



**Generalitat
de Catalunya**

2013 Annual Report on Radiofrequency Electromagnetic Field Exposure Levels in Catalonia



February 2014

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1. Introduction

The enormous popularity of mobile telephony in recent years has not only meant a major technological revolution, but has also produced a highly significant transformation from a social, economic and environmental point of view.

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

Mobile telephony is a radio communication system, 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 appearance of television and radio towers and antennae on mountains has enabled society to enjoy decades of these services. However, mobile phones, unlike radio and television, require antennae closer to the users, in order to offer quality mobile voice and data services.

The appearance of the first mobile phone antennae in urban environments generated a degree of public concern. Firstly, this was due to the visual impact of some of them, and, secondly, due to the uncertainty regarding possible harmful effects on health due to exposure to the electromagnetic fields generated by the antennae. The European Union noted this public concern in surveys carried out in 2007¹ and 2010.²

Such public unease caused problems in deploying mobile phone antennae. 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 solutions agreed by consensus with respect to the deployment of mobile phone antennae. In addition, in order to guarantee information to the public on the matter, it calls for Member States to publish maps showing electromagnetic field exposure levels, and suggests that these maps be made available online for consultation. The same resolution also requires the European Commission to present an annual report on electromagnetic field exposure levels in the European Union.

With the information currently available on possible effects on the human body, it is known that there may be an increase in temperature, depending on the strength, exposure time and part of the body exposed to the radiofrequency electromagnetic fields (radio, television, mobile phone and Wi-Fi, among others): this is the so-called thermal effect. Furthermore, according to statements from various expert groups,⁴ no

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/757/757441/757441es.pdf

⁴ The World Health Organisation (WHO) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP)

conclusive scientific evidence has been found establishing a cause-effect relationship between exposure to radiofrequency electromagnetic fields and harmful effects on health if exposure levels are under the maximum permitted levels indicated in the ICNIRP recommendations.

With respect to the possible long-term effects of exposure to radiofrequency electromagnetic fields, in 2011 the International Agency for Research on Cancer (IARC) classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B).⁵ This basically means that the observed evidence of risk is limited, although it cannot be ruled out, hence the continuing support for research programmes.

2. Government of Catalonia: actions undertaken

Also aware of the problems associated with deploying mobile phone antennae 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 Radiofrequency Monitoring System (SMRF) network of monitoring devices for the continual measurement of electromagnetic field levels from mobile phone antennae, which is currently the largest network of its kind in the world, with 300 monitoring devices 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 Telecommunications Infrastructure) in 18 municipalities in Catalonia. The main objective is to generate a consensus among town councils, mobile phone service providers and the public with respect to deploying mobile phone antennae. The results in the municipalities where this process has been implemented have been highly satisfactory for all parties.

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 co-funding was applied for and in 2010 the European Commission and the Catalan Government signed a co-funding agreement through the LIFE instrument for the period 2010-2014⁶ to develop the project LIFE09 ENV/ES/000505 'Radio-electric Governance: Environment and Electronic Communications Policies for Deployment of Radiocom Infrastructures'.

⁵ http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf

⁶ An application for extending the period to 2015 is currently underway.

The project LIFE09 ENV/ES/000505 includes different actions, whose main objective is to offer the public extensive information on electromagnetic fields and the operation of radio communication systems. Among the most notable aspects, 100 electromagnetic field level monitoring devices were acquired, to expand the existing SMRF network by installing them in the 10 most-populated cities in Catalonia. In addition, 50 portable electromagnetic field level measuring devices were acquired for transfer to a number of Catalan organisations (mostly local councils), in order to measure electromagnetic field levels in their municipalities.

The measurements taken with the SMRF network monitoring and portable devices can be viewed on the Radio-electric Governance website (governancaradioelectrica.gencat.cat). You can also visit this website to consult detailed information on electromagnetic fields 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 electromagnetic fields and harmful health effects.

The LIFE09 ENV/ES/000505 project also plans to create and disseminate a yearly report showing the Catalan population's exposure levels to radiofrequency electromagnetic fields, based on measures taken by the monitoring and portable devices.

