Survey on Scope of Green Communication

Sneha Nagarkar[1], Prof. Bhavna Ambudkar[2]
[1, 2] Department of E&TC
[1, 2] Dr. D.Y.P.I.E.T, Pune, Maharashtra, India

Abstract- *Today, Information and Communication Technology (ICT) devices are being used in almost every field and have become an important part of our lives. There is no doubt that its versatility has not only changed our way of thinking but has also accelerated the rate development many times. Electromagnetic field radiations and carbon footprints from the ICT devices are becoming ubiquitous within the environment which further is causing various health problems to the device users. So, there is a need to control and reduce these harmful emissions. Green communication does have the potential to significantly reduce these harmful emissions worldwide. In this paper, we are presenting the survey of research done about radiations from ICT devices and green communication technologies to help control and reduce these emissions.*

Keywords- ICT devices, carbon footprints, electromagnetic radiations

I. INTRODUCTION

Now a days there is widespread research interest in Information and Communication Technologies (ICTs) which is crucially important for sustainable development in developing countries. For the past two decades most developed countries have witnessed significant changes observed in almost all aspects of life: economics, education, communication, and travel that can be traced to ICTs. In a technology-driven society, getting information quickly is important for both sender and receiver, ICTs have made it possible to quickly find and distribute information. This will continue at least until the end of the first half of the century, when other major technological breakthroughs in the area of new materials, biotechnology, or energy, may provide entirely new ways of living. ICT is all around us, in our homes, in our schools and businesses and in the infrastructure that allows our society to work and function.

The health risks of using ICT devices are a concern to most of the people now a days. It has been known since many years that radiations emitted from ICT devices can cause or contribute to the cause of various health problems which include sleep interference, allergic reactions and even the severe health issues like heart disease, cancer and Alzheimer's disease etc [6]. Studies over the last 15 years have given hints of the connection between Electromagnetic Fields (EMF's) and health problems [11]. EMF radiations and carbon footprints from ICT devices have been implicated in behavioral changes, memory loss, birth defects and Alzheimer's disease [11].

Technology analysts estimate that the manufacture, use and disposal of ICT equipment contribute around 2% of global emissions of CO2 [1] and some electromagnetic radiations. As the use of ICT grows, its emissions are likely to increase despite improvements in efficiency. It is estimated that ICT will be responsible for 50% increase of global emissions by 2020 [1]. In this paper, we are going to focus on the survey of various researches carried for radiations from ICT devices and scope of green communication.

II. HEALTH IMPACTS DUE TO RADIATIONS FROM ICT DEVICES

ICT devices basically include all the devices related to ICT such as computers, laptops, mobile phones, wireless networks and routers etc. The amount of time the average person spends in contact with ICT devices is growing every day. Needless to say, these devices are so integral to modern life that interaction with them on a daily basis is seemingly inevitable. This reality makes the idea of radiation from ICT devices that much more alarming.

Excess exposure to EMF and CO2 radiation can have a myriad of negative effects on the body such as; fertility issues with both men and women, DNA fragmentation (irreversible changes to the genetic code), skin burns and rashes as well as other serious health conditions [6]. These dangers come from both thermal and low-energy non-ionizing radiation. Furthermore, mental and physical stress, eyestrain, wrist injuries, neck and back problems are added health issues which are prominently caused due to these harmful emissions [6]. Repetitive strain injury (RSI) [12], sometimes called ULD (Upper Limb Disorder), may also be a health hazard which causes aches and pain in hands, wrists, arms and neck [12] and may caused due to EMF and CO2 radiations. Usually these symptoms do not last but they can be persistent and eventually disabling. A level of EMF radiations, known as extra low frequency (ELF) radiations [13] are given out from all electrical devices including ICT devices. Some researchers believe that such fields could contribute to such conditions as leukemia, tiredness or general fatigue [10].

