BONNOR Advokater
Attorney-at-law Christian F. Jensen (L)
Øverødvej 5, 2. sal
2840 Holte
Tel.: (+45) 29 82 70 04
E-mail: cfj@bonnoradvokater.dk

LEGAL OPINION

on

whether it would be in contravention of human rights and environmental law to establish the 5G-system in Denmark

FINAL DANISH VERSION
TRANSLATED INTO ENGLISH
by Christian F. Jensen
attorney-at-law (L)

Rachel Santini, head of the scientist network the Danish Institute for Public Health, together with the Council for Health-Safe Telecommunications, the EHS-association, and the Danish Health Association May Day, have asked me to prepare a legal opinion on the above mentioned issue.

The legal opinion is based on the rules of law in the European Convention on Human Rights, the UN Convention on the Rights of the Child, the EU directive on the conservation of natural habitats and of wild fauna and flora, the EU directive on the conservation of wild birds, on the precautionary principle as well as on the Bern- and Bonn-conventions on the protection of animals and plants.

The opinion is divided into Section 1 which relates to the facts (regarding the 5G-system as well as scientific research concerning the damaging effects of radiofrequency electromagnetic radiation), Section 2 which compares the facts with the rules mentioned above and Section 3 which contains an overall conclusion.

Table of contents.

1. Facts.

1.1. What is 5G?

"5G" is a collective term for the next (fifth) generation communications system for mobile phones and internet use. There is no legal definition, and the system does not appear to be either completely defined or standardised.

The available information regarding the intended system is primarily found via expressions on what the intended tasks and purposes of 5G are, cf. e.g. the European Commission's September 14th 2016 "Working document," item 3, and the telecommunications industry's 5G-manifesto[1] of July 7th 2016.

The 5G-system is et al. described as follows in the scientific literature (cf. Neufeld og Kuster, 2018: p. 705):

"THE FIFTH generation of wireless communication technology (5G) promises to facilitate transmission at data rates up to a factor of 100 times higher than 4G. For that purpose, higher frequencies (including millimeter-wave bands), broadband modulation schemes, and thus faster signals with steeper rise and fall times will be employed, potentially in combination with pulsed operation for time domain multiple access. 5G is designed as a ubiquitous communication system spanning applications such as high-bandwidth mobile data and telephony, real-time machine-to-machine communication (e.g., autonomous mobility), and the Internet of Things (IoT)."

Among other elements, it has as yet not been established which frequency bands the 5G-system will utilise, and as can be seen from the table below, the frequencies currently being considered are the same as have thus far been used for previous generations[2]:

Table 1: The Main Frequency Bands for 5G Standards Taken up Globally

Frequency Band	Frequency Range	Countries/Regions	Comments
Low Band	<1 GHz (UHF) usually 600/700 MHz	EU, USA, India	Current favourite as longer range, so less costly infrastructure and more familiar technology
Mid Band	3-5 GHz (above UHF)	EU, Korea, Rep., China, India with USA at 2 GHz; China and Japan in 2020	More spectrum available, with compromise on range and performance
High Band	20-100 GHz	EU, USA, Korea, Rep.; in 2020 - China, Japan, India	Short range (10-150m), high speed, low latency

Source: Bertenyi, 2017; authors.

A reply from the Danish minister of Energy, Utilities and Climate to the parliamentary committee, dated April 1st 2019, regarding the intended system's implementation in Denmark states that:

---

1 Available from http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=16579

2 The table is used in the European Parliament's April 2019 report titled "5G Deployment – State of play in Europe, USA and Asia" (p. 10).

"The limits currently being employed in Denmark have their basis in recommendations from the EU, which are founded on limits set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

The telephone companies shall ensure compliance with these limits, which are 2 W/kg wherever people are staying and move about. These limits are technology neutral which means that the limits apply irrespective of the technology employed, e.g. 2G, 3G, 4G or 5G.

The telephone companies have informed that they expect the number of mast positions to be increased by 15-25% towards 2025 as a result of the phasing in of 5G. It is the companies' expectation that the combined electromagnetic exposure will be increased by 10-20% compared to today.

The telephone companies expect the exposure from the mobile nets to remain far below the limits, also when the 5G-nets have been fully expanded.

The 5G-net will be based on higher frequencies than the other technologies, and the mobile signals will therefore have a shorter range. This means that there will be need of a finer mesh with more base stations (small cells). These base stations will transmit using a lower effect than e.g. the antennas transmitting on 2G, 3G and 4G. The radiation will therefore be correspondingly smaller."[3]

1.2. Research.

Scientific research has been documenting health damage caused by electromagnetic fields since at least 1966.[4]

It is this research which will be compared with the intended 5G-system's known characteristics, cf. item 1.1 above, as well as the "limits" (maximums for emitting a certain kind of environmental affector) which are currently being employed in the EU and Denmark, cf. item 2.1 below.

It has not been practically possible to peruse the full body of available scientific material that underpins the above mentioned health damage effects on humans and animals by means of exposure to radiofrequent electromagnetic radiation, as this material comprises several thousand articles.

A portion of the analysed material has been compiled by the undersigned, and a portion has been sent by the commissioner of this legal opinion, including by request from the undersigned.

1.2.1. The focus of this legal opinion.

This legal opinion is centred around the results that positively document either actual damages or risks thereof to humans, animals, and plants.

To the extent that such provable research results are available, they are inherently of much greater significance than examinations which have been incapable of identifying a damage or risk thereof, since the latter group does not in itself exclude the possibility that there exist real damages or risks.

---

[3] For further information, see item 2.1 below which deals with the limits currently employed in Denmark.

[4] Cf. Pall (2018, p. 9) which refers to Marha K.'s (1966) article: "*Biological effects of high-frequency electromagnetic fields"* (translation).

If it has on one occasion defensibly been scientifically proven that there is a damaging effect or risk of damage, then the fact that ten other defensible trials did not show such an effect or risk is irrelevant. It is then merely up to the scientific community to clarify why the ten defensible trials did not show what is scientifically proven, in order to better understand why and how the damages occur or could occur.[5]

This point can be illustrated at the hand of swan populations: If one study shows that black swans exist, then it is not relevant that ten other studies did not find any black swans. It has been proven that the black swan exists, and it may be useful to determine why the ten other studies did not yield the same results.[6]

It would be misleading if one were to attempt a ”statistical average calculation” and in such a manner conclude that there is but a 1/11 chance that the black swan actually exists, as its existence has been shown in only one study, whilst ten others found no such proof.

1.2.2. Humans: Health damages and hazards.

1.2.2.1. DNA damage.

In 2015, a scientific review of the then more than 100 accessible peer-reviewed studies regarding the so-called ”oxidative effects” of low intensity radiofrequent radiation (hereafter: RFR) was undertaken.

The review (Yakymenko et al., 2015[7]) showed e.g. that it was plausible that EHS-like[8] conditions were in part caused by exposure to low intensity RFR (p. 195) and that the exposure could lead to cancer (p. 196), both of which are caused by ”oxidative stress”. It was thus found that 93% of studies showed that such radiation led to the forming of reactive oxidative connections in all investigated living organisms, from cells, plants, insects, lab animals to humans (sperm), (cf. ibid. p. 186).

Yakymenko et al. (2015, p. 186) continues thus:

”All above mentioned studies dealt with the effects of low-intensity RFR. This means that the intensity of radiation was far below observable thermal effects in biological tissues, and far below safety limits of the International Commissions on Non-Ionizing Radiation Protection (ICNIRP) (ICNIRP, 1998).”[9]

Ibid. (p. 187):

”Low-intensity RFR is referred to as radiation with intensities which do not induce significant thermal effects in biological tissues. Accordingly, any intensity of RFR under the ICNIRP limits can be referred to as low-intensity. In this paper we will analyze only the effects of low-intensity RFR.”

---

5 In the same vein, Philips et al. (2009) published an article titled *“Electromagnetic fields and DNA damage”* in the scientific journal “Pathophysiology,” no. 16, pp. 79 – 88. They state that “*Each study to investigate RFR-induced DNA damage must be evaluated on its own merits, and then studies that both show effects and do not show effects must be carefully evaluated to define the relationship of experimental variables to experimental outcomes and to assess the value of experimental methodologies to detect and measure these outcomes (see Section 2)”* (p.85)

6 The example has been used by e.g. the philosopher of science Karl Popper.

7 Published in 2016 in the scientific journal “Electromagnetic Biology and Medicine”, no. 35, pp. 186 – 202.

8 EHS stands for Electro Hyper Sensitivity, and is a physical condition in which a person displays a series of symptoms when they are near equipment which emits electromagnetic radiation, often termed “electric over-sensitivity”.

9 These limits are mentioned further in item 2.1 below.

They conclude (ibid., p. 196) that:

"...a broad biological potential of ROS and other free radicals, including both their mutagenic effects and their signaling regulatory potential, makes RFR a potentially hazardous factor for human health. We suggest minimizing the intensity and time of RFR exposures, and taking a precautionary approach towards wireless technologies in everyday human life."

On November 15th 2017, the US-based researcher-driven "BioInitiative 2012 – A Rationale for Biologically-based Exposure Standard for Low-Intensity Electromagnetic Radiation" published a review of 200 then available studies on the effect of radiofrequent electromagnetic radiation on free radicals, which provoke so-called "oxidative stress," cf. the mention of Yakymenko et al. (2015) in the above.

The review showed that in 180 of the 200 studies (90%) there was a statistically significant effect, whilst the last 20 (10%) did not report any statistically significant effect.

In May 2018, Martin Pall[10] ascertained that at the time there existed a minimum of 21 scientific studies (since 1971) that documented DNA damage caused by radiofrequent electromagnetic radiation, and that these led to chromosome damage and other mutations.

Further, he ascertained that there was a minimum of 19 studies (since 1981) that documented the causation of free radicals and oxidative stress by this radiation[11].

The REFLEX-study (2004) was conducted by 12 research institutions on behalf of the EU, with a budget of 3 million euro. The results included that fact that at the specific absorption rate (hereafter SAR) of 1,3 W/kg (i.e. below the ICNIRP guidelines recommendation of 2,0 W/kg for the body and head, cf. item 2.1. below), there was a significant increase of DNA damage (p. 109):

"RF-EMF exposure at a SAR of 1.0 W/kg and below had no effect on Comet formation in HL-60 cells (expressed as Olive Tail Moment OTM) as compared to control and sham-exposed cells. On the other hand RF-EMF at SAR of 1.3 W/kg and above caused a significant increase in DNA strand breaks. The maximum of this effect was observed at SAR 1.3 W/kg (OTM = 2.20 ± 0.16) and 1.6 W/kg (2.24 ± 0.10)."

Further, this radiation rate was the one that produced the greatest effect on DNA (p. 119, repeated on p. 222):

"...were applied following RF-field exposure of HL-60 cells at that exposure condition with the most significant effect on DNA integrity (1800 MHz, continuous wave, 1.3 W/kg, 24h)."

Ibid. (p. 223, section 5.2.1., lab participant 2, conclusion 9):

"Within the investigated SAR energy ranges RF-EMF under the in-vitro conditions used are genotoxic in HL-60 cells without affecting cell-cycle distribution cell proliferation or cell

---

[10] PhD, prof. emeritus in biochemistry and Basic Medical Sciences, Martin L. Pall "*5G: Great risk for EU, US and International Health! Compelling Evidence for Eight Distinct Types of Great Harm Caused by Electromagnetic Field (EMF) Exposures and the Mechanism that Causes Them"* (2018, pp. 6 – 8).

[11] Ibid., pp. 11 – 12.

progression."

Ibid. (conclusion 10):

"The partial-body SAR for any 10-gram tissue like for example the head as exposed region to mobile phone electromagnetic fields should not exceed 2 W/kg according to the Radio-Radiation Protection Guidelines. Notably, our findings on genotoxic effects of RF-fields in HL-60 cells have been shown for SAR levels below these acceptable partial-body SAR levels."

Ibid. (p. 223, section 5.2.2., lab participant 3):

"Our results imply a genotoxic action of RF-EMFs below proposed radiation safety levels."

However, it was also concluded (p. 226) that since these were "only" lab tests, the REFLEX-study was not in itself enough to draw the conclusion that the (still) employed limits posed a danger to human health, though the study made such a conclusion more likely. Further, it was concluded that:

"Furthermore, there exists no justification anymore to claim, that we are not aware of any pathophysiological mechanisms which could be the basis for the development of functional disturbances and any kind of chronic diseases in animal and man."

Beyond the REFLEX-study, it appears that over 40 studies that show DNA damage as a result of exposure to radiofrequent electromagnetic radiation have been conducted[12].

These include, e.g.:

Burlaka et al (2013), *"Overproduction of free radical species in embryonal cells exposed to low intensity radiofrequency radiation."*[13], p. 223:

"In conclusion,the exposure of developing quail[14] *embryos in ovo to extremely low intensity RF-EMR of GSM 900MHz during at least one hundred and fifty-eight hours discontinuously leads to the significantly increased rates of superoxide and nitrogen oxide generation in embryo cells. This was accompanied by a significantly increased level of lipid peroxidation,a depression of key antioxidant enzymes activity,and significantly,2–3-fold,increased level of oxidative damage of DNA in embryo cells."*

Blank og Goodman (2011), *"DNA is a fractal antenna in electromagnetic fields."*[15], p. 411:

"Since DNA can interact with EMF over a wide range of frequencies, and does not appear to be limited to an optimal frequency, it has the functional properties of a fractal antenna.
…

---

[12] A documentation list is attached to this legal opinion as Appendix 1.

[13] Published in 2011 in the scientific journal "International Journal of Radiation Biology" vol. 87, no. 4, pp. 409-15.

[14] It is common to use animals to assess health risks to humans, and to use such studies as the basis for guidelines and limits, cf. e.g. Engels et al. (2014), "*Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird"* (Nature, vol. 509), p. 354: "*...animal studies are commonly used to evaluate human health risks and have contributed to guidelines for human exposures…".* In a written reply dated February 20th 2019, the (Danish) Environmental Protection Agency stated the same and referred to the European Chemicals Agency with the following link https://echa.europa.eu/da/information-on-chemicals/biocidal-active-substances

[15] Published in the scientific journal "Experimental Oncology," vol. 35, no. 3, pp. 219 – 225.

From the above analysis of the effect of EMF on the stress response, DNA strand breaks and cancer epidemiology, the fractal property of DNA is apparent in the ELF and RF ranges.
…
Electron transfer is a plausible mechanism for EMF interactions with DNA at higher frequencies where higher energies are involved. The damage due to DNA strand breaks that occur at higher frequencies, including ionising radiation, is generally attributed to oxidation, another chemical name for electron transfer. Because of the greater energy at higher frequencies, reactive oxygen species, such as peroxides, contribute to the DNA damage. However, DNA strand breaks occur over a wide range of frequencies, and do not demonstrate frequency optima related to molecular reaction kinetics." (Emphasis added.)

It is further stated in the currently employed guidelines for human exposure to radiofrequent electromagnetic radiation (cf. item 2.1 below) (p. 413):

"...The existing 100 mT ELF exposure limit set by ICNIRP (International Commission for Non-Ionizing Radiation Protection) is many times higher than the 0.4 mT where a doubling of childhood leukemia risk is widely acknowledged. It has also been pointed out that the specific absorption rate (SAR), the widely used thermal standard for EMF safety, does not relate at all to the biological thresholds of the stress response in the ELF and RF ranges, and that the threshold for the same biological process differs by many orders of magnitude in the two ranges (Blank and Goodman 2004)."

Philips et al (2009), *"Electromagnetic fields and DNA damage."*[16], p. 85:

"RFR exposure does indeed appear to affect DNA damage and repair, and the total body of available data contains clues as to conditions producing effects and methodologies to detect them.
…
The lack of a causal or proven mechanism(s) to explain RFR-induced effects on DNA damage and repair does not decrease the credibility of studies in the scientific literature that report effects of RFR exposure, because there are several plausible mechanisms of action that can account for the observed effects. The relationship between cigarette smoking and lung cancer was accepted long before a mechanism was established. ..."

Panagopoulos (2019), *"Comparing DNA damage induced by mobile telephony and other types of* man-made electromagnetic fields*"*[17], p. 53 (abstract):

"The number of studies showing adverse effects on living organisms induced by different types of man-made Electromagnetic Fields (EMFs) has increased tremendously. Hundreds of peer reviewed published studies show a variety of effects, the most important being DNA damage which is linked to cancer, neurodegenerative diseases, reproductive declines etc. Those studies that are far more effective in showing effects employ real-life Mobile Telephony (MT) exposures emitted by commercially available mobile phones...." (Emphasis added.)

The investigation further ascertains that characteristics other than merely signal strength are significant causes of the damaging effects (cf. ibid.):

"...The crucial parameter for the intense bioactivity seems to be the extreme variability of the

[16] Published in 2009 in the scientific journal "Pathophysiology," no. 16, pp. 79 – 88.
[17] Published in 2019 in the scientific journal "Mutation Research-Reviews in Mutation Research," no. 781, pp. 53 – 62.

polarized MT signals, mainly due to the large unpredictable intensity changes."

Ibid. (p. 60, conclusion):

"The importance of exposure variability shown in the present study implies the need to define EMF-exposures not only by frequency components and average intensity values, but by reporting maximum and minimum intensity as well, frequency variations, pulsing or continuous wave, modulation, and - of course - polarization."

Ibid. (pp. 59 – 60, conclusion):

"It comes that variability in the EMF exposure is an extremely important factor in order for the specific type of polarized EMF to be able to induce biological/health effects.
…

The extreme and unpredictable variability of the real-life MT signals that apparently seems to be the reason for the corresponding intense bioactivity, does not concern only the 2nd generation (GSM) MT signals tested in our experiments and in the present review, but all existing types of digital MT signals (2nd, 3rd, 4th generation), and all types of modern digital microwave telecommunication signals/EMFs (DECT phones, Wi-Fi routers, etc.), since they all operate under the same principles combining RF carrier signals with ELF pulsing and modulation of similar frequency bands, emitting variable information each moment which in turn makes the emission variable in intensity, frequency, waveform etc. In fact, with every new generation of telecommunication devices (e.g. 3rd, 4th, 5th generation mobile phones or base antennas) the amount of information transmitted each moment (speech, text, images, video, internet, etc.) is increased, resulting in higher variability and complexity of the signals with the living cells/ organisms even more unable to adapt. The result of the recent study that found a real 3rd generation (UMTS) MT EMF to be more bioactive than real 2nd generation (GSM) MT EMF emitted by the same device [36] is in line with this fact." (Emphasis added.)

D'Silva et al. (2017)[18], the study cited as reference [36] in the above, contains the following description of its results and conclusions, cf. the corresponding abstract:

*"**Results:** In our study, the exposure of developing chick embryos to 2G and 3G cell phone radiations caused structural changes in liver in the form of dilated sinusoidal spaces with haemorrhage, increased vacuolations in cytoplasm, increased nuclear diameter and karyorrhexis and significantly increased DNA damage.*
***Conclusion:** The chronic exposure of chick embryo liver to RFR emitted from 2G and 3G cell phone resulted in various structural changes and DNA damage. The changes were more pronounced in 3G experimental group. Based on these findings it is necessary to create awareness among public about the possible ill effects of RFR exposure from cell phone."*

Regarding the method employed, the study states the following (ibid., p. 6):

"A popular brand cell phone hand set and a service provider were used for network connection for both 2G and 3G exposure. For exposure activation, the cell phone was rung from another cell phone for duration of three minutes each, every half an hour, with the first exposure given at 12th hour of incubation (4.30 am-4.30 pm). The total exposure for a 12 hour period was 75 minutes followed by 12 hour of exposure-free period. This was repeated daily up to 12th day of incubation."

The study further referenced that:

[18] Published in July 2017 in the scientific journal "Journal of Clinical and Diagnostic Research," vol. 11, no. 7, pp. 5 – 9.

"Non-thermal stress is more deleterious than thermal stress and is known to cause oxidative stress [5], production of free radicals [6], structural changes in plasma membrane [7], changes in ionic transport [8] and also increased DNA damage [9]."

1.2.2.1.1. Subject conclusion.

There is clear scientific documentation that radiofrequent electromagnetic radiation, including at levels below the limits employed in Denmark, cf. item 2.1 below, causes DNA damage to both humans and animals.

Panagopoulos (2019) states that not only the strength of radiation is significant to the expected damage. Further, the findings will also be applicable to 5G, owing to the commonalities between the technologies.

1.2.2.2. Cancer.

1.2.2.2.1. Classification.

The IARC (International Agency for Research on Cancer) is the WHO's agency for cancer research.

In 2011 the agency classified electromagnetic radiation as "possibly carcinogenic to humans".[19]

A later scientific review published in November 2018 concluded that according to the IARC criteria, there is sufficient basis for classifying electromagnetic radiation as "carcinogenic to humans"[20], reasoned with the referral to a review of a series of investigations conducted prior to that time.

Miller et al. (November 2018[21], p. 674):

"...Analysis of a subset of cases (58% of all cases) based on operator-recorded information showed significant brain cancer risks for children with a significant trend of increase in risk with increasing years of use. Based on children's memory of both ipsilateral and contralateral use there were significant increased risk of brain cancer along with a marginal increase of risk with an increasing number of calls..."

Ibid. (p. 675):

"Carlberg and Hardell (2013) also reported that persons diagnosed with a glioblastoma multiforme (GBM) exposed to RFR[22] emanating from WTDs[23] had a significantly shorter survival period than those without such exposures."

Ibid. (p. 676):

"Coureau et al. (2014) reported on a French national study of mobile phone use and brain tumors (glioma and meningioma) between 2004 and 2006.
…
There was a marginal increase in risk with increasing hours of use (p_{trend}=0.07). A small

[19] Cf. IARC monograph vol. 102, 2013, p. 419, item 6.3.
[20] A so-called "class 1-classification" in the IARC system.
[21] Published in November 2018 in the scientific journal "Environmental Research," no. 167, pp. 673 – 683.
[22] Radiofrequency radiation, cf. ibid., p. 673.
[23] Wireless Transmitter Devices, cf. ibid., p. 673.

number of urban users showed a significant 8-fold increased risk for brain tumors excluding temporal or frontal lobes (OR[24] 8.2. 1.37–49.07). The authors commented: 'Finally, we observed increased OR for urban use for gliomas, a result inconsistent with the hypothesis of a higher RF power output during calls in rural areas, documented by some Swedish study. However, our results are consistent with a recent international study showing no difference between rural and urban exposition in most countries except in Sweden, and a Hardell study when considering gliomas separately.'"

