Available online at www.elixirpublishers.com (Elixir International Journal)

Computer Science and Engineering

Elixir Comp. Sci. & Engg. 64 (2013) 19110-19117

ISSN: 2229-712X

Alarming global warming trends due to heat emission by computer monitors

K Parandham and RP Gupta

Aisect University, Bhopal-Chiklod Road, Raisen, Bhopal, India.

ARTICLE INFO

Article history:

Received: 13 September 2013;

Received in revised form:

28 October 2013;

Accepted: 4 November 2013;

Keywords

Computer Monitors,
Electronic,
Information and Communication Technology (EICT) products,
Heat Emission. Information Age, Computer Age,
Digital Age.

ABSTRACT

The world's entrance into the computer age along with web has certainly had a profound impact on our society. With increase in purchasing power, mass production, lesser costs, exponential growth in computer technology and population growth were one of the main drivers of increases in global warming and climate change. The onset of Information age is associated with the digital revolution, just as the Industrial Revolution marked the information age. Computerization of modern society has brought convenience to all aspects of human life. It seems evident that there will be both positive and negative effects on society and global environment. Computers have added a new source of heat generation and emission into environment. In spite of recent studies indicating possible threats to global warming and global climate, there is no long term data available on the amount of heat generated, emitted and dissipated into environment by computer monitors. The scope of this research work is to experimentally measure the heat generated by computer monitors during on (sleep/Idle) mode and working mode. For this research work four decimal digit temperature measurement test instrument was designed and exclusively fabricated. A special air locked container was also fabricated for conducting heat emission experiments on computer monitors. Population and computers projections for India, China, USA and the whole world were also included in this research work for 2050. An attempt is made to indicate amount of heat generated, emitted and dissipated into environment by India, China, USA and entire world by computer monitors at present and projections for 2050.

Introduction

Global warming is the rise in the average temperature of Earth's atmosphere and oceans since the late 19th century and its projected continuation. Since the early 20th century, Earth's mean surface temperature has increased by about 0.8 °C (1.4 °F), with about two-thirds of the increase occurring since 1980[1]. Global warming has been detected in a number of natural systems which are resulting in natural calamities. Some of these changes are due to temperature changes basically rise in temperature levels, e.g., sea level rise, changing monsoon patterns and widespread decreases in snow and ice extent [2]. The most general definition of *climate change* is a change in the statistical properties of the climate system when considered over long periods of time, regardless of cause [3].

The Earth's average surface temperature rose by 0.74±0.18 °C over the period 1906–2005. The rate of warming over the last half of that period was almost double that for the period as a whole (0.13±0.03 °C per decade, versus 0.07±0.02 °C per decade). The urban heat island effect is very small, estimated to account for less than 0.002 °C of warming per decade since 1900 [4]. Temperatures in the lower troposphere have increased between 0.13 and 0.22 °C (0.22 and 0.4 °F) per decade since 1979, according to satellite temperature measurements. Climate proxies show the temperature to have been relatively stable over the one or two thousand years before 1850, with regionally varying fluctuations such as the Medievel Warm Period and the Little Ice Age [5].

Increasing human activities are currently causing global warming and climate change is often used to describe human-specific impacts**.** Latest contributors to global warming and climate change are the continuous heat emissions by Electronics, Information and Communications Technology products.

The Computer age also known as Information Age is an incredible period in human history characterized by the shift from traditional industry that Industrial Revolution brought through industrialization, to economy based on the information computerization. The exponential developments and spread of computers and its products in the last four decades have increased the modern human involvement, its related ecological, biological and physical systems resulting in various undesirable and unintentional ill effects on global climate. The most pervasive global temperature increase in industrialized as well as developing countries today is the heat generated and created by the vast array of computers and their associated products into society. The heat generation pervading the global climate due to computer technologies is now increasingly realised and this has added to a new source to the list of heat generating sources into the environment.

Brief Historical Background

Evidence for climatic change is taken from a variety of sources that can be used to reconstruct past climates. The **instrumental temperature record** shows fluctuations of the temperature of the global land surface and oceans. This data is collected from several thousand meteorological stations, Antarctic research stations and satellite observations of sea-surface temperature. The longest-running temperature record is the Central England temperature data series, that starts in 1659. The longest-running quasi-global record starts in 1850 [6].

A major scientific study has found that global warming over 20th century has produced the hottest global average

Tele:
E-mail addresses: Param1959@yahoo.co.in

temperature in 1400 years. It was found that the period between 1971 – 2000 was the warmer than any other time in nearly 1400 years. The first continental-scale reconstruction of temperatures over the past 2000 years has highlighted the unusual nature of the warmest 20 th century in nearly 1400 years according the study published in Nature Geoscience.

Recent estimates by NASA's Goddard Institute for Space Studies (GISS) and the National Climatic data Center show that 2005 and 2010 tied for the planet's warmest year since reliable, widespread instrumental measurements became available in the late 19th century, exceeding 1998 by a few hundredths of a degree [7]-[8]-[9]. Estimates by the Climatic Research Unit (CRU) show 2005 as the second warmest year, behind 1998 with 2003 and 2010 tied for third warmest year. The World meteorological Organization (WMO) statement on the status of the global climate in 2010 explains that, "The 2010 nominal value of +0.53 °C ranks just ahead of those of 2005 (+0.52 °C) and 1998 (+0.51 °C), although the differences between the three years are not statistically significant[10].

