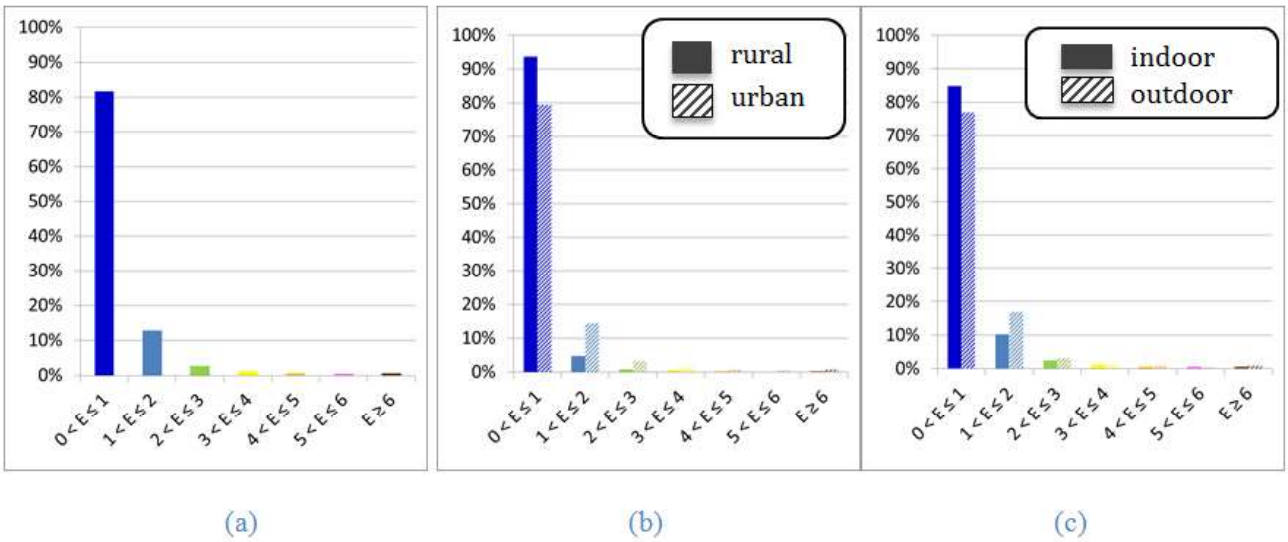

Figure 2. (a) distribution of global exposure levels (b) comparison between rural (solid bars) and urban (hatched bars) areas, (c) comparison between indoor (solid bars) and outdoor (hatched bars) areas

