Have Your Say - Europeans for Safe Connections

SCHEER Potential health effects of exposure to electromagnetic fields (EMF): Update with regard to frequencies between 1Hz and 100 kHz – preliminary opinion

Summary of Comments by ESC

Europeans for Safe Connections (ESC) welcomes the opportunity to comment on the opinion of SCHEER about the *Potential health effects of exposure to electromagnetic fields (EMF): Update with regard to frequencies between 1Hz and 100 kHz*.

ESC agrees that the exposure limits recommended in Council Recommendation 1999/519/EC should be reviewed given increasing exposures as a consequence of digitalisation and energy transition.

In ESC's view these exposure limits also need to be changed as a consequence of health impact given the following considerations.

The assessment in the SCHEER Opinion contains important shortcomings which have led to incorrect conclusions/opinion.

Despite the weaknesses of the assessment, some disturbing conclusions are included in the SCHEER Opinion:

Given the acknowledgement of evidence of harm in the SCHEER Opinion, ESC strongly calls for the **Precautionary Principle to be applied,** to prevent the harmful biological effects of EMFs, where until now only thermal effects are accounted for.

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Comment 1 - Opinion

Chapter 2, Opinion, p 9, lines 1-46:

The assessment in the SCHEER Opinion contains important shortcomings which have led to incorrect conclusions/opinion:

- The lack of meta-analyses and systematic reviews of the studies that have been carried out does not indicate that there is no evidence that EMF (1 Hz-100 kHz) causes harm.

Despite the weaknesses of the assessment, some disturbing conclusions are included in the SCHEER Opinion:

1) '*There is weak evidence regarding the involvement of interaction mechanisms (oxidative stress, genetic/epigenetic effects) on health risks from ELF-MF observed in epidemiological and in vivo studies.*' (2.2 Interaction mechanisms Page 9, Lines 8-9-10)
2) '*Published systematic reviews on leukaemia and ELF-EMF exposure, based, mainly on case- control studies, revealed that ELF-MF exposure showed consistent, but moderate risk estimates, ….*' (2.3 Health effects from ELF-EMF Page 9, Lines 19-21)
3) '*With respect to childhood leukaemia, there is weak to moderate weight of evidence from epidemiological studies' (the primary line of evidence).*' (2.3 Health effects from ELF-EMF Page 9, Lines 21-23)
4) '*Moreover, there is weak evidence from interaction mechanisms on the induction of neoplasias by ELF-MF exposure*.' (2.3 Health effects from ELF-EMF Page 9, Lines 25-26)
5) '*Overall, there is moderate evidence on the association between occupational exposure to ELF-EMF and ALS, weak evidence for the association of occupational ELF-EMF exposure with Alzheimer's disease, and dementia, ….*' (2.3 Health effects from ELF-EMF Page 9, Lines 28-30)

Given the acknowledgement of evidence of harm in the SCHEER Opinion, ESC strongly calls for the **Precautionary Principle to be applied,** to prevent the harmful biological effects of EMFs, where until now only thermal effects are accounted for.

Comment 2 - Assessment

Chapter 5, Assessment, p 12-29, all lines: general remarks on the assessment

The assessment in the SCHEER Opinion contains important shortcomings which have led to incorrect conclusions/opinion:

- The so-called *'Inconsistencies in the research outcomes'* can possibly be caused by neglecting the influence of various characteristics of EMFs, for example electromagnetic interference.
- The lack of an unequivocal dose-response relationship may be related to the human body striving to maintain homeostasis.
- A number of scientific hypotheses on EMF interaction mechanisms have been proposed but these have not been taken into account.

- The SCHEER Opinion contains inconsistencies in the evaluation of the degree of evidence (evidence in studies on the human body vs studies on other species).
- SCHEER considers exposure in residential situations to be low, without taking into account recent developments leading to a huge increase in exposure to EMF (1 Hz-100 kHz). The measurements carried out are not representative.

Given the acknowledgement of evidence of harm in the SCHEER Opinion, ESC strongly calls for the **Precautionary Principle to be applied,** to prevent the harmful biological effects of EMFs, where until now only thermal effects are accounted for.

