

Health, Scientific and Legal Issues Relating to Mandatory Remote Reading of Energy Consumption

(Directive (EU) [2023/1791/EU](#) – Italian Legislative Decree No. 73/2020)

Technical, Scientific and Legal Memorandum

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1. Introduction

This Technical, Scientific and Legal Memorandum aims to examine the health, scientific and legal issues associated with the mandatory¹ installation of remote-reading systems for energy consumption provided for by Directive (EU) [2023/1791/EU](#) and transposed into Italian law through Legislative Decree No. 73/2020, with a compliance deadline set for 1 January 2027.

¹It should be noted that this obligation is not unconditional under Union law but is expressly dependent on the fulfillment of the mandatory requirement of cost-effectiveness. The present memorandum argues that such a condition cannot be regarded as satisfied where the assessment fails to take into account the full range of health, environmental and social costs. Moreover, many Member states even do not have the cost-effectiveness analysis.

In its practical technical implementation, this obligation results, in the vast majority of cases, in the adoption of devices based on radiofrequency (RF) technologies, involving continuous or periodic electromagnetic emissions within residential environments.

As a consequence, the population is subjected to involuntary, chronic and widespread exposure to artificial electromagnetic fields in a particularly sensitive setting, namely the home, where individuals should be able to exercise fully and safely their right to health and to physical and psychological integrity. (Annex I)

In light of the available scientific evidence concerning the biological effects of RF radiation (Annex II), as well as the implications for persons affected by Electrohypersensitivity (EHS) (Annex III), this obligation raises significant concerns with regard to the protection of public health, the principle of non-discrimination and compliance with the precautionary principle.

Although European legislation does not formally mandate the use of RF technologies, the practical implementation of remote reading is predominantly carried out through wireless systems without non-wireless alternatives. This is not a democratic solution.

2. Critical Issues Associated with Mandatory Remote Reading

2.1 Market forces

The mandatory installation of remote-reading systems for energy consumption raises significant technical, health-related and environmental concerns, primarily due to the lack of genuine technological neutrality within the regulatory framework. Although the legislation does not formally impose a specific technological solution, it does not explicitly provide for the adoption of alternatives that do not generate electromagnetic emissions, such as wired systems. As a result, market forces are effectively directed towards wireless technologies, which are easier to install, but which entail continuous exposure of the population to RF electromagnetic fields without providing adequate safeguards for vulnerable individuals.

Although European legislation does not formally require the use of RF technologies, the practical implementation of remote-reading requirements is predominantly carried out through wireless communication systems, which are generally regarded by operators as the simplest, least expensive and most easily deployable solution. Consequently, a requirement that is formally technology-neutral results, in practice, in the progressive and widespread deployment of radiofrequency-emitting sources within residential buildings and everyday living environments.

In other words, the problem is not that the European Union explicitly mandates RF technologies. Rather, the problem is that the requirement for remote reading is driving, through market dynamics and the technological choices of service providers, the widespread deployment of wireless technologies without ensuring the effective availability of equivalent alternatives that do not generate electromagnetic emissions.

2.2 Environmental perspective

A further concern arises from an evident contradiction from both an energy-efficiency and environmental perspective, as wireless technologies are inherently less efficient than wired solutions.

It has been estimated that wireless communications consume up to ten times more energy than wired communications, such as optical fibre networks.² The widespread deployment of remote-reading systems therefore appears inconsistent with the stated objectives of energy efficiency and environmental sustainability pursued by the legislation.

This aspect of environmental inconsistency becomes particularly relevant in light of the fact that the cost-effectiveness assessments used to justify the deployment of remote-reading systems tend to focus primarily on the economic benefits for network operators and energy service providers, such as reductions in meter-reading, administrative and maintenance costs. By contrast, health, social and environmental costs, as well as those associated with the protection of fundamental rights and any obligations arising from the need to provide reasonable accommodation for vulnerable individuals, are generally excluded from such assessments.

As a consequence, economic cost-benefit evaluations risk reflecting only part of the overall balance, without taking into account the full range of externalities borne by society as a whole.

2.3 Proportionality and appropriateness

A further concern relates to the actual effectiveness of remote-reading systems in achieving energy savings. The benefits associated with such systems appear to depend heavily on consumer behaviour and are not supported by unequivocal and universally applicable evidence sufficient to justify the introduction of a mandatory measure that entails widespread and involuntary exposure of the population to electromagnetic fields. As such, the proportionality and appropriateness of this regulatory intervention appear open to question in light of the currently available scientific and technical evidence.

An additional element of concern arises from a broader issue of systemic inconsistency within European Union law, particularly in relation to the provisions of Directive (EU) 2019/944 on common rules for the internal market for electricity and Directive (EU) 2024/1788 on common rules for the internal markets for renewable gas, natural gas and hydrogen. These Directives establish that smart metering systems should be designed in the interests of final customers, ensuring access to consumption data, the possibility of direct monitoring, and effective control over the use and transmission of such data, in accordance with the principles of proportionality, necessity and personal data protection. Within this regulatory framework, remote communication of data does not constitute an absolute obligation but rather a tool subordinate to the protection of users' rights.³

² Baliga Jayant (University of Melbourne and National ICT Australia) e Robert Ayre, Kerry Hinton, and Rodney S. Tucker (University of Melbourne), Energy Consumption in Wired and Wireless Access Network, Energy Efficiency In Communications, IEEE Communications Magazine, June 2011.

