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Health and ecological aspects of mobile telecommunications and transmitters – scientific discourse, regulatory needs and public debate

Summary

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SUMMARY

The debate about possible health effects of high-frequency electromagnetic fields has run in parallel with the expansion of the digital mobile wireless networks since the start of the 90s. However, following the tender for the UMTS licences to launch the so-called third-generation cell phones, the discussion and public protest have become considerably more intense and in part emotional, so that politicians, network operators and regulators are now seeking ways to channel discussion on electromagnetic tolerance in the environment (EMTE) towards dealing constructively with the potential risks of mobile phones.

As the political actors also feel called on to influence this dialogue proactively and tackle popular concerns, in autumn 2001 the TA rapporteurs proposed to the Committee for Education, Research and TA of the 14th German Parliament that the TAB should study the question »EMTE in mobile phones and transmitters«. The project duly conceived by TAB involves structuring the scientific discussion and providing an overview of the current legislative framework and possible new regulatory options.

The present status report focuses on the following key points and questions:

> Analysing the scientific discourse on the health risks of mobile phones and transmitters, and analysing new thematic trends and information, identifying the existing dissent and consensus in evaluating the risks (and possible measures for reducing risk)
> Overview of the regulatory framework and prevailing limits in Germany and other countries, analysis of the framework conditions in countries with a high level of mobile phone penetration or high consumer protection standard and the state of acceptance there
> Analysis of the public debate: How does the layperson perceive electromagnetic sources of risk? For what population groups does electrosmog have special significance? What arguments and concerns are being voiced? What is the role of the experts in the debate? What roles are played by the media, how are issues selected and presented? How are network operators and local authorities reacting?

EMF AND CELL PHONES

Cell phones operate on the basis of high-frequency (HF) electromagnetic fields. Electromagnetic fields (»EMF« for short) are part of the natural environment, such as solar radiation (daylight), thunderstorms or the earth's magnetic field. Everyday we are constantly affected by electromagnetic fields. For many years we have known numerous other sources of EMF radiation. Technologically generated EMF are found everywhere electricity flows, for example in homes (radio, TV, computer monitors, radio alarm clock, hairdryer, electric shaver, microwave, electric heating, remote controls, cordless DECT phones for static and cell phones etc), at work (medical equipment, communications systems etc) or in the open air (high tension cables, railways, communications systems for police and emergency services, alarm systems, radar equipment, transmitting stations for radio, TV and cell phones). All these cause electromagnetic fields of various strengths. The term »electrosmog« has become current to describe all these EMF caused by humans, to convey the image of living in a cloud of invisible waves which we cannot smell, hear or taste, but which may nevertheless influence our bodies.

The basic principle of wireless communication is the transmission of information using electromagnetic waves. Voice transmissions can be analogue or digital. Other information, such as data, is generally transmitted digitally. Electromagnetic waves can be distinguished by their frequency, i.e. the number of oscillations a second, and their intensity, i.e. the strength of the electromagnetic field, and the form of signal. Cell phones under the current GSM standard use high-frequency fields at 900 MHz and 1,800 MHz, and will use 2,170 MHz in the future UMTS network. Current cell phone technology uses electromagnetic waves in »pulsed« form, i.e. they are switched on and off in a certain rhythm.

PUBLIC CONCERN

Public concern about cell phone radiation is, of course, partly based on the spread of this technology, as almost everybody is potentially affected. It can, however, also be traced to the fact that telephones are normally used in direct proximity to sensitive body parts such as the brain or eye, and this proximity increases exposure. Another reason for concern for many people is the current nationwide construction of the so-called UMTS system, which requires erection of many new antennae and confronts citizens directly with this development. The public also has little voice for the most part in the choice of locations for the base stations, which are subject to constant change after construction. They

are bought and sold, integrated into different networks, modified, and in some cases also shut down again. People can decide for themselves whether or not to use a cell phone, although in many cases occupational needs limit their choice. In the case of the base stations, however, individuals have virtually no possibility of avoiding exposure.

The situation is further complicated by the fact that the possible risks of transmitting stations are also borne by those who do not use a cell phone themselves, while cell phone users also feel their health is at risk from transmission masts. There is also widespread concern about the radiation from cell phones themselves (see TAB 2002 survey). Here, however, people can protect themselves by avoiding at least private use. In the USA cell phone users suffering from brain tumours have already filed suit against cell phone companies.

