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

Electrical Engineering

Elixir Elec. Engg. 62 (2013) 17587-17593

ISSN: 2229-712X

Present and future threats to global climate due to cellular mobiles heat emission

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ARTICLE INFO

Article history:
Received: 15 July 2013;
Received in revised form:
20 August 2013;
Accepted: 2 September 2013;

Keywords
Cellular Mobiles,
Electronic,
Information and Communication Technology (EICT) products,
Wireless Technology,
Heat Emission.

ABSTRACT

Over the last three decades of the 20th century, gross domestic product per capita, exponential growth in mobile technology and population growth were the main drivers of increases in global warming and climate change. Industrial revolution and electronics, information and communication technology products have altered the landscape of modern society in countless ways, in office, at home and on mobility. However, they have created and added a new source of heat generation and emission into environment due to consumer electronics products. In spite of recent studies indicating possible threats to global climate, there is no long term data available on the amount of heat generated, emitted and dissipated into environment by cell phones. The aim of this research work is to experimentally measure the heat generated by cell phones during on(sleep/Idle) mode, Rx and Tx modes. The experiments were conducted using specially fabricated four decimal digit temperature measurement test instrument. Population and cell phones 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 cellular mobiles at present and projections for 2050.

Introduction

Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. It may be a change in average weather conditions, or in the distribution of weather around the average conditions. Climate change is caused by factors that include oceanic processes, biotic processes, and variations in solar radiation received by Earth, plate tectonics and volcanic eruptions and human-induced alterations of the natural world. Man made effects is currently causing global warming and climate change is often used to describe human-specific impacts.

On the broadest scale, the rate at which energy is received from the sun and the rate at which it is lost to space determine the equilibrium temperature and climate of Earth. This energy is distributed around the globe by winds, ocean currents, and other mechanisms to affect the climates of different regions. 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 [1].

The galloping developments in the field of wireless technology products in the last two decades have increased the modern human involvement, its related ecological, biological and physical systems resulting in various undesirable and unintentional negative impacts 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 wireless technologies. The heat generation pervading the global climate is now increasingly realised and this has added to a new source to the list of heat generating sources into the environment.

The term sometimes is used to refer specifically to climate change caused by human activity, as opposed to changes in climate that may have resulted as part of Earth's natural processes [2]. In this sense, especially in the context of environmental policy, the term *climate change* has become synonymous with anthropogenic global warming. Within scientific journals, *global warming* refers to surface temperature increases while *climate change* includes global warming and everything else that increasing greenhouse gas levels will affect [3].

Factors that can shape climate are called climate forcing or "forcing mechanisms. These include processes such as variations in solar radiation, variations in the Earth's orbit, mountain-building and continental drift and changes in greenhouse gas concentrations. Forcing mechanisms can be either "internal" or "external". Internal forcing mechanisms are natural processes within the climate system itself (e.g., the thermohaline circulation). External forcing mechanisms can be either natural (e.g., changes in solar output) or anthropogenic (e.g., increased emissions of greenhouse gases).

Evidence for climatic change is taken from a variety of sources that can be used to reconstruct past climates. Reasonably complete global records of surface temperature are available beginning from the mid-late 19th century. For earlier periods, most of the evidence is indirect. Climatic changes are inferred from changes in proxies, indicators that reflect climate, such as vegetation, ice cores[4], dendrochronology, sea level change and glacial geology.

Brief Historical Background

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

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the Central England temperature data series, that starts in 1659. The longest-running quasi-global record starts in 1850 [5].

The United States National Oceanic and Atmospheric Administration (NOAA) maintain the Global Historical Climatology Network (GHCN-Monthly) data base contains historical temperature, precipitation, and pressure data for thousands of land stations worldwide [6]. Also, NOAA's National Climatic Data Centre (NCDC), which has "the world's largest active archive [7] of surface temperature measurements, maintains a global temperature record since 1880 [8].

