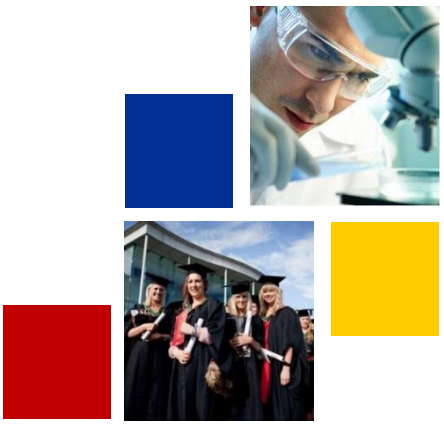
An Opinion of the Trustworthiness of and Unscientific Bias in the ICNIRP Guidelines 2020

Professor Tom Butler
University College Cork, Ireland

A submission to the European Commission's Scientific Committee on Health, Environmental and Emerging Risks (SCHEER) in response to its published Opinion: *Scientific evidence on radiofrequency.*



A TRADITION OF INDEPENDENT THINKING

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Biography



Dr. Tom Butler is a Professor at the Department of Business Information Systems, University College Cork. A former satellite and microwave systems engineer, Tom has an extensive career in the research, design, implementation and operation of information and communication technologies (ICT). Since 2004, he has received several major research grants totalling €8.7m, more recently to investigate how artificial intelligence could be applied for governance, risk and compliance (GRC) in the financial industry. His Government of Ireland Fellowship on the environmentally sustainable ICT focused his attention on the environmental, social and personal risks posed by technology and the ethical responsibilities of industry and government policymakers. His research is guided by the philosophies of science and technology and in collaboration with independent scientists across disciplines. Tom has 225 publications, which include 79 full papers and 84 conference papers: He is ranked in the top 2% of scientists by discipline globally by researchers at Stanford University.

An Opinion of the Trustworthiness of and Unscientific Bias in the ICNIRP Guidelines 2020

1 Introduction

Independent research on adverse biological effects in humans, plants and animals through exposure to microwave radiofrequency radiation (RFR) provides clear evidence of risk.[1] Researchers argue that policymakers have "failed to reassure citizens that their health and the health of their children is sufficiently protected" from current levels of RFR exposure.[2] Since 1998, member states of the EU look to the International Commission on Non-ionizing Radiation Protection (ICNIRP) for risk assessments and guidance on occupational and public exposure to RFR from all sources. ICNIRP's Guidelines published in 1998 and 2020 are the only point of reference for EU policymakers. The ICNIRP opinion dominates all others and heavily influences SCENIHR (Section 4.2.1) and WHO (Section 4.2.3) perspectives on environmental risks posed by RFR to human health and well-being. It is noted in social science research that dominant discourses "threaten the exclusion of counter-discourses and the silencing of voices of dissent from the political sphere of the policy- and decision-making process."[3] This Opinion operates from the critical rationalism of Karl Popper and Thomas Kuhn's perspective on paradigm change in scientific disciplines.[4] As this Opinion demonstrates, there is ample evidence from several research analyses and commentaries that the ICT industry initiated and maintains the dominant scientific paradigm on RFR thermal-only biological effects and associated risks to human health and safety: The industry exercises its power directly and indirectly through both the Institute of Electrical and Electronics Engineers (IEEE) and the ICNIRP. This is troubling, as the ICNIRP NGO (Section 4.2.2) has, through its commissioners' cross-membership of SCENHIR (Section 4.2.1) and the WHO (Section 4.2.3), exerted undue influence on the SCHEER Opinion. Compelling evidence will be adduced herein that the ICNIRP is not independent; instead, it is undoubtedly biased and clearly unethical in its application of the scientific method and, therefore, should not be trusted by policymakers or the SCHEER Committee.

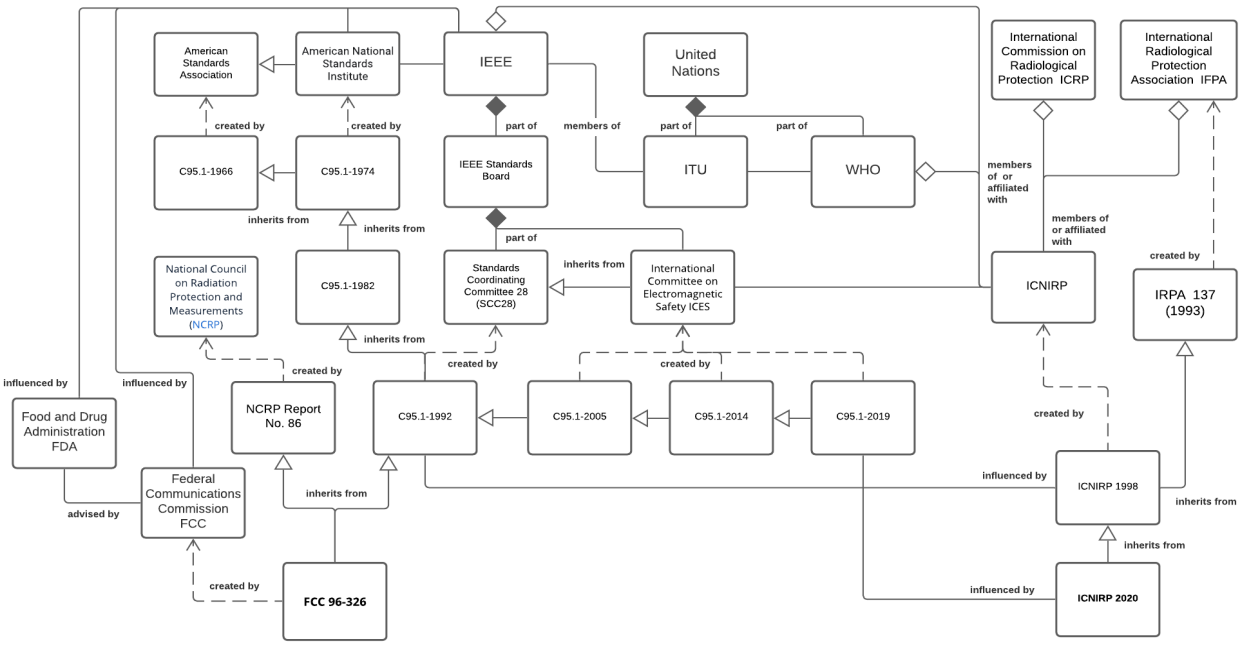


Figure 1 The Relationship between RFR Standards and Guidelines

2 The Origins of the ICNIRP Guidelines

Policymakers and public health bodies unquestioningly accept the ICNIRP Guidelines[5] and reject the existence of adverse bioeffects from nonthermal exposures to RFR.[6] The original ICNIRP Guidelines published in 1998 are similar to those published by the IEEE in C95.1-1991 Standard.[7] As can be seen from Figure 1, the IEEE, through its International Committee on Electromagnetic Safety (ICES), updated the C95 standard in 2005, 2014, and 2019 to accommodate new ICT developed by the industry.[8] The IEEE standards and related ICNIRP guidelines posit that RFR exposures are assumed to lead to adverse bioeffects only at the thermal threshold where human tissue is heated. They systematically, with scientific bias, discount the possibility of nonthermally-related adverse biological effects. Hence, they conclude, there is no risk to human health and well-being if public and occupational exposures adhere to those specified in the published guidelines—this is the dominant perspective,[9] which is influenced by a particular shared value system.[10] In this context, the shared value system among researchers in the IEEE and ICNIRP, which originates through industry influence and the physical presence of IEEE members acting as ICNIRP commissioners and advisors, refers to the set of shared beliefs about the thermal-only biological effects of RFR.

