Generalitat de Catalunya

2017 Annual Report on Radiofrequency Electromagnetic Field Exposure Levels in Catalonia

March 2018

1. Introduction

Mobile telephony, and in a broader sense, mobile communications have become an essential tool in today's society and have involved a highly significant transformation from a social, economic and environmental point of view.

Never before in the history of humanity had the appearance of a new technology been so widely accepted by society in such a short space of time.

Mobile communications are radio communication systems, like other equally popular ones such as radio or television. All such systems use electromagnetic waves to transmit and receive sound, image and data. Without radio communication systems, today's society would not be possible.

The construction of towers with television and radio antennas on hilltops has enabled society to enjoy these services for decades. Mobile communications, unlike radio and television, require antennas closer to the users, in order to offer quality mobile voice and data services.

Particularly, the appearance of the first mobile phone antennas in urban environments generated a degree of public concern. In part, this was due to the visual impact created by certain antennas and, in addition to the health risk perceived by a proportion of the public deriving from exposure to the electromagnetic fields generated by the antennas. The European Union echoed this public concern in the surveys performed in 2007 [1]and 2010[2].

As a result of this public concern, the deployment of mobile phone antennas has suffered difficulties, particularly as a result of the pressure to the local councils. Aware of this problem, the European Parliament, in Resolution 2008/2211 (INI)[3], among other aspects, encouraged service providers, public authorities and citizens' associations to find mutually acceptable solutions with respect to the deployment of mobile phone antennas. In addition, in order to guarantee information to the public on the matter, it called for European Union Member States to publish maps showing electromagnetic field exposure levels, and suggested that these maps be made available online for consultation. The same Resolution also required the European Commission to present an annual report on electromagnetic field exposure levels in the European Union.

[1] http://ec.europa.eu/health/ph_determinants/environment/EMF/ebs272a_en.pdf
[2] http://ec.europa.eu/public_opinion/archives/ebs/ebs_347_en.pdf
[3] http://www.europarl.europa.eu/meetdocs/2004_2009/documents/pr/757/757441/757441en.pdf

2. Government of Catalonia: actions undertaken

Also aware of the problems associated with deploying mobile phone antennas and, therefore, the associated deficiency in service, the Government of Catalonia has for some years been implementing different lines of control, planning, regulation, promotion and information in this area.

Notable control actions include the creation in 2005 of the SMRF network (RadioFrequency Monitoring System) of monitoring equipment for the continual measurement of RF EMF levels from mobile phone antennas. It is currently the largest network of its kind in the world, with more than 300 monitoring equipment installed in 184 municipalities in Catalonia.

Among the planning and promotion actions, in 2008 the Government of Catalonia initiated the GECODIT project (generation of consensus in the deployment of mobile phone infrastructures) in 18 municipalities in Catalonia. The main objective of the GECODIT project is to generate a consensus among town councils, mobile phone service providers and the public with respect to the deployment of mobile phone antennas. The results have been highly satisfactory for all parties in the municipalities where the process has been implemented.

2.1 Radio-electric Governance

In 2009, the Directorate-General for Telecommunications and the Information Society and the Directorate-General for Environmental Quality designed the Radio-electric Governance policy. European Union co-funding was requested and, in 2010, the European Commission and the Government of Catalonia signed a co-funding agreement through the LIFE instrument for the period 2010-2014[4] to develop the LIFE09 ENV/ES/000505 project *Radio-electric Governance*: *Environment and Electronic Communications Policies for Deployment of Radiocom Infrastructures*.

European LIFE co-funding for the project LIFE09 ENV/ES/000505 (hereinafter referred to as **Radio-electric Governance**) concluded on 30 September 2015. It included a set of actions aimed mainly at offering the public thorough information on electromagnetic fields (EMF) and how radio communications systems work, thus implementing the indications of European Parliament Resolution 2008/2211(INI). Among the most notable aspects, 100 EMF level monitoring equipment were acquired, to expand the existing SMRF network by installing them in the 10 most-populated cities in Catalonia. Furthermore, 50 portable RF EMF level measuring equipment were purchased with the aim of

[4] In 2014, the Catalan Government requested an extension of the project until 30 September 2015, which was approved by the European Commission.

providing them to government bodies in Catalonia (local and regional councils) so that RF EMF levels could be measured in several dozen municipalities in Catalonia.

The measurements performed with the SMRF network monitoring equipment and the portable equipment can be viewed on the Radio-electric Governance website (**http://radioelectricgovernance.gencat.cat).**

This website also provides extensive information on what EMF are and how mobile phones work (in an interactive explanatory section), as well as current regulations and the main international studies analysing possible links between exposure to RF EMF and harmful health effects.

The Radio-electric Governance project also plans to create and disseminate a yearly report showing the Catalan population's exposure levels to RF EMF, based on the measurements made by the monitoring equipment and portable equipment. This 2017 annual report is the fifth consecutive annual report presented by the Government of Catalonia.

As part of the Radio-electric Governance project, the Catalan Government carried out a survey in 2011[5] in which more than 60% of the respondents indicated that they would like to have more information about EMF, with 75% of these stating that they would prefer this information to be provided by the Catalan Government and by health organisations. 60% of those interviewed stated they would trust information published by the Catalan Government on this topic. In a second survey, carried out in 2015, this latter figure rose to 69%[6].

The actions carried out within the framework of the Radio-electric Governance project are aligned with the European Parliament's recommendations and suggestions (Resolution 2008/2211(INI)), and also with the main demands of the Catalan public, as shown in the survey carried out by the Government of Catalonia in 2011. Specifically:

- GECODIT project
  Related to the European Parliament recommendation to encourage service providers, public authorities and citizens' associations to find solutions agreed by consensus with respect to the deployment of mobile phone antennas.

5 http://governancaradioelectrica.gencat.cat/documents/10180/51436/inf_CTTI_20111107_def_CA_EN.pdf

6 http://governancaradioelectrica.gencat.cat/documents/10180/5044679/ENQUESTA%202015_EN.pdf

- Measuring electromagnetic field levels
  Creation of the SMRF network of monitoring equipment and the provision of 50 portable equipment, related to the European Parliament's call for Member States to measure levels of exposure to RF EMF.

