Chapter 1

Introduction

1.1 Introduction. Technology innovation has helped human kind tremendously with machines for his physical activities. With advancement in electronics, communications, computers and information technologies with automation, human brain or mental comfort has been enhanced to a large extent. Though human comfort has reached to the great extent there, it has started affecting environment and human lives. Further rapid changes in technology, mass production, ever increasing consumers, falling prices, have resulted in a fast-growing electronics industry with its large variety products affecting the environment and human lives including surplus of electronic waste around the globe. Research and development in modern age in science and technology have brought many rewards to society and humankind as whole but along with those brought some risks and few remedies.

In recent times India has emerged as a global leader in the field of Information Technologies. Even though Technological developments have revolutionised all aspects of human life and will certainly bring in some side effects. The electronics, communications, computers and information technologies have changed the human lives tremendously but have brought in some ill effects on our environment.

Development and usage of electronics devices is one of the major technological evolutions which have made a tremendous impact over the last few decades in the socio-ecumenical transformation all over the world. Several electronic devices and its derivatives are in constant use in almost every sector of society such as research, education, health, industry, households, trade and business, governance and a host of public services and utilities. A significant shift in the technological paradigm has also been witnessed. It has led to the emergence of highly sophisticated but very handy devices and gadgets along with a gamut of network connectivity in providing such services across the globe. This has generated a phenomenal growth in the business as well as application domains with deeper penetration into the every discipline and areas as well. Considering its vast utilities and ever growing demands, extensive research is being carried out in the electronics and its associated sector to
emerge out with environment friendly strategies to reduce its ill effects for a better human life style.

This call for continued research in different segments of electronics and its associated sectors with an objective to follow the approach of convergence of various technologies with a high degree of synergy across the Institutions to tackle the Techno-socio, economic and environmental issues for better living conditions is the necessity of the hour. Some of these issues include design of new engineering systems to minimize power consumption levels, less carbon emission, less EMF radiation levels, next generation devices and modules, efficient and compact data transmission systems, bringing down EMI to the safer living standards and addressing the aspects of clean environment. This puts through new challenges to both scientific and engineering community to come out with alternate strategies for innovative technologies generation with cost effectiveness for clean environment.

1.2 EMF Radiation Impacts on Human Health. Studies have shown that human beings are bio electrical systems. The heart and the brain are regulated by internal bioelectrical signals. Environmental exposures to EMF can interact with fundamental biological processes in the human body and in some cases this may cause discomfort as reported in literature. In a human body due to the proximity of a mobile phone to the head, the head is the targeted recipient of the electromagnetic energy from many wireless systems whose impulses are transmitted to other organs and parts. The effects of EMF radiation\textsuperscript{[1]} can be classified as follows.

(i) Bio effects are measureable responses to a stimulus or to a change in the atmosphere and are necessarily harmful to our health.

(ii) Health effects are the changes which may be short term or long term. These effects stress the system and may be harmful to human health.

Non-thermal effects are several times more harmful than thermal effects. Generally reported problems are concentration loss, sleep disruption, headache, depression, discomfort, irritability, nausea, dizziness, appetite loss, muscle spasms, numbness, tingling, altered reflexes\textsuperscript{[2-3]} and inclusive of cancer.

1.3 EMF radiation impacts on environment. The most pervasive environmental exposure in industrialized countries today is the Electro Magnetic
Radiation (EMR) or Electro Magnetic Fields (EMFs) exposures created by the vast array of wireless technologies. Environment represents the totality of physical, chemical, biological, behavioural and social-economic factors. The electromagnetic radiation pervading the environment\textsuperscript{[4-6]} is now increasingly realized and this has added to the list of another pollutant in the environment i.e. invisible electronic pollution. This has severe effect on human, animals, birds, bees, and other species.

1.4. Global Warming and Climate Change. Global warming is the rise in the average temperature of the earth’s atmosphere and oceans since the late 19 century and its projected continuation. Since the early 20 century, earth’s average surface temperature has increased by about 0.8\textdegree{}C with about two-thirds of the increase occurring since 1980\textsuperscript{[7]}. Warming of the climate system is unequivocal and scientists are more than 90\% certain that it is primarily caused by increasing concentration greenhouse gases produced by human activities. The climate models summarised in 2007 Fourth Assessment Report (AR4)\textsuperscript{[8]} by the Intergovernmental Panel on Climate Change (IPCC). They indicated that during 21 century the global surface temperature is likely to rise further 1.1 to 2.9\textdegree{}C for their lowest emissions scenario and 2.4 to 6.4 \textdegree{}C for their highest\textsuperscript{[9]}.

Human activity since the industrial revolution has increased the amount of greenhouse gases in the atmosphere leading to increased radioactive forcing from CO\textsubscript{2}, methane, tropospheric ozone, CFCs and nitrous oxide. The concentration of CO\textsubscript{2} and methane have increased by 36\% and 148\% respectively since 1750\textsuperscript{[10]}. Over the last three decades of the 20 century, gross domestic capita and population growth were the main drivers of increases in greenhouse gas emissions\textsuperscript{[11]}. The changes in monsoon patterns, melting of ice, sea level rise, declining crop yields, typhoons, floods, cyclones and the manmade reasons are the causes which are contributing for.

The world is consuming more and more electronic products every year. This has caused a dangerous explosion in electronic scrap (e-waste) containing toxic chemicals and heavy metals that cannot be disposed of or recycled safely. However this problem can be minimized. There is a pressing need for leading electronic companies to change; or to turn back the toxic tide of e-waste.
Every year, hundreds of thousands of old computers and mobile phones are dumped in landfills or burned in smelters. Thousands more are exported, often illegally, from the Europe, US, Japan and other industrialised countries to Asia. In under developed countries the workers at scrap yards, some of them are children, are exposed to a cocktail of toxic chemicals and poisons.

