

PHILIPS

sense and simplicity

Mains-related EMC-issues associated with Lighting Equipment

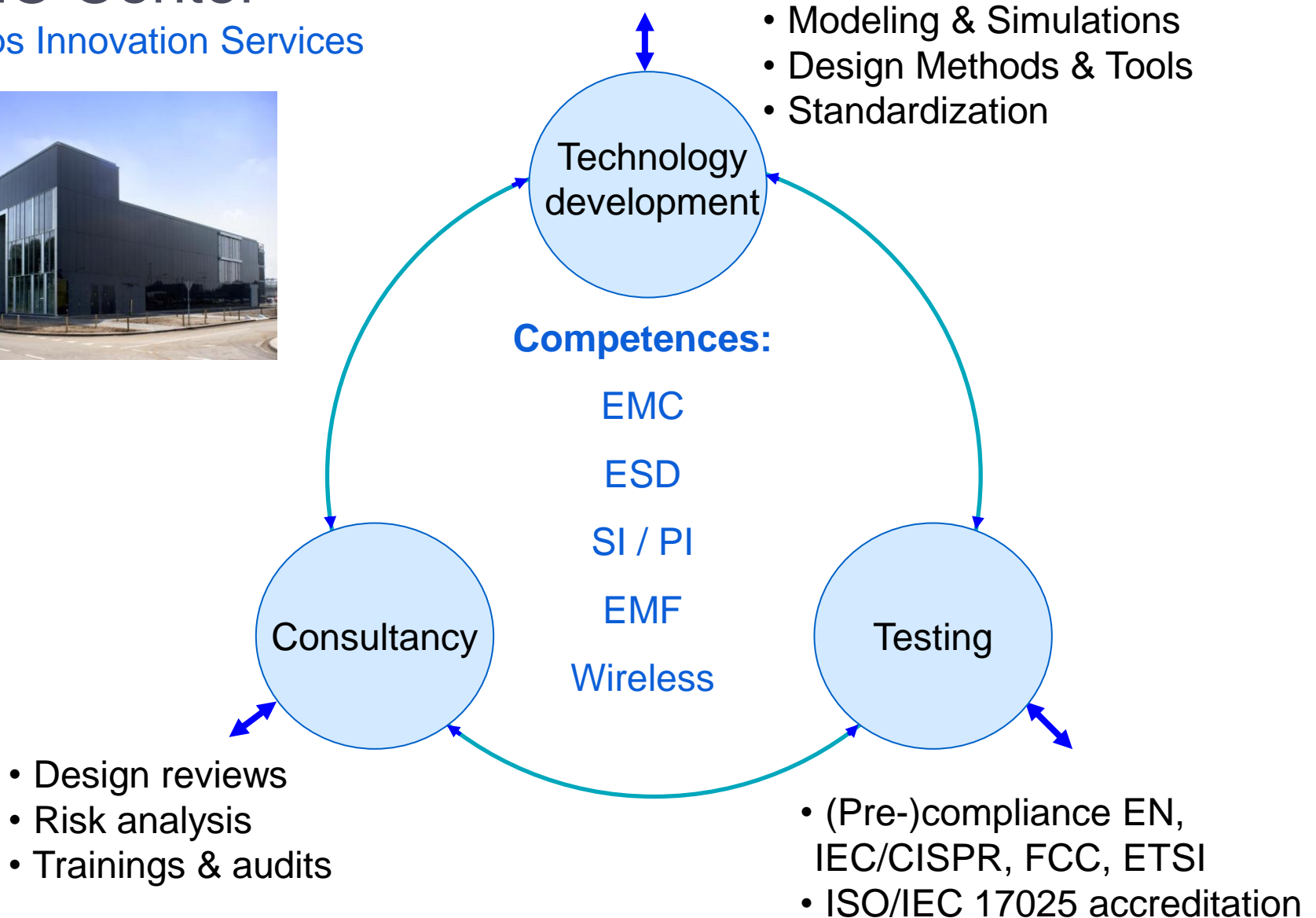
P.A. Beeckman

PGI/Philips Innovation Services

EMC Kennismarkt Oost - October 12, 2012

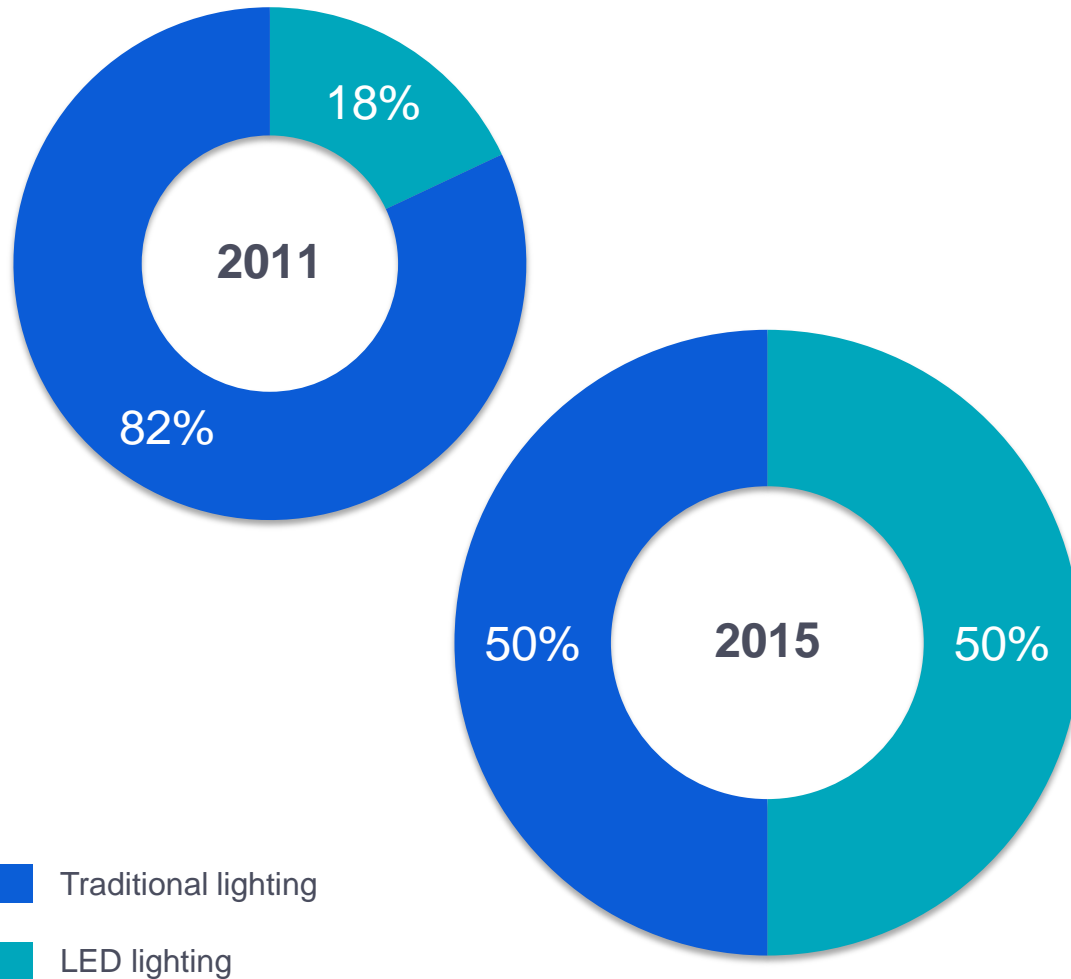
EMC Center

Philips Innovation Services



The LED revolution

Digital lighting is transforming the entire landscape*



*Source: Philips Lighting global market study 2009, updated for 2010



Banning of Incandescent lamps

EU example



	Sep. 2009	Sep. 2010	Sep. 2011	Sep. 2012	Sep. 2013	Sep. 2014	Sep. 2015	Sep. 2016
Clear	15W	15W	15W	15W	Banning of all Incandescent Lamps			
	25W	25W	25W	25W				
	40W	40W	40W	40W				
	60W	60W	60W	60W				
	75W	75W	75W	75W				
	100W	100W	100W	100W				
Opal	Banning of all opal Incandescent Lamps							
Reflector	15W	Directives in preparation						
	25W							
	40W							
	60W							
	75W							
	100W							
Special	Special Purpose Lamps							