Ibid. (p. 676):

"Momoli et al. (2017) undertook a re-analysis of the Canadian data from the 13-country case-control Interphone Study (2001–2004).
…
For glioma, when comparing those in the highest quartile of use (> 558 lifetime hours) to those who were not regular users, the odds ratio was 2.0 (95% confidence interval: 1.2, 3.4). After adjustment for selection and recall biases, the odds ratio was 2.2 (95% limits: 1.3, 4.1), thus allaying concerns that bias could explain the positive findings in the Interphone study."

Ibid. (p. 676):

"Akhavan-Sigari et al. (2014) reported that patients with glioblastoma multiforme who had used cellphones≤3 h per day had better survival than those with cellphone use of ≥3 h per day.
…
This study shows that genetic changes, compatible with carcinogenic effects, result from higher exposure to RFR."[25]

Ibid. (p. 676):

"Carlberg and Hardell (2015) performed a pooled analysis from 1997 to 2003 and 2007–2009 of the risk of meningioma from cell and cordless phone use. In total, 1625 meningioma cases and 3530 controls were analyzed. Overall no association with use of mobile or cordless phones was found. However, they reported an increased risk among heavy users of both mobile and cordless phones from various wireless phone types (wireless combines all phone types) (Table 11). The risk increased significantly per 100 h of use from four wireless phones categories."

Ibid. (p. 677):

"Hardell et al. (2013a) pooled acoustic neuroma results from casecontrol studies conducted in 1997–2003 and 2007–2009, including 316 participating cases and 3530 controls. ... There is some evidence of a dose-response relationship is evident with mobile and cordless phones associated with ORs of 4.5 and 6.5 respectively for 20 or more years of use. There were similar results per cumulative hours of use (Table 12)."

Ibid. (p. 677):

"Moon et al. (2014), in a matched case-control study from Korea examining 119 cases of vestibular schwannoma and 238 controls attending for routine examinations in the same institution found no difference between cases and controls in the duration, time of use or cumulative use of mobile phones. However, in a case-case analysis they found that vestibular Schwannoma tumor volume was greater in those with higher use compared to lower use of mobile phones and in those with regular compared to non-regular use (Table 13)."

---

[24] Odds ratio, cf. ibid., p. 674.

[25] The patients in the study (63 adults; 38 M 25 F) were operated on due to cancer tumours, between 2008 and 201, cf. Akhavan-Sigari et al., 2014, p. 117.

Ibid. (p. 678):

"Zada et al. (2012) examined data from three major U.p. cancer registries: Los Angeles County, California Cancer Registry, and the National Cancer Institute's Surveillance, Epidemiology and End Result for 12 U.p. states (SEER 12) from 1992. The APC for GBM (grade IV glioma) and Glioma was reported by brain region. Table 17 shows APC changes by cancer registry for GBM and for glioma located in three anatomical regions of the brain, showing significant increases compatible with increasing use of mobile phones.
Consistent with the study above, Cardis et al. (2011) reported that the combined percentage of the total radiation absorbed by the frontal lobe (19%), the temporal lobe (50%) and the cerebellum (18%) was 81% at 900 MHz and was 86% at 1800 MHz (frontal lobe 14%, temporal lobe 50%, cerebellum 13%)."

Ibid. (p. 679):

"7. Case series

West et al. (2013) reported multiple[26] primary breast cancers in young women who had regularly placed a cellphone in their bras (Table 20). Tumors were reported to have occurred subcutaneously directly under the antennas of the phones. Subsequently, a number of other such cases have come to light with unusually located breast tumors relative to reported cell phone storage in the bra.
Peleg (2012) discussed a cancer cluster among young workers at an Israeli Antenna Range Facility. It was believed that significant RFR exposures took place as a result of workplace conditions. Five of about 30 workers were diagnosed with cancer. This was regarded as significantly greater than the expectation. Peleg et al. (2018) extended this analysis to 47 patients with cancer previously exposed to whole-body prolonged RFR, mainly from communication equipment and radar. They found that the percentage frequency of haemo-lymphatic (HL) cancers in the case series was very high, at 40% with only 23% expected for the series age and gender profile, 95% confidence interval: 26–56%, $p < 0.01$; 19 out of the 47 patients had HL cancers.
Stein et al. (2011) studied 56 cancers among 49 military personnel (47 male, 7 females) exposed to intense prolonged RFR between 1992 and 2011. Based on exposure information reconstructed from reported histories, it was assumed that significant RFR exposures took place as a result of workplace conditions. The average duration of exposure was 13 years; the average age at diagnoses was 43. There appeared to be an excess of both haemolymphatic and testicular cancers."

Ibid. (p. 680, discussion):

"Nevertheless[27], recent case-control studies from Sweden and France corroborate findings of earlier studies in providing support for making a causal connection between cell phone use and brain cancer, as well as acoustic neuroma, also called Vestibular Schwannoma. Hardell and Carlberg (2013) concluded that the Bradford Hill criteria for causality have now been fulfilled. It is notable that three recent meta-analyses all confirm significant increased risk of glioma after 10 or more years of use of cell phones (Bortkiewicz et al., 2017; Prasad et al., 2017; Yang et al., 2017). The Aydin et al. (2011) data that relied on billing records along with children's recall of their uses of phones approaches and in some instances met conventional tests of statistical significance and indicated that four years or more of heavy cell phone radiation causes glioma in children. This finding is consistent with that of Hardell and Carlberg (2015) who showed that those who began using cell phones and/or cordless phones regularly as children had between 4 and 8-fold increased risk of glioma as adults."

---

[26] Four patients aged 21, 21, 33 and 39, cf. ibid., Table 20.

[27] In the article itself, the quote follows a review of usual reservations made in connection with the various, common research methods, which have likewise been used in the studies referred to in the article.

Ibid. (p. 680, discussion):

"Potential cancer sites and other outcomes for consideration in new studies include... Other sites than brain and acoustic neuroma could potentially increase in incidence when untested whole-body exposure occurs, this may be the case with several evolving technologies....other possible sources of exposures that have not been evaluated include areas close to cellular base station antennas, the yet-to-be introduced 5 G communication systems, and rapidly evolving occupational exposure and novel systems for Wi-Fi (Peleg, 2009)."

Ibid. (p. 681, discussion):

"There are indications particularly from the Ramazzini animal studies that other environmental exposures might make people more susceptible to a combination of exposures (Falcioni et al., 2018). This combinatorial issue been noted in studies of occupational exposure to chemicals, metals and electromagnetic fields (Navas-Acien et al., 2002). Separately, no effects were observed but when combined with EMF strong results were found. In the Ramazzini studies finding a synergistic interaction between RFR and ionizing radiation, RFR served as a promoter while in the NTP animal studies RFR served as a direct carcinogen and genotoxic agent (National Toxicology Program, a, b, 2018.)."

Ibid. (p. 681, discussion):

"Individual hypersensitivity to electric and radiofrequency fields (EHS) is a relatively newly reported phenomenon in the west, although cases of radiation sickness have been found in the former Soviet literature from the 1960s and 1970s. Case studies and individual reports together identify a population which would benefit from RFR exposure reduction (Davis et al., 2017). Because of serious methodological difficulties in operationalizing the concept and a lack of investment in research, definitive epidemiological studies of EHS have not yet been conducted."

Ibid. (p. 681, discussion):

"However, non-cancer outcomes such as sperm damage, hearing loss and loss of visual acuity are likely to be more commonly linked to mobile phone use."

Ibid. (p. 681, conclusions):

"The Epidemiological studies reported since the 2011 IARC Working Group meeting are adequate to consider RFR as a probable human carcinogen (Group 2 A). However, they must be supplemented with the recently reported animal data as performed at the Ramazzini Institute and the US National Toxicology Program as well as by mechanistic studies. <u>These experimental findings together with the epidemiology reviewed here are sufficient in our opinion, to upgrade the IARC categorization of RFR to Group 1, carcinogenic to humans.</u>
…
In light of the evolving science concerning mobile phone and screen time exposures and the longer-term risk of cancer established by both epidemiological and toxicological studies, current evidence is strong enough to go from precaution concerning possible risk to prevention of known risks.
…
The precautionary principle should be applied now and suitable warning messages provided to adults and critically to children and their parents.
…
experimental evaluations and modeling are essential before distributing newer systems (e.g. 5 G) for which no safety data have been obtained. The absence of systematic testing of such technologies should not be confused with proof of safety.
…
In the meantime, the evidence amassed thus far from epidemiology strengthens the case for

instituting the precautionary principle with respect to exposures to RFR, especially to young children and men and women that wish to reproduce. … Where studies have been carried out on human sperm quantity and quality there are increasing indications of serious human health impacts. To ignore those findings and subject humans to unevaluated novel RFR frequencies places current and future generations at risk." (Emphasis added.)

1.2.2.2.2. Further.

A long list of other scientific studies confirm that exposure to radiofrequent electromagnetic radiation (including below the levels stipulated in Denmark's currently employed guidelines, cf. item 2.1 below) can be carcinogenic. Some of them are:

Blank og Goodman (2011), *"DNA is a fractal antenna in electromagnetic fields."*[28], p. 411:

"Regarding the connection between EMF and the incidence of cancer, the different EMF energy levels in the non-ionising and ionising ranges all involve interaction with and activation of DNA and induction of protein synthesis. The ability of EMF to cause DNA strand breaks and damage to proteins in the non-ionising range is similar to the destructive effects on DNA of the much more energetic X-rays and gamma rays in the ionising ranges, where it is generally acknowledged that the cancers are due to DNA damage. The recent epidemiology studies in the non-ionising range link EMF-caused changes in DNA with cancer. Additional support comes from the study showing that the absence of DNA repair genes is associated with a greater incidence of leukemia from exposure to low frequency EMF (Yang et al. 2008)." (underlined here)

Lerchl et al (2015), *"Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans"*, p. 585 (abstract):

"...Since many of the tumor-promoting effects in our study were seen 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, further studies are warranted to investigate the underlying mechanisms. Our findings may help to understand the repeatedly reported increased incidences of brain tumors in heavy users of mobile phones."

Yakymenko et al. (2015, cf. item 1.2.1. above) showed e.g. that low intensity RFR could lead to cancer (p. 196).

Prasad et al (2017), *"Mobile phone use and risk of brain tumours: a systematic review of association between study quality, source of funding, and research outcomes."*[29], p. 808 (conclusion):

"In our review of the literature and meta-analysis of case–control studies, we found evidence linking mobile phone use and risk of brain tumours especially in long-term users (>10 years). We also found a significantly positive correlation between study quality and outcome in the form of risk of brain tumour associated with use of mobile phones. Higher quality studies show a statistically significant association between mobile phone use and risk of brain tumour. Even

[28] Published in the scientific journal "Experimental Oncology," vol. 35, no. 3, pp. 219 – 225.
[29] Published in 2017 in the scientific journal "Neurological Sciences," vol. 38, pp. 797 – 810.

the source of funding was found to affect the quality of results produced by the studies."

This is a systematic, scientific review of the then current research that found a clear basis for linking the use of mobile phones to cancer tumours in the brain.

Further, the review in question found that the studies that had the highest scientific quality were the same as those finding the link, and that the source of financing had also played a part in the quality of the studies.

In November 2018, the American National Institute of Health published a report titled *"Toxicology and Carcinogenesis Studies in Hsd:Sprague Dawley SD Rats Exposed to Whole-Body Radio Frequency Radiation at a Frequency (900 MHz) and Modulations (GSM and CDMA) Used by Cell Phones,"* which states (p. 125 – 126, conclusions):

*"**GSM-Modulated RFR***
Under the conditions of this 2-year whole-body exposure study, there was clear evidence of carcinogenic activity[30] of GSM-modulated cell phone RFR at 900 MHz in male Hsd:Sprague Dawley SD rats based on the incidences of malignant schwannoma of the heart. The incidences of malignant glioma of the brain and benign, malignant, or complex pheochromocytoma (combined) of the adrenal medulla were also related to RFR exposure. The incidences of benign or malignant granular cell tumors of the brain, adenoma or carcinoma (combined) of the prostate gland, adenoma of the pars distalis of the pituitary gland, and pancreatic islet cell adenoma or carcinoma (com-bined) may have been related to RFR exposure. There was equivocal evidence of carcinogenic activity of GSM-modulated cell phone RFR at 900 MHz in female Hsd:Sprague Dawley SD rats based on the incidences of schwannomas of the heart.*
…
CDMA-Modulated RFR
Under the conditions of this 2-year whole-body exposure study, there was clear evidence of carcinogenic activity of CDMA-modulated cell phone RFR at 900 MHz in male Hsd:Sprague Dawley SD rats based on the incidences of malignant schwannoma of the heart. The incidences of malignant glioma of the brain were also related to RFR exposure. The incidences of adenoma of the pars distalis of the pituitary gland and adenoma or carcinoma (combined) of the liver may have been related to RFR exposure. There was equivocal evidence of carcinogenic activity of CDMA-modulated cell phone RFR at 900 MHz in female Hsd:Sprague Dawley SD rats based on the incidences of malignant schwannoma of the heart, malignant glioma of the brain, and benign, malignant, or complex pheochromocytoma (combined) of the adrenal medulla. Increases in nonneoplastic lesions of the heart, brain, and prostate gland in male rats, and of the brain in female rats occurred with exposures to CDMA-modulated RFR at 900 Mhz." (Emphasis added.)

On the immediate transference of these results onto humans, it further states (ibid., p. 125):

"The malignant schwannomas of the heart observed in male rats in the current studies and the malignant gliomas observed in the brain of male rats, arise from the same cell type as the acoustic neuromas (vestibular schwannomas) observed in humans, though in a different location. This lends credence to the possible association of these tumors with cellular phone use. The cellular origin of malignant gliomas in the rat brain is unclear, but they do arise from glial cells (support cells in the brain), as do human glioblastomas, so it is possible that such an association exists for these tumors as well. However, the interpretation of these findings with

[30] The asterisk refers to p. 16 of the study, in which the standards of proof are more clearly defined. "Clear evidence" is defined as *"...studies that are interpreted as showing a dose-related (i) increase of malignant neoplasms, (ii) increase of a combination of malignant and benign neoplasms, or (iii) marked increase of benign neoplasms if there is an indication from this or other studies of the ability of such tumors to progress to malignancy."*

respect to specific risks to humans from cellular telephone use is beyond the scope of the current studies. Further efforts to characterize the molecular basis by which RFR elicits its effects in rats, and a more complete assessment of the exposure conditions in the current studies in relation to exposures to humans from cellular telephone technologies should provide con-text to aid understanding of the implications of the current findings to human health." (Emphasis added)

Falcioni et al. (2018), *"Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission"*[31], p. 496 (abstract):

"The RI[32] *findings on far field exposure*[33] *to RFR are consistent with and reinforce the results of the NTP study*[34] *on near field exposure, as both reported an increase in the incidence of tumors of the brain and heart in RFR-exposed Sprague-Dawley rats. These tumors are of the same histotype of those observed in some epidemiological studies on cell phone users. These experimental studies provide sufficient evidence to call for the reevaluation of IARC conclusions regarding the carcinogenic potential of RFR in humans."* (Emphasis added.)

The study continues (cf. ibid., p. 501):

"...The statistically significant increase in the incidence of heart Schwannomas observed in male rats in the late part of their life, both in the RI and NTP studies, are consistent with the epidemiological findings, where the highest increase in risk of vestibular Schwannoma among humans exposed to RFR was observed in men over 50 years of age with the highest cumulative exposure (Hardell et al., 2013, 2003)."

The trial was conducted in such a manner that the exposed animals were subjected to a radiation absorption estimated to be between 0,001 and 0,3 W/kg (cf. p. 499), which is significantly lower than the limits permitted in Denmark, at 2 W/kg, cf. item 2.1 below.

The statistically significant results occurred in the groups of rats exposed to a field strength of 50 V/m. This is below the limit of 58,34 V/m, which is currently used in Denmark for a frequency of 1,8 GHz, cf. item 2.1 below.

In May 2018, Martin Pall[35] ascertained that at the time there existed a minimum of 35 scientific studies (since 1978) that documented that radiofrequent electromagnetic radiation was carcinogenic.

Panagopoulos (2019), cf. item 1.2.1. above, likewise referred to "hundreds of peer reviewed articles" demonstrating a range of effects from electromagnetic fields, including cancer (p. 53).

---

[31] Published in 2018 in the scientific journal "Environmental Research", vol. 165, pp. 496 – 503.

[32] RI stands for "Ramazzini Institute," the research institute where the investigation took place.

[33] Far field exposure in this case implies that the study recreated the conditions for radiation with a 1.8 GHz mobile phone mast, cf. ibid., p. 497, item 2.1.

[34] The "NTP-study" is the immediately above mentioned from the American "National Health Institute".

[35] Dr Pall is prof. emeritus in biochemistry and basic medical sciences, and published "*5G: Great risk for EU, US and International Health! Compelling Evidence for Eight Distinct Types of Great Harm Caused by Electromagnetic Field (EMF) Exposures and the Mechanism that Causes Them"* (pp. 15 – 16).

The (Danish) Minister of Health, in her reply dated April 12th 2019 to question 693 in the Danish parliament's Health and Elderly Committee, presented figures from the Danish Health Registry's cancer registry, which show a clear increase in registered cases of cancer, in the form of glioblastoma, within the last 20 years.

The increase is particularly noticeable from 2005 to 2006 in individuals more than 30 years of age, and on average shows a doubling of the number of cases in this age range in the period from 2006 to 2017, compared to the preceding period from 1995 to 2006.

Altogether, there is an almost 80% increase in occurrences from 2015 to 2017, compared with the general level prior to 2006.

Tabel 1 Antal incidente tilfælde af Glioblastom, 1995-2017

Kilden : Cancerregisteret			
Udtrækskriterier : Der er trukket på : Glioblastom ICD03-morfologi = 94403 og Giant cell glioblastom ICD03-morfologi =			
	Antal		
aar	<= 30 år	>30 år	I alt
1995	9	143	152
1996	11	133	144
1997	<5	176	
1998	8	200	208
1999	8	169	177
2000	<5	173	
2001	6	156	162
2002	9	163	172
2003	<5	185	
2004	7	174	181
2005	<5	174	
2006	<5	221	
2007	<5	196	
2008	6	237	243
2009	<5	252	
2010	<5	271	
2011	<5	253	
2012	9	250	259
2013	7	280	287
2014	<5	292	
2015	10	311	321
2016	7	300	307
2017	<5	288	

Kilde: Cancerregisteret, 2019

Anm.: Tal under fem er angivet med < 5 af hensyn til diskretionering og summen for i alt er i disse tilfælde fjernet

Anm.: Opdelt i kolloner mindre eller lige end 30 år, større end 30 år og i alt

The same doubling tendency is documented in England, cf. Philips et al. (2018), *"Brain Tumours: Rise in Glioblastoma Multiforme Incidence in England 1995–2015 Suggests an Adverse Environmental or Lifestyle Factor,"*[36] which states the following (p. 1, abstract):

*"*Results. *We report a sustained and highly statistically significant ASR* [37] *rise in glioblastomamultiforme (GBM) across all ages. The ASR for GBM more than doubled from 2.4 to 5.0, with annual case numbers rising from 983 to 2531. Overall, this rise is mostly hidden in the overall data by a reduced incidence of lower-grade tumours.* Conclusions. *The rise is of importance for clinical resources and brain tumour aetiology. The rise cannot be fully accounted for by promotion of lower–grade tumours, random chance or improvement in*

[36] Published in 2018 in the scientific journal "Journal of Environmental and Public Health," article ID 7910754.

[37] Age Standardised Rate.

diagnostic techniques as it affects specific areas of the brain and only one type of brain tumour. Despite the large variation in case numbers by age, the percentage rise is similar across the age groups, which suggests widespread environmental or lifestyle factors may be responsible." (Emphasis added.)

In the Netherlands, an increase of 20% over a 21-year period, from 1989 to 2010, is documented, cf. Vincent et al. (2014), *"Changing incidence and improved survival of gliomas,"*[38] p. 2311:

"The incidence rate of glioma increased from 4.9 per 100,000 inhabitants in 1989 to 5.9 in 2010..."

1.2.2.3. Other health damages to humans.

In their article "*Systematic Derivation of Safety Limits for Time-Varying 5G Radiofrequency Exposure Based on Analytical Models and Thermal Dose,"* Neufeld and Kuster (2018) ascertained that even at brief exposures to radiation corresponding to the planned 5G-radiation using higher frequencies and/or changed modulation, etc., cf. item 1.1. above, tissue damage to humans is possible, cf. p. 705, 706 and 711:

"Extreme broadband wireless devices operating above 10 GHz may transmit data in bursts of a few milliseconds to seconds. …these bursts may lead to short temperature spikes in the skin of exposed people. … To stay consistent with the current safety guidelines, safety factors of 10 for occupational exposure and 50 for the general public were applied. … The results also show that the peak-to-average ratio of 1,000 tolerated by the International Council on Non-Ionizing Radiation Protection guidelines may lead to permanent tissue damage after even short exposures, highlighting the importance of revisiting existing exposure guidelines.
…
THE FIFTH generation of wireless communication technology (5G) promises to facilitate transmission at data rates up to a factor of 100 times higher than 4G. For that purpose, higher frequencies (including millimeter-wave bands), broadband modulation schemes, and thus faster signals with steeper rise and fall times will be employed, potentially in combination with pulsed operation for time domain multiple access. 5G is designed as a ubiquitous communication system spanning applications such as high-bandwidth mobile data and telephony, real-time machine-to-machine communication (e.g., autonomous mobility), and the Internet of Things (IoT). Exposure to radiofrequency (RF) radiation from wireless devices to large radar installations and medical equipment can result in increases in body core temperature or cause localized temperature rises, with the potential for adverse health effects. The thresholds for frequencies above 10 MHz set in current exposure guidelines (ICNIRP 1998; IEEE 2005, 2010) are intended to limit tissue heating.
…
However, short pulses can lead to important temperature oscillations, which may be further exacerbated at high frequencies (>10 GHz, fundamental to 5G), where the shallow penetration depth leads to intense surface heating and a steep, rapid rise in temperature...
…
The recommendations in the ICNIRP guidelines limit the power density during short pulses to 1,000 times the limit for the time-averaged incident power density. The IEEE standard limits the radiant exposure (energy absorption per unit area) during any 100 ms to one-fifth of the total radiant exposure for the whole averaging time. The physical or biological rationales for these limits, however, are not provided.
…
Laakso et al. (2017) … The authors conclude that the current guidelines do not adequately prevent excessive heating from pulsed exposure, as peak temperatures can easily exceed the

[38] Published in 2014 in the scientific journal "European Journal of Cancer," vol. 50, pp. 2309 – 2318.

mean temperature by more than a factor of 3 and suggest that radiant exposure limits be introduced.
Morimoto et al. (2017) … They conclude that the thermal time constants can be as short as 30 s for narrow-beam exposures and that short pulses can carry enough energy to cause injuries;
…
Another conclusion of this study is that the current ICNIRP (1998) and IEEE (2005, 2010) guidelines urgently need to be revised, as the duty cycle of 1,000 currently tolerated can produce unacceptable temperature increases that may result in permanent tissue damage. ..."
(Emphasis added.)