- Creation of the Radio-electric Governance website
  Related to the European Parliament recommendation and the survey of the Catalan population, to provide information on EMF and the operation of radio communication systems, and also to publish the EMF exposure levels measured on maps available online.

- Production of an annual report on electromagnetic field exposure levels among the general public
  Related to the European Parliament recommendation to the European Commission to submit an annual report on electromagnetic field exposure levels in the European Union.

All the actions included in the Radio-electric Governance project have two aims: firstly, to ensure that the public is provided with quality mobile voice and data services for their social and economic activities; and, secondly, to ensure that the deployment of mobile phone antennas, which is necessary in order to offer quality services, is sufficient, regulated and respects both people and the environment.

As stated above, European co-funding for the LIFE project ended on 30 September 2015, but the **Radio-electric Governance** project is still being run by the Government of Catalonia, ensuring continuity for the actions mentioned above.

3. Regulations on exposure to radiofrequency electromagnetic fields in Catalonia

The various public administrations must ensure that citizens, wherever they are, can enjoy the benefits of the information society from mobile networks and also to ensure compliance with current regulations.

In Catalonia, the electromagnetic emissions generated by radio communication systems must comply with Royal Decree 1066/2001[7], which establishes the maximum EMF levels to which the general public may be exposed.

The maximum levels defined in RD 1066/2001 are the same maximum levels defined in the Recommendation of the Council of the European Union in 1999 (1999/519/EC)[8] which, in turn, are the same as those defined by the ICNIRP[9] (International Commission on Non-Ionizing Radiation Protection) in 1998. A large number of European Union Member States apply the same regulations that are in force in Catalonia. It should be pointed out that the maximum permitted levels stipulated in the regulations for the general public include a safety factor of 50, applying the precautionary principle[10].

The maximum permitted levels of exposure to RF EMF fields specified in RD 1066/2001 are directly related to each radio communication system's transmission frequency. Thus, for example:

Frequency range	Service	Restrictive level (V/m)[11]
530 – 1605 kHz	AM radio	**87 - 68**
88 – 108 MHz	FM radio	**28**
470 – 790 MHz	DTT	**29 - 38**
790 – 2600 MHz	Mobile phones	**38 - 61**
2400 MHz and 5000 MHz	Wi-Fi	**61**
2450 MHz	Microwave ovens	**61**
2500 MHz	WiMAX	**61**

With the scientific information currently available on possible effects on the human body, it is known that there may be an increase in body temperature,

[7] Royal Decree 1066/2001, of 28 September, approving the Regulations establishing protection conditions in the radio-electric public domain, restrictions on radio-electric emissions and health protection measures against radio-electric emissions.
[8] http://ec.europa.eu/health/electromagnetic_fields/docs/emf_rec519_en.pdf
[9] http://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf
[10] http://europa.eu/legislation_summaries/consumers/consumer_safety/l32042_en.htm
[11] Electromagnetic field exposure levels may be given in different units. The most commonly used units are the electric field (V/m) or the power density (W/cm^2 or mW/m^2).

depending on the strength, exposure time and part of the body exposed to the RF EMF (radio, television, mobile phone and Wi-Fi, among others): this is the so-called thermal effect.

However, there are hundreds of studies that have analysed and are currently analysing other relationships between exposure to RF EMF and possible harmful effects on human health. A number of international organisations specialised in this field (ICNIRP, WHO[12], SCENIRH[13]) regularly review the main international studies that have been carried out in this area. Thus, according to the information published by these organisations, **to date, there is no conclusive evidence regarding a cause-effect relationship between exposure to RF EMF and harmful effects for human health**, if the levels of exposure are below the restrictive levels specified by the ICNIRP.

In 2011, the International Agency for Research on Cancer (IARC) classified RF EMF as Group 2B[14], possible carcinogen for human beings, based on limited evidence in epidemiological studies and laboratory animals. The epidemiological evidence was considered limited, based on an increased risk of gliomas and acoustic neuromas associated with the use of mobile phones, observed in some epidemiological studies. Limited evidence means that a positive association has been observed between exposure to RF EMF and cancer. Accordingly, it is considered that a causal interpretation is possible but it is not possible to rule out with a reasonable degree of confidence the effect of chance, bias or confounding factors. Consequently, research programmes are continuing, particularly those focused on exposure over long periods (more than 15 years) and exposure in children and teenagers.

In 2017, the Scientific Advisory Committee on Radio Frequency and Health (*Comité Científico Asesor en Radiofrecuencias y Salud – CCARS*) presented its new *Informe sobre Radiofrecuencias y Salud 2016*[15] (Radio Frequency and Health Report, 2016), which compiles, updates and analyses scientific evidence on the subject for the period January 2013 to June 2016.

According to the conclusions of the report, '*critical analysis of the evidence confirms that there are no technical or health reasons to justify arbitrary and discretional imposition of exposure limits more demanding than those recommended by the WHO-ICNIRP and the European Union*', while the application of more restrictive limits '*would mean increasing the number of antennas, with the subsequent visual, social and economic impact*'. Furthermore, the report states that '*public exposure levels to radio frequencies*

[12] http://www.who.int/en/

[13] Scientific Committee on Emerging and Newly Identified Health Risks http://ec.europa.eu/health/scientific_committees/emerging/index_en.htm

[14] International Agency for Research on Cancer - http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf

[15] http://ccars.org.es/publicaciones/documentos-elaborados-por-el-ccars/160-informe-sobre-radiofrecuencias-y-salud-2016

from Wi-Fi equipment, which have been well studied under realistic operating conditions, are well below those recommended by scientific agencies and committees'.

With regard to the work environment, the European Commission drew up European Directive 2013/35/EU in 2013 [16] and 22 July 2016 saw the publishing of RD 299/2016[17], on protecting the health and safety of workers against risks related to EMF exposure.