³From a historical perspective, the predecessor of Directive (EU) 2023/1791, namely Directive 2012/27/EU, originally provided consumers with an unconditional possibility to submit self-readings of hot water, cold

In light of these principles, the widespread imposition of remote-reading systems based on RF technologies, without the provision of equivalent technical alternatives that do not generate electromagnetic emissions, appears inconsistent with the user-centred approach underlying European legislation. It deprives citizens of effective control over the methods used to collect and transmit their data and imposes a specific technological solution that is not strictly necessary to achieve energy-efficiency objectives. This results in a clear inconsistency between different instruments of Union law, which on the one hand promote user control and freedom of choice, while on the other hand, in practical implementation, lead to the imposition of technological systems that affect fundamental rights without adequate guarantees of proportionality and availability of alternatives.

2.4 Remote management

A further concern relates to the remote control capabilities inherent in the architecture of smart metering systems. New-generation electronic meters are integrated into remote management infrastructures that allow not only the collection of consumption data but also the remote execution of operations such as power limitation, suspension of service and reconnection of supply. Although such functionalities are governed by formal procedures and safeguards, their existence entails the technical possibility of directly intervening in access to an essential service within the home environment.

Such remote-control capabilities have significant implications for the private sphere of the individual and therefore require a high level of protection with regard to proportionality, security and the safeguarding of fundamental rights. In addition, the availability of high-frequency consumption data may, under certain circumstances, allow the daily habits of household occupants to be reconstructed with a high degree of accuracy, creating a potential risk of interference with the right to privacy.

To this must be added the non-theoretical risk of unauthorized access to remote-management systems. The digital infrastructures upon which smart-metering systems rely may be vulnerable to cybersecurity threats, creating the possibility of external interference, data manipulation or unlawful interruption of essential services. In a context where such technologies are deployed on a widespread and mandatory basis, any compromise of these systems could assume a systemic dimension, with significant implications not only for the security of personal data but also for the continuity of essential services.

From this perspective, the widespread introduction of remote-reading systems based on connected and remotely controllable technologies requires particularly rigorous scrutiny in light of the precautionary principle, the principle of proportionality and the protection of fundamental rights. Such risks cannot be regarded as marginal or negligible.

2.5 The definition of "remote"

water and heat consumption. Following the amendments introduced by Directive (EU) 2018/2002, applicable from 24 December 2018, that possibility became conditional upon the Member State deciding to make it available. The same approach has been maintained in Directive (EU) 2023/1791.

There is no definition what remote means. The term "remote reading" is not defined in the legislative.

Meters with a remote reading function ("intelligent" consumption meters, smart meters) - in addition to the visual reading, they send data remotely)

- data is sent via data cable to the connected device
- data is sent via power line cable
- data is sent wirelessly, i.e. through radio frequency radiation
 - data transfer takes place on request to the recording portable device of the authorized worker (Walk-by mode)
 - data transmission happens regularly and the signal is received by **the bus** or reading center (AMR mode)
 - combined modes (Walk-by + AMR)
- On top of those mentioned above it can also be a way that a person takes a photo of the display and sends the numbers via mail or email (self-reading).

In democracy, a citizen must be able to choose among them freely without any sanctions or discrimination.

3. Legal Grounds of Illegitimacy

3.1 Violation of the Right to Health

The mandatory installation of remote-reading systems based on RF technologies, insofar as it entails involuntary and continuous exposure within the home environment, may be in conflict with the fundamental right to health, as protected by Article 32 of the Italian Constitution, which recognizes health as both an individual right and a collective interest, and by Article 35 of the Charter of Fundamental Rights of the European Union, which recognizes the right of every individual to preventive healthcare and health protection. In the presence of scientific evidence documenting biological effects occurring even at non-thermal exposure levels, the imposition of unnecessary exposure in a particularly sensitive setting such as the home appears incompatible with the obligation of public institutions to ensure a high level of protection of human health.

3.2 Violation of the Precautionary Principle

The precautionary principle, recognized under European Union law by Article 191 of the Treaty on the Functioning of the European Union (TFEU) and consistently reflected in the case law of the Court of Justice of the European Union, requires public authorities to adopt preventive measures where there is a potential risk to human health or the environment, even in situations of scientific uncertainty. In the present case, this principle is particularly relevant because scientific evidence exists documenting biological effects associated with exposure to RF electromagnetic fields; such exposure is technically avoidable through the

adoption of alternative solutions that do not generate electromagnetic emissions, including wired systems; and the home environment constitutes a setting of continuous and prolonged exposure characterized by particular vulnerability. Within this framework, the widespread imposition of RF-based technologies appears inconsistent with the obligation to adopt a precautionary approach aimed at minimizing risks to the population.