3 Why the ICNIRP Guidelines Cannot be Trusted

According to former ICNIRP commissioner and IEEE member Professor James C. Lin, the ICNIRP is "a privately constituted group, with self-appointed membership."[11] This NGO was established at the General Assembly of the International Radiation Protection Association (IRPA) on May 29, 1992, to protect public health from exposure to non-ionizing radiation such as RFR. Research cited herein demonstrates that the ICT industry shaped and influenced the ICNIRP from the outset through its first Chair, Dr Michael Repacholi.

IRPA expected the ICNIRP to apply and employ similar fundamental principles and approaches as the International Commission on Radiological Protection (ICRP). However, many ICRP members are unhappy with the ethical approach adopted by the ICNIRP. Through the agency of its Chair, Michael Repacholi, and instigator within the IRPA, the ICNIRP secured the support of the WHO from the outset and subsequently influenced its understanding of and research on RFR safety. ICNIRP also had the help of the telecommunications and electrical industries, and particularly the IEEE, of which Repacholi was a member and contributor to the C95.1-2005 standard. The ICNIRP is based in the German Radiation Protection Agency (Bundesamt für Strahlenschutz) building in Munich, Germany.

3.1 Fruit of the Poison Tree

Evidence shows that since its inception, the ICNIRP systematically ignored any independent scientific evidence demonstrating adverse health effects from RFR.[12] The ICNIRP's founder and first chair carefully selected commission members and advisors to have one thing in common: To share the perspective, values, and beliefs of members of the IEEE. Many ICNIRP members, past and present, have close funding and scientific relationships with the ICT industry. According to Professor Franz Adlkofer, *"A milestone in putting through the interests of the mobile communication industry was the establishment of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in 1992. It is a non-governmental organization. Michael Repacholi, [later] head of the WHO's EMF Project, managed to get official recognition for this group by the WHO as well as the EU and a series of its member states, among them Germany. Repacholi, first ICNIRP chairman and later emeritus–member, left the WHO after allegations of corruption in 2006 and found a new position as a consultant to an American electricity provider."*[13] Adlkofer adds that when the ICNIRP *"established the European safety limits it uncritically based its decision on [Dr. Herman] Schwan's pseudo-theorem [of 10 mW /cm2]. The American safety limits were taken over with only minor alterations"*.[14] This is clear from even a rudimentary examination of the ICNIRP guidelines, past and present.

Historical evidence supports Prof. Adlkofer's argument. Dr Michael Repacholi led a research team at The Royal Adelaide Hospital in South Australia tasked with investigating the association between RFR and cancer: it found clear evidence of risk with RFR exposure and the development of lymphomas in mice.[15] Repacholi secured funding from Telstra, formerly Australian Telecom, before privatisation. Repacholi and Telstra expected the experimental study to show no association. Briefly, 100 transgenic

mice, with susceptibility to develop lymphomas were exposed to 900 MHz pulsed radiation for 30 minutes twice a day for 18 months. 43% of the exposed mice developed lymphomas, compared to 22% of the unexposed controls. The exposed mice also developed cancer more quickly. Dr Repacholi and his co-authors called the increased incidence of lymphoma among the exposed mice "highly significant." They added that the faster onset of cancer was not due to chance. They believed it to be the first animal study showing a verifiable nonthermal bioeffect in animals. How Dr Repacholi treated the results of his own study is interesting as it reported that *"Lymphoma risk was found to be significantly higher in the exposed mice than in the controls (OR = 2.4, P = 0.006, 95% CI = 1.3-4.5). Follicular lymphomas were the major contributor to the increased tumor incidence. Thus long-term intermittent exposure to RF fields can enhance the probability that mice carrying a lymphomagenic oncogene will develop lymphomas".*[16] That is, exposed mice were 2.4 times the greater odds of developing lymphomas than controls. The significance of the findings is reported by journalist Mr Stewart Anthony Fist in his statement to the UK Parliament's Select Committee on Science and Technology in 1999 viz. Mr Fist reports that researchers…

> *"conducted two parallel studies on EMF exposure between 1993 and 1995. The research design was checked by a committee of the National Health and Medical Research Council (NHMRC) of Australia (the supreme medical research authority) and the hospital had a special committee supposedly oversighting the day to day activities.*
>
> *The promoter of these two research projects, Dr Michael Repacholi … sold the idea to the electricity supply organisation and cellphone industry as a way to solve their problems once and for all.*
>
> *Repacholi is not so much a scientist (he has no research credentials before this), but is well-known as a spokesman and science administrator. He has long been one of the world's best known and most vocal "No Possible Effects" promoters for both low-frequency mains power and cellphones and therefore had the confidence of both the ESAA and Telstra."* The mobile phone study was funded by *"Telstra (Australia's dominant carrier) to look specifically at possible effects of GSM digital cellphone exposures."*[17]

The GSM study was acknowledged as being scientifically rigorous in that it was a double-blind method and employed control groups of 100 animals with sham exposures, as indicated above. The study's findings were published in Radiation Research in 1997, almost contemporaneously with the development and publication of the ICNIRP guidelines published in 1998, which it should have influenced: Its findings were ignored by both the ICNIRP and the IEEE in drafting its C95.1-2005 standards in which Repacholi also participated. Mr Fist states to the House of Commons Select Committee that the study *"established clearly and with little room for doubt that the industry claim that "cellphone radiation cannot possibly affect biological tissue at non-thermal exposure levels," is a complete lie. And this finding is only one of hundreds which have consistently shown this, with varying degrees of validity and credibility over many years. It fits almost perfectly into the overall "assemblage" of evidence accumulated by many different independent biomedical researchers from many varied studies on animals and cell-cultures".*[18]

This extended extract from Fist's statement to the Select Committee on Science and Technology is exposes Repacholi's bias and values:

> *"What interests me here is the way in which the release of the information was manipulated—by the scientists, by the hospital, and by the ESAA and Telstra (it is often not clear which)—and sometimes by all of them together.*
>
> *Remember, two and a half years after the completion of the study, not one word of results had leaked out. In the interim, Dr Repacholi had attended dozens of conferences and given dozens of interviews, and still vocally maintained his stance that there was no evidence connecting cellphone exposures to adverse health consequences—knowing all the time that his mice had shown a major, highly significant, increase in basal-cell lymphomas.*
>
> *Yet Michael Repacholi told me off-the-record at a London Conference on 15 November 1997 (it is recorded in my journalist's notebook) that the research had turned up "nothing of any*

significance". … At the same London conference, he was very vocal in supporting industry claims that there were no studies linking cellphones to adverse health effects and strongly criticised a few scientists who had turned up positive results. There were dozens of people at the conference who can attest to this.

At this time Dr Repacholi was the head of WHO's EMF Project and probably the second most powerful cell-research-funding bureaucrat in the world (Dr George Carlo was the most powerful)—yet he was publicly denying and discounting his own unpublished research.

