

Comments on Extending Local Full Fibre Networks: Call for Evidence.

Question 4:

What other changes, locally and/or nationally, are needed to reduce the cost of full fibre rollout, such as opening access to publicly and privately owned facilities, or changes to wayleaves, streetworks and other areas? What evidence is there to demonstrate the effectiveness of such changes?

RESPONSE

More openly recognising, and publicising, the risks of standard wireless technologies can greatly help increase the appeal and adoption of full fibre rollouts, and reduce the likelihood of adverse health and environmental effects from cutting edge communications infrastructures.

ENVIRONMENTAL EFFECTS OF EMF EXPOSURES

There is a vast body of peer-reviewed scientific literature connecting radiofrequency radiation with numerous potentially serious health and environmental effects. Tens of thousands of papers show evidence of harm ranging from those registered at molecular level, such as oxidative stress, through to systemic effects that have been shown to affect all systems.

It is proposed by the present authors that electromagnetic pollution costs the UK £ billions every year.

ADVERSE HEALTH CONDITIONS LINKED WITH EMR

An increasing number of studies indicate adverse health effects as a result of environmental exposure to electromagnetic pollution. There is substantial evidence indicating that even low intensity EMF exposures can cause ill health. Conditions linked with environmental EMF exposures include:

Cancer (Coureau et al. 2014, Moon et al. 2014, Hardell & Carlberg 2013); **Alzheimer's disease** (Davanipour & Sobel 2009, Huss et al. 2009); **Childhood & adult leukaemia** (Dolk et al. 1997, Hocking 1996); **Autism** (Herbert & Sage 2012, Kane 2004); **Immune system effects** (Boscolo et al. 2001, Novoselova et al. 1999); **Miscarriage** (Li et al. 2002); **Infertility** (Avendaño et al. 2010, Otitolaju et al. 2010, Aitken & De luliis 2007); **DNA damage** (De luliis et al. 2009, REFLEX 2004); **Oxidative stress** (Kumar et al. 2012, Agarwal et al. 2009, Ilhan et al. 2004).

We suggest the cost of electromagnetic pollution to the UK economy will be exacerbated still further through the proposed widespread expansion of wireless digital services across wireless networks that the Government additionally seeks to promote.

CANCER: Radio frequency exposure at levels that can be experienced environmentally can cause DNA damage, which can be a precursor of cancer (De luliis et al. 2009, Adlkofer 2004). Cancer rates for females living adjacent base stations 4.15 times greater than those at lower exposures ($p < 0.0001$) (Wolf & Wolf 2004).

After 5 years, the risk of malignant tumours in individuals exposed to raised radio frequency exposures from base stations was 3 times higher than those with lower exposures (Eger et al. 2004). In 2009 cancer cost the EU €126 billion (Luengo-Fernandez et al. 2013).

CHILDHOOD LEUKAEMIA: Association noted between increased incidences of this and mortality at exposures of $8 \mu\text{W}/\text{cm}^2$ (Hocking et al. 1996).

It is important to note that radio waves are already classified as 'Group 2B Possible Carcinogens' (WHO/IARC 2011) based on increased rates of the fatal brain tumour, glioma, linked with increased radiofrequency radiation exposure. Some experts are calling for an upgrade to Group 2A 'Probably carcinogenic to humans', or even to Group 1 'Carcinogenic to humans' (Hardell & Carlberg 2015, 2013). The partial report from the US National Toxicology Program (NTP 2016, 2016a) is already creating pressure for a classification upgrade. The full report, to be published this year, will further corroborate this concerning finding with evidence of DNA damage.

SLEEP QUALITY: The annual cost of chronic sleep deprivation in the UK alone has been estimated at £1.6 billion (Bupa 2010). Many studies indicate that individuals sleep better in environments with very low EMF levels compared to those with even slightly raised EMF levels. As examples: Improved sleep has been noted in low-field environments with exposures of 0.05-0.22 V/m ($0.0006\text{-}0.0128 \mu\text{W}/\text{cm}^2$) compared to 0.25-1.29 V/m ($0.0165\text{-}0.4400 \mu\text{W}/\text{cm}^2$) (Oberfeld et al. 2004) and for 0.7 V/m exposures compared to 1.17 V/m exposures (Eger & Jahn 2010).

