In the Cold Light of Day: Energy-Saving Lamps

The End of the Light Bulb - The End of Healthy, Natural Lighting?

If you want natural light, you must go outside, to a window or channel daylight inside your home. If you want artificial lighting to be as natural as possible, you need incandescent or halogen lamps. No energy-saving lamp or compact fluorescent lamp can compete with the light quality of incandescent and halogen lamps, the latter generating far less electrosmog, flicker, toxins, ultrasound… If you want no flickering at all, but the smooth light of nature, you need to use direct current.

In comparison with incandescent lamps, compact fluorescent lamps (CFL) have one advantage: low energy consumption - at least most products do. This is only one part of the problem, albeit an important economic and ecological one.

The advantage, however, can only be bought at the cost of a long list of disadvantages. Manufacturers, distributors, the media, consumer protection advocates and advertisements hardly ever mention these disadvantages. And if they do, they do so only partially. The negative aspects of CFLs, which either do not exist in incandescent bulbs at all or to a much lesser degree, are numerous:

- **Electrosmog** across several low- and high-frequency bands, much higher than allowed for computer screens, including lots of harmonic distortions, interference, spikes, pulses, distorted sine waves
- **Light flicker** across several low- and high-frequency bands, also rich in steep harmonics, spikes, interference, distorted sine waves, "dirtier" light
- **Light spectrum** of poorer quality, more inhomogeneous, more artificial, "synthetic", with only two to four narrowband color peaks, strongly deviating from natural daylight
- **Color rendering** of poorer quality; uncomfortable, uncheerful, unusual, "cool" light
- High percentage of **blue** und **UV light**
- Emissions of **toxins** und odors
- **Brightness** often lower than specified, may become even much lower over time, some CFLs were dimmer than comparable incandescent lamps in the latest tests
- **Life span** often shorter than specified, especially after numerous switching cycles; some CFLs blew out before the incandescent lamps did in the latest tests
- **Manufacturing** very costly, over ten times more costly than for incandescent lamps
- Toxic **contents**: various heavy metals, chemicals, synthetic compounds, adhesives, phosphorescent coatings, electronics, capacitor, printed circuit boards… (radioactive components until 2007)
- **Mercury**: on average 2-5 milligrams, this amounts to several 100 kilograms in Germany alone
- **Toxic waste** disposal required, but most end up in household garbage anyhow
- **Energy savings** often not as high as specified for most CFLs
- Long **warm-up time**, taking up to several minutes until maximum light output is reached
- Above-mentioned electrosmog emissions occur not only at lamp, but also spread across the **electrical wiring**, including its cables and appliances
- **Spurious signals** and **net currents** that can cause technical problems in electrical wiring and appliances, data transmission and bus systems, **overtaxing the power grid**, higher reactive power, "dirty power"
- The generated electrosmog interferes with **broadcasting frequencies**, especially AM or longwave radio
- **Ultrasound** emissions
- **Ecological balance**, life cycle assessment questionable
- **Expensive**

As already mentioned above, the many critical aspects and side effects of CFLs do not exist in incandescent lamps or to a much lesser degree.

Electrosmog

Incandescent bulbs emit only minimal electric and hardly any magnetic fields. In contrast, CFLs generate not only power-frequency fields, but also higher frequency signals due to their integrated electronics. The emission levels are several or umpteen (!) times higher than allowed for computer screens. Incandescent lamps do not emit pulsed fields with steep signals and clock frequencies, all of which are known to be especially biologically harmful. In contrast, CFLs emit lots of these signals, including lower and higher frequencies. Incandescent lamps hardly generate any harmonics, but CFLs do - in spades.

The electric-field emissions of CFLs at higher frequencies (from the electronics in the socket) are especially plentiful in the kHz range. Here are the test results in volt per meter:

- 'Öko-Test' (16 lamps, 2008) 7-12 V/m
- 'K-Tipp' (14 lamps, 2007) 7-40 V/m
- 'Guter Rat' (12 lamps, 2009) 16-41 V/m
- 'Test' (55 lamps, 2006/2008) 7-67 V/m
- German Federal Office for Radiation Protection (37 lamps, 2008) 4.8-59 V/m
- Swiss Federal Agency for Energy and Health (11 lamps, 2004) all below 1 V/m

A total of 134 CFLs showed electric-field emissions between 4.8 and 67 V/m, up to 67 times higher than the TCO standard for computer screens specifies: 1 V/m. The Swiss government agencies found almost nothing in 11 CFLs, no surprise because they measured wrong - with rod-like E-field probes which did not comply with the TCO standard.

Moreover, the power-frequency electric fields and the power- and ballast-frequency magnetic fields are much more dominant in CFLs than in bulbs, sometimes reaching or exceeding the TCO emission limits for computer screens, too.

"Keep distance, at least 1.5 meter!" the consumer organization 'Stiftung Warentest' demands because of the electromagnetic pollution. "Energy-saving lamps generate electrosmog!" the TV show 'ARD-Technik' warns. "All tested CFLs cause electrosmog!" the Swiss consumer magazine K-Tipp concludes. Dr. Heinrich Eder from the Bavarian Environment Agency explains: "The body currents caused by the unnecessary electrosmog of energy-saving lamps are 30 to 100 times higher than from incandescent lamps."

Light Flicker

As a result of the frequency used for the AC electricity in our power grid, incandescent lamps also flicker, but the flicker is rather subtle and weak because of the slow-acting filament.

The CFL-light, however, flickers, pulsates, fluctuates, crackles with low power- as well as higher ballast-frequency flashes of light including lots of harmonics - though not consciously detectable by the human eye. These powerful, recurrent light frequencies are unknown to nature. Natural daylight features a smooth spectral distribution, without frequency spikes with stroboscopic patterns.

"Flicker frequencies - whether perceived consciously or not - have a negative impact on the eyes, brain, brain waves, hormones, nervousness, neurological processing, regulation and control centers, coordination, metabolism, glucose consumption, capillary blood flow or sleep quality. They can also trigger migraines, headaches or epileptic seizures." So says Dr. Christin Steigerwald in her doctoral thesis at Ludwig-Maximilian University in Munich. "Low-frequency light signals show up in brain wave patterns." So says the neurophysiologist Prof. Ulf T. Eysel from Ruhr University in Bochum. "Energy-saving lamps flicker. This affects the brain and nervous system." So says the occupational scientist Prof. Ulrich Burandt from Essen University.

If we were to have natural, completely flicker-free artificial indoor lighting without frequency spikes, electricity would have to be supplied as direct current. As for the future, building biology demands separate circuits for direct current (lighting) and alternating current (other appliances). Or inverters can also be used that reliably convert the alternating current into a direct current. This holds especially true for future LED lighting that sometimes generates worse stroboscopic flickering than seen in CFLs when connected to the standard AC power.

Light Spectrum, Color Temperature

Incandescent as well as halogen lamps offer a balanced, nearly natural light spectrum with the most complete spectral power distribution. CFLs only pluck two to four small single color bands out of the full light spectrum; this is a far cry from the harmony of natural light.

Don't have wool pulled over your eyes: in publications and discussions, industry representatives and politicians alike argue that the light quality of CFLs would be just as good as incandescent light. Wrong. Time and again, the color temperature is used as "proof". The color temperature, however, only characterizes one single aspect of light quality, namely the general light color.

An even more important aspect is the light spectrum, its spectral distribution as well as the balance and interactions of its individual colors, which form light as a whole. Just as the color white only comes into being when all wavelengths from violet and blue over green and yellow to orange and red come together in harmony and blend into each other. Just as a good orchestra with its many different instruments coalesces into one, thereby creating harmony and musical pleasure.

It is the light spectrum that is essentially responsible for the quality, health and balance of a light source, for its resemblance to natural daylight, for the important color rendering of our entire environment, for a sense of well-being.

Thus Thomas Mertes, a Philips plant manager, said in 'Spiegel-TV': "I would not recommend using energy-saving lamps for areas where colors need to be rendered accurately, for example, above the dining table. Otherwise, the food will not look too appetizing and the person sitting across such as a guest may appear rather gray. Actually, you may have the impression as if the food was not to his liking." Sabine Gedder, head of the Hamburg School of Painting, says in the NDR broadcast 'Markt': “It looks terrible. The color red turns into orange and the yellow looks almost green.”

In comparison with natural daylight and bulbs, the spectral distribution of CFL is worse, featuring unnaturally narrow color bands. CFLs contain only few colors with steep spikes, having hardly any spectral color output in-between them. Staying with the orchestra, this would be as if only two or three of the many musicians were to take center stage, playing loud and out of tune. And all the others were to keep silent.

"An artificial light source is the more harmful, the more strongly it deviates from the spectral characteristics of natural sunlight," health care professionals warn. All of this and more is swept under the rug, even by science journalists who should know better than that such as the TV host Ranga Yogeshwar in the ARD discussion panel "Hart aber Fair".

Both the unnatural light spectrum as well as the annoying flickering are not too inviting. Both occurs when a light source illuminates something close or farer away. In the outside darkness, I can still measure the light flicker many meters away from those homes illuminated by CFLs, including the flickering of TV and computer screens. Go for a walk along such homes in the dark and let the various lights wash over you: Here is a home that feels warm and inviting, owing its cheerful glow to incandescent light. And over there they have typical energy-saving lamps, fluorescent lamps or computer screens just like at a supermarket.

Manufacturing and Disposal

The manufacturing of bulbs is environmentally friendly and much more ecologically sustainable than the manufacturing of CFLs. The latter consume far more energy during manufacturing and, in addition, are packed with polluting electronics.

The disposal of incandescent bulbs is equally kind to the environment; they can go into the household garbage. Not so CFLs, they must go to a toxic waste site, which most of the time does not happen.

Energy Consumption, Life Span, Light Output, Heat

The reason for the ban of incandescent lamps is the lower energy consumption of energy saving lamps at a higher light output, longer life span and lower heat loss. But even regarding energy consumption, light abundance and a long life span, CFLs show not only advantages in tests. It is lamented that incandescent lamps would become too hot and waste too much energy. True enough. CFLs, however, do not remain quite as cool. According to our testing, their surface temperature can reach up to 90 °C (195 °F).

Pioneering Work

Once again, it was the pioneering work of building biology to bring to light the disadvantages of newly emerging technologies, in this case, compact fluorescent lamps. Already back in 1992, we from Baubiologie Maes were the first to point out the high electric- and magnetic-field emissions and to criticize the lack of brightness. The consumer magazine 'Öko-Test' reported about it. Before the EU imposed the ban of incandescent lamps, we not only repeated the tests for 'Öko-Test', but for the first time we also demonstrated the distinct light flickers and verified the presence of ultrasound emissions and toxins. Afterwards, the media and consumers became increasingly critical.

What Are They Doing to Us?

"This is not light, this is garbage!" 'Öko-Test' quoted the spontaneous response of a lighting expert after having seen testing results of the electromagnetic-field emissions, light flicker, light spectrum, and color rendering of CFLs. For this quote, the magazine has been criticized by the complaints committee of the German Press Council on behalf of the CFL manufacturer Megaman. But not because of the contents of the statement, but because the name of the expert was not given. Several other complaints by Megaman about the contents of the 'Öko-Test' article (light spectrum, light quality, testing criteria, etc.) have not been accepted by the Press Council.

"Our new light: cold, ugly, expensive and dangerous. What do they think they are doing to us in Brussels?" read the headline of the lead story in the Neuss newspaper 'Stadt-Kurier' in its Sunday edition on 19 September 2009.

Did You Already Know...?

Did you know that incandescent lamps could last much longer than CFLs but are not allowed to do so? In 1924 the leading electronic companies founded a worldwide cartel called Phoebus. It was its goal to cap the unlimited life expectancy of incandescent lamps to increase sales. At first it was limited to 5000 hours; one year later it was reduced to 2000 hours. After World War Two, only 1000 hours were allowed. Current quality standards are still based on this number and specify life expectancy with 1000 hours - even though much better lamps would be possible. The Chinese did not play along, which is why their incandescent lamps still last at least 5000 hours. At the firehall of Livermore in California, one of the first incandescent lamps has already burnt continuously for one million hours, for over 100 years. It is celebrated as a good luck charm and made it into the Guinness Book of Records.

Besides, the incandescent lamp is capable of even more: You can hammer a nail into a board with it as was shown at Thomas Gottschalk's TV show "Wetten dass..." in 2002. This would be far too dangerous with a compact fluorescent lamp, if only because of the toxic mercury.

Let's get back on track: "Energy-saving lamps radiate as much as ten cell phones." This comparison from the newspaper 'Bild-Zeitung' is more than questionable. A wireless phone radiates microwaves, reaching up to a few hundred meters (cordless phone) or several kilometers (cell phone). A CFL emits an electric field within a few meters and a magnetic field within a few decimeters. This is bad enough if you spend longer periods of time within its reach. But "ten cell phones"? This is quite exaggerated. In the case of a cell phone, the radiation is part of the inevitable function, but for lamps as well as many other electronic devices it is unnecessary and thus a preventable side effect - if only we wanted to.

In spite of all the critical warnings out there and a lack of fundamental research, the German Ministry of Labor spent 700,000 euros on energy-saving lamps in the fall of 2009. And Norderney, an island in the North Sea, is very proud to count itself among the first zones to be free of incandescent lamps.

How to Take Measurements?

Beside complicated, expensive equipment required for the accurate measurement of illumination and electromagnetic field aspects of energy-saving lamps, there are also quite simple devices with which first, fascinating insights can be gained.

With the help of spectroscopes, which are commonly used in e.g. physics classes, you can observe the light spectrum, also the colour distribution of the light. When we hold this spectroscope up against daylight, sunlight, the integrated prism reveals a smooth, balanced distribution of all colors, ranging from violet over indigo, blue, green, yellow, orange to red, as can be seen in a rainbow. When we do the same with an incandescent light bulb, the spectral light distribution resembles very much natural day- and sunlight. And when we take a look at energy-saving lamps, fluorescent lamps or computer screens, the image is terrible: nothing but a few spikes or color fragments scattered here and there. No more natural harmony, not a bit.

Some of the flickering of energy-saving lamps and other light sources can be made audible with minimal effort. Take a small solar module or photodiode and hook up a loudspeaker. What an amazing acoustic difference between the white noise of daylight and the humming of incandescent lamps and the ghastly shrieking of energy-saving or fluorescent lamps.

Soon there will be the first mass-produced testing devices commercially available that measure lower and higher flicker frequencies. Professionals use oscilloscopes and spectrum analyzers; see the sample graphs on the following page.

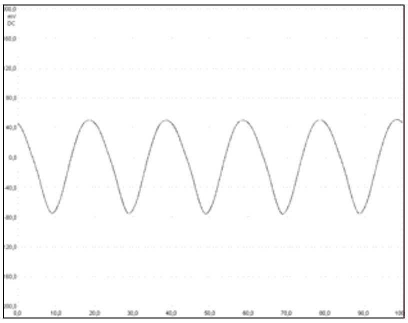
The measurements of AC electric and magnetic fields can be done with the usual equipment, preferably those that meet the TCO standard for low-emission computer screens. This way it is guaranteed that both the ELF signals of the power grid as well as the VLF signals of the lamp electronics are detected.

The brightness of a light can already be measured with an inexpensive light meter from an electronics store, thereby, discovering that 15 watts are not always equivalent to - as promised by the manufacturers - 75 watts.

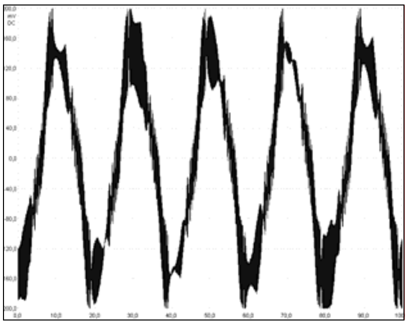
Technically Interested? Electrosmog and Light Flicker in Oscilloscope and Spectrum

a) Electrosmog

This is not only about field intensity, the field quantity, but also about the type of field, the field quality which turns out to be so much worse in energy-saving lamps: tons of harmonics, interfering frequencies and spikes both in the electric as well as the magnetic field. This can clearly be seen in the two oscilloscope graphs below, depicting sine waves of the electric field. Though the "sine wave" of all energy-saving lamps can hardly be recognized as such anymore, it is so distorted and spiky (see bottom graph). For the incandescent lamps, it still looks rather clean (see top graph).

