

## Determination of Invisible Environmental Pollution Due to Cell Phones EMF Radiation and projections for 2030

K. PARANDHAM GOWD, R.P. GUPTA and SANGEETA JAUHARI

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

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### ABSTRACT

In the last decades cell phones usage have altered the land scape of modern human beings in countless ways, in office, at home and on mobility. However, created the environmental electronic pollution due to electromagnetic fields. In spite of the recent studies indicating possible harmful impact of EMF pollution on several species, there is no long term data available on the environmental impacts of EMF pollution and how much power density is radiated in the environment due to cell phones. The aim of this research work is to experimentally measure the EMF radiated electronic pollution levels of cell phones in three different states such as on(sleep/idle) mode, receive and transmit modes as an invisible environmental pollution. These measurements are carried out at the centre frequency of 1800 MHz and in the 300 MHz- 50 GHz frequency band. Another main aim is to carry out the projections of cell phones growth due to exponentially expanding mobile technology products, industrialization along with urbanization. Further to estimate the current (2013) EMF radiation pollution levels into environment and projections for 2030 due to cell phones.

**Key words:** Electromagnetic Field (EMF) Radiation; Radiation Survey meter; probe ; Mobile Telephony ; Environmental EMF exposures ; Electronic pollution

### INTRODUCTION

Current world environment is increasingly getting polluted with a new entrant called Electronic pollution which is invisible. Extraordinary developments in various fields of science and technology in last few decades have increased the human involvement deeply into the natural environment, its related ecological, biological and physical systems resulting in various undesirable and unintentional negative impacts on human health and environment. Rapid development and usage of electronic products in all walks of life, electronic pollution into environment has become a great concern to entire world community. In this electro-magnetic pollution has assumed prominent importance which is in limelight in recent times for all negative reasons. The intensity of manmade electromagnetic radiation has become so ubiquitous and it is now increasingly recognised as a form of invisible and insidious environmental

pollution which is affecting environment and human health alike in different ways<sup>1</sup>.

Electromagnetic radiations are not easily recognised and detectable, However their impacts are being felt on human health hazards such as blood barrier resulting in neuronal damage, risk to children/pregnant women, DNA damage, skin problems, ringxiety including ear damage, cause for tumour in the eye, sleep disorders, headaches, increase in cancer causes which have been attributed by World health Organization(WHO) and other researchers. WHO has conducted study in 13 countries has reported 5117 brain tumour cases<sup>2-4</sup>. Professor Girish Kumar of IIT, Bombay has in his research quoted saying there are 200 research papers contributing to effects of EMF radiation to human health problems<sup>5-6</sup>. The impact of EMF radiation on environment further escalates on forests, birds, bees and wildlife<sup>5</sup> and<sup>7</sup>. The cello phone operators association and government of

India reject these allegations due to lack of evidence.

Thus the conflict among designers, manufacturers, corporate, distributors, government and consumers need to be controlled and resolved. In such a situation there is a great demand for determination of quantum of invisible EMF radiation into environment and society.

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. 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<sup>8</sup>, China<sup>9</sup>, USA<sup>10</sup> and the entire world<sup>11-14</sup> are as shown in the table.1 below till 2030.

Due this exponential growth of population, urbanization, consumer electronics products concern for environment and human health hazards is growing through out the world. There is a great need to know what are the current EMF emissions into environment and for 2030 by cell phones. Hence, measurement and estimation of invisible EMF emissions into environment and society are required to be determined through experiments.

### EXPERIMENTAL

In spite of the recent studies indicating possible harmful impact of EMF on several species, there are no long-term data available on the environmental impacts of EMF radiations as of now. Studies on impact of cell phones and cell phone towers and EMF radiations on birds and other wildlife are almost non-existent in India. Moreover pollution from invisible EMF radiations being a relatively new environmental issue. In this research work EMF radiations of 6 randomly selected cell phones and their EMF emissions were measured on; on, receiving and transmitting modes.