Latest analysis by scientists studying the changing mass of the Greenland island using satellite data confirms that every year, Green land is losing 200m tonnes of ice. Isabella Velicogna, a researcher in the University of California in his most recent study from the Gravity Recovery and Climate Experiment (GRACE) confirms the Greenland ice loss every year since 2003 which is having big impact on sea levels.

Necessity

The warming that is evident in the instrumental temperature record is consistent with a wide range of observations, as documented by many independent scientific groups [11]. Examples include sea level rise (water expands) as it warms) [12], widespread melting of snow and ice [13], increased heat content of the land and oceans [11], increased humidity [11], and the earlier timing of spring events, [14][e.g., the flowering of plants and changing patterns of monsoon[15]. The probability that these changes could have occurred by chance is virtually zero [11].

Warming of the climate system is unequivocal, and scientists are more than 90% certain that it is primarily caused by increasing concentrations of greenhouse gases produced by human activities such as the burning of fossil fuels and deforestation [16-19]. These findings are recognized by the national science academies of all major industrialized nations [20]. There is a strong need for present and future studies to consider and take into account temperature increases due to consumer electronics devices and their contribution to global warming and climate change.

Every year, hundreds of thousands of new computer monitors are introduced into market. Digital (computer) age revolution in the modern world has triggered not only the growth of world economy but has changed the life style of millions of people resulting in to global warming and climate change. Computer technology is growing exponentially in India and across the world. At present there are about 56 million computer monitors in India and over 1514 million computer monitors in the world.

The population projections for India , China, USA and the entire world [21-27] are as shown in the table.1 below till 2050. Due this exponential growth of population, urbanization, consumer electronics products concern for environment and human health hazards is growing throughout the world. There is a great need to know how much heat is generated, emitted and dissipated into environment by cell phones for 2050. Hence, measurement and estimation of heat emissions into environment and society are required to be determined through experiments.

Table 1. Population trends for 2050.

Country	2020 popln (Billions)	2030 popln (Billions)	2030 popln (Billions)	2050 popln (Billions)
India	1.326	1.460	1.571	1.657
China	1.423	1.454	1.376	1.320
USA	0.325	0.351	0.392	0.438
World	7.900	8.800	9.800	10.60

The growth of computer monitors and their estimated projections for India, China, USA and the entire world [28] for 2050 are as shown in the table below.

Table 2. PC Monitors projections for 2050

Year	India	China	USA	World
2010 PC Monitors (Millions)	56	192	306	1514
2015 PC Monitors (Millions)	74	486	380	2324
2020 PC Monitors (Millions)	96	729	475	3060
2030 PC Monitors (Millions)	144	802	518	3396
2040 PC Monitors (Millions)	288	842	564	3770
2050 PC Monitors (Millions)	432	885	615	4185

Design and Fabrication of Digital Temperature Measurement Device

For this research work a 4 decimal digit precision digital temperature device as shown figure 1 was specially designed and fabricated to provide reliable and highly accurate temperature measurement. To make it more efficient an ATMEL microcontroller ATMEGA-8L, which has 10 bit Analog to Digital converter and LM 35 temperature sensor were used.

The Atmel®AVR® ATmega8 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega8 achieves throughputs approaching 1MIPS per MHz, allowing the system designed to optimize power consumption versus processing speed. The Atmel®AVR® core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.

A printed circuit board was designed using AUTOCAD software as shown in figure.3 and print it over by means of screen printing process. The components used are indicated in the table.3 are soldered using sharp tip soldering iron as per the circuit diagram as shown in figure 2 and placed in metal box for carrying out experiments. To enhance accuracy oversampling was used and to increase resolution suitable programming was carried out.

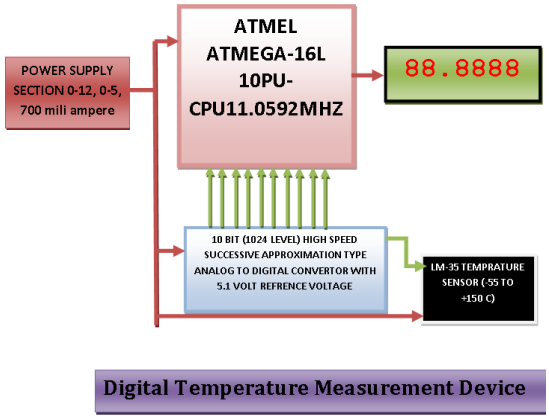

Figure 1. Block Diagram of Digital Temperature Measurement Device

Table 3. Components used for Fabrication

ITEM	QTY.
Atmega8	1
Glass epoxy pcb	2
Seven segment display common anode	5
28 pin ic base	1
7805 regulator	1
2200uf/25volt capacitor	2
LED	1
Resistor 10 kilo ohm	2
Lm-35 temperature sensor	1
Ribbon wire	1 meter
9-0-9 transformer	1
Power cable	1
Lm-317	1
Screw and fittings	4