Both Directive 2013/35/EU and RD 299/2016 indicate maximum permitted levels of exposure in working environments that are higher than the maximum permitted levels for the general public, as indicated in Recommendation 1999/519/EC and RD 1066/2001.

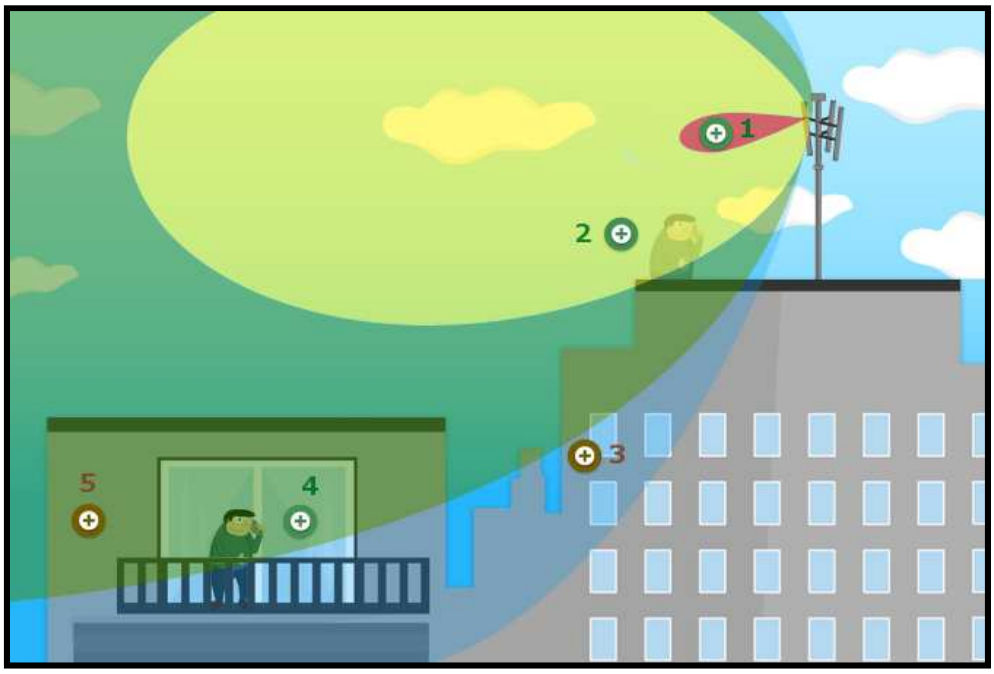
[16] Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (20th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and repealing Directive 2004/40/EC.

[17] Royal Decree 299/2016, of 22 July, on the protection of the health and safety of workers against risks related to electromagnetic fields (https://www.boe.es/boe/dias/2016/07/29/pdfs/BOE-A-2016-7303.pdf)

4. Levels of exposure to radiofrequency electromagnetic fields around an antenna

The signals transmitted by radio communication systems are electromagnetic waves that travel in a straight line at the speed of light. The signal is strongest near the antenna and in the direction of maximum transmission, while it rapidly decreases the further away one is from the antenna. The signal further decreases as it passes through ceilings, walls or other obstacles.

The following diagram shows five different types of space of exposure to radio frequency (RF) EMFs from mobile phone antennas, the result of analysing thousands and thousands of measurements of RF EMF levels from over 300 SMRF network monitoring equipment and portable equipment:



1. Outdoor measurement
   This is where the highest levels are found. It is generally in areas 3 or 4 metres from the antenna in the direction of maximum transmission. This area is not accessible to people, as it is part of the protection zone assigned to the antenna. It is the only area where levels higher than those indicated in regulations might be measured.

2. Outdoor measurement
   Outdoor spaces up to 10 metres from the antenna in the direction of maximum transmission. This area is outside the protection zone and the levels are thus lower than the maximums indicated in regulations. People can enter these areas, although they are generally unfrequented places, such as roofs.

3. Indoor measurement
   Indoor spaces in buildings with the antenna on the roof. The levels are lower because, firstly, the antenna on the roof is not directly pointed at these spaces and, secondly, the walls and ceilings of the building greatly weaken the signal.

4. Outdoor measurement
   Outdoor spaces approximately 10 to 20 metres from the antenna, in the same or a neighbouring building to the antenna. The levels are lower because, as well as the signal being weaker due to distance, the antennas are not generally pointing directly at these areas, as this would reduce the capacity to provide the service from the antenna.

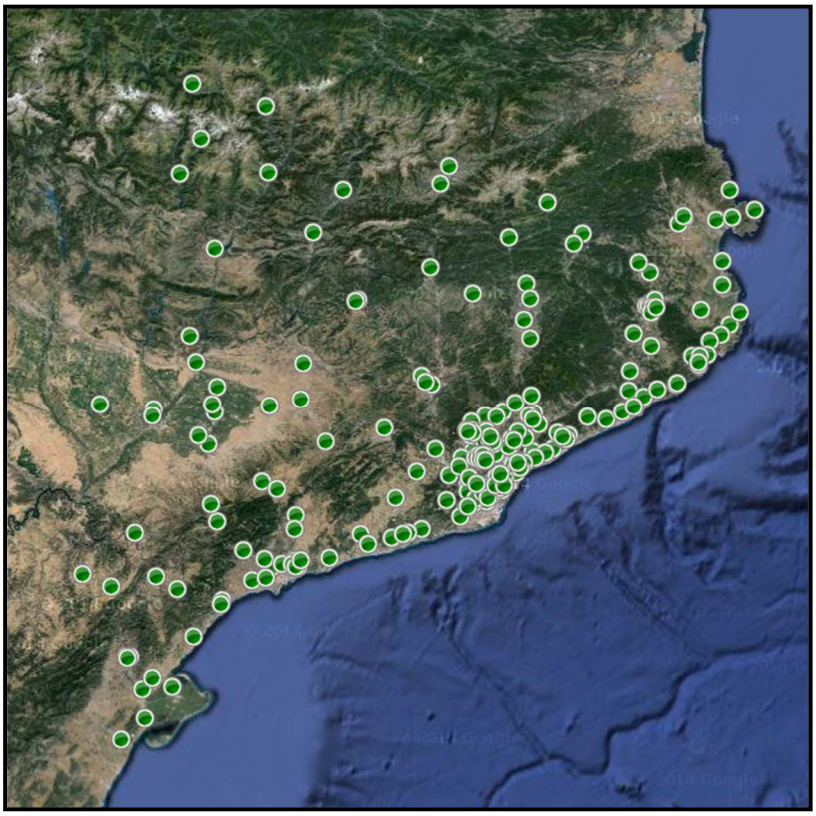
5. Indoor measurement
   Indoor spaces in buildings next to buildings with the antennas. They have low levels, because, as stated in the previous point, building walls weaken the signal.

