Smart Meter – and many open questions

Smart Meter for electricity, gas, and water is intended to create the precondition for transparence of used electricity, gas and water without additional personal (meter reading at site).

European Union

With the EU-directive 2006/32/EG for energy efficiency and energy services from 5. April 2006 the EU has decided, that in all member states, if technically possible, financially justifiable and compared with the energy savings appropriate, every end customer should get individual counter for electricity, gas district heating/district cooling for a competitive price, which show the exact usage volume and usage time.

Germany

In Germany Smart Meter are not obligatory yet – only new buildings and total restorations have to get a smart meter according to § 21b Abs. 3 EnWG.
From 2020 on >80% of all households have to be equipped with smart meter.

The network operator is responsible for that. He has to offer minimal solutions confirming to the law for his customers (§ 21b Abs. 3b EnWG).The lawful minimal solutions only contain the basic function to show the energy use and usage time. A remote readout is not necessary here.

Since 2005 metering has been liberated in Germany.

Until 2020 over 80% of all EU house holdings should be equipped with the „new“ smart meter and the „old“ Ferraris-meters banned from usage.


Smart Meter

Ferraris - Meter

The new kind of measuring the usage brings many questions for the users. It is not clear what data are measured and for what these data are used. Another aspect is the reliability of those accountings. There have been cases where the usage increased up to 20% when counter has been changed to smart meter (without having a real increase in usage)

On the other side feed-in remuneration has decreased after changing to smart meter.

Energy suppliers actually do not really care about this problem. They assume that smart meter manufacturer will take care of this problem. Actually it is also not really relevant, because too less SM

are used now and therefore the reclamations are not much. And there are also not much messages that SM can switch on and off induction cookers and electronic controlled lights.

What are the reasons for the influence?

In the years 1999 to 2001 well-known manufacturers like Ascon, Siemens, etc. cancelled working in the PLC sector. Sometimes because of unconquerable technical problems.

Here some German headlines from that time:

- *ASCOM Actually got out of PLC - PLC modem technology economic flop (30.1.2003)*
  PLC-Engagement of RWE finished (6.9.2002)
- *„Off" for PLC in Japan (5.8.2002)*
- *Austria Radio Amateurs warn of consequences of PLC (14.3.2002)*
- *Finnish Minister rejects from PLC - German NB 30 Determination viewed as inadequate (15.8.2001)*
- *Broadcasting service active against PLC - vote for interference-free reception (12.8.2001)*
- *PLC interference can not be further reduced*
- *German radio wave interference from PLC (26.06.2001)*
- *Press release of the German radio eV to PLC (13.8.1999 / 24.3.2001)*
- *South West (SWR) confirmed interference from PLC (26.7.2000)*
- *PLC disorders: ARD for tighter restrictions (11.5.2000)*
- *PLC disrupts radio and other wireless services*
- *PLC fails to abide by limits (NTZ, issue 3/99)*

What has changed, so everything that had been insoluble 10 or 12 years ago works fine now? Have the problems disappeared of their own?

Quite the contrary: The problems with the supply grid have increased by the growing use of switching power supplies, frequency converter, solar inverter, induction devices, thyristor controls, and leading edge phase controls and LED clocked lights.

The supply grid problems and the integration of PLC is noticeable, but why is PLC enforced now?

The economic aspect:

What has been 12 years ago today……

- PLC – HAS BEEN USED BY SINGLE COMPANIES LIKE SIEMENS, ASCOM - RWE, POLYTRAX, WHICH ADDITIONALLY HAVE BEEN IN COMPETITION TO EACH OTHER
- NO EU - INTERESTS
- NO DECISION TO EQUIP 80% OF ALL HOUSEHOLDS WITH SMART METER WITHIN 7 YEARS
- NO INTEREST OF MINISTRY OF COMMERCE FOR INTRODUCTION OF PLC
- NO DECISION YET OF THE GOVERNMENT FOR QUITTING ATOMIC ENERGY.