Additionally, a dose-response relationship has been shown between sleep-related fatigue and injuries (Swaen et al. 2003); and almost 20% of all serious car crash injuries are associated with driver sleepiness (Connor et al. 2002).

DEPRESSION: Suicide is the leading cause of death in England and Wales for men between 20-49 years old, and one of the main causes of death among 5-19 year olds (ONS Digital 2015). Depression is a gigantic public health burden that exceeds other common sources of morbidity and mortality. [In England in 2000, the annual cost of depression was estimated to be £9 billion (Thomas & Morris 2003)]. Individuals with depression are at heightened risk of: Alzheimer's disease; Cancer; Diabetes (type 2); Epilepsy; Obesity; and Stroke (BC's Physicians 2009).

Oberfeld et al. (2004) noted depressive tendency with 900/1800 MHz exposures of 0.25-1.29 V/m ($0.0165\text{-}0.4400 \mu\text{W}/\text{cm}^2$) compared to 0.05-0.22 V/m ($0.0006\text{-}0.0128 \mu\text{W}/\text{cm}^2$) ($p = 0.0016$). Others have made similar findings (Eger & Jahn 2010, Bortkiewicz et al. 2004, Santini et al. 2002). [Many wireless smart meters create RF EMF exposure levels above those associated with increased depressive tendency].

EFFECTS OF EMR ON BIOIVERSITY

Unfortunately, Nature too can be adversely affected by electromagnetic pollution. As examples:

Ants: Ants perform many vital services including: pollination, predation and seed removal and dispersion. Exposures of $0.0795 \mu\text{W}/\text{cm}^2$ significantly inhibited memories and association between food sites and visual and olfactory cues. The overall state in exposed colonies appeared similar to bee colony collapse disorder (CCD) (Cammaerts et al. 2012). [Effects of on pollinators, such as bees, have also been reported (Rahmani et al. 2011)].

Birds: "... migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise," Engels et al. (2014). The RF levels assessed [$0.001 \mu\text{T}$, approximately equal to 0.3 V/m or $0.0236 \mu\text{W}/\text{cm}^2$] are similar to the levels found in the 2 kHz to 5 MHz frequency range in urban environments as a result of electromagnetic pollution.

Mice: Mice and rats can act as pollinators and form an important part in Nature's food chain (Pattimore & Wilcove 2012). Exposure to 80-900 MHz radiation at 1.053 $\mu\text{W}/\text{cm}^2$ could cause irreversible infertility in mice after 3 generations, and levels of 0.168 $\mu\text{W}/\text{cm}^2$ caused total infertility after 5 generations (Magras & Zenos 1997). As mentioned earlier, research has additionally shown that EMFs can reduce human fertility (Avendaño et al. 2012, Falzone et al. 2011, Santini et al. 2002).

Low EMF initiatives, such as the creation of full fibre networks create more biologically friendly exposures than standard wireless systems, are urgently required to help protect the environment and permit more viable and sustainable connectivity.

HIGH CAPACITY NETWORKS

In addition to full fibre networks being of great importance to the creation of faster, more reliable, resilient, secure and future-proof networks, they are more biologically friendly and lower risk than the millimetre waves used in 5G technologies and for 4G backhaul.

"It's expected that high frequency millimetre-wave spectrum in the 3-300GHz range will be at the core of any 5G network" (5G.co.uk 2017). It has been known for well over a hundred years that millimetre waves can be biologically active (Bose 1906). Though beneficial effects can result from short-term millimetre wave treatments (MMWT) (Table 1), side effects can also arise. The effects of long-term chronic exposures, as would arise from their widespread use, have yet to be assessed.

