dab+
mehr radio

green radio

A Comparison of Energy Consumption on FM and DAB+

green radio

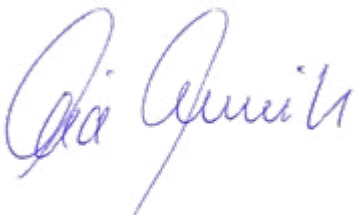
Making Radio More Sustainable with DAB+

Broadcasting is a public service. The German dual system ensures a unique range of services in terms of both breadth and diversity: with a strong public broadcasting service committed to its legal mandate and the common good on the one hand, and a large number of powerful private-sector services on the other. It enables everyone to receive his, her, or their radio and TV programmes without much effort. However, the obligation to the general public also includes broadcasters' commitment to ecological, economic and social sustainability. For this reason, broadcast services provide information about sustainability issues as part of its programming; it educates and promotes public discourse on the subject. In addition, private and public broadcasters have themselves been investing increasingly in climate-friendly and resourceconserving productions for some time.

Another important building block on the path to greater sustainability is the reduction of energy consumption in programme distribution - especially in view of the ongoing technological transition from FM to DAB+. The digital radio standard enables a significantly greater variety of programmes, affordable receivers, and consistent or even improved coverage in many places without higher costs. Thanks to the good and long-standing cooperation between the Bavarian Regulatory Authority for New Media (BLM) and the Bavarian Public Broadcaster (Bayerischer Rundfunk, BR) Bavaria has created the appropriate infrastructure for this. This study now also reveals the ecological advantages of DAB+ as „green radio": on broadcasting a single service, between 70% and 90% of energy can be saved by switching from FM to DAB+. In view of the extensive infrastructure that radio broadcasting operates to serve the population, the cumulative resulting effect is considerable.

Innovative public and private stations have led to almost half of the population in Bavarian households (42%) already receiving radio services via DAB+. The switch to more energy-efficient receivers also improves the ecological footprint of listeners. In addition to the programme-related, technological and economic aspects mentioned above, all this confirms that we should continue to pursue the path we have taken toward DAB+ as the successor of FM.

Munich, September 2021



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1. Management Summary

Climate change is a challenge for governments, business and society. In order to achieve the climate goals, radio is also required to contribute. The Bavarian Regulatory Authority for Commercial Broadcasting (BLM) and the Bavarian Public Broadcaster, Bayerischer Rundfunk (BR), together with another DAB+ network operator and two radio receiver manufacturers, have compared the energy consumption of broadcasting and receiving radio programmes via FM and DAB+.

The studies show that, with a comparable supply, the energy consumption when broadcasting a programme via DAB+ is significantly lower than with FM. Bayerischer Rundfunk would save around 75% per station and Antenne Bayern would save 85% in energy if its audio service were broadcast exclusively via DAB+. Deutschlandradio would not only save around 70% of the energy per station if it ceased FM broadcasting for its services Deutschlandfunk and Deutschlandfunk Kultur, but would also reach significantly more listeners with DAB+, since the available FM frequencies are unable to provide nationwide coverage for Deutschlandradio. Even more than 90% of the energy could be saved for the Klassik Radio station in the Hamburg/Schleswig-Holstein area, if it were broadcast exclusively via DAB+.

Independently of DAB+, considerable energy savings would be possible on the reception side by replacing the approximately 122 million FM radio sets in existence. Although most radio sets are often equipped with additional functions such as displays or WiFi, their power consumption has dropped by around 40% in recent years. The reason is the lower energy need of a radio set, which is mainly determined by the power supply unit and the power output stages, rather than by the reception. The very low additional consumption due to an extra DAB+ receiver is negligible in comparison.

The prerequisites for being able to do without FM are a DAB+ broadcasting infrastructure comparable to that of FM and households equipped with DAB+ or other digital radio devices. In Bavaria, all stations from private providers and Bayerischer Rundfunk are broadcast via DAB+. In Bavaria, 42% of the population aged 14 and over have at least one DAB+ receiver in their household.