For this research work Narda 8718 B Radiation Survey Meter was used. These 8700 series EMF measurement system offers a very broad selection of probes. 8700D series probe has a quick release, eight pin connector that allows the probe to attach directly to 8718B Radiation Survey meter and hence it was used. The 8718 B Radiation Survey meter can store up to 6 probes. The procedure illustrated in Narda EM Radiation Survey Meter 8718B was followed<sup>16-17</sup> in measuring the direct digital readings for selected seven mobiles in three conditions, i.e.; ON, Receiving and Transmitting conditions. The auto-zeroing with internal calibration and spatial averaging facility of this Radiation Survey meter were utilized for this research work. The Narda 8718 B radiation Survey meter and 8700 D antenna probe are as shown in figure 1. Below.

The following salient features and steps were followed in the research work for EMF emissions measurement.

- (a) Connecting the antenna probe 8710 D with the Radiation Survey Meter.
- (b) Placing the probe inside the radiation free storage case.
- (c) Switching on the meter.
- (d) Selecting the exact probe model from the list of probes.
- (e) Selecting the test frequency.
- (f) Auto zeroing with inbuilt features of the meter.
- (g) Reading the back ground EMF level.
- (h) Measure the EMF levels in different modes (on/Tx/Rx) placing different models of mobiles at the same distance from the probe.
- (i) Subtracting the back ground levels from the respective readings.
- (j) Tabulating the EMF data according to the modes and the models.

### RESULTS AND DISCUSSION

The EMF radiation levels of 6 randomly selected cell phones were experimentally measured using Narda Radiation Survey meter 8718 B along with probe 8700D. The EMF levels were determined under three specific conditions on cell phones, namely ON, Receiving and Transmitting conditions. These measurements were carried out at centre frequencies of 800 MHz, 1800

**Table 1: Population projections for 2030**

Country	2012 Population (Billions)	2020 Population (Billions)	2030 Population (Billions)
India	1.240	1.326	1.460
China	1.339	1.423	1.454
USA	0.304	0.325	0.351
World	7.060	7.900	8.800

**Table 2: Cell phones projections for 2030**

Country	2012 Population (Millions)	2020 Population (Millions)	2030 Population (Millions)
India	908	994.5	1095
China	1046	1071.8	1105
USA	316	338	361
World	6000	6873	7656

**Table 3: Average EMF radiation of a cell phone**

Frequency	Average Rad Power Density- On mode (w/m <sup>2</sup> )	Average Rad Power Density- Rx mode (w/m <sup>2</sup> )	Average Rad Power Density-Tx mode (w/m <sup>2</sup> )
1800 MHz	0.08	3.198	3.354
300 MHz – 50 GHz	0.213	4.439	4.2067

**Table 4: EMF radiation projections of cell phones at 1800 MHz**

Country	2013 Rad Power Density (Million w/m <sup>2</sup> )			2020 Rad Power Density (Million w/m <sup>2</sup> )			2030 Rad Power Density (Million w/m <sup>2</sup> )		
	ON	Rx	Tx	ON	Rx	Tx	ON	Rx	Tx
India	72.64	2903	3045	79.56	3180	3335	116.8	4669	4896
China	83.68	3345	3508	84.74	3427	3594	116.3	4649	4876
USA	25.28	1010	1059	27.04	1080	1133	29.20	1167	1224
World	480.0	19188	20124	549.8	21979	23052	612.5	24484	25678

**Table 5: EMF radiation projections of cell phones between 300 MHz- 50 GHz**

Country	2013 Rad Power Density (Million w/m <sup>2</sup> )			2020 Rad Power Density (Million w/m <sup>2</sup> )			2030 Rad Power Density (Million w/m <sup>2</sup> )		
	ON	Rx	Tx	ON	Rx	Tx	ON	Rx	Tx
India	19.34	4030	3819	21.18	4414	4183	31.09	6480	6142
China	22.28	4643	4400	22.83	4757	4509	30.97	6454	6116
USA	6.730	1402	1329	7.199	1500	1421	7.774	1620	1535
World	127.8	26634	25242	146.4	30509	28914	163.1	33985	32209

MHz and between 300 MHz- 50 MHz frequency band.

