greeting cards (e-cards) can be used as an alternative to physical cards. The e-card can be personalised and obtained at low cost and in some cases, free of cost. Some employ a very interesting animation and sound. The disadvantages of such cards are that some have an expiry date, so do not provide a permanent record of the communications as well as requiring both the sender and the recipient to utilise computing facilities.

Green savings are now be made with weddings, by using computers to produce and send the invitations with replies by e-mail. Digital photographs of the wedding can now be put immediately onto a wedding website so that guests can download pictures of their choice.

BCS INITIATIVES AND QUALIFICATIONS

The BCS (formerly known as the British Computer Society) has over fifty Specialist Groups, the majority of which have members throughout the world. The Green IT Specialist Group, the e-learning Specialist Group and the Data Centre Specialist Group have particular interest in raising awareness and encouraging the implementation of green practices. The e-learning Specialist Group [3] encourages the effective use of computers as an aid to learning including the use of learning environments and virtual worlds in addition to promoting safe practice for learners on the Internet. The Green IT Specialist Group [4] is particularly concerned with raising awareness and good practice for end users and management, whereas the BCS Data Centre Specialist Group [5] is more concerned with effective and efficient operations of data centres.

This Data Centre Specialist Group encourages good practices such as redirecting airflow to reduce the cost of cooling, and the reduction of servers and has been active in the development of the EC Code of Conduct for Data Centres [6]. Any organisation can sign up to this Code at no cost but it should lead to significant savings.

ISEB Qualifications

The BCS has developed a series of qualifications which are administered by the ISEB (Information Systems Examination Board) that range from the ECDL (European Computer Driving Licence) to the BCS Professional Graduate Diploma Examinations which are at the level of a final year undergraduate degree course. An ISEB Intermediate Certificate [7] on-line multi-choice examination has been developed based mainly on the understanding, the implementation and the business benefit of the EC Code of Conduct for Data Centres. There is no requirement to attend a course to take this examination, although it is recommended. The GreenIT Foundation Certificate qualification [8] , which is again based on approximately forty multi-choice questions, has been designed for end users, managers, teachers and home users with an interest in gaining a qualification in GreenIT and improving their understanding of green issues, how to implement savings by end users as well as legal considerations.

BCS Conferences and the Greening Model

The BCS and together with various Specialist Groups are active in promoting green issues. The annual Software Quality Management (SQM) conferences[11] and the INSPIRE [12] conferences aimed respectively at benefit to business and to improving the quality related to teaching computing and learning with computers, both have green themes to encourage the participation and exchange of ideas on the green issues from both industrialists and academics.

A simple five stage Greening model, initially conceived by Ross, has been presented at these conferences. This can be freely used and adapted by any organisation to suit their requirements. The stages of the Greening model [13] “were as follows:

Level 2

- Recycling paper and cartridges
- Sign indicating switching off of lights/machines
- Timing out of machines
- Double-glazed windows
- Use of recycling of output (paper etc)
- Arranging time/shifts/meetings to encourage car-sharing/alternative travel arrangements
- Encouraged teleworking where appropriate, understand the need for advice and training, and be aware of the possible negative greening aspects
- Monitor final disposal of equipment
- Understand the basic measurement of carbon footprint
- Measure the use of electricity etc

Level 3

- Purchase of recycled paper
- Designed Data centres for changing from air cooling to water cooling (building with suitable plumbing and floor strength)
- Online conference facilities to reduce travel
- Taking account of greening issues when purchasing goods (manufacturing, running and disposal)
- Company cars chosen with greening considerations (energy efficiency, increased time before replacement etc)
- Consider location (transportation of components etc) and method of manufacture of goods
- Consider if updates necessary (requiring full replacement or only parts)
- Require to see greening of suppliers/outsourcers, including the final outsourcers
- Collection and monitor relevant data, identifying trends (power usage etc)

Level 4

- Heat to be re-used for the building
- Water cooling of servers
- Check carbon footprint on staff travel
- Consider energy efficiency and carbon footprint in the manufacturing of equipment
- Consider energy efficiency and carbon footprint in the delivery of equipment
- Consider energy efficiency and carbon footprint in the running of equipment
- Consider the distance for the delivery of spare parts and servicing of equipment
- Free advice/help on greening of teleworkers' homes,
- Monitor policy for greening and recycling by suppliers

Monitor policy full greening and recycling by outsourcers including their final outsourcers
Check and require proof of the implementation of the policies for primary and secondary suppliers
Check and require proof of the implementation of the policies for outsourcers and their suppliers and supply chain
Maintain quantitative data records
Maintain an Action Plan for greening improvement

Level 5

Generate own power (solar power, wind turbines etc)
Use surplus heat outside the organisation
Free advice/help on greening of employees' homes
Free advice and help on greening issues to suppliers
Free advice on greening issues to customers
Action Plan to be regularly reviewed and updated
Constantly looking for methods to improve greening within the organisation and beyond.