- COSTS OIL PER LITER INCREASES UNTIL 2013 COMPARED WITH 2001 FROM 35,19CT. TO 100,15CT (184,59%) – RISING TREND
- ELECTRICITY COSTS INCREASED UNTIL 2012 COMPARED WITH 2000 FROM 13,9 CT TO 26 CT. = 87,05% - TREND UNTIL 2020 UP TO 65CT. = 367,62%
- NO NEWS ON COMMODITY SHORTAGE.

http://www.unendlich-viel-energie.de/de/detailansicht/article/226/grafik-dossier-strompreis-2013-und-stromkosten-privater-haushalte.html

Bajog electronic GmbH
the EMC specialist

Heizölpreis-Historie

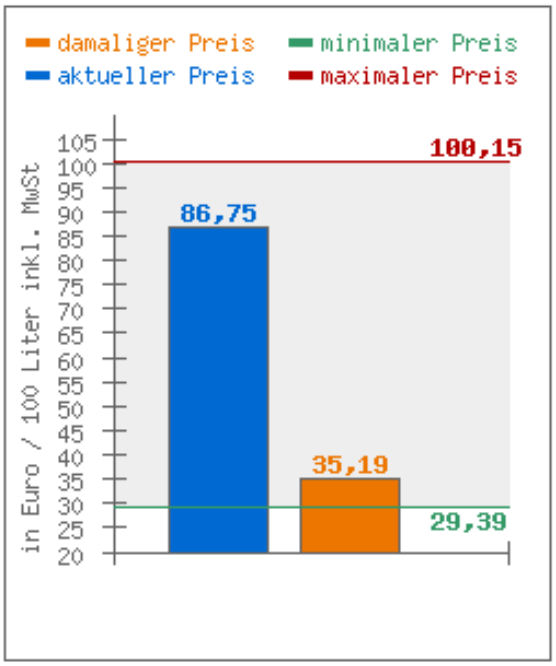
**Wollen Sie wissen, was Heizöl an einem bestimmten Datum gekostet hat?
Sie können Sich das Preisniveau von einem beliebigen Datum ab dem Jahr 2001 ausrechnen.**

Außerdem zeigen wir Ihnen auf, wann in diesem Zeitraum Ihr Heizölpreis seinen Höchst- und Tiefstand hatte. So können Sie sehen, wann Sie besonders günstig bzw. besonders teuer eingekauft hätten.

historischen Heizölpreis berechnen

PLZ 94431
Menge 3000 Liter
Datum 1 1 2001
berechnen

	Nettopreis	inkl. MwSt.	Datum
damaliger Preis:	30,34 €	35,19 €	01.01.2001
max. Preis:	84,16 €	100,15 €	11.07.2008
min. Preis:	25,34 €	29,39 €	17.12.2001
aktueller Preis:	72,90 €	86,75 €	14.01.2013



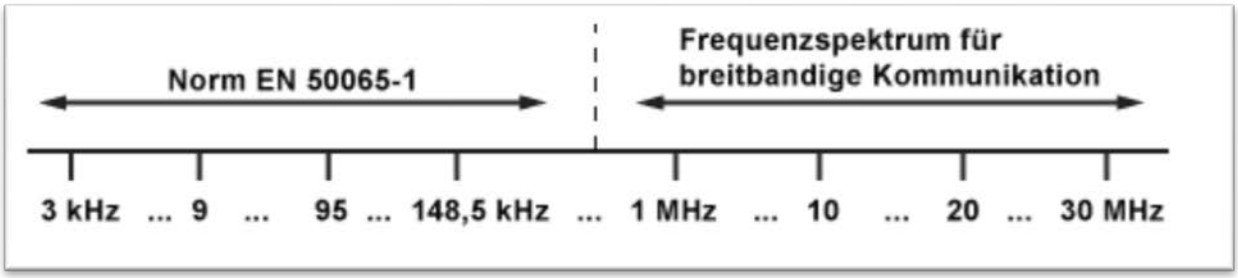
alle Preise in € / 100 Liter inkl. MwSt. für Standardqualität nach DIN 51603-1 bei 1 Abladestelle

The number of new registered cars in China with 3.919.500 each quarter (= 15.780.000 cars each year) and in India with 725.900/Quarter (= 2.903.600 cars each year) shows that the oil resources will be empty before 2050. Only in the years 2000 – 2009 worldwide 242 Billion Barrels (1 Barrel is approx. 159 Liter)l have been mined. The IEA sais for 2012 there is a daily volume of consumed oil of 89,7 million Barrel (14.250.000.000 liter per day).