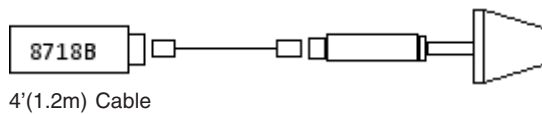
The table 1 shows the population projections for 2030 and table 2 indicates the cell

phones projections for 2030 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 2030, it is assumed that 74.71%, 75.32, 103.9% and 87% of respective



8700D Series Probe

Fig. 1: Radiation Survey Meter 8718B with 8710 Probe



4'(1.2m) Cable

Fig. 2: Radiation Survey Meter 8718B Connectivity with 8710 Probe

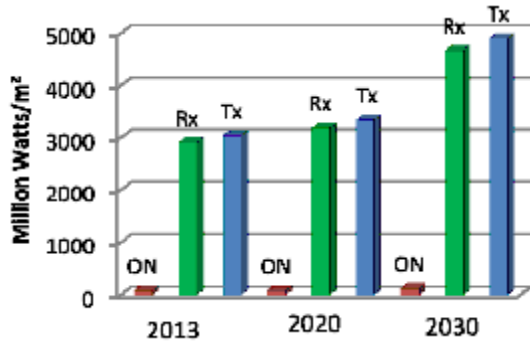


Fig. 3: Cellphone EMF Radiation Pollution Projections For India At 1800 MHz

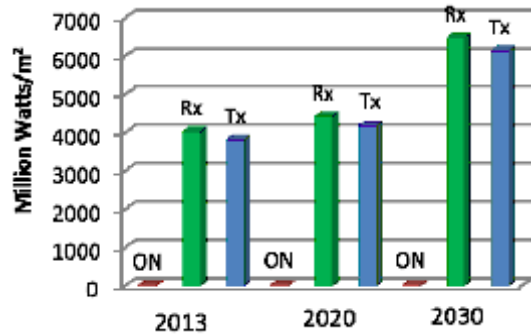


Fig. 4: Cellphone EMF Radiation Pollution Projections For India At 300 MHz-50 GHz

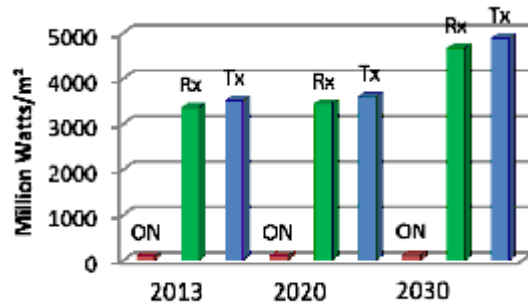


Fig. 5: Cellphone EMF Radiation Pollution Projections For China At 1800 MHz

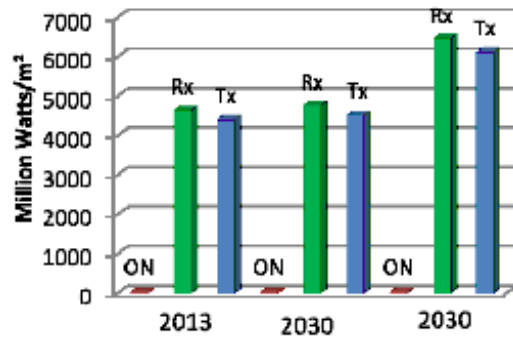


Fig. 6: Cellphone EMF Radiation Pollution Projections For China At 300 MHz-50 GHz