Comment 3 - Childhood Leukaemia

Chapter 5, Article 5.3.1.1, p 19, lines 32-45: childhood leukaemia

We give feedback on the SCHEER´s claimed lack of evidence for risk of childhood leukaemia in the context of ELF-EMF. And we would draw attention to the two systematic review and meta-analysis, as we did not find them in the sources of Opinion.

We give feedback on the SCHEER´s claimed lack of evidence for risk of childhood leukaemia in the context of ELF-EMF. We refer to a systematic review by Seomun G, Lee J and Park J: '*Statistically significant associations were observed between exposure to ELF-MF and childhood leukaemia.' (Re* 2.3 Health effects from ELF-EMF, 4.2.1.3 Low Frequency, 5.2.4 Cryptochrome – radical pair mechanism, 5.3.1.1 Epidemiological studies & 5.3.1.3 Conclusions on neoplastic diseases)

The results of another systematic review and meta-analysis conducted in Belgium suggest that ELF-MF higher than 0.4 µT may increase the risk of childhood leukaemia, probably acute lymphoblastic leukaemia.

Comment 4 - Health Effects

Chapter 5 – other details (Article 5.2.6, p 18, lines 9-33, articles 5.3, p19-26, articles 5.4, p26-29): Health effects

We give feedback on SCHEER's position on oxidative stress from ELF-EMF. We give feedback on SCHEER's position on oxidative stress from ELF-EMF. (Re 2.2 Interaction mechanisms, 5.2.6 Oxidative stress & 5.2.8 Conclusions on interaction mechanisms)

ESC would like to draw SCHEER's attention on the work of Professor H. Lai, who has analysed a huge number of ELF EMF exposure studies on oxidative, free radicals, genetic neurological effects. Among hundreds of studies of ELF and static fields, 74% to 91% reported significant effects:

- 91% (n=282) of 311 ELF/static EMF oxidative effects (or free radical) studies published since 1990 reported significant effects.

- 84% (n=282) of 337 ELF/static EMF genetic effects studies published since 1990 reported significant effects including 95% (n=168) of 177 studies of gene expression.

- 91% (n=310) of 339 ELF/static EMF neurological studies published since 2007 reported significant effects.

- 74% (n=62) of 83 ELF/static EMF reproduction and development studies published since 1990 reported significant effects.

Comment 5 - IEI-EMF (EHS)

Chapter 5, article 5.3.6: *IEI-EMF* (electromagnetic hypersensitivity) or symptoms

We give feedback on next articles about IEI-EMF (electromagnetic hypersensitivity) or symptoms:

- Article 5.3.6, page 25, line numbers 40-42
- Article 2.3, p 9, line numbers 15-18
- References, p 30-34, line numbers 1-50

It is not correct that no reviews have been done on the exposure to ELF-EMF and IEI-EMF (electromagnetic hypersensitivity) or symptoms. We refer to the review by Leszczynski in 2021 and by Stein&Udasin in 2020. Leszczynski's review, for example, also covers ELF-EMF.

For more explanation see annex 1,2 and 3.

Annex 1: Explanation of our considerations:

Shortcomings in the SCHEER Opinion

A frequently used argument in SCHEER's opinion for presenting lack of evidence is the occurrence of inconsistencies in the research outcomes.

There are numerous references throughout the Opinion to inconclusive, inconsistent, or contradictory results but until the reasons for these anomalies have been fully understood, the existence of such anomalies does NOT justify concluding that the results which showed harmful effects are invalid and hence there is no cause for concern.

ESC points out that alleged inconsistencies can be the result of neglecting the influence of various characteristics of EMFs, important for the impact on the health of humans and other living beings.

The only two characteristics taken into account are exposure level and frequency.

The Opinion gives the suggestion that other characteristics are not taken into consideration. Nevertheless there is a sufficient number of scientific studies that show the importance of other characteristics as well as exposure level and frequency, including: AC/DC, pulses, intermediate EMFs, modulation, and disturbances in the power grid such as electromagnetic

interference including the so-called 'dirty electricity'. If these are not taken into consideration inconsistency between various studies may be falsely concluded.