Land and sea measurements independently show much the same warming since 1860[9]. The data from these stations show an average surface temperature increase of about 0.74 °C during the last 100 years. The Intergovernmental Panel on Climate Change (IPCC) stated in its Fourth Assessment Report (AR4) that the temperature rise over the 100 year period from 1906–2005 was 0.74 °C [0.56 to 0.92 °C] with a confidence interval of 90%[10]. For the last 50 years, the linear warming trend has been 0.13 °C [0.10 to 0.16 °C] per decade according to AR4 [10].

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.

Necessity

Every year, hundreds of thousands of new cell phones are introduced into market. Mobile telecom 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 climate change. Mobile telephony is growing exponentially in India and across the world. At present there are about 800 million mobile subscribers in India and over 4.03 billion in the world

The population projections for India , China, USA and the entire world [12]-[18] are as shown in the table.1 below till 2050[20].

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 cell phone numbers and their estimated projections for India, China, USA and the entire world [19] for 2050 are as shown in the table below.

Table 2. Cell phones projections for 2050.

Country	2020 Cell Phones (Millions)	2030 Cell Phones (Millions)	2040 Cell Phones (Millions)	2050 Cell Phones (Millions)
India	994.5	1460	1178	1242
China	1071.8	1454	1045	1003
USA	338	365	408	456
World	6873	7656	8526	9222

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.

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.

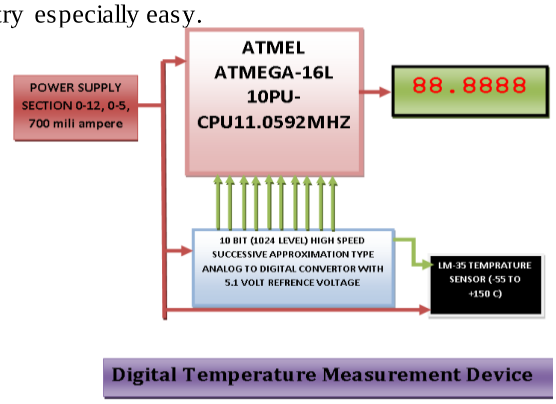

Figure 1:- Block Diagram of Digital Temperature Measurement Device

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

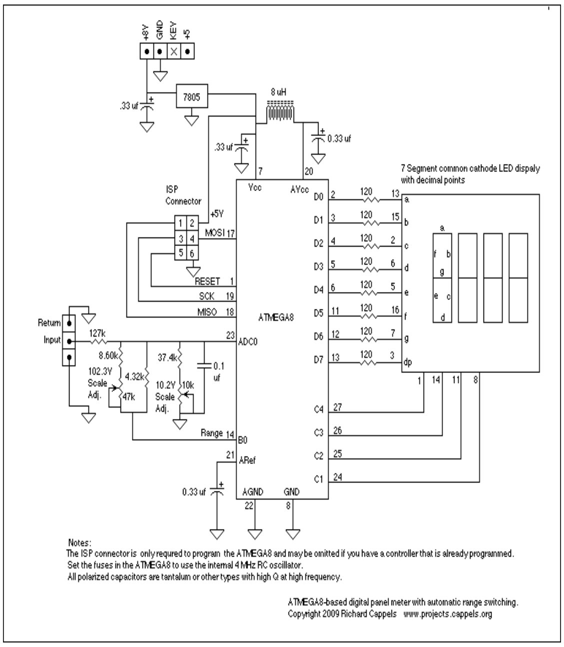

Figure 2:- Circuit Diagram of Digital Temperature Measurement Device

A printed circuit board was designed using AUTOCAD software 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.