3.3 Indirect Discrimination under the Convention on the Rights of Persons with Disabilities (CRPD)

The mandatory use of RF technologies may constitute a form of indirect discrimination within the meaning of the United Nations Convention on the Rights of Persons with Disabilities (CRPD), ratified by Italy through Law No. 18 of 3 March 2009 and binding upon both the European Union and its Member States. In particular, Article 2 of the Convention defines discrimination as any distinction or exclusion that has the effect of impairing the enjoyment of fundamental rights, while Article 5 establishes the principle of equality and non-discrimination and Article 25 guarantees the right to health without discrimination on the basis of disability.

In the case of persons affected by EHS, the imposition of residential environments saturated with RF emissions may result in concrete limitations on access to housing, employment and social participation, thereby creating an environmental barrier incompatible with the principles of the Convention. Furthermore, the principle of reasonable accommodation, also established by the CRPD, may be violated where technically feasible alternatives are available but are neither guaranteed nor made accessible, effectively transferring the burden of protection onto the vulnerable individual.

3.4 Violation of the Principle of Proportionality

The principle of proportionality, a cornerstone of European Union law and recognized by Article 5 of the Treaty on European Union (TEU), requires that every measure adopted by public authorities be appropriate, necessary and proportionate to the objectives pursued.

In the case of mandatory remote reading, this principle appears compromised because the measure entails widespread exposure of the population to a potential health risk without clear and unequivocal evidence demonstrating significant and structural benefits in terms of reducing energy consumption. Moreover, the availability of less intrusive technological alternatives, such as wired systems, demonstrates that the objectives pursued could be achieved through means that are less invasive and more respectful of fundamental rights, rendering the current configuration of the obligation open to challenge on proportionality grounds.

It follows that the objective of energy efficiency pursued through the mandatory introduction of remote-reading systems is not supported by unequivocal scientific evidence demonstrating a significant and structural reduction in energy consumption. The available literature indicates that any positive effects are largely dependent upon user behaviour rather than upon the technology itself, making the contribution of remote reading uncertain, variable and non-determinative.

In this context, the widespread imposition of RF-based technologies constitutes a measure that is not necessary for achieving the stated objectives, since the same results may be pursued through alternative solutions that do not generate electromagnetic emissions and are less intrusive from both a health and environmental perspective.

The absence of a certain and demonstrable benefit therefore renders disproportionate the introduction of an obligation that results in widespread and continuous environmental exposure, creating an avoidable risk for the general population and, to an even greater extent, for individuals affected by EHS, for whom such exposure may result in concrete limitations on access to housing, employment and social participation.

Consequently, the current regulatory framework produces an illegitimate imbalance between energy-policy objectives and fundamental rights, insofar as it permits the sacrifice of the right to health, the precautionary principle and the principle of non-discrimination in the absence of a proportionate, necessary and adequately demonstrated benefit.

4. Conclusions

In light of the scientific evidence and legal considerations examined in this memorandum, the mandatory implementation of remote-reading systems for energy consumption provided for under Directive (EU) [2023/1791/EU](#) and transposed into Italian law through Legislative Decree No. 73/2020, in its current implementation predominantly based on RF technologies, constitutes a measure that significantly and unnecessarily affects fundamental rights.

The available scientific evidence documents biological effects occurring at non-thermal exposure levels, thereby calling into question the adequacy of current safety standards, which remain based exclusively on thermal effects. In this context, the imposition of continuous exposure within the home environment appears incompatible with the right to health protected by Article 32 of the Italian Constitution and Article 35 of the Charter of Fundamental Rights of the European Union, as well as with the precautionary principle established under Article 191 of the Treaty on the Functioning of the European Union (TFEU).

From a legal perspective, the measure also results in an unjustified restriction of the rights of persons affected by EHS, raising concerns regarding compliance with the United Nations Convention on the Rights of Persons with Disabilities (CRPD), particularly Articles 2, 5 and 25, including the obligation to provide reasonable accommodation.

Taken together, these elements reveal a structural lack of proportionality, as the restrictions imposed upon fundamental rights are not justified by demonstrated benefits nor by the absence of viable technological alternatives.

In other words, the problem is not that the European Union explicitly mandates RF technologies. The problem is that the requirement for remote reading is, in practice, driving the widespread deployment of wireless technologies through market dynamics and industry choices, without ensuring the effective availability of equivalent alternatives that do not generate electromagnetic emissions. As a result, a policy that is formally technology-neutral

is producing, in practice, an increasing proliferation of radiofrequency-emitting sources within homes and residential environments.

This situation becomes particularly concerning in view of the approaching 1 January 2027 deadline, which risks accelerating the replacement of existing systems with wireless technologies selected primarily on the basis of economic considerations and ease of deployment, before adequate non-radiofrequency alternatives have been sufficiently developed, assessed and made available.