At that time Repacholi had known for over two years that the Adelaide Hospital research finding was the most significant link yet discovered."

In 2003, Repacholi published *An Overview of WHO's EMF Project and the Health Effects of EMF Exposure.* He cites just 20 references, one of which is the GSM study he led. That is constructively dismissed in the same fashion as all ICNIRP reviews.

Research in organisations notes the impact of the founders and leaders in shaping an organisation's culture, values, and commitment.[19] There is abundant evidence that the ICNIRP, as the creation of Michael Repacholi, implemented his values and beliefs. These are evident in the 'thermal only view' on the physical and biological effects of RFR, which the ICNIRP holds to the present day. It is also apparent that such values and beliefs dominate in fora in which ICNIRP members participate. Take, for example, that critical peer-reviews of ICNIRP Guidelines and reports where ICNIRP Commissioners and Expert Advisors participated, e.g. in the WHO EMF Committee, European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), and the UK's Advisory Group on Non-ionising Radiation (AGNIR), are essentially compromised and exhibit the same pattern of *"constructive dismissal"* tactics described by Dr Neil Cherry.[20]

3.2 On the ICNIRP's Constructive Dismissal approach to Scientific Findings that Contradict the Dominant Paradigm

The ICT industry, through lobbyists, law firms, and consulting scientists, targeted scientific research funding and co-opted NGOs such as the ICNIRP, and captured agencies and organisations such as the FCC, FDA and the WHO International EMF Project, disputed the health risks of RFR, and undermined scientific findings by using what Michaels and others term a *"junk science"* approach.[21] This approach involves the perverse and biased application of epidemiological approaches and statistical methods to reinterpret valid scientific data to arrive at conclusions that support the industry view of no harm or effect. Proof of this comes from Dr Neil Cherry in his report on the ICNIRP (1998) Guidelines to the New Zealand Ministry of Health and Ministry for the Environment before their adoption (Cherry, 2000, 2004). Dr Cherry termed the way the ICNIRP-WHO treated extant findings as *"The Constructive Dismissal Approach."* He states that *"to maintain the RF-Thermal View against the extremely strong evidence from epidemiology, animal experiments and of non-thermal mechanisms, the WHO and ICNIRP assessors and their colleagues have developed a set of dismissive methodologies. These include:*

- *Maintaining that the RF-Thermal view as the "consensus of science". This allows the biological mechanism to dominate and epidemiology and animal evidence is dismissed.*
- *Maintaining a contrast between Ionizing radiation and Non-ionizing radiation.*
- *Moving the level of evidence goalpost where for a study to become "evidence" it must first be replicated, whereas in the past each study was evidence and replication was required to "establish" a biological effect.*
- *Promoting strict sets of scientific criteria which are proposed as being necessary for reliable use of the results, e.g. the Bradford Hill "criteria", instead of "viewpoints", and Dr Martin Meltz's 13 experimental criteria for testing genotoxicity (Meltz, 1995). In this way all non-thermal evidence is rejected.*
- *Citing studies which are too small and have small follow-up periods so there is little or no opportunity for cancer to develop, as evidence that radar [RFR] exposure does not cause cancer.*

- *Citing studies which do show significant increases in cancer as showing no evidence of increases in cancer.*
- *Preferring to simply quote the conclusions of papers and reports that state that there were no adverse effects found, while failing to recognize that the data and analysis within the documents do show significant associations, including significant dose response relationships.*
- *Dismissing epidemiological studies on the grounds that populations and exposures are not well defined. Lilienfeld explains that this is a difficulty, but results are still relevant and important. (Lilienfeld et al. 1978).*
- *Dismissing research results one by one and failing to assemble and interpret the whole pattern of research results - the divide to conquer approach.*

All of these are demonstrated methods used by WHO and ICNIRP which amounts to a systematic approach to wrongly dismiss evidence of effects, i.e. Constructive Dismissal".[22]

The most recent example of this approach is found in Appendix B: Health Risk Assessment Literature to the ICNIRP Guidelines in 2020, the commission published to its draft guidelines. This brief 11-page overview contains just 24 cited references of research by only by ICNIRP members.[23]The ICNIRP's conclusions are based on two reviews, both led and heavily influenced by ICNIRP Commissioners. The first was the SCENIHR report to the European Commission,[24] the second a literature review by the WHO, which was never published.[25] Both of these reviews are heavily criticised for employing the 'constructive dismissal' approach. ICNIRP made no attempt to review the extant body of research. Indeed, there was no reference to IARC (2011) evaluation of RFR and its subsequent classification as a possible carcinogen. Perhaps the most glaring omission is the significant literature on oxidative stress. The ICNIRP Appendix B summarises it thus:

> *"There is a large body of literature concerning cellular and molecular processes that are of particular relevance to cancer. This includes studies of cell proliferation, differentiation and apoptosis-related processes, proto-oncogene expression, genotoxicity, increased oxidative stress, and DNA strand breaks. Although there are reports of effects of radiofrequency EMF on a number of these endpoints, there is no substantiated evidence of health-relevant effects."*[26]

ICNIRP clearly places greater emphasis on negative findings or claims of no-effect and provides not a single shred of evidence for this claim, or indeed any of the others. ICNIRP, however, is claiming that the cited effects of RFR exposure are not relevant to human health. Yet, as indicated herein, there is an extraordinarily significant body of peer-reviewed scientific literature that demonstrates that these have a key role in cancer causation. That ICNIRP omits the extensive and conclusive review by Yakymenko and colleagues[27] that oxidative stress is caused by RFR exposure and is an adverse bioeffect. This finding is noted in subsequent reviews.[28] ICNIRP also attempts to dismiss and discredit the most important contemporaneous studies that should have it change its guidelines—the NTP and Ramazzini Institute studies.

The NTP study is the subject of particular critical evaluation in the ICNIRP Appendix B. ICNIRP's evaluation follows the *"constructive dismissal"* approach to the letter and ignores the fact that the NTP study was subject to extensive peer-review between 2016 and 2018, including former ICNIRP scientist Prof. J.C. Lin. He was a long-standing member of ICNIRP (2004-2016): Significantly, however, he was invited by the National Institute of Environmental Health Sciences (NIEHS) with 13 other scientists (10 pathologists and toxicologists, 2 electrical engineers, and 1 biostatistician) to carry out a peer-review of the NTP draft reports on cancer development through RFR. Subsequently, he published several papers, the first in 2018 titled: *Clear evidence of cell phone RF radiation cancer risk*.[29] This view stands at odds with that of his former colleagues in the ICNIRP.