Cindy Russell (2018), *"5 G wireless telecommunications expansion: Public health and environmental implications"*, p. 485:

"There are no long term exposure guidelines, nor are there guidelines for low level, non-thermal or biological effects considered in the International Commission on Non-Ionizing Radiation Protection (ICNIRP) standards which are the basis for standards used worldwide..."

Ibid. (p. 491):

"Although 5G technology may have many unimagined uses and benefits, it is also increasingly clear that significant negative consequences to human health and ecosystems could occur if it is widely adopted. Current radiofrequency radiation wavelengths we are exposed to appear to act as a toxin to biological systems. A moratorium on the deployment of 5G is warranted, along with development of independent health and environmental advisory boards that include independent scientists who research biological effects and exposure levels of radiofrequency radiation.
…
Public health regulations need to be updated to match appropriate independent science with the adoption of biologically based exposure standards prior to further deployment of 4G or 5G technology."

In May 2018, Martin Pall[39] ascertained that the following further kinds of health damage could result due to radiofrequent electromagnetic radiation on humans:

- reduced fertility and sex drive, increased spontaneous abortions, etc. (18 studies since 1971);
- neurological/neoropsychiatrical effects (25 studies since 1966);
- apoptosis/cell death (13 studies since 1971);
- hormonal effects (12 studies since 1971); and
- increased levels of intracellular calcium ions, causing a range of diseases (15 studies since 1988).

Pall (ibid., p. 1 – 2) stated:

"Each of these effects is produced via the main mechanism of action of microwave/lower frequency EMFs, activation of voltage-gated calcium channels (VGCCs) (Chapter 2). Each of them is produced via what are called downstream effects of VGCC activation. It follows from this that we have a good understanding not only that these effects occur, but also how they can occur. The extraordinary sensitivity of the VGCC voltage sensor to the forces of the EMFs

[39] Dr Pall is prof. emeritus in biochemistry and basic medical sciences, and published "*5G: Great risk for EU, US and International Health! Compelling Evidence for Eight Distinct Types of Great Harm Caused by Electromagnetic Field (EMF) Exposures and the Mechanism that Causes Them,"* pp. 8 - 15.

tells us that the current safety guidelines allow us to be exposed to EMF levels that are something like 7.2 milion times too high. That sensitivity is predicted by the physics. Therefore, the physics and the biology are each pointing to the same mechanism of action of non-thermal EMFs. The different effects produced are obviously very deep concerns. They become much deeper and become existential threats when one considers that several of these effects are both cumulative and eventually irreversible.

…

Obviously 4G and 5G will make the situation much worse." (Emphasis added.)

1.2.2.4. Particulars regarding children and cancer or other health damages.

There exists a series of studies, some of which are mentioned above, which specifically refer to health damage and risks of cancer or other adverse effects on children, such as:

Divan et al. (2012), *"Cell phone use and behavioural problems in young children,"*[40] (p. 524 abstract):

"The findings of the previous publication were replicated in this separate group of participants demonstrating that cell phone use was associated with behavioural problems at age 7 years in children, and this association was not limited to early users of the technology. Although weaker in the new dataset, even with further control for an extended set of potential confounders, the associations remained."

This investigation, which was a repetition of a previous investigation undertaken by the same scientists, confirmed a connection between behavioural problems with children aged 7 and the prenatal use of mobile phones by the mother as well as the children's own use postnatally, without it being possible to determine with certainty that there was a causal link, cf. p. 529. The investigation thus confirmed a potential risk.

Birks et al (2017), *"Maternal cell phone use during pregnancy and child behavioral problems in five birth cohorts"*[41], p. 1 (abstract, script version):

"Overall, 38.8% of mothers, mostly from the Danish cohort, reported no cell phone use during pregnancy and these mothers were less likely to have a child with overall behavioral, hyperactivity/inattention or emotional problems. Evidence for a trend of increasing risk of child behavioral problems through the maternal cell phone use categories was observed for hyperactivity/inattention problems (OR for problems in the clinical range: 1.11, 95%CI 1.01, 1.22; 1.28, 95%CI 1.12, 1.48, among children of medium and high users, respectively). This association was fairly consistent across cohorts and between cohorts with retrospectively and prospectively collected cell phone use data." (Emphasis added.)

Ibid. (p. 13 conclusion, script version):

"Maternal cell phone use during pregnancy may be associated with an increased risk of behavioral problems, particularly hyperactivity/inattention problems, in the offspring. This is the largest study to date to evaluate these associations and to show mostly consistent results across cohorts with retrospectively and prospectively assessed maternal cell phone use. Still, the interpretation of these results is unclear and should take into consideration that uncontrolled confounding by social factors or maternal hyperactivity may influence both

[40] Published in 2012 in the scientific journal "Journal of Epidemiology and Community Health," vol. 66, no. 6, pp. 524 – 529.

[41] Published in 2017 in the scientific journal "Environment International," vol. 104, pp. 122 – 131.

maternal cell phone use and child behavioral problems."

The result is thus reserved, though consistent, in confirming that there could be an increased risk of health problems for children due to their mothers' use of mobile phones during pregnancy.

Sudan et al (2018), *"Maternal cell phone use during pregnancy and child cognition at age 5 years in 3 birth cohorts"*[42], p. 155 (abstract):

"We observed patterns of lower mean cognition scores among children in relation to high frequency maternal prenatal cell phone use. The causal nature and mechanism of this relationship remain unknown."

There is a row of related tests on animal foetuses, e.g.:

Jing et al (2012), *"The influence of microwave radiation from cellular phone on fetal rat brain"*, p. 64:

"In order to protect human's health from the microwave damage, the relevant radiation limits have been given by many countries. The current limited guidelines for microwave from cellular phone in U.p. and Europe are 1.6 W/kg and 2.0 W/kg, respectively. New lower limits should also be used for children and/or pregnant women.
Due to the proximity of cellular phone antenna to the user's ear and head, the brain is inevitably exposed to EMFs with a relatively high specific absorption ratio (SAR), so the potentially danger from EMFs has been a concern of more and more people, especially by pregnant women.

…

As a whole, the results obtained in the present study indicate that exposure to EMFs of cellular phone (SAR 0.9 W/kg) could induce modifications in the fetal rat brain, not only oxidative stress system but also neurotransmitters. Because of the widespread use of cellular phones, further investigations with complementary techniques will be necessary to understand the mechanism of relation between EMFs of cellular phone and physiological implications."

It is noted that the radiation absorption rate is below the 2 W/kg limit currently employed in Denmark, cf. item 2.1 below.

Megha et al (2015), *"Low intensity microwave radiation induced oxidative stress, inflammatory response and DNA damage in rat brain"*[43], p. 164 (conclusion):

"In conclusion, prolonged exposure to low intensity microwave radiation at frequencies 900, 1800 and 2450 MHz leads to oxidative stress and inflammatory imbalances which subsequently leads to DNA damage in brain. These findings suggest that microwave radiation induced oxidative stress and inflammatory imbalances may be the causative factors involved in causing DNA strand breaks in brain cells."

Aldad et al (2012), *"Fetal Radiofrequency Radiation Exposure From 800-1900 Mhz-Rated*

[42] Published in 2018 in the scientific journal "Environment International," vol. 120, pp. 155 – 162.
[43] Published in 2015 in the scientific journal "NeuroToxicology" vol. 51, pp. 158 – 165.

Cellular Telephones Affects Neurodevelopment and Behavior in Mice"[44], p. 2 and 6:

"Overall, the mice exposed in-utero to radiation were hyperactive, had decreased memory, and decreased anxiety.
…
Our findings indicated significant electrophysiological and behavioral changes in mice exposed in-utero to radiation. The significant trend between the groups treated for 0, 9, 15, and 24 hours/day demonstrates that the effects are directly proportional to usage time, and suggests that safety limits, particularly for pregnant women, can be established. Though it is difficult to translate these findings to human risks and vulnerability, we identify a novel potential contribution to the increased prevalence in hyperactive children, one that is easily prevented. However, it is important to note that hyperactivity and anxiety are closely related and may confound one another.
...
In summary, we demonstrate that fetal radiofrequency radiation exposure led to neurobehavioral disorders in mice. We anticipate these findings will improve our understanding of the etiology of neurobehavioral disorders. The rise in behavioral disorders in developed countries may be, at least in part, due to a contribution from fetal cellular telephone radiation exposure. Further testing is warranted in humans and non-human primates to determine if the risks are similar and to establish safe exposure limits during pregnancy."

Buchner og Eger (2011), *"Changes of Clinically Important Neurotransmitters under the Influence of Modulated RF Fields—A Long-term Study under Real-life Conditions"*[45], p. 1 (translated from German):

"Since the 1960s, occupational studies on workers with continuous microwave radiation exposures (radar, manufacturing, communications) in the Soviet Union have shown that RF radiation exposures below current limits represent a considerable risk potential. A comprehensive overview is given in the review of 878 scientific studies by Prof. Hecht, which he conducted on behalf of the German Federal Institute of Telecommunications (contract no. 4231/630402) (2, 3).
As early as the 1980s, US research projects also demonstrated in long-term studies that rats raised under sterile conditions and exposed to "low-level" RF radiation showed signs of stress by increased incidences of endocrine tumors..."

Further, ibid. (p. 9, summary of results):

"...dopamine levels decrease substantially after the exposure begins. Even after one and a half years, the initial levels are not restored. Six months after the activation of the transmitter, PEA levels decrease continuously over the entire exposure period. Only in the exposure group above 100 µW/m2 is this effect observed immediately. All findings were observed well below current exposure limits (14)." [46]

Also, ibid. (p. 12, epidemiological evidence):

"As part of the German Mobile Telecommunication Research Programme, approximately 3000 children and adolescents were studied in Bavaria for their individual cell phone radiation exposure levels in relation to health problems. Among the various data sets, the data set

---

[44] Published in 2012 in the scientific journal "Nature Scientific Reports" 2, article no. 312. In 2013, a corrigendum (article no. 1320) was issued, with no changes to the article's conclusions.

[45] Originally published in German in 2011 in the scientific journal "Umwelt-Medizin-Gesellschaft," vol. 24, no. 1, pp. 44 – 57.

[46] (14) is the scientists' referral to the ICNIRP-guidelines, cf. item 2.1 below.

regarding behavioral problems showed a significant increased risk for both adolescents (OR: 3.7, 95%-CI: 1.6-8.4) and also children (OR: 2.9, 95%-CI: 1.4-5.9) in the highest exposure group (56). For the first time, the "Rimbach Study" provides a model of explanation in biochemical terms. "

Sudan et al (2012), *"Prenatal and Postnatal Cell Phone Exposures and Headaches in Children."* [47], p. 1 (abstract, script version):

"In this study, cell phone exposures were associated with headaches in children, but the associations may not be causal given the potential for uncontrolled confounding and misclassification in observational studies such as this. However, given the widespread use of cell phones, if a causal effect exists it would have great public health impact."

Byun et al (2013), *"Mobile Phone Use, Blood Lead Levels, and Attention Deficit Hyperactivity Symptoms in Children: A Longitudinal Study"* [48], p. 1:

"The results suggest that simultaneous exposure to lead and RF from mobile phone use was associated with increased ADHD symptom risk, although possible reverse causality could not be ruled out."

Herbert and Sage (2013), *"Autism and EMF? Plausibility of a pathophysiological link part II "*, p. 211 (abstract):

"Autism spectrum conditions (ASCs) are defined behaviorally, but they also involve multileveled disturbances of underlying biology that find striking parallels in the physiological impacts of electromagnetic frequency and radiofrequency radiation exposures (EMF/RFR).
…
Brain oxidative stress and inflammation as well as measures consistent with blood–brain barrier and brain perfusion compromise have been documented. Part II of this paper documents how behaviors in ASCs may emerge from alterations of electrophysiological oscillatory synchronization, how EMF/RFR could contribute to these by detuning the organism, and policy implications of these vulnerabilities. It details evidence for mitochondrial dysfunction, immune system dysregulation, neuroinflammation and brain blood flow alterations, altered electrophysiology, disruption of electromagnetic signaling, synchrony, and sensory processing, detuning of the brain and organism, with autistic behaviors as emergent properties emanating from this pathophysiology.
…
All of these phenomena also occur with EMF/RFR exposure that can add to system overload ('allostatic load') in ASCs by increasing risk, and can worsen challenging biological problems and symptoms; conversely, reducing exposure might ameliorate symptoms of ASCs by reducing obstruction of physiological repair.
…
With dramatic increases in reported ASCs that are coincident in time with the deployment of wireless technologies, we need aggressive investigation of potential ASC—EMF/RFR links. The evidence is sufficient to warrant new public exposure standards benchmarked to low-intensity (non-thermal) exposure levels now known to be biologically disruptive, and strong, interim precautionary practices are advocated." (Emphasis added.)

---

[47] Published in 2012 in the scientific journal "The Open Pediatric Medicine Journal," no. 6, pp. 46 – 52.
[48] Published in March 2013 in the scientific journal "PLOS One," d. 21.

Wiart et al. (2008)[49] ascertained, using models of heads, that children's heads absorbed around twice as much radiation as adults, cf. p. 3693:

"...The comparisons have also shown that the maximum SAR in 1 g of peripheral brain tissues of child models aged between 8 and 15 is comparable to the maximum SAR in 1 g of peripheral brain tissues of adult models while it is about two times higher for child models aged between 5 and 8. This is certainly due to the smaller thicknesses of pinna, skin and skull. … The results obtained in this study need to be confirmed since they have been derived from data sets of limited size. Nevertheless these results are comparable to those obtained in other studies involving several phantoms (Beard et al 2006, Kainz et al 2005). ..."

Hardell et al (2011), *"Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects"* [50], p. 1465 (abstract) found:

"...an increased risk was found for glioma and use of mobile or cordless phone. The risk increased with latency time and cumulative use in hours and was highest in subjects with first use before the age of 20."

From Miller et al november 2018, p. 676 – 677:

"In a population-based case-control study of children Li et al. (2012) included 939 leukemia and 394 brain neoplasm[51] *cases newly diagnosed between 2003 and 2007, aged 15 years or less.*
…
They reported that a higher than median averaged APD[52] *was significantly associated with an increased Adjusted Odds Ratio (AOR) for all neoplasms (1.13; 1.01–1.28), and for leukemia (1.23; 0.99–1.52), but not for all brain neoplasms (1.14, 0.83–1.55). They did not specifically analyze data on gliomas."*

Ibid., (p. 681, conclusions):

"The precautionary principle should be applied now and suitable warning messages provided to adults and critically to children and their parents. Until technology has been devised that substantially lowers exposures, special efforts should be advanced to ensure that the exposures of children are limited to those deemed essential. Children should be encouraged to text to reduce their exposure to RFR, while every attempt should be made to reduce exposure to RFR in schools, as well as homes."

1.2.2.5. Subject conclusion.

It seems clearly and scientifically well documented that exposure to radiofrequent electromagnetic radiation (also below the limits currently used in Denmark, cf. item 2.1 below)

[49] Published in 2008 in the scientific journal "Physics in Medicine & Biology," vol. 53, no. 13, pp. 3681 – 3695.
[50] Published in 2011 in the scientific journal "International Journal of Oncology", vol. 38, no. 5, pp. 1465 – 1474.
[51] Neoplasms are abnormal tissues which can develop into tumours, and in the worst case malignant cancer tumours.
[52] Stands for "Average Power Density", cf. ibid. p. 677.

can be carcinogenic, and in this respect pose a health risk to humans, a health risk that could prove life threatening.

Further, Pall's (2018) summarised scientific documentation of a range of further kinds of damage, including reduced fertility, spontaneous abortions, neurological/neuropsychiatrical effects, etc., can be added to this.

Further, it must be concluded that children are especially vulnerable and that several studies point to a possible connection between exposure to radiofrequent electromagnetic radiation and behavioural difficulties, autism, reduced perception, etc.

1.2.3. Animals.

Regarding animals, reference can be made to, e.g. Alfonso Balmori's review of the scientific literature in "*Electromagnetic pollution from phone masts. Effects on wildlife,"*[53] p. , where the conclusions (regarding birds, mammals and insects):

"This literature review shows that pulsed telephony microwave radiation can produce effects especially on nervous, cardiovascular, immune and reproductive systems [111]:

- Damage to the nervous system by altering electroencephalogram, changes in neural response or changes of the blood–brain barrier.
- Disruption of circadian rhythms (sleep–wake) by interfering with the pineal gland and hormonal imbalances.
- Changes in heart rate and blood pressure.
- Impairment of health and immunity towards pathogens, weakness, exhaustion, deterioration of plumage and growth problems.
- Problems in building the nest or impaired fertility, number of eggs, embryonic development, hatching percentage and survival of chickens.
- Genetic and developmental problems: problems of locomotion, partial albinism and melanism or promotion of tumors.

In the light of current knowledge there is enough evidence of serious effects from this technology to wildlife. For this reason precautionary measures should be developed, alongside environmental impact assessments prior to installation, and a ban on installation of phone masts in protected natural areas and in places where endangered species are present. Surveys should take place to objectively assess the severity of effects."

1.2.3.1. Birds.

There is a larger number of scientific investigations which document direct damage or the risk thereof on birds (and consequently also their habitats if, e.g. a mast is placed sufficiently nearby).

In the following, a range of these investigations are reviewed, with a focus on the documentation of damage or risks:

Balmori (2005), *"Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork (Ciconia ciconia)"*[54], p. 109 and 113 – 114:

"Monitoring of a white stork population in Valladolid (Spain) in the vicinity of Cellular Phone Base Stations was carried out, with the objective of detecting possible effects.
…
Birds are especially sensitive to the magnetic fields [48]. The white stork (Ciconia ciconia) build their nests on pinnacles and other very high places with high electromagnetic contamination (exposed to the microwaves). Also, they usually live inside the urban environment, where the electromagnetic contamination is higher, and remain in the nest a lot of the time, for this reason the decrease on the brood can be a good biological indicator to detect the effects of these radiations. The results indicate a difference in total productivity but not in partial productivity between the near nests and those far from the antennae. This indicate the existence of nests without chicks, or the death of young in their first stages in the nests near cellsites (40% of nest without young, compared to 3.3% in nests further 300 m).

[53] Published in 2009 in the scientific journal "Pathophysiology," vol. 16.
[54] Published in 2005 in the scientific journal "Electromagnetic Biology and Medicine," vol. 24, pp. 109 – 119.

…
The faithfulness of the white stork to nest sites can increase the effects of the microwaves.
…
Other studies find a decrease of fertility, increase of deaths after the birth in rats and dystrophic changes in their reproductive organs [16]. A recent study shows a statistically significant high mortality rate of chicken embryos subjected to the radiation from a cellphone, compared to the control group [43]. ..."

The white stork is admitted to "Annex I" of the EU directive on the conservation of wild birds, and thus belongs to the species for which "special conservation measures" must be made, cf. item 2.3.2. below.

Balmori and Hallberg (2007), *"The Urban Decline of the House Sparrow (Passer domesticus): A Possible Link with Electromagnetic Radiation"*[55], p. 141 (abstract):

"During recent decades, there has been a marked decline of the house sparrow (Passer domesticus) population in the United Kingdom and in several western European countries. The aims of this study were to determine whether the population is also declining in Spain and to evaluate the hypothesis that electromagnetic radiation (microwaves) from phone antennae is correlated with the decline in the sparrow population.
Between October 2002 and May 2006, point transect sampling was performed at 30 points during 40 visits to Valladolid, Spain. At each point, we carried out counts of sparrows and measured the mean electric field strength (radiofrequencies and microwaves: 1MHz–3GHz range). Significant declines (P=0.0037) were observed in the mean bird density over time, and significantly low bird density was observed in areas with high electric field strength. The logarithmic regression of the mean bird density vs. field strength groups (considering field strength in 0.1V/m increments) was R = −0 87 P = 0 0001.
The results of this article support the hypothesis that electromagnetic signals are associated with the observed decline in the sparrow population. We conclude that electromagnetic pollution may be responsible, either by itself or in combination with other factors, for the observed decline of the species in European cities during recent years. The appearently strong dependence between bird density and field strength according to this work could be used for a more controlled study to test the hypothesis" (Emphasis added.)

Elaborating on the manner in which it pertains to the currently employed limits, cf. item 2.1. below, it was ascertained (pp. 145 – 146) that :

"According to this calculation, no sparrows would be expected to be found in an area with field strength >4V/m. ... In monitored Area 14, Plaza de la Libertad, a picocell was installed at the beginning of January 2005 and removed at the end of March 2005. Between January and March 2005, the mean field strength was greater than 3V/m, and the number of sparrows decreased drastically (generally, the number of sparrows increases towards a midwinter peak). In April 2005, after the picocell was removed, the sparrows became abundant again."

These electrical field strengths (V/m) are below the limits recommended by ICNIRP and are used by Denmark, cf. item 2.1. below.

Cucurachi et al.[56], *"A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF)"* (p. 122):

"Balmori (2005) monitored the variation of a population of white storks (Ciconia ciconia) in the vicinity of a GSM base station i.e. 900–1800 MHz with 217 Hz modulation) in search of

[55] Published in 2007 in the scientific journal "Electromagnetic Biology and Medicine," vol. 26, pp. 141 – 151.
[56] Published in 2013 in the scientific journal "Environment International," vol. 51, pp. 116 – 140.

possible effects from the exposure. Total productivity within 200 m was on average 46% less than that found at a distance greater than 300 m from the emitting station. An analogous significant difference was found in the breeding success: in 40% more of the cases no new-born chicks were found in the nest.