Already in 2005 the outstanding cell study under the name Reflex, financed by the EU Framework Program, showed important biological effects of ELF EMFs, like DNA damage and oxidative stress and also the importance of the characteristics of the fields used during the study.

We also refer to the book of S. Milham 'Dirty electricity electrification and the diseases of civilization', and we include the references of his book in the Annex of this document.

Electromagnetic interference and dirty electricity, comes from many sources including switched mode power supplies and inverters, or by using powerlines as a means of data transfer (powerline communication - PLC). Dirty electricity has particularly increased with the energy transition (including inverters from solar panels), and urgently requires updated standards.

In the SCHEER Opinion a division is made between ELF-EMF (extremely low frequency fields – 0,1 Hz-300 Hz) and IF-EMF (intermediate frequency fields - 300 Hz-100 kHz) without giving any reason for this division related to health risks.

ESC Notes: The more divisions one makes, the harder it will be to find a significant number of studies within a sub-division that can support the evidence of harm. Without a plausible reason for dividing-up the IF band regarding the potential for health risks no sub-divisions should be made.

Another argument used in the opinion of SCHEER is the lack of an unequivocal dose-response relation. (Re 5.3.1.1 Epidemiological studies & 5.3.1.3 Conclusions on neoplastic diseases)

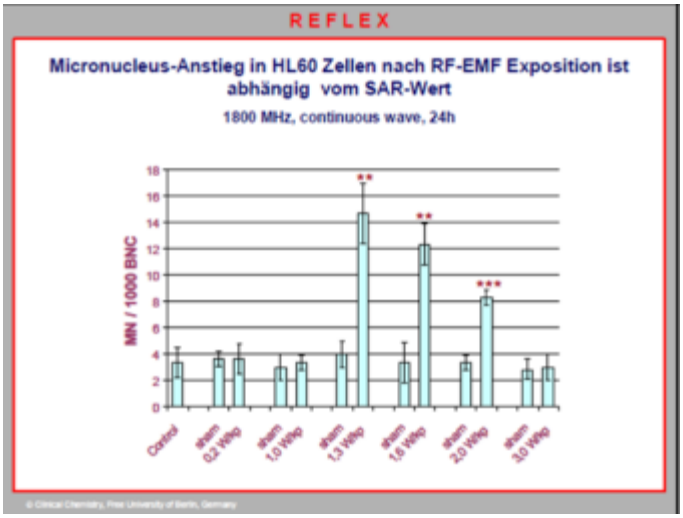
Earlier studies have shown that the health effects are not always more severe with higher exposure levels.

ESC points out the complex biochemical reality in living organisms that explains the existence of non-linear relations. Biological systems have the ongoing tendency for maintaining equilibria by up- and down-regulating mechanisms. Additionally serial and parallel biochemical processes can also be involved. Separately and together these are logical causes to non-linearity.

The biological effects of EMF involve an extremely complex matrix of interacting factors across all cell lines/functions. The interaction mechanism of EMF on cellular level is not fully known and understood. This may and will lead to unexpected results, that wrongly may be seen as inconsistencies.

So, it may not be surprising, that scientifically it is shown that a higher level of RF-EMF (100kHz-300GHz) may cause less effect in living organism. This can also be the case for EMF (1Hz-100kHz). See the graph of the Reflex study below. Where the model used by SCHEER is based on toxic compounds (where more toxins have a larger effect than less toxins), the Reflex study shows the cause effect relation between EMF and the biological effect is complex and unexpected compared to the model for toxins. Given this kind of scientific

knowledge, a different cause-effect relationship is to be considered possible also for LF-EMFs. Considerations of these aspects is required in an opinion like this.



A number of scientific hypotheses on EMF interaction mechanisms have been proposed but these have not been taken into account.

The opinion doesn't look to earlier studies, reviews or meta-studies. This can give the wrong impression that the Opinion is valid for all the existing research and not only for the new research later than 2015.

As an example concerning the interaction mechanisms, we refer to the work of Davanipour Z. and Sobel E. (2009).