In his response to the ICNIRP dismissal, NTP scientist Dr. Ron Melnick (2020) states the ICNIRP *"made several incorrect statements that appear to be written to justify retaining exposure standards that were established 20 years ago."* The ICNIRP 2020 Guidelines acknowledge the problems that would have arisen had its scientist accepted the NTP and Ramazzini findings: *"…if the research was shown to have relevance to humans, this would represent a crucial issue for ICNIRP to incorporate into the advice and guidance that it provides to the community…such as its RF EMF exposure*

guidelines." Dr. Melnick focuses on *"correcting ICNIRP's false claims about the methodology, interpretation and relevance"* of the NTP studies. Melnick states unequivocally that the *"ICNIRP wrongly claims that methodological issues "preclude drawing conclusions about carcinogenicity" from the NTP studies on RF radiation."* In response to criticism regarding the pathology aspects, Melnick points out that *"for all NTP studies, an independent quality assessment pathologist (second tier) reviews all lesions identified by laboratory pathologist…with reviews by working groups (third tier involving over 30 pathologists)."* These were blind reviews. Melnick adds that *"the assertion by the ICNIRP, which has never been made in the 40-y existence of the NTP, impugns the validity of all 600 bioassays performed by this program."* Dr Melnick is defending what he considers a spurious and uncorroborated attack on the integrity of the entire NTP approach to science. He then points out that all original slides and data from the NTP studies are available. Overall, Melnick holds that the ICNIRP provides *"an inaccurate portrayal and interpretation of the data"* and statistical approaches of the NTP study. Melnick goes on to state that the National Toxicology Program (NTP) study on radiofrequency radiation (RFR) *"was designed to test the (null) hypothesis that cell phone radiation at non-thermal exposure intensities could not cause adverse health effects, and to provide dose-response data for any detected toxic or carcinogenic effects."*[30] He states with equivocation that the null hypothesis that nonthermal RFR exposure does not cause cancer is falsified, and the link with cancer is proven beyond all doubt.

Additional first-hand insights into the modus operandi of the ICNIRP and its values come from Professor James Lin, a former ICNIRP commissioner mentioned previously, who critiques fellow commissioners' response to the publication of the US National Toxicology Program and Ramazzini Institute studies:

> *Recently, a privately constituted group with self-appointed membership, published a set of guidelines for limiting exposure to RF electromagnetic fields in the 100-kHz and 300-GHz frequency range [ICNIRP, 2020]. The proposed guidelines were primarily based on the tissue-heating potentials of RF radiation to elevate animal body temperatures to greater than 1° C. While recognising that the two aforementioned studies used large numbers of animals, best laboratory practice, and animals exposed for the entirety of their lives, the private group preferred to quibble with alleged "chance differences" between treatment conditions and the fact that the measured animal body core temperature changes reached 1° C, implying that a 1° C body core temperature rise is carcinogenic, ignoring the RF exposure. The group then pronounced that, when considered either in isolation or within the context of other animal carcinogenicity research, these findings do not provide evidence that RF radiation is carcinogenic. Furthermore, the group noted that, even though many epidemiological studies of RF radiation associated with mobile phone use and cancer risk had been performed, studies on brain tumors, acoustic neuroma, meningioma, and parotid gland tumors had not provided evidence of an increased cancer risk. It suggested that, although somewhat elevated odds ratios were observed, inconsistencies and limitations, including recall or selection bias, precluded these results from being considered for setting exposure guidelines. The simultaneous penchant to dismiss and criticize positive results and the fondness for and eager acceptance of negative findings are palpable and concerning. In contrast, the IARC's evaluation of the same epidemiological studies ended up officially classifying RF radiation as possibly carcinogenic to humans."*[31]

This critique by James Lin of the ICNIRP's values is significant in that it comes from an insider eager to set the record straight, aside from implications that ICNIRP commissioners, who also dominate the WHO panel, are devoid of scientific ethics.

Among hundreds of scientists from across disciplines, eminent scientists Frank Barnes and Ben Greenebaum found issues with ICNIRP Guidelines in 1998 and 2020.[32] Twenty years on from Cherry's (2000, 2004) report to the New Zealand government, they argue: *"Current limits for exposures to non-ionizing electromagnetic fields (EMF) are set, based on relatively short-term exposures. Long-term exposures to weak EMF are not addressed in the current guidelines. Nevertheless, a large and growing amount of evidence indicates that long-term exposure to weak fields can affect biological systems and might have effects on human health. If they do, the public health issues could be important because of the very large fraction of the population worldwide that is exposed"*. This is a strong and suitably

restrained statement, as is the norm for independent scientists. They review the literature and provide a succinct summary of the issues:

> *"The results of these papers have not been considered convincing or relevant by the [ICNIRP and WHO] panels due to methodological issues, because they did not relate closely enough to human health, and because the experimental results are mixed, showing increases, decreases, or no change in similar situations. However, taken as a group, they provide strong evidence that weak EMF can be sensed by biological systems and suggestive evidence that fields may affect human health."*[33]

Barnes and Greenebaum also call for additional research to identify new guidelines that limit levels of exposure to mitigate the risks: They argue that *"Eventual guidelines might suggest limiting cell phone calls to X hours per day with exposure levels above Y W/m^2, and for Z days per week exposure should be less than Y W/m^2 to allow the body to reset its [oxidative] baseline. The time between heavy exposures might be initially estimated by looking at recovery times from other stresses such as exercise … A possibility might be that cell phones and WiFi are turned off at night or over the weekend to allow for resetting of the oxidative baseline levels."*[34] However, if a foetus, child, or adult receives an injury, these measures may be inadequate. The focus on oxidative stress is, I believe, necessary, as the ICNIRP and IEEE constructively dismiss a significant body of peer-reviewed science and omit essential findings that would undoubtedly alter guideline threshold levels.[35]

Another recent research paper provides further evidence of unethical and unscientific behaviour on behalf of the authors of the ICNIRP Guidelines and their affiliates. Norwegian researchers Nordhagen and Flydal shed light on this. [36] Their analysis reveals that the ICNIRP references just 158 papers in support of the guidelines published in 2020 and in its two related appendices: About 1/3 or 50 of these were 'technical papers' and had little to do with identifying or assessing health risks. The network analysis by Nordhagen and Flydal revealed that while 15 independent papers were included, the 91 remaining papers formed a web of published work with ICNIRP members and their associates as authors and co-authors. This was a small, close-knit group of 17 researchers comprised of either ICNIRP Commissioners, or former commissioners, or are closely associated with the ICNIRP, or are members of the IEEE and linked with the ICNIRP through that association. Significantly, 10 of the 17 authors responsible for many of these publications are directly affiliated with the ICNIRP. More troubling is that 6 of these are directly responsible for drafting the 2020 guidelines. 11 of the independent papers cited in the guidelines and appendices found athermal-related biological effects and were, according to the established ICNIRP review approach, constructively dismissed. Nordhagen and Flydal conclude that the ICNIRP peer-reviewed studies and committee reports underpin the risk assessment on which the guidelines *"are cherry-picked from the ICNIRP 2020 authors' own network of collaborating researchers, and from committee reports, they have themselves produced."* This is an extreme case of 'bad science.' In bad science, findings and conclusions are typically based on insufficient or inconsistent data, or on biased 'cherry picking' of specific studies to support a particular argument.[37] Few, if any, of the extant body of hundreds of high-quality, objective, peer-reviewed independent research studies on non-thermal bioeffects possess such weaknesses. Nevertheless, they were not deemed worthy of inclusion in ICNIRP's literature review.

In my opinion, and the evidence supports this, the 'so-called scientific reviews' conducted by ICNIRP consistently exclude, misinterpret, or misrepresent data from original peer-reviewed studies: We now know unequivocally that ICNIRP chiefly includes only research from its extended network of sitting and former commissioners and associates from a small number of Western countries, including the US, Japan, Australia, UK, Netherlands, Greece, Finland, Switzerland, and Sweden. We also know that the ICNIRP exerts undue influence on regulatory agencies in the US, Australia, UK, Netherlands, Switzerland, and Sweden. Based on the evidence presented above, ICNIRP stands accused of not only conducting 'bad science': Its commissioners and their associates should be held to account for unethical behaviour by their host institutions.