Power Density [$\mu\text{W}/\text{cm}^2$]	Frequency range	Exposure type	Effects noted	Author
0.000,000,000,1 to 0.0001	30-60 GHz	5-15 minutes exposure	Stimulated growth of pine seed microflora.	Ratushnyak et al. (2008)
0.000,000,01	54-76 GHz	5 minutes per day for 5 days on mice previously exposed to ionising radiation	Normalizing effect on growth of damaged cells.	Bundyuk et al. (1994)
0.07	53.37-78.33 GHz	1-hour exposure every 2 days. 5 treatments given to human breast cancer cells in culture.	Cell number approximately 60% less in irradiated group of cells than in sham-exposed control.	Beneduci et al. (2005)
0.1	41.303 GHz	10-minute irradiation.	Maximum effect on E. coli cells' genome conformational state.	Alipov et al. (1993)
≥ 0.3	60 GHz	1-minute exposure [3 current cycles - 5 second exposures every 20 seconds].	Changes in firing rate of neurons.	Siegel & Pikov (2010)
1 – 3	54-78 GHz	4-6 treatment sessions, each of 10-20 minutes duration.	Complete relief of headaches in 122 out of 177 patients with pre-stroke forms of cerebrovascular pathology ¹	Kuz'menko (1998)
10	42.2GHz	Mice received 30-minute whole body exposure daily for 15 days.	Tumor growth inhibited by 33.5% compared to controls.	Kalantaryan et al. (2016)

¹ 65% of patients receiving this treatment remained in remission for around 1 year, versus 20% in control group receiving standard medication.

Mild side effects have been reported as a result of short-term mm wave exposures. It is suggested by the authors that such side effects may be likely to arise in members of the general population as a result of chronic long-term environmental exposures.

Paresthesias

In a number of patients minor short-term paresthesias [a sensation of burning, numbness, prickling or tingling that most often occurs in the body's extremities] has been reported as a result of exposure, as have feelings of fatigue and sleepiness (Usichenko et al. 2006, Radzievsky et al. 1999).

Altered neuronal activity

Tests have indicated that neuronal activity in the brain can be affected by very low intensity short-term exposures to mm waves (Siegel & Pikov 2010).

Cancer risk from millimeter waves

In research by Bellossi et al. (2000), DBA/2 mice were irradiated with 60 GHz waves for 30 minutes a day, for 5 consecutive days a week at 500 $\mu\text{W}/\text{cm}^2$. While mice with lymphocytic leukaemia cells showed increased survival (for 2 series out of 4), mice with Lewis tumour cells exhibited accelerated tumour growth. The exposure level shown to influence cancer risk was half that permitted by both ICNIRP (1998) and the FCC (1996) in basic restrictions for members of the general public.

THE UK IS OBLIGED TO RESPECT BASIC HUMAN RIGHTS WHEN SEEKING TO PROMOTE BROADBAND CONNECTIVITY

Universal Declaration of Human Rights

The Universal Declaration of Human Rights "... is based on the *"inherent dignity"* of all people and affirms the equal rights of all men and women, in addition to their right to freedom. **The Declaration gives human rights precedence over the power of the state. While states are permitted to regulate rights, they are prohibited from violating them,**" UNAC (2012, 2012a).

There is a need to create and retain low EMF zones and white zones within the UK when providing broadband connectivity as around 3-5% of individuals are electromagnetically hypersensitive (EHS) and others are also adversely affected by electromagnetic pollution (Jamieson 2014, Mallery-Blythe 2014a).

UK - Human Rights Act 1998

Human rights are required to be part of all UK policy making (DCA 2006). This Act is one of the most important statutes ever passed in the UK (Hoffman & Rowe 2010). **There is a REQUIREMENT to better protect the vulnerable from electromagnetic pollution.** This is already recognised in many countries (Jamieson 2014). The adoption of full fibre infrastructures helps address many of the issues raised below.

PART I: RIGHTS AND FREEDOMS

ARTICLE 2: Right to life

1. **"Everyone's right to life shall be protected by law. No one shall be deprived of his life intentionally save in the execution of a sentence of a court following his conviction of a crime for which this penalty is provided by law"** (HRA 1998).

