Computing for Carbon Emission Reduction: ICT Role.

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ABSTRACT

Concern for the environmental pollution is now universally accepted as an issue that is not only for environmentalists. As the impact of global warming continues to show its destructive nature, different professions are now embracing minimising carbon emission in their practice. Computing profession is embracing green computing. Automation of processes and increase in use of internet based operations can enable work to be done remotely minimising the need for human movement through vehicles. Telecommuting, telemedicine etc are some of the approach that enables professional expertise to be accessed from wherever the expert is. Computing applications offer the means through which the world can respond to minimise the emission of carbon dioxide in the atmosphere. Information and communication technologies application can contribute in reducing carbon emissions of almost all the major sources of carbon emission. Policy makers need to make concerted efforts to embrace carbon emission policies.

KEYWORDS

ICT, greenhouse gas, carbon emission, green IT, green computing.

1 INTRODUCTION

This paper is an overview of literature on how computing can contribute to reduction of carbon emission. It uses desktop research methodology to explore the topic.Reduction of carbon emission can be looked at from different approaches. Some of the approaches are; reducing energy requirements consumption of a machine, using renewal energy instead of fossil fuel etc [1]. This paper addresses the issue of carbon emission reduction by looking at how use of information and communications technology (ICTs) can contribute to reduction of carbon emission. Computer based information systems that are web based have the potential to be used anytime anywhere. Some of the challenges limiting the use of information and communication technologies are also discussed.

1.1 Definitions

Some of the key terminologies that are used widely in environmental pollution are stated here. This is mainly to the benefit of the computer science community who now need to embrace environmental agenda. The key word in this paper is carbon emission. The phrase carbon emission is used widely in academic literature with very little attempt to define it. The online Macmillan dictionary defines it as a combination of carbon dioxide and carbon monoxide that is added to the atmosphere from use of fossil fuel by cars and other machinery as part of industrial process [2]. Carbon dioxide and carbon monoxide are harmful to animal life, though they contribute to food production life cycle as they support plant life when in moderation. Greenhouse gas (GHG) is defined as all the gases that act to retain heat in the atmosphere [3]. This heat retention by GHG leads to increase in atmospheric temperature which is often referred to as global warming [4]. Greenhouse gases that are naturally produced are absorbed by plants. However, as a result of human activities that produce GHG, such increase cannot be absorbed by existing plants/vegetation. This is worsened by increase in destruction of natural forests that reduce plants and other vegetations available.

2 AN OVERVIEW OF GREENHOUSE GASES.

Fossil fuels are the main source of electricity globally yet they are the main contributor of increase in GHG. Like Stickley stated "fossil fuels are what make the world go round" [4]. Globally, not enough has been made to invest in renewable energy which produce less carbon emission. Use of solar power even in countries with higher solar radiation is still limited. For example Botswana has about 3200 hours of sunshine annually, but this energy contributes less to national electricity demand [5]. There is over dependence on fossil fuel and in the US, petroleum, coal and natural gas have been the main top three source of energy since the mid 1920s [6]. Global data show that if fossil fuels continue to be the main source of energy, there will be increase in carbon dioxide emissions [7]. Developing countries are likely to overtake industrialised countries in terms of carbon emission as shown in Figure 1.

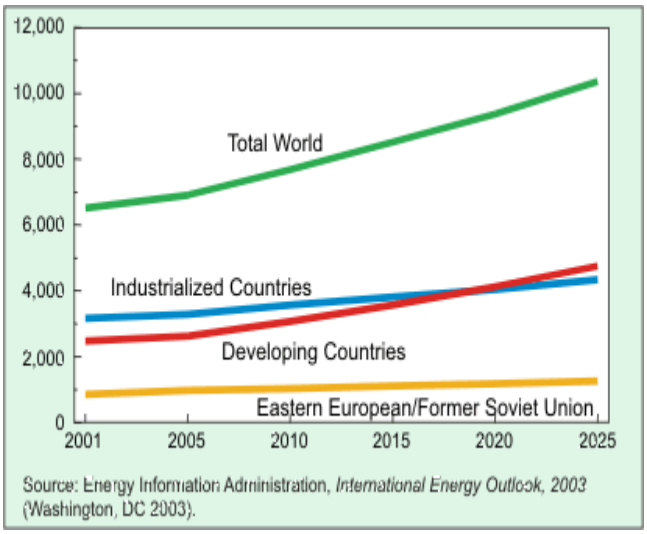

Figure 1 World Carbon Dioxide Emissions by Region, 2001-2025 (Million Metric Tons of Carbon Equivalent) [7]

2.1 ICTs Carbon Emission Contribution

Since ICTs rely on electricity to run, for example every computer requires electricity to operate. Depending on the source of such electricity, ICT can also be looked at as a contributor to greenhouse gas, or contribute to increase in carbon emissions. Recent research has shown that ICT based systems if fully implemented have the potential to reduce carbon emissions by 16.5% [8]. Some of the ICT applications that have the potential to reduce carbon emission are the concept of working from home. This minimise the need for employees to travel to work. In majority of cities traffic jams are common. A car stuck in traffic with a running engine is burning fuel and yet not in motion. Hence this is not an efficient way to use energy. However not many businesses have implemented the concept of work from home not because of lack of the technology, but mainly for other social reasons. Financial institutions have embraced online banking mainly to reduce the need to have branches, but indirectly this also contribute to carbon emission reduction from customers not having to travel to a bank branch.
City of Las Vegas in its efforts to reduce electricity wastage has implemented ICT based systems that can remotely switch of computers that are not in use. Through this process the city managed to save about $50 000 per annum [9].