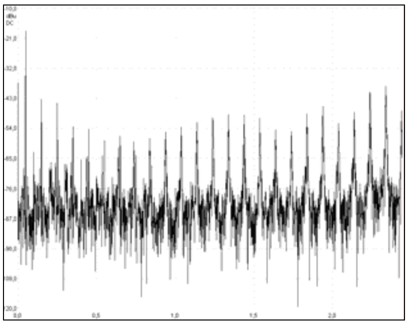


Electrosmog Sine Wave for the Incandescent Light Bulb Osram Classic 60 W

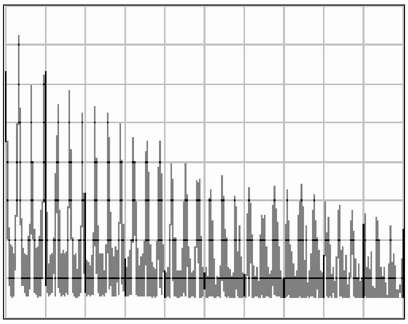


Electrosmog "Sine Wave" for the Compact Fluorescent Lamp Osram Deluxe 12 W

Typical for CFL, the electrosmog contains lots of distortions across the entire kilohertz range (as a consequence of the power frequency) up into the megahertz range (as a consequence of the electronics frequency). In order to illustrate this particular type of "electromagnetic garbage", we present two graphs of a spectrum analyzer below. So many and distinct harmonics as seen in the CFLs are unknown to incandescent bulbs.

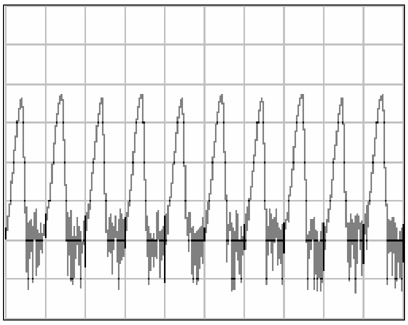


Electrosmog Harmonics due to the 50-Hz Power Frequency (shown up to 2.5 kHz) CFL by Megaman 11 W



Electrosmog Harmonics due to 32-kHz Operating Frequency (shown up to 1 MHz) CFL by Megaman 11 W

And there is yet another special electrosmog problem that we found in all energy saving lamps and only them: distinct, steep 100-Hz frequency pulses that are generated by the electronics integrated into the lamp socket.



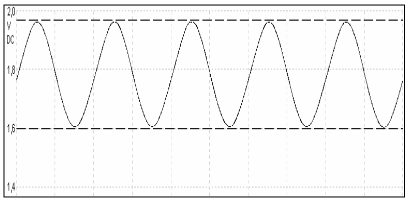
Electrosmog Pulses at 100 Hz CFL Attralux 11 W

b) Light Flicker

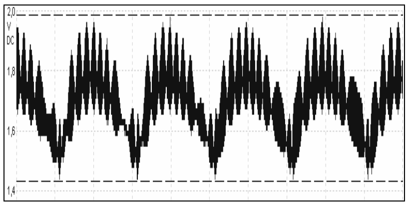
CFL-light flickers intensely, including both frequencies generated by the power supply as well as by the electronics of the lamp. The light is also packed with spurious signals, spikes and harmonics, all of which are rather similar to what we have already seen with the electrosmog or is known as distortion factor in acoustics.

Bulbs and halogen flicker much less, much weaker, "cleaner" and do so only as a result of the power frequency. Depending on the wattage, the flicker percentage of the light amounts to: 5-20% in bulbs and halogen, 20-50%, in CFLs, up to 70% in older fluorescent lamps. In LEDs flicker can be almost constant, up to 100%.

Two oscilloscope graphs of typical light flicker in a CFL compared to an incandescent lamp.

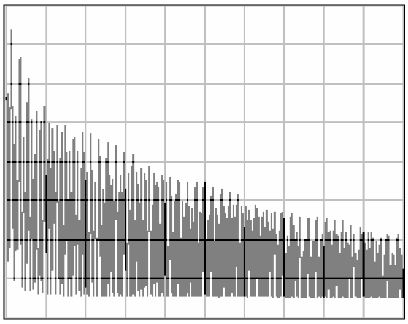


Light Flicker Sine Wave Bulb Osram Classic 60 W



Light Flicker "Sine Wave" CFL Tip 10 W

The similarity is striking: electrosmog and light flicker - distortions reach up to the megahertz range. The graph below shows how the "dirty" frequencies of the electromagnetic field continue on into the visible light.



Light Flicker Harmonics (shown up to 3 MHz) CFL Philips 11 W

A 30-page collection of critical information and quotes about energy-saving lamps is available at www.baubiologie.de (IBN-Code 13328) and www.maes.de.

At the above Internet addresses, you can also find additional oscilloscope graphs, spectrum analyzer graphs, diagrams and commentaries.

Furthermore, see the German article "Glühbirne raus - Energiesparlampe rein? - Moment mal..." in 'Wohnung+Gesundheit', issue 124, fall 2007.

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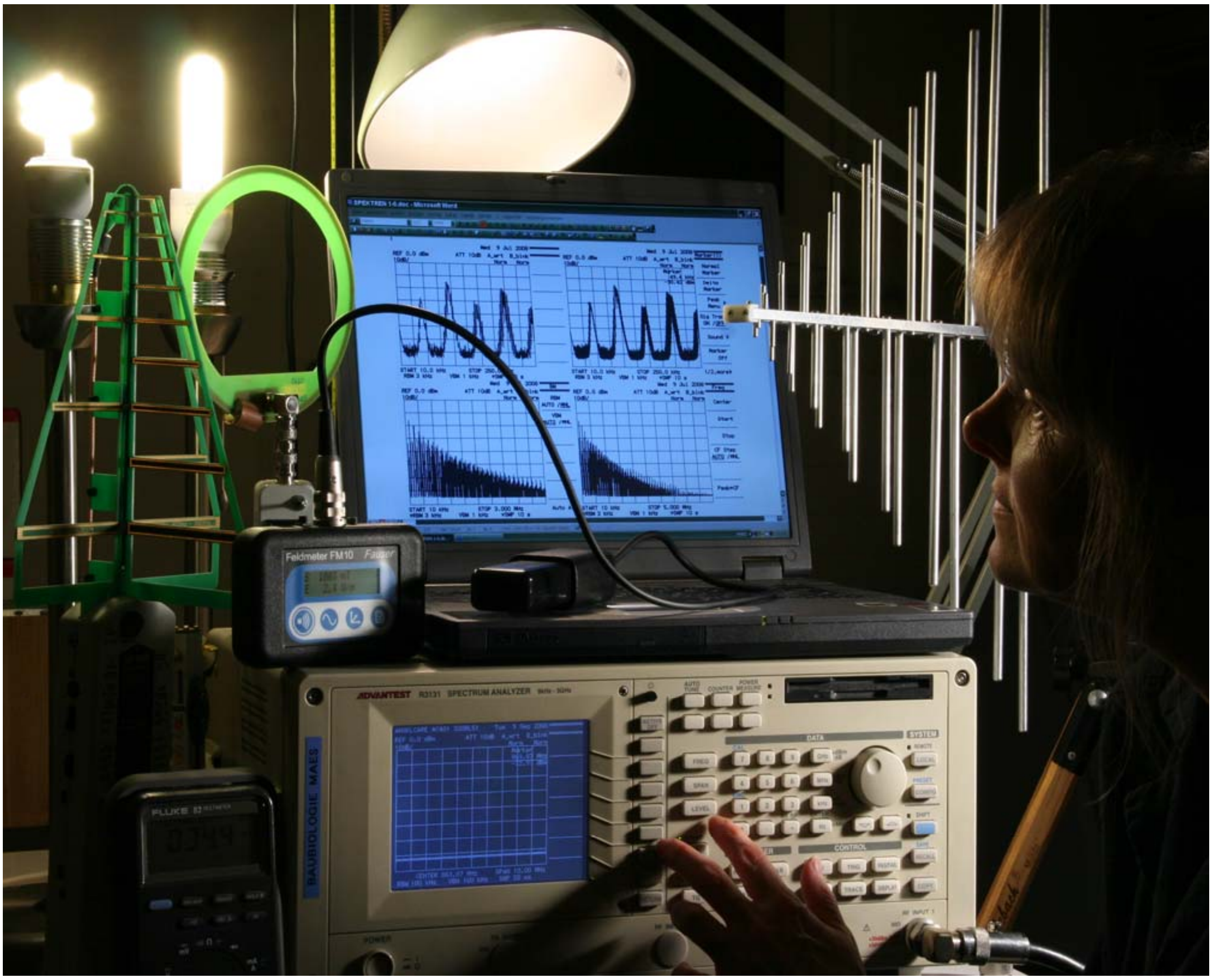
The End of the Light Bulb - The End of Healthy, Natural Lighting?

Additional diagrams, oscilloscope graphs, spectrum analyses, tables and commentaries on the report in the IBN journal 'Wohnung+Gesundheit', issue 133/2009, and the presentation at the Building Biology Expert Workshop in Fulda from 21 to 22 November 2009

The testing results and graphs on the following pages are based on the testing of 16 compact fluorescent lamps, one incandescent lamp and one halogen lamp; the testing was performed by Baubiologie Maes for the consumer magazine 'Öko-Test' in the summer of 2008 (published in issue 10/2008).

This also includes the compact fluorescent lamp that was praised to the skies by the Environment Minister Sigmar Gabriel in the media during his election campaign. Having given away 5000 of them, he claimed that they were better than any other tested so far. On behalf of 'Spiegel-TV' and 'Öko-Test', we tested his claim. We will see...

Once again, it was the pioneering work of building biology to bring to light the disadvantages of newly emerging technologies, in this case, compact fluorescent lamps. Already back in 1992, we from Baubiologie Maes were the first to point out the high electric- and magnetic-field emissions and to criticize the lack of brightness. The consumer magazine 'Öko-Test' reported about it. Before the European Union imposed the ban of incandescent lamps, we not only repeated the tests for 'Öko-Test', for the first time we also demonstrated the distinct light flickers and verified the ultrasound emissions and toxins. Afterwards, the media and consumers became increasingly critical.



Energy-Saving Lamps: Electrosmog, Flicker, Poor Light Quality...

In comparison with incandescent lamps, energy-saving lamps have only one advantage: a low energy consumption - at least most products do. This is only one aspect of the problem, albeit an important economic and ecological one.

The advantage, however, can only be bought at the cost of a long list of disadvantages. Manufacturers, distributors, the media, advertisements, consumer protection advocates, and politicians hardly ever mention the disadvantages. And if they do, they do so only partially. The following negative aspects do not exist in incandescent lamps:

- **Electrosmog** emissions across several frequency bands, much higher than allowed for computer screens, including lots of harmonic distortions, interference, spikes, pulses, distorted sine waves
- **Light flicker** across several frequency bands, also rich in steep harmonics, spikes, spurious signals, distorted sine waves, "dirtier" light
- Poor-quality, inhomogeneous, "artificial" **light spectrum** with only two to four narrow-band color peaks, strongly deviating from natural broadband daylight
- Uncomfortable, uncheerful, unfamiliar, "cool" light with poor **color rendering**
- High percentage of **blue** and **UV light**
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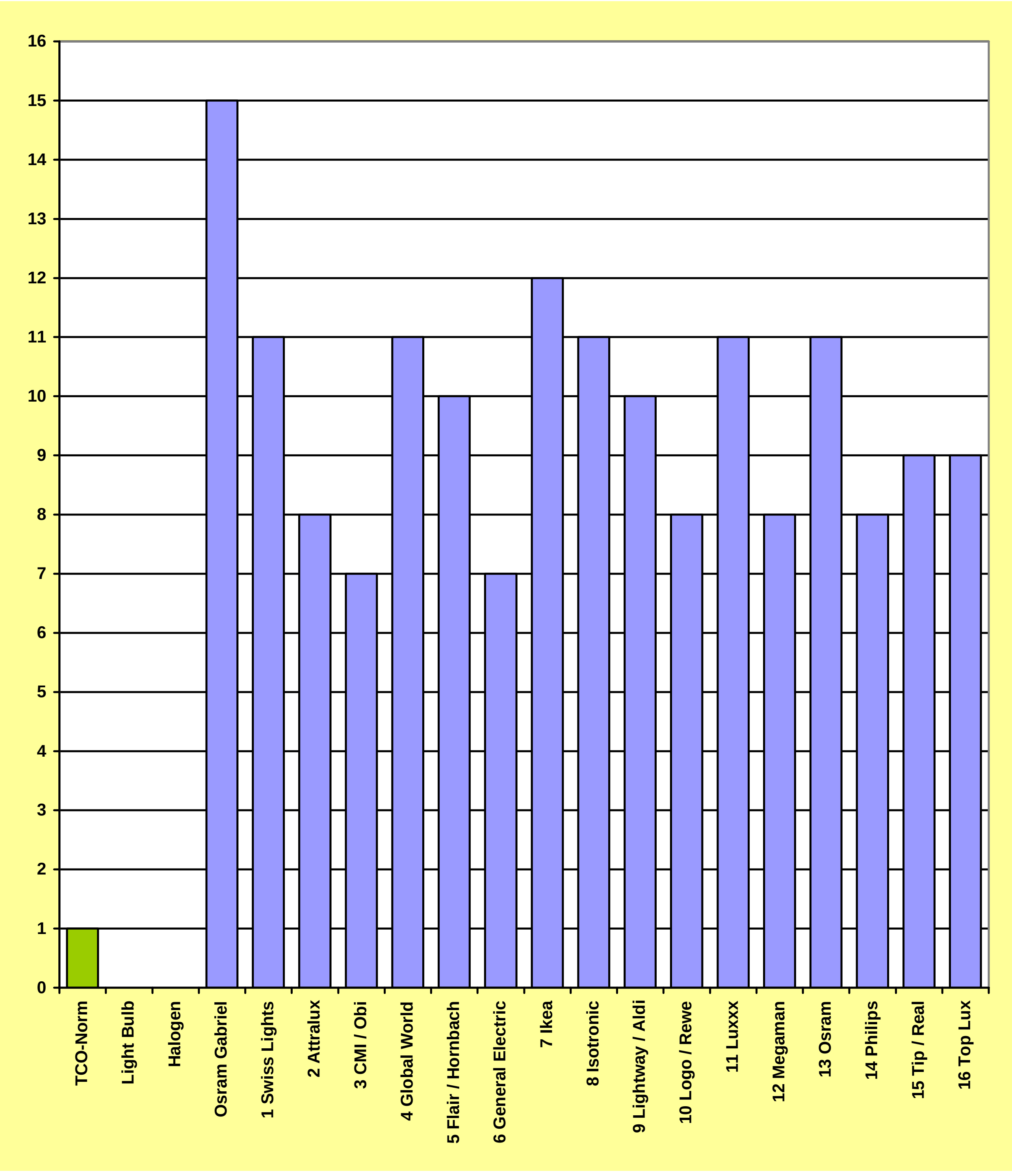
- **Spurious signals** and **net currents** that may cause technical problems in electrical wiring and appliances, data transmission and bus systems…, overtaxing the power grid, higher reactive power, "dirty power"
- The generated electrosmog interferes with **broadcasting frequencies** and disturbs them, especially AM or longwave radio
- **Ultrasound** emissions
- **Life cycle assessment** questionable
- **Expensive**

The predominant and most discussed electrosmog problem in energy-saving lamps is shown below as a diagram: electric-field emissions caused by the electronic ballast in the socket are 7 to 15 times higher than permitted by the TCO standard for low-emission computer screens. Incandescent lamps do not generate any such fields.

The Osram energy-saving lamp, of which Environment Minister Gabriel (blue bar to the left) had given away 5000 during his election campaign in 2009, did poorly as the one with the highest emissions (15 V/m) in comparison to the other 16 CFLs tested for 'Öko-Test' (7-12 V/m). Though he had claimed repeatedly that his was the better one.