'RESULTS: The evidence indicates that long-term significant occupational exposure to ELF MF may certainly increase the risk of both Alzheimer's disease and breast cancer. There is now evidence that two relevant biological processes (increased production of amyloid beta and decreased production of melatonin) are influenced by high long-term ELF MF exposure that may lead to Alzheimer's disease. There is further evidence that one of these biological processes (decreased melatonin production) may also lead to breast cancer. Finally, there is evidence that exposures to RF MF and ELF MF have similar biological consequences. CONCLUSION: It is important to mitigate ELF and RF MF exposures through equipment design changes and environmental placement of electrical equipment.

Simkó M. (2007) concluded that the cell type specific redox status is responsible for diverse electromagnetic field effects.

'Epidemiologic and experimental research on the potential carcinogenic effects of extremely low frequency electromagnetic fields (ELF-EMF) has been performed for a long time. Epidemiologic studies regarding ELF-EMF exposure have focused primarily on leukaemia development due to residential sources in children and adults, and from occupational exposure in adults, but also on other kinds of cancer. Genotoxic investigations of EMF have shown contradictory results, a biological mechanism is still lacking that can explain the link

between cancer development and ELF-EMF-exposure. Recent laboratory research has attempted to show general biological effects, and such that could be related to cancer development and/or promotion. Metabolic processes which generate oxidants and antioxidants can be influenced by environmental factors, such as ELF-EMF. Increased ELF-EMF exposure can modify the activity of the organism by reactive oxygen species leading to oxidative stress. It is well established that free radicals can interact with DNA resulting in single strand breaks. DNA damage could become a site of mutation, a key step to carcinogenesis. Furthermore, different cell types react differently to the same stimulus, because of their cell type specific redox status. The modulation of cellular redox balance by the enhancement of oxidative intermediates, or the inhibition or reduction of antioxidants, is discussed in this review. An additional aspect of free radicals is their function to influence other illnesses such as Parkinson's and Alzheimer's diseases. On the other hand, modulation of antioxidants by ELF-EMF can lower the intracellular defence activity promoting the development of DNA damage. It has also been demonstrated that low levels of reactive oxygen species trigger intracellular signals that involve the transcription of genes and leading to responses including cell proliferation and apoptosis. In this review, a general overview is given about oxidative stress, as well as experimental studies are reviewed as they are related to changes in oxidant and antioxidant content after ELF-EMF exposure inducing different biological effects. Finally, we conclude from our review that modulations on the oxidant and antioxidant level through ELF-EMF exposure can play a causal role in cancer development.'

The SCHEER Opinion makes multiple references to the lack of meta-analyses and systematic reviews and finally concludes therefore that the limits set don't have to be changed.

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2.2 Interaction Mechanisms

(Lines 7-8) *'There are no systematic reviews and meta-analysis available for melatonin hypothesis, radical pair mechanisms, oxidative stress or epigenetic effects'.* (Also quoted in ABSTRACT Lines 5-6)

2.3 Health effects from ELF-EMF

(Lines 16-17) *'No systematic reviews or meta-analysis on ELF-EMF exposure and self-reported symptoms could be identified.'* (Also quoted in ABSTRACT Lines 13-14)

(Lines 33-35) *'No systematic reviews or meta-analyses could be identified on exposure to ELF-EMF and neurophysiological outcomes. Therefore, it is still not possible to draw a definite conclusion on potential effects.'* (Also quoted in ABSTRACT Lines 31-32)

2.4 Health effects from IF-EMF

(Lines 39-41) *'The weight of evidence on the health effects of IF-EMF exposure is due to contradictory information from different lines of evidence. No conclusive results can be reached based on human studies, either.'* (Also quoted in ABSTRACT Lines 36-38)

- The absence of systematic reviews and meta-analysis of the available research papers on each of the given topics is NOT a valid justification for concluding there is insufficient evidence of harmful effects. These statements only highlight the need to ensure that systematic reviews and meta-analysis are carried out before any meaningful conclusions can be drawn.

ESC argues that there are plenty of studies that contribute to the understanding that EMFs are harmful. We refer to our list of references in the Annex to this document.