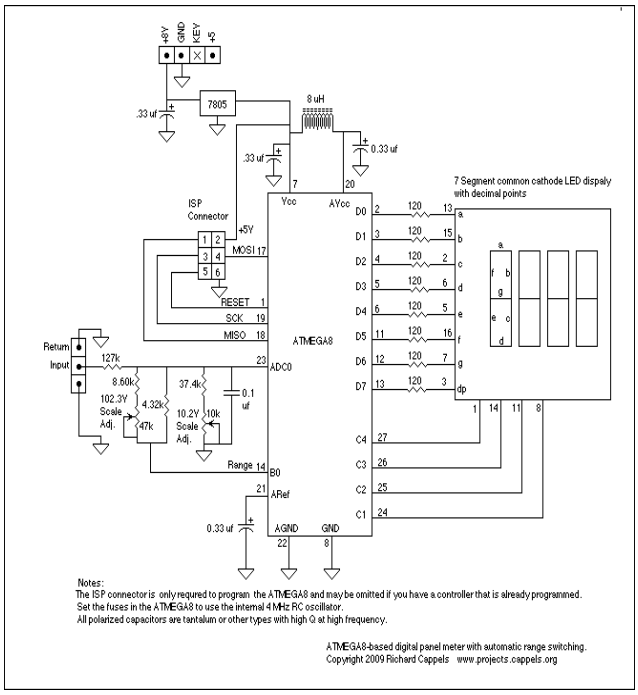

Figure 2. Circuit Diagram of Digital Temperature Measurement Device

Experimental Methodology

Scientists actively work to understand past and future climate by using observations and theoretical models. Borehole temperature profiles, ice cores, floral and faunal records, glacial and periglacial processes, stable isotope and other sediment analyses, and sea level records serve to provide a climate record that spans the geologic past. More recent data are provided by the instrumental record. Physically based general circulation models are often used in theoretical approaches to match past climate data, make future projections, and link causes and effects in climate change

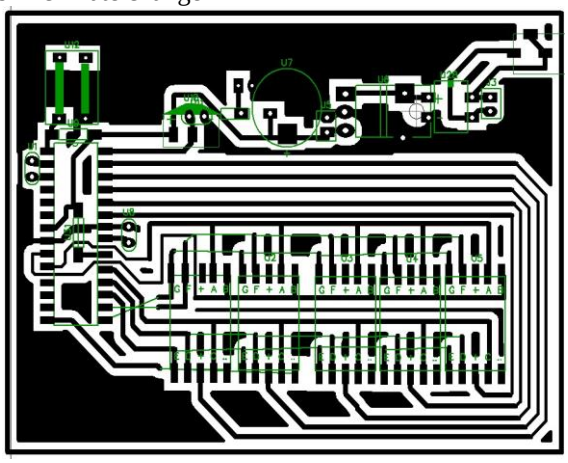

Figure 3. Circuit Diagram of Digital Temperature Measurement Device

For this research work for measurement of temperature to determine heat generated by computer monitors and emitted into environment specially designed and fabricated 4 decimal digit temperature measurement devices [29] is utilised. Temperature measurements carried out in three different modes which are as follows.

(a) On (Sleep/Idle) mode of operation.
(b) working mode of operation for duration of 60 seconds.

Salient features of experimental procedure followed for these measurements are as explained below.

(a) Identify a air locked room/laboratory.
(b) Place the sensor of the temperature measurement device inside the container as shown in figure 4.
(c) Switch on the device and measure the background temperature inside the container after reading becomes constant.
(d) Introduce the computer monitor gently with switched on condition near the sensor inside the container (On mode).
(e) Measure the temperature after reading on the display becomes constant.
(f) Remove the computer monitor and measure the background temperature.
(g) Introduce the computer monitor gently near the sensor when the it is in working condition (mode).
(h) Measure the temperature after 60 seconds and note the reading.
(i) Change the computer monitor model and repeat the above steps.
(j) Tabulate the collected temperature data for further analysis.
(k) Subtract the background value from measured values of on and working modes every time for each monitor.
(l) Working mode measurements were also carried out for all the monitor models and found that heat emission is between 9 to 14 degrees centigrade for a duration of 6 hours.

Results, Analysis and Discussion

The preliminary results of an assessment carried out by the Berkeley Earth Surface Temperature group and made public in October 2011, found that over the past 50 years the land surface warmed by 0.911°C, and their results mirrors those obtained from earlier studies carried out by the NOAA, the Hadley Centre and NASA's GISS. The Antarctic Peninsula has warmed by 2.5 °C (4.5 °F) in the past five decades at Bellingshausen Station [11].recent studies have indicated that temperatures in Mumbai

and Delhi have shot up by up to 2.3^0 C in the last 15 years and the global average temperature shot up by 0.45^0 C above 1961-1990 average.