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

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

(a) On (Sleep/Idle) mode of operation.
(b) Receive (Ringing) mode of operation for duration of 30 seconds.
(c) Transmit mode of operation for duration of 30 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 2.
(c) Switch on the device and measure the background temperature inside the container after reading becomes constant.
(d) Place the mobile gently with switched on condition on the sensor inside the container (On mode).
(e) Measure the temperature after reading on the display becomes constant.
(f) Remove the mobile and measure the background temperature.
(g) Place the mobile gently on the sensor when the mobile is in receiving (ringing) condition (receive mode).
(h) Measure the temperature after mobile stops ringing and note the reading.
(i) Remove the mobile and measure the background temperature after reading becomes constant on the display.
(j) Place the mobile gently on the sensor when the mobile is in transmitting condition (transmit mode).
(k) Measure the temperature after the mobile stops transmitting.
(l) Change the mobile model and repeat the above steps.
(m) Tabulate the collected temperature data for further analysis.
(n) Subtract the background value from measured values of on, transmit and receive modes every time for each mobile.

Table 4 – Measured Temperature Values of Cellular Mobiles in Different Modes

Make/ Model	On mode (Sleep / Idle) ^{0}C	Rx mode ^{0}C	Tx mode ^{0}C
Nokia 6630	1.0518	00.5021	00.6256
Samsung SDH C1401	00.6890	00.4651	00.5106
Nokia C2	00.7932	00.2932	00.2943
Carbon K-157	01.2898	00.3488	00.4222
KECHAD – K9+	01.4006	00.3906	00.4106
Beetal GD218	01.3915	00.4281	00.2629
LG - RD3450	01.0519	00.2629	00.3919
Nokia 100	00.4006	00.3906	00.4106
Intex Smart	00.2629	00.6065	00.8375
Nokia X5	01.0320	00.2326	00.2740
Samsung	00.7890	00.5106	00.7890
Nokia 5800	00.5006	00.5020	00.5444
GT-1205T	00.2945	00.2290	00.3622
Zen M-72	00.5572	00.4693	00.6686
Vell com M2	00.5572	00.5572	00.2942
Nokia 1200	00.5262	00.5088	00.4426
Videocon V-1670	00.5992	00.0733	00.9899
Nokia 2600	008799	00.2855	00.2920
Nokia C6	00.9992	00.2619	00.2834
VOX - V9500	01.0517	00.4425	00.5415
Nokia E-63	00.5260	00.3357	00.4219
Samsung M-5650	01.3147	00.4660	00.5444
Nokia 5030	00.7901	00.1300	00.2586
Intex 4470-IW	01.0017	00.2916	00.3259
Forme C606	00.3138	00.2628	00.3925
MAXX MQ340	01.0002	00.2465	00.1185
LG KP 500	01.0003	00.2700	00.3039
FCXCE 0682	00.5258	00.2806	00.3145
Vell-com M2	00.6560	00.8130	00.3330
Kovitra K340	01.2898	00.3488	00.4222
Average	0.7843	0.3737	0.4360

Figure 3:- Photo of Experimental Setup

Results, Analysis and Discussion

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 cell phones projections for 2050 for India, China, USA and the entire world. In this research work for calculating cell phones projections for India, China, USA and the world for 2050, it is assumed that 74.71%, 75.32, 103.9% and 87% of respective countries population will be owning the cell phone connectivity. It is seen that 154% of Russian population will be having cell phone connectivity, though not included in this research work.

From the experimental data it is seen from the table 4 where mobile models used as samples are also shown, that every cellular mobile on an average emits 0.7843^{0}C during on(sleep/idle) mode. It was observed that this becomes constant after 7 minutes of switching on after which there is no increase in the temperature. It is also observed that cellular mobile on an average emits 0.3737^{0}C in receive (Ringing) mode and 0.463^{0}C during transmit mode which is recorded for 30 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 small cellular mobile 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

YEAR	INDIA		
	ON MODE (Million℃) (SLEEP/IDLE)	TX MODE (Million℃)	RX MODE (Million℃)
2013	712.144	395.888	339.319
2020	779.986	433.602	371.644
2030	858.808	477.42	409.2015
2040	923.905	513.608	440.218
2050	974.101	514.512	464.135