2. Climate Change and Energy Transition

Coping with climate change is a challenge for governments, business and society. The Federal Constitutional Court has mandated that the country take climate protection measures today in order to prevent disproportionate restrictions on the fundamental civil rights of today's younger people in the future.[1] The Federal Government has responded by tightening its climate protection targets. The Climate Protection Act stipulates a 65% reduction in greenhouse gas emissions by the end of the decade, compared to 1990. By 2045, Germany is to have achieved greenhouse gas neutrality. To this end, a comprehensive package of measures was adopted, including regulatory requirements, financial incentives for energy saving, and the promotion of alternative energies („Climate Pact Germany").

Broadcasting cannot sidestep this challenge and needs to look for ways to contribute its share. ARD has described its measures in the „ARD Sustainability Report 2020".[2] ZDF has formulated sustainability goals and reports regularly on their implementation.[3] Other institutions are currently concretising their sustainability strategy. In a „Joint Declaration for Sustainable Film and Series Production", the major television broadcasters and many film funding organisations have committed to making their contribution to ecological sustainability.[4] In the new Film Funding Act, which will come into force on 1 January 2022, funding will for the first time be linked to a significant reduction in CO_2 emissions and other environmentally harmful immission.[5] This study will examine the potential savings that radio broadcasting has in terms of energy consumption for the terrestrial transmission of its programmes and for radio reception. The focus is on a comparison of energy consumption of radio services via FM and DAB+.

3. Study Participants

This study was conducted by the Bavarian Regulatory Authority for New Media and Bayerischer Rundfunk. Contributing also were JVCKENWOOD Deutschland GmbH, Media Broadcast GmbH and TechniSat Digital GmbH.

1 BVerfG 1 BVR 2656/18; Rdz. 148 f

2 https://www.ard.de/nachhaltigkeit

3 https://www.zdf.de/zdfunternehmen/nachhaltigkeit-csr-106.html

4 https://www.bundesregierung.de/breg-de/bundesregierung/staatsministerin-fuer-kultur-und-medien/aktuelles/gemeinsame-erklaerung-fuer-nachhaltige-filmproduktion-im-bundeskanzleramt-unterzeichnet-kulturstaatsministerin-gruetters-film-bewegt-nachhaltig--1723124

5 § 59a und § 67 Abs. 12 FFG 2022

4. Study Design

The focus of this study is on power consumption during programme transmission, although the value chain extends from programme production to signal supply from the studio to the transmitter and finally to transmission. Power consumption during production and signal feed to the transmitter are not taken into account as they do not differ significantly between DAB+ and FM.

The Federal State of Bavaria was selected as part of the study region because the DAB+ radio landscape is most developed here. In Bavaria, all services by private radio providers and Bayerischer Rundfunk are already available via DAB+. With around 13 million inhabitants, approximately 16% of Germany's population lives in Bavaria.[6]

For comparison, the distribution area Hamburg/Schleswig-Holstein and the nationwide distribution of Deutschlandradio services were examined.

Taken into account in this investigation of energy consumption were the input power of the transmitter and the different propagation conditions for FM and DAB+.

With FM, the radio signal is transmitted in frequency modulation. When transmitting an identical radio signal via neighbouring transmitters, multiple transmitting frequencies must be used because the overlapping of footprints causes interference, which may cancel out the transmitted signal. As a rule, high power transmitters are used to cover large areas. To avoid interference, the same frequencies can only be reused a long distance away.

In contrast, DAB+ is a single frequency network. In this network, interference is compensated for by technical measures. In general, the result is that identical radio signals of neighbouring transmitters are being amplified. Due to this single frequency network gain, it is possible to operate transmitters with lower power, i.e. using less energy.

Only one station can be broadcast via an FM frequency. With DAB+, several stations are combined in a multiplex and transmitted together on a common frequency. In the receiver, the data stream is then split again into individual stations. The power consumption of a station in DAB+ depends on the data rate used and how many services are being combined in the multiplex. Usually, a multiplex consists of up to 16 radio stations in good sound quality.

6 https://www.bpb.de/nachschlagen/zahlen-und-fakten/soziale-situation-in-deutschland/61535/bevoelkerung-nach-laendern

5. Terrestrial Radio Service Coverage

In Germany, around 330 radio stations are broadcast locally, regionally, state-wide and nation-wide via analogue FM.

