

The Influence of Light Sources on the Public Power Supply System

- Light sources which comply with **primary metrics and the corresponding international requirements** do not have negative effects on the quality of the public power supply system.
- ELC recommends the **use of primary metrics** instead of the composite metric, as this helps regulators monitor and regulate the real causes of quality issues.
- **Power Quality related requirements** for light sources are more stringent than requirements for any other electronic equipment.
- **Local public power supply system capacities and dynamics** must be taken into account in order to avoid overly rigid quality requirements, which would negatively impact the successful introduction of energy efficient lamps into the market.

Discussion on Power Factor

The question as to whether the power factor of light sources have had a significant impact on the power supply system has been an on-going discussion ever since the first compact fluorescent lamps (CFLs) entered the market.

This discussion is timelier than ever, particularly due to the fact that the recent wave of incandescent phase-outs is spreading worldwide. Alternative light source technologies requiring integrated or external electronics to operate lamps such as low and high intensity discharge and LEDs are therefore likely to dominate the consumer market in the near future.

The move to energy efficient technologies with decreased peak-load demands will result in reducing the strain on many overloaded public power supply systems. The technical challenge of being able to replace incandescent technologies effectively is a significant one. The main barriers to achieving their savings potential include their initial high price, size and reliability. The political decision on whether or not to make the use of high power factor (HPF) lamps compulsory will on many occasions have an impact on these barriers.

The decision to bring in HPF or low power factor (LPF) lamps into the market remains in the hands of policy makers. Given that the information currently available is complex and does not always address all the relevant policy considerations, this may lead to decisions being taken which do not maximize the potential benefits of using energy efficient lighting solutions.

Quality of Public Power Supply System

The influence of the new light sources on the Quality(Q) of public power supply system is a key factor with regards to the introduction of energy saving lamps into the market.

The ELC position paper "Mains power-quality effects by electronic lighting equipment" of May 2009 [1] showed that the requirements of the internationally accepted regulations [2][3] and standards [4] - managed by the relevant stakeholders (public power supply system operators, test laboratories, manufacturers) - sufficiently safeguard the Q of the public power supply system. This has been reconfirmed by recent independent studies [5][6][7]. No negative effects on the grid are therefore to be expected from energy saving lamps which will comply with these regulations and standards in the near future.

Due to future developments, such as the charging of electrical cars decentralized energy generation by wind and solar systems, it is not yet possible to predict how the public power supply systems will function in twenty years. ELC therefore believes that no long-term conclusions should be drawn. The issues should be addressed as and when relevant standards are due for revision.

Finally it should be emphasized that the metric Power Factor (PF), which is used to quantify the effect of light sources on the Q of the public power supply systems, is not the most effective metric. The reason is that the *PF* metric is a composite metric consisting of the primary metrics displacement factor ($\kappa_{displacement}$) and distortion factor ($\kappa_{distortion}$).

The relation between the composite metric *PF* and its primary $\kappa_{displacement}$ and $\kappa_{distortion}$ metrics is demonstrated in the following equations:

with
$$PF = \kappa_{displacement} \cdot \kappa_{distortion}$$

and
$$\kappa_{displacement} = \cos\varphi_1$$

and
$$\kappa_{distortion} = \frac{1}{\sqrt{1 + THD_i^2}}$$

resulting in

$$PF = \frac{\cos\varphi_1}{\sqrt{1 + THD_i^2}}$$

Note: Linear loads have no distortion ($THD_i = 0$). In that case $PF = \cos\varphi_1$

Angle φ_1 is the phase angle between the fundamental of the supply voltage and the fundamental of the mains current. The Total Harmonic Distortion (THD_i) is quantified by the harmonics of the mains current, which is already regulated according to the international standard IEC 61000-3-2. The relation between the individual harmonics of the mains current and the THD_i is explained in the equation:

$$THD_i = \sqrt{\sum_{n=2}^{\infty} \left(\frac{i_n}{i_1} \right)^2}$$

where i_n is the amplitude of the n^{th} harmonic of the mains current.

The relation between potential Power Quality (PQ) related issues and the fundamental metrics is described in table 1.

Potential PQ issue:	Cause:	
	Displacement	Distortion:
Additional losses in the grid	Yes	Minor effect
Overload of the PEN conductor	n.a.	Yes
Distortion of the mains-voltage	n.a.	Yes

Table 1: Potential Power Quality related issues and their causes

ELC Position on the Quality of Public Power Supply Systems

ELC proposes the split of the power factor into the primary metrics displacement factor ($\kappa_{displacement}$) and distortion factor ($\kappa_{distortion}$).

ELC would like to emphasize that no negative effects on the public power supply systems are to be expected from light sources, which comply with the following primary metrics and the corresponding international requirements (the requirements of $P \leq 2\text{ W}$ and $2\text{ W} \leq P \leq 5\text{ W}$ are under consideration):

Table 2: Mains-voltage self-ballasted lamps and LED modules

Metric	Limit			
	$P \leq 2\text{W}$	$2\text{W} < P \leq 5\text{W}$	$5\text{W} < P \leq 25\text{W}$	$P > 25\text{W}$
$\kappa_{displacement}$ ($\cos \phi_1$) [*]	No Limit	≥ 0.4	≥ 0.7	≥ 0.9
$\kappa_{distortion}$ To be regulated by IEC 61000-3-2 ^{**}	No Limit	No Limit	Clause 7.3b	Clause 7.3a

* ELC propose to include the definitions & measurement method in the relevant IEC performance standards

** These limits are set and continuously monitored by the regional regulators and the International Electrotechnical Committee (IEC)

In addition, these Power Quality related requirements for light sources are more stringent than requirements for any other electronic equipment.

Local public power supply system capacities and dynamics must be taken into account in order to avoid overly rigid PQ requirements, which would negatively impact the successful introduction of energy efficient lamps into the market.

ELC strongly recommends the use of primary metrics instead of the composite metric, as this helps regulators to monitor and regulate the real causes of PQ issues. It also provides guidance to installers and end-users on how to correctly select and implement light sources.

About the European Lamp Companies Federation (ELC)

For over 20 years the European Lamp Companies Federation (ELC), has represented the leading European lamp manufacturers. The ELC is dedicated to promoting efficient lighting practice for the benefit of the global environment, human comfort and the health and safety of consumers. More information about the ELC can be found at www.elcfed.org.

*The
Federation of National Manufacturer's Associations for Luminaires and Electrotechnical Components
for Luminaires in the European Union (CELMA) supports the content of this document.*

References

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