Meta-analyses are only useful when they seek explanations for the differences found and shed light on the mechanisms involved. On top of that an alleged lack of evidence that EMFs are unsafe does not constitute evidence that these EMFs are safe.

SCHEER prefers unity in outcomes for different lines of evidence of different species for definition of the grade of EMFs having effect. (Re 4.1 Data/Evidence)

The SCHEER Opinion states that '*animals and plants possess receptors and structures not existing in humans, which could give species-specific biological effects.*' (5.5 Effects from low frequency fields on fauna and flora Page 28, Lines 42-43) This clearly is incongruous with SCHEER's need for having more lines of evidence to adopt a fact of harmfulness.

As a consequence it is also not proper to consider evidence as 'weaker overall evidence' if proven effects exist on human, but limited evidence on fauna or flora or vice versa. NB: if evidence shows insects are affected, but humans are not, this is still an alarming signal that calls for action since loss of biodiversity and damage to ecosystems will also eventually harm man.

SCHEER goes back to an older study on exposure of humans and considers the exposure in residential situations low. However the measurements carried out are not representative.

ESC points out the modern developments including the use of electric cars with high levels of MF-EMFs, the high MF-EMFs of induction cooking, the strong EMFs when wireless charging, and the general transition to the use of renewable electricity will cause higher EMFs from the electricity grid, which already sometimes causes exposures higher than acceptable.

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5 ASSESSMENT

5.1 Exposure

5.1.1 Intermediate frequency (IF) fields

5.1.1.1 Household appliances

(Lines 8-11) *'A survey of the IF fields in **42 residences** in **three European countries** (Belgium, Slovenia, and the United Kingdom (UK)). Typical field levels in the properties were assessed*

*by **measurements in the middle of the most-frequented rooms** (living room, kitchen, and bedroom), as reported by residents'*

- The sample size is far too small to be anywhere near representative given the variations in building types and construction methods, and in domestic power supply configurations, standards and equipment over the years in each country, together with the huge variety of combinations of different appliances and devices, their ages, and the evolution of their design technology, and manufacturing practices – all of which will affect the levels and frequencies of EMFs present.

  NB: Although the maximum electromagnetic disturbance generated by products placed on the market after the introduction of the EMC Directive must not hinder the use of other apparatus, and the products must have an adequate level of electromagnetic immunity in the usual electromagnetic environment where the product is intended to work so as to allow its unhindered operation, meeting these criteria does not necessarily preclude the potential to harm humans or flora and fauna who can have adverse reactions to much lower levels. The EMC Directive does not define actual limits for levels of emissions and for any given product type there can be significant differences between the emissions from different models of the same brand, let alone from those of different brands who may have used different design approaches, materials and construction methods, consequently a wide range of each type of appliance / device needs to be evaluated to obtain truly representative results.

- Taking measurements in the middle of the rooms is totally unrepresentative of reality as in most homes the layout is such that people do not spend the majority of their time in the middle of the room (with the exception of dining rooms) because their armchairs, beds and sofas are placed close to, if not right up against, the walls – which is very often close to the electrical supply wiring and sockets, and as a consequence, close to where most appliances, and also devices containing SPMSs, are located. Closer to the source the exposure will be higher.

SCHEER advises more research with standardised conditions to be optimised in vitro cell lines (Re 6 RECOMMENDATIONS FOR FUTURE WORK)

ESC points out there is extensive material about adverse health effects of electricity, including all the studies of epidemiologist Samual Milham.

The demand for more research is no excuse for not immediately applying the Precautionary Principle based on what is already known. Moreover, it is well known that many scientists who have conducted independent research at often reputable universities have seen their research budgets reduced or cut.

SCHEER is aware of the possibility for flora and fauna to be affected by anthropogenic EMFs and even relies on the outcome of studies on non-human species to judge the possible effects on humans, but does not make recommendations to revise the standards for flora and fauna. SCHEER advises to keep exposure limits as they are.