As part of the LIFE09 ENV/ES/000505 project, the Government of Catalonia carried out a survey in 2011⁷, in which more than 60% of those interviewed indicated they would like more information on electromagnetic fields and, in this context, 75% stated they would prefer this information to be provided by the Government of Catalonia and health organisations. Sixty per cent of those interviewed stated they would trust information published by the Catalan Government on this topic.

All the actions included in the Radio-electric Governance project have two aims: firstly, to ensure 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 antennae, required to offer quality services, is sufficient, regulated and does not harm people or the environment.

3. Regulations on exposure to electromagnetic fields in Catalonia

In Catalonia, the electromagnetic emissions generated by radio communication systems must comply with the regulations of Royal Decree 1066/2001, which

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<http://governancaradioelectrica.gencat.cat/documents/10180/51436/Enquesta%202011%20a%20Catalunya.pdf>

establishes maximum electromagnetic field levels to which the general public may be exposed.

The maximum levels indicated in RD 1066/2001 are the same as those indicated in the European Union Council Recommendation in 1999 (1999/519/EC), which, in turn, are the same as those given by the ICNIRP in 1998. Other European Union countries apply the same regulations.

These maximum exposure levels are directly related to the emission frequency of radio communication systems. Thus, for example:

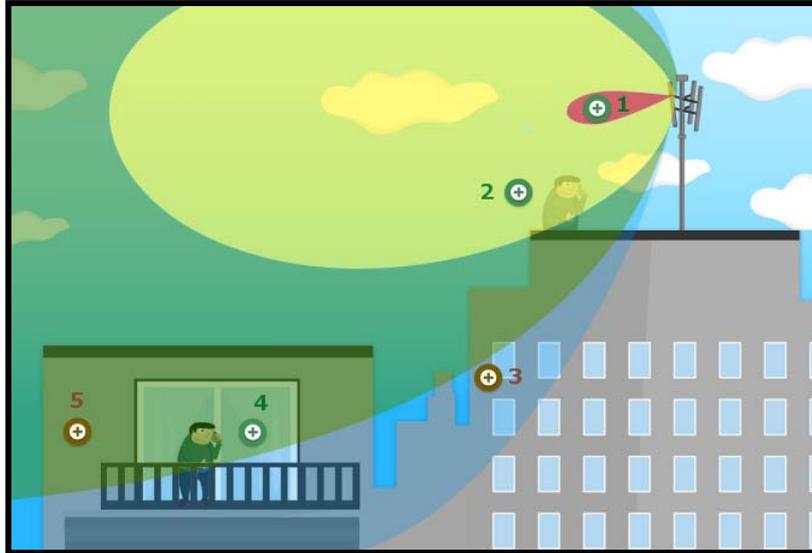
| Frequency range | Service | Maximum permitted level (V/m) ⁸ |
|-----------------------|-----------------|--|
| 530 – 1605 kHz | AM radio | 87 |
| 88 – 108 MHz | FM radio | 28 |
| 470 – 862 MHz | DTT | 29 |
| 900 – 2600 MHz | Mobile phones | 41 |
| 2400 MHz and 5000 MHz | Wi-Fi | 61 |
| 2450 MHz | Microwave ovens | 61 |
| 2500 MHz | WiMAX | 61 |

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 illustration shows the different types of areas of exposure to electromagnetic fields from mobile phone antennae:

⁸ Electromagnetic field exposure levels may be given in different units. The most common units are power density (W/cm^2 or mW/m^2) and electric field (V/m).



1. External 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 indicated in regulations might be measured.

2. External 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. Internal 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. External 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 antennae are not generally pointing directly at these areas, so the capacity to provide the service from the antenna is unused.