3.3 How does the ICNIRP Fund its Activities?

Given the worldwide acceptance of the ICNIRP and the influence its commissioners and their research and published guidelines have on the WHO and policymakers generally, it is not unreasonable to

assume that its finances are substantial and commensurate with its research activities. First, the ICNIRP is an NGO that has persistently and consistently denied receiving industry funding. Hence, its commissioners and advisors declare no conflicts of interest at any level. Given the range of its presumed research, investigatory and dissemination activities, and the fact that it has 14 sitting commissioners, 25 expert advisors, and office and administration staff, then the ICNIRP's income and expenditures should be comparable to its international standing and influence in shaping public policy on wireless ICT risk to human health. The ICNIRP Annual Report 2018 declares that its annual income for 2018 was €133.254, while its expenditures are listed at €150,959: This is troubling as its income is significantly less than the salaries of university professors sitting on the Commission. The other standards-making body in the wireless technology sector is the IEEE. The published accounts for the IEEE show that in 2018 its income stood at $531,942,200. A desktop search found no other international NGO of significance with such poor financial statements or a dearth of funding to this degree. A serious question arises as to this extremely low level of income and expenditure, viz. *how can the ICNIRP fund its many activities and deliver high quality, reliable and accurate research outputs and guidelines and disseminate these globally given such low levels of funding?*

I was recently invited to attend the European Parliament's Panel for the Future of Science and Technology - Workshop on 5G.[38] The workshop was attended by ICNIRP Chair Rodney Croft (Australia) and Vice-Chair Eric van Rongen (Netherlands). In answer to a query to the panel by the author—How can the ICNIRP fund its research activities and finance regular global meetings?— Dr. van Rongen answered in the Chat function that commissioners and advisors fund their travel and expenditure: This is incredible and requires closer examination. As a university professor and former principal investigator of a €6.5 million research centre, I know that any expenditure on university business is closely audited. Any university would not support global travel for a private NGO. This is just one example of the many questions asked of the ICNIRP regarding the transparency of its activities and its income—these issues are now addressed.

3.4 Compelling Evidence of Bad Governance and Conflicts of Interests at the ICNIRP

The ICNIRP stands accused of unethical behaviour in conducting scientific reviews, possessing conflicts of interest, and exercising questionable governance.[39] Scientists are concerned about the practice of ICNIRP Commissioners drafting safety guidelines, and promoting them at ITU and other meetings around the world, while also acting as members of key bodies and expert groups responsible for objectively assessing those safety guidelines: This practice is anathema to fundamental principles of good governance, let alone good science. It is a *conflict of interest*, as indicated by Hardell and Carlberg writ large, and a clear breach of the *separation of duties* required of any public body.[40] Acting in such ways is akin to academics working as authors and reviewers of their own scientific papers. No other area of scientific or business endeavour would countenance such a conflict of interest or lack of independence.

In a 98-page detailed report on the ICNIRP and its activities, Members of the European Parliament (MEPs), Michèle Rivasi and Dr Klaus Buchner find that "*[t]he composition of ICNIRP is very one sided. With only one medically qualified person (but not an expert in wireless radiation) out of a total of 14 scientists in the ICNIRP Commission and also a small minority of members with medical qualifications in the Scientific Expert Group, we can safely say that ICNIRP has been, and is still, dominated by physical scientists. This may not be the wisest composition when your remit is to offer advice on human health and safety to governments around the world."*[39] However, the MEPs demonstrate that this makes it easier to ignore or dismiss research from medical and related disciplines. Buchner and Rivasi observe that *""a closed circle of like-minded scientists" has turned ICNIRP into a self-indulgent science club, with a lack of bio-medical expertise and scientific expertise in specific risk assessments. Thereby, creating a situation which might easily lead to "tunnel-vision" in the organisation's scope. Two leading experts, Hans Kromhout and Chris Portier, confirmed to us that ICNIRP is a closed, non-accountable and one-sided organisation."*[41] Professor Kromhout and Dr. Portier report that "*In addition to the fact that certain members of ICNIRP, are simultaneously members of the International Committee on Electromagnetic Safety (ICES) of the US-registered Institute of Electrical and Electronics Engineers (IEEE), we have seen further evidence of a close cooperation between ICNIRP and ICES, an organisation in which many people from the media and telecom*

industries, as well as from the military, are actively and structurally involved. During the current leadership of ICNIRP, these ties have become even closer "with the goal of setting internationally harmonized safety limits for exposure to electromagnetic fields." This must surely be considered as a situation in which conflicts of interest are a real possibility. It is clear from ICES minutes that ICNIRP worked very closely with IEEE/ICES on the creation of the new RF safety guidelines that were published in March 2020. And this implies that large telecom-companies such as Motorola and others, as well as US military, had a direct influence on the ICNIRP guidelines, which are still the basis for EU-policies in this domain." The Buchner and Rivasi Report provides detailed evidence of a range of conflicts of interests of ICNIRP members, including that of its current chair.

This Opinion argues that there is significant moral, ethical, and related questions to be answered by the ICNIRP. One central question concerns conflicts of interest: While peer-reviewed analyses provide convincing evidence,[42] recent studies published by Members of the European Parliament and eminent Swedish researchers are conclusive.[43] The International Committee of Medical Journal Editors provides the following conceptualization of conflicts of interest in the field of medicine, which is of relevance to this study.

> *"The potential for conflict of interest and bias exists when professional judgment concerning a primary interest (such as patients' welfare or the validity of research) may be influenced by a secondary interest (such as financial gain). Perceptions of conflict of interest are as important as actual conflicts of interest…*
>
> *Financial relationships (such as employment, consultancies, stock ownership or options, honoraria, patents, and paid expert testimony) are the most easily identifiable, the ones most often judged to represent potential conflicts of interest and thus the most likely to undermine the credibility of the journal, the authors, and science itself. Other interests may also represent or be perceived as conflicts, such as personal relationships or rivalries, academic competition, and intellectual beliefs." [44]*

In a US context, University of California at San Diego Professor Beatrice Golomb points out that the *"[e]ffects of conflicts of interest on research results (as well as on funding, regulatory agencies, legislation and academics) vis a vis RF/MW, has been repeatedly documented and decried."*[45] She cites Richard Smith, Editor in Chief of the British Medical Journal, who argues that financial interests cloud objectivity, and who states *"far from conflict of interest being unimportant in the objective and pure world of science where method and the quality of data is everything, it is the main factor determining the result of studies"*.[46] She (ibid.) adds that *"[it] has been generally assumed that the disproportionately product-favorable results from industry-funded studies (including less evidence of product harm) arises by virtue of choices, selecting study design, exposure specifics, subjects, and outcomes to support the desired result. (… these can in fact influence outcomes.) But where harms of lucrative products are concerned, there is precedent for industry-funded studies going beyond those factors to hide even large and lethal harms, even for prespecified or primary outcomes – via means that have the appearance, at least, of fraud…. Special circumstances enabled the apparent shenanigans in those cases to be uncovered. Whether frank manipulation of data to hide harms of lucrative products is the rule or the exception in industry-funded studies is simply not known."*