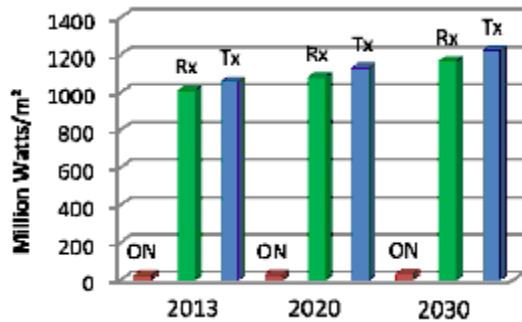


Fig. 7: Cellphone EMF Radiation Pollution Projections For USA At 1800 MHz

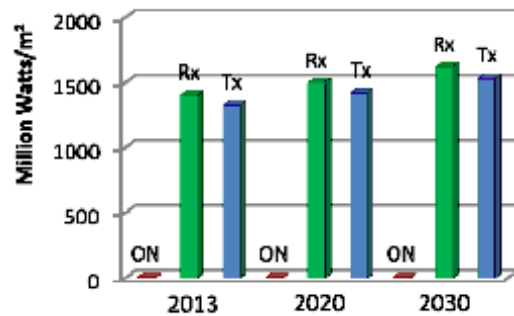


Fig. 8: Cellphone EMF Radiation Pollution Projections For USA At 300 MHz-50 GHz

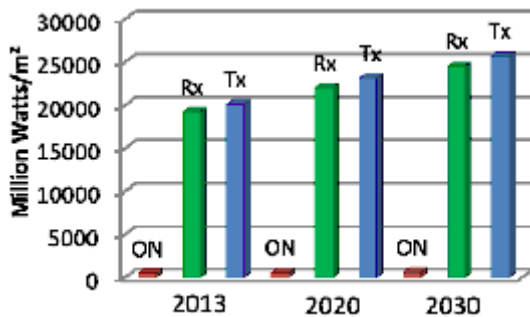


Fig. 9: Cellphone EMF Radiation Pollution Projections For World At 1800 MHz

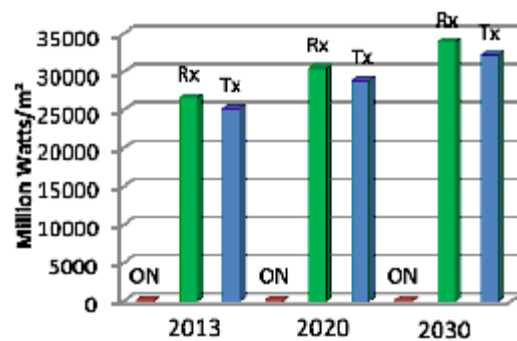


Fig. 10: Cellphone EMF Radiation Pollution Projections For World At 300 MHz-50 GHz

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. The table 3 shows the averaged EMF radiated power density of a cell phone determined through this experimental work. The table 4 illustrate the EMF radiated power densities of India, China, USA and the entire world due to different statuses of cell phones alone such as on, receive and transmit conditions at 1800 MHz centre frequency for 2013, 2020 and 2030.

The table 5 shows the EMF radiated power densities of India, China, USA and the entire world due to different statuses of cell phones alone such as on, receive and transmit conditions between 300 MHz and 50 GHz frequency band for 2013, 2020 and 2030.

**EMF Radiation projections for India**

In 2013 when India is asleep and all cell phones are in on(sleep) mode, India emits invisible EMF power density of 72.64 and 19.34 million watts per square meter at 1800 MHz and in 300 MHz-50 GHz frequency band into environment respectively. By 2020 these figures would be 79.56 & 21.18 million watts per square and by 2030 these figures will increase to 116.8 & 31.09 at the above stated frequencies. The radiated power densities when all cell phones of India are in receiving and transmitting modes are also shown in tables 4 and 5 at stated frequencies for 2013, 2020 and 2030 respectively.

The cell phones radiated power densities in on, receive and transmit modes by India at 1800 MHz and in 300 MHz-50 GHz band are shown in bar charts in figures 3 and 4 for 2013, 2020 and 2030 respectively.