5. Internal measurement

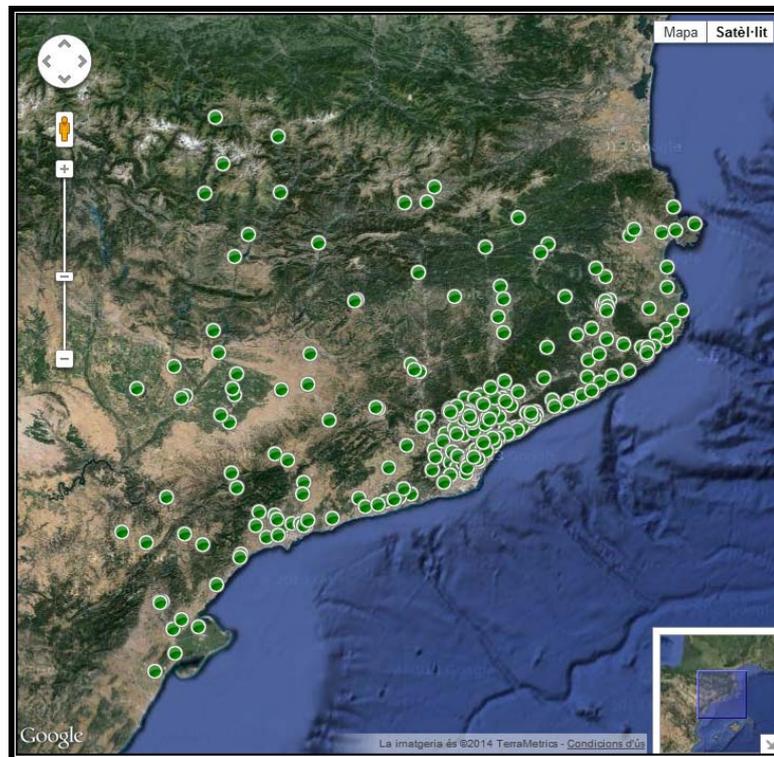
Indoor spaces in buildings next to buildings with the antennae. Very low levels, because, as stated in the previous point, building walls weaken the signal.

4.1 Levels measured with monitoring equipment

As previously mentioned, Catalonia has the SMRF network of electromagnetic field level monitoring equipment, with 300 devices installed in 184 municipalities in Catalonia. These devices continuously measure electromagnetic field levels and send the measurements automatically to a control centre owned by the Catalan Government.

There are monitoring devices installed in all the regions of Catalonia, with larger numbers in more heavily populated areas, where there are generally more mobile phone antennae.

The following map shows the geographic distribution of monitoring devices:



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

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

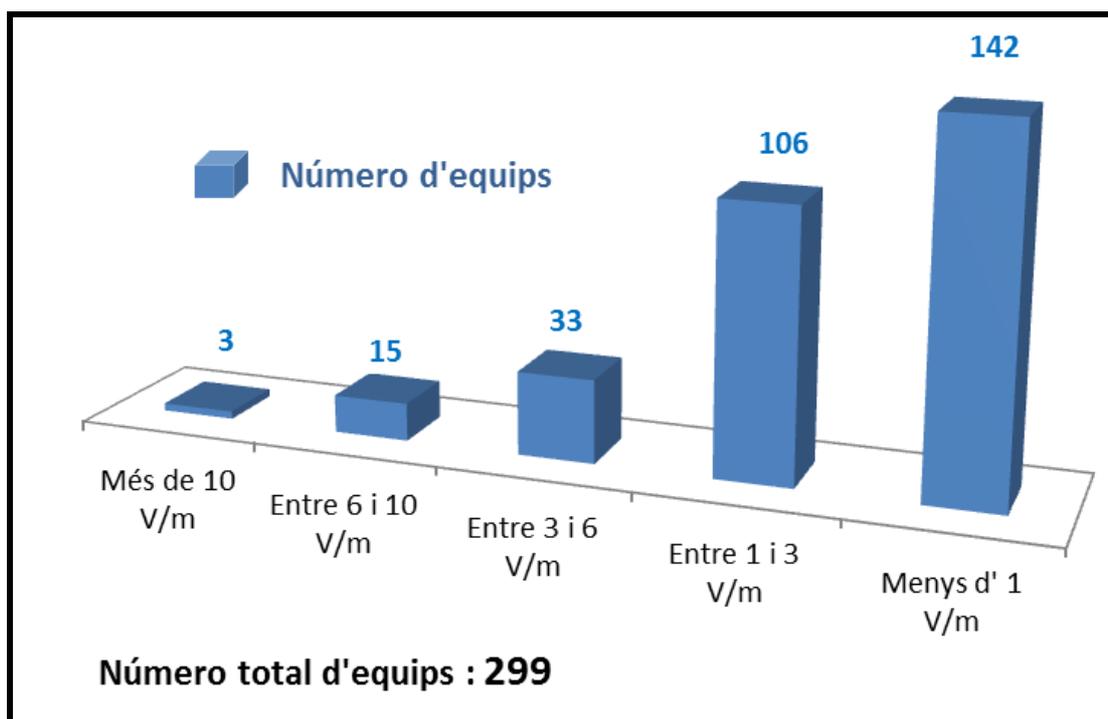
- The distance of the monitoring device from the antenna.
- The number of antennae in a given antenna site.