In their analysis of conflicts of interest, as they pertain to the activities of the ICNIRP, eminent scientists Hardell and Carlberg delineate several unequivocal instances of the presence of conflicts of interest.[47] They examine the Swiss government's policy on 5G, which was clearly influenced by the ICNIRP's Martin Röösli, a professor in environmental epidemiology at the Swiss Tropical and Public Health Institute. In issuing the formal statement, he opined: *"Regarding the health issue, the working group concludes that, until now, no health effect has been consistently proven below the given exposure limits."* As Hardell and Carlberg demonstrate, this stands in stark contrast with the views of the majority of scientists and the scientific evidence. Indeed, a study co-authored by Professor Röösli in 2018 found *"a potential adverse effect of RF-EMF brain dose on cognitive functions [of adolescents] that involve brain regions mostly exposed during mobile phone use"*.[48] Why would Professor Röösli, like Michael Repacholi before him, ignore the findings of his research? Hardell and Carlberg point to significant conflicts of interest (COI) involving Professor Röösli and other members of the government panel. They

extend this critique to other members of the ICNIRP viz. in *"2008, the Ethical Council at Karolinska Institute in Stockholm stated that being a member of ICNIRP is a potential COI. Such membership should always be declared. This verdict was based on activities by Anders Ahlbom in Sweden, at that time a member of ICNIRP, but is a general statement (2008-09-09; Dnr, 3753-2008-609). In summary: 'It is required that all parties clearly declare ties and other circumstances that may influence statements, so that decision makers and the public may be able to make solid conclusions and interpretations. AA [Anders Ahlbom] should thus declare his tie to ICNIRP whenever he makes statements on behalf of authorities and in other circumstances' (translated into English)."*[49]

In addition, Hardell and Carlberg point out that the…

> *"ICNIRP has not managed to conduct a novel evaluation of health effects from RF radiation. However, as shown in Table [6] several of the present ICNIRP members are also members of other committees, such as the EU Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), the Swedish Radiation Safety Authority (SSM) and the WHO, thus creating a cartel of individuals known to propagate the ICNIRP paradigm on RF radiation […]. In fact, six of the seven expert members of the WHO, including Emelie van Deventer, were also included in ICNIRP […]. Therefore, Emilie van Deventer, the team leader of the Radiation Programme at WHO (the International EMF Project), is an observer on the main ICNIRP commission, and SSM seems to be influenced by ICNIRP. Among the current seven external experts (Danker-Hopfe, Dasenbrock, Huss, Harbo Polusen, van Rongen, Röösli and Scarfi), five are also members of ICNIRP, and van Deventer used to be part of SSM.*
>
> *As discussed elsewhere, it is unlikely that a person's evaluation of health risks associated with exposure to RF radiation would differ depending on what group the person belongs to. Therefore, by selecting group members, the final outcome of the evaluation may already be predicted (no-risk paradigm). Additionally, we believe that this may compromise sound scientific code of conduct."*[50]

In relation to ICNIRP membership of the SCENIHR committee, independent researchers Sage, Carpenter, and Hardell report that SCENIHR never *"answered the question it was appointed to investigate. The Committee has answered a different question, limiting its conclusions to whether certainty or causal effect is established, instead of possibility of health risks... Overall, SCENIHR has not conducted a scientific review process for judging possible health risks. This results in erroneous and deceptive conclusions by failing to conclude such possible health risks do exist. Evidence that SCENIHR has presented clearly and conclusively demonstrates that EMF health risks are possible, and in some cases are established."* [51] Independent researchers conclude that the exercise of bias by, and the presence of, significantly conflicted ICNIRP members was responsible for the obfuscation, erroneous and deceptive conclusions.

Hardell and Carlberg, among many others, echo this conclusion by Dr. Susan Pockett:

> *"ICNIRP is a self-selected, private (non-governmental) organization, populated exclusively by members invited by existing members. The organization is very concerned to project the image that it is composed of disinterested scientists—indeed all ICNIRP members are required to post on the organization's website detailed declarations of interest (DOIs). However, a closer inspection of these DOIs reveals that a good many of the sections of a good many of the forms remain unfilled, and a detailed list of undeclared conflicts of interest among ICNIRP members has been published by a group of concerned citizens […]. The relevant section of WHO is essentially identical to ICNIRP […]: Michael Repacholi, the founder of ICNIRP, established the WHO International EMF Project (IEMFP) in 1996 and remained in charge of it until 2006 […], when he reportedly resigned after allegations of corruption […] to officially become an industry consultant […]. In 2004, Repacholi stated in a conference presentation that the IEMFP was able to "receive funding from any source through Royal Adelaide Hospital; an agency established through WHO Legal Department agreement to collect funds for the project"—an arrangement that reportedly enabled receipt of annual payments of $150,000 from the cellphone industry […]." Thus, in spite of their stated rules and protestations to the*

> *contrary, there have been persistent allegations that both ICNIRP and the relevant section of WHO are riddled with undeclared conflicts of interest."*[52]

So successful is the ICNIRP in influencing the EU and governments globally, including the US federal agencies such as the FCC and FDA, that industry lobbying in this area is now practically non-existent, although that was not always the case as the report by Members of the European Parliament argues viz. the *"European Telecommunications Networks Operators' Association (ETNO) does not lobby for lowering the ICNIRP standards, as these are not seen as part of the "regulatory pressure" that hampers technological development. On the contrary: the norms ICNIRP proposes are the "harmonised limits" that ETNO welcomes. All in all, the telecom-sector seems to be quite pleased with ICNIRP's positioning. This deviates from the standard procedure in EU-policy making, where a specific industry concerned will, on essential aspects, always try to influence laws and regulations in its favour through various lobbying strategies. Apparently, in the case of ICNIRP, there is simply no need to do so. At the same time, the insurance sector does not, at present, seem very reassured and does not want to be put in a situation of having to pay potential litigation costs, if and when telecom companies get sued, something that is happening more and more often."*[53] The same applies to the US, where the industry has captured the FCC.[54]

Hardell and Carlberg conclude the following in relation to conflicts of interest at the ICNIRP and its influence on policymaking:

> *"Few individuals, and mostly the same ones, are involved in different evaluations of health risks from RF radiation and will thus propagate the same views on the risks in agencies of different countries associated with the ICNIRP views (…). Therefore, it is unlikely that they will change their opinions when participating in different organizations. Furthermore, their competence in natural sciences, such as medicine, is often low or non-existent due to a lack of education in these disciplines (…). Therefore, any chance for solid evaluations of medical issues is hampered. Additionally, it must be concluded that if the 'thermal only' dogma is dismissed, this will have wide consequences for the whole wireless community, including permissions for base stations, regulations of the wireless technology and marketing, plans to roll out 5G, and it would therefore have a large impact on the industry. This may explain the resistance to acknowledge the risk by ICNIRP, EU, WHO, SSM and other agencies. However, the most important aspects to consider are human wellbeing and a healthy environment."*[55]

The credibility and integrity of the ICNIRP's position are undermined by former ICNIRP members that now recognise RFR as a significant risk to human health, as exemplified above by the quotes from James Lin. ICNIRP members find themselves in direct opposition to their former colleagues, particularly where the results of the NTP study are concerned. Even their current colleagues in IRPA are now voicing similar concerns following the release of the ICNIRP Guidelines in 2020.