1.5 Green Electronics Devices. Carbon free electronic devices or green electronics describes the study, design, manufacturing and the utilization of electronics resources efficiently in an environmental friendly manner with zero carbon emissions. The increase in electronics devices utility over the years has a direct impact on environmental issues and needs reducing the negative impact on the environment. The thrust toward carbon free electronics is to design and develop the green power sources. Under the IT green technology, the manufactures need to produce environmental friendly products, recycling of waste materials encouraging for more options like virtualization, power management, using the alternate source of energies etc. The government also needs to formulate new compliance regulations which would work towards certifying the electronics devices as green. The present expectation is that this filed will bring innovation and changes in daily life of similar magnitude to the “information technology” explosion over the last two decades. In these early stages, it is impossible to predict what “green technology” may eventually encompass.

There’s no simple path to green electronics, but some simple actions need to be initiated. For example, one can orient racks of Servers in a Data Centre to exhaust their heat in a uniform direction, thus reducing overall cooling coasts. A comprehensive plan for achieving green electronics revolution does require an architectural proactive approach for the green electronics and its derivatives solutions. The ecosystem complexities-ranging from the all electronics devices and from customer impacts to business impacts-needs trade-offs of investments and process decisions.

Business value metrics, such as total cost of ownership and return on investment is considered against the carbon footprint, energy consumption, and pollution generating metrics. Green computing has no widely accepted metrics, so we must be careful to compare apples to apples when taking an architectural view. The
definitions of the Data Centre’s green quotient for example is the ratio of plug power consumption to total-site power consumption. At some level, it’s likely that government or industry authorities will step in with more widely accepted metrics that will help to solve this problem. But again, we must be careful to take the whole picture into account when measuring green success or progress.

Green electronics is becoming a booming industry as the world increasingly focuses on sustainable initiatives. All the major companies of the world have embraced some form of green technology and look for ways to increase their involvement in the future green technologies. That may include using low-emission building materials, recycling and packaging facilities, alternative energy sources, energy efficient equipments and other green technologies.

The spiralling growth in consumer electronics products and their side effects are not much available in open literature which requires investigation. The contribution of electronic devices is essential at present. Once the negative contributions from these devices are investigated and realised. The necessity is the mother of invention, then only the remedial measures can be developed.

The e-pollution effects on environment and human health needs to be controlled and reduced and make consumer electronics products greener. The government also needs to formulate new compliance regulations which would work towards certifying the electronics devices as green by certain environmental criteria which is the research area for this PhD study.

1.6 Motivation

1. Desire to find a solution to a practical problem faced by society in the form of environmental pollution and human health hazards due to electronic pollution.

2. Experience the joy of doing some useful creative work to minimise the electronic pollution.

3. To get recognition and respectability in the field of green electronics.

4. Desire to get PhD degree with its consequential respect in academic circles and society.
5. Service to society to mitigate health hazards to human, as well as other living bodies, wild life including Bees and birds and reduce environmental pollution due to e-devices.

1.7 Organization of Thesis

Chapter-2 Describes the critical review of available literature, specifications and basic designing parameters for existing rating systems for green electronic devices.

Chapter-3 Describes the necessity, significance, scope of this research work, objectives and problem formulation.

Chapter-4 Presents the investigations and selection of electronic pollution parameters comprehensively. This chapter also includes selection of samples and projections for 2050.

Chapter-5 Describes the experimental procedure and determination of primary data of EMF radiation (power density) from cellular mobiles at 800MHz, 1800MHz and 300 KHz-50GHz band including at 900MHz. Heat generation, CO₂ emission and power consumptions from cellular mobiles and computer monitors were also experimentally determined.

Chapter-6 Describes the secondary data generation on hazardous material content, E-waste, Scalability, Biodegradability and Ethics and self Discipline for electronic devices

Chapter-7 Describes the Results, Analysis, Discussions and Findings.

Chapter-8 Introduces a new concept of national grading system namely Hind Greener Electronics Grading Process for 2050 for electronics devices based on electronic pollution parameters identified in this research work after bench marking based on current determined levels. Here critical justification is also included.

Chapter-9 Concludes the work as novel and efficient concept for environmental sustainability and human health for entire globe through implementation greener electronic grading process. Its advantages, limitations, applications and future scope. Conclusion section is then followed by listing out the references and then publications of this research work.
Except for Chapter-1, all the other chapters present illustrative and useful concepts on electronic pollution parameters, some of which involve the practical experiments for determination of present electronic pollution levels and forecasted levels for 2050 as real-time data.

During the journey of this research work the available literatures found are about rating of electronic devices and its improvements, basically on two parameters namely power consumption and hazardous material content with corporate responsibility being the rest of the pollution care. The details of electronic pollution parameters are comprehensively investigated and experimental determination are considered in this work, There are absolutely problem dependent and are required for benchmarking and development of this new grading system.

Most of the material presented here has not appeared before. This grading system should be of serious interest to United Nations Framework Convention on Climate Change(UNFCC), International Commission on Non-Ionizing Radiation protection (ICNIRP), International Committee on Electromagnetic Safety(ICES) of IEEE, World Health Organization(WHO),environmentalists, researchers, developers, manufacturers, retailers and consumers alike for environmental sustainability and human health and at the same time development.