- Whether the monitoring device is placed in the direction of maximum emission of any of the antennae.
- Whether the monitoring device is at a similar height to the antennae.
- The range of electromagnetic field frequencies measured by the monitoring device.

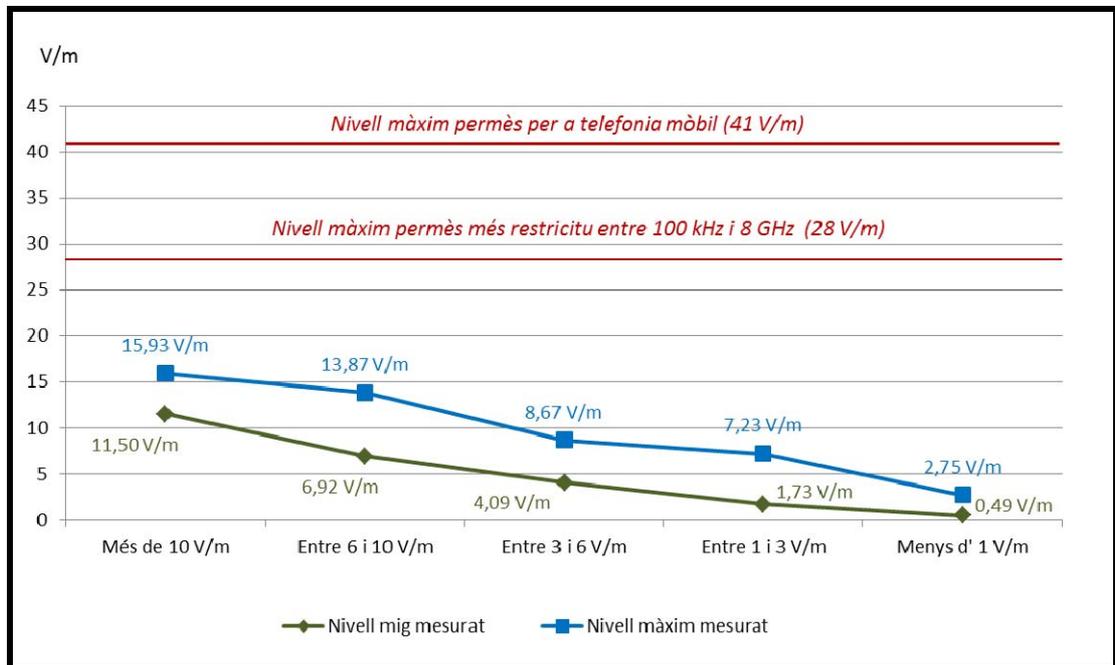
Ninety-two per cent of the SMRF network monitoring devices only measure the electromagnetic field level from mobile phone antenna with frequency bands of 900 MHz, 1800 MHz and 2100 MHz. The other 8% measure the electromagnetic field level of all frequency bands from 100 kHz to 8 GHz; that is, as well as mobile phones, they also measure the electromagnetic fields from other radio communication systems, such as AM and FM radio, DTT, Wi-Fi or WiMAX, among others.