Table 6: Heat Emissions by Cellular Mobiles From China

YEAR	CHINA		
	ON MODE (Million℃) (SLEEP/IDLE)	TX MODE (Million℃)	RX MODE (million°C)
2013	820.378	456.056	390.89
2020	840.613	467.305	400.532
2030	866.6515	481.78	412.9385
2040	819.593	455.62	390.516
2050	786.65	437.31	374.82

Table 7: Heat Emissions by Cellular Mobiles From USA

YEAR	USA		
	ON MODE (Million°C) (SLEEP/IDLE)	TX MODE (Million°C)	RX MODE (Million°C)
2013	247.839	137.776	118.089
2020	265.093	147.368	126.311
2030	283.1323	157.396	134.9057
2040	319.99	177.888	152.47
2050	357.65	198.816	170.407

Table 8: Heat Emissions by Cellular Mobiles From World

YEAR	WORLD		
	ON MODE (Million°C) (SLEEP/IDLE)	TX MODE (Million℃)	RX MODE (Million°C)
2013	4706	2616	2242
2020	5390.49	2996.63	2568.44
2030	6004.601	3338.02	2861.047
2040	6686.94	3717.34	3186.17
2050	7232.81	4020.79	3446.26

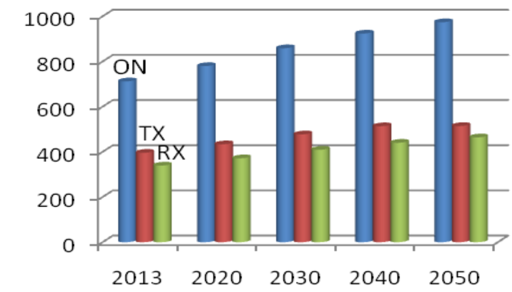

Figure-4 Heat Emissions by Cellular Mobiles from India

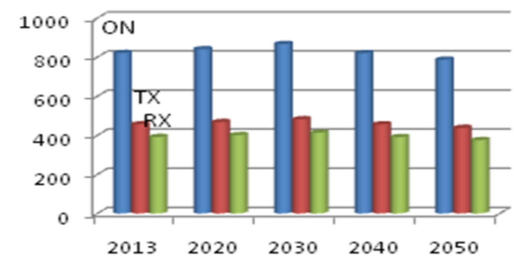

Figure-5 Heat Emissions by Cellular Mobiles from China

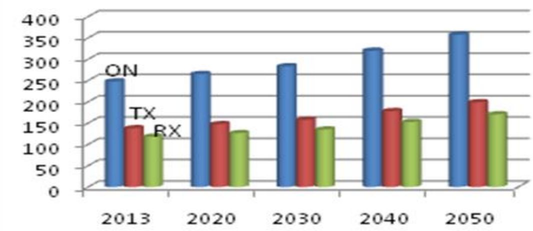

Figure-6 Heat Emissions by Cellular Mobiles from USA

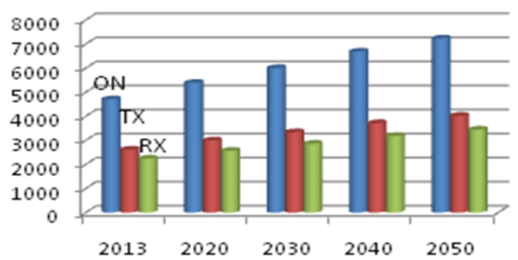

Figure-7 Heat Emissions by Cellular Mobiles from World

Heat Emission Data Projections for India.

It is seen from table 5 and figure 4 that India is expected to generate, emit approximately 712million^{0}C, 396million^{0}C and 339million^{0}C during on, transmit and receive modes respectively in 2013 by cellular mobiles which is dissipated into environment. These values will increase to 859million^{0}C, 477 million^{0}C and 409million^{0}C by 2030. These values will further increase to 974million^{0}C, 515million^{0}C and 464million^{0}C during on, transmit and receive modes respectively by 2050.