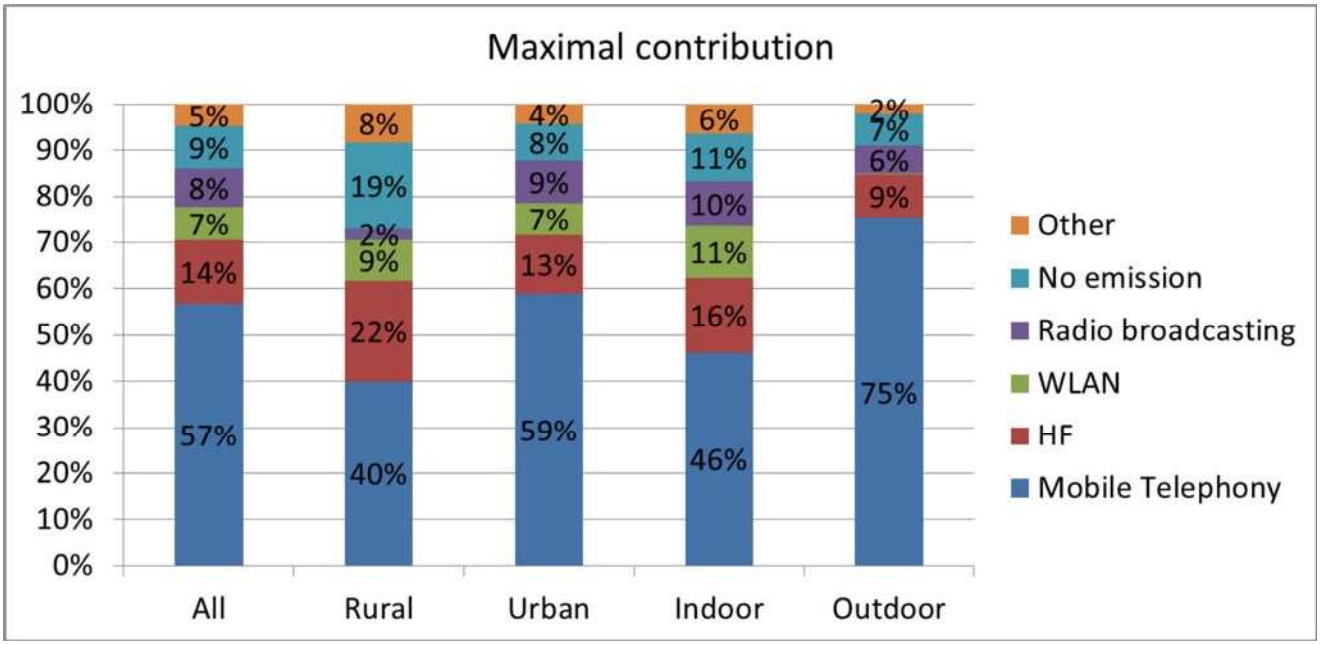

Figure 3. strongest contributors depending on the typology of the places of measurements for case B

S10-5 [12:20]

Measurements of residental intermediate frequency exposures due to home appliances

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The exposure of the population in the intermediate frequencies (IF) is increasing. A part of the GERoNiMO project was an assessment of the IF exposure at homes in three EU countries. From 87 measured appliances 21 of them had the exposure quotient above 0, whereas for 66 of them the exposure quotient was 0. The important contributors in the IF range are induction hob and (C)FL. For the measured induction hobs the highest vale at the distance of 20 cm from the appliance was 62 percent of the ICNIRP 2010 exposure. At 50 cm the maximum value was 12 percent of the ICNIRP 2010 exposure. For the CFL the values are similar: at 20 cm the maximum exposure was 51 percent of the ICNIRP 2010 and it drops to 20 percent at 50 cm.

Introduction

The exposure of the population in the intermediate frequencies (IF) is increasing. In the last 10 years several IF sources became common at homes, for example induction hobs, compact fluorescent lights, different switching adapters and drivers... A part of the GERoNiMO project (Generalized EMF research using novel methods) was also an assessment of the IF exposure at homes in three countries: Belgium, United Kingdom and Slovenia. In each country at least 15 different homes were analyzed.

Methods

The measurements in all three participating countries followed the harmonized measurement protocol prepared as part of the GERoNiMO project [1].

Residential IF measurements were divided into two measurement scenarios. The first scenario involved measurements of the IF fields in the three most occupied rooms of the residence as an assessment of the background exposure (further called room measurements). The second scenario involved the measurements of the IF fields emitted by household appliances (further called source measurements).

For measurements two types of devices were used. The device representing the first type is the Gigahertz Solutions NFA 1000 meter, whereas the other type is represented by Narda EHP-50 and EHP-200 probes. The NFA 1000 is a broadband measurement device with different predefined filters for electric and magnetic field measurements. Its frequency range is 5 Hz to 1 MHz and it was primarily used to monitor the time variability of the fields. For more precise measurements EHP-50 and EHP-200 probes were used, which are spectrum selective electric and magnetic field measurement probes with the frequency range of 5 Hz to 100 kHz and 9 kHz to 30 MHz. The uncertainty of the EHP probes is in the range of 30 to 40 percent.

Regardless the frequency range of the measurement devices, the measurements were targeted in frequencies between 300 Hz and 1 MHz, as there the IF sources in homes operate.

For room measurements the value of the IF fields was measured in the centre of the room at the height of 1.5 m and at the distance of at least 1 m from any of the IF EMF source. The measurements were repeated two times: first for a "hibernated" state of the room and then in the "max living" state. "Hibernated" state is a typical state if the room when no one is at home, whereas the "max living" state is when all the sources normally in the room are switched on.

For appliance measurements the value of the IF fields was measured at the distances of 20 and 50 cm. If the appliance had an operating cycle (for example, washing machine) measurements were repeated three times during the operating cycle.

After the measurements all the results were analyzed with a set of custom algorithms in Matlab. The exposure was analyzed according to the INICRP guidelines [2]. The exposure quotient was defined as a sum of peaks weighted by the corresponding ICNIRP reference levels and according to the CENELEC EN 50366 [3] standard as a root of sum of squares of peaks weighted by the corresponding ICNIRP reference levels.

Results

The results are presented in the Table 1, where the exposure quotient is given for the electric and magnetic field for ICNRIP 2010 and CENELEC EN 50366 algorithm.

Table 2: Exposure quotient given in the percentage for the CENELEC EN 50366 and for the ICNIRP 2010 algorithm at two distances of 20 and 50 cm. The appliances with all exposure quotients 0 are not shown.