After a long introductory phase, DAB+ has established itself as the digital terrestrial transmission standard with a strong upward trend alongside FM. Thanks to DAB+, the capacity limitations of FM were overcome, creating the possibility to broadcast many new stations. Further advantages are the noise-free sound, the user-friendliness of radio sets and the additional data services on a display in parallel to the programme.

DAB+ achieved its breakthrough in Germany with the launch of the first nationwide multiplex on 1 August 2011, and a second nationwide multiplex has been on the air since October 2020. In the meantime, all public broadcasters are broadcasting their FM services plus new services via DAB+. With the exception of Lower Saxony, Mecklenburg-Western Pomerania and Thuringia, regional and/or state-wide DAB+ multiplexes with private services are now available in all other states. In North Rhine-Westphalia, the start of the state-wide DAB+ transmitter network with private stations is planned for the end of 2021. The number of receivable DAB+ stations varies according to the individual regions of Germany. However, the overview map shows that in most regions, 20 or more stations can be received. In many regions of Bavaria, in the Rhine-Neckar area, in Leipzig-Halle and Berlin, listeners can choose from 70 or more DAB+ offerings. This does not include overspill of DAB+ stations from neighbouring countries.

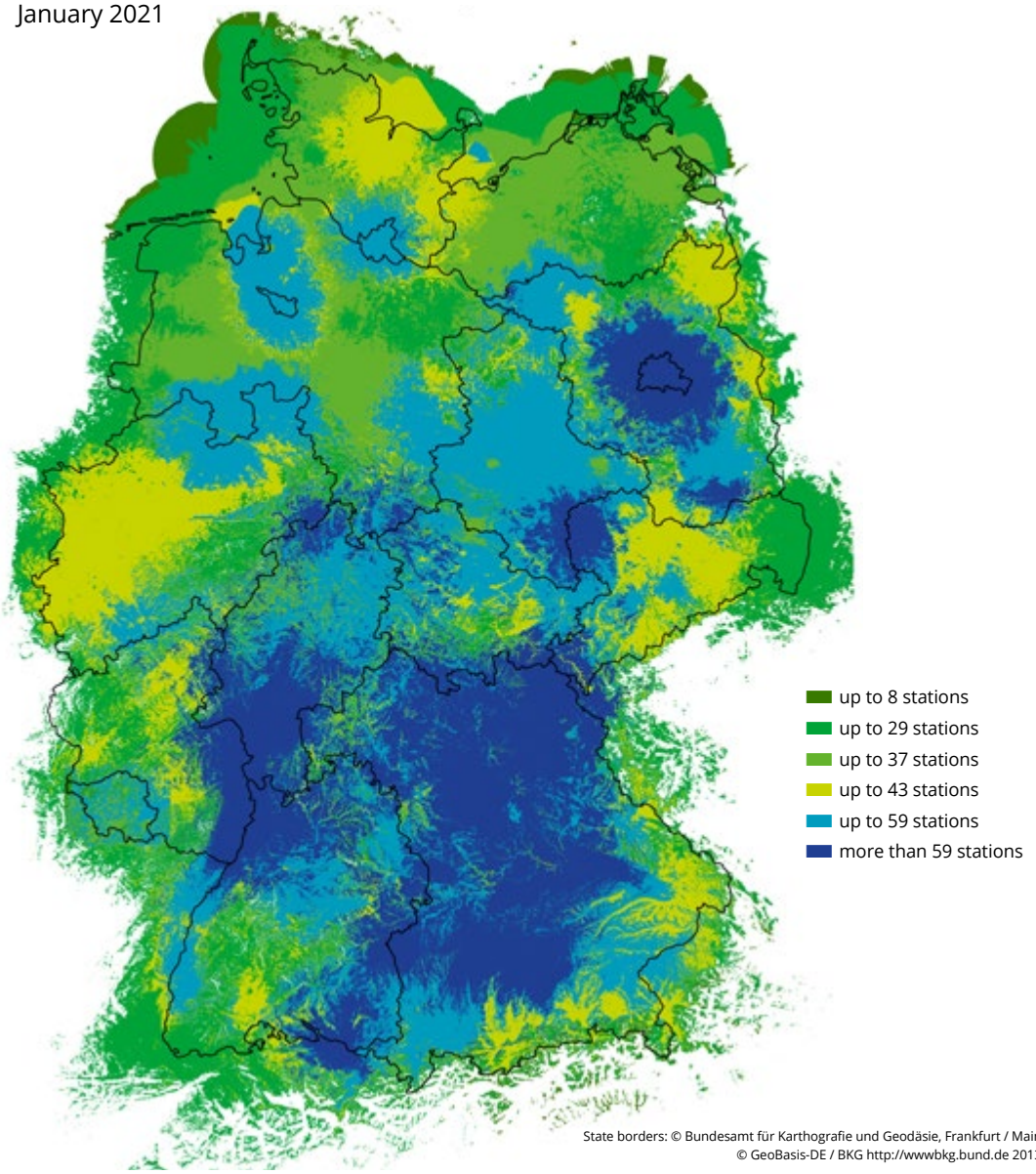
Today, DAB+ has established itself as the new transmission standard throughout Europe. To encourage digital radio, the EU Commission issued a regulation in 2018 stipulating that in future, only car radios able to receive digital terrestrial radio may be sold in new cars in the member states. This digital radio obligation in cars was introduced in Germany from 21 December 2020. According to WorldDAB, 80% of new cars were already equipped with DAB+ radios by the second half of 2020.[7]