ESC draws attention to the comprehensive review by Levitt, Lai and Manville of studies on the effects of non-ionizing electromagnetic fields on flora and fauna. They conclude '*The majority of studies have found biological effects at both high and low-intensity man-made*

exposures, many with implications for wildlife, health and viability. It is clear that ambient environmental levels are biologically active in all non-human species ..' and '*Long-term chronic low-level EMF exposure standards, which do not now exist, should be set accordingly for wildlife, and environmental laws should be strictly enforced*'

SCHEER members and expertise may have an impact on the findings, more balance can be achieved by inviting independent medical doctors and biologists

It is clear from the scientific literature, that the biological effects of EMF involve an extremely complex matrix of interacting factors across all cell lines/functions. This requires careful analysis of comprehensive data, the review of the setup of scientific studies, as well as the appropriate level and kind of expertise.
We advocate increasing SCHEER's credibility by inviting independent medical doctors and biologists to the Scientific Group to become members or as advisors to it in order to balance the composition of scientific knowledge against people who are oriented to more mechanical-technical issues.

Health effects (Re 5.3 Health effects from ELF fields & 5.4 Health effects from IF fields)

The opinion of SCHEER is filled with a multitude of health effects due to EMFs. A brief summary:

- 'There is weak evidence regarding the involvement of interaction mechanisms (oxidative stress, genetic/epigenetic effects) on health risks from ELF-MF observed in epidemiological and in vivo studies.' (2.2 Interaction mechanisms Page 9, Lines 8-9-10)
- 'Published systematic reviews on leukaemia and ELF-EMF exposure, based, mainly on case- control studies, revealed that ELF-MF exposure showed consistent, but moderate risk estimates, ….' (2.3 Health effects from ELF-EMF Page 9, Lines 19-21)
- 'With respect to childhood leukaemia, there is written weak to moderate weight of evidence from epidemiological studies' (the primary line of evidence).' (2.3 Health effects from ELF-EMF Page 9, Lines 21-23) But there exist two systematic reviews and meta-analysis, which mention risks and at least one with the dose–response effect and high association between exposure to ELF-MFs and childhood leukaemia
- 'Moreover, there is weak evidence from interaction mechanisms on the induction of neoplasias by ELF-MF exposure.' (2.3 Health effects from ELF-EMF Page 9, Lines 25-26)
- 'Overall, there is moderate evidence on the association between occupational exposure to ELF-EMF and ALS, weak evidence for the association of occupational ELF-EMF exposure with Alzheimer's disease, and dementia, ….' (2.3 Health effects from ELF-EMF Page 9, Lines 28-30)

But all these health effects are set aside easily by the way the science is judged by SCHEER.

In addition, as explained above, the assessment in the SCHEER Opinion contains important shortcomings.

If the processes underlying the harmful effects are not sufficiently understood, this does not mean that there is no risk of harm. It should lead to further investigation instead of creating a false sense of health safety.

Additionally there are a number of references to doubts concerning the lack of convincing evidence regarding plausible interaction mechanisms, however as Council Recommendation 1999/519/EC states '(5) Measures with regard to electromagnetic fields should afford all Community citizens a high level of protection;' the Precautionary Principle should be applied according to the following criteria:

- The Precautionary Principle (PP) applies **when there exist considerable scientific uncertainties about causality, magnitude, probability, and nature of harm.**
- Because the PP deals with risks with poorly known outcomes and poorly known probability, the unquantified possibility is sufficient to trigger the consideration of the PP.
- Interventions are required before possible harm occurs, or before certainty about such harm can be achieved (that is, a wait-and-see strategy is excluded).

The population is nowadays increasingly suffering from diseases with unknown causes but where the effects of EMFs as a cause can't be excluded. Also many people experience that their health complaints diminish when EMF exposure is reduced or avoided. At the same time society is encountering huge technological developments which will lead to much higher exposures.

Already in 2001, and continuing in 2013, the European Environmental Agency (EEA) wrote the reports 'Late Lessons from early warnings'. These show, in line with the experiences in society, that authorities are always too late in taking measures to protect the population and nature. It is shown in these EEA reports that the method applied in this SCHEER Opinion can and will lead to a delay in taking appropriate protection measures up to and even beyond 100 years.