Germany gets 80% of its oil from 6 states. 35% from Russia, 14% from Norway, 10% from Great Britain. Therefore a closer connection of Russia to Germany and Europe means a surrender of German and European politics. Facing risks by “Peak Oil” and the resulting weakness of the position of western industry nations, experts say that there should be a quick change in energy resources. In terms of the Germany Army studies say, that until 2100 the German army should be 100% switched to renewable energies.

The technical aspect:

For protection of disturbances and for electromagnetic compatibility CENELEC directive EN 50065-1 controls communication via supply grid in the range from 3 to 128,5 kHz.
This is a kind of „transfer-limit“ and for that reason all companies with PLC use transfers in the MHz range and use the transfer outside the CENELEC-norm.



Advantages of the PLC technology.

The major advantage of PLC is, that no additional cables have to be fixed to electric devices. **PLC is also working when high frequency fails**. Therefore it is unlikely that intelligent electric meters in the cellar of a house can communicate with the data concentrator via HF.
In terms of PLC, the communication with the data concentrator is done vie electric wires.

For this reason most energy supplier worldwide use PLC technology for their intelligent supply grids, and most towns use PLC for their intelligent public lightning.

Power line-Transceiver can be used in the CENELC A-band and the CENELEC C-band.
In countries with CENELEC-standardization the A-Band is reserved to public supply companies and their licensees. The C-band can be unlimited used by consumers and private companies, but a common access protocol and a co-existence protocol are obligatory.
In the A-band-mode, normally trans receiver support two channels within this band, one with 75kHz and one with 86kHz as average value. In the C-Band trans receiver mostly also support two channels, one with 115kHz and one with 132kHz as average value.
C**The existence of two channels is justified by the fact that if one band is blocked, it is unlikely that the other channel is also blocked by a resonance of the affected wire.**

The CENELEC-norm

- Basically the supply grids are only constructed for energy supply. According to the telecommunication law the usable specter is limited to the range from 3 to 148,5kHz (CENELEC –band). Additionally the transmission levels must not exceed 5mW.
  Mostly up to 396W occur – read more on the following pages!!!

CENELEC Band	frequency range	User
-	3 - 9 kHz	Energy supplier
A	9 - 95 kHz	Energy supplier
B	95 - 125 kHz	Customer devices
C	125 - 140 kHz	Customer devices
D	140 - 148,5 kHz	Customer devices

All devices work in the frequency range from 3 – 150 KHz:

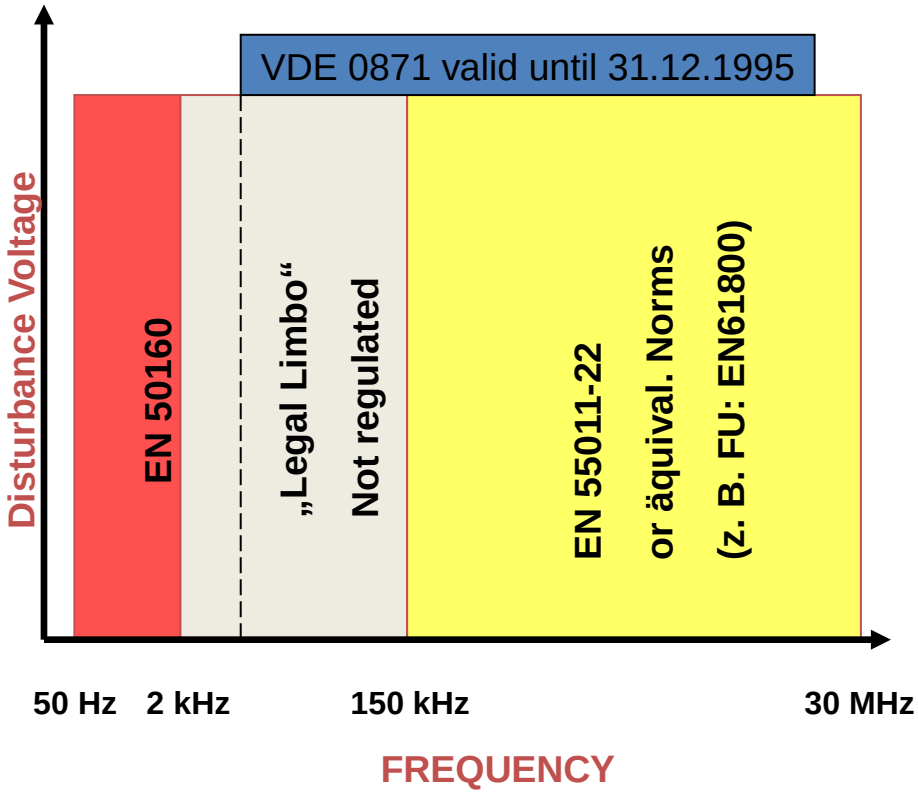
Typical clocking frequencies:

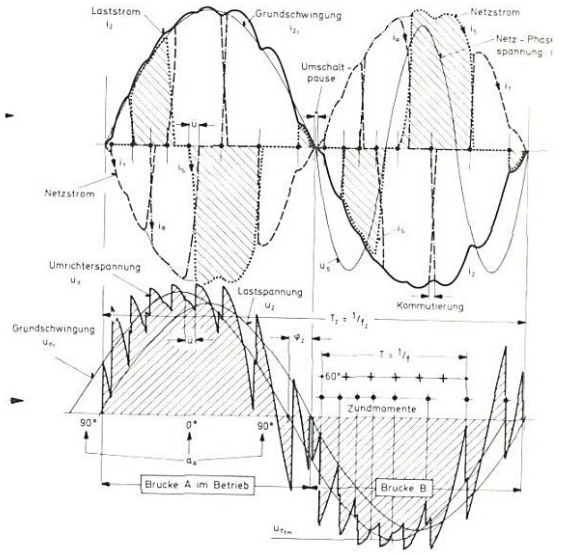
LED	**3-10KHz**
Frequency converter	**5 – 20kHz**
USV-devices	**15 – 25kHz**
Switch power supply	**20 – 300kHz**
Lightning EVG‘s	**20 – 200kH**

- **Induction plants** **100-150KHz**

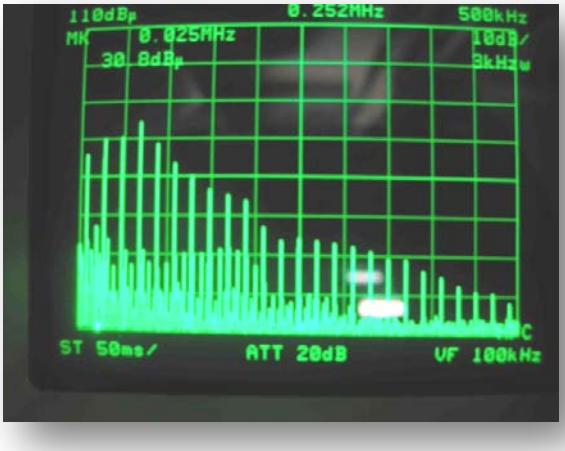
The frequency range from 150kHz – 30MHz is regulated by EN 55011… 55022 in terms of disturbance limit values. For the frequency range from 1kHz – 150 kHz there is no limitation!

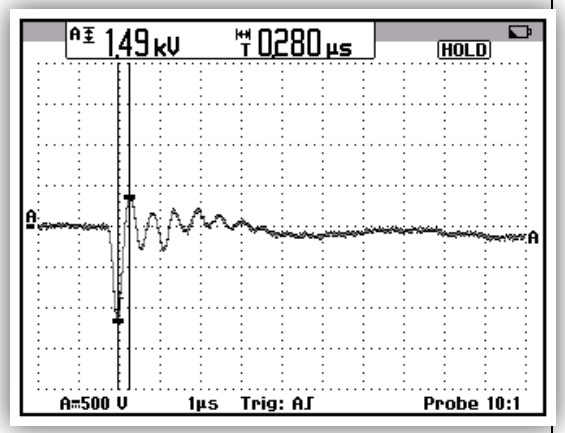
Until 31.12.1995 there was the directive VDE 0871 in Germany and regulated the disturbance limit values from 10KHz – 30MHz. Within the EU – harmonization, the frequency range from 10 KHz – 150 KHz has been canceled (legal limbo). Since 1996 the problems with the supply grid are the following:





Sinus distortion with high voltage peaks up to 5kV/µs caused by a frequency converter.