In addition, studies have shown that in some cases, due to excessive texting with mobile phones, inflammation of tendons and particular degeneration in the thumb joint and index fingers have been reported [15]. The latest smartphones and tablet computers tend to involve the index finger or the thumb to perform the touch functions. Even though the physical actions are very light, frequent repetitive actions last for long hours could lead to excessive strains in the finger joints advice about proper posture when using desktop computers, smartphones and tablet computers. Students overly obsessed with electronic games may suffer from adverse health effects in the long run. If they become accustomed to poor postures such as forward head or "poking-chin" posture, a kyphotic back and rounded shoulders, these may become fixed postural habits that would be difficult to correct when they turn adults [16]. A trend for risk for "forgetfulness" is also observed in overall mobile-phone users [8].

III. CRITIQUE AND ANALYSIS OF DATA

ICT can also be an enabler in reducing the global footprint and EMF emissions. The merit of ICT, and telecommunications is that it dematerializes streams like e-mail, tele-working, tele-conferencing, etc. Information technology can also be used to provide users with information about the energy consumption of systems. Furthermore, ICT can provide services to power manage these systems and thus reduce the impact. These smart grids are considered to enable Green Communication Technologies.

In a paper by Mohammad M. Abbas, Mohammed Maad Abbas, and Mustafa J. Kadhim [1] studied that the amount of energy involved in the production of these devices is considered to be greater than that of the non energy efficient devices. They basically investigated CO2 emissions from ICT devices in Linton University. Considering, commonamong students and staff of Linton College, most people have an average of 3 ICT devices. Drawn from observation, each individual had an average of 3 to 4 ICT devices that solely depend on electrical energy. Devices ranging from desktop PCs, laptops, smart phones, printers, photocopiers, televisions, airconditioners, tablets etc. all rely on the electrical energy. Similarly, people rely on these devices to meet their academic, social and economic needs. Ironically, these devices are meant to ease the lives of its users but indirectly causing environmental health hazards to these same individuals. Energy conservation is very important in environmental sustainability, particularly in terms of electricity use. However, this practice was to a large extent neglected around Linton College. In the laboratories for example, it had been observed that students are found with the negligence of leaving the computer systems on after use. In most cases these PCs remain on all through the weekend. This act of negligence was also found even among some staff offices. Studies have shown that there was vast amount of CO2 emission from use of these ICT appliances while using electricity. About 0.684 kg of CO2 is released from every 1KWh of electricity consumed (Blog: De Engineur, 2012). Therefore, calculating the total amount of CO2 released from excess electricity usage plus that which is released from ICT gadgets, amounts to a great volume of CO2 released, thereby harming the environment we live in. Therefore, the following were some recommended solutions to reduce the rate of CO2 emission from use of ICT devices in Linton University College.

- Encouraging or enforcing ground rules with regards to prolonged use of electricity in the students' apartment.
- Use of energy efficient ICT devices in students' labs and staff offices will reduce the amount of CO2 emission.
- Introduction of virtual meetings and class lectures could reduce the use of electricity.
- Introduction of a network technology known as "thin-client" could also reduce excess electricity consumption, which also signifies reduced CO2 emission for electricity use.
- Students and staffs should be encouraged to switch off electrical appliances when not in use so as to conserve energy.
- Support upgrading of ICT devices to meet modern standard as opposed to buying newer 'greener' devices.
- Use of virtual databases such as cloud computing as opposed to large data centers should be encouraged
- Encourage the use of laptops as opposed to desktop PCs where the former only consumes one third of the energy consumed by the latter.

In a paper by J. C. Wang, E. G. Lim, M. Leach, Z. Wang, K. L. Man and Y. Huang [2] disclosed two measurement methods for conducting SAR analysis; one is the Electric-field probe method, the other is the thermographic method. It mentioned that, the SAR in a biological body exposed to a radio frequency (RF) field depends on a number of factors, including tissue geometry and dielectric properties and the orientation of the body relative to the source [2]. There exist three different limits defined by: 1) a whole-body average SAR; 2) a local peak SAR; and 3) a specific absorption (SA), which limits the power of short pulses. 1) and 2) must beaveraged over a defined period of time. In wireless devices at frequencies above 300 MHz, the absorption affects only parts of the body, which are close to the device. Hence, the most critical value is the local peak