4.1 Levels measured with monitoring equipment

As previously mentioned, Catalonia has the largest SMRF network in the world of monitoring equipment that is continuously measuring RF EMF levels, with more than 300 equipment installed in 184 municipalities in Catalonia. These equipment continuously measure EMF levels and send the measurements automatically to a control centre owned by the Catalan Government.

There are monitoring equipment installed in all the regions of Catalonia, with larger numbers in more heavily populated areas, where there are also more mobile phone antennas.

The following map shows the geographic distribution of monitoring equipment:



All the SMRF network monitoring equipment are installed outdoors and most of them are on the roofs of buildings: some on the same roof as the antennas and others on the roofs of neighbouring buildings.

The RF EMF levels measured by the monitoring equipment provide clear information on the different types around the antennas. Thus, it can be seen that the levels measured depend directly on:

- The distance of the monitoring equipment from the antenna.
- The number of antennas in a given antennas site.
- Whether the monitoring equipment is placed in the direction of maximum emission of any of the antennas.
- Whether the monitoring equipment is at a similar height to the antennas.
- The range of EMF frequencies measured by the monitoring equipment.

84% of the SMRF network monitoring equipment (281 equipment) only measure the RF EMF level from mobile phone antennas in the 900 MHz, 1800 MHz and 2100 MHz frequency bands. 14% of the monitoring equipment (48 equipment) measures the RF EMF level in all frequency bands from 100 kHz to 8 GHz (broadband); that is, as well as the mobile phone system, they also measure the RF EMF from other radio communication systems, such as AM and FM radio,

DTT, Wi-Fi or WiMAX, among others. The remaining 2% of monitoring equipment measures low-frequency electrical and magnetic fields, from 10 Hz to 3 kHz.

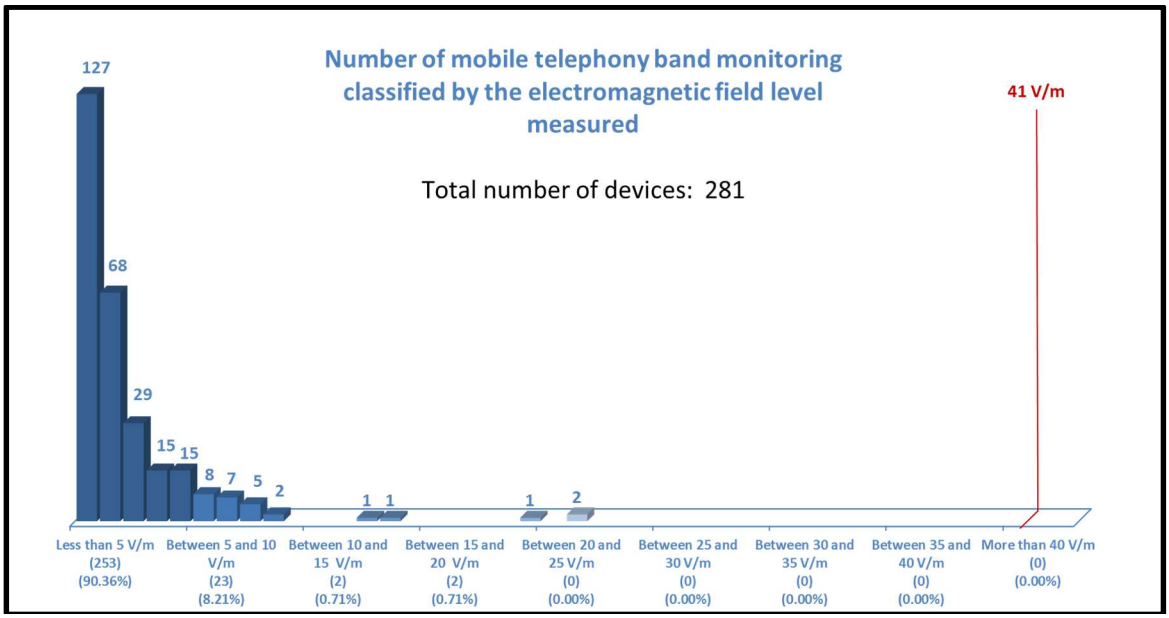
All the levels measured with the SRMF network's monitoring equipment, which measures both the RF EMF in the 900MHz, 1800MHz and 2100MHz mobile telephone band, as well as the entire 100 kHz to 8 GHz frequency band, have been below the restrictive levels set by regulations.

The Catalan Government has designed an investment plan so that the 281 monitoring equipment currently only measure RF EMF levels from mobile phone antennas in the 900 MHz, 1800 MHz and 2100 MHz frequency bands, will also measure RF EMF level in all frequency bands from 100 kHz to 8 GHz (broadband). In 2018, 82 of the 281 monitoring equipment will be updated.

4.1.1 Levels measured by monitoring equipment that only measure the mobile phone radiofrequency electromagnetic field level in the 900 MHz, 1800 MHz and 2100 MHz frequency bands

The most restrictive level of RF EMF exposure in the regulations for the 3 frequency bands of mobile telephony of 900 MHz, 1800 MHz and 2100 MHz is 41 V/m, for the 900 MHz band. This is the restrictive level of RF EMF exposure that we will apply to the levels measured by these equipment.