In addition, it was regulated in Germany that – with a few exceptions – all commercially available receivers must also support at least one digital receive path (§ 48 para. 5 TKG).

7 https://www.worlddab.org/system/news/documents/000/012/060/original/WorldDAB_press_release_DABPLUS_RADIO_AS_STANDARD_IN_NEW_EUROPEAN_CARS_23.6.21.pdf

Number of German DAB+ Stations

January 2021



Norway was the first country to migrate from FM to DAB+ in 2017. Only a few local stations may continue to broadcast via FM until 2027. Switzerland intends to end radio broadcasting via FM on 31 December 2024 and then broadcast terrestrially exclusively via DAB+. In Germany, it is currently at the broadcasters' discretion whether they will continue to broadcast a service simultaneously via both distribution channels. Deutschlandfunk, Bayerischer Rundfunk and some private broadcasters have for some time begun to give up FM sites in favour of DAB+, also for cost reasons.

6. Internet Radio

The internet is indispensable for the distribution of radio services. Most radio broadcasters are pursuing a hybrid strategy with DAB+ and internet (IP).[8] Around 2,400 stations with a focus on Germany are offered on the internet. This includes almost all terrestrially distributed stations, web streams from FM broadcasters and a large number of stations from new providers. The power consumption of radio use on the internet was not subject of this study.

7. Studies on the Energy Efficiency of DAB+ Compared to FM

Several studies have been conducted over the last years on the energy efficiency of analogue and digital terrestrial radio broadcasting.

The most detailed study of its carbon footprint was carried out by the BBC[9] in the UK. In terms of radio broadcasting, the study found that DAB+ has the lowest energy consumption. The BBC further found that a hybrid approach of DAB+ and IP would achieve the greatest energy savings.

Studies by MDR[10], the Swiss SRG[11], the transmitter manufacturer GatesAir[12] and WorldDAB[13] came to comparable conclusions.

8 https://www.online-audio-monitor.de

9 https://downloads.bbc.co.uk/rd/pubs/whp/whp-pdf-files/WHP393.pdf

10 https://www.mdr.de/digitalradio/index.html

11 https://www.srgssr.ch/de/news-medien/dossiers/abloesung-ukw

12 https://www.gatesair.com/documents/slides/gatesair-ve-digital-radio-rich-redmond.pdf

13 https://www.worlddab.org/system/news/documents/000/012/007/original/10.05.21_Factsheet_-_Environmental_impact_of_DAB_.pdf

8. Energy Consumption in Selected Areas

8.1 Bayerischer Rundfunk

At Bayerischer Rundfunk, FM coverage is largely identical to the current coverage of the nationwide DAB+ transmitter network in block 11D. Measuring FM energy consumption of the networks for the five analogue BR stations, the very good coverage of Bayern 1 as well as the limited coverage of BR24, which is broadcast in mono quality only, have been taken into account. The following table shows the energy consumption, also with regard to the DAB+ expansion planned until 2028.