A review of the current European regulatory framework therefore appears urgently necessary. In particular, the 1 January 2027 deadline should be suspended or postponed in order to allow for a comprehensive assessment of the health, environmental and social implications of remote-reading systems and to facilitate the development and deployment of alternative technologies that fully respect the precautionary principle, technological neutrality and the protection of fundamental rights.

The current economic and energy context may encourage decisions driven primarily by immediate cost reductions for network operators and service providers, while transferring potential health, environmental and social costs to citizens and future generations. Responsible public policy cannot be based solely on short-term economic efficiency but must take into account the full balance of costs and benefits for society as a whole.

Energy efficiency cannot override the right of people with EHS to live, work and participate fully in society. The ecological transition cannot justify the introduction of a new form of environmental pollution where technically feasible and less intrusive alternatives exist. A genuinely sustainable policy must simultaneously protect the climate, public health, fundamental rights and freedom of technological choice.

The energy transition must adapt to people, rather than forcing people to adapt to technologies that may restrict their health, autonomy and full participation in society.

ANNEX I

Nature of Exposure and Characteristics of Artificial RF Fields

Artificial electromagnetic fields, and in particular RF fields, are characterized by physical properties and modes of biological interaction that differ substantially from those of natural electromagnetic fields, to which living organisms have adapted throughout the course of evolution. Whereas natural fields are predominantly static or slowly varying and occur within relatively stable environmental conditions, artificial RF fields consist of pulsed signals characterized by rapid and continuous changes in polarity and are introduced into an exposure environment that is unprecedented both in terms of intensity and mode of propagation.

Pulsation represents a central element in understanding biological effects, as the continuous changes in polarity generate phenomena of electrical induction within living tissues, with the potential to alter cellular function and biological regulatory systems. Such effects occur independently of any increase in tissue temperature and are therefore attributable to non-

thermal mechanisms involving the cell's electromagnetic environment, enzymatic systems and metabolic processes.

The human organism, having evolved under electromagnetic conditions characterized by stable signals of extremely low intensity, is now exposed to pulsed artificial fields of significantly greater intensity and complexity, resulting in a qualitative modification of the electromagnetic environment in which biological systems operate. In this context, risk assessment based exclusively on thermal parameters appears reductive and scientifically incomplete, as it fails to take into account the biological effects associated with chronic low-intensity exposures, which have been extensively documented in the scientific literature.

Current safety standards, based primarily on the prevention of acute tissue-heating effects, do not adequately take into account bioelectrical interaction mechanisms and non-thermal effects, thereby potentially underestimating the health impact of prolonged exposure to RF fields. Consequently, risk assessment relating to such technologies requires a broader approach capable of considering the full range of biological interactions, including those occurring at the cellular, enzymatic and systemic levels, which may arise even in the absence of detectable thermal effects.

ANNEX II

Scientific Evidence Concerning Health Risks

Non-Thermal Biological Effects

The independent scientific literature increasingly indicates that exposure to RF electromagnetic fields is capable of producing biological effects at levels below the exposure limits currently in force, which are based predominantly on the prevention of acute thermal effects. These effects, extensively documented in both experimental and observational studies, involve multiple biological systems and manifest through neurological and behavioural alterations, sleep and concentration disturbances, endocrine dysfunctions, effects on fertility, and interference with enzymatic systems.

In particular, RF fields have been shown to increase oxidative stress and induce DNA damage, suggesting direct interactions with fundamental cellular mechanisms and biological regulatory processes. These findings are consistent with the hypothesis of non-thermal effects mediated by alterations in the cellular electromagnetic environment and biochemical systems. Such effects have also been observed under conditions of chronic low-intensity exposure, further supporting the view that an exclusively thermal paradigm is insufficient to explain the full spectrum of biological effects associated with RF electromagnetic fields.

Epidemiological Evidence and Carcinogenicity

From both an epidemiological and experimental perspective, the evidence concerning the carcinogenicity of RF electromagnetic fields led the International Agency for Research on Cancer (IARC) to classify such exposures in 2011 as a Possible Human Carcinogen (Group

2B), acknowledging the existence of an association between exposure and an increased risk of cancer.

Subsequent studies have further strengthened this body of evidence, reporting increased incidences of gliomas and Schwann-cell tumours in experimental animal models, as well as epidemiological associations between long-term exposure to radiofrequency-emitting devices and an increased risk of brain tumours among the most heavily exposed individuals.

In 2015, oncologist Lennart Hardell concluded that the available scientific evidence supported the classification of RF radiation as a human carcinogen according to the criteria used by the IARC. Hardell argued that the accumulated epidemiological and experimental findings justified a reassessment of the existing classification and warranted consideration of a higher level of carcinogenic risk.

Although scientific debate continues regarding the precise classification of RF radiation, the existence of credible evidence suggesting carcinogenic potential is of particular relevance from a public-health perspective. This is especially true in situations involving widespread, involuntary and long-term exposure affecting large segments of the population, including vulnerable groups and children.