The figure below shows the number of monitoring equipment with respect to the average RF EMF level measured during 2017:

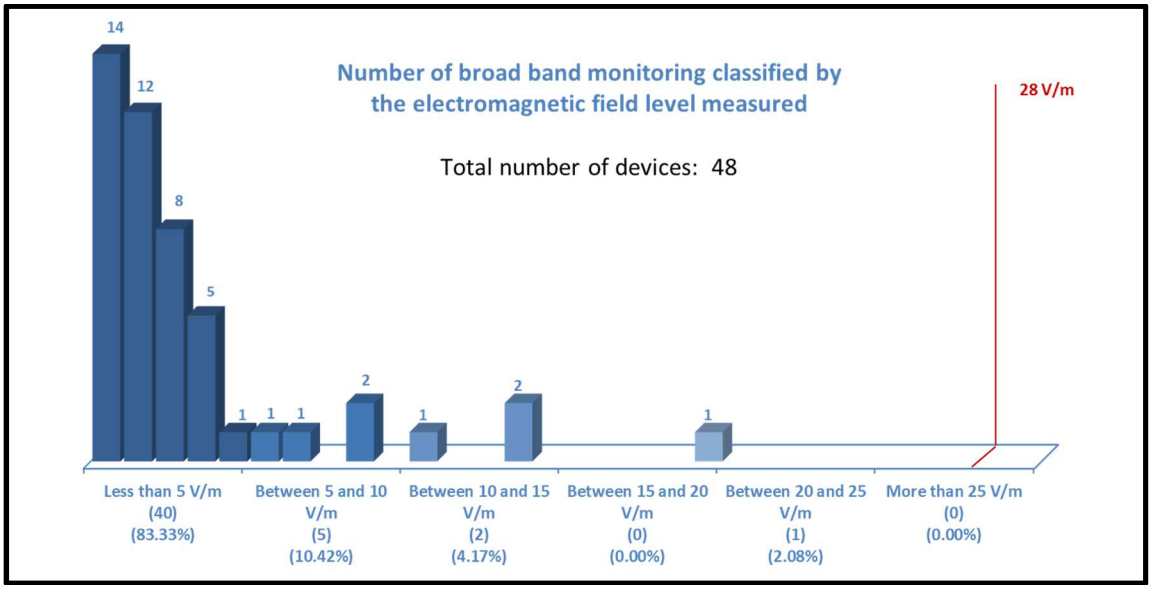


The 3 monitoring equipment shown in the above graph that measure more than 15 V/m are installed on the same roof as the mobile phone antennas, less than 10 metres away, at a similar height to the antennas and in the area of the strongest directivity of some of the positioning antennas. In all three cases, these are areas where there is little pedestrian traffic, which would correspond to the zone *2. Outdoor measurements* such as those indicated in section *4. Levels of exposure to radiofrequency electromagnetic fields around an antenna* in this report).

4.1.2 Levels measured by the radiofrequency electromagnetic field level monitoring equipment in all the frequency bands from 100 kHz to 8 GHz (broadband)

The most restrictive level of exposure in the regulations for the frequency bands from 100 kHz to 8 GHz is 28 V/m. This is the restrictive level of RF EMF exposure that we will apply to the levels measured by these equipment.

The figure below shows the number of monitoring equipment with respect to the average RF EMF level measured during 2017:



The 2 monitoring equipment shown in the above graph, which measure the highest levels, are installed just a few metres from the broadcast antennas of DTT and FM radio, and are NOT mobile phone antennas.

4.2 Levels measured with portable equipment

In 2017, no portable equipment was transferred to organizations and hence few measurements were undertaken with portable equipment. For this reason, we do not consider it necessary to show a table of the measurements taken. However, all the levels of the measurements of RF EMF taken with the portable equipment during 2017 were far lower than the restrictive levels established by the law.

5. Conclusions concerning the radiofrequency electromagnetic field levels measured

With regard to the levels measured by the SRMF network monitoring equipment and the portable equipment over the course of 2017, the following may be noted:

- **All the levels measured comply with current regulations** and can be viewed on the Radio-electric Governance website: **http://radioelectricgovernance.gencat.cat/**

- The levels measured are directly related to the distance from the antennas and whether the measurement was taken at a height similar to that of the antennas and in the direction of maximum emission of any of the antennas. Thus, the highest levels measured are found only a few metres from and at a similar height to the antennas and in the direction of maximum emission of any of these antennas. In all the other cases, the levels measured are much lower.

- The measurements performed with the monitoring equipment enable the levels to be observed over long periods, which in turn enables analysis of possible variations over time of the levels measured.

- Portable equipment in urban areas enable measurements to be taken in places where people stay for longer and allow checks to be carried out to ensure that the measured levels are generally below the levels measured with monitoring equipment, because most of the sites where measurements are taken with portable equipment are further away and at a lower altitude than the antennas.

- Indoor measurement levels are much lower than outdoor measurements, due to weakening by building walls and ceilings.

- The levels measured with the portable equipment in rural locations correspond to positions very close to radio communication infrastructures, and where the major part of the total RF EMF level measured corresponds to FM, AM and DTT services, and not to mobile phone services.

6. Recommendations regarding deployment of mobile phone antennas

With respect to the deployment of mobile phone antennas, especially in urban locations, it can be stated that:

- It would be wise for local governments, mobile phone service providers and the representatives of citizens' associations to work more closely together in deploying mobile phone antennas, in order to create a climate of mutual trust. This will, firstly, ensure that mobile phone antennas deployment is sufficient, regulated and respects both people and the environment and, secondly, that the public is provided with quality mobile voice and data services for their social and economic activities.

- When planning the deployment of mobile phone antennas, service providers must abide by the ALARA (as low as reasonably achievable) and ALATA (as low as technologically achievable) principles with respect to reducing the level of exposure to RF EMF from antennas. Therefore:

    - The deployment of mobile phone antennas in urban locations should be as evenly distributed as possible.

