United Nations Environment Programme
en.lighten initiative

MEPS & available technology solutions
Break out group: MEPS

ECOWAS workshop, Dakar, Senegal
July 2 & 3 2012
Irene Klein- Philips Lighting
Agenda

• Introduction – goal of this presentation
• Standards and legislation: differences & meaning
• MEPS: Focus on quality levels
• Experience :
  • Alternative lamps in the market & choice of consumers
  • Technology neutral or specific MEPS
  • Which elements are relevant to be described in MEPS
  • Power factor – an explanation
  • Advised balanced performance standards for CFL-I & Halogen
  • Engagement stakeholders in switch to energy efficient lighting
• Off-grid lighting solutions for Homes
The goal of standards and MEPS

Protect the end user / consumer:
- Unsafe and very low quality products are kept from the market.
- Interoperability of products is guaranteed. (*So customers have freedom to choose between individual brands*).
- Vendors are being kept to their promise (*"what is on the box is in the box"*).
- Protect / safeguard consumers investment in better, more sustainable products

Support the local government:
- A minimum level of energy efficiency is guaranteed, so the energy saving targets can be achieved

Protect the environment:
- Products with high levels of hazardous materials (e.g. Hg) are kept from the market.

Support the industry
- Adequate market surveillance is in place to enable fair business
Standards and legislation: differences & meaning

Safety standard (IEC 60968 for CFL)
- Sets requirements to ensure safety & interchangeability of lamps

Performance Measurement standard (IEC 60969 for CFL)
- Prescribes how to measure and test the lamps

National Legislation (MEPS)
- Defines minimum performance requirements (levels) of lamps
Importance of well defined MEPS

No MEPS or too low level:

Too high level MEPS:

Irrelevant criteria in MEPS:

Well defined & balanced MEPS:
Experience: Choice for alternative lamp based on cultural & economical differences

- Australia, Europe, Argentina > EcoHalogen preferred alternative
  - Reference is 60W GLS bulb
  - Light effect (cozy) & shape very similar to known GLS bulb
  - Next sales price level after incandescent bulb, but with low energy saving (20 – 25%)

- China, rest of Asia > CFL-I preferred alternative
  - Switch to CFL-I without pressure of legislation because of:
    - Money saving (energy use & lifetime)
    - Bright cool light (6500K = 85% of market) serves single light point
    - Affordable price point (incl. savings)

LED is an alternative technology, but so far has not reached the price levels to make consumers to massively change-over
Australian market development – Case Example

Equal market split between CFLi and Eco Halogen.

National Grocery Market (Actual Lamps)

Government announced the ban of GLS 22 Feb 2007

Stockpiling Effect

Introduction of Eco-Halogen to Woolworths 15 Oct 2008

Woolworths commence GLS Phase out Nov 2008
Argentina market development – Case example

Argentina GLS, CFLi & Halo Market Evolution
(Mio Pcs)

GLS Banning:
Since May 31st 2011
All GLS types >25W
China market development – Case Example

*Split between GLS and CFL-I, LED will come as 3rd alternative*

**Market trend China bulbs**

- 2010:
  - GLS: 62%
  - CFli: 38%
- 2011:
  - GLS: 64%
  - CFli: 36%
- 2012:
  - GLS: 59%
  - CFli: 40%
Should MEPS be technology neutral?

• Critical elements differ per technology, examples:
  – Luminous efficacy (lm/W) is critical to phase out GLS, levels differ for Halogen, CFL-I and LED
  – Mercury is relevant in CFL-I, but not for Halogen or LED
  – Switch cycles are relevant for CFL-I and LED, but not for Halogen
• Making formula’s that apply to all technologies are very complicated (hardly possible, e.g. maximum rated Power)

➤ Recommendation:
  To keep the MEPS simple and short, best approach is to include a small chapter per technology with the relevant elements.
Which elements should be included in MEPS?