Energy Consumption BR Radio Services [Bavaria]

Bayerischer Rundfunk	FM transmitter network Status 2021	DAB transmitter network in Block 11D Status by end of 2021	DAB transmitter network in Block 11D Planned status by end of 2028
Number of transmitter sites	199*	78	110
Annual consumption [kWh]	5,116,510	2,482,083	3,089,762
Share of transmission capacity used by BR	100%	93.06%	93.06%
Number of BR services	5	9**	11**
Consumption kWh per service	1,023,302	256,635	261,381
Share of power requirement of a service compared to FM	100%	25%	26%
Population coverage indoors	13,061,000	12,457,000	12,785,000

* 199 transmitters at 41 transmitter sites

** As of 2021, 9 channels will be broadcast on the BR multiplex primarily with increased error protection, in an effort to partially compensate for existing reception gaps in the transmitter network. When expansion of the transmitter network is completed, error protection may be reduced to enable 11 channels to be accommodated.

The table shows that – with a largely comparable DAB+ coverage of a topographically above-average coverage area such as Bavaria – the energy consumption of the transmitters for a DAB+ radio service in a state-wide network is only 25% (end of 2021) or 26% (end of 2028) of FM broadcasting.

8.2 Antenne Bayern

The state-wide private radio broadcaster Antenne Bayern operates a FM transmitter network consisting of 43 transmitter sites. This network requires approximately 1.46 gigawatt hours of electric power per year. Based on an infrastructure agreement between BLM and Bayerischer Rundfunk, Antenne Bayern is part of the state-wide Block 11D of Bayerischer Rundfunk.

Energy Consumption Antenne Bayern [Bavaria]

Antenne Bayern	FM transmitter network Status 2021	DAB transmitter network in Block 11D Status by end of 2021	DAB transmitter network in Block 11D Planned status by end of 2028
Number of transmitter sites	43	78	110
Annual consumption [kWh]	1,460,000	2,482,083	3,089,762
Share of transmission capacity used by Antenne Bayern	100%	6.94%	6.94%
Number of Antenne Bayern services	1	1	1
Consumption kWh per service	1,460,000*	172,256	214,429
Share of power requirement of a service compared to FM	100%	12%	15%
Population coverage indoors	12,819,000	12,457,000	12,785,000

* The higher value compared to the BR network is due, among other things, to a higher energy supply because of different antenna configurations.

The power requirement for Antenne Bayern is lower than that of the stations of Bayerischer Rundfunk because of the slightly lower data rate. Due to the higher annual consumption in the FM network, the savings of 88% (end of 2021), respectively 85% (end of 2028) are even higher than for BR.

8.3 Klassik Radio in Hamburg/Schleswig-Holstein

In terms of energy consumption for Klassik Radio broadcasting in Hamburg and Schleswig-Holstein, there is a large difference between FM and DAB+ for identical coverage. Klassik Radio is broadcast in Hamburg/Schleswig-Holstein via the first nationwide DAB+ multiplex.

Energy Consumption Klassik Radio [Hamburg/Schleswig-Holstein Region]

Klassik Radio	FM transmitter network Stand 2021	DAB transmitter network* Stand 2021
Number of transmitter sites	13	8
Annual consumption [kWh]	65,725	80,802
Share of transmission capacity used by Klassik Radio	100%	6.25%
Number of Klassik Radio services	1	1
Consumption kWh per service	65,725	5,050
Share of power requirement of a service compared to FM	100%	8%
Population coverage indoors	4,690,000	3,667,500

* First nationwide DAB+ multiplex with a total of 13 transmitter sites.

In the table, the station's energy consumption for DAB+ is only around 8% compared to FM. This is not going to change significantly when further DAB+ sites will be set up to attain the technical coverage achieved with FM.

8.4 Deutschlandradio

The differences between FM and DAB+ coverage are particularly evident for the nationwide services from Deutschlandfunk and Deutschlandfunk Kultur. Due to the fact that there are not enough frequencies available, both of Deutschlandradio's services cannot be received everywhere in Germany via FM. Almost nationwide coverage is only possible with the nationwide DAB+ transmitter network.