The EEA proposes how to better use science in decision making and taking protection measures. We would promote the EU Commission to accept that the current approach is not in line with the EU objectives to protect society from harm in this fast-moving innovation society and to courageously make the adjustments needed. We all know the history of lead in petrol, DDT, PCBs, Asbestos, PFAS, dust particles, tobacco and the impact of industry lobbies.

Feedback on SCHEER position to childhood leukaemia related to ELF-EMF *(Re* 2.3 Health effects from ELF-EMF, 4.2.1.3 Low Frequency, 5.2.4 Cryptochrome – radical pair mechanism, 5.3.1.1 Epidemiological studies & 5.3.1.3 Conclusions on neoplastic diseases)

We would like feedback on the claimed SCHEER´s lack of evidence for risk of childhood leukaemia in the context of ELF-EMF. And we would draw attention to the two systematic review and meta-analysis, as we did not find them in the sources of Opinion.

The first is the review of Seomun G, Lee J, Park J. (2021). The conclusion from the authors of the Korean systematic review and meta-analysis reports that:

'Statistically significant associations were observed between exposure to ELF-MF and childhood leukaemia. Furthermore, the intensity of the association between exposure to ELF-MFs and childhood leukaemia was high, as indicated by the dose–response effect.'

The results of another systematic review and meta-analysis conducted in Belgium by Brabant C, Geerinck A, Beaudart C, Tirelli E, Geuzaine C, Bruyère O (2022) suggest that ELF-MF higher

than 0.4 µT may increase the risk of childhood leukaemia, probably acute lymphoblastic leukaemia.

We also refer to earlier individual studies, like from Carpenter (2010)

'(…) While there has been strong evidence for an association between leukemia and residential or occupational exposure to ELF EMFs for many years, the standards in existence are not sufficiently stringent to protect from an increased risk of cancer. (…)'

Feedback on SCHEER position on oxidative stress from ELF-EMF (Re 2.2 Interaction mechanisms, 5.2.6 Oxidative stress & 5.2.8 Conclusions on interaction mechanisms)

- ESC would like to draw SCHEER's attention on the work of Professor H. Lai, who has analysed a huge number of ELF EMF exposure studies on oxidative, free radicals, genetic neurological effects. **Among hundreds of studies of ELF and static fields, 74% to 91% reported significant effects**.
- 91% (n=282) of 311 ELF/static EMF oxidative effects (or free radical) studies published since 1990 reported significant effects. Link: **ELF Oxidative Effects studies**
- 84% (n=282) of 337 ELF/static EMF genetic effects studies published since 1990 reported significant effects including 95% (n=168) of 177 studies of gene expression. Link: **ELF Genetic Effects studies**
- 91% (n=310) of 339 ELF/static EMF neurological studies published since 2007 reported significant effects. Link: **ELF Neurological Effects studies**
- 74% (n=62) of 83 ELF/static EMF reproduction and development studies published since 1990 reported significant effects. Link: **ELF Reproduction studies**
- ESC recommends that SCHEER examine these materials and conduct their own detailed investigation and suggest that a good overview on how ELF as a cellular stressor affects the processes of living *organisms* can be found in the papers by H.Lai and B.B. Hewitt:
- https://www.degruyter.com/document/doi/10.1515/reveh-2023-0023/html
- https://www.degruyter.com/document/doi/10.1515/reveh-2021-0050/html
- Supplementary materials accompanying these two documents also contain a large number of studies demonstrating the adverse effects of ELF.

Comments on the SCHEER opinion about IEI-EMF (EHS)

We have comments on:

- Article 5.3.6, page 25, line numbers 40-42
- Article 2.3, p 9, line numbers 15-18
- References, p 30-34, line numbers 1-50

It is not correct that no reviews have been done on the exposure to ELF-EMF and IEI-EMF (electromagnetic hypersensitivity) or symptoms. We refer to the review by Leszczynski in 2021 and by Stein&Udasin in 2020. Leszczynski's review, for example, also covers ELF-EMF. See more explanation and references in annex.

Explanation of our considerations:

'5.3.6 IEI-EMF and symptoms

No systematic reviews or meta-analyses were identified on the exposure to ELF-EMF and IEI-EMF (electromagnetic hypersensitivity) or symptoms.'