Elements related to the performance of the lamp
- The lamp should work for a certain amount of time > Lamp life
- The lamp should save energy > Luminous efficacy
- The lamp should give normal light quality > Color rendering
- The lamp should be able to turn on/off often enough > Switch withstand
- Also after some time the lamp should still give light > Lumen maintenance

Non-lamp-performance related elements
- Mercury content > important for environment
- Power Factor > important for power supply (or not?)

Labeling & marking for communication purposes
- Marking on the lamps > safety standards like IEC give guidelines
- Labeling on the package > regional labeling keeps prices lower
Power factor – a mathematical explanation

Displacement = \cos \theta

Current is not in sync with voltage

the **higher** the displacement,
the **lower** the \cos \theta,
the **lower** the power factor \lambda.

Distortion = \frac{1}{\sqrt{1 + THD^2}}

Current has not the same wave shape as voltage

the **higher** the distortion,
the **lower** the distortion factor,
the **lower** the power factor \lambda.
**Impact of Power factor**

<table>
<thead>
<tr>
<th></th>
<th>Displacement gets worse</th>
<th>Distortion gets worse</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power company</strong></td>
<td>Needs to generate more power that is unpaid for.</td>
<td>No effect.</td>
</tr>
<tr>
<td><strong>Transport &amp; Distribution company</strong></td>
<td>Causes a higher current (I) to flow that requires upgrading of wiring, isolators and materials. It also causes higher losses in the system.</td>
<td>No effect.</td>
</tr>
<tr>
<td><strong>Commercial buildings, Industry</strong></td>
<td>No effect.</td>
<td>Can lead to overheating of the neutral wire in a 3-phase, 380V electrical installation.</td>
</tr>
<tr>
<td><strong>Consumer</strong></td>
<td>No effect.</td>
<td>No effect.</td>
</tr>
</tbody>
</table>
Impact of electrical devices on power factor

Resistive devices:
- Heaters
- No impact

Reactive devices:
- Inductive
  - Electro engines • pumps • cooling
  - Displacement only

Capacitive devices:
- Electronics
  - Displacement and distortion

BUT

- Inductive: Engines • pumps • compressors
- Capacitive: Electronics

less displacement
Displacement and Distortion in CFL

Applying the formula \( \approx \cos \phi \times \frac{1}{\sqrt{1 + THD^2}} \) leads to following theoretical graph:

The power factor of CFLs is within two bandwidths:
- For low power factor CFL this is between **0.5 and 0.6**.
- For high power factor CFL this is between **0.9 and 1**

The typical values for CFL for the 3 metrics: (1) power factor, (2) distortion and (3) displacement are plotted in the graph:

- **High power factor CFL**:
  1. \( \approx 0.90 \)
  2. Distortion = 20%
  3. Displacement = 0.92

- **Low power factor CFL**:
  1. \( \approx 0.55 \)
  2. Distortion = 120%
  3. Displacement = 0.86
High Power Factor is a different spec.
It is NOT higher quality.

Both are trusted PHILIPS quality

\[ \lambda = 0.55 \]
\[ \lambda = 0.90 \]

Disadvantages of a HPF CFL

More components = higher cost
More components = less reliability
More components = more E-waste
More components = lower efficacy

NOT higher quality

200 km/h
Different spec
300 km/h
Conclusion

In IEC a lot of topics have been described & standardized. By joining this international association you can participate in working groups & co-write new standards. It is important to note that CURRENT EFFICIENCY FACTOR (CFL) is not a requirement in national standards and legislation for CFL.