This Greening Model would not be appropriate to all organisations and some would feel that the Key Practices should be altered between levels, and additional practices included for their particular environment. The model has been further developed into a grid of Green practices and knowledge that now forms the basis for the syllabus” of various GreenIT qualifications.

HIGHER EDUCATION

Higher Education has an essential role in the raising of awareness of green issues in the community: our colleges and universities produce those who are most likely to lead public opinion and to develop and work with the technologies which will create the 21st century economy, and we would wish these technologies to consume as little energy as possible, commensurate with completing their designed task. In order to make decisions about technology adoption, and to lead the debate about wider environmental issues, we require a group of students who are informed about the options and their implications. This requirement for information about their actions is necessary across all walks of life. The UK Government’s first (or interim) “Digital Britain” report has identified three categories of skills: Digital Life Skills, which will be needed by all to participate in the digital world; Digital Work Skills, which will be needed by those whose work involves the use of IT, this will comprise most of the workforce; and Digital Economy Skills, which will be required by those who implement and develop the emerging technologies [9]. The specific needs of each category are different in terms of the detail and focus of their information requirements. There is further discussion of the education and training requirements in the final report [10].

All users need to be aware of the energy costs of “normal” user activity, and the steps they can take to ameliorate these costs. Higher level users and developers whose decisions about technology use and specification have a more direct impact on energy use will require a fuller and deeper knowledge about the implications of their decisions. It is these people who are likely to become the leaders in the development of IT, and in order for that IT to be Green IT, this is the group which we definitely need to reach in a significant manner. Note that this discussion has emphasised the energy cost of IT provision, it is equally important that we are aware of the potential for IT to become an enabler of energy-efficient activity, and the “decision makers” group are of especial importance in this.

Thus, there are distinct but connected needs, which will be addressed by courses, or course components, of differing depth and structure. Typically, a general need for awareness would form a part of an “ethical” theme in many courses, and may well be introduced as an element of professionalism. Whilst this is generally the case in IT and other technology and science courses, as well as those with a business focus, it is the case that the general need for awareness of the energy costs of IT use is more general than that – after all, IT is now so widely used across almost every sector of the economy that its use is universal. Therefore, there is a general need for an awareness of the implications of that use, and it is arguable that such awareness should be an integral part of all higher education experiences, not simply those of science, engineering and business backgrounds..

However, the focus of this section is on the more technical, “higher end” of Green IT awareness. In particular, it is driven by two desires: to provide the future leaders in Green IT, and to tap into the emerging research activity in Green IT. As an added bonus, we are able to address the continuing professional development (CPD) needs of individuals who are likely to be in employment, and wishing to underpin their career plans with a recognised qualification. By adopting a research-driven approach, we are able to foster the sceptical, evidence seeking approach to understanding which is, perhaps, of particular relevance to “green” matters, especially in light of the wider public scepticism about green matters.

MSc at Leeds Metropolitan University

This is the approach followed at Leeds Metropolitan University, in developing its Master of Science (MSc) in Green Computing, which is currently in its first delivery, having recruited its first student cohort in October 2009. The overall curriculum emphases are relatively clear: it begins with a review of the tools and techniques which allow us to measure the current state of an organisation's IT energy use. It then identifies the twin opportunities for IT to make a difference with modules on the ways in which the technology itself can be made more efficient (where we consider current research into technologies such as cloud computing; virtualisation and thin client systems) and on the ways in which technology can support a more sustainable business operation (addressing issues such as teleconferencing and homeworking). It then considers the legal, regulatory and ethical drivers to energy efficiency, and complete the taught core of our curriculum with a module which encourages students to determine a strategy for the adoption of greener IT practices in an organisation. The course is then "topped out" with a traditional research orientated dissertation, which allows students to focus on a topic in some depth. We are fortunate in having the active support of our innovative technical services colleagues, who have implemented some of the technologies we discuss. These technical colleagues form an integral part of the course delivery, presenting their work and findings to students, and will also play a part in the development and support of the project work undertaken by our students.