Table 4. Measured Temperature Values of PC Monitors in Different Modes

Make / Model	ON Mode (^{0}C)	Working Mode (^{0}C)
HP LP 2065	0.7889	1.4531
HP LP 2065	0.7891	1.4514
HP S 1935a	0.7888	1.8406
HP L 1710	1.0204	2.0223
HP 1702	1.1037	1.3671
HP 1702	1.0018	1.4329
HP LP 2065	1.1554	1.4186
HP LP 2065	0.6205	1.2715
HP LP 2065	0.7891	1.4532
HP LP 2065	0.7889	1.4513
HP LP 2065	0.7891	1.4514
HP LP 2065	0.7889	1.4531
HP LP 2065	0.7889	1.4531
HP LP 2065	0.789	1.4514
HCL TFT 185W 80 PSA+(42cm)	1.7909	2.1048
HCL TFT 185W 80 PSA+(42cm	1.8133	2.1554
HPL 1702	1.1037	1.3667
HPL 1706	1.0015	1.0124
HP LE 1851w	0.8992	1.8619
HP Compaq L 1902x	0.8517	1.7425
TFT AOC-15”	0.8999	1.9517
TFT LG-15”	1.1947	2.166
TFT LG 18”	1.116	1.9469
TFT LG 18”	1.1168	1.9471
TFT LG-15”	1.188	2.147
TFT LG 18.5”	1.2012	1.948
TFT LG 18.8”	1.201	1.9467
CRT LG 14	1.4816	2.1364
CRT HP M76	1.4413	2.1983
HPL 1706 15X	0.951	1.915

Figure 4. Photo of Experimental Setup

We now know that man-made climate change is real and that it poses a great threat to the planet and its inhabitants. Current data suggest that we need to reduce greenhouse-gas emissions in developed countries by at least 80% by 2050 in order to have a chance of staying below an average temperature rise of over 2ºC.

The table 1 shows the population projections for 2050 and table 2 indicates the computer monitor projections for 2050 for India, China, USA and the entire world. In this research work for calculating computer monitor projections for India, it was assumed that the growth will increase by 30%, 30% 50%, 100% and 50% till 2050 respectively with respect to previous block of 10 years. These growth rates for China it will be 300%, 50%, 10%, 5% and 5% respectively till 2050. For USA it is assumed that the increase in computer monitors is expected to rise by 4.5% in 2015, 5% in 2020 and 9% after 2020 till 2050. For entire world the growth rate of computer monitors is assumed to increase by 9% in 2015 and by 7% in 2020 and 11% after 2020 till 2050. These expected increase in computer monitors is assumed for this research work.

From the experimental data it is seen from the table 4 where computer monitors models used as samples are also shown, that every monitor on an average emits 1.0418^0C during on(sleep/idle) mode. It was observed that this becomes constant after 2 minutes of switching on after which there is no increase in the temperature. It is also observed that computer monitor on an average emits 1.7173^0C in working mode which is recorded for 60 seconds each. All these heat is dissipated into environment.

For further determination, analysis, and understanding the total heat generated, emitted and dissipated by India, China, USA and the entire World it was assumed that all the computer monitors heat sources put together is treated as a single heat source. This is similar to all components in a printed circuit board dissipating individually into a single heat sink.

Table 5: Heat Emissions by Cellular Mobiles From India

	INDIA	
Year	ON Mode (Sleep/Idle) (Million ^{0}C)	Working Mode (Million ^{0}C)
2010	58.3408	96.1688
2015	77.0932	127.0802
2020	100.0128	164.8608
2030	150.0192	247.2912
2040	300.0384	494.5824
2050	450.0576	741.8736

Table 6: Heat Emissions by Cellular Mobiles From China

	CHINA	
Year	ON Mode (Sleep/Idle) (Million ^{0}C)	Working Mode (Million ^{0}C)
2010	200.0256	329.7216
2015	506.3148	834.6078
2020	759.4722	1251.9117
2030	835.5236	1377.2746
2040	877.1956	1445.9666
2050	921.993	1519.8105

Table 7: Heat Emissions by Cellular Mobiles From USA

	USA	
Year	ON Mode (Sleep/Idle) (Million ^{0}C)	Working Mode Million (^{0}C)
2010	318.7908	525.4938
2015	395.884	652.574
2020	494.855	815.7175
2030	539.6524	889.5614
2040	587.5752	968.5572
2050	640.707	1056.1395

Table 8: Heat Emissions by Cellular Mobiles From World

	WORLD	
Year	ON Mode (Sleep/Idle) (Million ^{0}C)	Working Mode (Million ^{0}C)
2010	1577.2852	2599.9922
2015	2421.1432	3991.0052
2020	3187.908	5254.938
2030	3537.9528	5831.9508
2040	3927.586	6474.221
2050	4359.933	7186.9005