Current existing international standards are sufficient:

- **CFL with power < 25 Watt:** \( \varphi \geq 0.55 \)
- **CFL with power \( \geq 25 \) Watt:** \( \varphi \geq 0.90^{(*)} \)

\( (*) \) High Voltage only
Advised balanced performance standard – CFL-i

<table>
<thead>
<tr>
<th>Main functionality criteria</th>
<th>Advised minimum performance requirement</th>
<th>Philips additional remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamp life</td>
<td>≥ 6000 hrs</td>
<td>Test conform IEC 60969</td>
</tr>
<tr>
<td>Efficacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Power of bare lamp (W)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Luminous Efficacy (lm/W)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCT</td>
<td>≤ 4500K</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥ 4500K</td>
<td></td>
</tr>
<tr>
<td>&lt; 5</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>≥ 5 to &lt; 9</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>≥ 9 to &lt; 16</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>≥ 16 to &lt; 25</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>≥ 25</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Colour rendering (CRI)</td>
<td>≥ 80</td>
<td></td>
</tr>
<tr>
<td>Switching withstand</td>
<td>≥ 3000</td>
<td>half the lamp lifetime expressed in hours &amp; 50% samples shall survive at the rated number of switching cycles</td>
</tr>
<tr>
<td>Lumen maintenance</td>
<td>@ 2000hrs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥ 80%</td>
<td></td>
</tr>
<tr>
<td>Start up time (to 1 lumen)</td>
<td>2.0 sec</td>
<td></td>
</tr>
<tr>
<td>Run up time (to 60%)</td>
<td>180 sec</td>
<td></td>
</tr>
<tr>
<td>Non-performance related elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Factor</td>
<td>not included</td>
<td>This element has no effect on quality of the lamp, see Annex B</td>
</tr>
<tr>
<td>Mercury content</td>
<td>≤ 5mg</td>
<td>Philips supports the UN Minamata Treaty: &lt;=5mg for CFL &lt;=30W in general lighting</td>
</tr>
</tbody>
</table>
Advised balanced performance standard – Ecohalogen

<table>
<thead>
<tr>
<th>Main functionality criteria</th>
<th>Advised minimum performance requirement</th>
<th>Philips additional remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamp life</td>
<td>≥ 1500 hr</td>
<td></td>
</tr>
<tr>
<td>Maximum rated power (Pmax) for a given rated luminous flux (Φ)</td>
<td>0,8 * (0,88VΦ+0,049Φ) Specialties exempted: colored lamps, directional lamps, lamps &lt; 60lm &amp; &gt; 12000lm, lamps with specific radiation</td>
<td>Correction factor: filament lamp requiring external power supply have maximum rated power Pmax/1,06</td>
</tr>
<tr>
<td>Lumen maintenance</td>
<td>≥ 85 % at 75 % of rated average lifetime</td>
<td></td>
</tr>
<tr>
<td>Number of switching cycles</td>
<td>≥ four x rated lamp life expressed in hours</td>
<td></td>
</tr>
<tr>
<td>Starting time</td>
<td>&lt; 0,2 s</td>
<td></td>
</tr>
<tr>
<td>Lamp warm-up time to 60 % Φ</td>
<td>≤ 1,0 s</td>
<td></td>
</tr>
<tr>
<td>Premature failure rate</td>
<td>≤ 5,0 % at 200 h</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-performance related elements</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamp power factor for lamps with integrated control gear</td>
<td>≥ 0,95</td>
<td></td>
</tr>
</tbody>
</table>

Make use of existing MEPS for definitions, formula’s & exemptions (e.g. EU directive)
Stakeholder engagement

• Experience Europe (EU)
  • EU Parliament promised communication to the people
  • In reality market partners have informed their customers
  • National Lighting Associations have communicated through the chain

• Important to decide regarding GLS ban implementation:
  • Stepwise approach (75&100W / 40&60W / all) <> all at once
  • First import/production ban, then retail ban <> off the shelves at once
  • In case of stepwise / phased approach, choose appropriate timing > preparation of consumers, retailers, distributors, government, industry
Off-grid lighting solutions for Homes