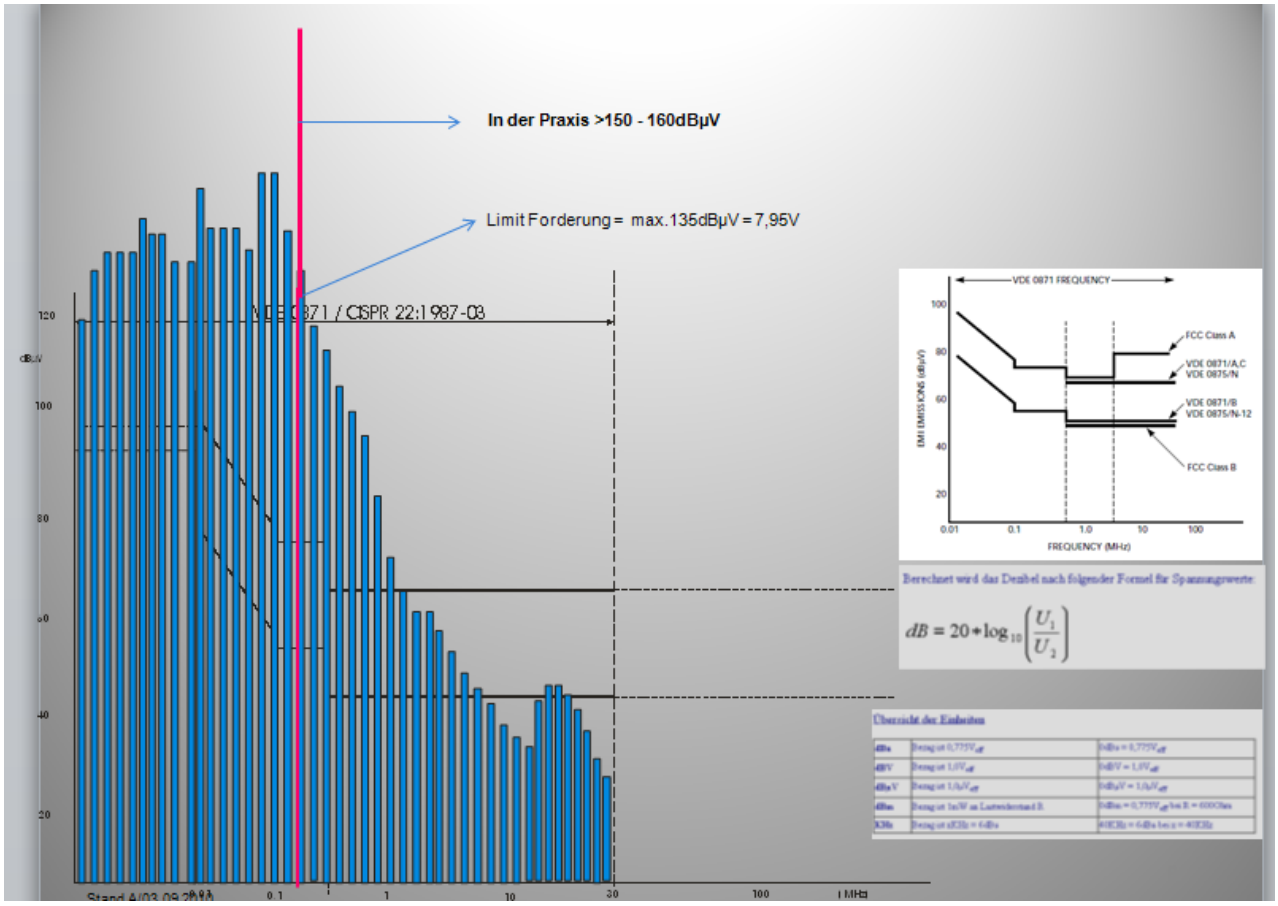
5,32KV/µs measured on30.01.2013
In a public supply grid in Austria

Usual parts like X2 and Y2 capacitors cannot resist those dU/dt-pressure from the supply grid. Also have a look to this report:

http://www.bajog.de/fileadmin/downloads/Fachberichte/Ursachenermittlung_fuer_X2_Zerstoerung/X2_Y2_destruction.pdf