TRANSMITTERS AND CELL PHONES

Cell phones can only be used in areas served by a transmitter (base station, transmission mast, antennae) in the local cell phone network. The transmitter can be installed at a wide range of altitudes. Radio waves from the transmitter antenna are largely broadcast horizontally and in just one direction (main transmission direction). This results in a transmission shadow under the antenna with very weak EMF. The strength of the fields in the main transmission direction declines at least proportionally with distance from the antenna. In Germany there are four different wireless networks which operate in parallel. All of them – including the future UMTS networks – have the same network structure. To serve a specific region, the region is divided into separate sub-areas (cells). These extend like a honeycomb over the entire Federal territory, but have different sizes. The diameter of a cell ranges from less than 100 metres in inner cities to 15 kilometres in rural areas. The more transmitter locations there are, the smaller the individual cells can be. The smaller the cell, in turn, the lower the broadcasting power of the individual antennae can be. To ensure a nationwide cell phone service in Germany, c. 40,000 adjoining cells are needed.

The concept behind cell phones is that they can contact the nearest base station with the minimum possible energy consumption, to make the most effective use of the limited power in the battery. Whether this is possibility is fully utilised depends on the network structure. The possibility of energy regulation with cell phones means that the strength of the EMF in the environment of the unit varies with time and location. Generally speaking, the weaker the connection, the stronger the transmission power the unit needs to establish a connection with

the base station. Conversely, this means that a rising number of base stations leads to a reduction in the transmission power needed by the unit, so that the strength of the EMF in the environment of the unit also declines.

The (transmission) power of future UMTS cell phones will be lower than that of current GSM cell phones. (The maximum power is said to be 150–250 mW, compared with 2 W for GSM.)

CELL PHONE USE AND UMTS

Various surveys assume a billion cell phone users worldwide by 2002/2003 and 1.6 billion by the middle of the decade. According to current data, some 60% of the EU population have a cell phone. It is expected that this share will rise to almost 100% within 10 years. By 2010 there should also be some 630 million users worldwide of the new UMTS cell phone standard, some 200 million of them in Europe. Considering media reporting on so-called third generation cell phones, it seems doubtful, however, that this goal is attainable. The focus today is less on new services and potential applications of wideband wireless data transmission than on the economic risks to network operators and equipment producers, and the possible health risks that could be caused by this intensity of cell phone use.

In the European nations this debate is being conducted with varying levels of commitment. The intensity of regulation, behaviour of network operators, government agencies and the population and the type of measures all differ accordingly. The increasing number of citizen's action groups, rising number of court cases and intensity of media reporting suggest that this is an issue of European relevance, which has probably not climaxed in many countries. Various interest groups from the general population, media, cell phone network operators, cell phone manufacturers and – not least – science are involved in the discourse and try not only to use objective and rational arguments to win support for their interests but also to introduce and enforce their values, convictions and claims for protection.

LIMITS AND IMPACTS

It is undisputed that electromagnetic waves can have biological effects. However, whether this results in adverse consequences to health is a matter of dispute. It is important to distinguish between a biological effect and an adverse impact

on health. Although the literature does not use these terms as synonyms, the following distinction may help clarify the situation:

- A biological effect is a measurable (although not necessarily damaging) physiological reaction in a biological system to exposure to electromagnetic fields.
- A negative impact on health is a biological effect whose impact (consequences) goes beyond the normal physiological ability of the body to compensate and results in damage to health or injury.

The fact that public and media frequently fail to distinguish between these two terms and that a biological effect is interpreted as an adverse impact on health often leads to confusion and inaccuracies in the electrosmog debate.

Biological thresholds are limits below which there is no biological effect. This limit must be expressed in terms of measurable units. In the case of cell phones, the threshold represents the amount of energy above which biological effects must be expected. The most informative measure of energy absorption in the body from high-frequency electromagnetic fields is the SAR value (Specific Absorption Rate). SAR is accordingly the most important parameter in scientific studies on exposure to high-frequency EMF. Solid scientific findings on biological effect thresholds are the basis for recommendations on limits by the International Commission on Non-Ionising Radiation Protection (ICNIRP). ICNIRP recommendations on limits form the main element in the EU Council Recommendation 1999/519/EEC on 12 July 1999 for limits to public exposure to EMF, which is currently the core of the protective measures at EU level.

ICNIRP limits currently form the basis for setting limits in 26 countries, but these are not entirely uncontested. There is disagreement whether they take adequate account of preventive aspects, e.g. in the case of long-term exposure. Supporters of the limits point out that there is a safety factor of around 50 between the threshold for acute effects and the basis limits, so that protection against long-term effects is also ensured. Critics point particularly to the fact that there is no further safety factor allowed for with respect to possible so-called athermal effects.

SCIENTIFIC DISCUSSION

Despite over 20,000 scientific publications on the issue (primary studies) and several hundred metastudies, the results are still extensively viewed as unsatisfactory by the general public, scientists and decision-makers.