The WHO's International EMF Project is concerned about the poor management of risk to public health from RFR. However, it is informed by the deeply flawed and biased guidelines from ICNIRP, with which the International EMF Project cooperates closely, and the fundamental ignorance by policymakers of the large body of extant research on the significant non-thermal health effects of RFR.

Independent scientists conducting research on the biological effects of RFR argue that their peers in ICNIRP are unscientific and unethical in their assessments of the evidence and risk to public health. Take, for example, the increasing body of evidence in peer-reviewed academic research that confirms governments and policymakers; (1) may be misled by the ICNIRP; (2) are succumbing to pressures from industry and lobbyists; or (3) are turning a blind eye to scientific and public concerns for economic reasons.[56]

3.5 Why the ICNIRP Thermal Effect Threshold Guidelines Fail to Protect the Public

This section builds on the evidence and arguments presented above regarding the failure of ICNIRP Guidelines and IEEE/ICES C95.1 standards to protect public health. First, a logical observation: *If adverse health effects occur at relatively low levels of RFR power densities, below the levels known to cause body heating, then thermal-only guidelines are insufficient to protect public health*. The guidelines in question are those published by ICNIRP. They are for all intents and purposes identical to

the reviews and risk assessments presented in the IEEE/ICES C95.1 standard series. As indicated, the original guidelines were published in 1998, commented upon in 2009, and *"somewhat modified"* in 2020 to accommodate 5G technologies.[57] A majority of research papers demonstrate the existence of biological or adverse health effects at power density levels far below the ICNIRP thermal guidelines. These studies were peer-reviewed, which indicates the validity of the findings. Many of these studies were also included in peer-reviewed review studies cited herein, where scientists examined the outcomes and found them worthy of inclusion in presenting a balanced view of the risks. Hence, it may be reasonably inferred that by failing to include evidence from valid, published studies, the ICNIRP (and IEEE) guidelines are deficient and do not protect public health or the biosphere.

The only biological effects the ICNIRP guidelines protect against are thermal effects, as heating is the only physical-biological effect taken into account when arriving at protection RFR threshold levels. The ICNIRP and the IEEE use the Specific Absorption Rate (SAR) to arrive at protective levels against thermal injury from high levels of RFR exposure. The problem with this approach is highlighted by scientist and IEEE member Om Gandhi and colleagues:

> *"The existing cell phone certification process uses a plastic model of the head called the Specific Anthropomorphic Mannequin (SAM), representing the top 10% of U.S. military recruits in 1989 and greatly underestimating the Specific Absorption Rate (SAR) for typical mobile phone users, especially children."* [58]

The paper by Gandhi and colleagues provides a useful summary of the use of this measure by the IEEE, FCC and ICNIRP. It concludes that *"Because, the SAM-based cell phone certification process substantially underestimates the SAR for 97% of the population, especially for children, the SAM-based certification process should be discontinued forthwith."* Hence, even here the ICNIRP Guidelines fail to protect against thermal effects. This point was recently underlined by Gandhi[59] who pointed out that:

> *"In published literature it has been reported that because of a larger volume for 10 g of tissue the ICNIRP standard will permit radiated powers of cell phones to be 2.5 to 3 times higher than those allowed by the IEEE/FCC standard."*

Thus, the ICNIRP's accommodation of industry needs in terms of relatively high wireless signal power levels to increase the range of smartphones and other devices is even more generous than that of the IEEE: This fact alone indicates the ICNIRP's close association with the ICT industry. However, Gandhi's analysis also illustrates that mobile phones produce "*SARs that are within ICNIRP guideline of 2.0 W/kg for manufacturer-suggested distances (5, 10, 15, or 25 mm), but give SARs that are considerably higher than those of ICNIRP guidelines (by factors of 1.6 to 3.7 times) when the telephones are held against the body to mimic likely actual use conditions."* Thus, the ICNIRP Guidelines do not protect even against thermal exposures in real-world conditions.

The ICNIRP (2020) guidelines state that *"below about 6 GHz, where EMFs penetrate deep into tissue (and thus require depth to be considered), it is useful to describe this in terms of "specific energy absorption rate" (SAR), which is the power absorbed per unit mass (W kg−1). Conversely, above 6 GHz, where EMFs are absorbed more superficially (making depth less relevant), it is useful to describe exposure in terms of the density of absorbed power over area (W m−2), which we refer to as "absorbed power density."* While the ICNIRP Guidelines are designed to protect against thermal effects (and fail in this regard in comparison to those of the IEEE/FCC), it does acknowledge recognises that RFR used in all current personal wireless devices penetrates deep into the tissue of adults and children. It should be noted that the threshold in its guidelines does not differentiate between adults and children and recognize the accepted physiological fact that children absorb greater levels of RFR for the same transmitted power density, whether frequencies are below or above 6GHz. As bad as that is, the admission that microwave RFR penetrates deeply into the human body means that accepted nonthermal bioeffects such as cellular RoS and oxidative stress may lead to an increased risk of the downstream adverse health effects detailed in many of the independent peer-reviewed papers cited herein.

In 2002, the US Environmental Protection Agency (EPA) stated that the *"FCC's exposure guideline is considered protective of effects arising from a thermal mechanism but not from all possible mechanisms. Therefore, the generalisation by many that the guidelines protect human beings from harm*

by any or all mechanisms is not justified."[60] This observation also applies to the ICNIRP guidelines. The EPA's reservations were justified, given research findings published up to 2022, which, in my opinion, and that of hundreds of independent scientists, overwhelmingly refute the theory that hazards are confined to thermal effects at the levels specified in guidelines.

So, why do the IEEE, FCC and ICNIRP continue to use SAR? I believe one reason they continue to use SAR is that it is favourable to their mission – to maintain the dominant paradigm/perspective and its set of values while protecting industry interests. To minimise the risk of adverse bioeffects, RFR power density levels that produce SAR far below those set by regulators or in standards or guidelines should be used. For example, in one study, tumour-promoting effects were observed *"at low to moderate exposure levels (0.04 and 0.4 W/kg SAR), thus well below exposure limits for the users of mobile phones."*[61] The authors of this study conclude that their *"findings may help to understand the repeatedly reported increased incidences of brain tumors in heavy users of mobile phones."* Another recent study, for example, exposed Wistar rats to 900 MHz, 1.8 GHz, and 2.1 GHz RFR 1 h/day, 5 days/week for 1 month with a restricted power density (900 MHz at 11.638 $\mu W/m^2$, 1.8 Ghz at 11.438 $\mu W/m^2$ and 2.1 GHz at 8.237 $\mu W/m^2$): This corresponded to SAR at 0.434, 0.433 and 0.453 W/Kg respectively. Exposure showed a frequency-dependent change in the body weight and hematologic parameters (RBCs, WBCs, platelets, haemoglobin, and hematocrit) as compared with the control group ($p \leq 0.01$) ($p \leq 0.001$). Significant adverse bioeffects were found at these levels of exposure, indicating that the brain is more susceptible to oxidative injury compared to the liver of exposed animals.[62]