	20 cm				50 cm			
	CEN		ICN10		CEN		ICN10	
Appliance	E (%)	H (%)	E (%)	H (%)	E (%)	H (%)	E (%)	H (%)
induction hob	46	13	57	13	12	0	12	0
induction hob	31	0	41	0	6	0	6	0
induction hob	47	9	62	9	9	0	9	0
induction hob	12	0	12	0	0	0	0	0
induction hob	50	0	50	0	12	0	12	0
induction hob	17	0	21	0	7	0	7	0
induction hob	30	0	39	0	8	0	8	0
induction hob	37	0	37	0	10	0	10	0
CFL	7	0	7	0	0	0	0	0
CFL	34	0	48	0	5	0	5	0
CFL	13	0	13	0	0	0	0	0
CFL	36	0	51	0	0	0	0	0
CFL	9	0	9	0	0	0	0	0
CFL	36	0	51	0	14	0	20	0
FL	26	0	26	0	9	0	9	0
blender	7	0	7	0	0	0	0	0
dishwasher	0	0	0	0	0	6	0	6
oscillating sander	5	0	5	0	0	0	0	0
LCD TV	29	0	29	0	20	0	20	0
LED light	34	0	34	0	0	0	0	0
LV halogen lamp	0	6	0	6	0	0	0	0

CFL: compact fluorescent lamp, FL: fluorescent lamp

The appliances with all the exposure quotients equal to 0 are not included in the Table 1. These devices are:

- 17 large household appliances: 4 washing machines, 2 dishwashers, 2 tumble driers, fridge, 3 microwave ovens, 2 air conditionings, heat pump, electric heater, moisture remover;
- 12 small appliances: 2 extractor hoods, 4 vacuum cleaners, robot vacuum cleaner, meat slicer, blender,

coffee maker, electric cattle;
- 7 health and beauty appliances: razor, vaporizer, hair straightener, hair drier, electric toothbrush, electric massager, electric epilator;
- 5 lighting devices: 3 led lights, LV halogen lamps, dimmer;
- 13 hand tools: 4 drills, 2 jigsaws, belt sander, angle grinder, chainsaw, hedge trimmer, 2 electric lawnmowers, portable planner;
- 13 consumer electronics: 3 gaming consoles, MP3 player, tablet, portable radio, laptop, baby sitter, battery charger, electric RC plane, 2 LCD TVs, electric power saver.

From all the measured appliances only two types of the appliances always have exposure quotients higher than 0: induction hobs and CFL. Beside induction hobs and CFL only few other appliances have only one representative which has the exposure quotient above 0: FL (only one measured), blender, dishwasher, oscillating sander (only one measured), LCD TV, LED light and LV halogen lamp.

The typical frequency spectrums of the most important IF EMF sources (induction hob and CFL) are presented in Figure 1 and 2. It can be seen that the frequency spectrum of the induction hob has the main peak a the frequency of 20 to 60 kHz, followed by a series of odd and even harmonics, which are slightly attenuated. The CFL spectrum is quite different. The main peak is much wider, but the harmonic components are attenuated much more compared to induction hob spectrum.

Discussion

From 87 measured appliances 21 of them had the exposure quotient above 0, whereas for 66 of them the exposure quotient was 0. As the appliances were selected among those, which are likely to emit some EMF in the IF range, this means that the IF exposure from home appliances is low and limited mainly to two types of appliances: induction hob and (C)FL. Beside these two types of appliances only two other appliances have significant EMF in the IF range: one LCD TV and one LED light have the exposure quotient higher than 10 percent at the distance of 20 cm: 29 and 34.

Conclusion

Results of IF EMF of the home appliances showed that the important contributors are induction hob and (C)FL. Induction hobs are important sources as the exposure close to them is significant. For the measured induction hobs the highest vale at the distance of 20 cm from the appliance was 62 percent of the ICNIRP 2010 exposure. At 50 cm the maximum value was 12 percent of the ICNIRP 2010 exposure. For the CFL the values are similar: at 20 cm the maximum exposure was 51 percent of the ICNIRP 2010 and it drops to 20 percent at 50 cm.