• In 2013 600 - 750 mio people in Africa don’t have access to electricity yet
• In most parts of rural Africa there will not be cables in the ground for decades
• Still these people will need light, because light means education, productivity, security, community life, healthcare after sunset.
• Solar lighting solutions for homes making their entrance into the market
• Solar solutions are usually LED-based
• Key in this start up is to ensure good balance between quality & affordability
• Make use of Lighting Africa, that works towards improving access to better lighting in areas not yet connected to the electricity grid (www.lightingafrica.org)
• List of Minimum Quality Standards & test methods defined, products tested for compliance to performance standards
Proposal

Currently, a proposal is being discussed to replace the power factor requirement in IEC 60969 by the two metrics Displacement and Distortion that define the overall power factor:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P &lt; 2W</td>
</tr>
<tr>
<td>$K_{\text{displacement}}$</td>
<td>No Limit</td>
</tr>
<tr>
<td>$K_{\text{distortion}}$</td>
<td>No Limit</td>
</tr>
</tbody>
</table>

Regulated by IEC 61000-3-2

Applying above values in the formula $\varphi = \cos \theta \times \frac{1}{\sqrt{1 + THD}}$ will NOT change the current required values of power factor ($\varphi$) for CFL:

- **CFL with power < 25 Watt:** $\varphi \geq 0.55$
- **CFL with power ≥ 25 Watt:** $\varphi \geq 0.90$
Power factor consists of two metrics:

Displacement (cosφ)  and  Distortion (THD)

When the power factor gets worse, it DOES have a negative effect on the efficacy and efficiency of the power system.

(generation, transport and distribution)
Power Factor Summary - 2

When looking at power generation and power transport & distribution, the negative effects are caused by the metric displacement (cosφ) only.

The metric distortion (THD) can lead to overheating of the PEN conductor that only affects a 3-phase 380V system as used in large buildings.

For the metric that matters, cosφ, the values for low and high power factor CFLs are very similar.

Low power factor CFL: Ψ = 0.55 → Cos φ = 0.86
High power factor CFL: Ψ = 0.90 → Cos φ = 0.92
Independent studies of large scale replacement programs, DID NOT find any negative effect of using low power factor CFLs on the overall power factor of the grid in situations of a national grid with mixed load.

Only in the very specific situation of an isolated grid with only CFLs connected, high power factor CFLs can have a benefit.
Power Factor Summary - 4

International standards prescribe a power factor for Lighting equipment of:

- \( \lambda \geq 0.55 \) with power < 25 Watt:
- \( \lambda \geq 0.90 \) with power \( \geq 25 \) Watt:

Since there is no advantage of HPF versus LPF CFL, any new NATIONAL standard and/or legislation can copy this.
Governments often ask for HPF for reasons of

Governments think that High Power Factor is higher quality.  

**False**

Governments are ignorant to the power factor subject, so just to play it safe, they ask for high power factor, thinking **High Power Factor will not have any disadvantages.**

**False**

Governments think that a large replacement of GLS that have power factor of 1 by CFLs with **power factor of 0.55 will have a negative impact on the overall power factor of the grid and thus the efficacy.**

**False**

Governments say the CFLs are distributed in a newly electrified area. They claim that in situations where **CFLs are the only electrical products connected to the grid, its power factor does matter.**

**True**
Wattage equivalences for GLS

<table>
<thead>
<tr>
<th>GLS</th>
<th>Halogen</th>
<th>CFL-i</th>
</tr>
</thead>
<tbody>
<tr>
<td>25W</td>
<td>~ 18W</td>
<td>~ 5W</td>
</tr>
<tr>
<td>40W</td>
<td>~ 28W</td>
<td>~ 8W</td>
</tr>
<tr>
<td>60W</td>
<td>~ 42W</td>
<td>~ 12W</td>
</tr>
<tr>
<td>75W</td>
<td>~ 53W</td>
<td>~ 15W</td>
</tr>
<tr>
<td>100W</td>
<td>~ 70W</td>
<td>~ 20W</td>
</tr>
</tbody>
</table>