Further inference from this data is that when India is asleep, it will generate and emit 712million^{0}C, 859million^{0}C and 974million^{0}C heat during 2013, 2030 and 2050 respectively which is dissipated into environment. These are the minimum values since experimentally measured for first seven minutes after which it is assumed to remain constant. Transmit and receive values determined are for 30 seconds duration.

Heat Emission Data Projections for China

It is seen from table 6 and figure 5 that China is expected to generate, emit approximately 820million^{0}C, 456million^{0}C and 391million^{0}C during on, transmit and receive modes respectively in 2013 by cellular mobiles which is dissipated into environment. These values will increase to 867million^{0}C, 482million^{0}C and 413million^{0}C by 2030. These values will further decrease to 787million^{0}C, 437million^{0}C and 375million^{0}C during on, transmit and receive modes respectively by 2050.

Further inference from this data is that when China is asleep, it will generate and emit 820million^{0}C, 867million^{0}C and 787million^{0}C heat during 2013, 2030 and 2050 respectively which is dissipated into environment. These are the minimum values since experimentally measured for first seven minutes after which it is assumed to remain constant. Transmit and receive values determined are for 30 seconds duration.

Heat Emission Data Projections for USA

It is seen from table 7 and figure 6 that USA is expected to generate, emit approximately 248million^{0}C, 138million^{0}C and 118million^{0}C during on, transmit and receive modes respectively in 2013 by cellular mobiles which is dissipated into environment. These values will increase to 283million^{0}C, 157million^{0}C and 135million^{0}C by 2030. These values will further decrease to 358million^{0}C, 199million^{0}C and 170million^{0}C during on, transmit and receive modes respectively by 2050.

Further inference from this data is that when USA is asleep, it will generate and emit 248million^{0}C, 283million^{0}C and 358million^{0}C heat during 2013, 2030 and 2050 respectively which is dissipated into environment. These are the minimum values since experimentally measured for first seven minutes after which it is assumed to remain constant. Transmit and receive values determined are for 30 seconds duration.

Heat Emission Data Projections for World

It is seen from table 8 and figure 6 that entire world is expected to generate, emit approximately 4706million^{0}C, 2616million^{0}C and 2242million^{0}C during on, transmit and receive modes respectively in 2013 by cellular mobiles which is dissipated into environment. These values will increase to 6005million^{0}C, 3338million^{0}C and 2681million^{0}C by 2030. These values will further increase to 7233million^{0}C, 4021million^{0}C and 3446million^{0}C during on, transmit and receive modes respectively by 2050.

Further inference from this data is that when entire world is asleep, it will generate and emit 4706million^{0}C, 6005million^{0}C and 7233million^{0}C heat during 2013, 2030 and 2050 respectively which is dissipated into environment. These are the minimum values since experimentally measured for first seven minutes after which it is assumed to remain constant. Transmit and receive values determined are for 30 seconds duration.

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

(a) Transmit and receive modes average is taken for mobile usage.

(b) It is assumed that 50% mobiles are in transmit mode and 50% are in receive mode for 18 hours in a day.

(c) On mode values obtained for 7 minutes is assumed to be constant for 6 hours where users are in sleep mode.

Table 9:- Heat Emissions by Mobiles Per Day

YEAR	INDIA (Million°C)	CHINA (Million°C)	USA (Million°C)	WORLD (Million°C)
2013	7336	8443	2552	48428
2020	8034	8644	2722	55476
2030	8833	8922	2911	61792
2040	9510	8443	3299	68814
2050	9785	8095	3688	74436

Table10:- Heat Emissions by Mobiles Per Year

YEAR	INDIA (Million°C)	CHINA (Million°C)	USA (Million°C)	WORLD (Million°C)
2013	2677640	3081695	931480	17676220
2020	2932410	3155060	969032	20248740
2030	3224045	3256530	1062515	22554080
2040	3471150	3081695	1204135	25117110
2050	3571525	2954675	1346120	27169140