As already noted, mere observation of biological effects is no indication (or proof) of adverse health impact. With regard to the biological effects which various scientific studies have identified in experiments on exposure to electromagnetic radiation, there is relative consensus that several of these effects have been demonstrated (e.g. changes in cognitive functions or changes in the blood-brain barrier) and that there is further an apparent connection between exposure to high-frequency radiation and the observed biological effect. There is broad consensus on the exposure to EMF caused by cell phones: for these, it is generally established that the resulting exposure in the user's head and their immediate environment exceeds the EMF generated by transmitters. These can in individual instances reach the limit recommended by ICNIRP for exposure of body parts. If there are other sources of electromagnetic fields in addition, this may under certain circumstances lead to exceeding the level of exposure regarded as safe.

The only generally recognised health risks at present which could be caused by cell phones are thermal effects in excess of a SAR value of 4 W/kg. The current state of scientific knowledge of the biological effects of high-frequency EMF does not generally permit a uniform and useful answer to questions about risks.

In formulating its recommendations for limits, the International Commission for Non-Ionising Radiation Protection (ICNIRP) limited itself to the known thermal effects. Generally, public exposure to electromagnetic fields is significantly lower than the ICNIRP recommended limits, and emissions by most cell phones are also below these limits. When safety intervals between cell phone transmission stations are observed, thermal effects can be ruled out. This applies to all wireless networks. In the case of cell phones, it is at least ensured that local limits (SAR value) are so low that possible local temperature increases are less than 0.1°C. Numerous scientific studies show that regular use of a cell phone and associated local heating of tissues of at most 0.1°C has no impact on health.

However, it is not scientifically established whether electromagnetic fields from cell phones may have other effects on the human body in addition to the thermal effect. These so-called athermal effects are possible effects of EMF which do not cause any temperature increase in the body but might have other effects. Among others, migraines and headaches, disturbance of sleep and concentration and other general feelings of unwellness are frequently placed in context with the athermal effects of EMF. Possible effects on cancer or effects on the central nervous system or brain activities are also being discussed.

The results of research in this area are not clear. While several studies have led to the assumption that athermal effects are actually present, many other

studies failed to identify the cited effects. Many researchers see indications that low-intensity electromagnetic radiation can cause weak athermal effects if – as in the case of cell phone technology – it is pulsed. This means that this form of radiation could lead to effects which appear below the current thresholds. The relationship between the pulsed secondary frequencies of cell phone radiation and specific electrochemical processes in the human body could accordingly give rise to concern (although the secondary frequencies are inherently concerned with low-frequency radiation). Critics have noted that observations of effects of weak radiation have so far been impossible to replicate. Conversely, it cannot be firmly expected that athermal effects should be as stable as thermal effects, or that the exposed individuals will react to weak radiation in the same way, because the possible effects involved are very closely related to electrochemical processes in the human body. One suspicion, for example, is that a small part of the population is more »electrosensitive« than the overwhelming majority.

Until such time as there is clarity on whether the suspected athermal effects have an adverse impact on health, a relationship cannot be ruled out between these effects and health problems reported by many cell phone users and others. If a relationship between this type of cell phone radiation and adverse health effects were to be scientifically demonstrated, the prevailing limits may have to be amended. Consideration would accordingly also have to be given to reducing the intensity of radiation of cell phones and transmitters – as far as possible in the current state of the art.

There is also a lack of (adequate) research in particular on the long-term effects of pulsed electromagnetic fields. In this area, further efforts seem to be urgently needed.

REGULATORY FRAMEWORK

To help create a basic consensus in the EU member nations on risk evaluation and management, the European Commission published a report in 2000 on the application of the precautionary principle. As no binding regulations exist for EMF limits in the EU, member countries can set lower limits (than those recommended in the above Council report), following the precautionary principle.

In Germany the network operators, national associations of local authorities and Federal government made major efforts in 2001 in the context of the electrosmog debate. A »voluntary commitment by providers«, a »cooperation agreement between local authorities and operators« and »the Federal Government's

action programme« form a pack of measures based on voluntary self-regulation. Important elements are the involvement of the local authorities in the search for locations for antennae, further promotion for research and information campaigns and trade and consumer fair campaigns. A quality seal for cell phones based on the »blue angel« has already been introduced, although it is meeting criticism from both manufacturers and environmental associations. Based on a recommendation of the Radiation Protection Commission, the German Federal Ministry of the Environment has retreated from its original plans to reduce limits below the ICNIRP level.

An international comparison with other states considered in the report shows that transparency and early explanation of potential EMF risks and a sensitive approach to finding locations can make a major contribution to constructive debate on electrosmog (cf. Denmark). In Sweden, for example, complaints and protests by »electrosensitive« individuals and their representatives were taken seriously at an early stage by the health authorities. »Electrosensitivity« has been recognised as an illness and associated with special preventive health measures. Dealing with possible EMF risks is perceived by the public as a whole as a personal problem which does not necessarily require further general precautionary measures.