In such circumstances, the precautionary principle requires that regulatory authorities take into account not only established risks, but also plausible and scientifically supported indications of potential serious harm, particularly where exposure can be reduced or avoided through the adoption of alternative technological solutions.⁴

Researchers involved in the French CERENAT study reached similar conclusions in the same year, reporting a positive association between both glioma and meningioma and the cumulative duration of mobile phone use.⁵

As early as the 1990s, epidemiological studies conducted among populations exposed to sources of RF radiation had already identified signals of potential health risk. In 1995, an initial study by Dr. Neil Cherry highlighted a possible public-health concern associated with exposure to RF transmitters, reporting increased incidences of cancer and other adverse health outcomes among populations residing in the vicinity of transmission facilities.⁶

Subsequently, investigations conducted by Dr. Roger Santini in France (2001–2002) documented a significantly increased prevalence of symptoms including fatigue, sleep disturbances, headaches, difficulties in concentration, memory impairment, depression and irritability among populations living in proximity to mobile phone base stations. The reported effects showed a relationship with residential distance from the transmitting

⁴ Hardell L, Carlberg M. Mobile phone and cordless phone use and the risk for glioma - Analysis of pooled case-control studies in Sweden, 1997-2003 and 2007-2009. *Pathophysiology*. 2015 Mar;22(1):1-13. doi: 10.1016/j.pathophys.2014.10.001. Epub 2014 Oct 29.

⁵ Coureau G et al, Mobile phone use and brain tumours in the CERENAT case-control study, *Occup Environ Med*, doi:10.1136/oemed-2013-101754 Online First 9 May 2014.

⁶ Cherry N. Swiss shortwave transmitter study sounds warning, *Electromagnetic Forum*, Vol. 1, No. 2, Article 10. Institut für Sozial- und Präventivmedizin (Bern), 1995.

antennas, suggesting a possible association between chronic exposure to RF electromagnetic fields and adverse health outcomes.^{7,8}

Of particular relevance are the epidemiological studies reporting increased cancer incidence in relation to proximity to sources of RF exposure. In Germany, a study conducted by Dr. Horst Eger in 2004 involving approximately 1,000 patients found a cancer incidence rate up to three times higher among individuals residing within 400 metres of mobile phone base stations compared with those living at greater distances. The study also reported a shorter latency period for cancer development among the populations living closest to the transmitting antennas.⁹

Similarly, a study conducted by Wolf and Wolf (2004) in Israel reported a fourfold increase in cancer incidence among residents living within 350 metres of mobile phone base stations. The authors also observed a substantially higher increase among female residents, with cancer incidence reported to be up to ten times greater than that observed in the comparison population.¹⁰

These findings were further supported by subsequent studies, including that of Sadetzki et al. (2010), which reported a cancer incidence approximately four times higher among individuals residing within a 350-metre radius of mobile phone base stations,¹¹ and by the Brazilian epidemiological study conducted by Dode (2011), which documented a significant increase in cancer mortality among populations residing in the vicinity of mobile phone base stations, with a relationship between the density of installations and cancer incidence.¹² These studies contributed to a growing body of epidemiological evidence suggesting an association between long-term residential proximity to radiofrequency-emitting installations and increased cancer risk.

The Polish study conducted by Gadzicka et al. (2006) identified a significant correlation between distance from mobile phone base stations and the frequency of reported symptoms,

⁷ Santini R, et al.. Symptomes exprimés par des riverains de stations relais de telephonie mobile. La Presse Medicale. 2001;30:1594.

⁸ Santini R, et al. Enquête sur la sante de riverains de stations relais de telephonie mobile : I/Incidences de la distance et du sexe. [Symptoms experienced by people in vicinity of base station: I/Incidences of distance and sex.] Pathol Biol (Paris). 2002 Jul;50(6):369-73.

⁹ Eger, H., Hagen, K., Lucas, B. Vogel, P. & Voit, H. (2004). The Influence of Being Physically Near to a Cell Phone Transmission Mast on the Incidence of Cancer. Published in Umwelt Medizin Gesellschaft 17,4 2004, as: "Einfluss der räumlichen Nähe von Mobilfunksendeanlagen auf die Krebsinzidenz".

¹⁰ Wolf, R. & Wolf, D. (2004). Increased incidence of cancer near a cell-phone transmitter station. International Journal of Cancer Prevention. Vol. 1, No. 2, April 2004.

¹¹ Sadetzki S, Chetrit A, Jarus-Hakak A, Cardis E, Deutch Y, Duvdevani S, et al. Cellular phone use and risk of benign and malignant parotid gland tumors—a nationwide case-control study Am J Epidemiol 167(4): 457–467, 2008.

¹² Dode AC1, Leão MM, Tejo Fde A, Gomes AC, Dode DC, Dode MC, Moreira CW, Condessa VA, Albinatti C, Caiaffa WT. Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil. Sci Total Environ. 2011 Sep 1;409(19):3649-65. doi: 10.1016/j.scitotenv.2011.05.051. Epub 2011 Jul 13.

particularly headaches ($p = 0.013$). The authors also excluded a placebo effect, noting the low level of risk awareness among the study population.¹³

Similar findings were reported in the study conducted by Hutter et al. (2006), which identified significant associations between power density levels and neurological symptoms, even at exposure levels below the regulatory limits in force.¹⁴

Subsequent studies, including those conducted by Abdel-Rassoul et al. (2007)¹⁵ and Shahbazi-Gahrouei et al. (2013),¹⁶ confirmed an increased prevalence of neuropsychiatric, cognitive and behavioural disturbances among exposed populations, with statistically significant differences compared with control groups.