Significant reduction of the electrical usage of lighting equipment during the next 10 years (10% → 4% → 2%)

...results into various EMC/PQ issues of lighting applications

- Harmonics, power factor, inrush currents
- Voltage fluctuations & flicker
- Gap in EMC standards
- From equipment to systems

Impact of multiple non-linear lighting loads of the same kind on harmonics, inrush currents etc



Expo Zaragoza, Spain

Impact of mixed & non-mixed loads on harmonics, inrush current

And the practical consequences on installations

Mixed-load field tests by Luleå University (Bollen et al) Sweden show...

HOME

Mixed load scenario's:

(6 appliances + 32 lamps)

- Before: incandescent lamps (PF=1)
- After: energy saving lamps (PF=0.6)

Result:

- Before: PF total home = 0.92
- After: PF total home = 0.91

HOTEL

Mixed load scenario's:

(76 rooms; multiple appliances + 560 lamps)

- Before: incandescent lamps (PF=1)
- After: energy saving lamps (PF=0.6)

Result:

- Before: PF total hotel = 0.95
- After: PF total hotel = 0.93

.....a negligible effect of energy saving lamps on the PQ of the grid

What we need?

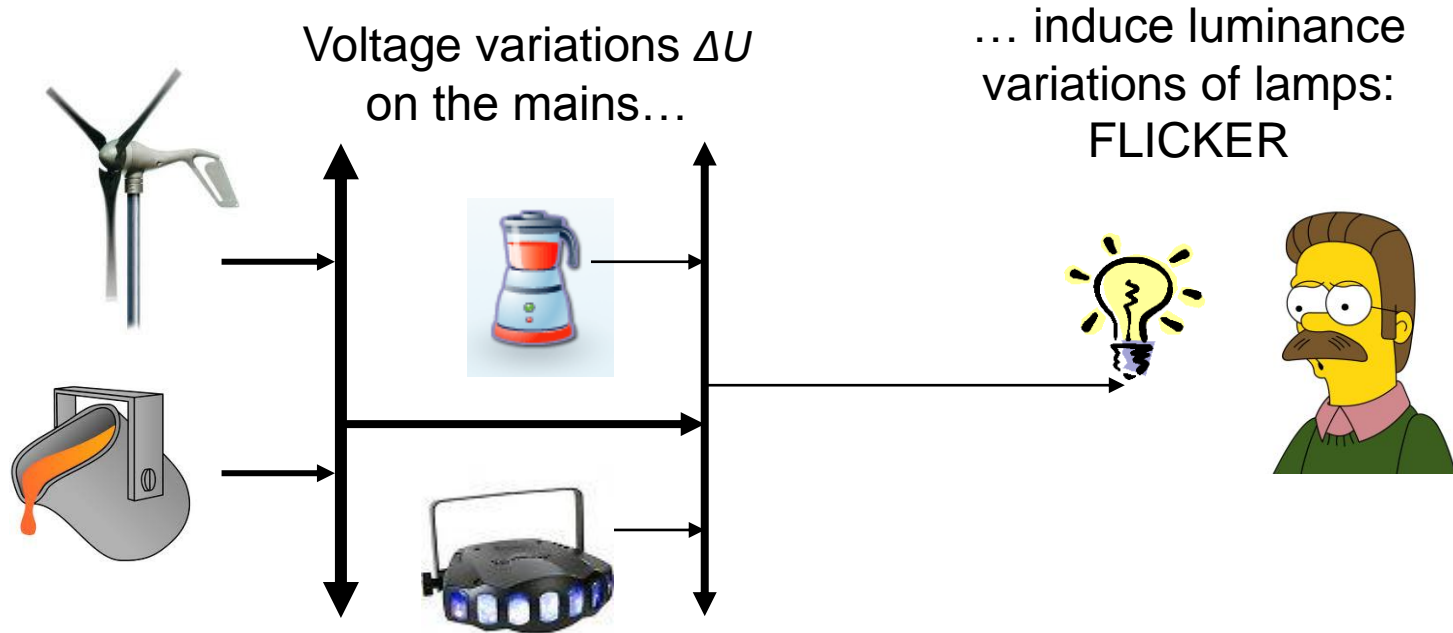
Meaningful and validated metrics, limits and feasible and reproducible test methods to quantify