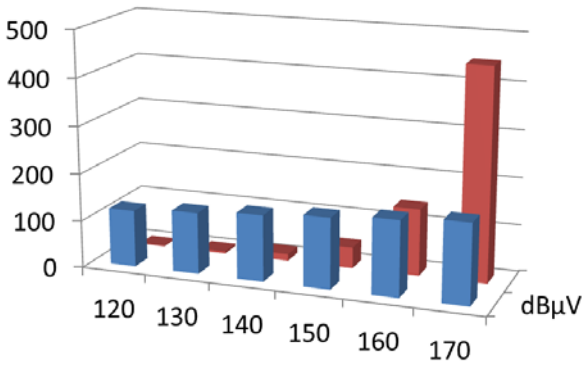
Smart Meter PLC communicates in the PLC range.
The manufacturers of SM agreed on transmission level of 135dBµV (please have a look at the conversion of dBµV to V below)

The base interference level with partially destructive energy sometimes exceeds 160dBµV and a voltage peak of up to 141V.



Measured base interference level in public energy supply up to 153dBµV

Conversion from dBµV to V



dBµV	Volt
120	1,41
130	4,47
140	14,14
150	44,72
160	141,42
170	447,21

The basic disturbance level in the supply grid (page 9) often enables the data communication between SM and data additionally there can be errors in correct measurement of the energy usage volume.

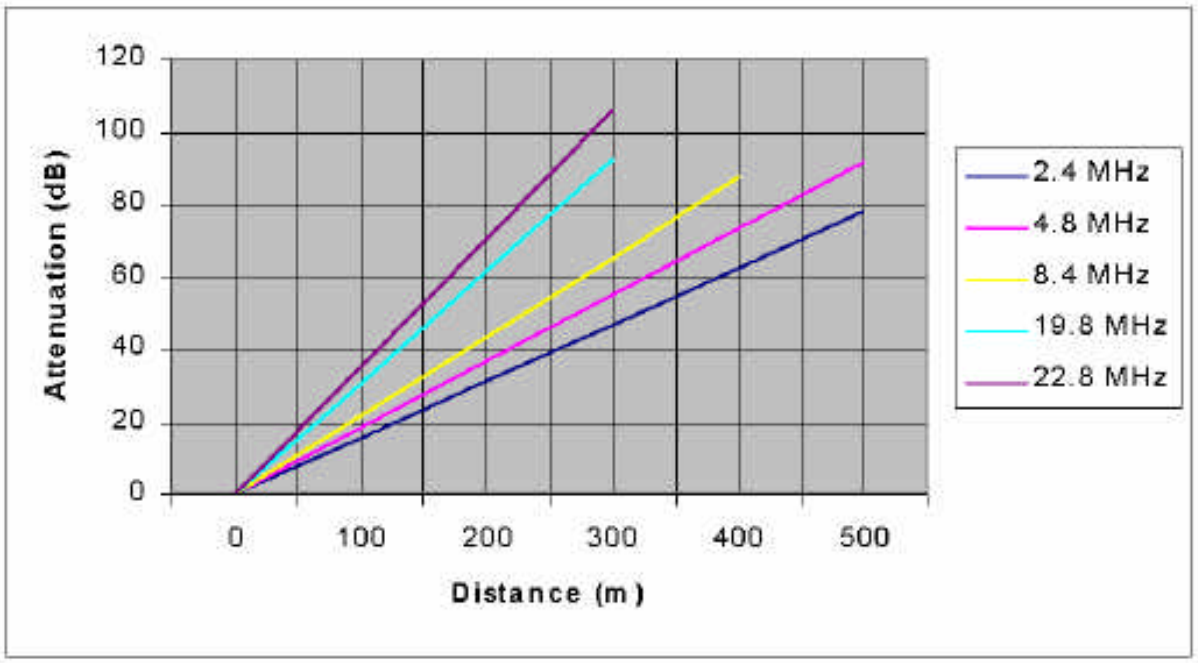
Possible solutions for the smart meter manufacturer are:
1) „two channel solutions“ ,
2) massive increase of transmission level
3) switch to broadband solution in the range of MHz

But……

The two-channel-solution is not possible when for the frequency range up to 150kHz when the basic interference level is over the PLC transmission level.

The increase of the transmission level leads to device destructions because 230V household devices normally cannot stand a voltage peak of 400V.