The delivery pattern is designed to allow students from a range of locations and work commitments to access the course: the course team did not wish to adopt a fully "distance learning" approach since they wished to achieve some element of group cohesion. However, the traditional weekly series of activities was also felt to be restrictive. Hence they adopted a style we refer to as "seminar plus". In this delivery pattern, each module is based around a 2-day intensive seminar programme. Prior to this, students are provided with directed reading and suggested research activities. During the 2 day events, the module assessment (typically a research-orientated exploration and analysis) is introduced. Following the delivery, students are supported by staff through on-line support via the university's virtual learning environment. This pattern appeals to those in employment, who are more able to commit to this short time away from the office, and has also meant that students have felt able to enrol on the course from places inside and outside the UK.

In conclusion, the course team believe that they have developed a course which should be attractive to the CPD market, and will be of wider benefit in assisting in the development of individuals skilled in the matters affecting the adoption of Green IT across a number of economy sectors. The post graduate level makes it possible for their research activity to support, and be supported by, the work of students on this course. We are aware that there are other opportunities to be explored, in particular the "non-IT" parts of engineering and technology, which could meet similar needs, for example in building design and use; transport and travel; energy production and waste handling. The existence of a "suite" of such courses offers a particularly attractive vision.

CONCLUSION

Although many of the activities discussed could only produce minor savings in cost and reduction of Carbon Footprint, it is felt that if these are undertaken by sufficiently large number of people, the saving could be beneficial both to the individual, the business or university as well as to the wider environment. We feel that lecturers and those involved in education, have a particularly important role in raising awareness of these issues with their students, who in turn will be able to promote various green related good practices.

REFERENCES

- [1] Carbon Trust, (accessed 20/4/2010), <http://www.carbontrust.co.uk>
- [2] UK WEEE Man statue, (accessed 20/4/2010), <http://weeeman.org/>
- [3] BCS e-learning Specialist Group, (accessed 20/4/2010), <http://www.bcs.org/server.php?show=conWebDoc.22952>
- [4] BCS GreenIT Specialist Group, , (accessed 20/4/2010), <http://www.greenIT.bcs.org/>
- [5] BCS Data Centre Specialist Group, (accessed 20/4/2010), <http://www.bcs.org/server.php?show=ConWebDoc.7710>
- [6] EC Code of Conduct for Data Centres, (accessed 20/4/2010), http://sunbird.jrc.it/energyefficiency/html/standby_initiative_data_centers.htm
- [7] Data Centre ISEB Intermediate Certificate in EU Code of Conduct on Data Centres, (accessed 20/4/2010), <http://www.bcs.org/server.php?show=nav.12339>
- [8] ISEB Foundation Certificate in GreenIT , (accessed 20/4/2010), <http://www.bcs.org/server.php?show=nav.11537>
- [9] Department for Business Innovation and Skills (2010) The Final Digital Britain Report. Available from:, (accessed 20/4/2010), <http://interactive.bis.gov.uk/digitalbritain/report/>
- [10]. Department for Culture Media and Sport (2009) Digital Britain – The Interim Report (accessed 20/4/2010), http://www.culture.gov.uk/images/publications/digital_britain_interimreportjan09.pdf
- [11] BCS Software Quality Management (SQM)conferences, , (accessed 20/4/2010), <http://go.to/sqm>
- [12] BCS INSPIRE conference, (accessed 20/4/2010), <http://get.to/inspire>,
- [13] Greening model, Raising Awareness of Green IT - The BCS Way, Bob Crooks (Defra CIOD Lead on Green IT, Chair BCS GreenIT SG), Bob Harvey (Chair BCS Ethics Panel), Zahl Limbuwala (Chair of BCS Data Centre SG), Liam Newcombe (Secretary BCS Data Centre SG), Margaret Ross,

(Southampton Solent University; Secretary of BCS GreenIT SG), Geoff Staples (Chair BCS Quality SG), Pete Bayley, (BCS), Proc SQM 2009, Southampton