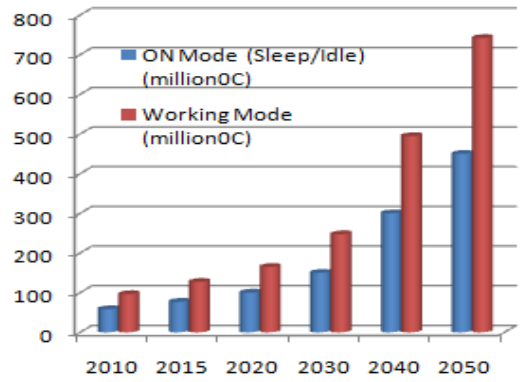

Figure 5. Heat Emissions by PC Monitors from India

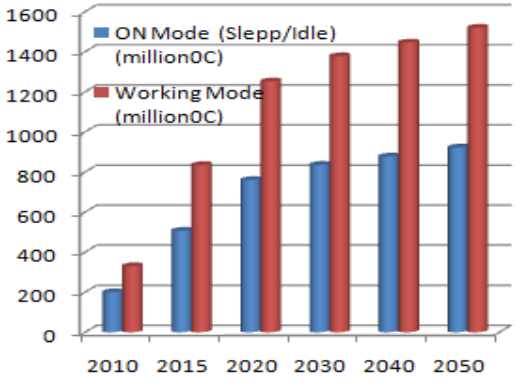

Figure 6. Heat Emissions by PC Monitors from China

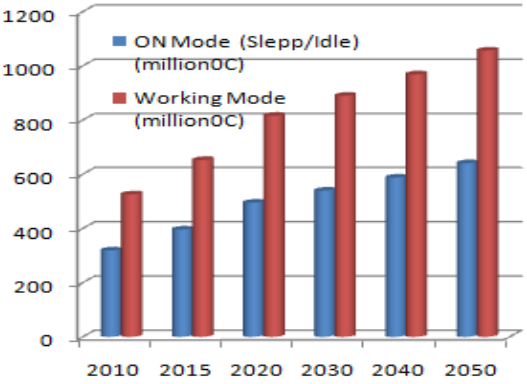

Figure 7. Heat Emissions by PC Monitors from USA

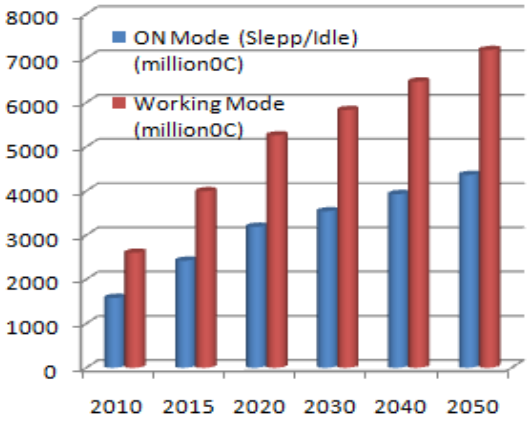

Figure 8. Heat Emissions by PC Monitors from World

Heat Emission Data Projections for India

It is seen from table 5 and figure 5 that India is expected to generate, emit approximately 58million ^{0}C, 77million ^{0}C , 100million ^{0}C, 150million ^{0}C, 300million ^{0}C and 450million ^{0}C of heat during on/sleep mode by 2010,2015,2020,2030,2040 and 2050 respectively by computer monitors which is dissipated into environment. These values will increase to 96, 127, 165, 247, 495 and 742 millions of centigrade during working mode for a duration of 60 seconds for the respective years by India due to computer monitors.

Heat Emission Data Projections for China

It is seen from table 6 and figure 6 that China is expected to generate, emit approximately 200million ^{0}C, 506million ^{0}C , 759million ^{0}C, 835million ^{0}C, 877million ^{0}C and 922million ^{0}C of heat during on/sleep mode by 2010,2015,2020,2030,2040 and 2050 respectively by computer monitors which is dissipated into environment. These values will transform to 330, 835, 1252, 1377, 1446 and 1520 millions of degrees centigrade of heat during working mode for a duration of 60 seconds for the respective years by China due to computer monitors.

It is seen that China is expected to have a drastic increase by 2015 and then have a gradual increase of number of computer monitors due to rapid industrialization.

Heat Emission Data Projections for USA

It is seen from table 7 and figure 7 that USA is expected to generate, emit approximately 319million ^{0}C, 396million ^{0}C , 495million ^{0}C, 540million ^{0}C, 588million ^{0}C and 641million ^{0}C of heat during on/sleep mode by 2010,2015,2020,2030,2040 and 2050 respectively by computer monitors which is dissipated into environment. These values will increase to 526, 653, 816, 890, 969 and 1056 millions of degrees centigrade of heat during working mode for a duration of 60 seconds for the respective years by USA due to computer monitors.

Further inference from this data is that though USA is having less population compared to India and China the heat produced due to computer monitors is large because of extensive industrialization and automation.

Heat Emission Data Projections for World

It is seen from table 8 and figure 8 that Entire world is expected to generate, emit approximately 1577million ^{0}C, 2421million ^{0}C , 3188million ^{0}C, 3538million ^{0}C, 3928million ^{0}C and 4360million ^{0}C of heat during on/sleep mode by 2010,2015,2020,2030,2040 and 2050 respectively by computer monitors which is dissipated into environment. These values will increase to 2600, 3991, 5255, 5832, 6474 and 7187 millions of degrees centigrade of heat during working mode for a duration of 60 seconds for the respective years by entire world due to computer monitors.

To understand and appreciate better in a realistic situation the following assumptions and procedure evolved.

(a) All computers and monitors are in working mode continuously for duration of 6 hours in a day.

(b) It is assumed that all the computers and monitors are in On/sleep mode for a duration of 6 hours in a day and are in Off mode for a duration of 12 hours.

(c) It works out to be approximately that each computer monitor is generating, emitting 13 degrees centigrade of heat in a day.