4.1.1 Breakdown of the number of monitoring devices by average measured level

Below is a graph showing the number of monitoring devices in relation to the electromagnetic field level measured:



Below are the average and maximum levels measured in each measurement range given in the above graph:



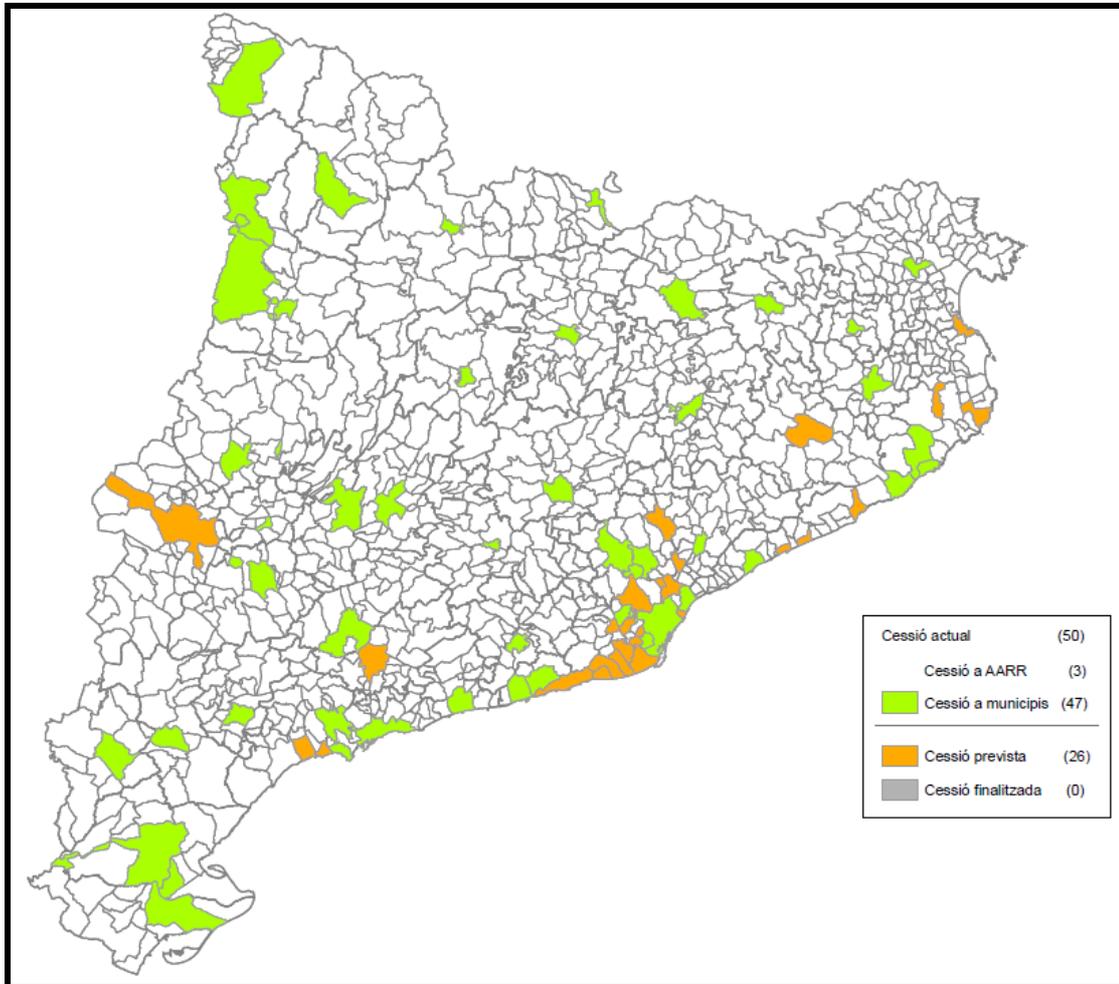
Conclusion: All the measurements taken with SMRF network monitoring devices are below the regulatory maximum levels.

4.2 Levels measured with portable devices

Fifty portable electromagnetic field level measuring devices have been transferred to different organisations in Catalonia: town and regional councils and the Rangers of Catalonia. In 2013, measurements were taken at **1,266 sites**, with a total of **4,019** readings taken. The measurements were taken in nurseries, pre-schools, primary and secondary schools, primary care centres, hospitals, nursing and care homes, public parks, private homes and others.

The 50 portable devices provided measure the electromagnetic field level of all frequency bands from 100 kHz to 8 GHz; that is, as well as mobile phones, they also measure the electromagnetic fields from other radio communication systems, such as AM and FM radio, DTT, Wi-Fi or WiMAX, among others.