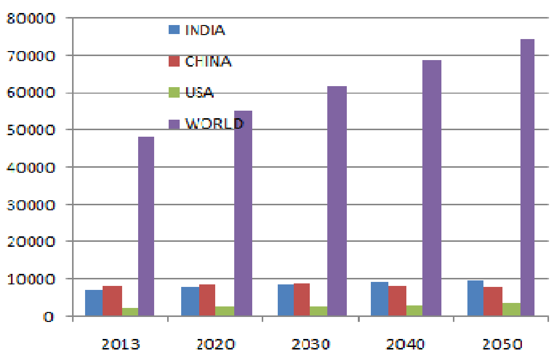

Figure 8:- Heat Emissions by Mobiles Per Day

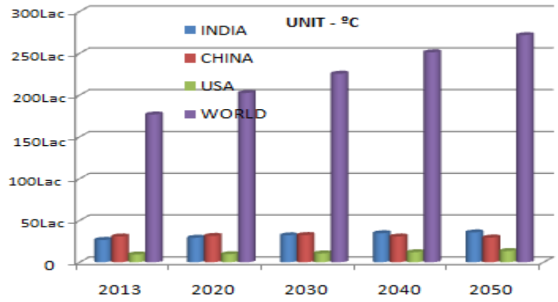

Figure 9:- Heat Emissions by Mobiles Per Year

With these conditions every mobile on an average generates, emits and dissipates as a heat source of 8.0765^{0}C in a single day into environment.

With these assumptions the calculated heat emissions by all mobiles put together as a single source, the values are shown in table 9/figure 8 and table 10.figure 9 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 mobiles on yearly basis, the cumulative heat dissipation into environment over land surface for India, China, USA and entire world, in terms of million ^{0}C per square meter are as shown in table.11 from 2013 to 2050 respectively. Here it is clearly understood that the heat source due to mobiles 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 cellular mobiles 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 different ways.

Climate change means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

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 3. Exact heat emission was determined after subtracting background every time for each mode of operation. Every mobile is generating and dissipating 8.0765^{0}C in a single day.

Table.11 yearly temperature rise due to mobiles

YEAR	INDIA (Million°C) Sq km	CHINA (Million°C) Sq km	USA (Million°C) Sq km	WORLD (Million°C) sq km
2013	0.8146	0.3211	0.0948	0.1192
2020	0.8921	0.3288	0.0986	0.1365
2030	0.9808	0.3393	0.1081	0.1521
2040	1.0559	0.3211	0.1225	0.1694
2050	1.0865	0.3079	0.137	0.1832

Considering all mobile 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[21] the temperature contributed and created is also determined which presumably gives the global warming value as shown in table 11.

It is observed from the table 11 that currently in the year 2013, India, China, USA and world contribute cumulative temperature increase of 0.8146million^{0}C, 0.3211million^{0}C, 0.0948million^{0}C and 0.1192million^{0}C per square kilometre over land surface area respectively. The increase and contribution due to cellular mobiles for 2020, 2030, 2040 and 2050 are as shown in table 11.

For further accurate near realistic global temperature increase, considering entire surface area of earth including water surface, the distributed cumulative heat rise is 0.0347million^{0}C, 0.0397million^{0}C, 0.0422million^{0}C, 0.0492million^{0}C and 0.0533million^{0}C per square kilometre for 2013, 2020, 2030, 2040 and 2050 respectively. This is more so because all the mobiles are continuously working in one of the three modes such as On(sleep/Idle), receive and transmit modes. These are the realistic values of temperature rise contributed by cellular mobiles globally for climate change.

From the table 9 it can be determined that heat rise (addition) distributed over a square kilometre area of globe which is continuously maintained throughout the day with respect to total surface area of the earth(510,072,000 Sq km), works out to be 95^{0}C/Sq km in 2013, 109^{0}C/Sq km in 2020, 121^{0}C/Sq km in 2030, 135^{0}C/Sq km in 2040 and 146^{0}C/Sq km in 2050. It can be concluded that these are the additions to global temperature increase in recent times is the heat generated and created by the mobiles 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 cellular mobiles 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 cellular mobiles. 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.

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