- PQ-performance of new grid topologies
- New load scenarios
- At different application levels (equipment, MV, HV)

...while taking into account reduced power consumption share by lighting equipment

...and this has to be disseminated to industry & installers

Flicker induced by equipment connected to the grid

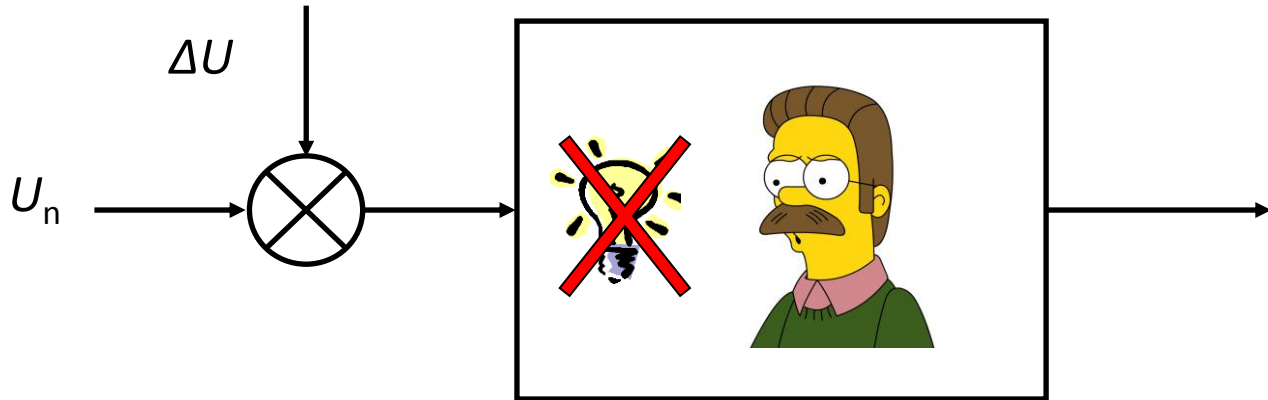


Varying & switching sources & loads

- heavy industry on the MV-grid
- appliances on the LV-grid

Flicker meter: emulates perception of flicker of a 60 W incandescent lamp = reference

Mains voltage + variations

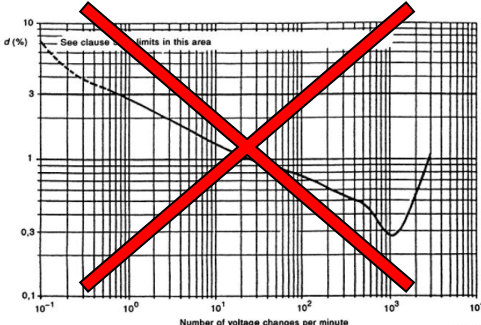


Flicker meter i.a.w. IEC 61000-4-15 emulating ~~60 W~~ lamp + eye/brain response

Limits & test conditions in IEC 61000-3-3

Various flicker metrics and limits for various product categories:

- P_{st}
- P_{lt}
- P_{inst}
- d
- d_{max}
- etc



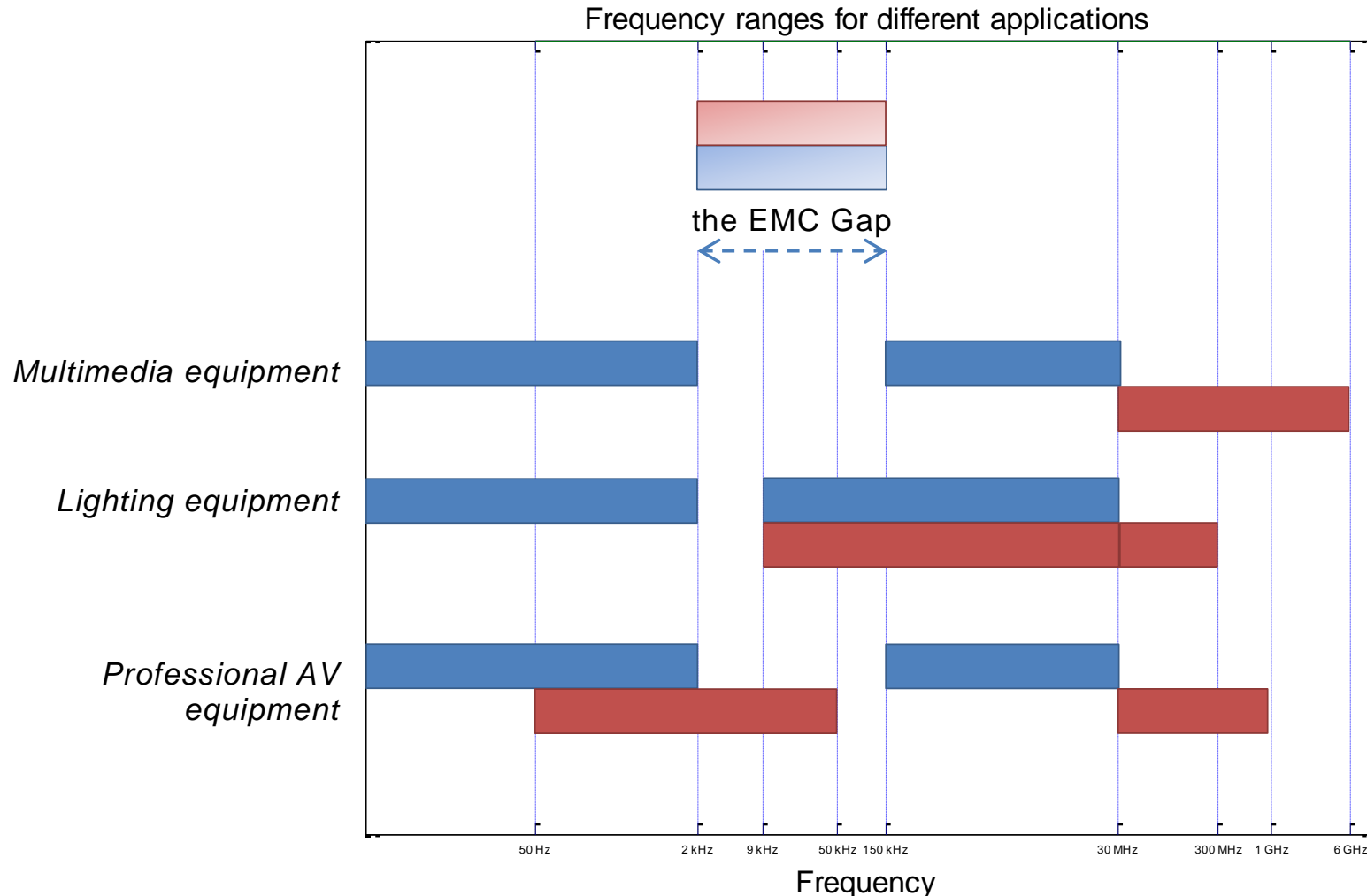
What we need?

- Do distributed generation and non-linear loads increase the risk of voltage fluctuation & flicker?
- Is the current flicker-curve of IEC 61000-3-3 and the current flicker meter (IEC 61000-4-15) still adequate for new lighting technologies?
- What is the impact of existing and new dimming technologies on flicker?
- Is future lighting equipment sensitive to flicker at modulation frequencies beyond the flicker curve (e.g. due to non-linear detection)?