…

Amongst the more recent laboratory studies, evidence of an effect of RF-EMF on mortality and development of embryos was in all cases found at both high and low dosages. In all the five field studies found a significant effect of RF-EMF on breeding density, reproduction or species composition. Field observations give a closer representation of real-life exposure, thus RF-EMF, especially in the 900 MHz GSM band could be a certain factor influencing the ecology of birds."

Burlaka et al. (2013, p. 223):

"In conclusion, the exposure of developing quail embryos in ovo to extremely low intensity RF-EMR of GSM 900MHz during at least one hundred and fifty-eight hours discontinuously leads to the significantly increased rates of superoxide and nitrogen oxide generation in embryo cells. This was accompanied by a significantly increased level of lipid peroxidation, a depression of key antioxidant enzymes activity, and significantly, 2–3-fold, increased level of oxidative damage of DNA in embryo cells." (Emphasis added.)

Alfonso Balmori (2015), *"Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation"*[57], p. 59:

Low-voltage electricity current-generated electromagnetic field can produce a significantly negative effect on the breeding success of birds (Ciconia ciconia) nesting directly on electricity lines (Vaitkuvienė and Dagys, 2014) and these same results have been found in nests exposed to radiofrequency radiation near phone masts (Balmori, 2005)."

Yakymenko et al. (2015, p. 194):

"We could ascertain the signaling effects of moderate levels of free radicals from our experiments in quail embryos irradiated with the commercial cell phone. Thus, we were able to show that the prolonged exposures of embryos in ovo led to robust repression of their development (Tsybulin et al., 2013), which was concomitant with significant overproduction of superoxide radical and NO radical, increased rates of lipid peroxidation and oxidative damage of DNA (Burlaka et al., 2013; Tsybulin et al., 2012)." (Emphasis added.)

Shende et al. (2015) *"Electromagnetic Radiations: A Possible Impact on Population of House Sparrow (Passer Domesticus)"*[58] (p. 45):

"By monthly monitoring in urban and rural area, it is found that the population of house sparrow is declining in the urban area, where cell phone towers are more as compared to the rural area in every season."

An area of special attention in the scientific literature is comprised of investigations into the effect of radiofrequent electromagnetic radiation on birds' biologically determined orientation abilities.

Birds are, like a range of other animals, cf. item 1.2.3.2. below, born with what can be described a form of a built-in, magnetically based compass, which implies that they will be able to find their way when migrating..

[57] Published in 2015 in the scientific journal "Science of the Total Environment," pp. 58 – 60.

[58] Published in 2015 in the scientific journal "Engineering International," vol. 3, no. 1, pp. 45 – 52.

Reference can be made to, e.g. Alfonso Balmori (2015), *"Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation,"*[59] (p. 58 – 59):

"Radio frequency fields in the MHz range disrupt birds' orientation interfering directly with the primary processes of magnetoreception and therefore disable the avian compass as long as they are present (Wiltschko et al., 2014). Ritz et al. (2004 & 2009) reported the sensitivity for orientation of European robins (Erithacus rubecula) to radiofrequency magnetic fields. The orientation of migratory birds is disrupted when very weak high-frequency fields (broadband field of 0.1–10 MHz of 85 nT or a 1.315 MHz field of 480 nT) are added to the static geomagnetic field of 46.000 nT (Thalau et al., 2006). It was convincingly demonstrated that robins are unable to use their magnetic compass in the presence of urban electromagnetic radiofrequency noise in the frequency range of 2 kHz–5 MHz (Engels et al., 2014). Therefore, electrosmog scrambles birds' magnetic sense and this finding could inform policies written to protect the habitats of endangered species. (Emphasis added.)

Balmori (2005), *"Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork (Ciconia ciconia),"*[60] (p. 115):

"... The perception to the terrestrial magnetic field can be altered by the electromagnetic radiation from the antennae. The reports of carrier pigeons losing direction in the vicinity of cellsites are numerous, and more investigation is necessary. ..."

The EU-based research project EKLIPSE published a report by Malkemper et al. (2018) titled *"The impacts of artificial ElectromagneticRadiation on wildlife (flora and fauna).Current knowledge overview: a background document to the web conference,"* in which it is, e.g. stated (p. 15):

"...It is established that the magnetic compass of migratory birds can be disrupted by the weak RF background in larger cities (nT-intensities) but it is currently unclear which exact frequencies are most effective. ..."

Regarding this effect further reference can be made to Engels et al (2014), *"Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird"*[61], p. 353 (abstract):

"...Here we show that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise. When European robins, Erithacus rubecula, were exposed to the background electromagnetic noise present in unscreened wooden huts at the University of Oldenburg campus, they could not orient using their magnetic compass. Their magnetic orientation capabilities reappeared in electrically grounded, aluminium-screened huts, which attenuated electromagnetic noise in the frequency range from 50kHz to 5MHz by approximately two orders of magnitude. When the grounding was removed or when broadband electromagnetic noise was deliberately generated inside the screened and grounded huts, the birds again lost their magnetic orientation capabilities. The disruptive effect of radiofrequency electromagnetic fields is not confined to a narrow frequency band and birds tested far from sources of electromagnetic noise required no screening to orient with their magnetic compass. These fully double-blinded tests document a reproducible effect of anthropogenic electromagnetic noise on the behaviour of an intact vertebrate." (Emphasis added)

---

[59] Published in 2015 in the scientific journal "Science of the Total Environment," pp. 58 – 60.

[60] Published in 2005 in the scientific journal "Electromagnetic Biology and Medicine," vol. 24, pp. 109 – 119.

[61] Published in 2014 in the scientific journal "Nature," no. 509, pp. 353 – 356.

1.2.3.1.1. Subject conclusion.

As is the case in relation to health damages and risk thereof for humans, it appears highly scientifically well documented that radiofrequent electromagnetic radiation, including that which remains within the (Danish) authorities' guidelines, is and can be damaging to the health of birds and (in extenso) their habitats.

Birds have a special trait that is their ability to orientate themselves partially based on an interaction with the Earth's naturally occurring magnetic field. Radiofrequent electromagnetic radiation's effect on birds' biologically determined abilities to orientate themselves can lead to the destruction of a species, including inside specially designated protected habitats. Particular to this issue, however, it must be highlighted that, for the time being, this does not seem to relate to 5G-frequencies, etc., though it could be the case. It appears that at the present time studies on this only show that birds' biologically determined sense of orientation is negatively affected by radiofrequent electromagnetic radiation.

1.2.3.2. Other animals.

Pertaining to insects, reference can be made to, e.g. Alfonso Balmori, *"Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation,"*[62] (2015, p. 59):

"As with birds, radio frequency magnetic fields disrupt magnetoreception in insects. The geomagnetic field reception in American cockroach is sensitive to weak radio frequency field causing a disruptive effect (Vacha et al., 2009), so these authors suggest that electromagnetic smog will have to be taken more seriously in animal magnetoreception experiments. In an experimentally-generated electromagnetic field of about 1 V/m with a realistic (and even lower) power intensity similar to those surrounding communication masts, the results and observations suggest that GSM (Global System for Mobile communications) 900 MHz radiation might have a severe impact on the nerve cells of exposed ants, especially affecting the visual and olfactory memory, causing the loss of their ability to use visual cues and suggesting that electromagnetic radiation may have an impact on the orientation behaviour and navigation of animals that use magnetic fields to find their way (Cammaerts et al., 2012, 2014). Honeybees are sensitive to pulsed electromagnetic fields generated by mobile phones and observable changes in the bee behaviour could be one explanation for the loss of colonies (Favre, 2011). Magnetoreception system in Monarch butterfly orientation (Guerra et al., 2014) may be also suffering interference with anthropogenic radio frequency magnetic fields and this, together with other factors (Brower et al., 2012), may be a cause of their population decline." (Emphasis added.)

Correspondingly, in Cucurachi et al. (2012, p. 116)[63]:

"Information was collected from 113 studies from original peer-reviewed publications or from relevant existing reviews… The majority of the studies were conducted in a laboratory setting on birds (embryos or eggs), small rodents and plants. In 65% of the studies, ecological effects of RF-EMF (50% of the animal studies and about 75% of the plant studies) were found both at high as well as at low dosages. ..."

Ibid. (p. 122 – 123):

"It has been demonstrated that insects can sense magnetic fields as a means for navigation and orientation (Abraçado et al., 2005; Kirschvink et al., 2001; Liedvogel and Mouritsen,

[62] Published in 2015 in the scientific journal "Science of the Total Environment," pp. 58 – 60.
[63] Published in 2013 in the scientific journal "Environment International," vol. 51, pp. 116-140.

2010; Wajnberg et al., 2010; Winklhofer, 2010). Magneto-reception has been associated with the use of ferromagnetic iron oxide particles embedded in tissue or through pairs of molecules with unpaired electrons (known as radical pairs) that are associated with a light sensitive photoreceptor (Ritz et al., 2002; Knight, 2009; Vácha et al. 2009). The exposure to RF-EMF might disrupt this magneto-reception mechanism, which could in turn affect the survival of insects. The most commonly studied species are the honey bee (A. mellifera) and the fruit fly (Drosophila melanogaster)."

And (p. 129):

"The studies analysing the effects of RF-EMF on fruit flies found in all cases a significant effect. Results of one study show an increased reproductive success after exposure. The remaining studies, which were conducted by the same research institute in Greece, found in all cases a significant depression of growth and reproduction at both 900 and 1800 MHz. Two studies on the American cockroach and a species of ant analysed the effects of exposure to RF-EMF on the magneto-reception and orientation of the insects. The behaviour of target systems was disrupted by the exposure to RF-EMF."

Also (p. 136, conclusions):

"...The effects of RF-EMF on different biological groups were investigated. With reference to the groups under investigations in the selected studies (i.e. birds, honeybees, mammals, plants, Drosophila and others) there is ecologically relevant evidence that the RF-EMF caused an effect in about 50% of the animal studies and about 90% of the plant studies. ..."

Kumar et al. (2011), *"Exposure to cell phone radiations produces biochemical changes in worker honey bees"*[64] (abstract, results and discussion):

"The present study was carried out to find the effect of cell phone radiations on various biomolecules in the adult workers of Apis mellifera L. The results of the treated adults were analyzed and compared with the control. Radiation from the cell phone influences honey bees' behavior and physiology. There was reduced motor activity of the worker bees on the comb initially, followed by en masse migration and movement toward "talk mode" cell phone. The initial quiet period was characterized by rise in concentration of biomolecules including proteins, carbohydrates and lipids, perhaps due to stimulation of body mechanism to fight the stressful condition created by the radiations.
At later stages of exposure, there was a slight decline in the concentration of biomolecules probably because the body had adapted to the stimulus.
…
Very little work has been done on biochemical, metabolic and physiological influences of cell phone radiations pertaining to health risk in man.[8] Therefore, the present investigations on the influence of cell phone radiations on some biochemical and physiological aspects of honeybee biology were undertaken. That the behavior of honeybee is altered to some extent by high or low energy fields or electromagnetic radiations has been known for quite some time.[9]
During the present investigation, it was observed that there was an increase in concentration of total carbohydrates in the bees exposed to cell phone radiation for 10 min as compared to unexposed or control bees. Increasing the exposure time to 20 min resulted in further increase in the concentration, while an exposure of 40 min had a reverse effect and there was a decline in carbohydrate concentration, though it was still higher as compared to control. Hemolymph glycogen and glucose content also showed the same trend, i.e., there was increase in content up to 20 min exposure after which there was a slight decline in the concentration which

[64] Published in 2011 in the scientific journal "Toxicology International," vol. 18, no. 1, pp. 70 – 72.

remained more than the control. Sharma[10] had also reported increase in glycogen and glucose levels in the exposed pupa of A. mellifera.
Lipids are the major energy reserves of insects. Certain lipid classes are structure components of membranes while others are raw materials for a variety of hormones and pheromones. Estimation of total lipids and cholesterol during the present study showed that the trend was similar to that of carbohydrates. After an initial increase in concentration at the 10 and 20 min exposure period, a decline was observed in the concentration of total lipids and cholesterol at 40 min exposure.
It was interesting to note that during the present study as the exposure time increased, it appeared that the bees having assessed the source of the disturbance decided to move and a large scale movement of the workers toward the talk-mode (not toward the listening mobile) was observed. Also, the bees became slightly aggressive and started beating their wings in agitation. This mobility of the bees could be responsible for increase utilization of energy sources and consequent decrease in concentration of carbohydrates and lipids in the 40 min exposed sample." (Emphasis added.)

Margaritis et al. (2014), *"Drosophila oogenesis as a bio-marker responding to EMF sources,"*[65] (p. 165, abstract):

"A total of 280 different experiments were performed using newly emerged flies exposed for short time daily for 3–7 d to various EMF sources including: GSM 900/1800 MHz mobile phone, 1880–1900 MHz DECT wireless base, DECT wireless handset, mobile phone-DECT handset combination, 2.44 GHz wireless network (Wi-Fi), 2.44 GHz blue tooth, 92.8 MHz FM generator, 27.15 MHz baby monitor, 900 MHz CW RF generator and microwave oven's 2.44 GHz RF and magnetic field components.
…
All EMF sources used created statistically significant effects regarding fecundity and cell death-apoptosis induction, even at very low intensity levels (0.3 V/m blue tooth radiation), well below ICNIRP's guidelines, suggesting that Drosophila oogenesis system is suitable to be used as a biomarker for exploring potential EMF bioactivity. Also, there is no linear cumulative effect when increasing the duration of exposure or using one EMF source after the other (i.e. mobile phone and DECT handset) at the specific conditions used. ..."

The study was carried out on fruit flies, and on the strength of the findings it was recommended that this insect be used in future as a biological marker in examinations of the effects of radiofrequent electromagnetic radiation.

As is stated, cell death occurred even at very low intensities of radiation, as far down as 0,3 V/m from Blue Tooth-products.

The investigation shows that equipment which lies inside the ICNIRP recommended limits (e.g. 61 V/m for equipment within a frequency range of 2 – 300 GHz), cf. also item 2.1 below, must be expected to be highly damaging to insects.

Some insects are encompassed by the protection of the EU directive on the conservation of natural habitats and of wild fauna and flora, cf. item 2.3.3. below.

Add to this the fact that birds that live on insects will likewise have their habitats destroyed. For the contents of the EU directive on the conservation of wild birds cf. item 2.3.2. below.

---

[65] Published in 2014 in the scientific journal "Electromagnetic Biology and Medicine," vol 33, no. 3, pp. 165 – 189.

Cammaerts and Johansson (2014), *"Ants can be used as bio-indicators to reveal biological effects of electromagnetic waves from some wireless apparatus,"*[66] (p. 286, item 3):

"All radiating sources tested in this study on the ants demonstrated clear and statistically significant effects. It was already known that a mobile phone in standby mode affects living organisms (e.g. see Cammaerts et al.,2011; Favre, 2011; Panagopoulos et al., 2004; Sharma and Kumar, 2010). In this study, we showed that a common mobile phone has an effect while in standby mode and even in off-condition. Of course, when activated, the effect of a mobile phone is stronger. Without its battery, such a phone has no longer an effect. Our ants demonstrated that a modern smartphone and even more so a DECT phone do affect living organisms. Furthermore, the electromagnetic waves generated by a WiFi router impact our ants and such an effect increases during the course of the exposure time. Persons working in rooms provided with wireless equipment should note this result. A modern personal computer also generates electromagnetic waves. This is due to the PC WiFi function, which is automatically activated. Based on these results, we advice users to deactivate the WiFi function of their PC as long as they do not use it. This can also be deduced from the study related in http://bigbrouser.blog.lemonde.fr/2011/12/01/microonde-le-wi-fi-tueur-de-spermatozoı¨des/." (Emphasis added.)

Especially regarding pollinators reference must be made to Lázaro et al. (2016), *"Electromagnetic radiation of mobile telecommunication antennas affects the abundance and composition of wild pollinators,"*[67] (p. 322, conclusion):

"Electromagnetic radiation from telecommunication antennas affected the abundance and composition of wild pollinators in natural habitats....Pollinators and their host plants constitute pollination networks. Although the architecture of these mutualistic networks can increase the capacity of pollinator populations to persist under harsh conditions, once a tipping point in human-induced environmental change is reached, pollinator populations may collapse simultaneously (Lever et al. 2014). Therefore, these changes in the composition of pollinator communities associated with electromagnetic smog may have important ecological and economic impacts on the pollination service that could significantly affect the maintenance of wild plant diversity, crop production and human welfare."

This study thus shows a connection between radiation from mobile masts and the number of (flying) insects.

The composition of pollinators must be seen as an important ecological element for the production of crops, human welfare, and biodiversity in general.

Vilic et al. (2017), *"Effects of short-term exposure to mobile phone radiofrequency (900 MHz) on the oxidative response and genotoxicity in honey bee larvae,"*[68] (p. 430, abstract):

"Exposure of different animal species to radiofrequency electromagnetic fields (RF-EMF) could cause various biological effects such as oxidative stress, genotoxic effects and dysfunction of the immune system. However, there are a lack of results on oxidative stress response and genotoxicity in the honey bee (Apis mellifera) after exposure to RF-EMF. This study was performed to investigate the effects of exposure to RF-EMF on the activity of catalase, superoxide dismutase, glutathione S-transferase, lipid peroxidation level and DNA damage in

[66] Published in 2014 in the scientific journal "Electromagnetic Biology and Medicine," vol 33, no. 4, pp. 282 – 288.
[67] Published in 2016 in the scientific journal "Journal of Insect Conservation," vol. 20, no. 2, pp. 315 – 324.
[68] Published in 2017 in the scientific journal "Journal of Apicultural Research," vol. 56, no. 4, pp. 430 – 438.

honey bee larvae. Honey bee larvae were exposed to RF-EMF at 900 Mhz and field levels of 10, 23, 41 and 120 V m−1 for 2 h. At a field level of 23 V m−1 the effect of 80% AM 1 kHz sinusoidal and 217 Hz modulation was investigated as well. Catalase activity and the lipid peroxidation level decreased significantly in the honey bee larvae exposed to the unmodulated field at 10 V m−1 compared to the control. Superoxide dismutase and glutathione S-transferase activity in the honey bee larvae exposed to unmodulated fields were not statistically different compared to the control. DNA damage increased significantly in honey bee larvae exposed to modulated (80% AM 1 kHz sinus) field at 23 V m−1 compared to the control and all other exposure groups. These results suggest that RF-EMF effects in honey bee larvae appeared only after exposure to a certain EMF conditions. The increase of the field level did not cause a linear dose-response in any of the measured parameters. Modulated RF-EMF produced more negative effects than the corresponding unmodulated field. Although honey bees in nature would not be exposed to such high field levels as used in our experiments, our results show the need for further intensive research in all stages of honey bee development." (Emphasis added)

Ibid. (p. 437, conclusion):

"In conclusion, the results of our study showed that effects of RF-EMF at 900 MHz in honey bee larvae appeared only after exposure to the certain EMF conditions. RF-EMF modulated at 1 kHz showed an increase of DNA damage, while unmodulated RF-EMF produced alteration in catalase activity and lipid peroxidation at the lowest field level of 10 V m−1. Evidently, the increase of the field level did not cause a linear dose-response relationship in any of the measured parameters. Although honey bees in nature would not be exposed to such high field levels as used in our experiments, our results show the need for further intensive research in all stages of honey bee development, as well as the intensive research on the possible existence of a "window" effect under natural conditions during the annual cycling of bees."

Thielens et al. (2018), *"Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz,"* (p. 9, conclusion, script version):

"The insects show a maximum in absorbed radio frequency power at wavelengths that are comparable to their body size. They show a general increase in absorbed radio-frequency power above 6 GHz (until the frequencies where the wavelengths are comparable to their body size), which indicates that if the used power densities do not decrease, but shift (partly) to higher frequencies, the absorption in the studied insects will increase as well. A shift of 10% of the incident power density to frequencies above 6 GHz would lead to an increase in absorbed power between 3–370%. This could lead to changes in insect behaviour, physiology, and morphology over time due to an increase in body temperatures, from dielectric heating. The studied insects that are smaller than 1 cm show a peak in absorption at frequencies (above 6 GHz), which are currently not often used for telecommunication, but are planned to be used in the next generation of wireless telecommunication systems. At frequencies above the peak frequency (smaller wavelengths) the absorbed power decreases slightly."

As can be seen, this study also pertains to frequencies above 6 GHz, which will be employed with the use of 5G.

Studies regarding radiofrequent electromagnetic radiation's effect on bats[69] have been done in, e.g. Nicholls and Racey (2009), *"The Aversive Effect of Electromagnetic Radiation on Foraging*

[69] 15 species of bats are encompassed by the special conservation rules of the EU directive on the conservation of wild fauna and flora, cf. item 2.3.3. below.

Bats—A Possible Means of Discouraging Bats from Approaching Wind Turbines," in which it is e.g. found that (p. 1, abstract):

"Large numbers of bats are killed by collisions with wind turbines and there is at present no accepted method of reducing or preventing this mortality. Following our demonstration that bat activity is reduced in the vicinity of large air traffic control and weather radars, we tested the hypothesis that an electromagnetic signal from a small portable radar can act as a deterrent to foraging bats. From June to September 2007 bat activity was compared at 20 foraging sites in northeast Scotland during experimental trials (radar switched on) and control trials (no radar signal). Starting 45 minutes after sunset, bat activity was recorded for a period of 30 minutes during each trial and the order of trials were alternated between nights. From July to September 2008 aerial insects at 16 of these sites were sampled using two miniature light-suction traps. At each site one of the traps was exposed to a radar signal and the other functioned as a control. Bat activity and foraging effort per unit time were significantly reduced during experimental trials when the radar antenna was fixed to produce a unidirectional signal therefore maximising exposure of foraging bats to the radar beam. However, although bat activity was significantly reduced during such trials, the radar had no significant effect on the abundance of insects captured by the traps." (Emphasis added.)

Correspondingly, in *"Electromagnetic pollution from phone masts. Effects on wildlife,"*[70] (p. 4):

"Electromagnetic radiation can exert an aversive behavioral response in bats. Bat activity is significantly reduced in habitats exposed to an electromagnetic field strength greater than 2 V/m [73]. During a study in a free-tailed bat colony (Tadarida teniotis) the number of bats decreased when several phone masts were placed 80m from the colony [74]."