2.2 Green Computing

Green computing or green IT is the use of computer and its related resource in an environmental friendly manner. From the design, manufacturing, use and disposable of hardware and other related resources [10]. The main concepts of green computing are as follows:

- Green use: Using computer devices in a way that minimises electricity consumption. Example switching off a device when not in use.
- Green disposal: When computer devices are no longer needed, they can either be re-cycled or disposed off in an environmental friendly manner. Not just thrown in the rubbish bin to be disposed of in a local landfill. Almost every year there is a new computer device/hardware that emerges in the market that is better than the previous

ones. What happens to the hardware that is considered to be obsolete?

- Green design: Designing computer devices that are energy efficient Designing energy-efficient computers, servers, printers, projectors and other digital devices reduces their energy consumption.
- Green manufacturing: When producing computer hardware devices minimise waste to reduce the amount of material that is thrown away. Minimising waste during the manufacturing of computers and other subsystems reduces the environmental negative impact of such activities.

An average computer user can employ the following to make their computing green [10]:

- Use the hibernate or sleep mode when away from a computer for extended periods.
- Use flat-screen or LCD monitors, instead of conventional cathode ray tube (CRT) monitors.
- Buy energy efficient notebook computers, instead of desktop computers.
- Activate the power management features for controlling energy consumption.
- Make proper arrangements for safe electronic waste disposal.
- Turn off computers at the end of each working day.
- Refill printer cartridges, rather than buying new ones.
- Instead of purchasing a new computer, try refurbishing an existing one.

There is increasing interest in green computing by the academic community. For example googling "green computing" produces about 7650 results from the Google scholar online search engine.

3 ICT ROLES IN CARBON EMISSION

ICT applications dominate almost all spheres of human life today. Businesses rely on it to run; it also supports social life as evidence in the use of social media like Facebook and Twitter. People are able to organise association, share information and take action without the need for face to face meeting.

GHG emissions are strongly correlated with economic activity as shown by their decline in 2008 economic slow down [3].

The main sources of GHG globally are as shown in Figure 2. Production of energy from fossil fuels like coal is the leading source of GHG. The other sources are all activities that are carried out to support consumption needs of people.

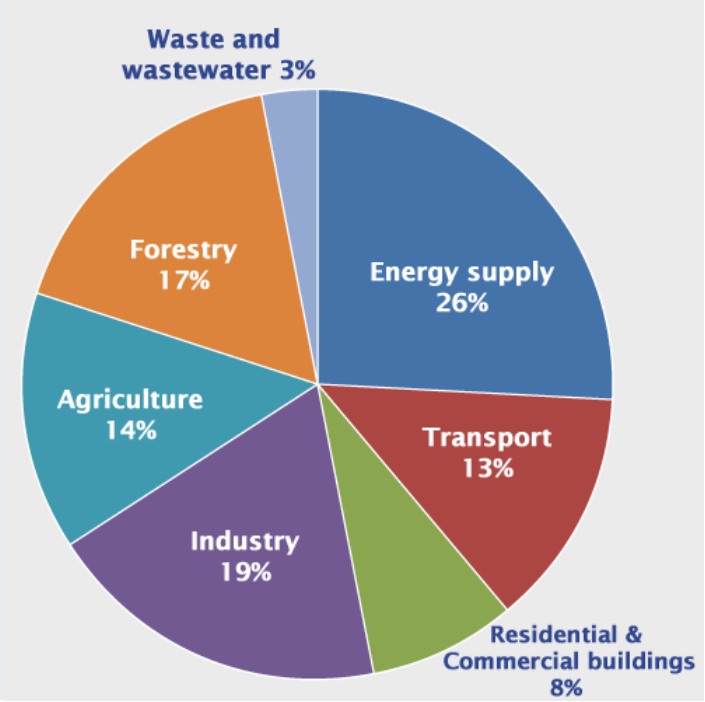

Figure 2 Global greenhouse gas emission by source (adapted from [11]

3.1 ICT and Energy Supply

ICT can reduce carbon emission from energy generation by enabling using computerised systems that manage the demand of energy. For example, Botswana Power Corporation has installed smart meters in residential areas. This allows electricity users to manage their energy consumption and minimise the need to travel to designate paying points as was the case before. The ability to even buy electricity, pay bills online or through use of mobile phones further reduce the need to travel. The corporation was also able to remotely switch geysers to balance electricity demand during peak hours through the use of

smart meters [12]. Osaka Gas, a company in Japan, has used server virtualisation to reduce the company's electricity costs, hence reducing its carbon emission [13].
Demand management, time of day pricing, power loading balancing etc are all ICT based processes that can minimise energy production wastage. Minimising wastage indirectly reduces the need to generate more energy.