AC electric field levels
at the typical CFL operating frequencies from 20-60 kHz:

Field strength (blue) in volt per meter (V/m)   PC standard TCO (green) = 1 V/m (30 cm)

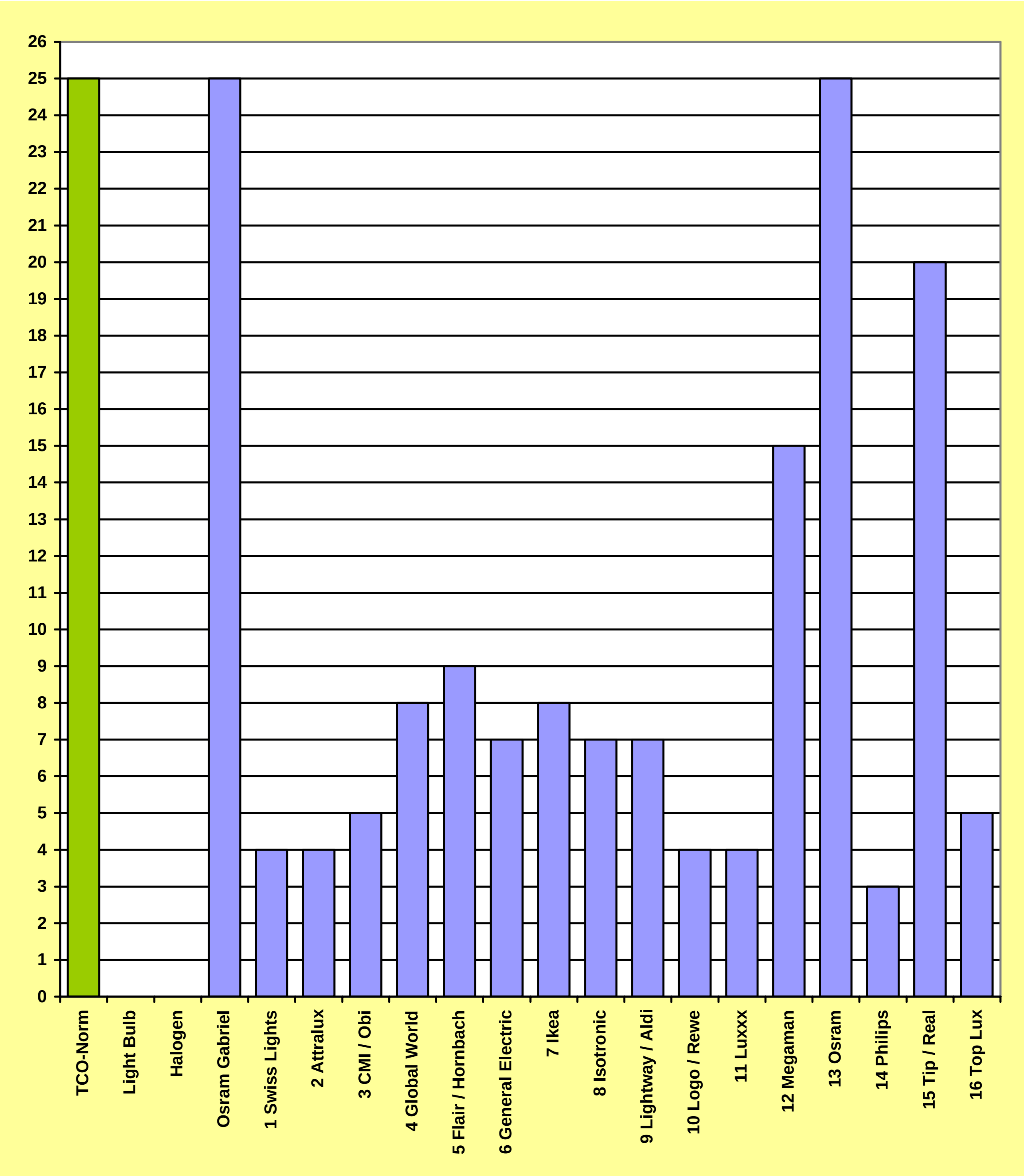


Although it is much less of a problem compared to electric-field emissions, an additional electrosmog problem in CFLs is shown below as a diagram: magnetic-field emissions caused by the electronic ballast in the socket; some emissions are as high as permitted by the TCO standard for low-emission computer screens. Again, incandescent lamps do not generate such fields at all.

Contrary to his claim, the Osram Election Campaign Lamp of Environment Minister Gabriel (blue bar to the left) is the one with the highest emissions (25 nT) in comparison to the other 16 CFLs tested for 'Öko-Test' (3-25 nT).

AC magnetic field levels
at the typical CFL operating frequencies from 20-60 kHz:

Flux density (blue) in nanotesla (nT) PC standard TCO (green) = 25 nT (30 cm)



A comparison of all energy-saving lamp tests on the predominant electrosmog problem, the ballast-induced electric-field emissions (operating frequency 20-60 kHz) that have been carried out so far:

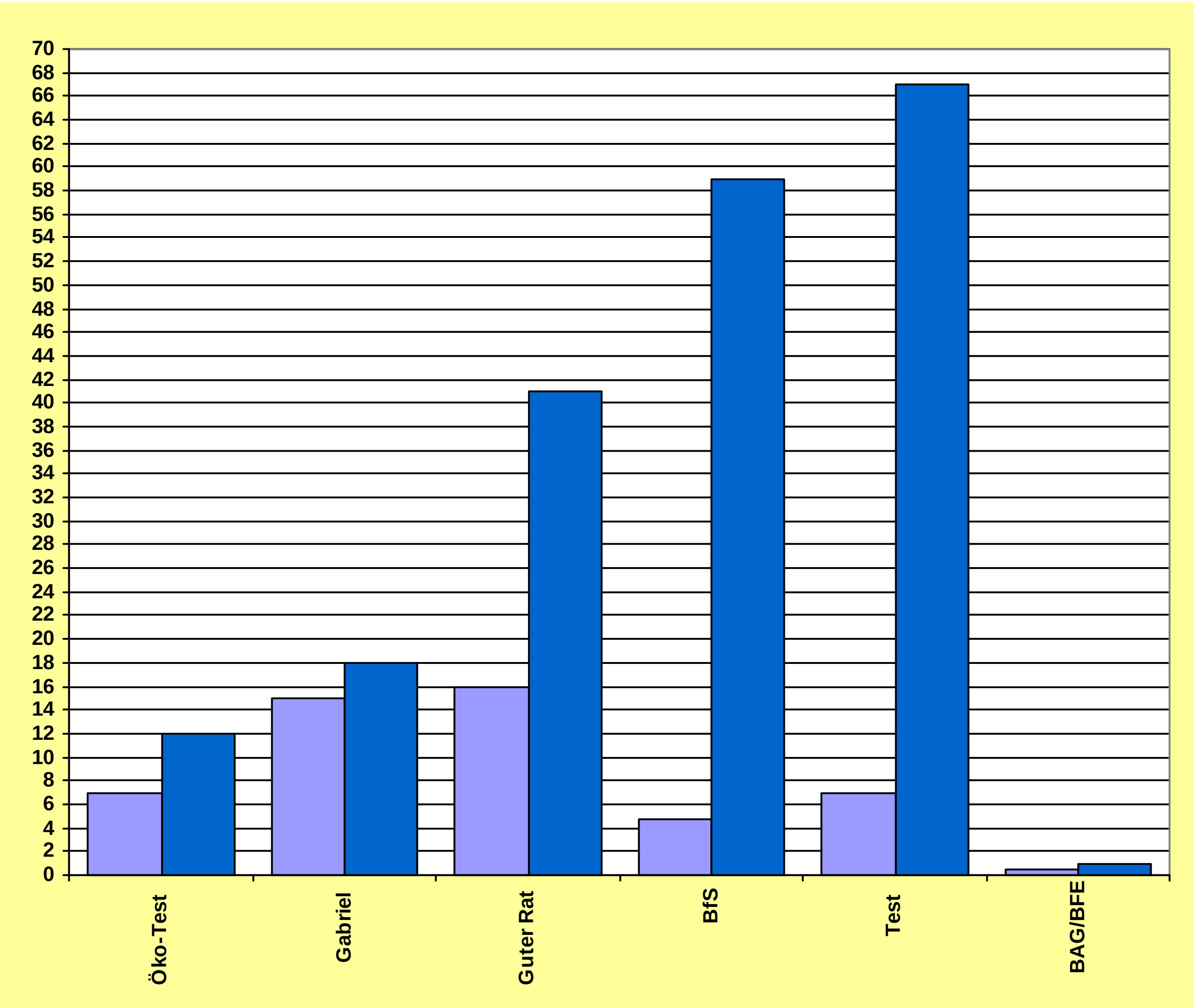
'Öko-Test' (2008): 16 lamps 7-12 V/m
Environment Minister Sigmar Gabriel's election campaign (2009): 3 lamps 15-18 V/m
Swiss consumer magazine 'K-Tipp' (2007): 14 lamps 7-40 V/m
Consumer magazine 'Guter Rat' (2009): 12 lamps 16-41 V/m
German Federal Office for Radiation Protection BfS (2008): 37 lamps 4.8-59 V/m
Consumer magazine Stiftung Warentest 'Test' (2006 and 2008): 55 lamps 7-67 V/m
Swiss Federal Agency of Health and Energy BAG/BFE (2004): 11 lamps < 1 V/m

Even though Öko-Test documented comparatively low emission levels and Stiftung Warentest the highest, it was often criticized and the latter was always praised. Why? Öko-Test did not only measure the electrosmog, but also evaluated it. Stiftung Warentest did take measurements, but did not evaluate the results.

The Swiss federal agencies BAG (Swiss Federal Office of Public Health) and BFG (Swiss Federal Office of Energy) found almost no emissions from all 11 lamps tested. No surprise there, they measured inappropriately with a rod-like E-field probe that does not comply with the TCO standard and therefore came to wrong results.

AC electric fields (20-60 kHz) in various tests:

Field strength (blue) in volt per meter (V/m) light blue - from / dark blue - to



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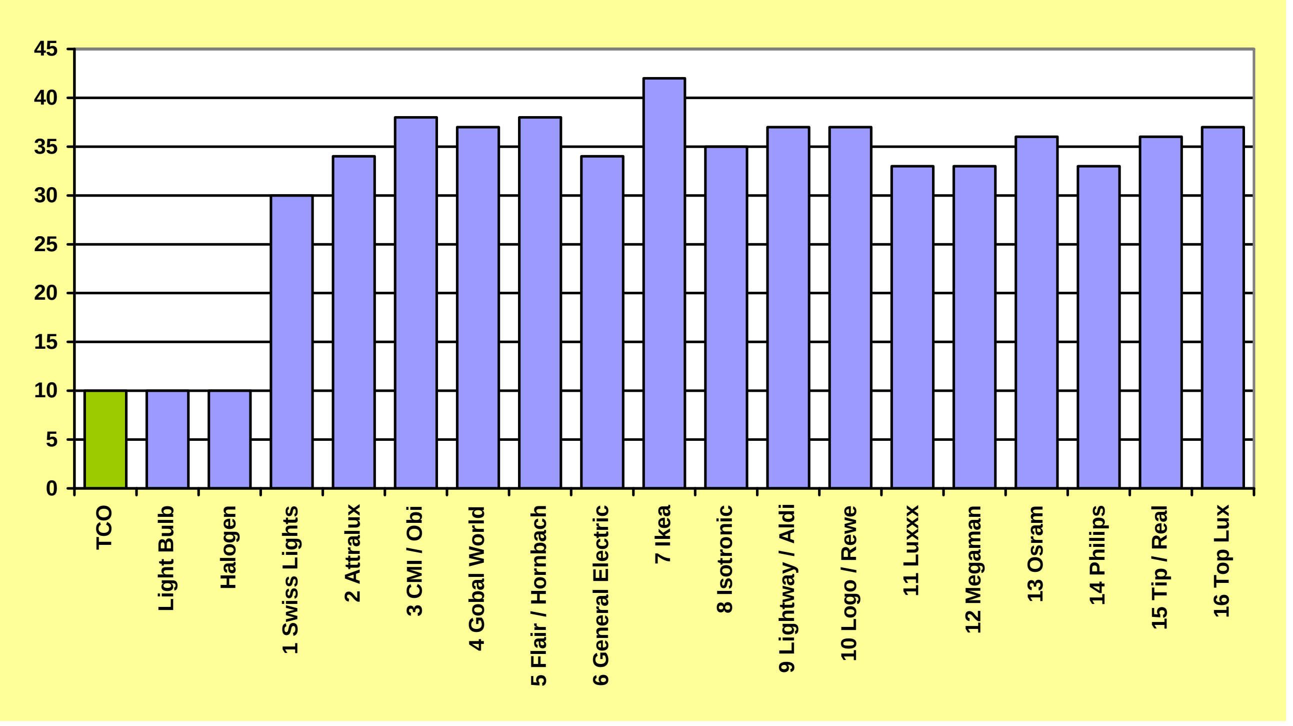
The electric and magnetic fields of the power frequency also show in a major way: In CFLs, electric fields are more predominant than in incandescent lamps, exceeding the TCO also in this frequency range. Magnetic fields hardly occur in incandescent lamps and in CFLs they are rather weak.

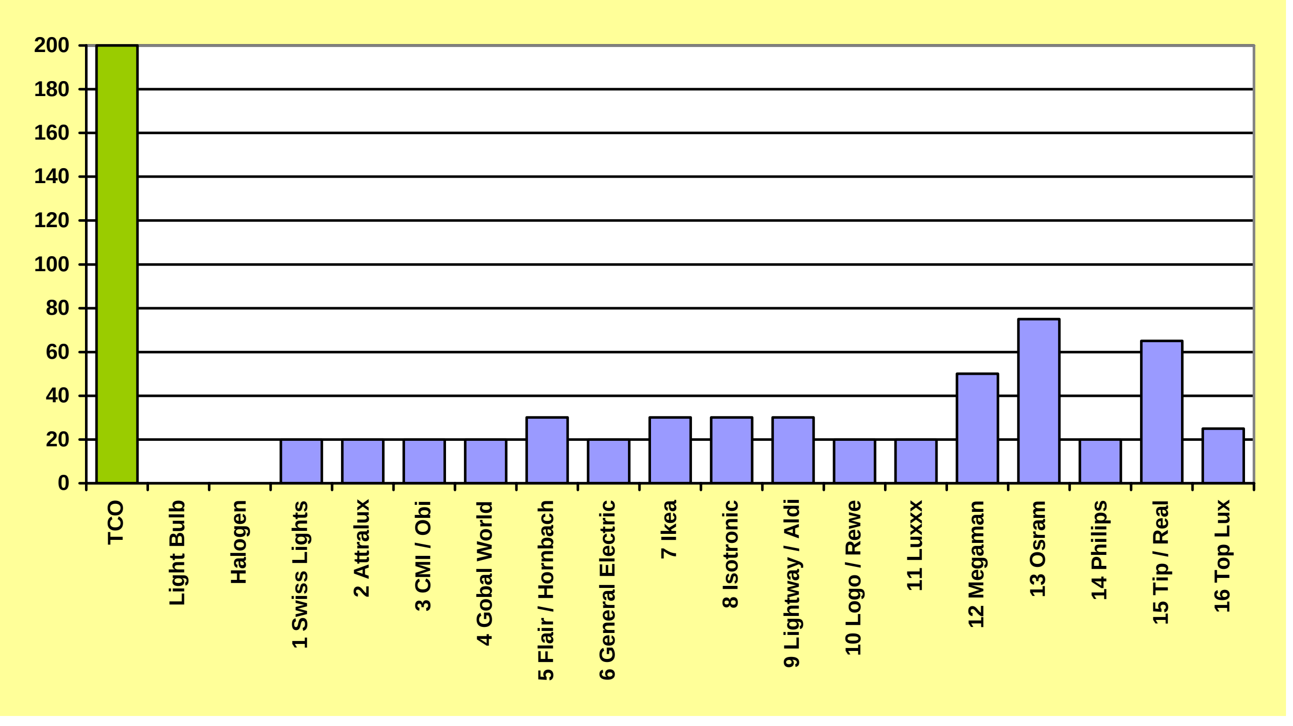
AC electric fields
at the power frequency of 50 Hertz (Hz), typical for light bulbs and appliances:

Field strength (blue) in volt per meter (V/m)   PC standard TCO (green) = 10 V/m (30 cm)



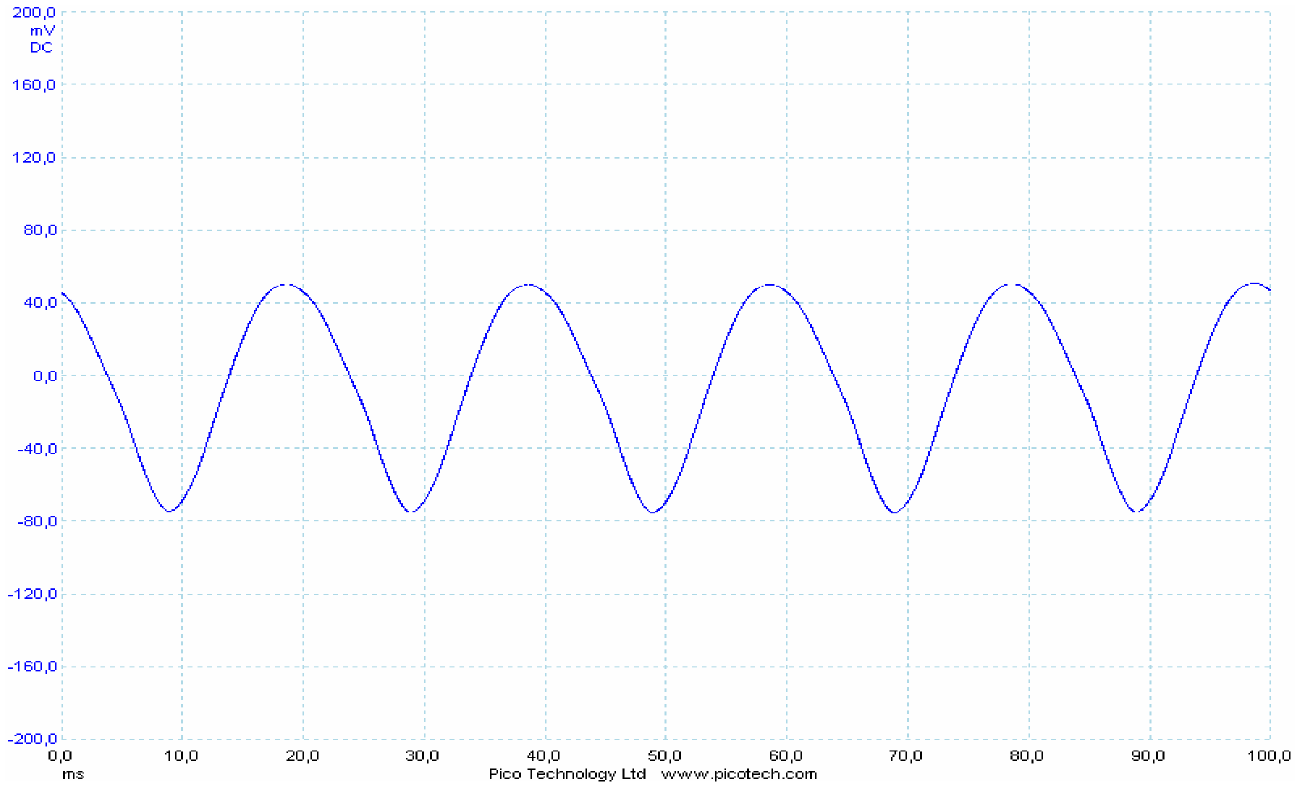
AC magnetic fields
at the power frequency of 50 Hertz (Hz), typical for light bulbs and appliances:

Field strength (blue) in nanotesla (nT)   PC standard TCO (green) = 200 nT (30 cm)

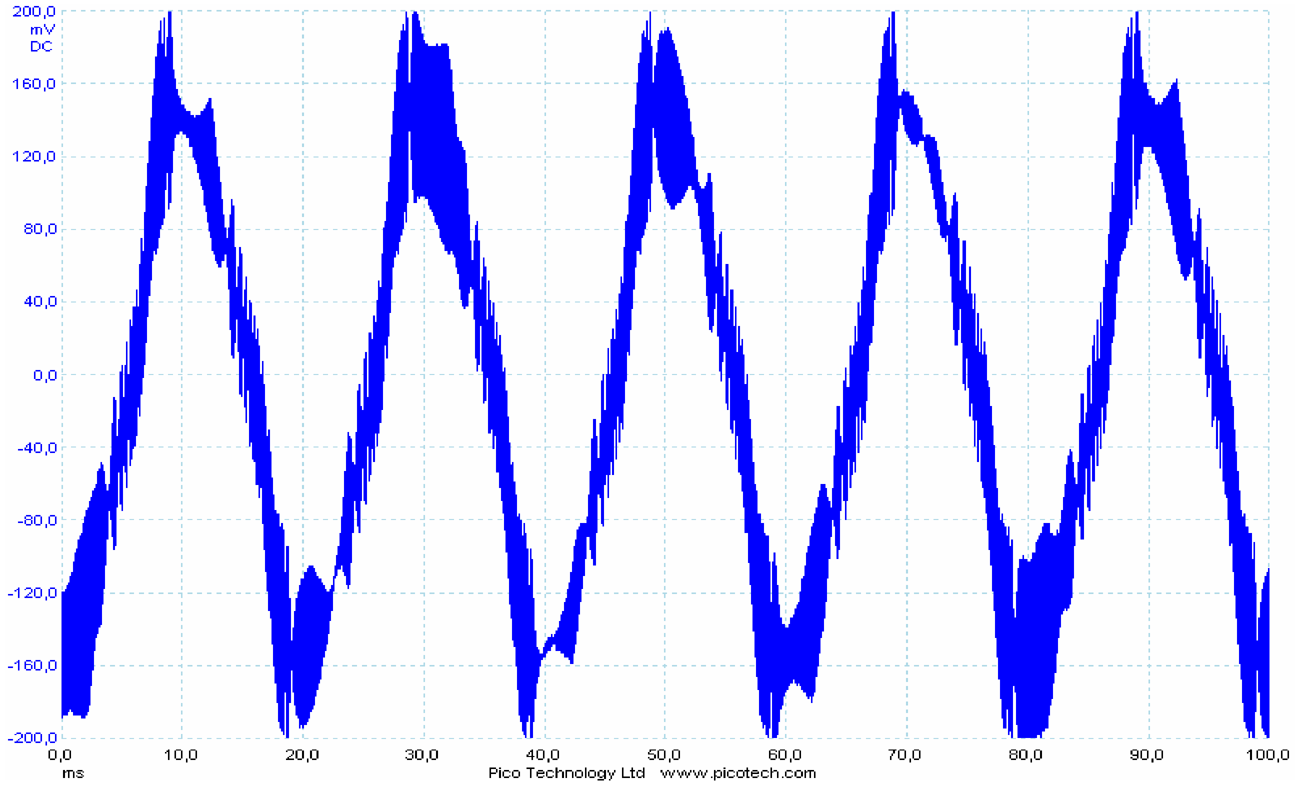


It is not only the intensity of the electromagnetic pollution that is so much worse in CFLs, but especially also the field quality: tones of spurious signals, harmonics, "dirty electricity", and that from both electric as well as magnetic fields. The sine waves displayed by the oscilloscope graphs below show the distortions very clearly. In the case of CFLs, we can hardly speak of a sine wave anymore; it is distorted so much.

Sine waves of electrosmog in light bulbs are relatively balanced, harmonious - a sample graph of Osram Classic 60 Watt:

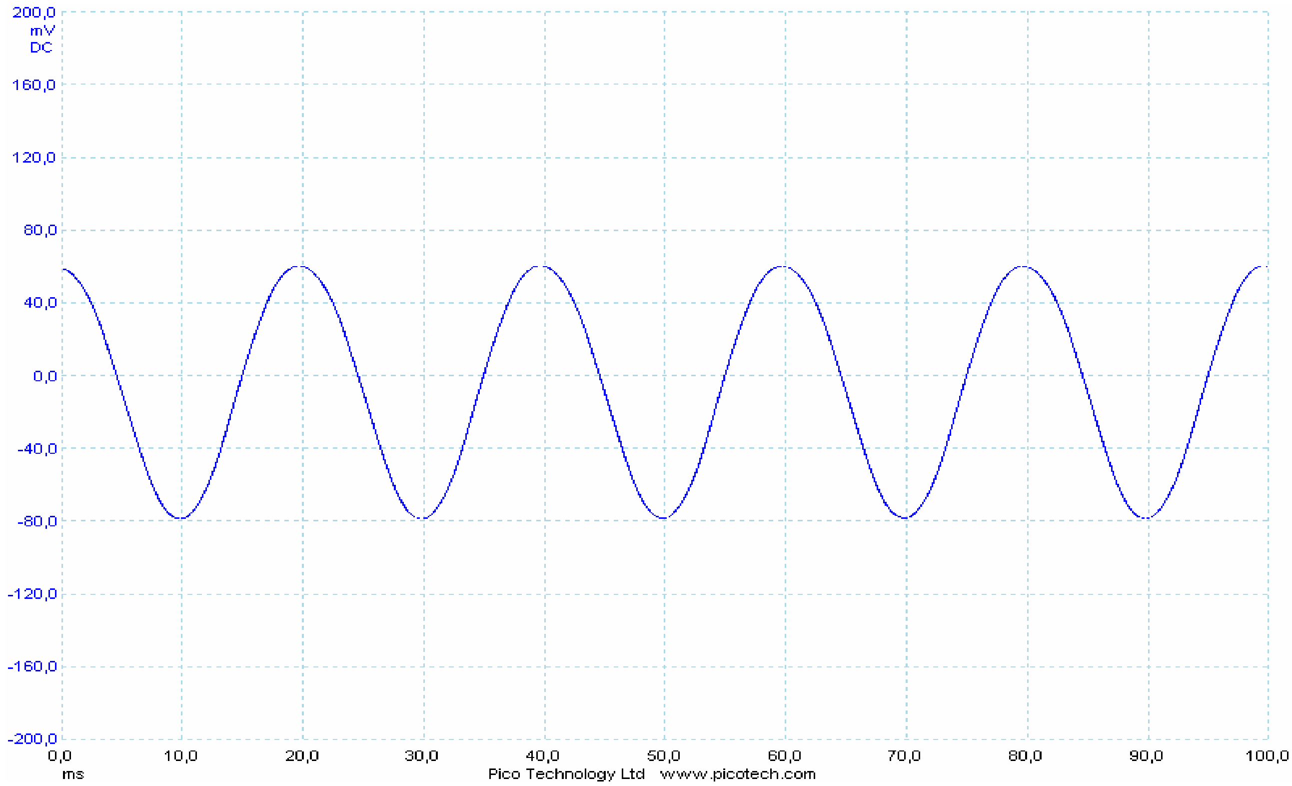


"Sine waves" of electrosmog in CFLs are completely distorted, disharmonious, "dirty" - a sample graph of Osram Deluxe 12 Watt:

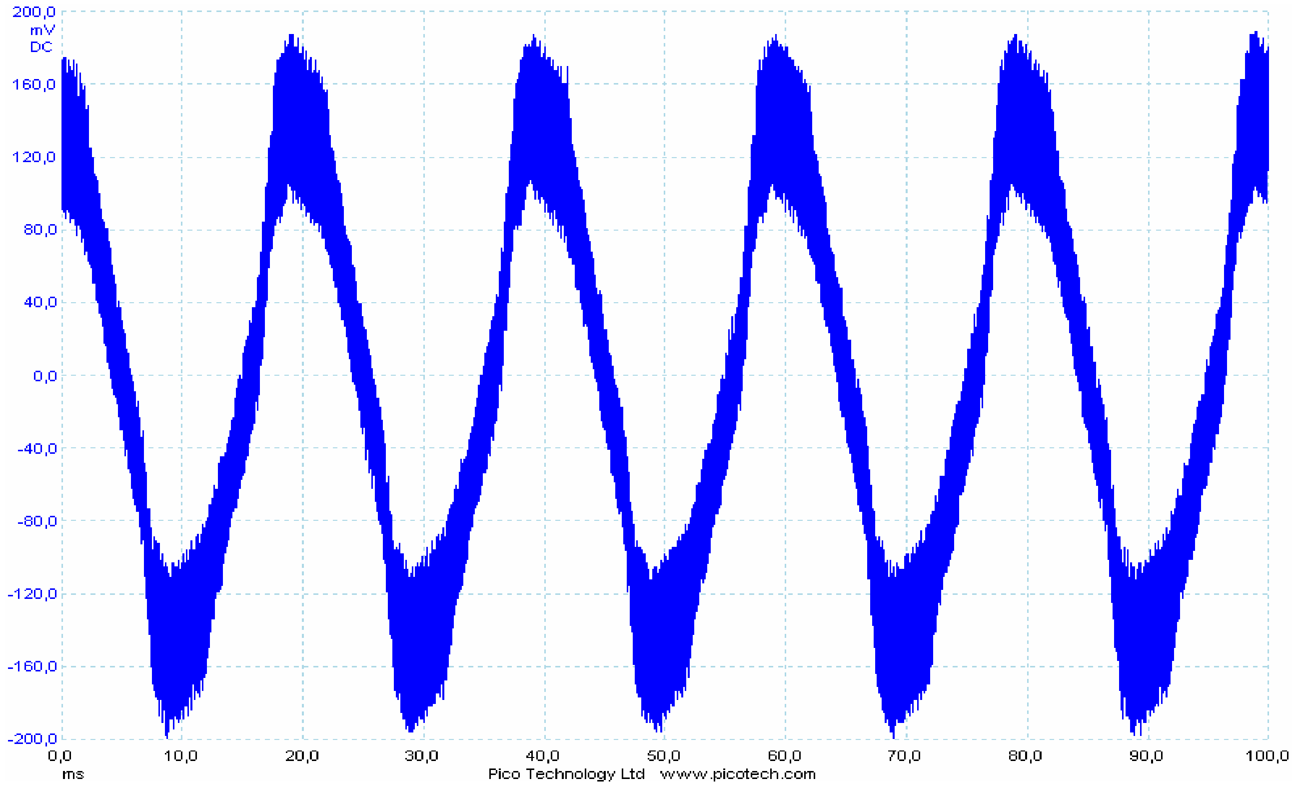


Here is another set of oscilloscope graphs, showing electrosmog sine waves of a typical halogen lamp and a CFL. The curve of the halogen light is almost identical with the one of the incandescent light. The power-frequency fields contain very little harmonic distortions or other interferences. Quite different from the CFL, here we see again - as always - considerable amounts of harmonic frequencies and distortions.