    - Once the location of a mobile phone antenna has been decided:

        - The service provider should minimise as much as possible exposure to RF EMF in locations close to antennas where people may stay for periods of a certain length and, in particular, should avoid pointing the antennas towards these locations.

        - Antennas should be positioned as high as possible on their mast.

- We consider that public administrations should make public land available to mobile phone service providers so that they can analyse the radio-electric viability of installing mobile phone antennas on this land.

- In order to reduce the visual impact, the antennas and other equipment should blend into the environment as far as is reasonably possible.

7. Appendix

7.1 Comparison of the levels measured with monitoring equipment between 2013 and 2017

There follows a comparison of the RF EMF levels measured by the monitoring equipment between 2013 and 2017.

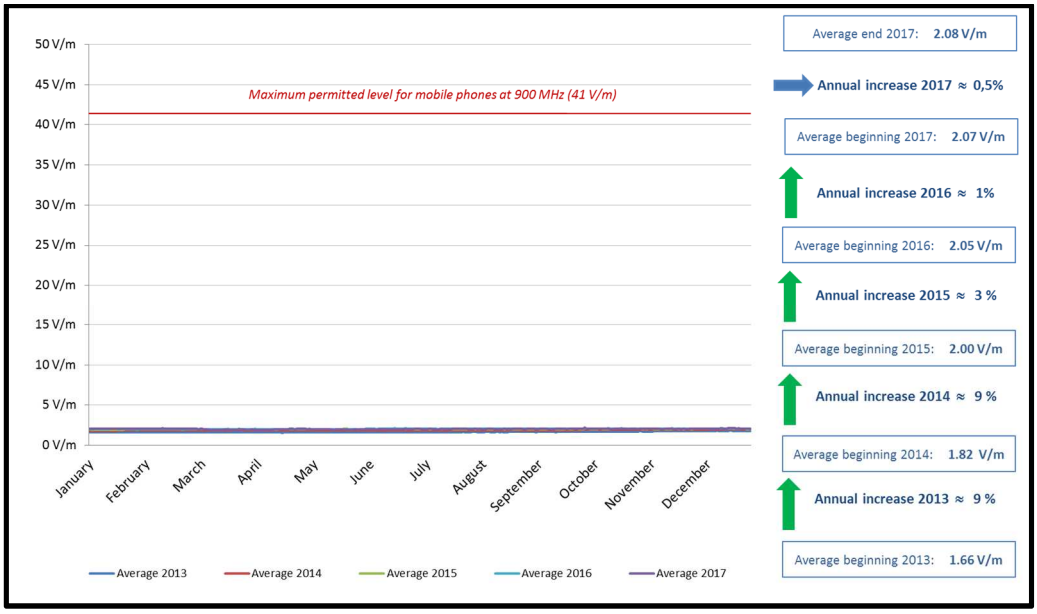
The monitoring equipment are permanently installed in the same locations. Consequently, comparing the measurements between 2013 and 2017 gives the information of the trend in the levels measured.

7.1.1 Levels measured by monitoring equipment measuring only the mobile phone electromagnetic field levels in the 900 MHz, 1800 MHz and 2100 MHz frequency bands

In total, 281 monitoring equipment measuring only the mobile phone RF EMF levels in the 900 MHz, 1800 MHz and 2100 MHz frequency bands have been used between 2013 and 2017.

The most restrictive level of RF EMF exposure in the regulations for these 3 frequency bands of mobile telephony of 900 MHz, 1800 MHz and 2100 MHz is 41 V/m, for the 900 MHz band. This is the restrictive level of RF EMF exposure that we will apply to the levels measured by these equipment.

The figure below gives a month-by-month comparison between the RF EMF levels measured between 2013 and 2017 by the monitoring equipment used solely to measure the mobile phone RF EMF level in the 900 MHz, 1800 MHz and 2100 MHz frequency bands:



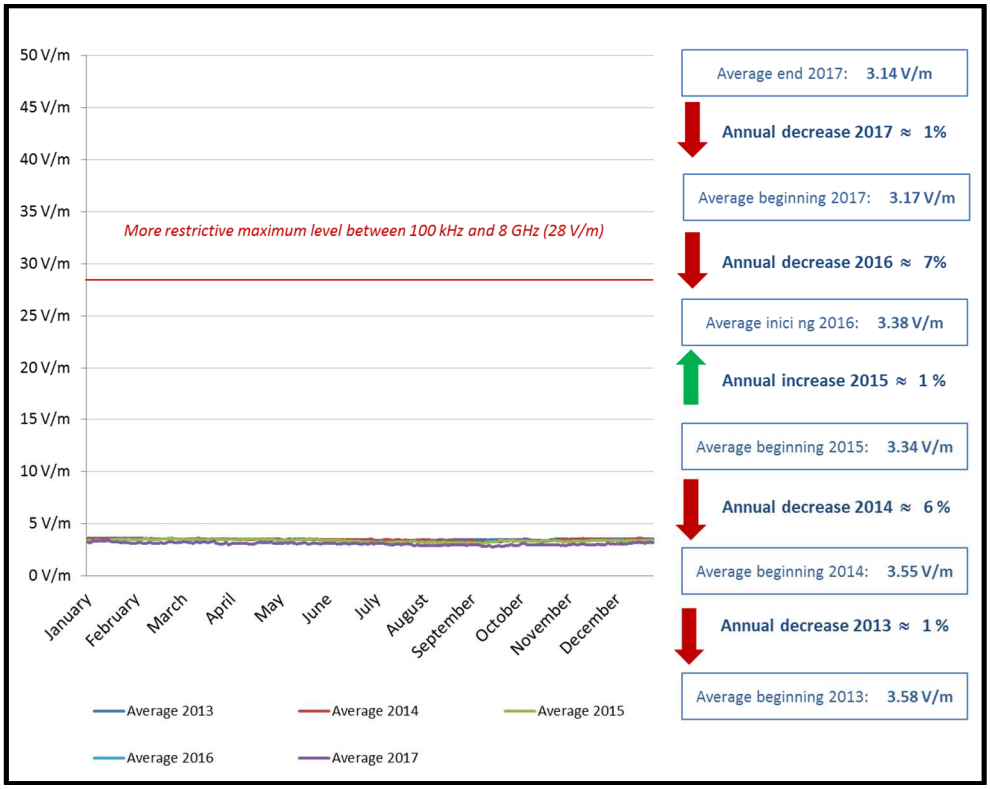
An analysis of the graph shows a very slight upward trend of 0.5% in RF EMF levels measured for mobile phone bandwidths of 900 MHz, 1800 MHz and 2100 MHz in 2017. The increase since 2013 is about 20%. The increase is due to the installation of new mobile phone antennas of 900 MHz, 1800 MHz and 2100 MHz bands in recent years. However, as can be seen in the graph, the measured RF EMF levels continue to be well below maximum regulatory levels.