3.2 ICT and Industry GHG

Industrial manufacturing is a key economic activity that almost every country wants to have. Manufacturing provides employment activities as well as producing goods for sale. Manufacturing is among the top GHG emission among user activities. Higher manufacturing in emerging economies like China, India etc are increasing carbon emissions. Lack of enough economic incentives to reduce carbon emission in manufacturing is a great challenge [14]. Automation of industrial processes and monitoring can also reduce energy consumption by the manufacturing industry. ICT is required in this automation and monitoring as it acts as the underlying driving technology.

3.3 ICT and Agriculture GHG

There is growing demand to produce more food to feed the increasing global population. Methane from cattle and irrigation using fresh water contribute to increase in carbon emission. Agricultural GHG emission can be reduced by making agricultural processes efficient, minimising wastage in the production process. Farmers in developing countries are slowly adapting to ICT based solution for example using mobile phones to find prices and markets for their produce.
According to the World Bank, "ICT can be used to monitor pest thresholds in integrated pest management, provide relevant and timely information and agricultural services, map agrobiodiversity in multiple-cropping systems, forecast disasters, and predict yields. Crop losses diminish as farmers receive relevant and timely information on pests and climate warnings through SMS technology" [15].

3.4 ICT and Buildings GHG

Most buildings have not been constructed to be energy efficient. About 60% of energy is wasted by commercial buildings through lighting, appliance use, heating and cooking [8]. Literature shows that in the US building account for about 40% of energy consumption and carbon emission [16]. To make buildings to be more energy efficient requires investing in ICT that can sense and monitor energy demands of a building so that any wastage can be detected earlier. The concept of smart city of the future is driven by application of ICT based systems that collects and transmits information to wherever it is needed.

3.5 ICT and Transport GHG

Trasportation of people and goods are some of the main activities of modern life. People travel for leisure, work, business etc. Goods need to be transported from where they are produced to their market place. There is significant amount of energy that is required to power transportation of goods and people. Currently the main source of power comes from fossil fuels. The car industry is responding to carbon emission by producing car engine that consume less power. The industry is also pushing for research to make electric cars a reality for the masses. However, an electric car runs on a battery that must be charged, hence this is only environmental friendly if it is charged from a renewable energy source.

4 ICT CHALLENGES IN GHG REDUCTION

Many countries especially developing countries do not have GHG emission data and efficiency standards for machinery. Therefore manufacturing companies do not have a yard stick against which to monitor their carbon footprint.
Costs of ICT and lack of knowledge in ICT supported agriculture are some of the challenges facing ICT adoption. ICT infrastructure is mainly limited to areas with high population density like cities and villages. So in developing countries it

will take time for such infrastructure to be made available at farms as investors consider it to be unproductive investments to provide such infrastructure in thinly populated areas.

Green computing is generating interest among professionals; however it has not yet been fully implemented as part of the body of knowledge in computing curriculum. For example Curricula 2013 is silent on this subject [17].

The work from home idea concepts has not fully taken off. When employees work from home, they save energy by not traveling to work especially if their mode of transport is not environmentally friendly.

The impact of global warming are already showing thier negative impact globally. Draught, floods, increase in atmospheric temperature and changes in patterns of seasons are now becoming common. Global warming does not recognise geographical boundaries, hence low producers of carbon emission are equally affected just like the high producers.

5 CONCLUSIONS

Carbon emission needs to be looked as international tragedy that need to me monitored and evaluated at central and local government level. Carbon emission needs to be given highest priority by policy makers and measure put in place to monitor it. Carbon emission data need to be part of data that is collected and shared globally just like poverty level indicators.

Carbon emission rates data need to be made part of information of any goods that are produced just like labeling in the food industry. Carbon emission data of any human activity need to be made publicly available to increase level of awareness among people. For example, when carbon emission data of running a conference thorugh video conference and the traditional method are available, individual may choose the method with less carbon footprint. When the right information is made available people will be able to make environmental friendly decisions.

Recent and continuing advances in computing application have the potential to minimise human activities or at least make them more efficient. The banking industry, despite high risks of online banking has taken a lead in providing its services online, making them accessible at any place at any time. This indirectly minimise the need to have physical buildings of bank branches. In some parts of the world the ability for retail stores to provide cash back facilities turns them into mini bank branches. Once customers do no longer have to travel to the bank this reduces the banking industry carbon emissions. Other sectors especially central governments through the e-government initiateves can embrace application of green computing to minimise carbon emissions.

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