A broad band solution is not accepted by most people. BPLC has a kind of antenna effect in the MHz range. Most people want an electric smog free area

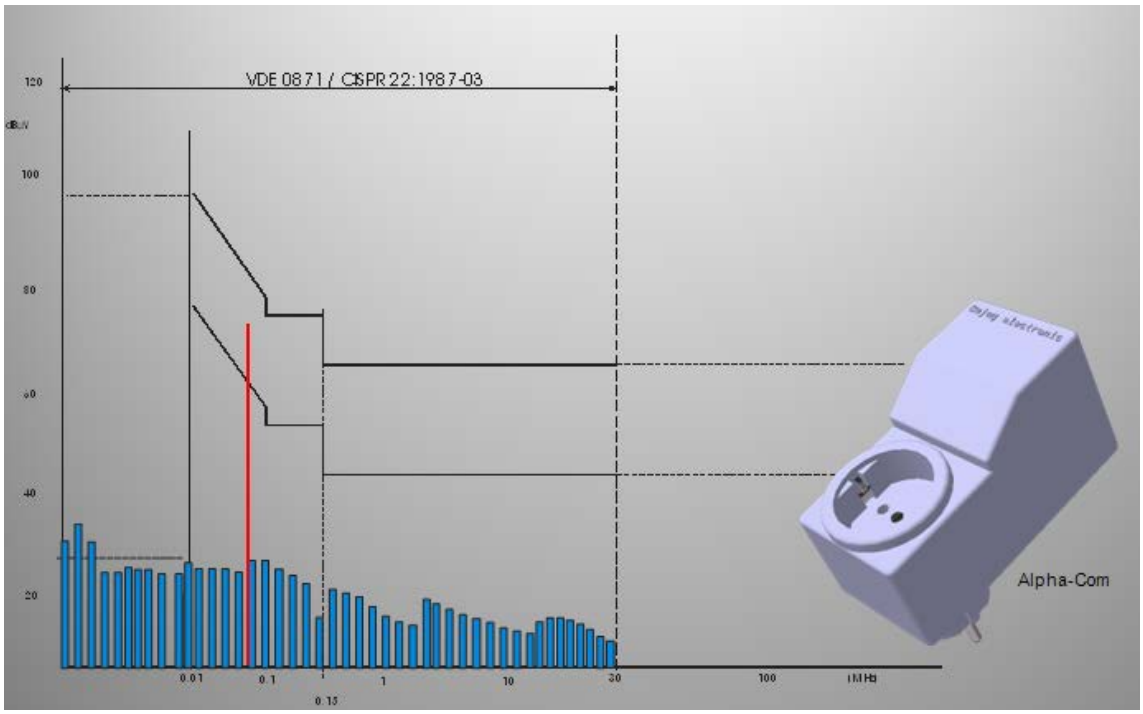


Broadband

This video shows clearly which influence broadband signals have to the environment.
http://www.addx.de/plc/plc-audio.php

So a good solution is:

The basic transmission level in the supply grid has to be reduced to a harmless value through an expanded EN-norm. This solves the described supply grid problems in terms of devices and PLC level can be reduced to a minimum (red bar).



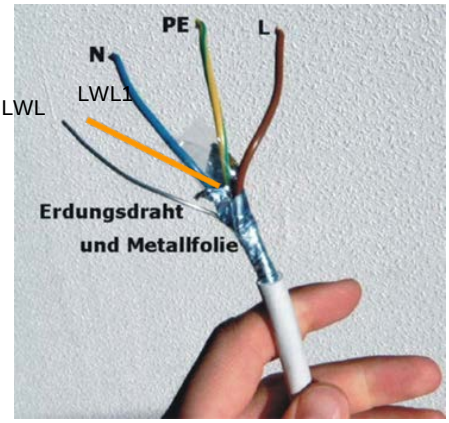
Another solution can be created by a PLC – LWL combination.

This is how it works:

SM with a transmission frequency within the CENELEC band communicates between house owner / leaser and data concentrator (energy supplier).

Limited data volume can be accessed by house owner / leaser via PLC house internal. Data volume is limited at 150kHz, but for energy analysis it is sufficient.

With a combined electric wire, (which should be standard for future electric wires), live leads (L/N/PE) or 3-phase (L1/L2/L3/N/PE) together with a LWL / light wave cable combined in a kind of “intelligent” electrical socket. Every electrical socket in a room should be attached to this interface, so the user is connected with the SM and its interface from every position.