Below is a map with the geographical distribution of the organisations to which portable devices have been provided:



The portable devices have enabled measurements to be taken in areas generally further away from mobile phone antennae and often less high. Therefore, the levels measured with portable devices are generally much lower than the levels measured with monitoring devices, which, as stated above, are generally near the antennae and at similar heights and locations to the maximum direction of the antennae.

The following table gives a summary of measurements with portable devices in 2013, indicating the number of measurements taken indoors and outdoors and the average levels measured for each type of location:

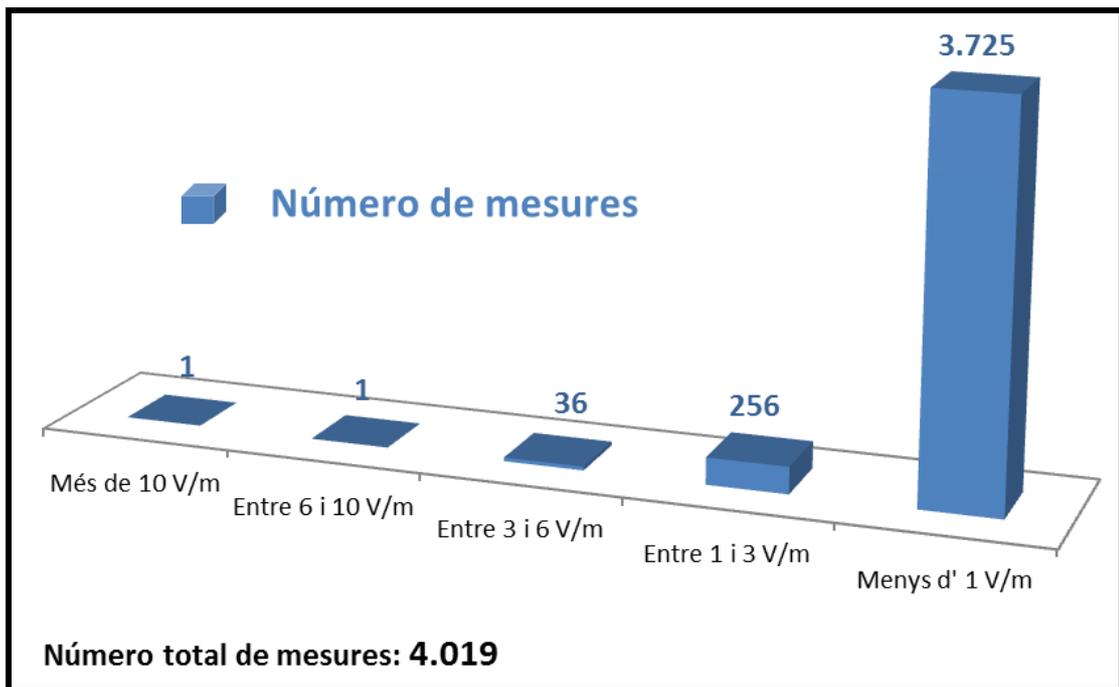
| | Number of reports | Number of measurements | Average level measured (V/m) |
|---------------------------------------|-------------------|------------------------|------------------------------|
| Nurseries | 148 | 446 | |
| Outdoor measurements | | 228 | 0.25 |
| Indoor measurements | | 218 | 0.13 |
| Pre-school and primary schools | 255 | 1,103 | |
| Outdoor measurements | | 488 | 0.32 |
| Indoor measurements | | 615 | 0.18 |
| Compulsory secondary schools | 115 | 489 | |
| Outdoor measurements | | 216 | 0.36 |
| Indoor measurements | | 273 | 0.27 |
| Primary care centres | 104 | 287 | |
| Outdoor measurements | | 101 | 0.30 |
| Indoor measurements | | 186 | 0.17 |
| Hospitals | 19 | 131 | |
| Outdoor measurements | | 30 | 0.43 |
| Indoor measurements | | 101 | 0.53 |
| Nursing and care homes | 93 | 335 | |
| Outdoor measurements | | 125 | 0.37 |
| Indoor measurements | | 210 | 0.23 |
| Private homes | 49 | 126 | |
| Outdoor measurements | | 46 | 1.93 |
| Indoor measurements | | 80 | 0.83 |
| Public parks | 198 | 314 | |
| Outdoor measurements | | 313 | 0.43 |
| Indoor measurements | | 0 | - |
| Other | 285 | 788 | |
| Outdoor measurements | | 398 | 0.57 |
| Indoor measurements | | 390 | 0.23 |
| Total | 1,266 | 4,019 | |

Conclusion: The levels of the 4,109 measurements taken with portable devices at 1,266 sites are under the regulatory maximum levels.