SAR limit. Localized SAR averaged over 10-g and 1g of tissue i.e. peak 10-g SAR and peak 1-g SAR not exceeding 2.0 W/kg and 1.6 W/kg respectively, are recommended by the IEEE/ANSI/FCC as the upper safety limit. The first method of conducting SAR analysis was the electric-field probe method. The electric-field probe method, as a rapid and non - invasive SAR measurement solution, is based on utilizing automatic positioning systems to move an E-Field measuring probe in a liquid phantom to assess SAR values. The second method of conducting SAR analysis was the thermographic method. The thermographic method offers a more efficiency route to establishing SAR over a two-dimensional internal plane within an exposed model. This is valid for both far- and near-zone fields. It involves the use of a thermographic camera to record temperature distributions produced by energy absorption in phantom models after exposure to radiating fields. The model is first disassembled along a plane where SAR is to be determined and a thermograph-temperature scan is made over the plane. The model is then reassembled and exposed to a high power density signal for a short time; followed by disassembly and another thermographic scan.

In a proposal by Jin Liu, Zan Li, Member, IEEE [3] disclosed a novel EE improvement scheme based on SR technique to achieve green wireless communications. The SNR of the received signal can be increased when the bistable parameters expression derived is fulfilled, and consequently results in a bandwith efficiency and EE improvement. The core idea of proposed scheme was the realization of noise energy transferring into transmitted signal, which revealed a possibility turning the noise from a nuisance into a benefit. The simulation results showed the effectiveness of proposed noise enhanced EE improvement scheme, which made it to have potential application value in future green wireless communications.

In a study by Charles Despins, Prompt Inc. and École de Technologie Supérieure et al [4] disclosed research challenges and potential solutions to be considered when trying to reduce the carbon footprint of communications. It further discloses that the creation of a green cyber-infrastructure must rely on advances in many areas, from energy-efficient hardware components to better software. This article has targeted energy consumption and carbon emission abatement. In general, the development of green ICT cyber-infrastructure requires testbeds that combine new ICT infrastructures and renewable sources of energy. In the disclosed study, reporting on various Canadian efforts to develop such testbeds are done.

In a study by Willem Vereecken, Ward Van Heddeghem et al [5] elaborated on the environmental footprint of ICT and the possibilities ICT has in environmental footprint reduction. It is demonstrated that this environment footprint encompasses more than only energy efficiency. It is also disclosed based on global electricity production statistics, an average of 500 g CO2e/kWh is emitted. However, in reality the CO2e emissions per kWh vary depending on the country or region where the electricity is produced. For example, in Australia the emissions are approximately 875 g CO2e/kWh while in Iceland the emissions are virtually 0. It is finally disclosed that the potential energy savings are estimated to be approximately five times ICT's own footprint. However, this potential is largely dependent on adoption parameters which are beyond the control of the ICT itself.

In a paper by R.C.Radha, P.Gurupranesh [6] disclosed the Electro Magnetic Radiation generated by the electronic appliances such as desktop computers, laptops, personal grooming appliances, kitchen appliances, televisions, mobile phones and their towers, and their related health effects, reason for health effects along with the measures to reduce the radiation are proposed. Zero radiation emission cannot be achieved in the technological world. But by following safety measures protection from harmful radiation is possible. Further it is disclosed, CRT monitors produce computer radiation of 3 milli gauss at 30cm, measured from the front and 4 milli gauss at the same distance from sides. Computer monitors radiation is a health hazard in itself at this distance. UPS produces radiation of 20 milligauss at 30 cm and over 1 milligauss at 1 meter, even when apparently switched off but still connected to mains electricity and charging the battery. Small desktop computer printers generally produce less than 0.5 milligauss at 60 cm in standby mode and up to twice the amount when printing. Wi-Fi information networks, wireless routers, modems and other wireless devices emit Microwave and radio frequency Electro Magnetic Radiation. They are not safe and result in cell and DNA damage, Infertility and interfere with Biological process. Large sub – woofers that are used as part of computer's sound system emit 20 milligauss of ELF radiation at 0 cm, 3 milligauss at 60 cm, 0.5 milligauss at 90 cm even though it is not producing sound and it is only powered. Personal grooming appliances like hairdryers, Electric shavers, electric toothbrushes and similar personal grooming products have 20 – 200 milligauss of magnetic fields at their normal operating distance. Kitchens are the areas of high EMF radiation. If a person is cooking in kitchen for one hour means he is exposed to EMF of 5-10 milli gauss. So if he do cooking for two to four hours means he crossed the suggested maximum daily EMF exposure of 20 milligauss. The EMF from TV is more because of the CRT monitors and it produces radiation of 20 milligauss at 30 cm and over 1 milligauss at 1.5 meter. Part of the radio waves emitted by a mobile telephone handset is absorbed by the body. The radio waves emitted by a GSM handset can have a peak power of 2watts and a US analogue phone had a maximum transmit power of 3.6 watts.