Possibilities of a communication network

When signal in the house is wanted:

1) The phase cable L1/N or L1,L2,L3,N transfers PLC signals (CENELEC band) for data rates <150kBit (energy usage info). Modulation models can be embedded.

2) Optical wave guides LWL transfer high data volumes to a central consumer registration via interface (PC or other devices) and to the smart meter in every direction.

3) PLC takes over controlling and switching functions via magnetic switches, or semiconductor witches (like for example turning on or off devices like washing machines, dishes washer, heating etc.) In an extended functionality there would be the possibility, that the SM interface is used by an internet connection from external, in order to check and control the devices. (Alarm devices, door functions, etc.)

4) ***Special: Both wires (current and optical wave) can be used at the same time and support each other.***
With this, errors and risks of failure can be banned (plausibility check).
Additional control and monitoring functions can be used and hacking the data of third party is very difficult or nearly not possible.

When the signal is only wanted partially or not at all:

1) Optical wave guide can be used as a remote switch for he SM
Even with this function the communication with EVU is not affected.
2) PLC signal at the SM can be completely blocked by a appropriate filter, This “block function” can also be activated and deactivated by optic al wave guide.
3) With a blocked PLC signal at the SM a communication can be still done via optical wave guide. And also a consumption analysis via PC can be done. The communication with EVU is not affected
Quite the contrary, by an appropriate „Z-Filter“ it is ensured that the PLC signal to the data concentrator is not influenced by the consumer or disturbing devices in the household supply grid. Additionally it ensures the correct data collection and analysis in the SM.
4) Feature: Both wires (current and optical wave guide) can be used simultaneous and complement one another in their interaction. Important is, that in every room there is at least one combination socket available, so a communication and switching function is possible without additional wiring.

If generally a phase/optic wave guide wires are laid, optical wave guide terminals can be expanded to the sockets later.

Every user can decide on his own which signals he wants to allow and which emissions he wants to avoid. BPLC is not obligatory.

It is important to be able to detect, which disturbance voltage actually is present in the lower frequency range, and what reasons they have.

To detect a disturbance source in the house a good way us to pull all fuses and turn them on again step by step. With an appropriate hand held analyzer the disturbance „path“ and the disturbance source can be detected easily and the network agency informed of it.

The network agency (former Deutsche Bundespost) has to intervene exceeding limits of disturbances and to ensure that it will be helped, for the case that these disturbances have destructive influences on devices. Please read this report for more details:
http://www.bajog.de/en/technical-report/cenelec-new-regulation.html

**Network Analyzing Handheld NA 02-13
for measuring grid-bound
disturbance voltage in the
low voltage range, according to EN 55011
- EN 55022 in the range 150KHz – 500KHz
and the new Norm CEI – 0-21
for the lower frequency range
from 1 KHz to 500KHz**

The special feature of this handset network analysis is:

- The small size (handheld)
- The direct measurement of the power without any further test equipment / devices
- The accuracy of the measurements (noise) in accordance with EN 55 011 .. 22 in the lower frequency range. New regulation in Europe like CEI - o -21 are requesting this frequency range since October 2012 and other EU - members will follow soon
- Ease of use as well for non-electrical experts and users
- The flexible use as a simple substitute for a network analyzer and test receivers to

analyze responsible voltage sources and interruption causes of devices and electrical components inside the house

General solution:

It is possible and technically makeable, that a household with 4 persons to self-supply themselves with current and heating for 95% and be independent from the public supply.

This is possible by use of fuel cells (hydrogen). The usage of hydrogen is often combined with fear of accidents, but this technology is already safe enough for implementing it. Solar parks could create the hydrogen and deliver it to a kind of distribution station.

House holdings and cars can be supplied with it and complement one another in exchange of energy. PV – houses would be able to use the generated current for creating hydrogen and deliver overcapacity of energy to the neighbors or the town with payment. Or the other way round get energy from town or neighbors for the case that there could not be generated enough. Autarkic energy generation, broadcasting and communication via the supply grid will be a central element of upcoming energy economics. This conception is possible, but precondition is an ordinary, clean supply grid…a “Smart Grid” “

If a change in energy generation and smart grid should be a success for Germany, than we have to prepare the technical and physical rules now.