Regarding toads, reference can e.g. be made to Alfonso Balmori (2010), *"Mobile Phone Mast Effects on Common Frog (Rana temporaria) Tadpoles: The City Turned into a Laboratory,"*[71] (p. 35):

"...Most prevailing hypotheses suggest that a field acts to directionally guide the growth and migration of some embryonic cells (Hotary and Robinson, 1992).
Strong magnetic fields (1.74–16.7T) disrupt cell division of exposed frog eggs (Xenopus laevis) (Denegre et al., 1998). Valles (2002) proposed a model to explain their influence.
Several studies on effects of electromagnetic fields on amphibians have been conducted in laboratories. When amphibian eggs and embryos of Ambystoma maculatum and Rana sylvatica were exposed to high magnetic fields (6.3 103 G), a brief treatment of early embryos produced several types of abnormalities, incuding microcephaly, retarded (abnormal) growth, edema, and scoliosis (Levengood, 1969).
Adult newts (Notophthalmus viridescens) exposed to a pulsed electromagnetic field (1 T and 0.15 V/m, approx.) for the first 30 days post forelimbs were amputated and produced more abnormalities in their skeletal patterns than the native limbs or the normal regenerates. Twelve percent exhibited unique abnormalities not observed in either the native or regenerate limb population. These forelimbs demonstrated one or more of the following gross defects: acheiria (lack of carpus and digits), aphalangia, or oligodactylia (loss of digits) as well as carpal bone and long bone (radius and ulna) abnormalities (Landesman and Douglas, 1990).
Exposed frog tadpoles (Rana temporaria) developed under electromagnetic field (50Hz, 260A/m) show an increase in mortality. Exposed tadpoles developed more slowly and less synchronously than control tadpoles and remained at the early stages for longer. Tadpoles developed allergies and EMF caused changes in their blood counts (Grefner et al., 1998). These results are consistent with the observations of this work.
Deformities and disappearance of amphibians and other organisms is part of the global biodiversity crisis (Blaustein and Johnson, 2003). Some authors consider that the

[70] Published in 2009 in the scientific journal "Pathophysiology,"
[71] Published in 2010 in the scientific journal "Electromagnetic Biology and Medicine," vol. 29, pp. 31 – 35.

electromagnetic pollution is destroying nature (Warnke, 2007; Firstenberg, 1997).
Balmori (2006) proposed that electromagnetic pollution (in the microwave and radiofrequency range) along with other environmental factors is a possible cause for decline and deformations of some wild amphibian populations exposed. The results of this experiment conducted in a real situation in the city of Valladolid (Spain) indicate that the tadpoles that live near such facilities, exposed to relatively low levels of environmental electromagnetic fields (1.8–3.5V/m) may suffer adverse effects (low coordination of movements, asynchronous growth, and high mortality), and this may be a cause (together with other environmental factors) of decline of amphibian populations." (Emphasis added.)

The study has thus been carried out on what is perhaps the most common frog in Denmark, the "butsnudet frø" (Rana temporaria). The animal has been entered into Annex II of the EU directive on the conservation of natural habitats and of wild fauna and flora, and is thus protected by special rules of conservation, cf. item 2.3.3. below.

The investigation points out that aside from an indication of mutations and a long line of health damage to toads, the electromagnetic pollution from even relatively weak electromagnetic fields, which the environment is being exposed to, is a possible cause (along with other environmental factors) for the loss of reptilian populations.

On mice, reference can be made to, e.g. the following, in addition to the other articles mentioned in this legal opinion:

Magras and Xenos (1997), *"RF Radiation–Induced Changes in the Prenatal Development of Mice"* (p. 455):

"The possible effects of radiofrequency (RF) radiation on prenatal development has been investigated in mice. This study consisted of RF level measurements and in vivo experiments at several places around an "antenna park." At these locations RF power densities between 168 nW/cm2 and 1053 nW/cm2 were measured. Twelve pairs of mice, divided in two groups, were placed in locations of different power densities and were repeatedly mated five times. One hundred eighteen newborns were collected. They were measured, weighed, and examined macro- and microscopically. A progressive decrease in the number of newborns per dam was observed, which ended in irreversible infertility. The prenatal development of the newborns, however, evaluated by the crown-rump length, the body weight, and the number of the lumbar, sacral, and coccygeal vertebrae, was improved." (Emphasis added.)

The mechanism for the observed sterility of mice is explained in this manner in Shahin et al. (2017), *"Mobile phone (1800 MHz) radiation impairs female reproduction in mice, Mus musculus, through stress induced inhibition of ovarian anduterine activity,"* (p. 41, abstract):

"Present study investigated the long-term effects of mobile phone (1800 MHz) radiation in stand-by, dialing and receiving modes on the female reproductive function (ovarian and uterine histo-architecture, andsteroidogenesis) and stress responses (oxidative and nitrosative stress). We observed that mobile phone radiation induces significant elevation in ROS, NO, lipid peroxidation, total carbonyl content and serumcorticosterone coupled with significant decrease in antioxidant enzymes in hypothalamus, ovary anduterus of mice. Compared to control group, exposed mice exhibited reduced number of developing and mature follicles as well as corpus lutea. Significantly decreased serum levels of pituitary gonadotrophins(LH, FSH), sex steroids (E2 and P4) and expression of SF-1, StAR, P-450scc, 3 -HSD, 17 -HSD, cytochrome P-450 aromatase, ER- and ER- were observed in all the exposed groups of mice, compared to control. These findings suggest that mobile phone radiation induces oxidative and nitrosative stress, which affects the reproductive performance of female mice." (Emphasis added.)

Further, ibid. (p. 57):

"...Mobile phone radiation may result in ovarian and uterine dysfunction by increasing ROS and

RNS production and disturbing antioxidant status. Oxidative and nitrosative stress created at the hypothalamus and peripheral level (ovary and uterus) as a consequence of long-term mobile phone exposure may severely reduce both steroidogenesis and folliculogenesis in the ovary as well as the structural and functional status of the uterus. These results led us to conclude that chronic exposure to long-term mobile phone radiation may severely affect the ovarian and uterine activity of female mice and thus may lead to infertility. ..."

1.2.3.2.1. Subject conclusion.

It appears to be scientifically well documented that radiofrequent electromagnetic radiation, also within the limits set by (Danish) authorities, are and can be damaging to the health of insects.

Add to this that because of the special condition that insects' abilities to orientate are partially based on interaction with naturally occurring fields in, e.g. the flowers to be pollinated, radiofrequent electromagnetic radiation's effect on the biologically determined abilities to orientate can be devastating for the preservation of the species.

Further, the disappearance of insects from an area can have vital importance for insectivorous birds' abilities to survive as a species.

1.2.4. Further regarding habitats and plants.

Part of the research mentioned in item 1.2.3. above relates to habitats, as it pertains to studies on the effects of radiation on animals in the areas in which they nest, hunt, etc.

To this can be added scientific investigations on radiofrequent electromagnetic radiation on plants, including trees:

Magone (1996), *"The effect of electromagnetic radiation from the Skrunda Radio Location Station on Spirodela polyrhiza (L.) Schleiden cultures,"*[72] (p. 75, abstract):

"The effect of electromagnetic radiation from the Skrunda Radio Location Station was studied on the vegetative growth and morphology of the duckweed Spirodela polyrhiza (L.) Schleiden plant in the next generation. The impact of plant development stage and length of the exposure period were examined. The effect of short-term (5-day) exposures of Spirodela cultures depended on the stage of development at the time of exposure. Generally, the vegetative reproduction rate was accelerated in the first 20 days after the end of exposure. Exposure of plants just beginning formation lowered the vegetative growth rate. Eighty-eight-hour exposure caused the appearance of some abnormal individuals after 30 days of growth. At 55 days, various morphological and developmental abnormalities appeared in 6–10 daughter plants from 10 exposed mother plants, compared with 0.1 plants per 10 in the control condition. Plants developed completely to daughter fronds under exposure from the electromagnetic field had a shorter life-span (67 days compared to 87 days in the control) and fewer subsequent daughters (total eight compared to 10 in the control group)." (Emphasis added.)

Katie Haggerty (2010), *"Adverse Influence of Radio Frequency Background on Trembling Aspen Seedlings: Preliminary Observations,"*[73] (p.):

[72] Published in 1996 in the scientific journal "Science of The Total Environment," vol. 180, no. 1, pp. 75 – 80.
[73] Published in 2010 in the scientific journal "International Journal of Forestry Research," article ID 836278.

"The results of this preliminary experiment indicate that the RF background may be adversely affecting leaf and shoot growth and inhibiting fall production of anthocyanins associated with leaf senescence in trembling aspen seedlings. These effects suggest that exposure to the RF background may be an underlying factor in the recent rapid decline of aspen populations. Further studies are underway to test this hypothesis in a more rigorous way."

Waldman et al. (2016), *"Radiofrequency radiation injures trees around mobile phone base stations,"* (p. 554 – 555, abstract):

"...detailed long-term (2006–2015) field monitoring study was performed in the cities of Bamberg and Hallstadt (Germany). During monitoring, observations and photographic recordings of unusual or unexplainable tree damage were taken, alongside the measurement of electromagnetic radiation. In 2015 measurements of RF-EMF (Radiofrequency Electromagnetic Fields) were carried out. A polygon spanning both cities was chosen as the study site, where 144 measurements of the radiofrequency of electromagnetic fields were taken at a height of 1.5 m in streets and parks at different locations.
...
The measurements of all trees revealed significant differences between the damaged side facing a phone mast and the opposite side, as well as differences between the exposed side of damaged trees and all other groups of trees in both sides. Thus, we found that side differences in measured values of power flux density corresponded to side differences in damage. The 30 selected trees in low radiation areas (no visual contact to any phonemast and power flux density under 50 µW/m2) showed no damage. Statistical analysis demonstrated that electromagnetic radiation from mobile phone masts is harmful for trees. These results are consistent with the fact that damage afflicted on trees by mobile phone towers usually start on one side, extending to the whole tree over time." (Emphasis added.)

Malka Halgamuge (2017), *"Review: Weak radiofrequency radiation exposure from mobile phone radiation on plants"*[74], p. 213 (abstract):

"Subject and methods: In this study, we performed an analysis of the data extracted from the 45 peer-reviewed scientific publications (1996–2016) describing 169 experimental observations to detect the physiological and morphological changes in plants due to the non-thermal RF-EMF effects from mobile phone radiation. Twenty-nine different species of plants were considered in this work. Results: Our analysis demonstrates that the data from a substantial amount of the studies on RF-EMFs from mobile phones show physiological and/or morphological effects (89.9%, $p < 0.001$). Additionally, our analysis of the results from these reported studies demonstrates that the maize, roselle, pea, fenugreek, duckweeds, tomato, onions and mungbean plants seem to be very sensitive to RF-EMFs. Our findings also suggest that plants seem to be more responsive to certain frequencies, especially the frequencies between (i) 800 and 1500 MHz ($p < 0.0001$), (ii) 1500 and 2400 MHz ($p < 0.0001$) and (iii) 3500[75] and 8000 MHz ($p = 0.0161$)." (Emphasis added.)

1.2.4.1. Subject conclusion.

[74] Published in 2017 in the scientific journal "Electromagnetic Biology AND Medicine," vol. 36, no. 2, pp. 213 – 235.

[75] 3.5 GHz is among the frequencies which, according to the Danish Energy Agency, will be reserved for the 5G system, cf. their action plan of February 2019 regarding 5G: https://ens.dk/sites/ens.dk/files/Tele/5g-handlingsplan_for_danmark.pdf, p. 10.

It seems scientifically well documented that radiofrequent electromagnetic radiation, also within the limits set by (Danish) authorities, is and can be damaging to plants.

In addition, the disappearance of plants from an area can have vital importance for the survivability of birds and insects as species.

1.3. Overall subject conclusion.

It is my belief that the scientific research materials analysed above document a clear and substantial causal link between the exposure of humans and animals to radiofrequent electromagnetic radiation on the one hand, and a range of damaging effects as well as possible damaging effects on both groups, including life threatening consequence, on the other hand.

Additionally, there is a well supported causal link regarding damage done to plants.

This is also true below the current limits, cf. also item 2.1. below.

2. The law.

2.1. Limits used in Denmark for exposure to radiofrequent electromagnetic radiation.

The Danish Health Authority uses limits as recommended in 1998[76] (affirmed in 2009[77]) by the ICNIRP (International Commission on Non-Ionizing Radiation Protection). Further, a SAR-limit of 2 W/kg for manufacturers of wireless equipment is used. These limits will likewise be employed in relation to 5G[78]. A special limit for full body radiation is set at an average of 0,08 W/kg.

The limits are based on thermal heating and similar short and immediate effects, whilst much reseach as mentioned in item 1.2 above, documents that radiofrequent electromagnetic radiation is harmful regardless of thermal heating[79], and still more research finds harmful effects likely. The ICNIRP guidelines state (p. 496):

*"**BASIS FOR LIMITING EXPOSURE***
These guidelines for limiting exposure have been developed following a thorough review of all published scientific literature. The criteria applied in the course of the review were designed to evaluate the credibility of the various reported findings (Repacholi and Stolwijk 1991; Repacholi and Cardis 1997); only established effects were used as the basis for the proposed exposure restrictions. Induction of cancer from long-term EMF exposure was not considered to be established, and so these guidelines are based on short-term, immediate health effects such as stimulation of peripheral nerves and muscles, shocks and burns caused by touching conducting objects, and elevated tissue temperatures resulting from absorption of energy during exposure to EMF. In the case of potential long-term effects of exposure, such as an increased risk of cancer, ICNIRP concluded that available data are insufficient to provide a basis for setting exposure restrictions, although epidemiological research has provided suggestive, but unconvincing, evidence of an association between possible carcinogenic effects and exposure at levels of 50/60 Hz magnetic flux densities substantially lower than those recommended in these guidelines...." (Emphasis added.)

Regarding 5G, the Danish Health Authority states the following on its homepage:

"...Overall, the Danish Health Authority finds, that there is no reason to be concerned that there should be a health risk linked to 5G. Measurements show that the total radiation from mobile phones, wifi and other apparatus which today emits non-ionised radiation is weak and far below the limits for what is damaging to your health. Based on the accessible knowledge, we have no reason to believe that 5G will change that.
In the legislation on radio equipment there are rules that radio equipment must be constructed to ensure human health. This means that antennas etc. for 5G must follow the same common European limits as all other present equipment for telecommunication."

In the comparison between the research mentioned above in item 1.2. and the limits used by the Danish Health Authority, the following schematic has been employed[80]:

[76] "ICNIRP guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 Ghz)," published in 1998 in the scientific journal "Health Physics," no. 74, pp. 494 – 522.

[77] "ICNIRP statement on the 'guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 Ghz),'" published in 2009 in the scientific journal "Health Physics," no. 97, pp. 257 – 258.

[78] Cf. the Minister of Energy, Utilities and Climate's April 1st 2019 reply to question 226 of the corresponding parliamentary committee, as well as the Danish Health Authority's webpage: https://www.sst.dk/da/straalebeskyttelse/mobiltelefoni,-traadloese-netvaerk-med-mere/5g

[79] See, e.g. Philips et al., 2009, p. 83, with references to two studies.

[80] The source is the Council for Health Safe Telecommunications.

ICNIRP 1998 grænser

(frekvens) MHz	(feltstyrke) V/m	(effekttæthed) µW/m2	mW/m2	W/m2	
10	28,00	2.079.575,60	2079,58	2,08	→ 10 – 400MHz defineret som 28 V/m (ICNIRP har vist rundet op)
400	27,50	2.005.968,17	2005,97	2,01	
450	29,17	2.256.999,73	2257,00	2,26	
500	30,75	2.508.123,34	2508,12	2,51	
550	32,25	2.758.786,47	2758,79	2,76	
600	33,68	3.008.865,78	3008,87	3,01	
650	35,06	3.260.487,00	3260,49	3,26	
700	36,38	3.510.621,75	3510,62	3,51	
750	37,66	3.762.004,24	3762,00	3,76	
800	38,89	4.011.756,23	4011,76	4,01	
850	40,09	4.263.151,46	4263,15	4,26	
900	41,25	4.513.428,38	4513,43	4,51	
950	42,38	4.764.096,55	4764,10	4,76	
1000	43,48	5.014.616,45	5014,62	5,01	
1050	44,56	5.266.826,53	5266,83	5,27	I dette interval er grænsen frekvensafhængig Udregnes som: $1.375\,x10^{-3}\sqrt{frekvens}$
1100	45,60	5.515.543,77	5515,54	5,52	
1150	46,63	5.767.524,93	5767,52	5,77	
1200	47,63	6.017.551,46	6017,55	6,02	
1250	48,61	6.267.724,40	6267,72	6,27	
1300	49,58	6.520.361,80	6520,36	6,52	
1350	50,52	6.769.948,01	6769,95	6,77	
1400	51,45	7.021.492,04	7021,49	7,02	
1450	52,36	7.272.067,90	7272,07	7,27	
1500	53,25	7.521.385,94	7521,39	7,52	
1550	54,13	7.772.034,22	7772,03	7,77	
1600	55,00	8.023.872,68	8023,87	8,02	
1650	55,85	8.273.799,73	8273,80	8,27	
1700	56,69	8.524.551,99	8524,55	8,52	
1750	57,52	8.775.995,76	8776,00	8,78	
1800	58,34	9.027.998,94	9028,00	9,03	→ Her rammer vi 9 mio µW/m2 ved 1800 MHz som var den højeste GSM frekvens i anvendelse omkring 98'
1850	59,14	9.277.293,37	9277,29	9,28	
1900	59,93	9.526.803,45	9526,80	9,53	
1950	60,72	9.779.624,40	9779,62	9,78	
2000	61,49	10.029.231,03	10029,23	10,03	
300000	61,00	9.870.027,00	9870,03	9,87	→ 2 – 300GHz defineret som 61 V/m (ICNIRP har vist rundet ned)

A range of above mentioned research results in items 1.2 – 1.4 document that radiation below the current limits can damage the health of humans and/or animals, e.g.:

Balmori and Hallberg, 2007, p. 145 – 146.
Blank and Goodman, 2011, p. 413.
Jing et al., 2012, p. 64.
REFLEX-studies p. 109 and 223.
Yakymenko et al., 2015, p. 186.
Lerchl et al., 2015, p. 585.
Falcioni et al., 2018, p. 499.
Russell, 2018, p. 485.
Neufeld and Kuster, 2018, p. 711.

Add to this the number of studies conducted on commercially available products, including the following from items 1.2 – 1.4 above:

D'Silva et al., 2017, p. 6.

Panagopoulos 2019, p. 55 (left column, bottom).

As of September 1st 2018, 244 scientists from over 40 countries, who together have published more than 2,000 scientific research articles on electromagnetic fields, have signed an appeal to the UN and WHO encouraging the establishment of better protection of human (and animal) health in relation to the use of electromagnetic installations such as 5G.[81] These 244 scientists have stated their belief, under the heading *"Inadequate non-ionizing EMF international guidelines"* as:

"The various agencies setting safety standards have failed to impose sufficient guidelines to protect the general public, particularly children who are more vulnerable to the effects of EMF.
...
It is our opinion that, because the ICNIRP guidelines do not cover long-term exposure and low-intensity effects, they are insufficient to protect public health. "

The *"...belief..."* of these 244 scientists is reflected in item 1.2 above, in the mentioned scientific literature.

Pall (2018) concluded e.g. the following in his review of the ICNIRP guidelines:

"Each of these reviews, typically cite from 5 to over 100 primary literature citations, each showing that non-thermal EMF exposures produce the effect under which they are listed. It follows from this, that there are not only 11 or more reviews documenting each of these effects, but there is also a massive primary literature documenting these effects as well. It follows from this that the ICNIRP, FCC and International Safety Guidelines, which are entirely based only on thermal effects are inadequate and there have been petitions and other statements of international groups of scientists expressing great concern about this. It follows that the ICNIRP, FCC and International safety guidelines are completely unscientific and cannot be relied upon to protect our safety." (Emphasis added.)

In resolution 1815 of 2011, cf. item 8.1.2., the Council of Europe recommended that its member states:

"8.1.2. reconsider the scientific basis for the present standards on exposure to electromagnetic fields set by the International Commission on Non-Ionising Radiation Protection, which have serious limitations, and apply ALARA[82] principles, covering both thermal effects and the athermic or biological effects of electromagnetic emissions or radiation;"

[81] Cf. https://emfscientist.org/index.php/emf-scientist-appeal
[82] As Low As Reasonably Achievable.

2.2. Legal protection of humans (human rights).

2.2.1. The European Convention on Human Rights (ECHR).

The convention was incorporated directly into Danish law by the adoption of law no. 285 of 1992, and is thus part of "regular" national law, which can be invoked directly before Danish courts.

In addition, the jurisprudence of the Danish Supreme Court is such that other rules are "interpreted in light of" the convention and its case law.

It is a general principle of interpretation in the use of the articles in the convention that they must be interpreted in such a way that the rights contained therein are practical and effective, cf. e.g. Grand Chamber judgment of September 27th 1995 in the case of McCann et al. v. United Kingdom, paragraph 146:

"146. The Court's approach to the interpretation of Article 2 (art. 2) must be guided by the fact that the object and purpose of the Convention as an instrument for the protection of individual human beings requires that its provisions be interpreted and applied so as to make its safeguards practical and effective (see, inter alia, the Soering v. the United Kingdom judgment of 7 July 1989, Series A no. 161, p. 34, para. 87, and the Loizidou v. Turkey (Preliminary Objections) judgment of 23 March 1995, Series A no. 310, p. 27, para. 72)."

2.2.1.1. Art. 2 – the right to life and the positive obligations of the state.

ECHR article 2 is worded as follows:

"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.

2. Deprivation of life shall not be regarded as inflicted in contravention of this Article when it results from the use of force which is no more than absolutely necessary:(a) in defence of any person from unlawful violence;(b) in order to effect a lawful arrest or to prevent the escape of a person lawfully detained;(c) in action lawfully taken for the purpose of quelling a riot or insurrection."

Thus only the first and second sentence, first part of paragraph 1, are of relevance to the question in this legal opinion.

In its case law, the European Court of Human Rights (hereafter "the Court") has interpreted the article to contain a line of material, positive obligations (i.e., duties to act), e.g. under certain conditions to hinder that people die as a result of pollution which has been allowed or not stopped by the state.