Further, in a study by Sushil Pandey, Saisab Pradhan, Jay Karmacharya [7] highlighted the importance of calculating and knowing IT carbon footprint, following which how organizations can reap benefit in reducing costs and environmental impact through green computing, and featured experience of a leading-edge, mid-sized organization. Further disclosed is that the anthropogenic emission of greenhouse gases (GHG) is measured. Mass of CO2 equivalents per product per unit of time, in per year or per product life is the unit of measurement. Place of use and emission matters as their emission factor differs. Measurement of indirect emission of power consumed on use by computer products is one of the entity for which the carbon footprint has been calculated. The calculation method is based on AMEE tool that takes consumption data for representative period of time. Organizationally, it was considered that 158 PCs and 10 servers were in use, the average CO2 emitted per computer per year came out to be 4.9 Kg. For laptops, the energy consumption looks optimized by design and the default factory setting looks working best. Ultimately, it makes the case that use of power management features, needs to be applied by the users more uniformly and contributes to lowering CO2 emission. Furthermore, the paper was expected to impart a simple methodology to calculate carbon footprint of computing technology at any organization. By calculating total carbon footprints for all sources, organizations also get the opportunity to see if they can become carbon neutral, e.g. by balancing a measured amount with amount offset.

In this literature, from the various analysis, it creates a need to analysis and find out the safety or tolerable levels of CO2 and EMF radiations for human beings. Several parameters have been surveyed for measurement and hazardous levels of EMF and CO2 radiations from ICT devices. Reduction in the excess levels these emissions further contribute in development of green communication. The safety as well as hazardous levels of CO2, CO [9] and measurement of limit of SAR are illustrated below. These levels depicts the tolerable values of radiations and also hazardous levels which may affect the human health in various ways.

1. Levels of CO2[9]

Table 1.

Levels of CO2	Health effects and other information
250-350ppm	Normal background concentration in outdoor ambient air
350-1,000ppm	Concentrations typical of occupied indoor spaces with good air exchange
1,000-2,000ppm	Complaints of drowsiness and poor air
2,000-5,000 ppm	Headaches, sleepiness and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate and slight nausea may also be present.
5,000ppm	Workplace exposure limit (as 8-hour TWA) in most jurisdictions.
>40,000 ppm	Exposure may lead to serious oxygen deprivation resulting in permanent brain damage, coma, even death.

2. Levels of CO[9]

Table 2.

0 PPM	Normal, fresh air.
9 PPM	Maximum recommended indoor CO level
10-24 PPM	Possible health effects with long-term exposure.
25 PPM	Max TWA Exposure for 8 hour work-day
50 PPM	Maximum permissible exposure in workplace
100 PPM	Slight headache after 1-2 hours.
200 PPM	Dizziness, naseau, fagitue, headache after 2-3 hours of exposure.
800 PPM	Headache, nausea, and dizziness after 45 minutes; collapse and unconsciousness after 1 hour of exposure. Death within 2-3 hours.