7.1.2 Levels measured by the radiofrequency electromagnetic field level monitoring equipment in all the frequency bands from 100 kHz to 8 GHz (broadband)

During 2013 to 2017, 48 monitoring equipment were used to measure solely the RF EMF level in all frequency bands from 100 kHz to 8 GHz (broadband).

The most restrictive maximum level of exposure in the regulations for the frequency bands from 100 kHz to 8 GHz is 28 V/m. This is, then, the maximum permitted exposure value that we shall take into account for the levels measured by these equipment.

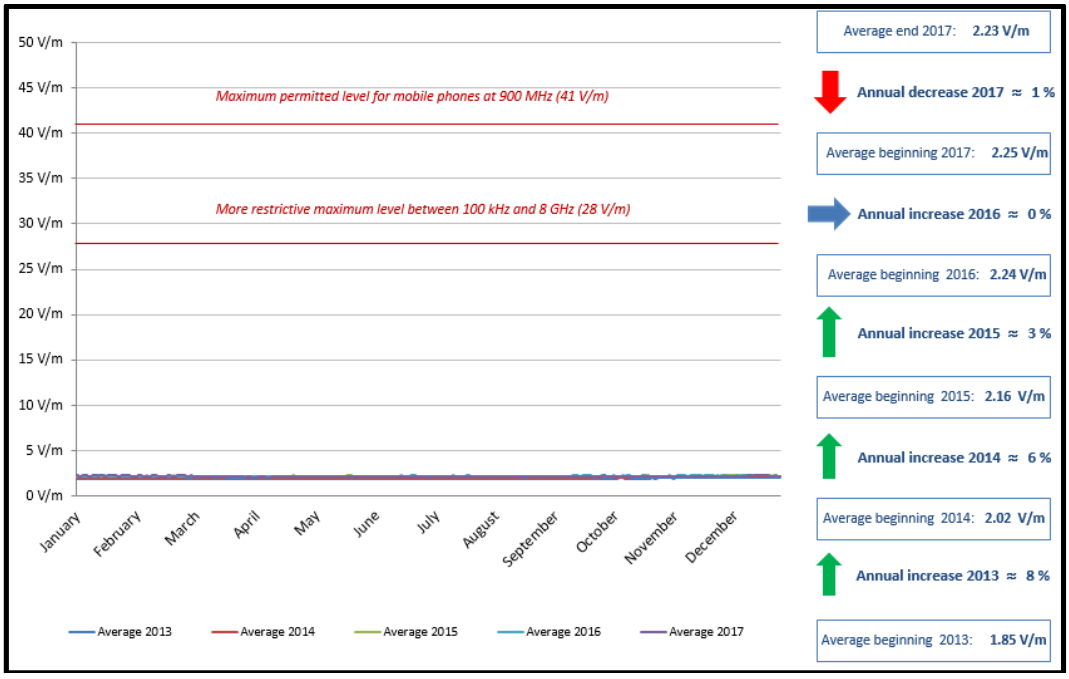
The figure below gives a month-by-month comparison between the levels measured between 2013 and 2017 by the monitoring equipment measuring the RF EMF level in all frequency bands from 100 kHz to 8 GHz:



The graph shows that there has been hardly any variation in measured levels in the last years, which have even dropped slightly. This is because these types of monitoring equipment are mostly installed near radio communications infrastructures, with antennas for services, such as AM, FM and WiMAX, rather than mobile phone antennas. This type of radio communications services have generally fewer changes after the installation of more antennas. With the updating of the monitoring equipment, the probes that currently only measure the mobile telephony bandwidths of 900 MHz, 1800 MHz and 2100 MHz by probes that measure the levels from 100 kHz to 8 GHz (indicated in section *4.1 Levels measured with monitoring equipment*), we will have more and more monitoring equipment with probes for 100 kHz to 8 GHz and therefore we will be able to obtain a more accurate measurement of the increase in the RF EMF level resulting from the installation of LTE/4G mobile telephone antennas operating at the frequencies of 800 MHz and 2.600 MHz.

7.1.3 Levels measured by all the radiofrequency electromagnetic field level monitoring equipment

If we consider, as a whole, all the RF EMF level measured by monitoring equipment (i.e. both that exclusively measuring the 900 MHz, 1800 MHz and 2100 MHz mobile telephone frequency bands, as well as that measuring the 100 kHz to 8 GHz frequencies), with a total of 329 monitoring equipment, trends in the levels measured between 2013 and 2017 are shown in the following graph:



The graph shows a slight drop in the RF EMF level measured of 1% in 2017.

7.2 Mobile telephony: some data

Below, we provide some information on mobile telephony use, to give some idea of the current situation and short- and medium-term forecasts.

According to the report on the Information Society in Spain 2017[18], published by *Fundación Telefónica*, the number of mobile telephone lines had reached 7.74 billion subscriptions by the end of 2017, which represents a penetration level of 103.5 lines per 100 inhabitants. In 2016, this figure exceeded the world's population for the first time, a booming trend that was consolidated in 2017.

Mobile telephone operators rolled out a total of 580 LTE networks in 188 countries in 2016 (according to the annual GSMA study[19]), which enabled 60% of the population to have access to 4G networks in 2016, 10 percentage points more than in the previous period and 49 points up on the figure reached in 2012.