As can be seen in the previous table, the measurements taken with portable devices (unlike the measurements with monitoring devices) also show the difference between measurements taken indoors and outdoors. In this context (except for some

measurements taken in hospitals⁹), the level of measurements taken indoors in 2013 at most of the 1,266 sites are between 26% and 65% lower than the measurements taken outdoors at the same sites. This difference, as indicated previously, is due to the weakening caused by walls and ceilings of buildings.

The number of measurements taken with portable devices with respect to the levels measured is shown below:



⁹ In the case of some hospitals, some indoor measurement levels are higher than outdoor ones, because these hospitals (as is also the case with many hotels and office buildings) have small indoor antennae, with the aim of providing an indoor service.

The levels measured in some homes are occasionally slightly higher than those measured at other sites because the private homes are relatively close to mobile phone antennae and at a similar height. However, in all cases they are below the maximum permitted levels.

5. Radio-electric Governance project

The actions carried out as part of the Radio-electric Governance project are in line with the recommendations and suggestions of the European Parliament (Resolution 2008/2211(INI)) and 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 antennae.

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

- Creation of the Radio-electric Governance website
Related to the European Parliament recommendation and the survey among the Catalan population to offer information to the public on electromagnetic fields and the operation of radio communication systems, and to publish the measured electromagnetic field exposure levels on maps online.

- Production of an annual report on electromagnetic field exposure levels among the general public.

6. Conclusions on the electromagnetic field levels measured

The list of levels measured by monitoring and portable devices can be downloaded at:

- All the levels measured comply with regulations and can be viewed on the Radio-electric Governance website: **governancaradioelectrica.gencat.cat**.
- The measured levels are directly related to: the distance from the antennae; whether the measurement was taken at a similar height to the antennae; and whether the measurement was taken in the direction of maximum emission of any of the antenna. Thus, the highest levels are found only a few metres from and at a similar height to the antennae and in the direction of maximum emission of some of them. In all other cases the measured levels are lower.
- The measurements taken with the continuous monitoring devices permit levels over long periods to be measured and possible variations in the levels to be analysed.
- The portable devices permit measurements to be taken in places where people are present for longer periods of time and check that the levels are below those measured with monitoring devices, because generally the sites where measurements are taken with portable devices are further away from and lower than the antennae.
- The levels of indoor measurements are generally around 26% to 65% lower than outdoor measurements, due to weakening by walls and ceilings of buildings.

7. Recommendations regarding deployment of mobile phone antennae

With respect to the deployment of mobile phone antennae, especially in the urban environment, it may be stated that:

- It is essential for local government, mobile phone service providers and citizens' associations to work more closely together in deploying the mobile phone antennae, in order to create a climate of mutual trust. This will, firstly, ensure that mobile phone antennae deployment is sufficient, regulated and does not harm people and the environment and, secondly, that the public is provided with quality mobile voice and data services for their social and economic activities.
- The deployment of mobile phone antennae must ensure that public exposure to electromagnetic fields in general and those from mobile phone antennae in particular comply with the 'as low as reasonably achievable' concept (*ALARA*). Therefore:
 - The deployment of mobile phone antennae in the urban environment must be as evenly distributed as possible.
 - Once the location of a mobile phone antenna has been decided:
 - The service provider has to minimise as far as possible the exposure to electromagnetic fields in the areas close to the antennae where people might enter. Similarly, directing the antennae towards these spaces must be avoided as far as possible, among other aspects.
 - The antennae must be placed as high as possible on the mast on which they are installed.
- It is important for government agencies to provide mobile phone service providers with available public land to analyse their radio-electric viability for installing mobile phone antennae.
- In order to reduce the visual impact, the antennae and associated equipment must blend into the environment as far as is reasonably possible.