Acknowledgements

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Figures

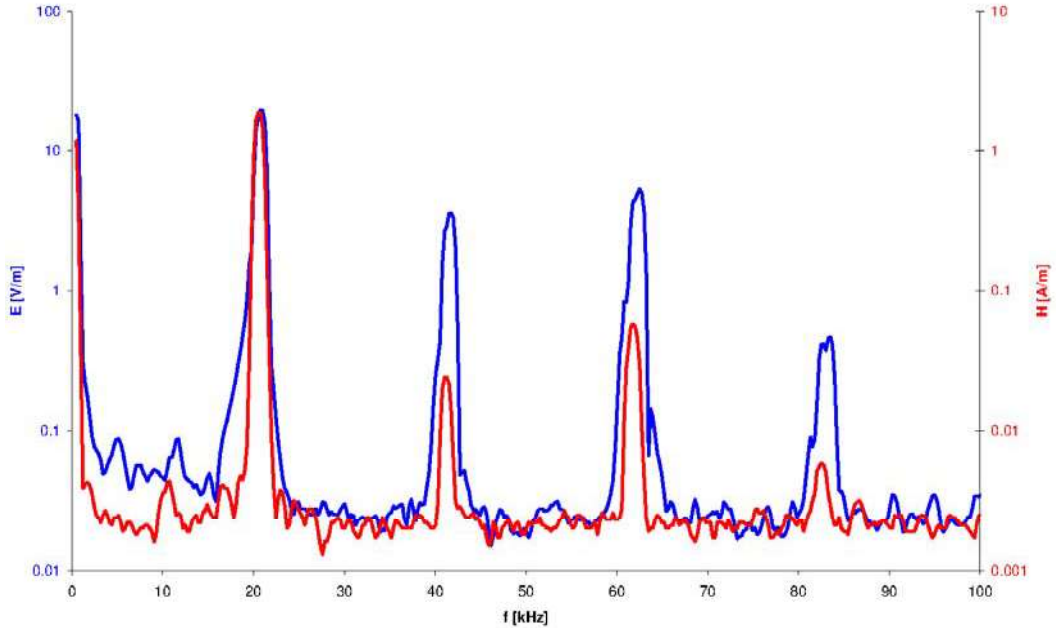

Figure 1. Typical frequency spectrum of the induction hob. The main peak is typically in the frequency range between 20 and 60 kHz with several odd and even harmonic components.

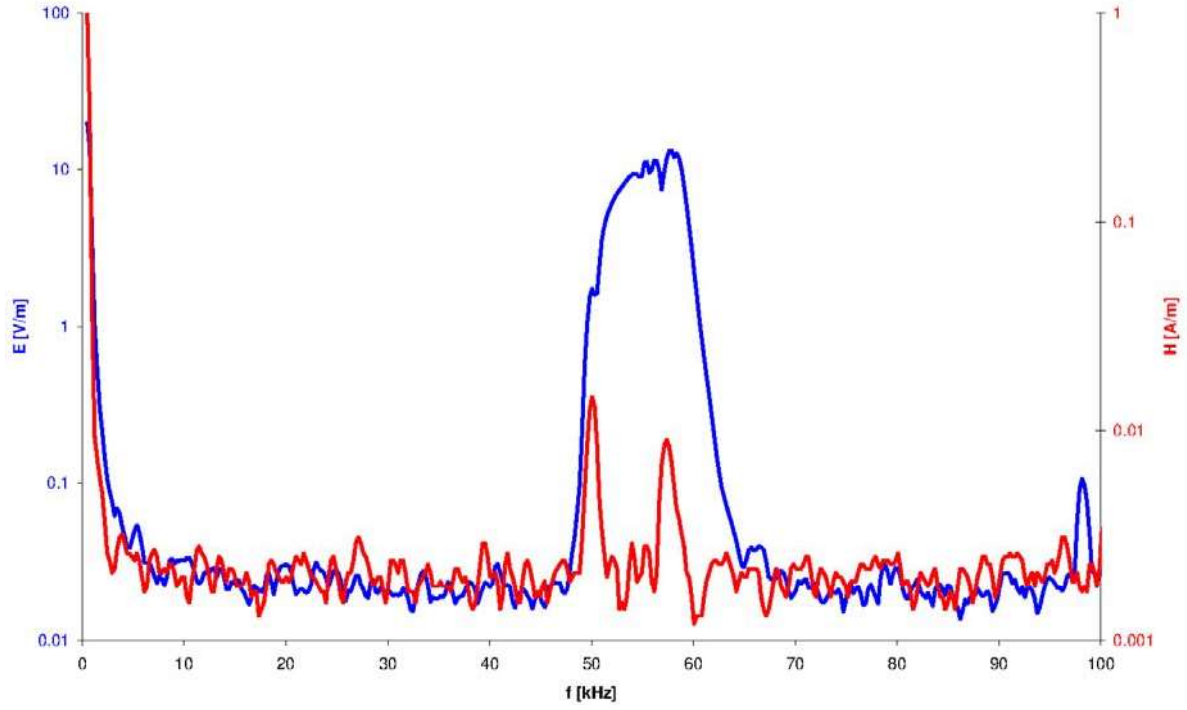

Figure 2. Typical frequency spectrum of the CFL. The main peak is typically in the frequency range between 50 and 60 kHz. Harmonic components are typically much lower than the main peak.