Expectant and New Mothers: It is recognised in The International Covenant on Economic, Social and Cultural Rights (OHCHR 1976) that “*Special protection should be accorded to mothers during a reasonable period before and after childbirth.*”

Exposures of mothers to be and new mothers to EMFs “*has raised public health concerns because of the possible effects (cancer, neurological effects, developmental disability effects, etc) from the long-term exposure to low-intensity, environmental level fields in daily life,*” (Bellieni & Pinto 2012).

Protection of Embryos/Foetuses: All EU States agree that the human embryo/foetus belongs to the human race (Hoffman & Rowe 2010). The potential of that being obliges it to be protected in the name of human dignity, even when it is not legally ruled as a person with right to life (Mowbray 2012). It can still have interests capable of protection under law (Deazley & Smith 2013).

Protection for Children: The need for special protection being accorded to children is recognised in human rights legislation. As examples, it is mentioned in The UN Convention on the Rights of the Child (United Nations 1989) and the Declaration of the Rights of the Child (UN1990) that “*the child, by reason of his physical and mental immaturity, needs special safeguards and care, including appropriate legal protection, before as well as after birth.*” Refer also to Mallery-Blythe (2014) for a detailed discussion on risks to children of EMF exposure [<https://www.youtube.com/watch?v=sNFdZVeXw7M>]

As noted by Hoffman & Rowe (2010), when authorities are aware [or should be aware] of real risk to life they are under obligation to take appropriate mitigative action to protect those at risk. The adoption, creation and extension of full fibre networks help reduce such risks while enabling faster connectivity creating a ‘Win/Win’ scenario.

The present proposals by the UK Government to increase use of wireless technologies to meet high service requirements in conjunction with fibre infrastructures appear to completely ignore warnings and best practice advice related to electromagnetic fields given by the Parliamentary Assembly of the Council of Europe (PACE) documenting ‘The potential dangers of electromagnetic fields and their effect on the environment’ (Parliamentary Assembly 2011), the European Parliament (2008) and the European Environmental Agency (EEA 2007).

ARTICLE 3: Prohibition of torture

“No one shall be subjected to torture or to inhuman or degrading treatment or punishment” (HRA 1998).

The term ‘Degrading treatment’ can be defined as “... *such as to arouse ... feelings of fear, anguish and inferiority, capable of humiliating and debasing... and possibly breaking... physical or moral resistance,*” (Conseil de l’Europe / Council of Europe 1978).

The above appears very similar to descriptions provided by some electromagnetically hypersensitive (EHS) individuals (EMFSN 2016), describing how their condition makes them feel when exposed to EMFs.

Article 3 embodies a fundamental human right. “... *the right to freedom from bodily harm is second only to the right to life, and is equally based on the right which all people have a level of basic respect and dignity as human beings,*” (Hoffman & Rowe 2010). The physical symptoms experienced by some of those with EHS, and some non-EHS individuals adversely affected by EMFs, are a form of torture.

It should be additionally noted that in Article 1 of the Charter of Fundamental Rights of the European Union (The European Parliament, the Council and the Commission 2010) it is declared that “*Human dignity is inviolable. It must be respected and protected.*”

ARTICLE 5: Right to liberty and security

1. ***"Everyone has the right to liberty and security of person. ... "*** (HRA 1998).

Right to Liberty: The liberty of EHS to go where they wish is compromised by electromagnetic pollution [as can be created by wireless networks]. The rights of such individuals may be violated if emissions prevent them from being able to go where they wish (even within their own homes and gardens) unhindered by exposures to electromagnetic field regimes perceived as detrimental to their wellbeing.

"EHS has been described by patients as a 'loner's disease'. Due to the prevalence of ubiquitous EMR in the contemporary urban environment, EHS causes patients to experience extreme social isolation. The serious symptoms confine them to their home. Venturing out to shopping malls, libraries, theatres, hospitals, and doctors' offices is often precarious because of the prevalence of wireless routers, cell phones, antennas, and other sources of EMR. Furthermore many ... are often no longer able to spend time in the homes of family members due to EMR issues. As a result, huge stresses are placed on marriages and families ..."
(Genius & Lipp 2012).