Table 9. Heat Emissions by PC Monitors Per Day

YEAR	INDIA (Million ^{0}C)	CHINA (Million ^{0}C)	USA (Million ^{0}C)	WORLD (Million ^{0}C)
2010	728	2496	3978	19682
2015	962	6318	4940	30212
2020	1248	9477	6175	39780
2030	1872	10426	6734	44148
2040	3744	10946	7332	49010
2050	5616	11505	7995	54405

Table 10. Heat Emissions by PC Monitors Per Year

YEAR	INDIA (Million ^{0}C)	CHINA (Million ^{0}C)	USA (Million ^{0}C)	WORLD (Million ^{0}C)
2010	265720	911040	1451970	7183930
2015	351130	2306070	1803100	11027380
2020	455520	3459105	2253875	14519700
2030	683280	3805490	2457910	16114020
2040	1366560	3995290	2676180	17888650
2050	2049840	4199325	2918175	19857825

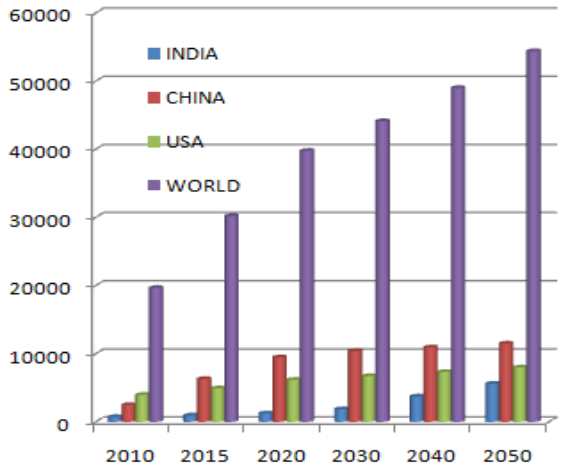

Figure 9. Heat Emissions by PC Monitors Per Day

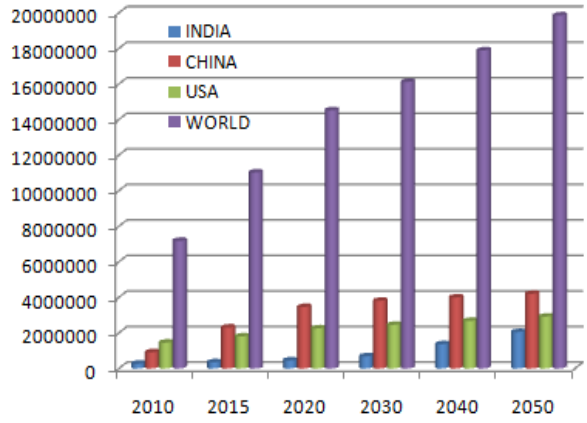

Figure 10. Heat Emissions by PC Monitors Per Year

With these conditions every computer monitor on an average generates, emits and dissipates as a heat source of 13^{0}C in a single day into environment. Though many industrialized and automated computer systems are working 24 hours in a day, but large numbers of personal computers are in off condition.

With these assumptions the calculated heat emissions by all the computer monitors put together as a single source, the values are shown in table 9/figure 9 and table 10.figure 10 for India, China, USA and the entire world for a single day and for entire single year respectively. Though the figures indicate mind boggling values of heat emission from computer monitors on yearly basis, the heat dissipation into environment over land surface for India, China, USA and entire world, in terms of ^{0}C per square meter are as shown in table.11 from 2010 to 2050 respectively. Here it is clearly understood that the heat source due to computer monitors is a distributed source over entire land surface area.

Conclusion

Rapid development and usage of electronic products in all walks of life, heat generation by computer monitors has become a great concern to entire world community. The intensity of manmade contributions to climate change and global warming has become so clear and it is now recognised as the most important factor which is affecting global climate in many ways.

Under present trends, by 2030, maize production in Southern Africa could decrease by up to 30% while rice, millet and maize in South Asia could decrease by up to 10%.[30] By 2080, yields in developing countries could decrease by 10% to 25% on average while India could see a drop of 30% to 40%[31]. By 2100, while the population of three billion is expected to double, rice and maize yields in the tropics are expected to decrease by 20–40% because of higher temperatures without accounting for the decrease in yields as a result of soil moisture and water supplies stressed by rising temperatures [32].

Future warming of around 3 °C (by 2100, relative to 1990–2000) could result in increased crop yields in mid- and high-latitude areas, but in low-latitude areas, yields could decline, increasing the risk of malnutrition [33]. A similar regional pattern of net benefits and costs could occur for economic (market-sector) effects [34]. Warming above 3 °C could result in crop yields falling in temperate regions, leading to a reduction in global food production [35].

This research work was undertaken to determine the heat contributions from cellular mobiles towards global warming and further to climate change. A 4 decimal digit digital temperature measurement device was designed and fabricated successfully using efficient ATMEL microcontroller ATMEGA-8L, which has 10 bit Analog to Digital converter and LM 35 temperature sensor. A printed circuit board was designed using AUTOCAD software and print it over by means of screen printing process

Measurements carried out in a air locked laboratory and using a air locked container as shown in figure 4. Exact heat emission was determined after subtracting background every time for each mode of operation. Every computer monitor is generating and dissipating 13^{0}C in a single day.