At the same time, additional research has reported systemic biological effects and biochemical alterations associated with RF exposure. The study conducted by Buchner and Eger (2011) documented dose-dependent alterations of neuroendocrine regulatory systems at exposure levels substantially below the currently applicable safety limits,¹⁷ while the study conducted by Meo et al. (2015) reported a significant increase in glycated haemoglobin (HbA1c) levels and in the risk of Type 2 diabetes mellitus among individuals exposed to higher levels of RF radiation.¹⁸

Experimental studies involving exposed populations, such as that conducted by Gandhi et al. (2014), also reported a significant increase in genetic damage, as assessed by the Comet Assay, suggesting a possible biological mechanism underlying the observed effects.¹⁹

A particularly important contribution comes from more recent studies reporting cytogenetic effects and oxidative stress associated with RF exposure. The European study conducted by Belyaev and Mosgöller (2024) demonstrated a significant increase in DNA damage and chromosomal aberrations among individuals exposed to RF electromagnetic fields in

¹³ Gadzicka, E., Bortkiewicz, A., Zmyslony, M., Szymczak, W. & Szyjowska, A. (2006). Assessment of subjective complaints reported by people living near mobile phone base stations. Nofer Institute of Occupational Medicine, Lodz, Poland. Workshop PTZE Electromagnetics technics in preventive health, Lodz, Poland 13-15 December 2006 (Biuletyn PTZE, nr 14, Warszawa 2006, pp 23-26).

¹⁴ Hutter, H., Moshhammer, H., Wallner, P. & Kundi, M. (2006). Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations, *Occupational and environmental medicine*, 63(5), 307-13.

¹⁵ Abdel-Rassoul G1, El-Fateh OA, Salem MA, Michael A, Farahat F, El-Batanouny M, Salem E. Neurobehavioral effects among inhabitants around mobile phone base stations. *Neurotoxicology*. 2007 Mar;28(2):434-40. Epub 2006 Aug 1.

¹⁶ Shahbazi-Gahrouei, D., Karbalae, M., Moradi, H. & Baradaran-Ghahfarokhi, M. (2013). Health effects of living near mobile phone base transceiver station (BTS) antennae: a report from Isfahan, Iran. *Electromagnetic Biology and Medicine*.

¹⁷ Eger, H., Hagen, K., Lucas, B. Vogel, P. & Voit, H. (2004). The Influence of Being Physically Near to a Cell Phone Transmission Mast on the Incidence of Cancer. Published in *Umwelt Medizin Gesellschaft* 17,4 2004, as: "Einfluss der räumlichen Nähe von Mobilfunksendeanlagen auf die Krebsinzidenz".

¹⁸ Sultan Ayoub Meo et al, Association of Exposure to Radio-Frequency Electromagnetic Field Radiation (RF-EMFR) Generated by Mobile Phone Base Stations with Glycated Hemoglobin (HbA1c) and Risk of Type 2 Diabetes Mellitus, *Int. J. Environ. Res. Public Health* 2015, 12, 14519-14528; doi:10.3390/ijerph121114519.

¹⁹ Gandhi, G., et al., 2014. DNA and chromosomal damage in residents near a mobile phone base station. *Int. J. Hum. Genet.* 14, 107–118.

residential environments, with a clear dose-response relationship.²⁰ These findings further narrow the traditional distinction between ionizing and non-ionizing radiation, suggesting the existence of comparable biological effects, albeit occurring through different mechanisms and over different time scales.

In this context, a systematic review of the scientific literature conducted by Balmori (2022) analysed 38 epidemiological studies involving populations exposed to RF electromagnetic fields under real-life conditions. The review found that 73.6% of the studies reported adverse health effects associated with exposure, with similar proportions observed for the occurrence of symptoms, cancer and biochemical alterations.²¹ These findings demonstrate a significant convergence of evidence and indicate that the biological impact of RF electromagnetic fields cannot be considered negligible, even at exposure levels below current international safety standards, which, as previously noted, are based exclusively on the prevention of acute thermal effects of electromagnetic fields.

Taken together, these epidemiological findings are particularly relevant because they document health effects under conditions of real-world chronic exposure and suggest the existence of biological effects that are not adequately addressed by current safety limits. They therefore reinforce the need for a review of existing regulatory standards, so that protection is extended beyond acute thermal effects and takes into account the growing body of scientific evidence concerning non-thermal biological effects associated with RF electromagnetic fields.

ANNEX III

Electromagnetic Hypersensitivity (EHS)

The scientific literature describes EHS as a condition characterized by a particular susceptibility to electromagnetic fields, in which exposure, even at levels significantly below current regulatory limits, is capable of producing a multi-system symptomatology.