Prohibiting individuals from enjoying proper liberty within society is dangerous, demeaning, degrading and a gross breach of human rights. It appears highly likely that individuals who consider that they are deprived of their liberty to go where they wish, when they wish, as a result of electromagnetic pollution may eventually seek legal recourse. The use of full fibre infrastructures, and other hard-wired alternatives, can help address this issue. LiFi may also provide a suitable solution if it is properly developed.

There is a need for low EMF / White Zones to help protect such individuals and allow them freedom of movement and access to general services and amenities. The same holds true for the workplace environment. Increased saturation of the environment with electromagnetic pollution would further restrict the freedom of movement of EHS individuals and compromise their right to liberty.

Right to Security: 'Security of person' can be legally defined as *"The legal and uninterrupted enjoyment by a man of his life, his body, his health and his reputation."*

Claims may be brought by some that their enjoyment of life, body, health and reputation may be seriously affected as a result of the increased electromagnetic radiation exposure they would receive from many types of wireless broadband provision.

Claims might additionally be brought that some individuals may have their reputations damaged as a result of how they are forced to behave as a result of exposures, or potential exposures. Claims could also be brought that they find that having to behave in this way is degrading and damaging to their security of person.

Security of health impacts both wellbeing and productivity. The health of a growing number of individuals is being adversely affected by electromagnetic pollution. Potential 'electromagnetic pollution' exposures can be greatly reduced through the adoption of technologies such as fibreoptics.

ARTICLE 8: Right to respect for private and family life

1. ***"Everyone has the right to respect for his private and family life, his home and his correspondence"*** (HRA 1998).

"Respect for home and home life means more than just providing some form of dwelling or shelter: it extends to maintaining the situation to which a person has become accustomed, and the very permanence of which gives comfort," Hoffman & Rowe (2010).

The quality of home life and enjoyment of inhabiting a dwelling may be “*spoilt by various forms of interference, such as noise, light, smells, fumes or other forms of pollution [including the present authors suggest electromagnetic pollution], and anyone who has experienced this might well refer to it as an invasion of their privacy,*” Hoffman & Rowe (2010).

In *Guerra and others v. Italy* (Conseil de l'Europe/Council of Europe 1998), it was ruled that environmental pollution can cause a violation of human rights. In that instance, the European Court found the state guilty of failing to take ‘positive steps’ to provide vital information and that the quality of life of individuals, and that of their home and private lives had suffered as a result of their human rights being breached on this issue.

In the case of *López Ostra v Spain* (Conseil de l'Europe/Council of Europe 1994), the European Court declared: “*environmental pollution may affect individuals' well-being and prevent them from enjoying their homes in such a way as to affect their private and family life adversely, without ... seriously endangering their health.*”

The right for people to be able to enjoy their property in the manner to which they have become accustomed can become severely compromised by electromagnetic pollution. It is already indicated that EMF emissions can prevent some individuals using parts of their homes and gardens, and can even cause them to move home in order to avoid/reduce adverse health effects (EMFSN 2016, Gregory 2011, Havas 2011). There is a need for low EMF environments to be retained whenever possible.

The extension of local full fibre networks can enhance the UK's broadband infrastructures while respecting this basic right. This provides further reason why full fibre networks should be adopted and adds to their financial attractiveness.

ARTICLE 12: Right to marry

“Men and women of marriageable age have the right to marry and to found a family [emphasis by current authors], according to the national laws governing the exercise of this right” (HRA 1998). [Refer back to ‘EFFECTS OF EMR ON BIOIVERSITY’ section of this present document that covers the effects of electromagnetic radiation on fertility].