Table 11. Yearly temperature rise due to monitors

YEAR	INDIA (°C) Sq km	CHINA (°C) Sq km	USA (°C) Sq km	WORLD (°C) Sq km
2010	80833	94930	147758	14084
2015	106815	240291	183490	21619
2020	138571	360437	229362	28465
2030	207856	396530	250126	31591
2040	415713	416307	272338	35070
2050	623570	437568	296964	38931

Considering all computer monitors heat sources as a single source the heat dissipated is enormous into environment as shown in the tables and figures discussed above. This is manmade heat source which is distributed all over the world. Due to this considering total surface area of India, China, USA and the world[29] the temperature contributed and created is also determined which presumably gives the global warming value as shown in table 11. Heat rise values are less for world due to entire land and water surface of the earth is taken into consideration for calculating.

Temperature changes vary over the globe. Since 1979, land temperatures have increased about twice as fast as ocean temperatures (0.25 °C per decade against 0.13 °C per decade) [36]. This is basically due to more and quick evaporation over sea surface.

It is observed from the table 11 that in the year 2010, India, China, USA contribute temperature increase of 80833^{0}C, 94930^{0}C, and 147758^{0}C per square kilometre over land surface[29] respectively due to computer monitors. Entire world will contribute in 2010 a temperature increase of 14058^{0}C per square kilometre including water surface. The yearly

temperature contribution due to computer monitors for 2015, 2020, 2030, 2040 and 2050 are as shown in table 11. This yearly contribution is the added temperature of all computer monitors of their daily generated heat.

For further accurate near realistic global temperature increase, considering entire surface area of earth including water surface (510,072,000 Sq km), the distributed heat rise at any given time on any of the day is 38.59^0C, 59.23^0C, 77.99^0C, 86.55^0C, 96.08^0C and 106.66^0C per square kilometre for 2010, 2015, 2020, 2030, 2040 and 2050 respectively. This is more so because all the computer monitor are continuously generating, emitting and releasing heat into environment.. These are the realistic values of temperature rise contributed by computer monitors globally for climate change.

It can be concluded that these are the additions to global temperature increase in recent times is the heat generated, created and disipated into environment continuously on all days by the computer monitors and their contribution to global climate change.

Current data suggest that we need to reduce heat generation, emission and dissipation into environmental for sustainability and safety over the years in a phased manner. All the players, consumer electronics industry, Government, Non Governmental Organizations (NGO's) Academic institutes and consumers have to accept the facts and dangers to environment and society from the heat generation by computer monitors for combined efforts to reduce the heat emission.

It may not be very easy to convince in the beginning but slowly researchers, designers and users have to come up with solutions for the cause of environment and society to safeguard the future. The data from the experiments is a way forward for clear and precise response from across the world and for all players of consumer electronics industry to resolve the growing crisis of heat from computer monitors. The world needs specific and dedicated regulatory mechanism for which following points are required to be driven for environmental sustainability.

(a) Consumer Electronics Manufacturers have to accept the hazards to environment leaving the desire for large profits alone and initiate steps for Research and Design using less heat generating materials.

(b) Consumers also have to compromise on performance factor.

(c) A strong standard legislation is required to be imposed on all concerned agencies.

(d) Discipline and ethics of all concerned and cooperation goes a long way in ensuring environmental heat control for climate change.

Future Scope

Future scope exists for further research for identification and monitor manmade heat sources contribution and to control them for global environmental safety and sustainability.

References

[1] Ameraca,z Climate Choicez . Washington, D.C.: The National Academies Press. 2011. p. 15. ISBN 978-0-309-14585-5. "The average temperature of the Earth's surface increased by about 1.4 °F (0.8 °C) over the past 100 years, with about 1.0 °F (0.6 °C) of this warming occurring over just the past three decades"

[2] IPCC, Synthesis Report Summary for Policymakers, Section 1: Observed Changes in climate and their effects in IPCC AR4 SYR 2007.

[3] Glossary-climate change,.*Education Center – Arctic Climatology and Meteorology*. NSIDC National Snow and Ice Data Center.; Glossary, in IPCC TAR WG1 ,2001.

[4] Trenberth *et al.*, Ch.3. Observations : Atmospheric Surface and Climate Change, Section 3.2.2.2: Urban Heat Islands and Land Use Effects. P.244 in IPCC AR4 WGI 2007.

[5] Jansen *et al.*, Ch.6. Palaeoclimate. Section 6.6.1.1 : What Do reconstructions based on palaeoclimate proxies Show, pp.466-478 in IPCC AR4 WGI 2007.

[6] Brohan, P., J.J. Kennedy, I. Harris, S.F.B. Tett, P.D. Jones (2006). "Uncertainty estimates in regional and global observed temperature changes: a new dataset from 1850". *J. Geophys. Res.* 111: D12106.

[7] Cole, Steve; Leslie McCarthy. "NASA-NASA Research Finds 2010 Tied for Warmest Year on Record " (Feature). *NASA*. Retrieved 3 March 2011.

[8] Hansen James E : *et al.* (12 January 2006). "Goddard Institute for Space Studies, GISS Surface Temperature Analysis". NASA Goddard Institute for Space Studies. Retrieved 17 January 2007.