The findings of these studies, among others, are significant and confirm the association between low-level RFR exposure and oxidative stress – at levels well below SAR limits. It is for such reasons that the European Academy for Environmental Medicine (EUROPAEM) argues that *"For all RF-based non-thermal EMF effects, SAR estimates are not an appropriate exposure metric, but instead either the field intensity or power density (PD) in combination with exposure duration should be used in safety standards. In contrast to the ICNIRP guidelines, the Russian safety standards, are based on non-thermal RF effects, which were obtained by several research institutes in the former Soviet Union during decades of studies on chronic exposures to RF"*.[63]

In comparison with the FCC and European regulatory agency thermal safety levels, the European Academy for Environmental Medicine (EUROPAEM) EMF Guidelines indicate a non-thermal safety level for humans of 10 $\mu W/m^2$ or 0.001 $\mu W/cm^2$ daytime exposure and 1 $\mu W/m^2$ night-time, with 0.1 $\mu W/m^2$ being the limit for sensitive populations.[64] This is 1,000,000 to 100,000,000 times less, in terms of permitted exposure than the FCC rules, vastly lower than the new ICNIRP Guidelines. The EUROPAEM guidelines focus on the prevention, diagnosis, and treatment of EMF-related health problems and illnesses and are based on recommendations by a committee of the Austrian Medical Association. However, the precautionary exposure guidelines recommended in the Bioinitiative Report stand at a more stringent 3–6 $\mu W/m^2$.[65]

A recent industry-oriented meta-review of studies revealed that the average exposure to WiFi in schools was up to approx. 240 $\mu W/m^2$.[66] Note, again, that the EUROPAEM recommended daytime exposures for normal adults is 10 $\mu W/m^2$ and 3–6 $\mu W/m^2$ in the Bioinitiative Report. Following EUROPAEM, the precautionary level for children should sensibly be in the range of 1 to 0.1 $\mu W/m^2$. These levels are between 25 to 2500 times lower than those currently observed in measured exposures in schools. Furthermore, the actual exposures while sitting in front of RFR emitting devices such as an iPad, a laptop, or when also carrying a smartphone are clearly going to be many times higher, probably somewhere between the average and peak levels reported above. And, if as Morgan et al. find *"Children absorb more [microwave radiation] than adults because their brain tissues are more absorbent, their skulls are thinner and their relative size is smaller"*,[67] then children are at significant risk from all RFR-based technologies. Thus, it would seem that there is great uncertainty about the degree of exposure to children and adolescents, and scientifically speaking, great risk, whether from near-field or far-field sources, which as this chapter demonstrates, is not being addressed by IEEE, FDA, or ICNIRP risk assessments.

4 Conclusions

Professor Nassim Taleb argues, *"[o]ur record of understanding risks in complex systems (biology, economics, climate) has been pitiful, marred with retrospective distortions (we only understand the risks after the damage takes place, yet we keep making the mistake), and there is nothing to convince me that we have gotten better at risk management"* [68] This is certainly the case where the risks to public health from RFR exposure are concerned and where the ICT industry and the ICNIRP have systematically misled policymakers and fellow members of the scientific community that there are no risks to public health other than those caused by thermal effects. Using the same playbook as the tobacco and similar industries, they cast constructively dismiss or cast doubt on the scientific findings and evidence provided by independent research through misuse of the scientific method.

Dr Christopher J. Portier, when Associate Director, National Institute of Environmental Health Sciences and Director, Office of Risk Assessment Research, co-authored an article with Dr Wendy Leonard in Scientific American, following the initial release of the NTP study findings in 2016. They conclude that *"[c]ellphones probably cause cancer... We don't yet know the risk for a given level of exposure in humans. We need more data in this area, not only for cellphones, but for Bluetooth devices, WiFi and all the other RF-EMF devices out there."*[69] Arguments presented earlier indicate that there is sufficient scientific evidence of risks to human health to temporarily halt any further deployment of wireless technologies in the environment, pending the results of independent and relevant research into "unknowns," such as the effects of the novel and complex exposures to 5G. Such a temporary moratorium could bring several advantages: Public policy would be seen as prudent in light of the further strengthening of the evidence of harm to people and the environment. This is likely if the adverse health risks from wireless technologies (including 5G) follow the trajectory of many other human innovations, where both harm and exposure expanded and became more evident with time.[70]

Several research reviews are cited herein on the adverse health effects caused by oxidative stress from RFR exposure. The current nascent body of research and reviews provides compelling reasons for the application of the precautionary principle. Kostoff et al. summarise the evidence of risk and indicates the role of oxidative stress in producing various impacts on human health and well-being. [71] Taking adverse health effects, the human, animal, and cellular evidence from scientific studies on brain tumours and other cancers, neurological effects, and developmental/reproductive effects are strong enough to justify action by policymakers to reduce potentially harmful RFR exposures. Children are particularly vulnerable, and their risk of adverse health effects from exposure to RFR is very high.[72] However, due to the relatively low background incidence of the cancers, their type and range, and the long latency of cancers in the general population (i.e., an average of 20-25 years for solid tumours), robust epidemiological evidence suggesting the carcinogenicity of RFR will not be available in the short term. That is, in less than 10-20 years since first exposures. Nevertheless, as indicated, prominent oncology researchers strongly argue that there is sufficient evidence to take precautionary action to protect human health and wellbeing.[73] An additional, and more immediate concern, is the range of neurobehavioral and neurodegenerative disorders, including EHS, that are increasingly linked to RFR exposures.[74] However, in response to the mounting evidence of these and other adverse health effects, the ICT industry sows doubt, and the ICNIRP place a scientific gloss on it by maintaining the dominant scientific paradigm in the face of mounting scientific evidence on the need for a paradigm change to admit the genuine risk of nonthermal biological effects. At the same time, most policymakers use that doubt and scientific bias as an excuse for inaction.

The costs of not facing the scientific truth and addressing the risks RFR poses are eloquently stated in the concluding paragraph of the book, *Deceit and denial: The deadly politics of industrial pollution*: The authors conclude that it may never *"be possible to evaluate the lost potential of individuals whose intelligence has been slightly lowered, whose behavior has become a bit more erratic, whose personalities have been altered in ways imperceptible to scientific measurement. We will never know the social, economic, and personal costs to society from the lost potential of our citizens."*[75] These points are reinforced in the context of the association between RFR exposures and cancer by Hardell and Carlberg, who state that there were *"missed opportunities for cancer prevention exemplified by asbestos, tobacco, certain pesticides and now RF radiation. No doubt economic considerations are favored instead of cancer prevention. The cancer victim is the loser in terms of suffering, life quality*

and shorter life expectancy. Also, the life for the next-of-kin is affected. A strategy to sow doubt on cancer risks was established decades ago and is now adopted and implemented in more sophisticated way by the telecom industry regarding RF-EMF risks to human beings and the environment. Industry has the economic power, access to politicians and media whereas concerned people are unheard."[76]

The only note of hope that can be offered is that the widespread use of wireless technologies is relatively recent. Thus, if the SCHEER acts now to inform society of the risk wireless technologies pose, citizens can then be enabled to learn how to use their digital technologies to enrich their lives and livelihoods without endangering their health and well-being and that of their children.

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[1] See for examples:
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