Assuming that 50% of cell phones of India are transmitting and 50% are receiving which is most realistic, in 2013 India will contribute 2975 and 3924 million watts per square meter at 1800 MHz and in 300 MHz- 50 Ghz band respectively. These quantities will increase to 3275.5 and 4782.5 in 2020 and 2030 respectively at 1800 MHz.

#### **EMF Radiation projections for China**

In 2013 when China is asleep and all cell phones are in on(sleep) mode, China emits invisible EMF power densities of 83.68 and 22.28 million watts per square meter at 1800 MHz and in 300 MHz-50 GHz frequency band into environment respectively. By 2020 these figures would be 85.74 & 22.83 million watts per square and by 2030 these figures will increase to 116.3 & 30.97 at the above stated frequencies. The radiated power densities when all cell phones of China are in receiving and transmitting modes are shown in tables 4 and 5 at stated frequencies for 2013, 2020 and 2030 respectively.

The cell phones radiated power densities in on, receive and transmit modes by China at 1800 MHz and in 300 MHz-50 GHz band are shown in bar charts in figures 5 and 6 for 2013, 2020 and 2030 respectively.

Assuming that 50% of cell phones of China are transmitting and 50% are receiving which is most realistic, in 2013 China will contribute 3446.5 and 3426.5 million watts per square meter at 1800 MHz and in 300 MHz- 50 Ghz band respectively. These quantities will increase to 3510.5, and 4762.5 million watts per square meter in 2020 and 2030 respectively at 1800 MHz.

#### **EMF Radiation projections for USA**

In 2013 when USA is asleep and all cell phones are in on(sleep) mode, USA emits invisible EMF power density of 25.28 and 6.730 million watts per square meter at 1800 MHz and in 300 MHz-50 GHz frequency band into environment respectively. By 2020 these figures would be 27.04 & 7.199 million watts per square meter and by 2030 these figures will increase to 29.20, & 7.774 million watts per square meter at the above stated frequencies. The radiated power densities when all cell phones of USA are in receiving and transmitting modes are

shown in tables 4 and 5 at stated frequencies for 2013, 2020 and 2030 respectively.

The cell phones radiated power densities in on, receive and transmit modes by USA at 1800 MHz and in 300 MHz-50 GHz band are shown in bar charts in figures 7 and 8 for 2013, 2020 and 2030 respectively.

Assuming that 50% of cell phones of USA are transmitting and 50% are receiving which is most realistic, in 2013 USA will contribute 1034.5 and 1370.5 million watts per square meter at 1800 MHz and in 300 MHz- 50 Ghz band respectively. These quantities will increase to 1106.5 and 1195.5 in 2020 and 2030 respectively at 1800 MHz.

#### **EMF Radiation projections for Entire World**

In 2013 when entire world is asleep and all cell phones are in on(sleep) mode, entire world emits invisible EMF power density of 480 and 127.8 million watts per square meter at 1800 MHz and in 300 MHz-50 GHz frequency band into environment respectively. By 2020 these figures would be 549.8 & 146.4 million watts per square and by 2030 these figures will increase to 612.5 & 163.1 at the above stated frequencies. The radiated power densities when all cell phones of USA are in receiving and transmitting modes are also shown in tables 4 and 5 at stated frequencies for 2013, 2020 and 2030. The cell phones radiated power densities in on, receive and transmit modes by entire world at 1800 MHz and in 300 MHz-50 GHz band are shown in bar charts in figures 9 and 10 for 2013, 2020 and 2030 respectively.