The example of Switzerland in turn shows that increased measures can still be accompanied by further calls for lower limits. The low (or lower) limits are seen by many people as risk thresholds above which damage to health can occur. To be plausible and acceptable, and accordingly have a steadying effect on the risk discourse, limits should be scientifically established and not based (exclusively) on political considerations – although at the same time precautionary limits can be initiated and politically justified.

A general problem seems to be that low (or lower) limits do not always apply everywhere or are not complied with everywhere, even within the countries involved.

RISK COMMUNICATION

In the media reporting on possible risks of EMF in cell phones matches the course of the debate. After the auction of the UMTS licences, there was a significant increase in the number of media reports. Overall, media reporting can be described as mostly critical, local and current, with specific stereotype arguments

repeatedly recurring in the critical articles: lack of democracy and legitimation, shortage of information and explanation, lack of knowledge, lack of precautions and shortcomings in implementation.

In the general population the general level of knowledge of EMF must be regarded as relatively low. Even so, surveys show that two-thirds of the population feel that EMF risks are possible in principle, which can be seen at least as an indicator of the high level of attention devoted to this issue. Another symptomatic feature of the electrosmog risk discourse is the apparent paradox of cell phone use accompanied by public protests against transmitters. The individual risk of using cell phones has so far mostly been seen as smaller than the collective risk of exposure due to base stations.

Federally active citizen's action initiatives often deliver ultimatums to politicians (»stop cell phone use until the risks have been resolved or safety proved«), while local groups push less for the abolition of cell phones and more for greater attention to their interests in choosing locations for transmitters. They feel that their rights as local inhabitants and citizens are being violated.

Characteristic of the EMF risk discourse among scientific and medical experts is the »expert dilemma«, as statements and assessments are diverse and contradictory. In addition scientific statements on the possible effects of electromagnetic radiation are inevitably provisional in their nature. Experts evaluate risks on the basis of probability of occurrence and the potential scale of damage. These probabilistic risk assessments contrast with lay assessments, and often lead to misunderstandings in discourse. For example, the »zero proof« required by many citizen's action initiatives cannot be provided by scientific methods, as it is not possible to prove absolute safety – only damage can be demonstrated. Expert assessments based on probability statements are frequently not understood by laypersons and this sometimes leads to science being seen as »pro« cell phones in the discourse on risk.

Cell phone network operators in their risk assessment rely on the results of internationally-recognised committees, and stand by the statutory regulations in developing their networks. However, they have recognised that the differing assessments of risk among the public is resulting in conflicts which they have to counter through heavy involvement in risk communication, unless they want to contribute to a permanent loss of confidence in the new technology. The operators are accordingly seeking to involve the local communities in their choice of locations for antennae. Most of the actors involved are responding favourably

to the operators' measures. However, it is still too early to form a judgment, as these only started in 2002.

CONCLUSIONS AND OPTIONS

Discussion of limits and precautions is at the focus of the electrosmog debate. Even if surveys show that the majority of people favour a reduction in limits, most people are still against taking measures without having solid research results available. Promotion of further scientific studies accordingly has high priority, as do efforts to optimise the technology to enable further reductions in emission by the various sources (cell phones and transmitters).

The question of finding locations for transmitters has become increasingly important primarily because the majority of the population feel excluded from decision-making processes in this search. Participation by local authorities in network planning offers the chance of ensuring concrete and important influence.

The introduction of a »blue angel« quality seal was not done in consensus between manufacturers and network operators. This fact casts doubt on the success of the seal. If manufacturers actually do in future stop using the seal, another solution should perhaps be discussed in the interests of consumers. It also seems doubtful whether a seal based on the maximum SAR values for a cell phone can in principle offer transparency to consumers on actual exposure, as the dynamic power regulation of cell phones means that actual levels can vary very widely.

Measuring campaigns and monitoring contribute towards creating confidence in the location search process. Even though measurements to date do not provide any suggestion from the scientific point that limits are being exceeded, they should still be intensified so that ongoing evidence of compliance with limits can be provided. A network of monitoring systems should be created to acquire measurement data on actual cell phone emissions and possibly compare and coordinate these with other EMF emissions. This also seems important because cell phone radiation is only a small fraction of total electromagnetic radiation in the environment, and further sources of radiation will also emerge in the near future, e.g. road guidance systems, vehicle separation radar, local passenger transport billing systems, weather doppler, wireless LANs, directional radio and many more.

All the actors involved agree that more and better research and information should play a central role in risk communication. So that such measures can

make a major contribution towards a more balanced discourse on electrosmog, attention must also be paid to preparing and communicating research results so that they can be registered by the population. More information on its own involves the risk of an overwhelming flood of information. An answer to the question how information can be presented, packaged and evaluated neutrally and objectively is a key challenge for the public actors.

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