Overview EMC standards lighting equipment

Subject of the standard	Harmonized EN- Standards	Corresponding IEC- standards
EMC	EMC	EMC
RF disturbances – emission	EN 55015	CISPR 15
LF disturbances – emission	EN 61000-3-2	IEC 61000-3-2
LF disturbances – emission	EN 61000-3-3	IEC 61000-3-3
Immunity to LF & RF disturbances	EN 61547	IEC 61547
-ESD	n.a.	Basic immunity standards
-radiated RF		IEC 61000-4-2
-EFT		IEC 61000-4-3
-surge		IEC 61000-4-4
-conducted RF		IEC 61000-4-5
-dips		IEC 61000-4-6
		IEC 61000-4-11

Consumer-type of EMC product standard have no requirements between 2 kHz & 9/150 kHz



What we need

1) As a result of new grid technologies, new applications, PLC & mains signalling, and

2) Based on validated EMI scenarios & risk assessments,

develop meaningful¹⁾

- Metrics & limits
- Phenomena & test levels

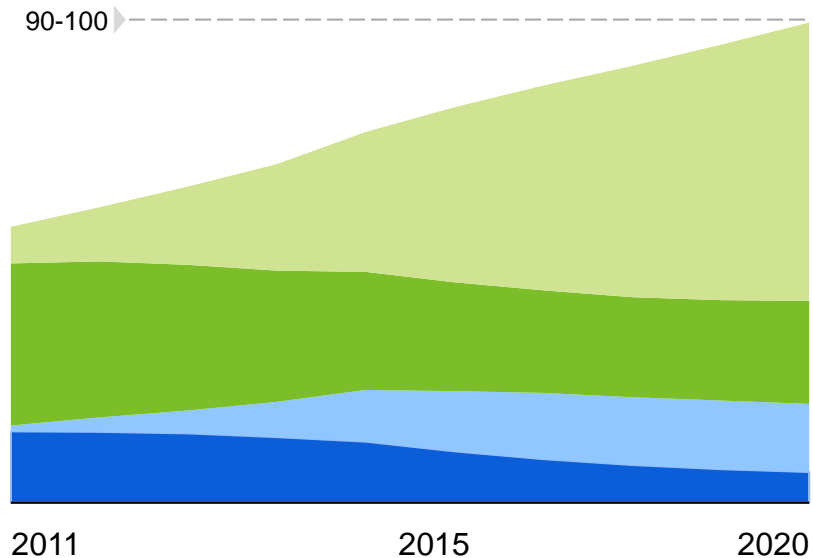
to achieve EMC/PQ in the 2 – 9/150 kHz region, that can be transposed to IEC-level standards

1) Fit for use, validated, including reproducible test methods

From lamps and luminaires to distributed and modular lighting systems

Global General Illumination¹ market

EUR billion



- LED luminaires and controls
- Conventional luminaires
- LED lamps and modules
- Conventional lamps and drivers

...including controls,

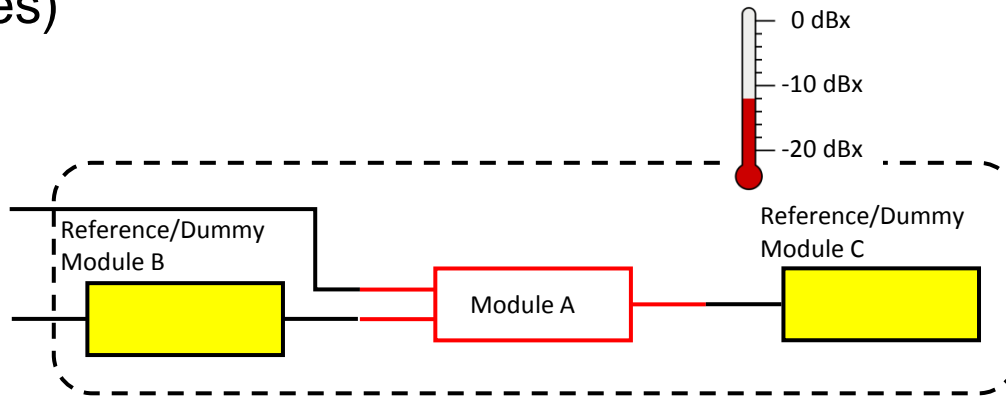
- Lighting EMC standards (CISPR 15 emission) apply for luminaires, self-ballasted lamps & independent auxiliaries



¹ Excluding Automotive Lighting and LED components market
Source: Philips Lighting global market study 2010, updated for 2011

What we need?