Sine wave of electrosmog in halogen lamps balanced similar to light bulbs - a sample graph of Osram Halogen Classic Energy Saving 42 Watt:

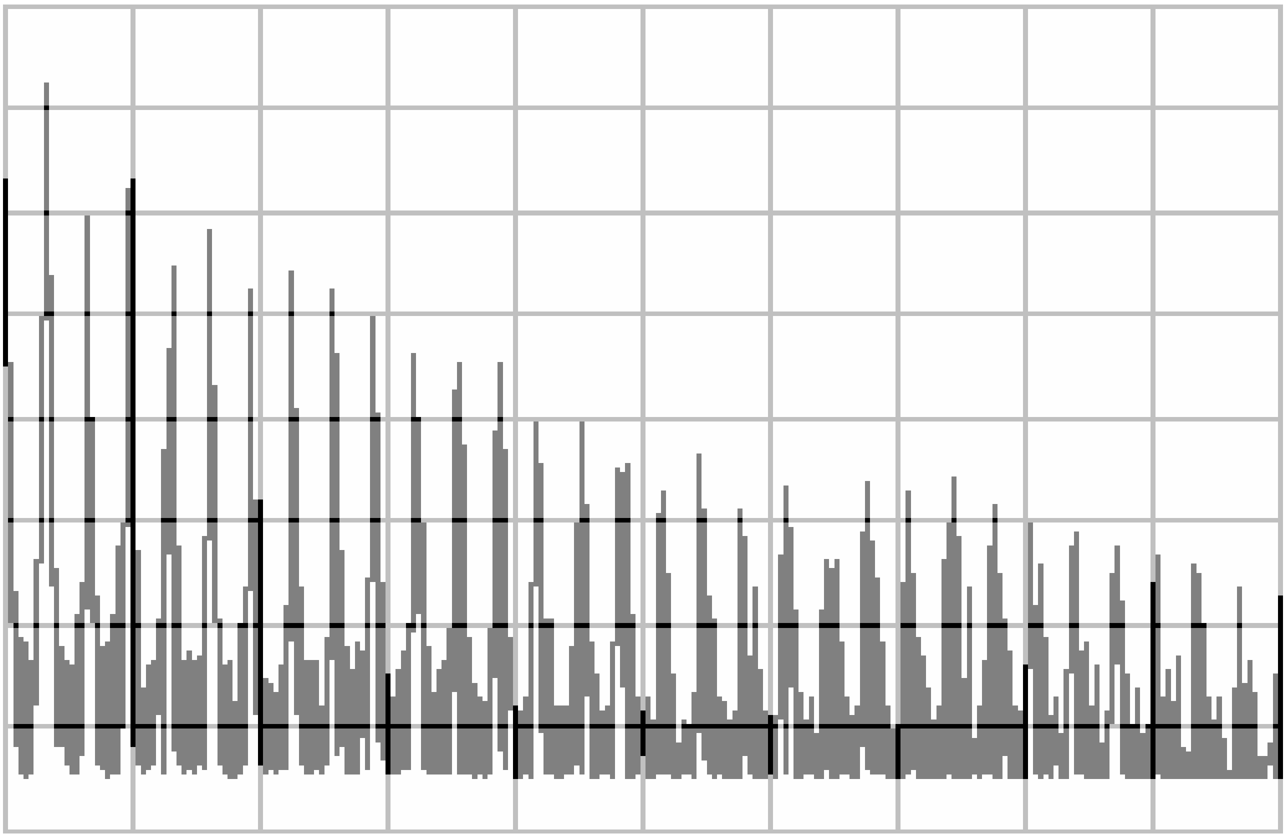


"Sine waves" of electrosmog in CFL are - as always - distorted, slanted, steep, frayed - a sample graph of Luxxx 11 Watt:

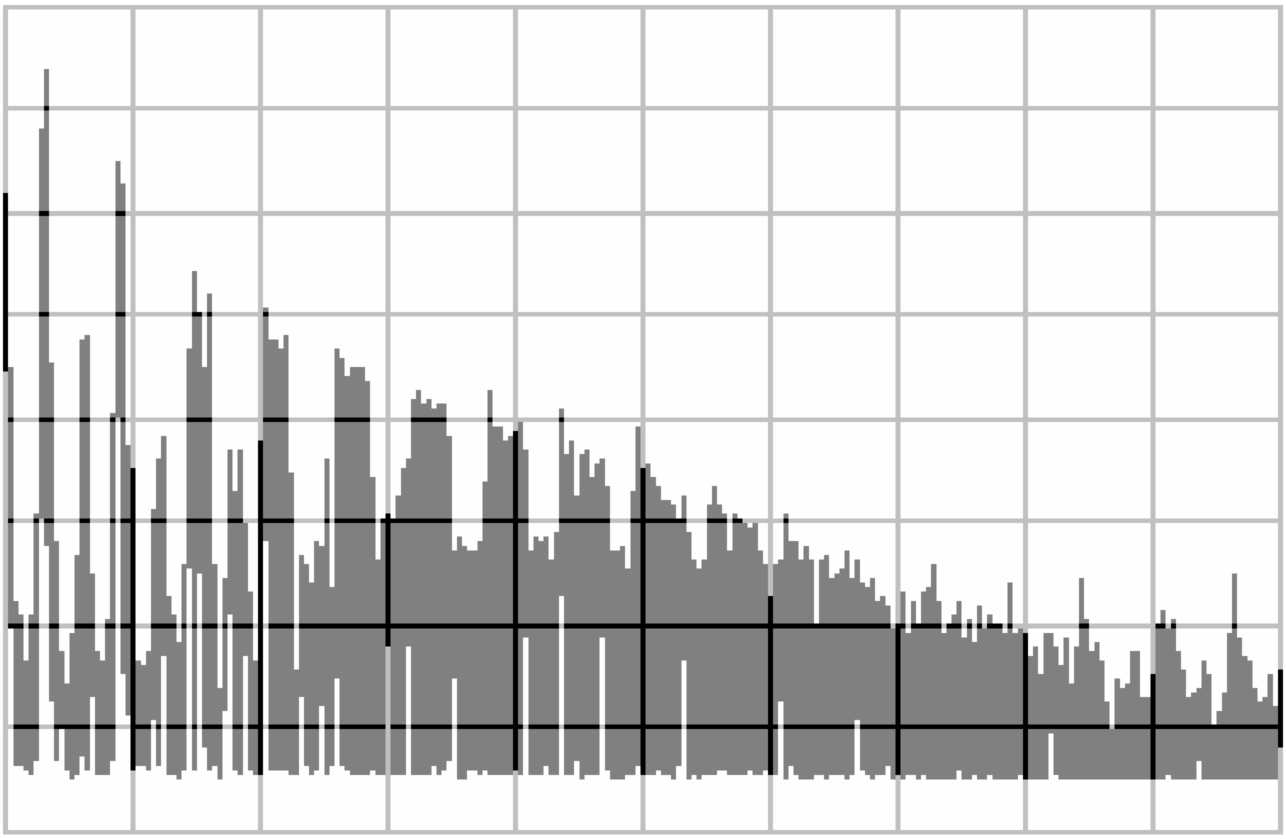


Typical for a CFL: Electrosmog with a high percentage of harmonics. Incandescent lamps do not have that; they would only show a straight line through zero.

Harmonics are plentiful in CFLs, up into the megahertz range, shown here is a sample spectrum analysis up to 1 MHz of Megaman 11 Watt:



And another spectrum analysis showing frequencies up to 3 MHz, this time of the CFL Swiss Lights 10 Watt:



And one more electrosmog problem only known to energy-saving lights: pulsed 100-Hz frequencies, predominant and steep due to the electronic ballast with its higher operating frequency (below 31 kHz). A CFL, therefore, also emits this pulse-modulated signal, which we know from DECT cordless phones.

Spectrum analysis of 100-Hz frequencies, a sample graph of Luxxx 11 Watt:

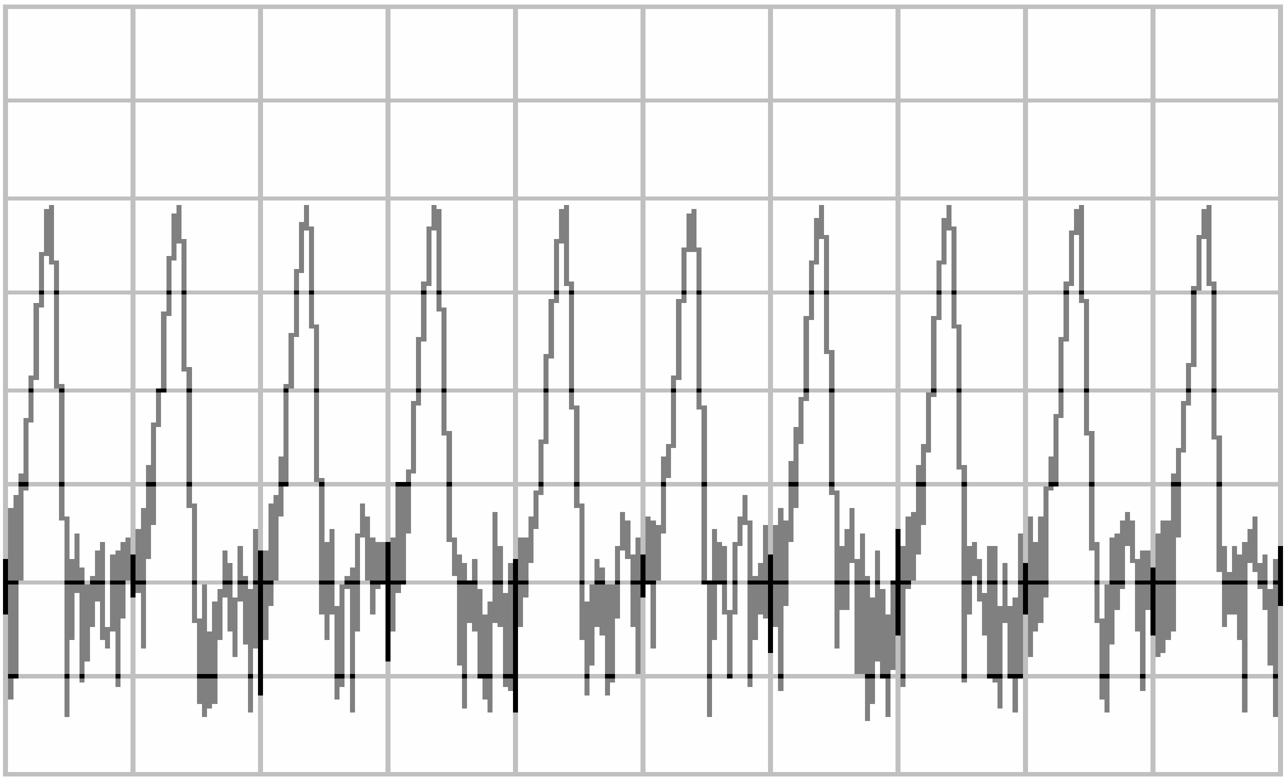
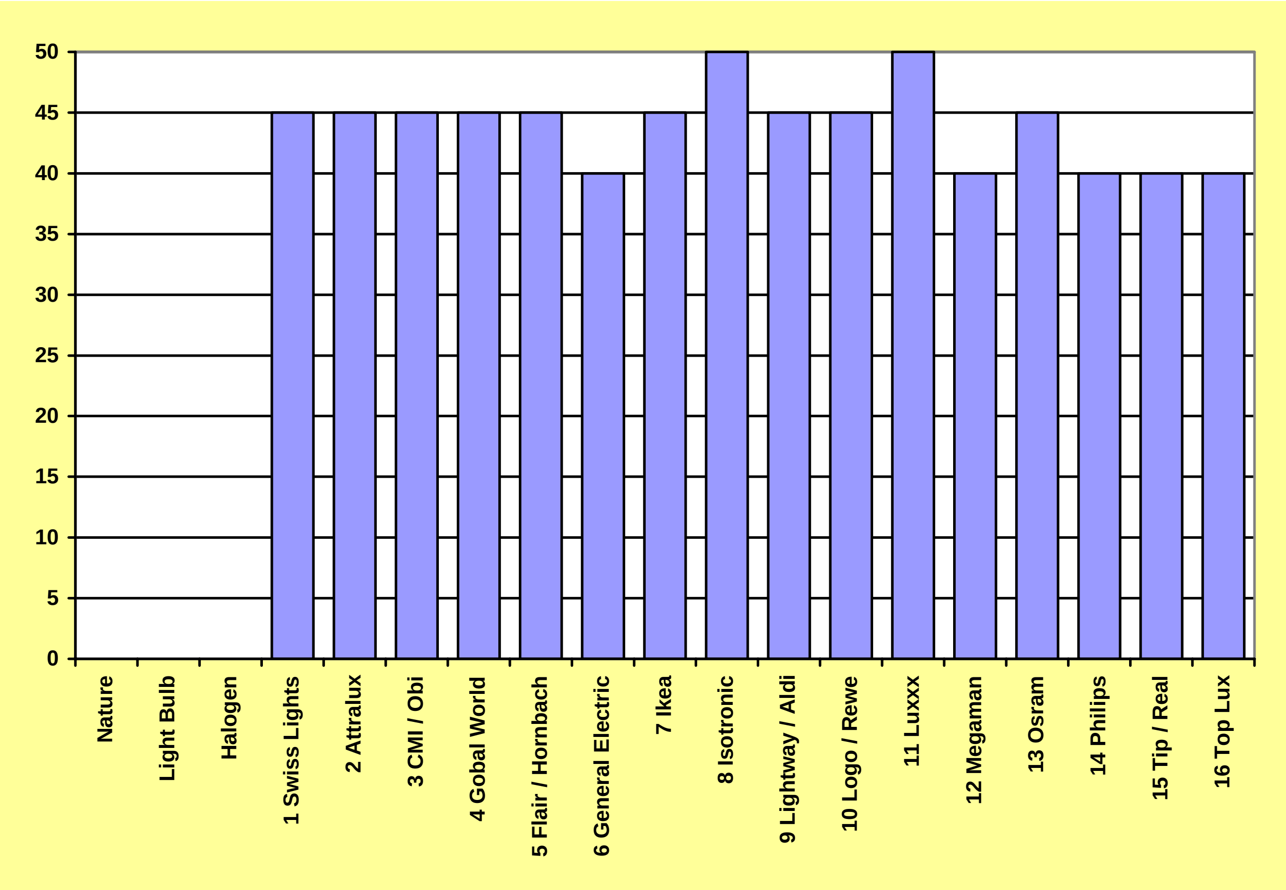
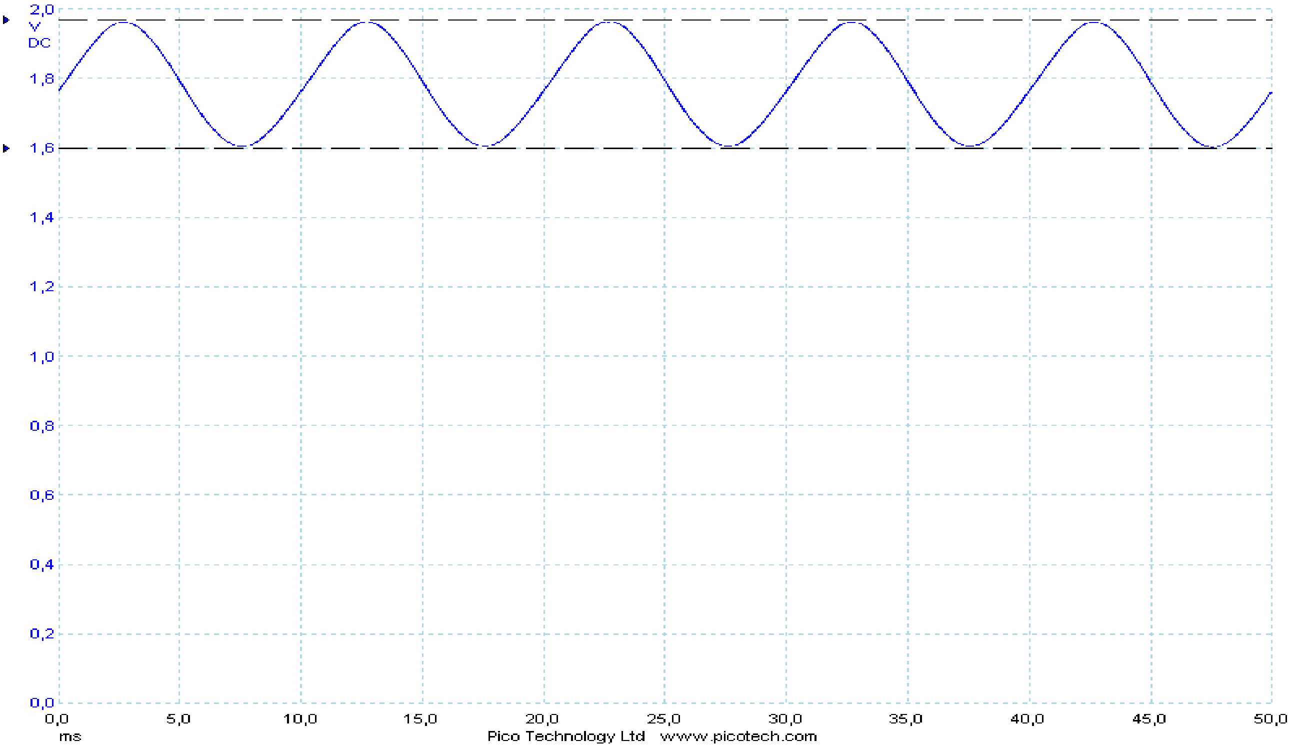