The Scientific Consensus on EHS published in 2021 concluded that EHS is a neurological disorder characterized by elevated oxidative stress and alterations in cerebral perfusion following electromagnetic exposure.²²

A fundamental clinical characteristic of this condition is the relationship between exposure and the onset of symptoms, with improvement or remission occurring following removal

²⁰ Gulati S et al, Evaluation of oxidative stress and genetic instability among residents near mobile phone base stations in Germany, *Ecotoxicology and Environmental Safety*, Volume 279, 1 July 2024, 116486.

²¹ Balmori A. Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer. *Environ Res.* 2022 Nov;214(Pt 2):113851. doi: 10.1016/j.envres.2022.113851. Epub 2022 Jul 14. PMID: 35843283.

²² Belpomme D et al. The Critical Importance of Molecular Biomarkers and Imaging in the Study of Electrohypersensitivity. A Scientific Consensus International Report. *Int J Mol Sci.* 2021 Jul 7;22(14):7321. doi: 10.3390/ijms22147321. PMID: 34298941; PMCID: PMC8304862.

from the electromagnetic source. This pattern is consistent with a specific biological response rather than with a non-specific or psychogenic phenomenon.^{23,24,25,26}

The reported symptomatology affects numerous organs and systems, highlighting the systemic nature of the condition. At the dermatological level, affected individuals commonly report paresthesia and tingling sensations, while musculoskeletal manifestations include joint and muscle pain. Symptoms involving the gastrointestinal system, such as digestive disturbances, are also frequently reported, as are cardiovascular manifestations, including alterations in blood pressure, tachycardia, and sensations of cranial and aural pressure.

From an otorhinolaryngological perspective, tinnitus and vertigo are commonly described, while involvement of the nervous system manifests through sleep disturbances, migraine, neuralgia, and a broad spectrum of neurovegetative symptoms, including fatigue, dizziness, concentration difficulties, memory impairment, anxiety and mood alterations, in some cases progressing to depressive symptoms.

In numerous cases, the severity of the symptoms is such that it results in a significant impairment of quality of life, to the extent of forcing affected individuals to abandon their employment, drastically reduce their social activities and, in more severe situations, relocate to environments characterized by lower levels of electromagnetic exposure in order to maintain minimum conditions of well-being. This circumstance highlights how the ubiquitous deployment of RF technologies may constitute a genuine invisible environmental barrier, with tangible consequences for the exercise of fundamental rights.

Although epidemiological estimates vary among different countries, the available data indicate that the prevalence of the condition is not negligible, with figures reaching significant percentages of the population in both European and international contexts. These findings suggest that the phenomenon represents a public-health and social issue of

²³ Havas M. 2006 Electromagnetic hypersensitivity: biological effects of dirty electricity with emphasis on diabetes and multiple sclerosis. *Electromagn Biol Med* 2006;25(4):259–68.

²⁴ Havas M, et al. 2010 Provocation study using heart rate variability shows microwave radiation from DECT phone affects autonomic nervous system. In: Giuliani L, Soffrio M, editors. “Nonthermal Effects and Mechanisms of Interaction Between Electromagnetic Fields and Living Mafer”, *European J Oncology — Library*. National Institute for the Study and Control of Cancer and Environmental Disease Bologna: Maooli; 2010. pp. 273–300. 2010.

²⁵ McCarty DE, et al. 2011 Electromagnetic hypersensitivity: evidence for a novel neurological syndrome. *Int J Neurosci*. www.ncbi.nlm.nih.gov/pubmed/21793784. 2011 Sep 5.

²⁶ Rea WJ, et al. Electromagnetic field sensitivity. *J Bioelectricity* 1991;10:241–56.

considerable relevance, whose magnitude appears to be increasing over time.^{27,28,29,30,31,32,33,34,35,36,37,38,39,40,}

From a pathophysiological perspective, numerous studies have identified objective biological alterations in individuals affected by EHS, including increased oxidative stress, altered melatonin levels, elevated histamine concentrations and heat-shock proteins, as well as evidence of increased permeability of the blood-brain barrier. These findings have also been confirmed by independent research groups, which have reported biochemical and metabolic abnormalities consistent with a pattern of systemic biological response.

Of particular relevance is the contribution of biophysical models identifying voltage-gated calcium channels (VGCCs) as a possible key mechanism in the development of symptoms. Exposure to electromagnetic fields may induce depolarization of the cell membrane, resulting in an increase in intracellular calcium levels and the subsequent activation of metabolic pathways leading to the production of nitric oxide and peroxynitrite, both powerful mediators of oxidative stress and cellular damage, including DNA strand breaks.

²⁷ Schreier N, Huss A, Rösli M. The prevalence of symptoms attributed to electromagnetic field exposure: a cross-sectional representative survey in Switzerland. *Soz Präventivmed.* 2006;51(4):202-9. doi: 10.1007/s00038-006-5061-2. PMID: 17193782.