And the conclusion in:

2.3 Health effects from ELF-EMF 15

No systematic reviews or meta-analysis on ELF-EMF exposure and self-reported symptoms could be identified. Therefore, the SCENIHR conclusion still stands, i.e., there is no convincing evidence for a causal relationship between ELF-MF exposure and self-reported symptoms.

It is not correct that no reviews have been done on the exposure to ELF-EMF and IEI-EMF (electromagnetic hypersensitivity) or symptoms. We refer to the review by Leszczynski in 2021 and by Stein&Udasin in 2020. Leszczynski's review, for example, also covers ELF-EMF. See references in the annex.

Moreover, the alleged absence of a review is no reason to conclude that there is no convincing evidence of a causal relationship between ELF-EMF and symptom occurrence. There are plenty of studies confirming the existence of EHS. We refer to our reference list in annex, in a relevant part of them ELF-EMF are included.

One cannot keep repeating that more research is needed when the studies that are conducted, are provocative studies of poor quality. We refer to Leszczynski's review.

Some recent case studies by Hardell found that symptoms, occurring at locations with high exposure to RF-EMF and LF-EMF, disappeared completely after a few weeks if the affected individuals left those locations. These results suggest a causal relationship with HF and/or ELF EMF. See reference list.

We also refer to the work done by Stein, Johansson, the Physicians' Health Initiative for Radiation and Environment (PHIRE) (https://phiremedical.org/) and so many other.

Asking for more research should also not be an excuse for not taking action yet. With the current growth of the electrification, more and more people are getting sick, without adequate help by customized technical solutions. This increasingly excludes them from society.

And if their numbers increase, as can be expected, it will reduce economic growth. We are losing valuable time by ignoring EHS persons. **It** is time to listen to them to make the technology safer now. It will help them, and in time, everyone.

Annex 2: List of references, non-exhaustive

- ADLKOFER, F. (2006). RISK EVALUATION OF POTENTIAL ENVIRONMENTAL HAZARDS FROM LOW ENERGY ELECTROMAGNETIC FIELD EXPOSURE USING SENSITIVE IN VITRO METHODS. In: Ayrapetyan, S.N., Markov, M.S. (eds) BIOELECTROMAGNETICS Current Concepts. NATO Security Through Science Series. Springer, Dordrecht. https://doi.org/10.1007/1-4020-4278-7_22

- Levitt, B. Blake, Lai, Henry C. and Manville, Albert M.. "Effects of non-ionizing electromagnetic fields on flora and fauna, Part 2 impacts: how species interact with natural and man-made EMF" Reviews on Environmental Health, vol. 37, no. 3, 2022, pp. 327-406. https://doi.org/10.1515/reveh-2021-0050

- Lai, Henry and Levitt, B. Blake. "Cellular and molecular effects of non-ionizing electromagnetic fields" Reviews on Environmental Health, 2023. https://doi.org/10.1515/reveh-2023-0023

- Brabant C, Geerinck A, Beaudart C, Tirelli E, Geuzaine C, Bruyère O. Exposure to magnetic fields and childhood leukemia: a systematic review and meta-analysis of case-control and cohort studies. Rev Environ Health. 2022 Mar 15;38(2):229-253. doi: 10.1515/reveh-2021-0112. PMID: 35302721.

- Seomun G, Lee J, Park J. Exposure to extremely low-frequency magnetic fields and childhood cancer: A systematic review and meta-analysis. PLoS One. 2021 May 14;16(5):e0251628. doi: 10.1371/journal.pone.0251628. PMID: 33989337; PMCID: PMC8121331.https://pubmed.ncbi.nlm.nih.gov/33989337/

- Residential extremely low frequency magnetic fields and skin cancer
  Muhammad Waseem Khan, Jukka Juutilainen, Jonne Naarala, Päivi Roivainen
  Occupational and Environmental Medicine
  https://pubmed.ncbi.nlm.nih.gov/34593542/

- Residential proximity to power lines and risk of brain tumor in the general population
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- Exposure to Magnetic Field Non-Ionizing Radiation and the Risk of Miscarriage: A Prospective Cohort Study
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