Diagram of 100-Hz pulse peaks, intensity shown in decibel (dB):

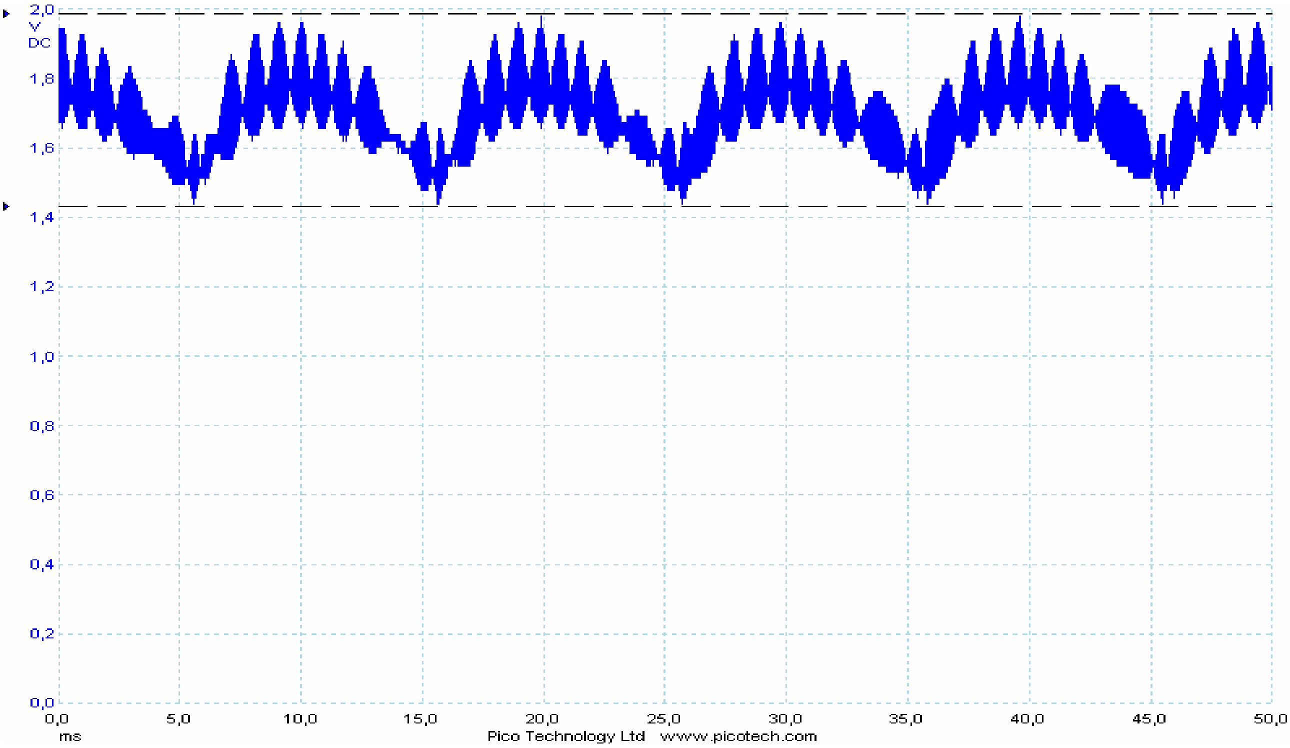


Let's focus on the light quality: The CFL-light flickers a lot, both at the lower frequencies of the power grid (100 Hz resp. USA 120 Hz) as well as at the higher frequencies of the electronic ballast (40 kHz and higher). The flickering light is packed with interfering frequencies, harmonics, "dirt" - similar to the one of the electrosmog. In contrast, bulbs and halogen lamps flicker far less, much weaker, much "cleaner", and this only because of the power frequency. Depending on the wattage, the flicker percentage in bulbs and halogen lamps amounts 5-20%, in newer CFLs around 20-50 %, in older CFLs up to 70%.

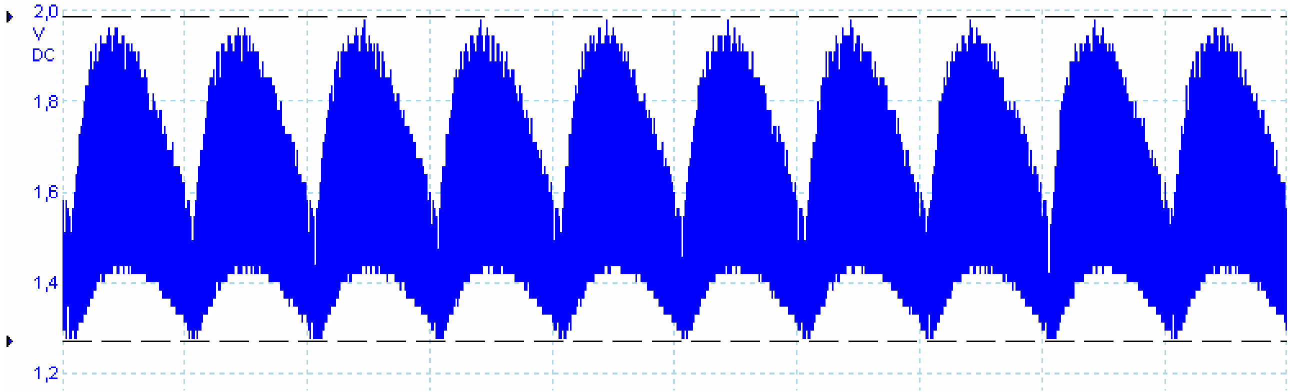
Sine wave of light flicker in bulbs and halogen lamps quite balanced, harmonious - a sample graph of Osram Classic 60 Watt (flicker percentage 18 %):



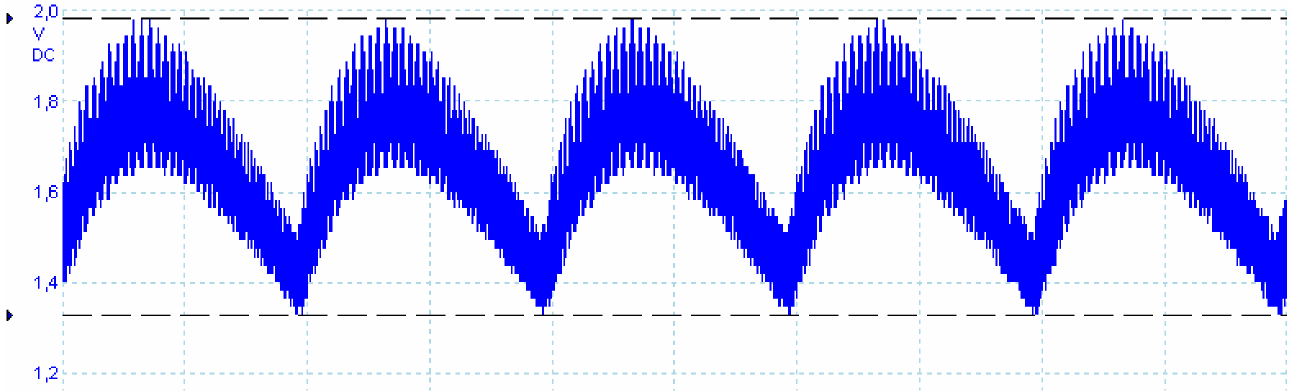
"Sine wave" of light flickers in CFLs completely distorted, disharmonious, "dirty" - a sample graph of Tip 10 Watt (flicker percentage 28 %):



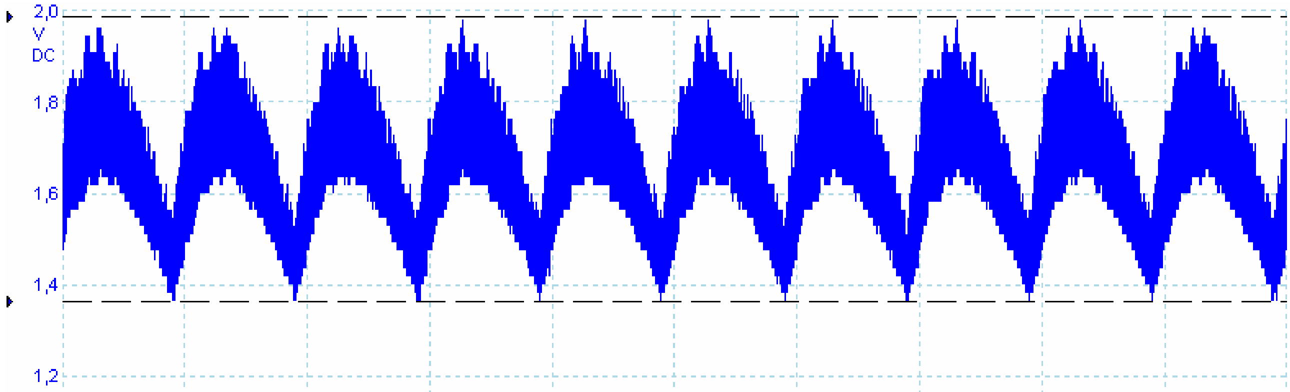
Four additional oscilloscope examples on the distinct low- and high-frequency light flicker in energy-saving lamps:



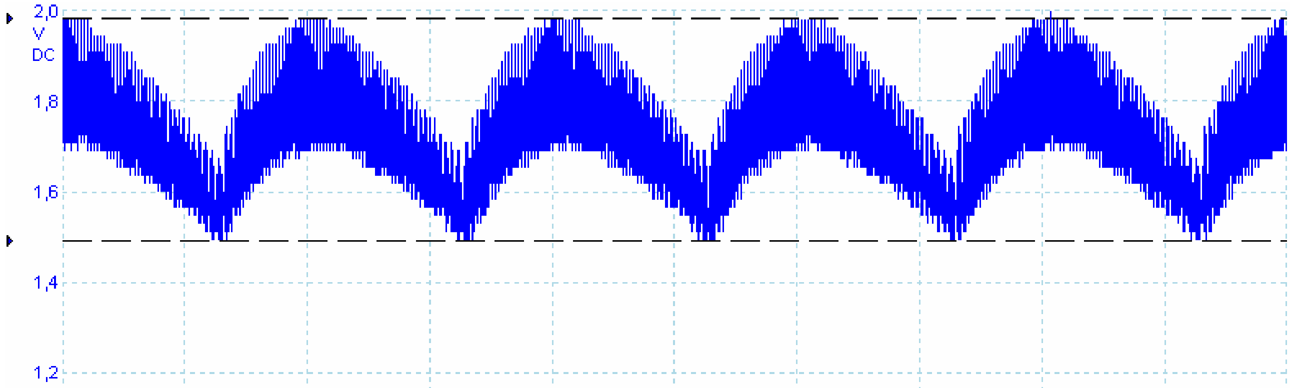
Attralux 11 Watt (flicker percentage 36 %)



Global World 11 Watt (flicker percentage 33 %)

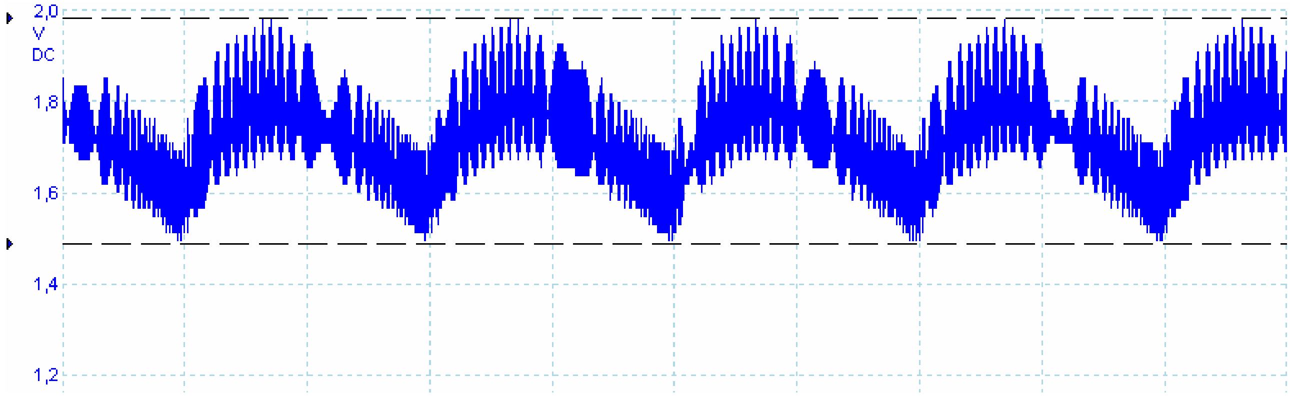


Logo / Rewe 11 Watt (flicker percentage 31 %)

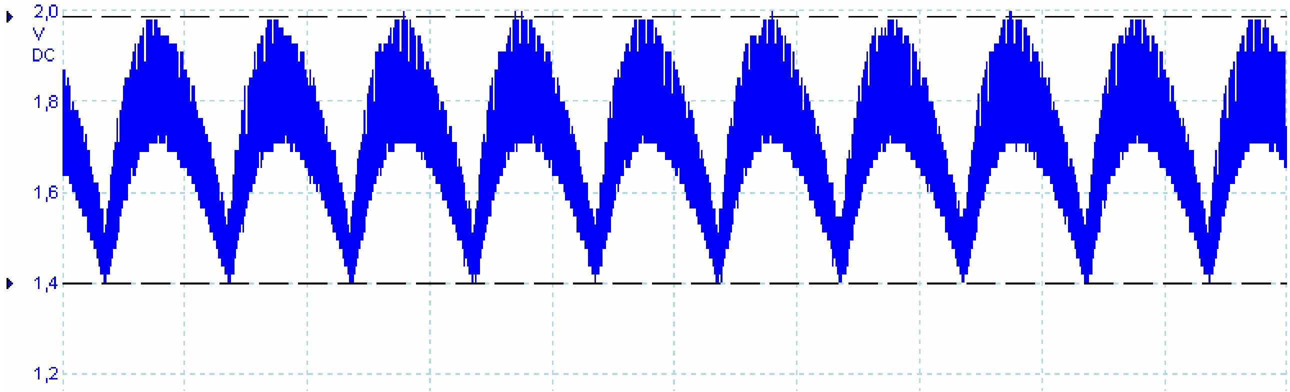


Top Lux 11 Watt (flicker percentage 25 %)

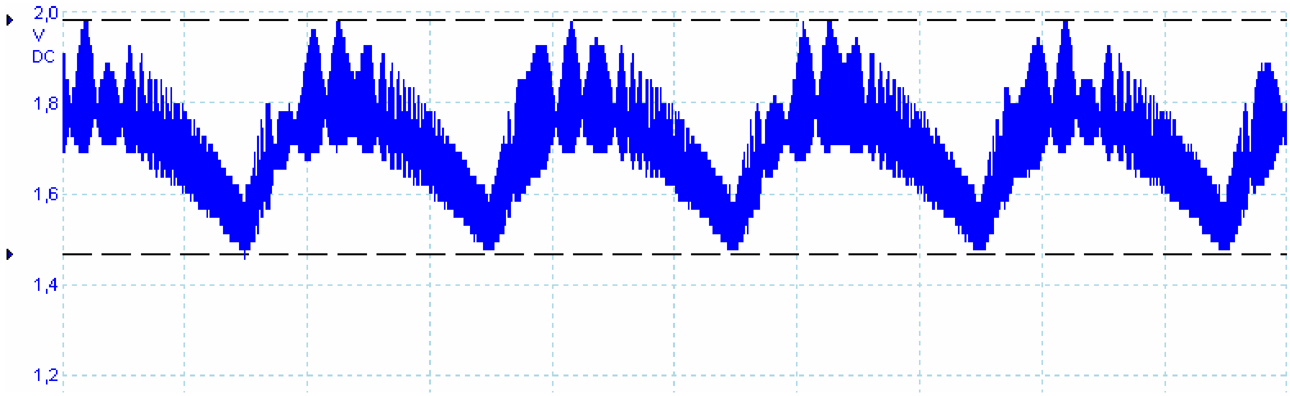
And four more oscilloscope graphs on the low- (power grid) and high-frequency (electronic ballast) light flicker in CFLs:



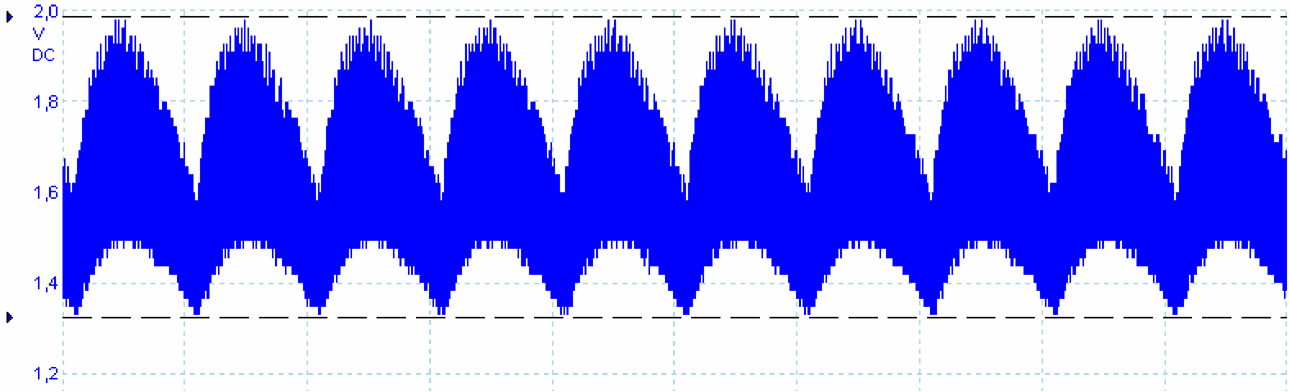
CMI / Obi 11 Watt (flicker percentage 25 %)



Ikea 11 Watt (flicker percentage 30 %)



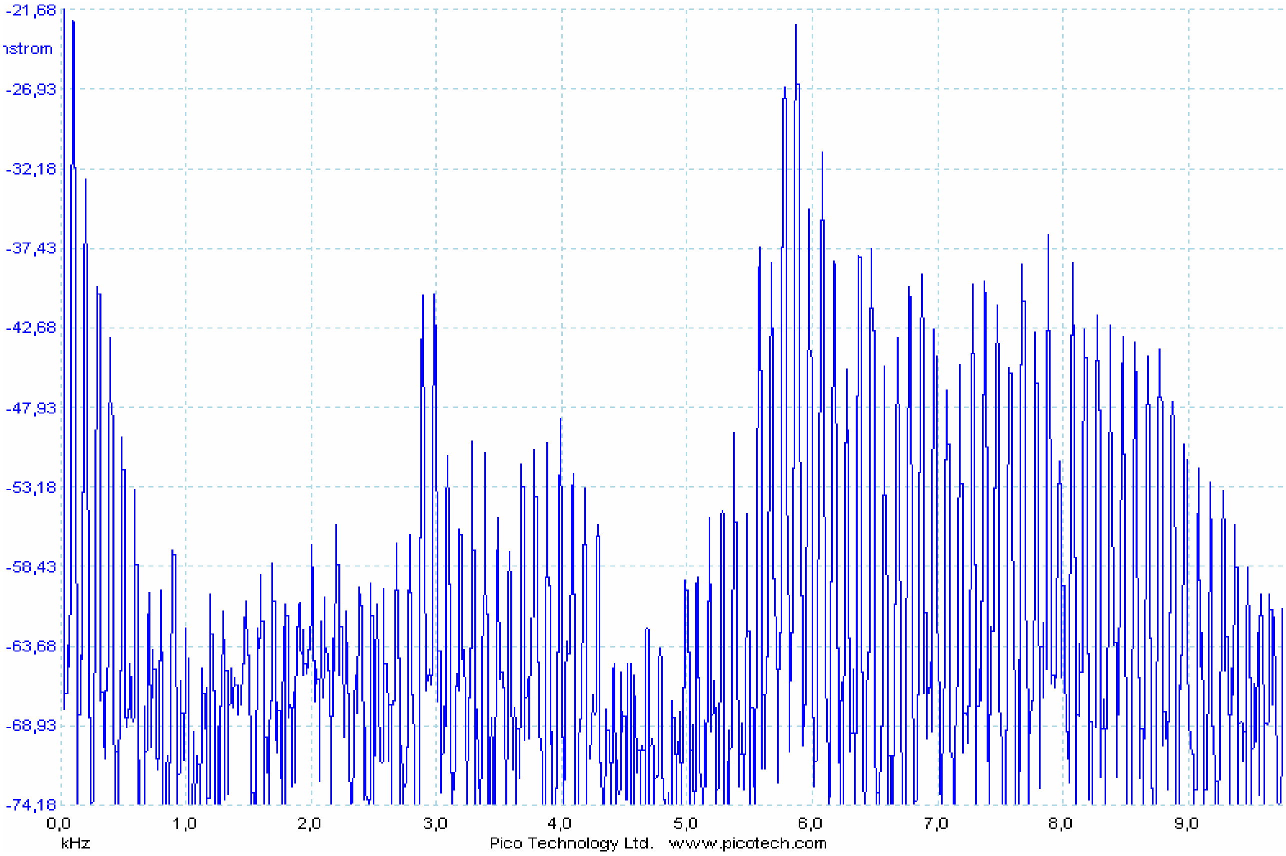
Isotronic 11 Watt (flicker percentage 26 %)



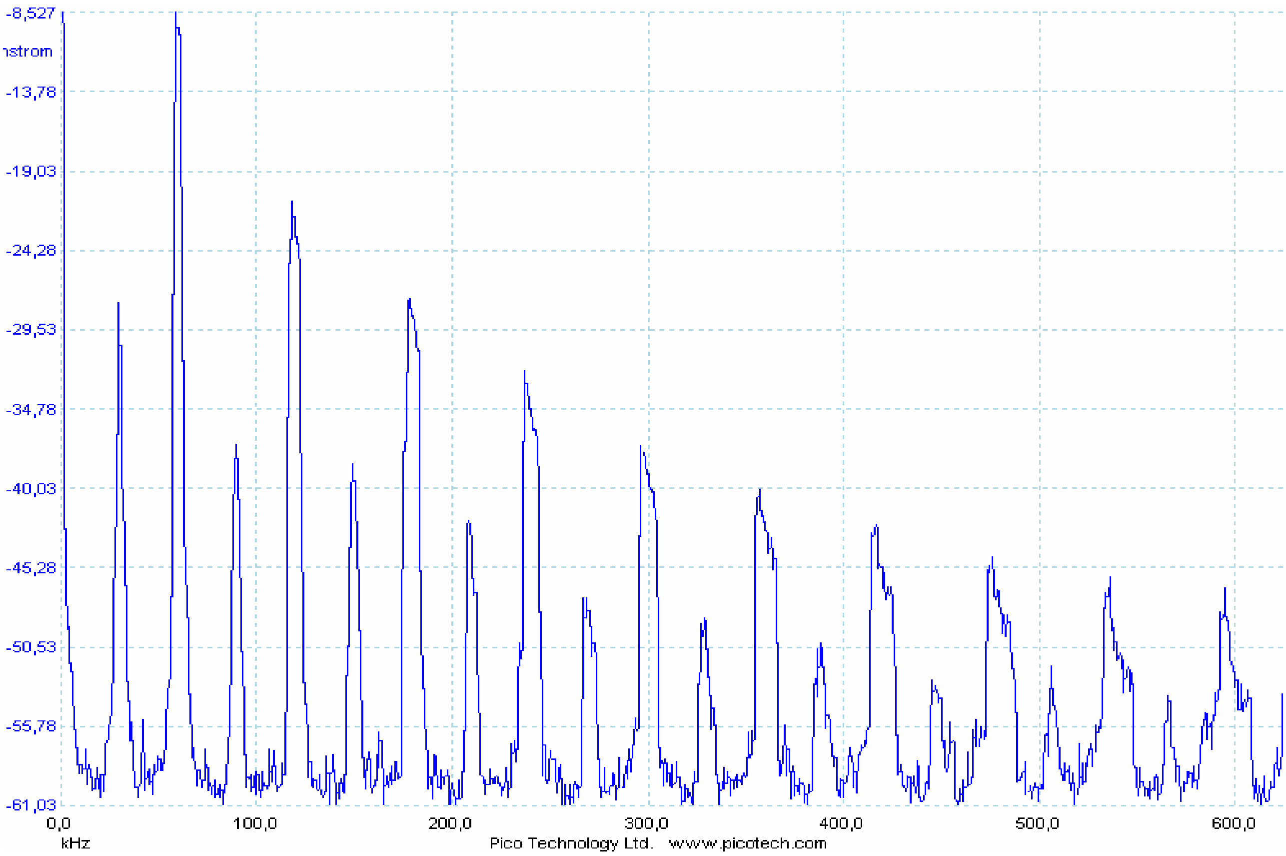
Megaman 11 Watt (flicker percentage 33 %)

No incandescent lamp looks like this, only CFLs: numerous, distinct, seemingly never-ending light "harmonics" that are a part of the "dirt light", similar to the nerving distortion factor in acoustics.

Light spectrum 0-10 kHz due to the power frequency - a sample graph of Ikea 11 Watt:

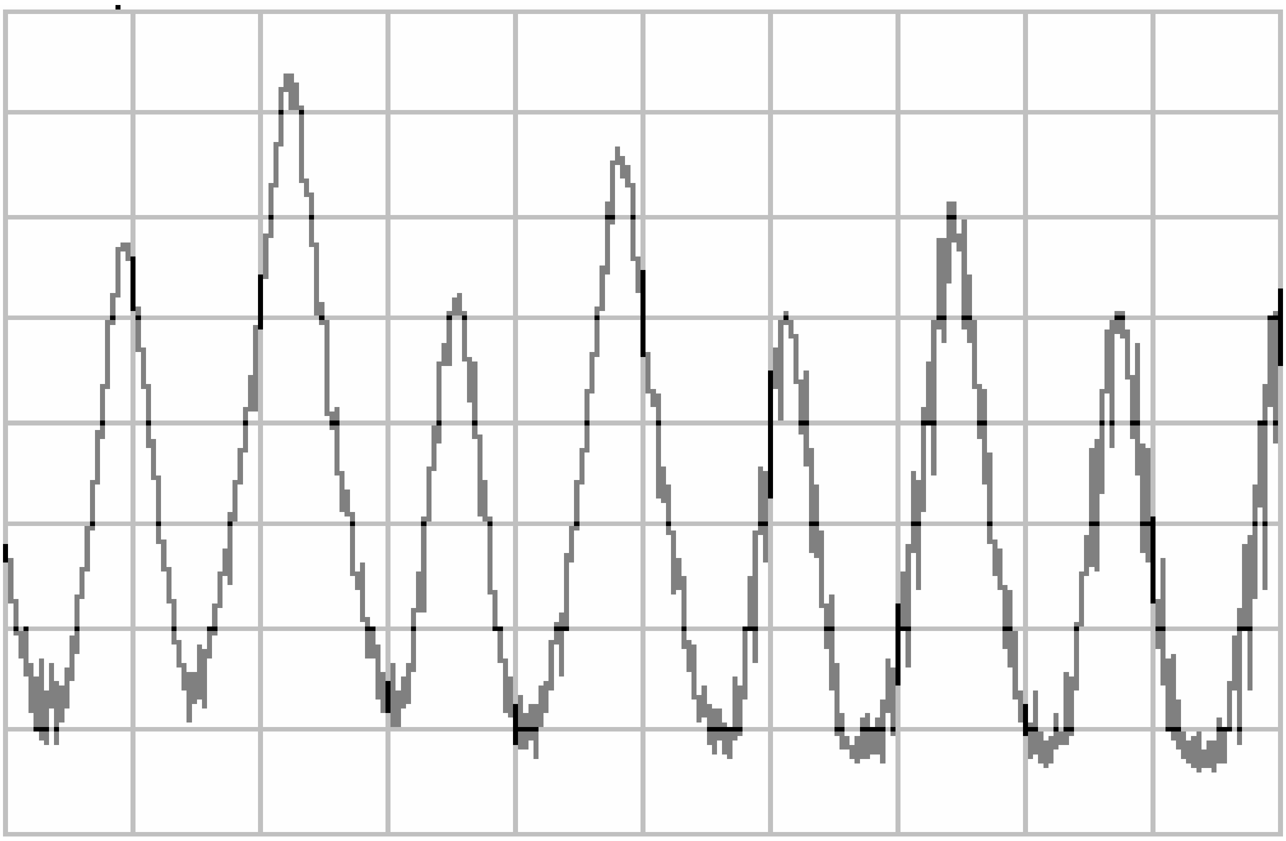


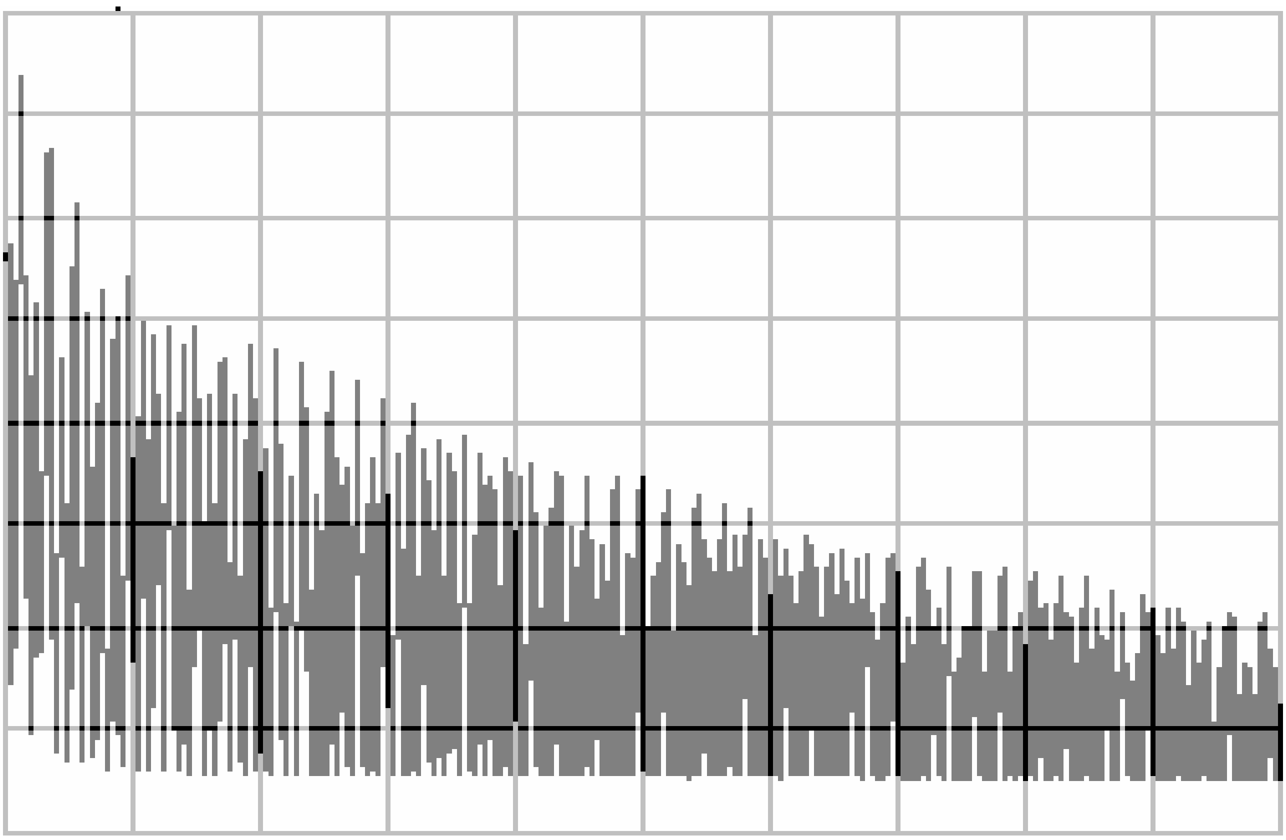
Spectrum 0-600 kHz due to ballast frequencies - a sample graph of Philips 11 Watt:



Like electrosmog, like light: typical energy-saving lamps, flicker with lots of interfering signals, frequency spikes and harmonics. Time and again, it is said that there would be no flicker at the higher frequencies of the electronic ballast. But this is not so; here is our evidence to the contrary.