Assuming that 50% of cell phones of entire world are transmitting and 50% are receiving which is most realistic, in 2013 entire world will contribute 19656 and 25938 million watts per square meter at 1800 MHz and in 300 MHz- 50 Ghz band respectively. These quantities will increase to 22515.5 and 28081 in 2020 and 2030 respectively at 1800 MHz

### **CONCLUSIONS**

The cell phones connectivity in modern society have altered the land scape of human beings in countless beneficial ways, however

created the environmental exposures to invisible Electromagnetic fields. As technology progresses and data demands have increased on mobile network, towns, cities and even rural villages have seen sharp increase in the cell phone numbers as projected in table 2 for India, China, USA and the entire world. Further as the costs of mobile technology and the cell phones have fallen, their uses have multiplied dramatically and the overall levels of exposure of the population and environment as a whole have increased drastically. The RF sources emit EMF radiation continuously. The level of EMF from sources has risen exponentially, by soaring popularity of wireless technology.

As of now there are no long term data available on environmental impacts of invisible EMF radiation, in spite of the recent studies indicating possible harmful effects on several species. Moreover, electronic pollution from EMF radiation being a relatively new environmental issue. There is a lack of established standard procedures and protocols to study and monitor the EMF effects especially among wildlife/ environment, which often make the comparative evaluation between studies difficult. In addition the uncoordinated research in this field, the necessary regulatory policies and their poor implementation mechanism also have not kept pace with growth of mobile telephoning.

There had already been some warning bells sounded in the case of bees and birds, which probably heralds the seriousness of this issue and indicates the vulnerability of other species as well. The invisible EMF radiations are being associated with the observed decline in the population of sparrow in London and several other European cities [18]. In this research work Population and cell phones projections have been stated for India, China, USA and the world for 2020 and 2030.

A cell phone that is 'ON', but not in use also radiates EMF energy. The EMF radiations from 6 randomly selected cell phones were measured using 8718B radiation survey meter with antenna probe 8710D. This meter has auto zeroing and spatial averaging facility to determine radiated power density. Based on this measurements and determination the projection of invisible EMF

radiated quantities in to environment for India, China, USA the whole world have been successfully projected with bar charts at three different status of cell phones such as on, receive and transmit modes. These projections are included for two different frequencies for 2013, 2020 and 2030. These measurements were carried out at 1800 Mhz and in 300 MHz-50 GHz frequency band.

It is seen that when the entire world sleeps and cell phones are in on(sleep) mode it radiates power densities of 480, 549.8 and 612.5 millions of watts per square in 2013,2020 and 2030 at 1800 MHz. Realistically assuming 50% of world is asleep at any given time the world radiates power densities of 280, 274.9 and 306.25 millions of watts per square meter into environment by 2013, 2020 and 2030 respectively at 1800MHz. Similarly, assuming that 50% of the world is awake and is transacting routine business, the world will radiate power densities of 20656, 22575.5, 25081 millions of watts into environment at any given time by 2013, 2020 and 2030 respectively at 1800MHz. This assumption of 50% of the world transacting means 50% of cell phones are in transmitting mode and rest 50% are in receiving mode.

The power density quantities measured for 2013 and projected for 2030 and 2030 call for immediate uniform EMF radiation policies. This is more so when referred to International Exposure Standards, in this it is seen that USA, Canada and Japan have 12W/m<sup>2</sup>, ICNIRP<sup>19</sup> and European recommendation 1998-adopted in India has 9.2w/m<sup>2</sup> (Reduced by 10 times in 2012by India), exposure limit in Austria is 0.001w/m<sup>2</sup>. The EMF radiation projected in this research paper expected to be correct approximately will be same into the environment across the world. It cannot recognize the Geography of any country. The current EMF levels due to mobiles and projections indicate growing threat to environment which require initiation of corrective steps by world agencies across the globe.

There is a strong case in point to have a uniform EMF radiation policy across the world. This is more so because of the reason that cell phones can work in Austria with exposure limit of 0.001w/m<sup>2</sup> and in USA, Canada and Japan with the exposure limit of 12W/m<sup>2</sup>, there is a strong message

from this research paper to advocate that entire world needs a single exposure policy. The EMF projections due to cell phones alone along with other EMF sources must be used as the precautionary principle and should prevail to better the standards of EMF radiation limits to match the best in the world to sustain the environmental safety.

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