Energy consumption Deutschlandradio [Germany]

Deutschlandradio	FM transmitter network Stand 2021	DAB transmitter network* Stand 2021
Number of transmitter sites	288	147
Annual consumption [kWh]	4,002,970	6,781,992
Share of transmission capacity used by Deutschlandradio	100%	45.83%
Number of Deutschlandradio services	2	5**
Consumption kWh per service	2,001,485	621,637
Share of power requirement of a service compared to FM	100%	31%
Population coverage indoors	59,535,000	76,950,000

* First nationwide DAB+ multiplex with a total of 13 transmitter sites.

** Deutschlandradio broadcasts four stations and additional data services via DAB+.

With DAB+, Deutschlandradio supplies around 30% more people with its Deutschlandfunk and Deutschlandfunk Kultur stations, using 69% less power. Since the two FM stations are not available in parallel at all transmitter sites, the actual additional coverage of DAB+ increases to approximately 40% of inhabitants served.

9. Energy Savings in Distribution

The comparison of energy consumption for FM and DAB+ in the areas analysed confirms the results of studies in other countries. When the multiplex operates at full capacity, energy savings for the areas and stations examined amount to between 70% and 90% for a DAB+ station in relation to the distribution of an FM station. The full power saving potential becomes evident when considering the fact that for FM stations, around 2,700 transmitters are deployed at around 1,054 locations, whereas only 654 transmitters are currently needed at around 300 transmitter sites for almost comparable coverage with DAB+ stations.[14] With the aim of achieving full DAB+ coverage, the installation of further transmitters is planned for the coming years. In the final expansion, however, fewer than 1,000 transmitters will be needed for DAB+ coverage.

14 https://fmscan.org/

10. Radio Reception

When deciding whether to switch from FM to DAB+, the energy balance must be considered not only in terms of transmission but also in terms of reception. According to the state media authorities' Digitalisation Report Audio 2021[15], a total of around 121.8 million FM radio sets exist in Germany, whereas the number of DAB+ receivers in households and vehicles is around 21.7 million. This figure will continue to increase following the digital radio obligation mandated in late 2020.
A BBC study serves as a relevant benchmark, revealing that for its stations, around 75% of the energy consumption is accounted for by reception and around 25% by transmission. In this context, it must be taken into account that new equipment is required for DAB+ reception (life cycle assessment).

10.1 Power Consumption of Radio Receivers

In previous years, radio sets were intended exclusively for listening to the radio. They were suitable for the reception of long-wave, medium-wave and ultra-short-wave services, usually standing in a special place in the living room. Today, there is a vast range of types of devices, depending on the situation they are used in (kitchen radio, radio alarm clock, boom box, stereo system, hi-fi component, pocket radio, construction site radio, car radio or car entertainment system, in-wall radio and more). Most of them feature a display to show the frequency or station.

However, radio receivers of current design are not comparable with their predecessor models of even ten years ago. Nowadays, they are equipped with a variety of additional functions or are themselves a built-in function in another device (dimmable and colour displays, touch screen, clock and date display, Bluetooth audio streaming, WiFi, voice a nnouncement, USB connection, timer, torch, wireless charging function, CD player, MP3 player, solar panel, USB charging function, multi-room functionality). Radios equipped exclusively with DAB+ are not available on the market.

Even though, according to the Telecommunications Act of December 2020, the requirement for a new commercially available radio with a display was just to have some kind of digital reception unit, most manufacturers decided to incorporate DAB+ in addition to FM. The radio sets are usually fitted with so-called multi-standard chips that can receive different types of transmission. Depending on the features, they enable the reception of FM, DAB+, DRM, IP and other digital services.

15 https://www.die-medienanstalten.de

The energy consumption of a radio set is essentially determined by the power supply unit and the power output stages. Over the years, manufacturers have minimised power consumption – regardless of the transmission standard – so that even an FM radio today consumes less energy than it did some years ago. An important specification was already contained in the „R&TTE“ Directive (1995/5/EC) concerning energy efficiency of electronic devices, which has led, for example, to significantly reduced power consumption in standby mode.