²⁸ Rösli, M.; Mohler, E.; Frei, P. Sense and sensibility in the context of radiofrequency electromagnetic field exposure. *Comptes Rendus Phys.* 2010, 11, 576–584.

²⁹ Palmquist E, Claeson AS, Neely G, Stenberg B, Nordin S. Overlap in prevalence between various types of environmental intolerance. *Int J Hyg Environ Health.* 2014 Apr-May;217(4-5):427-34. doi: 10.1016/j.ijheh.2013.08.005. Epub 2013 Aug 19. PMID: 24029726.

³⁰ Levallois, P.; Neutra, R.; Lee, G.; Hristova, L. Study of self-reported hypersensitivity to electromagnetic fields in California. *Environ. Health Perspect.* 2002, 110, 619–623.

³¹ Eltiti, S.; Wallace, D.; Zougkou, K.; Russo, R.; Joseph, S.; Rasor, P.; Fox, E. Development and evaluation of the electromagnetic hypersensitivity questionnaire. *Bioelectromagnetics* 2007, 28, 137–151.

³² Korpinen LH, Pääkkönen RJ. Self-report of physical symptoms associated with using mobile phones and other electrical devices. *Bioelectromagnetics.* 2009 Sep;30(6):431-7. doi: 10.1002/bem.20500. PMID: 19399784.

³³ Schröttner J, Leitgeb N. Sensitivity to electricity-temporal changes in Austria. *BMC Public Health.* 2008 Sep 12;8:310. doi: 10.1186/1471-2458-8-310. PMID: 18789137; PMCID: PMC2562386.

³⁴ Furubayashi T et al. Effects of short-term W-CDMA mobile phone base station exposure on women with or without mobile phone related symptoms. *Bioelectromagnetics.* 2009 Feb;30(2):100-13. doi: 10.1002/bem.20446. PMID: 18780296.

³⁵ Kowall, B et al. Determinants and stability over time of perception of health risks related to mobile phone base stations. *Int. J. Public Health* 2012, 57, 735–743.

³⁶ Blettner M et al. Mobile phone base stations and adverse health effects: Phase 1 of a population-based, cross-sectional study in Germany. *Occup. Environ. Med.* 2009;66:118–123. doi: 10.1136/oem.2007.037721.

³⁷ Tseng, M.C.; Lin, Y.P.; Cheng, T.J. Prevalence and psychiatric comorbidity of self-reported electromagnetic field sensitivity in Taiwan: A population-based study. *J. Formos. Med. Assoc.* 2011, 110, 634–641.

³⁸ Baliatsas, C.; van Kamp, I.; Hooiveld, M.; Yzermans, J.; Lebre, E. Comparing non-specific physical symptoms in environmentally sensitive patients: Prevalence, duration, functional status and illness behavior. *J. Psychosom Res.* 2014, 76, 405–413.

³⁹ van Dongen D, Smid T, Timmermans DR. Symptom attribution and risk perception in individuals with idiopathic environmental intolerance to electromagnetic fields and in the general population. *Perspect Public Health.* 2014 May;134(3):160-8. doi: 10.1177/1757913913492931. Epub 2013 Aug 2. PMID: 23912159.

⁴⁰ Tatoń G, Kacprzyk A, Rok T, Pytlarz M, Pawlak R, Rokita E. A survey on electromagnetic hypersensitivity: the example from Poland. *Electromagn Biol Med.* 2022 Jan 2;41(1):52-59. doi: 10.1080/15368378.2021.1995873. Epub 2021 Oct 22. PMID: 34686066.

These mechanisms are consistent with the observation of biological effects occurring at non-thermal exposure levels.

Further evidence derives from double-blind studies in which individuals affected by EHS have demonstrated objective physiological responses to electromagnetic field exposure, including alterations in heart rate, the onset of neurological symptoms within a short time after the beginning of exposure, and changes in brain activity documented through imaging techniques. These findings are inconsistent with an exclusively psychogenic interpretation of the condition.

Despite the existence of such evidence, EHS is not currently formally recognized by the major public-health agencies, which tend to classify it within non-specific diagnostic categories or to interpret it primarily through psychological models, in contrast with the emerging findings reported in the scientific literature. In particular, some institutional positions advocate therapeutic interventions focused exclusively on symptom management without considering the reduction of electromagnetic exposure, thereby adopting an approach that appears to be in evident tension with the fundamental medical principle of *primum non nocere* ("first, do no harm").

In this context, the widespread introduction of wireless devices within residential environments, including remote-reading systems and smart meters, assumes particular significance, as these technologies constitute a continuous and unavoidable source of domestic exposure. Both the scientific literature and clinical experience report cases in which the installation of such devices has been associated with the onset or worsening of symptoms consistent with Electromagnetic Hypersensitivity, suggesting a possible link between environmental exposure and clinical manifestations in susceptible individuals.

Taken together, this body of evidence outlines a scientific picture that cannot be considered negligible and calls for careful consideration of the health and social implications associated with the widespread deployment of RF technologies, particularly within residential environments, where exposure is continuous, involuntary and difficult to avoid.