[9] "State of the Climate: Global Analysis for Annual 2009". 15 January 2010. Retrieved 3 May 2011.

[10] World Meteorological Organization (2011), *WMO statement on the status of the global climate in 2010*, World Meteorological Organization (WMO)

[11] Kennedy, J.J., *et al.* (2010), "How do we know the world has warmed? in: 2. Global Climate, in: State of the Climate in 2009", *Bull.Amer.Meteor.Soc.* 91 (7): 26

[12] Kennedy, C. (10 July 2012), *ClimateWatch Magazine >> State of the Climate: 2011 Global Sea Level*, NOAA Climate Services Portal

[13] "Summary for Policymakers", Direct Observations of Recent Climate Change, in IPCC AR4 WG1 2007

[14] "Summary for Policymakers", B. Current knowledge about observed impacts of climate change on the natural and human environment, in IPCC AR4 WG2 2007

[15] Rosenzweig, C., *et al.*, "Ch 1: Assessment of Observed Changes and Responses in Natural and Managed Systems", Sec 1.3.5.1 Changes in phenology, in IPCC AR4 WG2 2007, p. 99.

[16] IPCC, Synthesis Report, Section 1.1: Observations of climate change, in IPCC AR4 SYR 2007.

[17] IPCC, Synthesis Report, Treatment of Uncertainty, in IPCC AR4 SYR 2007.

[18] IPCC, Synthesis Report, Section 2.4: Attribution of climate change, in IPCC AR4 SYR 2007.

[19] America's Climate Choices: Panel on Advancing the Science of Climate Change; National Research Council (2010). *Advancing the Science of Climate Change*. Washington, D.C.: The National Academies Press. ISBN 0-309-14588-0. "(p1,p21-22).

[20] "Joint Science Academies' Statement" (PDF). Retrieved 9 August 2010

[21] "World Bank Census ", data.worldbank.org

[22] www.China-profile.com/data/fig_pop_wpp2006.htm

[23] www.pewsocialtrends.org/us-population-projections-2005-2050.

[24] List of countries by population-Wikipedia, the free encyclopedia.

[25] www.worldometers.info/world-population.

[26] www.Census.gov/main/www/popclock.html.

[27] United Nations-Dept of Economic & social affairs, www.un.org.

[28] http://www.c-i-a.com/methodology.htm

[29] K Parandham et al./Elixir Elec. Engg. 62(2013)17587-17593.

[30] Lobell, David; Burke, Tebaldi, Mastrandrea, Falcon, Naylor (2008). "Prioritizing climate change adaptation needs for food security in 2030". *Science* **319** (5863): 607–10. doi:10.1126/science.1152339. PMID 18239122. Retrieved 13 April 2012.
[31] "Global warming and agriculture". International Monetary Fund. March 2008. Retrieved 5 May 2012.
[32] Battisti, David; Naylor (2009). "Historical warnings of future food insecurity with unprecedented seasonal heat". *Science* **323** (5911): 240–4. doi:10.1126/science.1164363. PMID 19131626. Retrieved 13 April 2012.
[33] Schneider *et al.*, Chapter 19: Assessing Key Vulnerabilities and the Risk from Climate Change, Section 19.3.3: Regional vulnerabilities, in IPCC AR4 WG2 2007.
[34] Schneider *et al.*, Chapter 19: Assessing Key Vulnerabilities and the Risk from Climate Change, Table 19.1, in IPCC AR4 WG2 2007
[35] Schneider *et al.*, Chapter 19: Assessing Key Vulnerabilities and the Risk from Climate Change, Section 19.3.2.1: Agriculture, in IPCC AR4 WG2 2007.
[36] Trenberth *et al.*, Chap 3, Observations: Atmospheric Surface and Climate Change, Executive Summary, p. 237, in IPCC AR4 WG1 2007

Author's Information

K Prandham Gowd obtained his B.Tech in Electronics and Communication Engineering with distinction from S.V.University, Tirupati and ME with specialization in Microwaves and Radar from IIT, Roorkee. In 1994 he has conducted Stealth Aircraft (RCS Reduction) experiments on coated (by pasting of absorber sheets) and uncoated scaled models of aircraft which is **first time in India** at IIT Roorkee. He has **49** research publications and **05** Technical reports to his credit most of them on RCS/RCS Reduction/Stealth Technology. He has one copyright to his credit on Dynamic RCS Range Validation Procedure from Govt of India. He is a Life Member of All India Management Association (AIMA), AeSI and Fellow of IETE. He had authored a book on Stealth Aircraft Technology in Hindi and English. Param1959@yahoo.co.in

Dr R P Gupta is PhD, ME &MBA. He has 37 years of experience in Industrial Research & Development; Production; Quality Management; ISO Certification in Indian telephone Industries and Optel Communications Ltd;Bhopal. Since 2003 he is associated with Engineering colleges in the capacity of Principal/Director in BITS, Globus Engg College, RGPM, Surabhi college of Engineering and Scope College Bhopal. Presently he is life member of nine societies. His area of interests are Satellite communication, Nanotechnology and book writing. Presently he is Chairman IETE Centre (MP &CG), Bhopal and Director Development at Radharaman Group of Institutions, Bhopal.