Radio reception alone accounts for only a small proportion of the total energy consumption of a radio set. For example, a typical car radio with display (multi-media device) draws a current of about 1.5 A when in operation. The DAB/FM receiver only has a share of about 150 mA – i.e., it uses a maximum of 10% of the power. 90% of the power consumption is thus accounted for by the power supply unit, display, power amplifier and other. However, compared to an exclusively FM receiver chip, an FM/DAB+ receiver chip consumes slightly more energy due to the system.

State-of-the-art radios have a significantly lower standby consumption and are more energy-efficient than older models. Today, a portable, modern design radio requires about 40% less energy in typical operation (DAB+ radio playback at 50% volume) than a comparable older model in FM mode. However, this better energy efficiency does not result from savings in DAB+ mode, but is due primarily to the improved energy footprint of the power supply and amplifier stage. This is the reason why, regardless of DAB+, the greatest energy saving effects would be achieved by replacing older FM radio sets.

10.2 Replacement of Radio Sets

In order to save energy in the medium and long term and contribute to the reduction of CO_2, there is no other alternative than to replace old receivers with new ones, for many reasons. In doing so, it is accepted that appliances which are in working order will be replaced by new, more energy-efficient appliances.

As decreed in the Energy Saving Ordinance (EnEV), which has been in force since May 2014, home-owners are obliged to replace their gas or oil furnace if it is 30 years old or more. In the context of the debate about pollutant emissions of diesel cars, owners in Germany were paid a scrappage premium if they scrapped their old car. Consumer advice centres recommend buying a new refrigerator if the old one consumes much more electricity than a newer, more economical appliance. In mobile communications in contrast, consumers often decide to buy a new mobile phone because it is trendy or because they want to surf the internet faster with the latest transmission standard. If users want to benefit from the advantages of DAB+, it is necessary to replace their radio set. The sooner such replacement takes place, the sooner radio broadcasters could abandon FM broadcasting altogether and make their contribution to saving energy. At the same time, it also helps consumers to save energy.

11. Conclusions for the Further Development of Radio Services

Radio audiences today expect to be able to listen to their radio programmes anytime, anywhere. They choose the type of reception depending on the situation. In most cases, they are unaware of the way in which they are receiving the programme. This forces radio broadcasters to broadcast their services in parallel via as many transmission channels as possible. In order to justify the associated higher distribution cost, they are compelled to examine whether a transmission channel is used by sufficient listeners, or whether a channel can be dispensed with. For public broadcasters, the basic service and the funds approved by the KEF, Kommission zur Ermittlung des Finanzbedarfs der Rundfunkanstalten (commission to determine the financial requirements of broadcasting organisations) are the benchmark. For private broadcasters, the criteria are the number of listeners and the marketing possibilities. The focus of considerations for politicians and the state media authorities is on programme and provider diversity.

Irrespective of these different perspectives, energy consumption and radio's contribution to climate protection are playing an increasingly important role. Radio services, like everyone else, must make their contribution to overcoming the climate crisis and attaining the climate goals. Radio's energy balance is the worst when services are broadcast simultaneously via FM and DAB+. With listeners' increased consumption of services via DAB+ and on the internet, the question for broadcasters arises as to whether they can do without broadcasting via FM. A study by Goldmedia[16] commissioned by the Landesanstalt für Medien NRW on the future of radio forecasts a decline in FM radio use to below 50% by 2028. According to the Bavarian research Funkanalyse Bayern 2021, only 58% of radio listeners still use FM services. 42% of the Bavarian population aged 14 and over have at least one DAB+ receiver in their household.

If radio stops broadcasting via FM, it can not only save between 70% and 90% of energy, but also has significantly lower broadcasting costs.

The energy transition in radio services would be achieved more quickly, if – following the example of Switzerland – all radio broadcasters agreed on a migration plan together with the federal states, the federal government and the state media authorities.

16 Goldmedia Gutachten 2018: „Zukunft des Hörfunks in Nordrhein-Westfalen 2028" https://www.medienanstalt-nrw.de/fileadmin/user_upload/lfm-nrw/Regulierung/Hoerfunk/Kurzfassung_LfM-Gutachten_Zukunft-des-Hoerfunks-NRW-2028.pdf

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