The obligations incumbent upon the state according to article 2 shall – owing to the importance of the right it is meant to protect – be interpreted strictly, cf. e.g. Grand Chamber judgment of September 27th 1995, in the case of McCann et al. v. United Kingdom, paragraph 147:

"147. It must also be borne in mind that, as a provision (art. 2) which not only safeguards the right to life but sets out the circumstances when the deprivation of life may be justified, Article 2 (art. 2) ranks as one of the most fundamental provisions in the Convention - indeed one which, in peacetime, admits of no derogation under Article 15 (art. 15). Together with Article 3 (art. 15+3) of the Convention, it also enshrines one of the basic values of the democratic

societies making up the Council of Europe (see the above-mentioned Soering judgment, p. 34, para. 88). As such, its provisions must be strictly construed."

In relation to the present legal opinion's subject, the case of Öneryildiz v. Turkey, Grand Chamber judgment of November 30th 2004, should be highlighted[83].

The case pertained to a deadly explosion in a landfill that killed a total of 39 people, including several of the applicant's close family members.

It was, e.g. found that the state has a positive obligation to set legal and administrative frameworks designed to provide an effective deterrence against life threatening dangers.

Para. 89 – 90 (with additional references to the Court's case law):

*"**(a) General principles applicable in the present case**(i) Principles relating to the prevention of infringements of the right to life as a result of dangerous activities: the substantive aspect of Article 2 of the Convention*

89. The positive obligation to take all appropriate steps to safeguard life for the purposes of Article 2 (see paragraph 71 above) entails above all a primary duty on the State to put in place a legislative and administrative framework designed to provide effective deterrence against threats to the right to life (see, for example, mutatis mutandis, Osman, cited above, p. 3159, § 115; Paul and Audrey Edwards, cited above, § 54; İlhan v. Turkey [GC], no. 22277/93, § 91, ECHR 2000-VII; Kılıç v. Turkey, no. 22492/93, § 62, ECHR 2000-III; and Mahmut Kaya v. Turkey, no. 22535/93, § 85, ECHR 2000-III).

90. This obligation indisputably applies in the particular context of dangerous activities, where, in addition, special emphasis must be placed on regulations geared to the special features of the activity in question, particularly with regard to the level of the potential risk to human lives. They must govern the licensing, setting up, operation, security and supervision of the activity and must make it compulsory for all those concerned to take practical measures to ensure the effective protection of citizens whose lives might be endangered by the inherent risks.

Among these preventive measures, particular emphasis should be placed on the public's right to information, as established in the case-law of the Convention institutions. The Grand Chamber agrees with the Chamber (see paragraph 84 of the Chamber judgment) that this right, which has already been recognised under Article 8 (see Guerra and Others, cited above, p. 228, § 60), may also, in principle, be relied on for the protection of the right to life, particularly as this interpretation is supported by current developments in European standards (see paragraph 62 above).

In any event, the relevant regulations must also provide for appropriate procedures, taking into account the technical aspects of the activity in question, for identifying shortcomings in the processes concerned and any errors committed by those responsible at different levels." (Emphasis added.)

It follows that there must be effective hindrances towards threats against the right to life, including dangerous activities such as the managing of the landfill in question in the case above.

When the activity is dangerous, particular weight must be attached to rules suitable for the special conditions which the activity in question demands, and then especially the potential danger to human life.

It is thus not a prerequisite for engaging article 2 that the certainty of a life threatening effect can be shown. It is adequate that the conduct in question imposes a potential risk to human life.

---

83 Further reference can be made to, e.g. Kolyadenko et al. v. Russia, paragraph 157 – 161.

The state must impose upon the participants, including those who would wish to build the infrastructure in question, that practical measures be made that are effective in safeguarding against the elements of danger which could cost humans their lives.

In view of the presented research material, cf. item 1.2. above, it is my assessment that the state at this time is clearly not living up to its obligations to set relevant limits, all the more prohibiting activities that carry with them a clearly documented risk of danger to human life.

Article 2 does not only apply to sudden incidents resulting in deaths. Pollution over a longer period of time also falls under its scope.

The Court uses the provision, regardless of whether the victim is deceased or "simply" in grave danger.[84]

Whether the polluter is public or private is not decisive.

If established that it is this pollution which has led to the loss of or danger to life, and that the state did not act in the face of a known risk (e.g. because the pollution in question was not in contravention of applicable national law, including limits), it will at the outset be in violation of the right to life, cf. in its entirety, e.g. the judgment of July 24th 2014 in the case of Brincat et al. v. Malta, paragraph 79 – 81 and 83 (with further references to case law):

"79. The Court reiterates that Article 2 does not solely concern deaths resulting from the use of unjustified force by agents of the State but also, in the first sentence of its first paragraph, lays down a positive obligation on States to take appropriate steps to safeguard the lives of those within their jurisdiction (see, for example, L.C.B. v. the United Kingdom, 9 June 1998, § 36, Reports 1998-III, and Paul and Audrey Edwards, cited above, § 54).

80. This obligation is construed as applying in the context of any activity, whether public or not, in which the right to life may be at stake, and a fortiori in the case of industrial activities which by their very nature are dangerous, such as the operation of waste-collection sites (see Öneryıldız v. Turkey [GC], no. 48939/99, §71, ECHR 2004-XII) or nuclear testing (see L.C.B. cited above, § 36) or cases concerning toxic emissions from a fertiliser factory (see Guerra and Others v. Italy, 19 February 1998, §§ 60 and 62, Reports 1998-I, although in this case the Court found that it was not necessary to examine the issue under Article 2, it having been examined under Article 8).

81. The Court considers that the same obligations may apply in cases, such as the present one, dealing with exposure to asbestos at a workplace which was run by a public corporation owned and controlled by the Government.

82. The Court reiterates that it has applied Article 2 both where an individual has died (see, for example, Öneryıldız, cited above) and where there was a serious risk of an ensuing death, even if the applicant was alive at the time of the application. Examples include cases where the physical integrity of an applicant was threatened by the action of a third party (see Osman v. the United Kingdom, 28 October 1998, §§ 115-122, Reports 1998-VIII) or as a result of a natural catastrophe which left no doubt as to the existence of a threat to the applicants' physical integrity (see Budayeva and Others v. Russia, nos. 15339/02, 21166/02, 20058/02,

[84] Further to Brincat et al. v. Malta, reference can, e.g. be made to Vilnes et al. v. Norway, paragraph 219: "*…the applicant was found to be the victim of conduct which by its very nature had put his life at risk, even though he survived. The Court found there that Article 2 was applicable and sees no reason for arriving at a different conclusion in the present case."*

11673/02 and 15343/02, § 146, ECHR 2008 (extracts)). More particularly, the Court has repeatedly examined complaints under Article 2 from persons suffering from serious illnesses. Such cases include G.N. and Others v. Italy (no. 43134/05, 1 December 2009) in which the applicants suffered from the potentially life-threatening disease hepatitis C; L.C.B. v. the United Kingdom (cited above), where the applicant suffered from leukaemia diminishing her chances of survival, Hristozov and Others v. Bulgaria, nos. 47039/11 and 358/12, ECHR 2012 (extracts), concerning applicants suffering from different types of terminal cancer; Karchen and Others v. France ((dec.), no. 5722/04, 4 March 2008) and Oyal v. Turkey (no. 4864/05, 23 March 2010), in which the applicants had been infected with the HIV virus, which endangered their life; Nitecki v. Poland ((dec.), no. 65653/01, 21 March 2002), in which the applicant suffered from amyotrophic lateral sclerosis; Gheorghe v. Romania ((dec.), no. 19215/04, 22 September 2005), in which the applicant suffered from haemophilia; and De Santis and Olanda v. Italy ((dec.), 35887/11, 9 July 2013) in which the applicant – who was severely disabled – suffered a cerebral haemorrhage as a consequence of an infection acquired in hospital.

83. The medical certification indicated that Mr Attard's death was likely to be a result of asbestos exposure; malignant mesothelioma is known to be a rare cancer associated with asbestos exposure. The Court observes that it has not been contested or denied that Mr Attard worked at Malta Drydocks for more than a decade (1959-1974), during which time he was repeatedly exposed to asbestos. Neither has it been shown that Mr Attard could have been contaminated elsewhere or that he was affected by other factors that could have led to the disease. In these circumstances, and given that Mr Attard has died as a result of his cancer, the Court considers that Article 2 is applicable to the complaint brought by the applicants in application no. 62338/11 relating to the death of the said Mr Attard." (Emphasis added.)

2.2.1.1.1. Subject conclusion.

Against the background of the scientific results in item 1.2 above, there remains in my assessment no reasonable doubt that the 5G-system is an industrial activity that poses a danger to humans.

As long as the current limits (as announced by the Danish Health Authority, cf. item 2.1 above) are in use, life threatening health conditions caused by radiofrequent electromagnetic radiation from activating the 5G-system must quite clearly be expected, and this would be in contravention of the positive obligations of the Danish state according to ECHR article 2.

As it must be assumed that the risk is well known to the Danish state, it is also obvious that it would incur liability in relation to the 5G-system[85], no later than when the life threatening health conditions appear.

2.2.1.2. Art. 8 – the right to respect for private and family life.

ECHR article 8 worded as follows:

"1. Everyone has the right to respect for his private and family life, his home and his correspondence.

2. There shall be no interference by a public authority with the exercise of this right except such as is in accordance with the law and is necessary in a democratic society in the interests of national security, public safety or the economic well-being of the country, for the prevention of disorder or crime, for the protection of health or morals, or for the protection of the rights and freedoms of others."

[85] It falls outside the parameters of this legal opinion to state corresponding assessments regarding 2G, 3G and 4G, etc.

Serious environmental pollution can affect individuals' well-being and prevent them from enjoying their private and family life. Such a condition will constitute an interference with the citizens' rights under the ECHR art. 8, cf. e.g. Guerra et al v. Italien, Grand Chamber judgment of February 19th 1998[86].

Paragraph 60:

"60. The Court reiterates that severe 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 (see, mutatis mutandis, the López Ostra judgment cited above, p. 54, § 51). In the instant case the applicants waited, right up until the production of fertilisers ceased in 1994, for essential information that would have enabled them to assess the risks they and their families might run if they continued to live at Manfredonia, a town particularly exposed to danger in the event of an accident at the factory.
The Court holds, therefore, that the respondent State did not fulfil its obligation to secure the applicants' right to respect for their private and family life, in breach of Article 8 of the Convention.

There has consequently been a violation of that provision."

In this respect the positive obligations overlap those of article 2 to a wide degree, cf. e.g. the judgment of March 20th 2008 in the case of Budayeva et al. v. Russia, paragraph 133, and the judgment of February 28th 2012 in the case of Kolyadenko et al. v. Russia, paragraph 216.

The right to respect for private and family life can be called upon where a malady has not been proven to be life threatening and will not necessarily be such. In this context, the Court uses the provision as a sort of secondary protection in relation to article 2, cf. above.

This was the approach for all but one applicant in, e.g. the judgment of July 24th 2014 in the case of Brincat et al. v. Malta, para. 85:

"85. However, in the context of dangerous activities, the scope of the positive obligations under Article 2 of the Convention largely overlaps with that of those under Article 8 (see Öneryıldız, cited above, §§ 90 and 160). The latter provision has allowed complaints of this nature to be examined where the circumstances were not such as to engage Article 2, but clearly affected a person's family and private life under Article 8 (see López Ostra v. Spain, 9 December 1994, Series A no. 303-C and Guerra and Others, cited above). The Court therefore considers it appropriate to examine the complaints in respect of the remaining applicants under Article 8, which is applicable in the present case (see also Roche v. the United Kingdom [GC], no. 32555/96, §§ 155-156, ECHR 2005-X)."

The deterioration of health must be such as to constitute an interference of the person's private and family life. Sickness which necessitates, e.g. lengthy or frequent hospitalisations, lasting and intrusive disabilities (including disabilities such as EHS, which entail high sensitivity towards equipment which emits electromagnetic radiation, possibly even in very small doses), markedly reduced fertility or spontaneous abortions, etc., could be suitable examples.

Where an event or condition that interferes with the right to respect for private or family life occurs, the ECHR can be expected to test whether, e.g. the technical preconditions were present in order to prevent the event or condition from taking place, and if this ought to have been foreseen by the state.

[86] Since the Grand Chamber found a violation of article 8, it was not necessary to also evaluate a complaint filed in the case regarding the right to life, cf. EMRK article 2, on account of the same.

If the Court finds that this is the case, then it will at the outset constitute a violation of the state's positive obligations under article 8. From the Court's case law, references can be made to the judgment of February 28th 2012 in the case of Kolyadenko et al. v. Russia, paragraph 215 – 216 (the case concerned the breaking of a water reservoir which lead to life endangerment and damage to peoples' homes):

"215. The Court further notes that the Government seem to have argued, with reference to the findings of the domestic courts in the applicants' civil cases, that the alleged infringements of their rights under Article 8 and Article 1 of Protocol No. 1 were the result of a natural disaster, in the form of exceptionally heavy rain, which could not have been foreseen, and could therefore not be imputed to the State. The Court cannot accept this argument. It reiterates in this connection that, being sensitive to the subsidiary nature of its role and cautious about taking on the role of a first-instance tribunal of fact, the Court nevertheless is not bound by the findings of domestic courts and may depart from them where this is rendered unavoidable by the circumstances of a particular case (see, for example, Matyar v. Turkey, no. 23423/94, § 108, 21 February 2002). In the present case, the Court has established in paragraphs 162-165 above that the flooding of 7 August 2001 occurred after the urgent large-scale evacuation of water from the Pionerskoye reservoir, the likelihood and potential consequences of which the authorities should have foreseen. The Court has furthermore established that the main reason for the flood, as confirmed by the expert reports, was the poor state of repair of the Pionerskaya river channel because of the authorities' manifest failure to take measures to keep it clear and in particular to make sure its throughput capacity was adequate in the event of the release of water from the Pionerskoye reservoir. The Court has concluded that this failure as well as the authorities' failure to apply town planning restrictions corresponding to the technical requirements of the exploitation of the reservoir put the lives of those living near it at risk (see paragraphs 168-180 and 185 above).
216. The Court has no doubt that the causal link established between the negligence attributable to the State and the endangering of the lives of those living in the vicinity of the Pionerskoye reservoir also applies to the damage caused to the applicants' homes and property by the flood. Similarly, the resulting infringement amounts not to "interference" but to the breach of a positive obligation, since the State officials and authorities failed to do everything in their power to protect the applicants' rights secured by Article 8 of the Convention and Article 1 of Protocol No. 1 (see Öneryıldız, cited above, § 135). Indeed, the positive obligation under Article 8 and Article 1 of Protocol No. 1 required the national authorities to take the same practical measures as those expected of them in the context of their positive obligation under Article 2 of the Convention (see, mutatis mutandis, Öneryıldız, cited above, § 136). Since it is clear that no such measures were taken, the Court concludes that the Russian authorities failed in their positive obligation to protect the applicants' homes and property.

217. There has, accordingly, been a violation of Article 8 of the Convention and Article 1 of Protocol No. 1 to the Convention in the present case."

The Court did not make an explicit assessment of proportionality in the case in question, which seems to be the consequence of the government having done nothing even though it should have foreseen the damaging event and could have acted to prevent it.

2.2.1.2.1. Subject conclusion.

Significantly, the same positive obligations apply under article 8 as under article 2 with regard to the protection of human beings from pollution, cf. item 2.2.1.1.1. For this reason alone, the activation of the 5G-network, with the employment of the current limits, must clearly be expected to lead to such interferences with citizens' private and family lives on account illnesses that there will also be a violation of these people's rights according to article 8.

2.2.2. The UN's Convention on the Rights of the Child.

The convention of December 20th 1989 on the rights of the child were ratified (by Denmark) through the royal decree of July 5th 1991. It has not been incorporated into Danish legislation, and national law must be interpreted in line with the obligations flowing from the convention, which the Danish state chose to undertake through its ratification. (This applies as long as it is not necessary to directly set aside a provision of a national law.)

Article 24, paragraph 1 and 2, subsection (c) of the convention is worded thus:

"1. States Parties recognize the right of the child to the enjoyment of the highest attainable standard of health and to facilities for the treatment of illness and rehabilitation of health. States Parties shall strive to ensure that no child is deprived of his or her right of access to such health care services.

2. States Parties shall pursue full implementation of this right and, in particular, shall take appropriate measures:

...

(χ) *To combat disease and malnutrition, including within the framework of primary health care, through, inter alia, the application of readily available technology and through the provision of adequate nutritious foods and clean drinking-water, taking into consideration the dangers and risks of environmental pollution;*

..." (Emphasis added.)

The state's actual obligation is to "strive to ensure" such treatment and care, and to "pursue full implementation" of the child's right to the highest attainable standard of health.

The highest attainable standard of health cannot imply the state allowing children (who belong to a particularly vulnerable group in this regard) to be exposed to radiation of a health damaging kind or strength.

There is scientific documentation that the establishment of the 5G-system will imply exposure to stronger and more dangerous[87] radiofrequent electromagnetic radiation than the already established 2G-, 3G- and 4G-systems (which according to the documentation available is in itself damaging or poses a risk thereof), in its current form, cf. item 1.1. above. It should thus clearly be expected to be more directly damaging to health and carry with it risks of damage, and as such be in contravention of Denmark's obligations according to article 24 of the UN Convention on the Rights of the Child.

The UN Committee on the Rights of the Child, which also makes decisions in complaints cases, in 2013 issued "general comment" no. 15, which constitutes guidelines as to how the committee interprets article 24 of the convention.

It is stated in item III.A, on the normative contents of the provision, that:

"The notion of "the highest attainable standard of health" takes into account both the child's biological, social, cultural and economic preconditions and the State's available resources, supplemented by resources made available by other sources, including nongovernmental organizations, the international community and the private sector.

[87] Parts of the radiation that, according to the information before me will be emitted from the 5G-system, will have less strength, though because of other characteristics will nonetheless be more dangerous than current radiation from the 2G-, 3G- and 4G-systems. See Kuster et al. (2018) in item 1.2.2.1.3. above.

Children's right to health contains a set of freedoms and entitlements. ... The entitlements include access to a range of facilities, goods, services and conditions that provide equality of opportunity for every child to enjoy the highest attainable standard of health." (Emphasis added.)

The telecommunications companies have already placed effective communications means at our disposal, which do not imply an establishment of the 5G-system.

Further, in paragraph 2, subsection (c), on pollution of the environment, the committee has stated thus, cf. ibid. (p. 6 – 7):

"States should take measures to address the dangers and risks that local environmental pollution poses to children's health in all settings. ... States should regulate and monitor the environmental impact of business activities that may compromise children's right to health,..." (Emphasis added.)

The wording "may compromise" strongly indicates that the committee employs a precautionary principle, and that the finding of a risk is sufficient for the state to be obligated to regulate and monitor such activities.

Through interpreting its purpose, it would follow that the consideration for children's health (which in itself must be assumed to weigh particularly heavy, especially when set against financial interests) must lead to the state prohibiting kinds of pollution that can endanger the health of children. Given the scientific documentation at hand, this would mean that the convention is a hindrance to establishing the 5G-system, if it only has to obey the ICNRIP recommendations regarding limits.

There is but one decision from the UN Children's Committee with respect to article 24 (communication case no. 35/2017). The case, which is not materially described on the committee homepage, does not appear from its sparse description (refugee child) to have any bearing on the issue at hand.

The question has not been addressed in Danish national law.

There is therefore no authoritative source which could verify the above interpretation.

2.2.2.1. Subject conclusion.

From an interpretation of the wording and purpose of the UN Convention on the Rights of the Child, compared to the scientific documentation at hand, with regard to both damages and risks, it is my assessment that activating the 5G-system, as it is described, cf. item 1.1. above, would be in contravention of the obligations of the Danish state according to article 24 of the convention.

2.3. Environmental regulations.

2.3.1. The precautionary principle in EU law.

The EU precautionary principle can currently be found in the Treaty on the Functioning of the European Union (TFEU), article 191, pararagraph 2:

"Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, ..."

According to the announcement of February 20th 2000 from the European Commission on the precautionary principle (p. 9 – 10), it can be applied *"...where scientific evidence is insufficient,inconclusive or uncertain and there are indications through preliminaryobjective scientific evaluation that there are reasonable grounds for concernthat the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the chosen level of protection ."*

As it relates to the topic of this legal opinion, evocation of the principle would clearly be relevant in so far as it was assumed that there was no scientific certainty with regard to concluding that radiofrequent electromagnetic radiation inside the currently utilised limits, cf. item 2.1. above, would be damaging to the health of (in casu) birds, animals and plants encompassed by the directives analysed in the following.

2.3.2. Directive on the conservation of wild birds.

The November 30th 2009 codified version of the EU-directive on the conservation of wild birds contains a line stipulating obligations for EU countries to "take the requisite measures" for "protection" (including preservation) of birds, their eggs, nests and habitats, cf. art.1.

The articles of the directive relevant to this legal opinion, on the basis of the information before me, are the following (emphasis added), with ongoing commentary:

Art. 1:

"1. This Directive relates to the conservation of all species of naturally occurring birds in the wild state in the European territory of the Member States to which the Treaty applies. It covers the protection, management and control of these species and lays down rules for their exploitation.
2. It shall apply to birds, their eggs, nests and habitats."

This means the protection applies to any wild species as well as their habitats.

Art. 2:

"Member States shall take the requisite measures to maintain the population of the species referred to in Article 1 at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level."

Art. 3, para. 1:

"In the light of the requirements referred to in Article 2, Member States shall take the requisite measures to preserve, maintain or re-establish a sufficient diversity and area of habitats for all

the species of birds referred to in Article 1."

The cited studies in item 1.2.3.1. above can in principle be relevant to all birds encompassed by the directive.

The referral to article 2 gives the member states a certain discretionary power as to the weighing of the considerations under article 3, even though it is clear from article 2 that financial interests cannot be the most important.

The most likely scenario, based on the research reviewed in item 1.2.3.1. above, is that an introduction of the 5G-system in areas where birds have their habitats would constitute a violation of this provision.

Art. 4, para. 1 and 4:

"The species mentioned in Annex I shall be the subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution.
In this connection, account shall be taken of:

(a) species in danger of extinction;

(b) species vulnerable to specific changes in their habitat;

…

4. In respect of the protection areas referred to in paragraphs 1 and 2, Member States shall take appropriate steps to avoid pollution or deterioration of habitats or any disturbances affecting the birds, in so far as these would be significant having regard to the objectives of this Article. Outside these protection areas, Member States shall also strive to avoid pollution or deterioration of habitats."