- Methods for testing modules in reference applications (i.e reference luminaires)



- Module-level compliance test methods using ‘the reference method’ already available CISPR 30-1 & 30-2 (discharge luminaires; a technical report for internal use only)

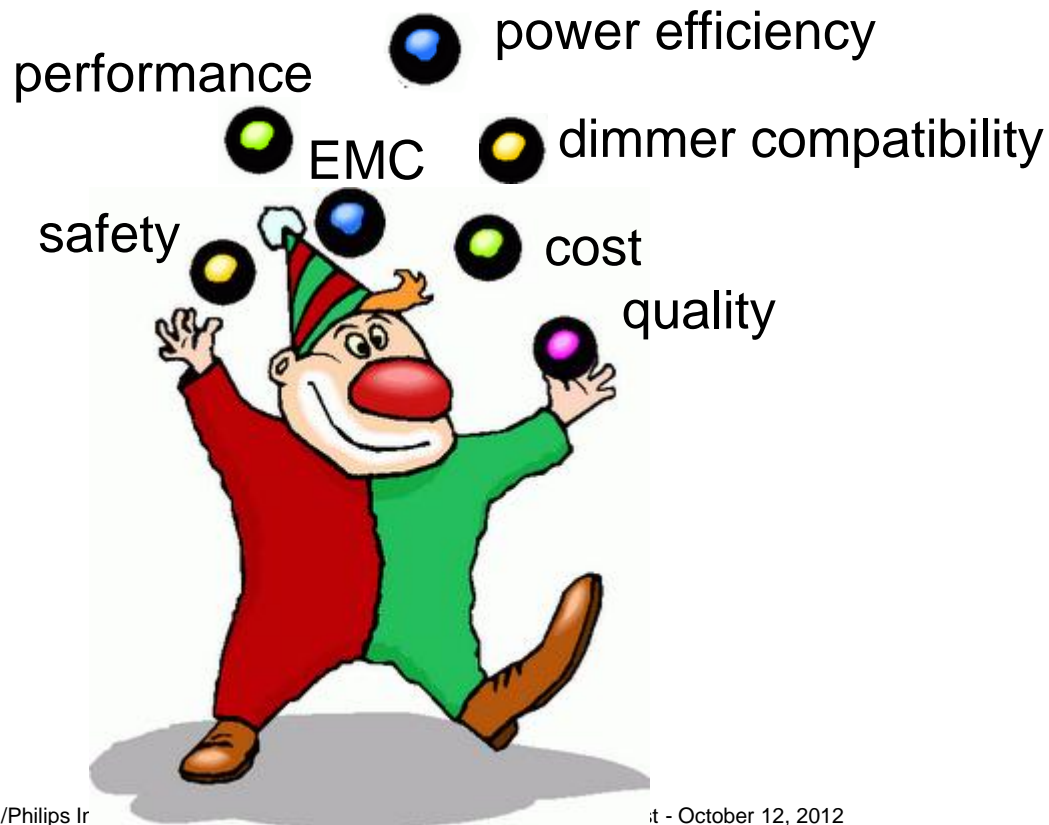
Eniac – Enlight project



- Philips Innovation Services investigates many of the before-mentioned PQ/EMC issues in the Enlight-project: <http://www.enlight-project.eu/>
- One of the project objectives is to validating and evaluate the impact of new EnLight devices and lighting systems on the electric distribution grid
- Enlight project consortium is a closed consortium with 28 partners: leading industrial companies and universities as well as research institutes out of 6 European countries within Europe

Summary

- The lighting industry faces a revolution in lighting technologies and a revolution in the grid where lighting equipment is connected
- Hence, the EMC risk and challenges need to be faced and solved by adequate, smart solutions, new EMC/PQ standards and clear guidelines for practical use



Acknowledgement

This work is supported by the Eniac Joint Undertaking project Enlight:
Energy efficient and intelligent lighting systems