As scientific research indicates environmental exposures to EMFs can reduce human fertility and increase risk of miscarriage (Bellieni & Pinto 2012), there is a risk that those promoting the proliferation of wireless devices may be found negligent if the resultant increase in electromagnetic pollution compromises the ability of individuals to found families. Such risks are diminished through the use of fibreoptics and wired connections [a factor that should be of interest to private sector investors seeking to provide capital investment and safeguard their returns].

ARTICLE 14: Prohibition of discrimination

“The enjoyment of the rights and freedoms set forth in this Convention shall be secured without discrimination on any ground ...” (HRA 1998).

Individuals with EHS are discriminated against with regards to jobs, place of residence and public access to most areas of life. They are not just restricted from access to desirable things, such as leisure and entertainment, but also essentials such as groceries, health care and even petrol as a result of the presence of electromagnetic pollution disrupting their lives.

The present proposal by the UK Government for the use of wireless technologies to be considered for funding as an alternative to full fibre infrastructures if they can meet necessary performance requirements (Department for Culture, Media and Sport 2016) appears inadvertently discriminatory. Claims might be brought that those who ignore the special needs of individuals who are, or believe they are, vulnerable to EMF radiation may be guilty of discrimination and wilful blindness. Claims might also be brought that those who deliberately ignore and dismiss relevant scientific evidence of potential risks, whether through wilful blindness or recklessness, may be guilty of inciting others to unwittingly discriminate against such individuals (Jamieson 2014a).

Social inclusion is one of the major goals of sustainable development. It is also one of the main declared objectives of the European Union (Atkinson 2009).

ARTICLE 17: Prohibition of abuse of rights

“Nothing in this Convention may be interpreted as implying for any State, group or person any right to engage in any activity or perform any act aimed at the destruction of any of the rights and freedoms set forth herein or at their limitation to a greater extent than is provided for in the Convention” (HRA 1998).

The rights and freedoms of EHS, and others adversely affected by EMFs, must be actively protected when seeking to enhance broadband connectivity within communities. Doing so will help protect, health, wellbeing and the economic prosperity of the UK.

PART II: The First Protocol

ARTICLE 1: Protection of property

“Every natural or legal person is entitled to the peaceful enjoyment of his possessions. No one shall be deprived of his possessions except in the public interest and subject to the conditions provided for by law and by the general principles of international law,” HRA (1998).

Many EHS individuals are forced to move home as a result of adverse health effects from electromagnetic pollution experienced in their property. The term ‘property’ can be legally defined as including real estate, land, growing plants and animals.

Evidence indicates that, in addition to potentially harming humans, EMFs at levels considerably below those permitted in ICNIRP guidelines, which can be created by wireless systems, appear capable of causing damage to plants and animals.

ARTICLE 2: Right to education

As the right to education of children who are EHS can be potentially compromised by electromagnetic pollution in schools, it is suggested that wired, instead of wireless, connections be used as a matter of best practice to enable connectivity.

UNDERSTANDING THE MARKET

Many individuals do not wish blanket wireless coverage

Ofcom's Communications Market Report 2016 indicates that approximately a third of adult UK Internet users (around 15 million individuals) have undertaken a ‘digital detox’ *“in a bid to strike a healthier balance between technology and life beyond the screen.”* It also suggests approximately 1 in 10 adults (11%) may undertake such a ‘digital detox’ every week. Of all those taking such measures, 25% spent ≤1 day without the Internet; 20% avoided it for ≤1 week; and 5% went web-free for ≤1 a month. It is likely that similar figures will be found elsewhere in Europe.

The report mentions that 30% of respondents had undertaken a holiday ‘digital detox’. 16% had deliberately gone on vacation to a place without Internet access; 13% deliberately went on holiday minus their mobile phone; and 9% who had chosen an area where there was neither mobile phone nor Internet access (Ofcom 2016). There are also the needs of those who are electromagnetic hypersensitivity (EHS) to take into account, which the provision of full fibre networks can help in part address.

Such facts add yet further weight to the benefits of creating full fibre networks within buildings and external environments when aiming to provide cutting edge communications infrastructures. This approach will also help reduce the risks of potential claims from those exposed to electromagnetic pollution.