The protection under this provision has a wide range, and includes, inter alia, the white stork, which was the subject of the scientific study referred to above item 1.2.3.1. (Balmori, 2005). The study showed, e.g. that there were differences in the amount of offspring, that there was a connection to the proximity of telecommunications masts and that some nests were thus without any offspring. The study's conclusions were further based on experimental studies on birds' eggs.

The cited investigations in item 1.2.3.1. above can in principle be relevant to all birds encompassed by Annex I.

As the investigations simultaneously constitute a significant scientific documentation that radiofrequent electromagnetic radiation can reduce the number of offspring, cause mutations of the offspring and do damage to living birds (possibly including their ability to navigate), it is my opinion that introducing the intended 5G-system will be a violation of Denmark's obligations according to the directive's article 4, subsection 1, as the survival and breeding of the birds is not "ensured".

Further, Denmark would not have taken relevant steps to avoid pollution, the degradation of the birds' habitats or disruption of the birds, despite this having a significant influence on fulfilling the purpose of article 4.

Nor will there have been any effort to avoid pollution or the degradation of the birds' habitats outside the protected areas, cf. paragraph 4, in fine.

A significant reduction of the populace of animals which insectivorous birds feed on, cf. item 1.2.3.2. above, must equally be expected to have the effect of disturbing the birds' habitats to such an extent that it will have significant bearing on their survival capabilities.

Art. 5, para. 1, litra a), b) and d):

"Without prejudice to Articles 7 and 9, Member States shall take the requisite measures to establish a general system of protection for all species of birds referred to in Article 1, prohibiting in particular:

(a) deliberate killing or capture by any method;

(b) deliberate destruction of, or damage to, their nests and eggs or removal of their nests;

...

(d) deliberate disturbance of these birds particularly during the period of breeding and rearing, in so far as disturbance would be significant having regard to the objectives of this Directive;

..."

Article 7, which regards hunting, and article 9, which contains a series of exemptions without significance for the establishing of the 5G-network, are not relevant in this context.

The provision obliges the member states to establish general protection schemes for the safe-keeping of the birds referred to in article 1, and particularly highlights the fact that there must be a prohibition against, e.g. the wilful killing of birds, regardless of the method employed, and the wilful destruction or damage of nests and eggs.

Even though the purpose of setting up, e.g. 5G-telemasts is not to kill birds or destroy their nests or eggs, it is a clear and predictable consequence of the masts being put in place in the vicinity of bird habitats.

Art. 8, para. 1:

"In respect of the hunting, capture or killing of birds under this Directive, Member States shall prohibit the use of all means, arrangements or methods used for the large-scale or non-selective capture or killing of birds or capable of causing the local disappearance of a species, in particular the use of those listed in Annex IV, point (a)."

Article 8 revolves solely around killings which are done in accordance with the rules stipulated in this directive.

The wording is noteworthy, as the prohibition refers to non-selective killings which could lead to the local vanishing of a species. I.e., the provision is risk-based, meaning that the very danger of the contraption or method leading to the local disappearance of an entire species, is

adequate for the contraption or method to be banned. No such directly expressed risk-based protection can be seen in the other provisions cited above. Instead, wordings such as ”protection,” ”ensure the survival,” etc., are used. These other wordings more or less entice the use of risk-based protection as well as the use of the precautionary principle. The wording of article 8, which even refers to species encompassing the lower-tier protection of ”Annex II” of the directive, supports such an interpretation of the other provisions, which would further be in good compliance with the protective purposes of the directive.

2.3.2.1. Subject conclusion.

On the strength of the referred research in item 1.2 above, it is my opinion that if the 5G-system is activated it will or could lead to significant harm of the protected birds with habitats sufficiently close to, e.g. a relevant telecommunications mast.

This effect would be enhanced by such installations also demonstrably affecting the animals which insectivorous birds feed on, cf. item 1.2.3.2. above.

It must thus be my assessment that the activation of the network would constitute a violation of Denmark's obligations according to the directive's article 4 and 5, and possibly article 3.

If a scientific doubt was assumed to remain, the use of the precautionary principle should lead to the same conclusions.

2.3.3. The EU directive on the conservation of natural habitats and of wild fauna and flora.

The May 21st 1992 directive contains a series of obligations for EU-countries to ”ensure” the sustainment of a favourable preservation status for the nature types and habitats protected by the directive, and to ”ensure” not to damage the protected localities' integrity or to ”disturb” the species in a way that has detrimental consequences for the purpose of the directive.

Thus not all animals and plants are encompassed by the protection. However, the research mentioned in item 1.3. above cannot be taken to mean that it has a significance for the studied species alone. This is especially true as many of them regard the disturbance of general mechanisms, and as it is explicitly mentioned in several cases that the investigated species (e.g. fruit flies) would make ”good indicators”.

The articles of the directive relevant to this legal opinion, on the basis of the information before me, are the following (emphasis added), with ongoing commentary:

Art. 2:

”1. The aim of this Directive shall be to contribute towards ensuring bio-diversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies.

2. Measures taken pursuant to this Directive shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest.

3. Measures taken pursuant to this Directive shall take account of economic, social and cultural requirements and regional and local characteristics.”

Art. 3, para. 1:

”A coherent European ecological network of special areas of conservation shall be set up under the title Natura 2000. This network, composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II, shall enable the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range.”

The Natura 2000 network shall include the special protection areas classified by the Member States pursuant to Directive 79/409/EEC.”

With reference to this provision, the states ”shall enable” the maintenance/restoration of a favourable conservation status for the habitats of the species encompassed in Annex II. This includes (in Denmark) the white stork as well as the bats mentioned in this annex.

Given the scientific documentation of the harmful effects, this does not appear to be possible.

Add to this that any (scientifically adequately founded) insecurity would have to be clarified.

Art. 6, para. 2 to 4:

”2. Member States shall take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this Directive.

3. Any plan or project not directly connected with or necessary to the management of the site

but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.

4. If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.

Where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest."

Particularly regarding para. 3:

This duty implies that the authorities must ensure that any project, etc. (e.g. the introduction of the 5G-system by raising new telecommunications masts or placing transmitters on existing masts) does not damage the integrity of the locale.

Given the scientific documentation for the harmful effects, this does not appear to be possible.

Further, any (scientifically adequately founded) insecurity would have to be clarified.

Particularly regarding paragraph 4:

Given that the Danish Health Authority does not recognise neither harmful effects nor risks thereof, as reviewed in the above, there is no basis for assuming that the state will have made "all compensatory measures necessary," cf. paragraph 4, if it is assumed that the research cited in item 1.2 above is accurate.

As far as locales with a prioritised nature type and/or prioritised species are concerned, there are no special exemptions. The establishment of a 5G-network thus has no significant beneficial effect on human health, public safety or the environment, including when compared to other technological possibilities. As far as the concern for human health, it is, on the contrary, clear that it will have a harmful effect. Nor is there any statement from the Commission (regarding Denmark) under this provision.

Art. 7:

"Obligations arising under Article 6 (2), (3) and (4) of this Directive shall replace any obligations arising under the first sentence of Article 4 (4) of Directive 79/409/EEC in respect of areas classified pursuant to Article 4 (1) or similarly recognized under Article 4 (2) thereof, as from the date of implementation of this Directive or the date of classification or recognition by a Member State under Directive 79/409/EEC, where the latter date is later."

Directive no. 79/409/EØF is the above mentioned directive on the conservation of wild birds (now: codified by directive 2009/147/EF). The new conservation directive is also encompassed by the referral provision of article 7 of the present directive on the conservation of natural habitats and of wild fauna and flora, cf. the bird directive's article 18, paragraph 2.

Art. 12, para. 1, 3 and 4:

"1. Member States shall take the requisite measures to establish a system of strict protection for the animal species listed in Annex IV (a) in their natural range, prohibiting:
(a) all forms of deliberate capture or killing of specimens of these species in the wild;

(b) deliberate disturbance of these species, particularly during the period of breeding, rearing, hibernation and migration;

(c) deliberate destruction or taking of eggs from the wild;

(d) deterioration or destruction of breeding sites or resting places.

...

3. The prohibition referred to in paragraph 1 (a) and (b) and paragraph 2 shall apply to all stages of life of the animals to which this Article applies.

4. Member States shall establish a system to monitor the incidential capture and killing of the animal species listed in Annex IV (a). In the light of the information gathered, Member States shall take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned."

Even though the purpose of setting up, e.g. 5G-telemasts is not to kill animals or destroy their nests or eggs, it is a clear and predictable consequence of the masts being put in place in the vicinity of protected animals' habitats.

The protection under this directive explicitly applies to all stages of life for the encompassed animals, whereas the bird directive states that protection applies to birds, their nests and eggs. It is unlikely that any different approach between the two provisions was intended, given that a "lacuna" in the protection of the species in question would be able to render the rules ineffective.

Art. 13, para. 1, subsection a) and para. 2:

"1. Member States shall take the requisite measures to establish a system of strict protection for the plant species listed in Annex IV (b), prohibiting:
(a) the deliberate picking, collecting, cutting, uprooting or destruction of such plants in their natural range in the wild;

...

2. The prohibitions referred to in paragraph 1 (a) and (b) shall apply to all stages of the biological cycle of the plants to which this Article applies."

Art. 15, para. 1, subsection a):

"In respect of the capture or killing of species of wild fauna listed in Annex V (a) and in cases where, in accordance with Article 16, derogations are applied to the taking, capture or killing of species listed in Annex IV (a), Member States shall prohibit the use of all indiscriminate means capable of causing local disappearance of, or serious disturbance to, populations of such species, and in particular:

(a) use of the means of capture and killing listed in Annex VI (a);

..."

Annex VI mentions, inter alia, "*Electrical and electronic devices capable of killing or stunning.*" It has not been clarified whether this definition could encompass apparatus such as telecommunications masts, antennas, etc., which over a longer or very long period could inflict mortal harm on the animals encompassed by the directive. It cannot be ruled out, regardless of the fact that the wording most likely intended to refer to apparatus which kill or paralyse in a more immediate manner. However, by using the term "in particular" in article 15 itself, it is stated that the means mentioned in Annex VI (a) are not comprehensive and that the prohibition encompasses any means which would locally be able to lead to a species vanishing or being seriously disturbed.

It seems apparent that the intended 5G-installations are in contravention of article 15 itself, irrespective of also being possibly attributable to Annex VI (a).

Art. 16, para. 1, subsection c):

"1. Provided that there is no satisfactory alternative and the derogation is not detrimental to the maintenance of the populations of the species concerned at a favourable conservation status in their natural range, Member States may derogate from the provisions of Articles 12, 13, 14 and 15 (a) and (b):

…

(c) in the interests of public health and public safety, or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment;
..."

There are others satisfactory alternatives.

Further, on the strength of the scientific material review under item 1.2 above, it has to be my opinion that a derogation of the protection would have a great probability of preventing the sustainment of populations over time.

2.3.3.1. Subject conclusion.

It is my opinion, based on the strength of the research referred to in item 1.2 above, that should the 5G-system be activated, it will or could lead to serious damage being done to the protected species of animals and plants whose habitats are located sufficiently close to, e.g. a telecommunications mast.

This effect would be enhanced by the fact that these installations have a proven harmful effect on insectivores, cf. item 1.2.3.2. above.

Therefore, it must be my conclusion that the activation of the system would constitute a violation of Denmark's obligations according to this directive's article 6, paragraph 2 – 4.

If a scientific doubt was assumed to remain, then the use of the precautionary principle should lead to the same conclusions.

2.4. The Bern convention.

The September 19th 1979 convention on the "Conservation of European Wildlife and Natural Habitats" (hereafter the "Bern-convention") was ratified by Denmark through royal decree on July 5th 1982. It has not been incorporated into Danish legislation, and national law must be interpreted in line with the obligations flowing from the convention, which the Danish state chose to undertake through its ratification. (This applies as long as it is not necessary to directly set aside a provision of a national law.)

The convention includes, inter alia, a number of obligations whereby the signatory states have taken on the responsibility to *"...ensure..."* the protection of a range of wild animals and plants, so that the populations are maintained, whilst at the same time "taking account of economic requirements," cf. article 2.

The articles of the directive relevant to this legal opinion, on the basis of the information before me, are the following (emphasis added), with ongoing commentary:

Art. 2:
"The Contracting Parties shall take requisite measures to maintain the population of wild flora and fauna at, or adapt it to, a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements and the needs of sub-species, varieties or forms at risk locally."

Art. 3, para. 2:
"Each Contracting Party undertakes, in its planning and development policies and in its measures against pollution, to have regard to the conservation of wild flora and fauna."

Art. 4, para. 1 to 3:
"1. Each Contracting Party shall take appropriate and necessary legislative and administrative measures to ensure the conservation of the habitats of the wild flora and fauna species, especially those specified in Appendices I and II, and the conservation of endangered natural habitats.

2. The Contracting Parties in their planning and development policies shall have regard to the conservation requirements of the areas protected under the preceding paragraph, so as to avoid or minimise as far as possible any deterioration of such areas.

3. The Contracting Parties undertake to give special attention to the protection of areas that are of importance for the migratory species specified in Appendices II and III and which are appropriately situated in relation to migration routes, as wintering, staging, feeding, breeding or moulting areas."

Art. 5, first sentence:
"Each Contracting Party shall take appropriate and necessary legislative and administrative measures to ensure the special protection of the wild flora species specified in Appendix I. ..."

Art. 6, subsection a to c:
"Each Contracting Party shall take appropriate and necessary legislative and administrative measures to ensure the special protection of the wild fauna species specified in Appendix II. The following will in particular be prohibited for these species:

a. all forms of deliberate capture and keeping and deliberate killing;

b. the deliberate damage to or destruction of breeding or resting sites;

c. the deliberate disturbance of wild fauna, particularly during the period of breeding, rearing

and hibernation, insofar as disturbance would be significant in relation to the objectives of this Convention;

…"

Art. 7, para. 1 and 2:
"1. Each Contracting Party shall take appropriate and necessary legislative and administrative measures to ensure the protection of the wild fauna species specified in Appendix III.

2. Any exploitation of wild fauna specified in Appendix III shall be regulated in order to keep the populations out of danger, taking into account the requirements of Article 2."

Reg. art. 4 to 7:

The continued "ensurance" of the protection of the species listed in Appendices I and II is not possible when comparing the above cited research, cf. item 1.2., to the current limits, should the intended 5G-system be introduced.

This is especially clear as it relates to the obligation in article 4, paragraph 2, to avoid or limit as far as possible any deterioration of such areas.

Art. 8:
"In respect of the capture or killing of wild fauna species specified in Appendix III and in cases where, in accordance with Article 9, exceptions are applied to species specified in Appendix II, Contracting Parties shall prohibit the use of all indiscriminate means of capture and killing and the use of all means capable of causing local disappearance of, or serious disturbance to, populations of a species, and in particular, the means specified in Appendix IV."

The provision is worded as being risk-based, so that the prohibition applies to the mere possibility that the non-selective method of killing or relevant means would be able to effect the extermination of a species. (It is thus particularly obvious to evoke the precautionary principle, if it is assumed that scientific doubt remains.)

Further, article 8 refers to a "*List IV"* with a list of prohibited means and methods of killing, etc., of wild animals encompassed by the convention's *"List III*" (cf. article 7 above). The list includes, e.g. a ban on using "*Electrical devices capable of killing and stunning"* in relation to both mammals and birds. It is undecided whether this definition can include apparatus such telecommunications masts, antennas, etc., which over a longer or very long period could inflict mortal damage to the animals included in list III. It cannot be excluded, even though the wording is most likely meant for apparatus that are able to kill or stun more immediately. However, by using the term "in particular" in article 8 itself, it is stated that the means mentioned in list IV are not comprehensive, and that the prohibition encompasses any means which would locally be able to lead to a species vanishing or being seriously disturbed.

Art. 9, para. 1:
"Each Contracting Party may make exceptions from the provisions of Articles 4, 5, 6, 7 and from the prohibition of the use of the means mentioned in Article 8 provided that there is no other satisfactory solution and that the exception will not be detrimental to the survival of the population concerned:

–for the protection of flora and fauna;

–to prevent serious damage to crops, livestock, forests, fisheries, water and other forms of property;

–in the interests of public health and safety, air safety or other overriding public interests;

..."

There are other satisfactory solutions.

It must be my opinion, given the research materials shown in item 1.2 above, that a derogation from the protection would carry with it a great probability of harming the survival of the populations.

2.4.1. Subject conclusion.

The continued ”ensurance” of the protection of species adopted in lists I and II is not possible with the introduction of the intended 5G-system, given the scientific research shown in item 1.2. above, when compared to the current limits.

It appears likely that the protection under article 8 of ”list III-species” would not be respected by the establishing of the 5G-system, when compared with the current limits.

2.5. The Bonn-convention.

The June 23rd 1979 convention on the "Conservation of Migratory Species of Wild Animals" (hereafter the "Bonn-convention") was ratified by Denmark through royal decree on July 5th 1982. It has not been incorporated into Danish legislation, and national law must be interpreted in line with the obligations flowing from the convention, which the Danish state chose to undertake through its ratification. (This applies as long as it is not necessary to directly set aside a provision of a national law.)

The convention includes, inter alia, a number of obligations whereby the signatory states have taken on the responsibility to "take appropriate steps" to keep safe endangered migrating animal species and their habitats, cf. article 2, paragraph 1.

The articles of the directive relevant to this legal opinion, on the basis of the information before me, are the following (emphasis added), with ongoing commentary:

Art. 2, para. 1 and 2:

"1. The Parties acknowledge the importance of migratory species being conserved and of Range States agreeing to take action to this end whenever possible and appropriate, paying special attention to migratory species the conservation status of which is unfavourable, and taking individually or in co-operation appropriate and necessary steps to conserve such species and their habitat.

2. The Parties acknowledge the need to take action to avoid any migratory species becoming endangered."

The presupposed protection of migrating species is not, in my opinion, possible when comparing the above cited research, cf. item 1.2., with the current limits, should the intended 5G-system be introduced.

Add to this, that in my estimation Denmark will be excluding themselves from having "taken the necessary steps" to preserve the migrating species if the current limits are upheld.

Art. 3, para. 4:

"Parties that are Range States of a migratory species listed in Appendix I shall endeavour:

a) to conserve and, where feasible and appropriate, restore those habitats of the species which are of importance in removing the species from danger of extinction;

b) to prevent, remove, compensate for or minimize, as appropriate, the adverse effects of activities or obstacles that seriously impede or prevent the migration of the species; and

c) to the extent feasible and appropriate, to prevent, reduce or control factors that are endangering or are likely to further endanger the species, including strictly controlling the introduction of, or controlling or eliminating, already introduced exotic species."

The wording *"to the extent … appropriate,"* which limits the obligation in subsection (c), cannot be found in subsections (a) or (b).

The presupposed protection of migrating species is not, in my opinion, possible when comparing the above cited research, cf. item 1.2., with the current limits, should the intended 5G-system be introduced.

2.5.1. Subject conclusion.

The presupposed protection of migrating species is not, in my opinion, possible when comparing the above cited research, cf. item 1.2., with the current limits, should the intended 5G-system be introduced.

3. Conclusion and final remarks.

It is the conclusion of this legal opinion that establishing and activating a 5G-network, as it is currently described, would be in contravention of current human and environmental laws enshrined in the European Convention on Human Rights, the UN Convention on the Rights of the Child, EU regulations, and the Bern- and Bonn-conventions.

The reason is the very significant body of scientific documentation available, showing that radiofrequent electromagnetic radiation is harmful and dangerous to the health of humans (particularly children), animals and plants.

This also applies when the radiation remains within the limits recommended by ICNIRP and currently used in Denmark as well as broadly within the EU.

The exact damaging effects to health from 5G are not known, since the system is not exactly defined, though given the background of the current research on the effects of radiofrequent electromagnetic radiation on, e.g. the bodies of humans and animals, including the provocation of DNA damage and oxidative stress, it appears highly unlikely that it would not lead to similar harm as the current systems, particularly since it is based on the same basic form of radiation.

The Danish state earns considerable amounts licensing the establishment and operation of the communications systems by, inter alia, auctioning off the frequency bands to telecommunications companies who then use the bands to generate billions of profit, which is then taxed.

Alfonso Balmori is one amongst many scientists who have spoken out in the following way about the inherent conflict of interest in this structural problem, cf. Balmori (2005, p. 116):

"Controversy is frequent when the scientists recognize serious effects on health and on the environment that cause high economic losses."

Holte, May 4th 2019

Christian F. Jensen
attorney-at-law (L)

APPENDIX 1 TO LEGAL OPINION

Agarwal A. et al. 2009, Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: an in vitro pilot study

https://www.sciencedirect.com/science/article/pii/S0015028208033566

"Result(s) Samples exposed to RF-EMW showed a significant decrease in sperm motility and viability, increase in ROS level, and decrease in ROS-TAC score. Levels of TAC [Total Antioxidant Capacity] and DNA damage showed no significant differences from the unexposed group."

Aitken R.J. et al. 2005, Impact of radio frequency electromagnetic radiation on DNA integrity in the male germline.

"In this study, mice were exposed to 900 MHz RFEMR at a specific absorption rate of approximately 90 mW/kg inside a waveguide for 7 days at 12 h per day. Following exposure, DNA damage to caudal epididymal spermatozoa was assessed by quantitative PCR (QPCR) as well as alkaline and pulsed-field gel electrophoresis... This study suggests that while RFEMR does not have a dramatic impact on male germ cell development, a significant genotoxic effect on epididymal spermatozoa is evident and deserves further investigation."

Fulltext & PDF: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2605.2005.00531.x

Avendaño C. et al. 2011, Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation

exposure of human spermatozoa to a wireless internet-connected laptop decreased motility and induced DNA fragmentation by a nonthermal effect.