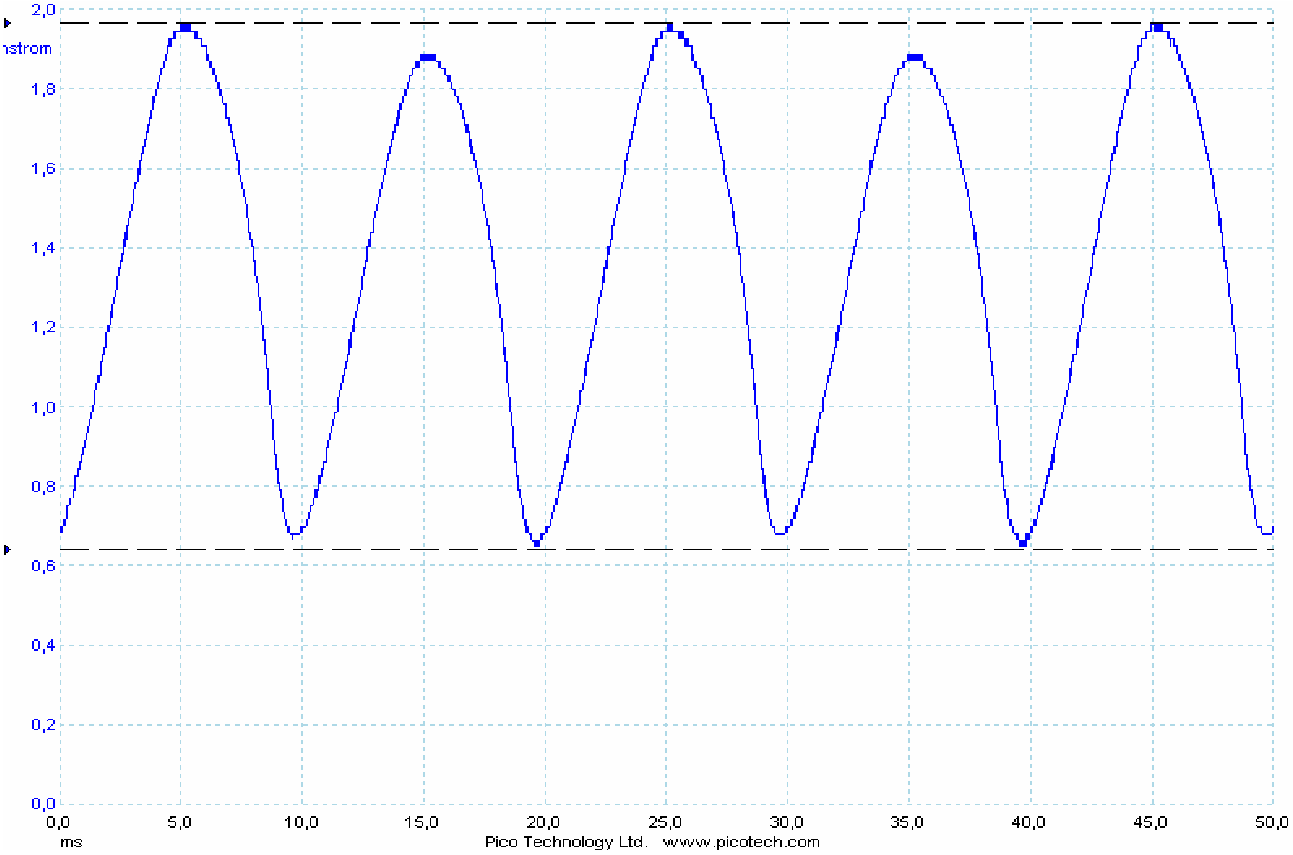
Light flicker in CFLs due to the electronic ballast, harmonics across the entire kHz range (first spectrum up to 200 kHz), but also up into the MHz range (second spectrum up to 3 MHz). The graphs below show the flicker of an 11-watt CFL by Philips:



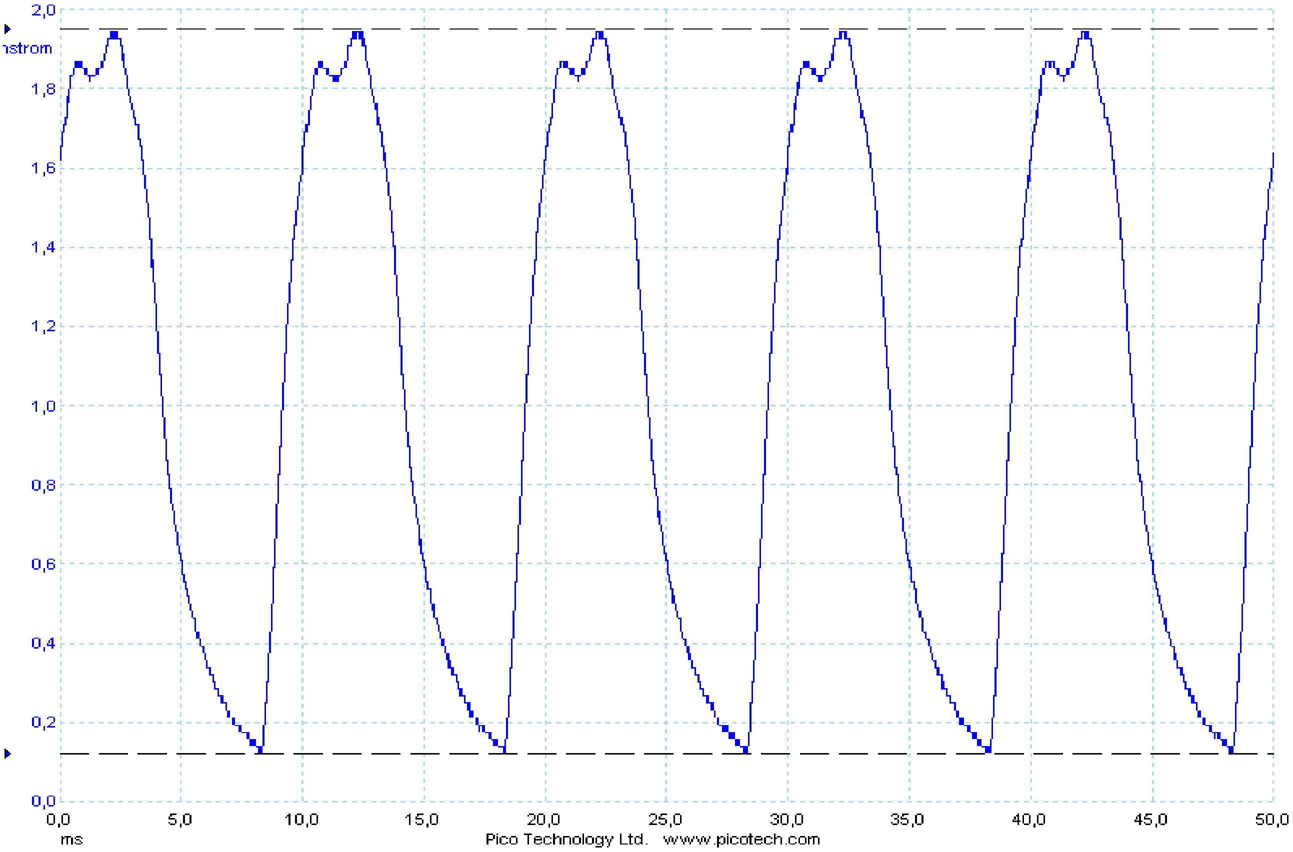


Here are two very intensely flickering lighting sources:

Sine wave of light flicker of an older CFL by Philips Type SL18 18 Watt (dominant flicker frequency 100 Hz, flicker percentage 67 %):



"Sine Wave" of light flicker of a modern LED lamp called Spot Galaxy 24 1.7 Watt (dominant flicker frequency 100 Hz, flicker percentage 92 %):



And as a last aspect: **Temperature** of luminaires and their **Brightness**

The temperature does not stay quite as cool on the surface of the energy-saving lamps (first column).

And in real life, most of the CFLs do not reach the light intensity levels (second column) as promised, as if an 11-watt CFL would be equivalent with a 60-watt incandescent lamp. Swiss Lights, with over 10 euros the most expensive CFL of the test, was very miserly with its light; it achieved only 34%, a third of the advertised level of brightness.

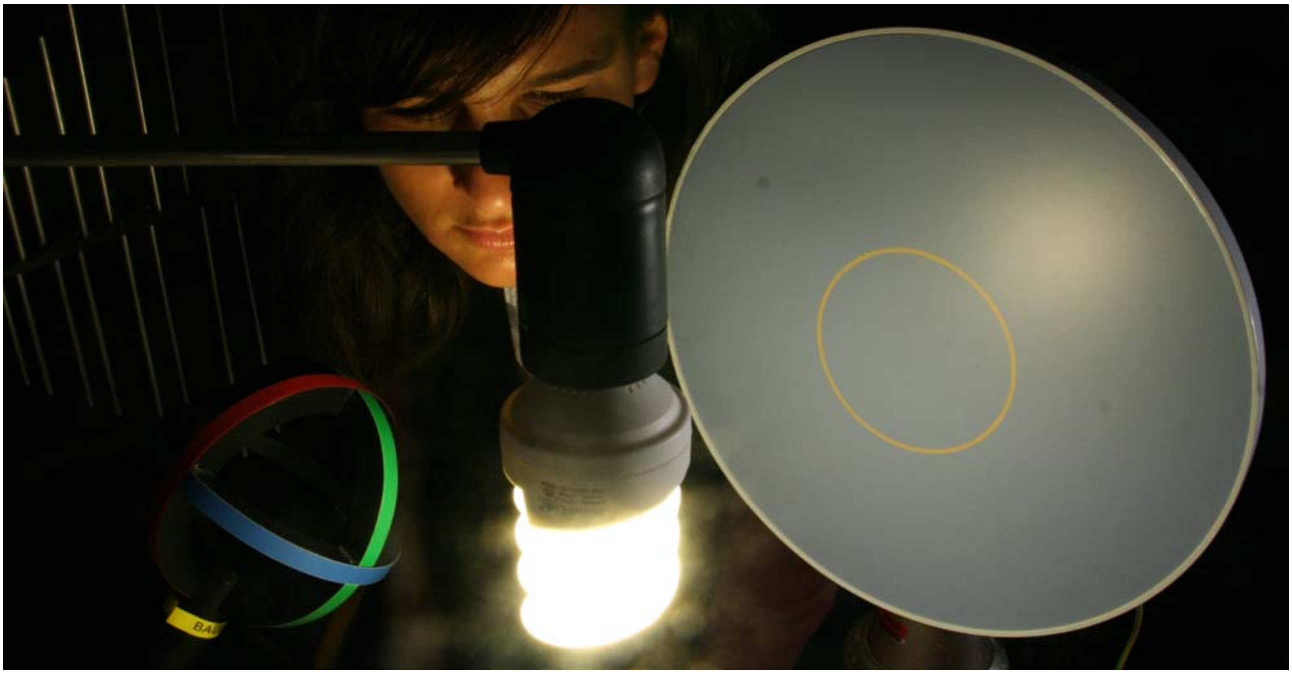
	Manufacturer		**Temperature of lamp surface of glass bulb in degrees Celsius**	**Illuminance level in reflector-style desk lamp Measurements taken at 50 cm below in Lux**	
	Osram light bulb	60 W	**180 °C**	**Reference 100 %**	**1150 lx**
	Osram halogen	42 W	**130 °C**	**96 %**	**1100 lx**
1	Swiss Lights	10 W	**65 °C**	**34 %**	**390 lx**
2	Attralux	11 W	**80 °C**	**76 %**	**870 lx**
3	CMI / Obi	11 W	**85 °C**	**72 %**	**830 lx**
4	Global World	11 W	**75 °C**	**53 %**	**610 lx**
5	Flair / Hornbach	11 W	**65 °C**	**48 %**	**550 lx**
6	General Electric	11 W	**90 °C**	**87 %**	**1010 lx**
7	Ikea	11 W	**75 °C**	**57 %**	**660 lx**
8	Isotronic	11 W	**75 °C**	**59 %**	**670 lx**
9	Lightway / Aldi	12 W	**85 °C**	**66 %**	**760 lx**
10	Logo / Rewe	11 W	**85 °C**	**57 %**	**650 lx**
11	Luxxx	11 W	**65 °C**	**61 %**	**700 lx**
12	Megaman	11 W	**90 °C**	**70 %**	**800 lx**
13	Osram	12 W	**85 °C**	**102 %**	**1170 lx**
14	Philips	11 W	**85 °C**	**88 %**	**1020 lx**
15	Tip / Real	10 W	**90 °C**	**73 %**	**840 lx**
16	Top Lux	11 W	**80 °C**	**52 %**	**600 lx**

Always keep in mind:
Many CFLs smell bad - **toxins**.
All of them screech - **ultrasound**.

Not to mention the poor **light spectrum**, the bad **color rendering**, the high percentage of **UV** and **blue** light, the often limited **life span**, the more costly **manufacturing**, toxic **components**, highly toxic **mercury**, the debatable **disposal**, also the dubious **protection** in case of a broken lamp, **interfering signals** and **net currents**, **dirty electricity**, **life cycle assessment**, **cost**, etc.

Measuring Equipment Used for the CFL **Testing:**

Electric Field Meter EMM-4, 5 Hz - 400 kHz (Radians Innova, Sweden)
Magnetic Field Meter BMM-3 und BBM-5, 5 Hz - 400 kHz (Radians Innova, Sweden)
Spectrum Analyzer Advantest R3131, 10 kHz - 3 GHz (Rohde&Schwarz, BRD)
Oscilloscope Fluke Scopemeter 196B, 0 Hz - 200 MHz (Fluke, USA)
PC-Oscilloscope PicoScope 2203, 0 Hz - 5 MHz (Pico Technology, UK)
Field Meter FM10, 5 Hz - 400 kHz (Fauser Elektrotechnik, BRD)
Field Meter EMT 3951A TCO, 5 Hz - 400 kHz (Gigahertz Solutions, BRD)
Field Meter EM1, 5 Hz - 400 kHz (Merkel Messtechnik, BRD)
Loop Antenna HFS1, 250 kHz - 80 MHz (Merkel Messtechnik, BRD)
E-Field Probe Active Dipole EFS 9218, 9 kHz - 300 MHz (Schwarzbeck Elektronik, BRD)
Digital-Analog-Multimeter Fluke 83 und Fluke 87 (Fluke-Philips, USA/BRD)
Silicium-IC-Photodiode TAOS TSL252R, 0 Hz - 200 kHz (Texas Optoelectronic, USA)
Silicium-PIN-Photodiode SFH 203, 0 Hz - 200 MHz (Osram / Infineon Technologies, BRD)
Solar Mini Panel 3V (Conrad Electronic, BRD)
Light Meter Lux-Meter 0500 (Testo, BRD)
Digital Luxmeter MS-1500 (Conrad Electronic, BRD)
Energy and Output Meter EPM 3022 (Conrad Electronic, BRD)
Infrared Laser Thermometer Raynger MX4+ (Raytek, USA/BRD)
M-light und Light-Fox Prototypes for Flicker Frequencies (Merkel-Messtechnik, BRD)
Self-Made Prototypes for Testing Flicker Frequencies (Honisch, Danell, Maes)



All pages translated by Katharina Gustavs, Canada (www.buildingbiology.ca)

Please also see the following German publications for further details:

Report "Hinters Licht geführt: Energiesparlampen - Das Ende der Glühbirne, das Ende gesunder, naturnaher Beleuchtung?" in 'Wohnung+Gesundheit', issue 133/2009

Report "Glühbirne raus, Energiesparlampe rein - Moment mal..." in 'Wohnung+Gesundheit', issue 124/2007

30-page collection of critical quotes, additional information and commentaries on energy-saving lamps (www.maes.de, www.baubiologie.de)

Report "Energiesparlampen ... keine Leuchten" in 'Öko-Test', issue 10, October 2008