RISK AND RETURNS FOR INVESTORS

IARC CLASSIFICATION OF RADIOWAVES

Radio waves are already classified as 'Group 2B Possible Carcinogens' (WHO/IARC 2011), with some experts now calling for them to be upgraded to Group 2A 'Probably carcinogenic to humans', or even to Group 1 'Carcinogenic to humans' (Hardell & Carlberg 2015, 2013). The recent NTP (2016) findings could be particularly instrumental in causing such an upgrade.

A strong case can be made for the provision and funding of full fibre networks and more biologically friendly communications networks.

Many insurers are excluding risks associated with electromagnetic radiation

As examples:

"... insurers over the past 10 years increasingly have been excluding coverage under both general liability and umbrella policies. Others are neither excluding nor making affirmative statements about the risk" (White Geisel 2007).

"Risk is so fundamental ... that there are some risks that we simply will not insure against. These include ... electromagnetic fields and electromagnetic radiation ..." (AVIVA 2012).

"We will not pay anything under this policy, ... in respect of ... Electromagnetic fields any liability of whatsoever nature directly or indirectly caused by, in connection with or contributed to by or arising from electromagnetic fields (EMF) ..." (Zurich Insurance Group 2014).

THE TELECOMMUNICATIONS INDUSTRY IS ALSO AWARE OF THE RISKS OF ELECTROMAGNETIC POLLUTION

As examples:

"The influence of electrosmog on the human body is a known problem. ... The risk of damage to health through electrosmog has also become better understood as a result of more recent and improved studies. When for example, human blood cells are irradiated with electromagnetic fields, clear damage to hereditary material has been demonstrated and there have been indications of an increased cancer risk. ..." Swisscom AG - major Swiss telecommunications provider (Swisscom AG 2003).

"Unfavorable litigation or governmental investigation results could require us to pay significant amounts or lead to onerous operating procedures," (AT&T 2014).

"... any perceived risk of adverse health effects of wireless communication devices could materially adversely affect the Company..." (BlackBerry Limited 2014).

It is important that both public and private sector investors are aware of the risks related to electromagnetic pollution and how full fibre infrastructures create a lower risk investment opportunity than wireless alternatives.

LEGAL RULINGS RELATED TO EMF EXPOSURE

2011: The Labour Court in Madrid declared that hypersensitivity, caused in part by microwave exposure, can cause permanent disability. Its ruling set a precedent for future conditions related to EHS. [The verdict awarded the college professor, who has been permanently incapacitated, a permanent disability pension at 100% of his base salary rate (WEPP News 2011)].

2012: The Italian Supreme Court affirmed a casual link between a businessman's heavy mobile phone use & his brain tumour (Alleyne 2012, Microwave News 2012).

2013: The Australian government ordered to pay claims for damaging the health of an employee with EMF sensitivity (Administrative Appeals Tribunal of Australia 2013, GSMA 2013).

2013: An Israeli cell phone company compensates a customer who contracted cancer (Leibovich 2013, Raz & Ziv/Israeli 2013).

CONCLUSION

"There are many examples of the failure to use the precautionary principle ..., which have resulted in serious and often irreversible damage to health and environments. Appropriate, ... actions taken now to avoid plausible and potentially serious threats to health from EMF are likely to be seen as prudent and wise ...," Professor Jacqueline McGlade, Executive Director of the European Environment Agency (2003-2013) (EEA 2007).

It is already known that electromagnetic fields can be biologically active. Proper assessment of the potential health and environmental consequences of their widespread use is urgently required. An unchecked proliferation of wireless technologies could create catastrophic results and is highly unwise, particularly given that safer alternatives are available and are already being advocated by the UK Government.

Full fibre networks provide a more environmentally friendly means to provide cutting edge communications infrastructures than 4G mobile networks, fixed wireless broadband and Wi-Fi networks, and future 5G networks. They also provide a better low risk investment than wireless technologies. Informed shareholders are more likely to back and receive good long-term returns from full fibre infrastructures.

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[Some sections within this commentary are from previous work by the present authors].

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