Fulltext & PDF: https://www.fertstert.org/article/S0015-0282(11)02678-1/fulltext

Behari J. et al. 2006, Single strand DNA breaks in rat brain cells exposed to microwave radiation

This study shows that the chronic exposure to these radiations (2.45 and 16.5 GHz, SAR 1.0 and 2.01 W/kg, respectively) cause statistically significant ($p < 0.001$) increase in DNA single strand breaks in brain cells of rat.

https://www.sciencedirect.com/science/article/pii/S0027510705005361

Belyaev I.Y. et al. 2009, Microwaves from UMTS/GSM mobile phones induce long-lasting inhibition of 53BP1/γ-H2AX DNA repair foci in human lymphocytes

"All data were pooled and highly significant inhibitory effects on formation of DNA repair foci were found as analyzed immediately after 1 h exposure to UMTS, 915 MHz and heat shock...The most striking observation was that these MW-
induced inhibitory effects continued up to 3 days following 1 h exposure to MWs... These effects depended on carrier frequency and type of signal and suggested misbalance between DNA damage and DNA repair"

https://onlinelibrary.wiley.com/doi/abs/10.1002/bem.20445

Blank M. et al. 2011, DNA is a fractal antenna in electromagnetic fields

Since DNA can interact with EMF over a wide range of frequencies, and does not appear to be limited to an optimal frequency, it has the functional properties of a fractal antenna....From the above analysis of the effect of EMF on the stress response, DNA strand breaks and cancer epidemiology, the fractal property of DNA is apparent in the ELF and RF ranges.

https://www.tandfonline.com/doi/full/10.3109/09553002.2011.538130

Burlaka A. et al. 2013, Overproduction of free radical species in embryonal cells exposed to low intensity radiofrequency radiation

CONCLUSION: Exposure of developing quail embryos to extremely low intensity RF-EMR of GSM 900 MHz during at least one hundred and fifty-eight hours leads to a significant overproduction of free radicals/reactive oxygen species and oxidative damage of DNA in embryo cells. These oxidative changes may lead to pathologies up to oncogenic transformation of cells.

Fulltext & PDF: http://exp-oncology.com.ua/article/6079

Busljeta I. et al. 2004, Erythropoietic changes in rats after 2.45 GJz nonthermal irradiation.

"Adult male Wistar rats (N=40) were exposed to 2.45 GHz continuous RF/MW fields for 2 hours daily, 7 days a week, at 5-10 mW/cm2... In the applied experimental condition, RF/MW radiation might cause disturbance in red cell maturation and proliferation, and induce micronucleus formation in erythropoietic cells."

https://www.ncbi.nlm.nih.gov/pubmed/15729835

Cam ST et al. 2011, Single-strand DNA breaks in human hair root cells exposed to mobile phone radiation

Conclusions: A short-term exposure (15 and 30 min) to RFR (900-MHz) from a mobile phone caused a significant increase in DNA single-strand breaks in human hair root cells located around the ear which is used for the phone calls.

https://www.tandfonline.com/doi/full/10.3109/09553002.2012.666005

Campisi A. et al. 2010, Reactive oxygen species levels and DNA fragmentation on astrocytes in primary culture after acute exposure to low intensity microwave electromagnetic field

Our data demonstrate, for the first time, that even acute exposure to low intensity EMF induces ROS production and DNA fragmentation in astrocytes in primary cultures, which also represent the principal target of modulated EMF. Our findings also suggest the hypothesis that the effects could be due to hyperstimulation of the glutamate receptors, which play a crucial role in acute and chronic brain damage. Furthermore, the results show the importance of the amplitude modulation in the interaction between EMF and neocortical astrocytes.

https://www.sciencedirect.com/science/article/abs/pii/S030439401000176X

d'Ambrosio G et al. 2002, Cytogenetic damage in human lymphocytes following GMSK phase modulated microwave exposure

Human peripheral blood cultures were exposed to 1.748 GHz, either continuous wave (CW) or phase only modulated wave (GMSK), for 15 min. The maximum specific absorption rate (approximately 5 W/kg) was higher than that occurring in the head of mobile phone users; however, no changes were found in cell proliferation kinetics after exposure to either CW or GMSK fields. As far as genotoxicity is concerned, the micronucleus frequency result was not affected by CW exposure; however, a statistically significant micronucleus effect was found following exposure to phase modulated field. These results would suggest a genotoxic power of the phase modulation per se.

https://www.ncbi.nlm.nih.gov/pubmed/11793401

De Luliis G.N. et al. 2009, Mobile Phone Radiation Induces Reactive Oxygen Species Production and DNA Damage in Human Spermatozoa In Vitro

"Principal Findings: Purified human spermatozoa were exposed to radio-frequency electromagnetic radiation (RF-EMR) tuned to 1.8 GHz and covering a range of specific absorption rates (SAR) from 0.4 W/kg to 27.5 W/kg. In step with increasing SAR, motility and vitality were significantly reduced after RF-EMR exposure, while the mitochondrial generation of reactive oxygen species and DNA fragmentation were significantly elevated (P<0.001). Furthermore, we also observed highly significant relationships between SAR, the oxidative DNA damage bio-marker, 8-OH-dG, and DNA fragmentation after RF-EMR exposure."

"Conclusions: RF-EMR in both the power density and frequency range of mobile phones enhances mitochondrial reactive oxygen species generation by human spermatozoa, decreasing the motility and vitality of these cells while stimulating DNAbase adduct formation and, ultimately DNA fragmentation. These findings have clear implications for the safety of extensive mobile phone use by males of reproductive age, potentially affecting both their fertility and the health and wellbeing of their offspring."

Fulltext & PDF: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2714176/

Diem E. et al. 2005, Non-thermal DNA breakage by mobile-phone radiation (1800 MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro.

"Abstract: Cultured human diploid fibroblasts and cultured rat granulosa cells were exposed to intermittent and continuous radiofrequency electromagnetic fields (RF-EMF) used in mobile phones, with different specific absorption rates (SAR) and different mobile-phone modulations. DNA strand breaks were determined by means of the alkaline and neutral comet assay. RF-EMF exposure (1800 MHz; SAR 1.2 or 2 W/kg; different modulations; during 4, 16 and 24h; intermittent 5 min on/10 min off or continuous wave) induced DNA single- and double-strand breaks. Effects occurred after 16 h exposure in both cell types and after different mobile-phone modulations. The intermittent exposure showed a stronger effect in the comet assay than continuous exposure. Therefore we conclude that the induced DNA damage cannot be based on thermal effects."

https://www.sciencedirect.com/science/article/abs/pii/S1383571805000896

D'Silva M.H. et al. 2017, Effect of Radiofrequency Radiation Emitted from 2G and 3G Cell Phone on Developing Liver of Chick Embryo – A Comparative Study

Conclusion: The chronic exposure of chick embryo liver to RFR emitted from 2G and 3G cell phone resulted in various structural changes and DNA damage. The changes were more pronounced in 3G experimental group. Based on these findings it is necessary to create awareness among public about the possible ill effects of RFR exposure from cell phone.

Fulltext og PDF: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5583901/

Fucić A. et al. 1992, X-rays, microwaves and vinyl chloride monomer: their clastogenic and aneugenic activity, using the micronucleus assay on human lymphocytes.

"In our study we chose the micronucleus assay with a new mathematical approach to separate clastogenic from aneugenic activity of three well-known mutagens (vinyl chloride monomer, X-rays and microwaves) on the genome of human somatic cells... Microwaves possess some mutagenic characteristics typical of chemical mutagens."

https://www.sciencedirect.com/science/article/pii/0165799292901333

Gajski G. et al. 2009, Radioprotective effects of honeybee venom (Apis mellifera) against 915-MHz microwave radiation-induced DNA damage in wistar rat lymphocytes: in vitro study.

The aim of this study is to investigate the radioprotective effect of bee venom against DNA damage induced by 915-MHz microwave radiation (specific absorption rate of 0.6 W/kg) in Wistar rats... Bee venom is demonstrated to have a radioprotective effect against basal and oxidative DNA damage. Furthermore, bee venom is not genotoxic and does not produce oxidative damage in the low concentrations used in this study.

https://journals.sagepub.com/doi/full/10.1177/1091581809335051

Gandhi G. et al. 2005, Cytogenetic Damage in Mobile Phone Users: Preliminary Data.

"The aim of the present study hence was to detect any cytogenetic damage in mobile phone users by analysing short term peripheral lymphocytes cultures for chromosomal aberrations and the buccal mucosal cells for micronuclei (aneugenicity and clastogenicity). The results revealed increased number of micronucleated buccal cells and cytological abnormalities in cultured lymphocytes indicating the genotoxic response from mobile phone use."

https://www.tandfonline.com/doi/abs/10.1080/09723757.2005.11885936
PDF: http://www.krepublishers.com/02-Journals/IJHG/IJHG-05-0-000-000-2005-Web/IJHG-05-4-225-288-2005-Abst-PDF/IJHG-05-4-259-265-2005-210-Gandhi-G/IJHG-05-4-259-265-2005-210-Gandhi-G.pdf

Gandhi G. et al. 2015, A cross-sectional case control study on genetic damage in individuals residing in the vicinity of a mobile phone base station.

Genetic damage parameters of DNA migration length, damage frequency (DF) and damage index were significantly (p = 0.000) elevated in the sample group compared to respective values in healthy controls.

https://www.tandfonline.com/doi/abs/10.3109/15368378.2014.933349

Garaj-Vrhovac V et al. 1992, The correlation between the frequency of micronuclei and specific chromosome aberrations in human lymphocytes exposed to microwave radiation in vitro.

Human whole-blood samples were exposed to continuous microwave radiation, frequency 7.7 GHz, power density 0.5, 10 and 30 mW/cm2 for 10, 30 and 60 min. A correlation between specific chromosomal aberrations and the incidence of micronuclei after in vitro exposure was observed. In all experimental conditions, the frequency of all types of chromosomal aberrations was significantly higher than in the control samples... The results of the study indicate that microwave radiation causes changes in the genome of somatic human cells and that the applied tests are equally sensitive for the detection of the genotoxicity of microwaves.

https://www.sciencedirect.com/science/article/pii/0165799292900064

Gorpinchenko I. et al. 2014, The influence of direct mobile phone radiation on sperm quality.

CONCLUSIONS: A correlation exists between mobile phone radiation exposure, DNA-fragmentation level and decreased sperm motility.

Fulltext & PDF: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4074720/

Güler G et al. 2012, The effect of radiofrequency radiation on DNA and lipid damage in female and male infant rabbits.

CONCLUSION: Consequently, it can be concluded that GSM-like RF radiation may induce biochemical changes by increasing free radical attacks to structural biomolecules in the rabbit as an experimental animal model.

https://www.tandfonline.com/doi/full/10.3109/09553002.2012.646349

Gursatej A.G. 2005, Genetic damage in mobile phone users: some preliminary findings.

"In the present study, DNA and chromosomal damage investigations were carried out on the peripheral blood lymphocytes of individuals using mobile phones, being exposed to MW frequency ranging from 800 to 2000 MHz.... CONCLUSIONS: These results highlight a correlation between mobile phone use (exposure to RFR) and genetic damage and require interim public health actions in the wake of widespread use of mobile telephony."

https://tspace.library.utoronto.ca/handle/1807/5943
PDF: https://tspace.library.utoronto.ca/bitstream/1807/5943/1/hg05022.pdf

Karaca E. et al. 2011, The genotoxic effect of radiofrequency waves on mouse brain

Brain cell cultures of the mice were exposed to 10.715 GHz with specific absorbtion rate (SAR) 0.725 W/kG signals for 6 h in 3 days at 25°C to check for the changes in the micronucleus (MNi) assay and in the expression of 11 proapoptotic and antiapoptotic genes. It was found that MNi rate increased 11-fold and STAT3 expression decreased 7-fold in the cell cultures which were exposed to RF. Cell phones which spread RF may damage DNA and change gene expression in brain cells.

https://link.springer.com/article/10.1007%2Fs11060-011-0644-z

Kesari K.K. et al. 2013, Effect of 3G cell phone exposure with computer controlled 2-D stepper motor on non-thermal activation of the hsp27/p38MAPK stress pathway in rat brain.

Result shows that microwave radiation emitted from 3G mobile phone significantly induced DNA strand breaks in brain.

https://link.springer.com/article/10.1007%2Fs12013-013-9715-4

Kumar S. et al. 2014, Effect of electromagnetic irradiation produced by 3G mobile phone on male rat reproductive system in a simulated scenario.

"Significant decrease in sperm count, increase in the lipid peroxidation damage in sperm cells, reduction in seminiferous tubules and testicular weight and DNA damage were observed following exposure to EMF in male albino rats. The results suggest that mobile phone exposure adversely affects male fertility."

http://nopr.niscair.res.in/bitstream/123456789/29335/1/IJEB%2052%289%29%20890-897.pdf

Liu C. et al. 2013, Mobile phone radiation induces mode-dependent DNA damage in a mouse spermatocyte-derived cell line: a protective role of melatonin.

RESULTS:The levels of DNA damage were significantly increased following exposure to Mobile Phone Radiation(MPR) in the listen, dialed and dialing modes. Moreover, there were significantly higher increases in the dialed and dialing modes than in the listen mode. Interestingly, these results were consistent with the radiation intensities of these modes. However, the DNA damage effects of MPR in the dialing mode were efficiently attenuated by melatonin pretreatment.

Link:https://www.ncbi.nlm.nih.gov/pubmed/23952262

Lu Y. et al. 2012, Reactive Oxygen Species Formation and Apoptosis in Human Peripheral Blood Mononuclear Cell Induced by 900 MHz Mobile Phone Radiation

Abstract: We demonstrate that reactive oxygen species (ROS) plays an important role in the process of apoptosis in human peripheral blood mononuclear cell (PBMC) which is induced by the radiation of 900 MHz radiofrequency electromagnetic field (RFEMF) at a specific absorption rate (SAR) of ~0.4 W/kg when the exposure lasts longer than two hours. The apoptosis is induced through the mitochondrial pathway and mediated by activating ROS and caspase-3, and decreasing

the mitochondrial potential. The activation of ROS is triggered by the conformation disturbance of lipids, protein, and DNA induced by the exposure of GSM RFEMF. Although human PBMC was found to have a self-protection mechanism of releasing carotenoid in response to oxidative stress to lessen the further increase of ROS, the imbalance between the antioxidant defenses and ROS formation still results in an increase of cell death with the exposure time and can cause about 37% human PBMC death in eight hours.

Fulltext & PDF: https://www.hindawi.com/journals/omcl/2012/740280/

Markova E. et al. 2010, Microwaves from Mobile Phones Inhibit 53BP1 Focus Formation in Human Stem Cells More Strongly Than in Differentiated Cells: Possible Mechanistic Link to Cancer Risk

"We studied whether microwaves from mobile telephones of the Global System for Mobile Communication (GSM) and the Universal Global Telecommunications System (UMTS) induce DSBs or affect DSB repair in stem cells... Microwaves from mobile phones inhibited formation of 53BP1 foci in human primary fibroblasts and mesenchymal stem cells. These data parallel our previous findings for human lymphocytes. Importantly, the same GSM carrier frequency (915 MHz) and UMTS frequency band (1947.4 MHz) were effective for all cell types. Exposure at 905 MHz did not inhibit 53BP1 foci in differentiated cells, either fibroblasts or lymphocytes, whereas some effects were seen in stem cells at 905 MHz. Contrary to fibroblasts, stem cells did not adapt to chronic exposure during 2 weeks."

Fulltext & PDF: https://ehp.niehs.nih.gov/doi/abs/10.1289/ehp.0900781

Megha K. et al. 2015, Low intensity microwave radiation induced oxidative stress, inflammatory response and DNA damage in rat brain.

In conclusion, the present study suggests that low intensity microwave radiation induces oxidative stress, inflammatory response and DNA damage in brain by exerting a frequency dependent effect. The study also indicates that increased oxidative stress and inflammatory response might be the factors involved in DNA damage following low intensity microwave exposure.

https://www.sciencedirect.com/science/article/pii/S0161813X15300097

Panagopoulos D.J. 2007, Cell death induced by GSM 900-MHz and DCS 1800-MHz mobile telephony radiation.

Results (excerpt): The data reveal that both GSM 900 and DCS 1800 mobile telephony radiations strongly induce cell death (DNA fragmentation) in ovarian egg chambers of the exposed groups, (63.01% in 900, 45.08% in 900A and 39.43% in 1800), while in the SE [Sham Exposed] and C [Control] groups the corresponding percentage of cell death was only 7.78% and 7.75%, respectively.

https://www.sciencedirect.com/science/article/abs/pii/S1383571806003202

Pandey N. et al. 2016 Radiofrequency radiation (900 MHz)-induced DNA damage and cell cycle arrest in testicular germ cells in swiss albino mice

"Result: Swiss albino mice were exposed to RFR (900 MHz) for 4 h and 8 h duration per day for 35 days. One group of animals was terminated after the exposure period, while others were kept for an

additional 35 days post-exposure. RFR exposure caused depolarization of mitochondrial membranes resulting in destabilized cellular redox homeostasis. Statistically significant increases in the damage index in germ cells and sperm head defects were noted in RFR-exposed animals."

https://journals.sagepub.com/doi/abs/10.1177/0748233716671206

Phillips JL et al. 2009, Electromagnetic fields and DNA damage

This review describes the comet assay and its utility to qualitatively and quantitatively assess DNA damage, reviews studies that have investigated DNA strand breaks and other changes in DNA structure, and then discusses important lessons learned from our work in this area. This is just a review, it is not an article representing a study in which the connection is proven. BUT IT IS IMPORTANT because it provides an overview of the factors which are decisive as to whether genotoxic effects are found in scientic studies (e.g. cell type and the pulsation of the radiation).

Fulltext & PDF: https://www.pathophysiologyjournal.com/article/S0928-4680(09)00014-5/fulltext

Salford L et al. 2003, Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones

Three groups each of eight rats were exposed for 2 hr to Global System for Mobile Communications (GSM) mobile phone electromagnetic fields of different strengths [0.24. 2.4, and 24 W/m^2]. We found highly significant ($p < 0.002$) evidence for neuronal damage in the cortex, hippocampus, and basalganglia in the brains of exposed rats.

Fulltext & PDF: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1241519/

Schwarz C. 2008, Radiofrequency electromagnetic fields (UMTS, 1,950 MHz) induce genotoxic effects in vitro in human fibroblasts but not in lymphocytes.

CONCLUSION: UMTS [3G] exposure may cause genetic alterations in some but not in all human cells in vitro.

https://link.springer.com/article/10.1007%2Fs00420-008-0305-5

Semra T.C. et al. 2012, Single-strand DNA breaks in human hair root cells exposed to mobile phone radiation

Conclusions: A short-term exposure (15 and 30 min) to RFR (900-MHz) from a mobile phone caused a significant increase in DNA single-strand breaks in human hair root cells located around the ear which is used for the phone calls.

https://www.tandfonline.com/doi/abs/10.3109/09553002.2012.666005

Tice R.R. et al. 2002, Genotoxicity of radiofrequency signals. I. Investigation of DNA damage and micronuclei induction in cultured human blood cells.

This research demonstrates that, under extended exposure conditions, RF signals at an average SAR of at least 5.0 W/kg are capable of inducing chromosomal damage in human lymphocytes.

https://onlinelibrary.wiley.com/doi/abs/10.1002/bem.104

Trosic I et al. 2011, Effect of electromagnetic radiofrequency radiation on the rats' brain, liver and kidney cells measured by comet assay

The results of this study suggest that, under the experimental conditions applied, repeated 915 MHz irradiation could be a cause of DNA breaks in renal and liver cells, but not affect the cell genome at the higher extent compared to the basal damage.

https://www.researchgate.net/publication/221683991_Effect_of_Electromagnetic_Radiofrequency_Radiation_on_the_Rats'_Brain_Liver_and_Kidney_Cells_Measured_by_Comet_Assay

Verschaeve L. 2009, Genetic damage in subjects exposed to radiofrequency radiation

A majority of these studies do show that RF-exposed individuals have increased frequencies of genetic damage (e.g., chromosomal aberrations) in their lymphocytes or exfoliated buccal cells.

https://www.sciencedirect.com/science/article/pii/S1383574208001415

Xu S. et al. 2010, Exposure to 1800 MHz radiofrequency radiation induces oxidative damage to mitochondrial DNA in primary cultured neurons.

In this study, we exposed primary cultured cortical neurons to pulsed RF electromagnetic fields at a frequency of 1800 MHz modulated by 217 Hz at an average special absorption rate (SAR) of 2 W/kg. At 24 h after exposure, we found that RF radiation induced a significant increase in the levels of 8-hydroxyguanine (8-OHdG), a common biomarker of DNA oxidative damage, in the mitochondria of neurons. Concomitant with this finding, the copy number of mtDNA and the levels of mitochondrial RNA (mtRNA) transcripts showed an obvious reduction after RF exposure. Each of these mtDNA disturbances could be reversed by pretreatment with melatonin, which is known to be an efficient antioxidant in the brain. Together, these results suggested that 1800 MHz RF radiation could cause oxidative damage to mtDNA in primary cultured neurons. Oxidative damage to mtDNA may account for the neurotoxicity of RF radiation in the brain.

https://www.sciencedirect.com/science/article/pii/S0006899309022999

Yakymenko I. et al, 2010, Risks of carcinogenesis from electromagnetic radiation of mobile telephony devices.

Among reproducible biological effects of low-intensive MWs are reactive oxygen species overproduction, heat shock proteins expression, DNA damages, apoptosis. The lack of generally accepted mechanism of biological effects of low-intensive non-ionizing radiation doesn't permit to disregard the obvious epidemiological and experimental data of its biological activity.

Fulltext &
PDF: https://www.researchgate.net/publication/45538585_Risks_of_carcinogenesis_from_electromagnetic_radiation_of_mobile_telephony_devices

Zalata A. et al. 2015 , In vitro effect of cell phone radiation on motility, DNA fragmentation and clusterin gene expression in human sperm.

CONCLUSION: Cell phone emissions have a negative impact on exposed sperm motility index, sperm acrosin activity, sperm DNA fragmentation and seminal CLU gene expression, especially in OAT* cases.
*** = cases where the concentration of sperm is low.**

Fulltext & PDF: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4410031/

Zothansiama et al. 2017, Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations

Subjects living within an 80 metre radius of a mobile mast had significantly more micronuclei (blood marker for DNA damage) and reduced anti-oxidant status than people living outside a 300 metre radius.

https://www.tandfonline.com/doi/abs/10.1080/15368378.2017.1350584

Zotti-Martelli L. et al. 2005, Individual responsiveness to induction of micronuclei in human lymphocytes after exposure in vitro to 1800-MHz microwave radiation.

The results show that microwaves are able to induce MN [micronuclei] in short-time exposures to medium power density fields. Our data analysis highlights a wide inter-individual variability in the response, which was confirmed to be a characteristic reproducible trait by means of the second experiment.

https://www.sciencedirect.com/science/article/abs/pii/S138357180500032X