3. Measurements of EMF radiations

The U. S. Federal Communications Commission (FCC) limit for RF radiation exposure from mobile phones is set at a SAR of 1.6 watts per kilogram (1.6 W/kg). ICNIRP recommends that the localized SAR in the head be limited to 2 W/kg averaged over any 10g mass of tissues in the head (0.02 W absorbed in any 10g mass of tissue in the head). A SAR of 4W/kg is associated with a temperature rise in humans of a fraction of a degree Celsius [10].

V. CONCLUSION

The growth scenarios for the ICT sector indicate that it is important to develop strategies to limit the carbon footprints and electromagnetic radiations from ICT devices. These strategies need to focus on reducing the power consumption, energy efficiency etc of the ICT devices and help in contributing scope for green communication. The safe levels of radiations must be maintained in order to reduce human health risks due to these radiations. Green communications have the potential to significantly reduce greenhouse gas emissions worldwide. This scenario can be obtained by maintaining the safe levels of radiations and solving network related issues. Maintaining the level of CO2 emissions below 350 ppm, CO emissions below 25ppm and RF radiations at an SAR of 1.6W/kg in the vicinity of human beings can help reduce the health hazards that can be caused due to their excess emissions. This can be a solution towards scope of green communication.

REFERENCES

[1] Mohammad M. Abbas, Mohammed Maad Abbas, and Mustafa J. Kadhim, "Investigates of CO2 Emission from ICT Devices in Linton University", Strategic Technologies of Complex Environmental Issues-A Sustainable Approach, 10 September 2015.

[2] J. C. Wang, E. G. Lim, M. Leach, Z. Wang, K. L. Man and Y. Huang, "Two Methods of SAR Measurement for Wearable Electronic Devices", Proceedings of the International Multi Conference of Engineers and Computer Scientists 2016 Vol II, IMECS 2016, March 16 - 18, 2016, Hong Kong.

[3] Jin Liu, Zan Li, "Noise Enhanced Energy Efficiency in Green Wireless Communications", IEEE ICC 2015 SAC - Green Communications, 2015.

[4] Charles Despins, Prompt Inc. and École de Technologie Supérieure et al, "Leveraging Green Communications for Carbon Emission Reductions: Techniques, Testbeds, and Emerging Carbon Footprint Standards", IEEE Communications Magazine, August 2011.

[5] Willem Vereecken, Ward Van Heddeghem, Didier Colle, Mario Pickavet and Piet Demeester, "Overall ICT Footprint and Green Communication Technologies", Proceedings of the 4th International Symposium on Communications, Control and Signal Processing, ISCCSP 2010, LimasBol, 3-5 March 2010.

[6] R.C.Radha 1, P.Gurupranesh, "Electromagnetic Radiation from Electronic Appliances", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE).

[7] Sushil Pandey, Saisab Pradhan, Jay Karmacharya, "Measuring Carbon Footprint of Computing Technology – A Case Study at ICIMOD", lib.icimod.org , 2013.

[8] Aditi Mishra, Neeraj Kumar Tiwari, "Green Communication: An Effective Approach to Minimize Risk of Forgetfulness from Mobile Phone Usage", E-Health Telecommunication Systems and Networks, 2014, 3, 1-7.

[9] https://www.kane.co.uk/knowledge-centre/what-are-safe-levels-of-co-and-co2-in-rooms

[10] Ng Kwan-Hoong, Ph.D., "Radiation, Mobile Phones, Base Stations and Your Health", Malaysian Communications and Multimedia Commission

[11] http://topicswhatsoever.blogspot.com/2013/03/computer-radiation-the-risks-effects-and-protection-from electromagnetic-radiation.html

[12] http://www.igcseict.info/theory/6/health/

[13] https://revisionworld.com/gcse-revision/ict/health-safety

[14] http://www.sciencedirect.com/science/article/pii/S0003687016301235

[15] http://www.goodhousekeeping.com/health/wellness/a24269/smartphone-syndromes/

[16] https://www.sciencedaily.com/releases/2013/09/130905160452.htm