With regard to the coverage of LTE/4G networks in Europe, the average for the Member States, according to DESI 2017, is 84.4% of households. Only two countries (Denmark and Sweden) have achieved total LTE/4G households coverage, while countries such as Romania have barely reached 40%. In relation to the number of subscribers, the leading countries in the EU-28 in terms of the number of lines per 100 inhabitants are primarily the Scandinavian ones such as Finland (147.2), Denmark (123.4) and Sweden (119.8).

Mobile broadband

According to the International Telecommunications Union (ITU), the number of active mobile broadband subscriptions reached 4.3 billion by the end of 2017, compared to 3.864 billion in 2016, representing a global increase of 9.2%.

In Spain, mobile data traffic grew by over 100% in 2017, to a large extent due to the 373% rise in LTE/4G data traffic, reaching 60% of the total, followed by 39% of data traffic across the 3G network, when in 2016 this accounted for 71%. The number of mobile broadband customers in Spain grew by 8.6%, and by early 2017 LTE coverage already exceeded 90% of the population, reaching more than 94% of Spanish households[20].

[18] https://www.fundaciontelefonica.com/conferencias/presentacion-del-informe-de-la-sociedad-digital-en-espana-sdie/

[19] GSMA. The Mobile Economy 2017

[20] Informe de cobertura de banda ancha en España a mediados de 2016. Ministerio de Energía, Turismo y Agenda Digital – Secretaría de Estado para la Sociedad de la Información y la Agenda Digital.

With regard to the speed of mobile data traffic, in Spain the average speed is 13.8 Mbit/s, compared to 26 Mbit/s in the United Kingdom, the country that tops the ranking, and 24.1 Mbit/s in Germany, in second position.

Worldwide, mobile data traffic in the last five years has increased by 1,200%, with growth of 70% in 2017, while mobile voice traffic increased by 28% over the same period.

Videos account for almost 50% of the total mobile data traffic and it is expected that in the next five years mobile video traffic will grow at a rate of 50% per year, while that of social networks will grow by just 38% per year.

With regard to mobile broadband penetration, Spain remains one of the world's leaders. In the fourth quarter of 2016, Spain ranked fifteenth among OECD countries, with 89.2 lines per 100 inhabitants, behind countries such as Japan (152.4), Finland (146.9), Australia (128.8), the United States (126.3), Denmark (123.2), Sweden (122.3) and South Korea (109.6).

With regard to mobile broadband networks, when making a distinction between technology platforms, the one with the highest coverage continues to be mobile broadband 3.5G (UMTS with HSPA), reaching 99.7% of all Spanish households. Meanwhile, LTE/4G networks are already reaching 94.4% of households, which represents an increase of 3.9 percentage points compared to the percentage recorded in early 2016[21].

Mobile devices

Worldwide, during the first quarter of 2017, smartphone manufacturers sold a total of 347.4 million equipment (an increase of 4.3% compared to the previous period), which represented greater growth than expected following the significant drop in sales in 2016[22].

The sale of smartphones in Spain is led by the Asian brands. Samsung achieved 24% of the market share, followed by Huawei with 21%. Apple comes fourth, with 8%[23].

Unlike smartphones, the sale of tablets has declined worldwide. This annual drop is estimated at 8.5%, this being the tenth quarter of year-on-year falls. This

[21] Informe de cobertura de banda ancha en España a mediados de 2016. Ministerio de Energía, Turismo y Agenda Digital – Secretaría de Estado para la Sociedad de la Información y la Agenda Digital.

[22] IDC, World Quarterly Mobile Phone Tracker 1Q2017. Press release: http://www.idc.com/getdoc.jsp?containerId=prUS42507917

[23] Kantar Worldpanel. Samsung lidera las ventas de smartphones en 2016. Press release: https://www.kantarworldpanel.com/es/Noticias/Samsung-lidera-las-ventas-de-smartphones-en-2016

international trend is also reflected in Spain, where in 2016 the sale of tablets dropped by 20.1% compared to the previous period[24].

With regard to the use of mobile phones, 86% of young people have a smartphone and use it as their primary equipment for instant messaging (81.7%), access to social media (77.5%), listening to music (65.2%) and streaming videos (52.2%). According to the Global Web Index[25], it is expected that some 50% of young people will be 'mobile first' in 2018; in other words, that 90%-100% of their network time will be spent on a smartphone.

Monthly data traffic by smartphone continues to increase in every region in the world. In North America (with the densest traffic), average consumption reached 6 GB per month in 2017, while in Western Europe this figure is 3.9 GB per month. Small-screen equipment (less than 6") generate more than 95% of the mobile data traffic in Spain.

5G

Numerous operators carried out field tests with pre-5G technologies in 2017. It is anticipated that the first commercial version of the 5G networks (developed in phases based on the evolution of the LTE standard) will be available by the end of 2019 or early 2020[26]. It is estimated that by 2025 there will be global 5G coverage of 34%; in other words, some 2.6 billion subscribers worldwide.

5G offers unprecedented capabilities (>20 Gbps/site, GHz bandwidths, high spectral efficiency, high equipment density of 1 million equipment/km², 500 km/h mobility), but what is really amazing is the decrease in latency (<1 ms) and its reliability which on the one hand will make new applications a reality and on the other will be the most complicated and costly to implement, requiring a complete overhaul of the architecture to make it more flexible, efficient and scalable.

5G represents an excellent opportunity to tackle a revolution in the network and its services, although the journey towards the final destination will not be short of challenges, both technical and economic, especially in Europe.

The evolution towards 5G is, therefore, a path of innovation that must be maintained in the long term. Although analysts are assuming that this new technology will not be a real commercial reality until 2020, the economic forecasts of consultancy companies seem very promising: IHS estimates that the contribution of 5G technology to the global economy will be in the region of 12.3 trillion dollars by 2035.

[24] Ditrendia, Informe Mobile en España y en el mundo 2017.
[25] https://www.globalwebindex.net/
[26] GSMA. The Mobile Economy 2017.