Day 2

Welcome Back!

Asia-Pacific
Economic Cooperation

Australian Government

Department of Climate Change
and Energy Efficiency

Key Actions for APEC Economies

LED Lamps: What Performance Criteria & Information Matter to Consumers?

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Asia-Pacific Economic Cooperation

Australian Government
Department of Climate Change and Energy Efficiency

Soft! Pleasing! Relaxing! Comfortable! Bright! Crisp!

So Many Unfamiliar Choices for Consumers…

Top Three Performance Criteria: Consumer Perspectives

1. **FIT:** Does it fit in my fixture (luminaire)?

2. **FUNCTION:** Does it give me enough light, where I need it?

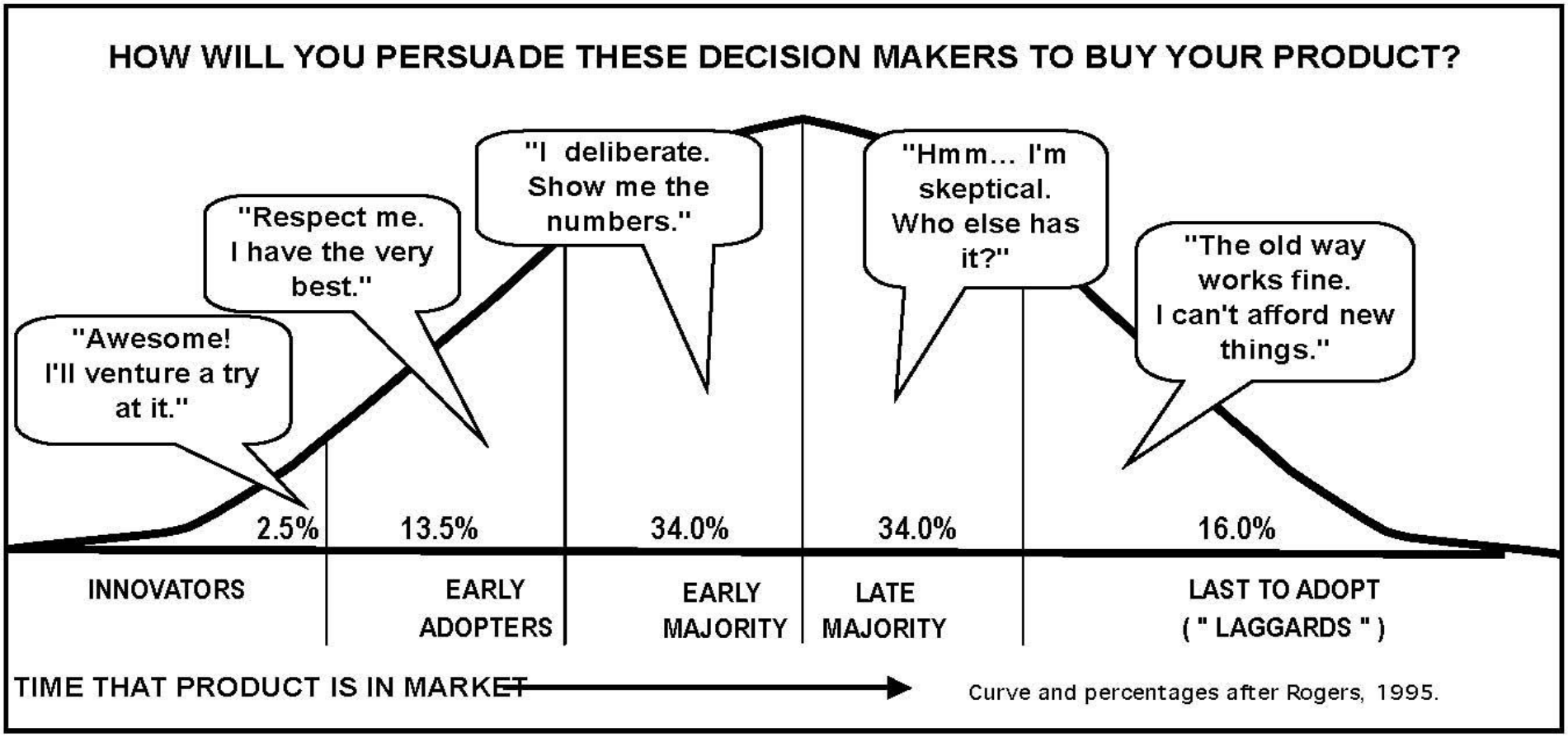
3. **COST:** Is it a reasonable cost for the service I expect?

Performance Criteria: Consumer Expectations

- **Same lighting service** (or better than) what was delivered by their legacy lamp, in their unique situation.
- **Same light distribution and intensity pattern.**
- Note: Total luminous flux (lumens) is not sufficient info!
- **Good color** rendering, at a similar **color temperature.**
- **Temporal control:** instant on; smooth dimming; automatic off/on with sensing.
- **Do no harm:**
  - "Don't blink, buzz or blow up!"
  - "Don't disable me with glare."
  - "Don't mess with my electronics gear."
  - "Don't put mercury in my home or near my kids."
  - "Don't leave me in the dark when I need to read!"

Consumer Marketing: Art & Science

- LED lamps are like anything else that's for sale…
- **Psychographic profiles** help target and influence buyers.
- **Multiple messages** required to appeal to each type of buyer

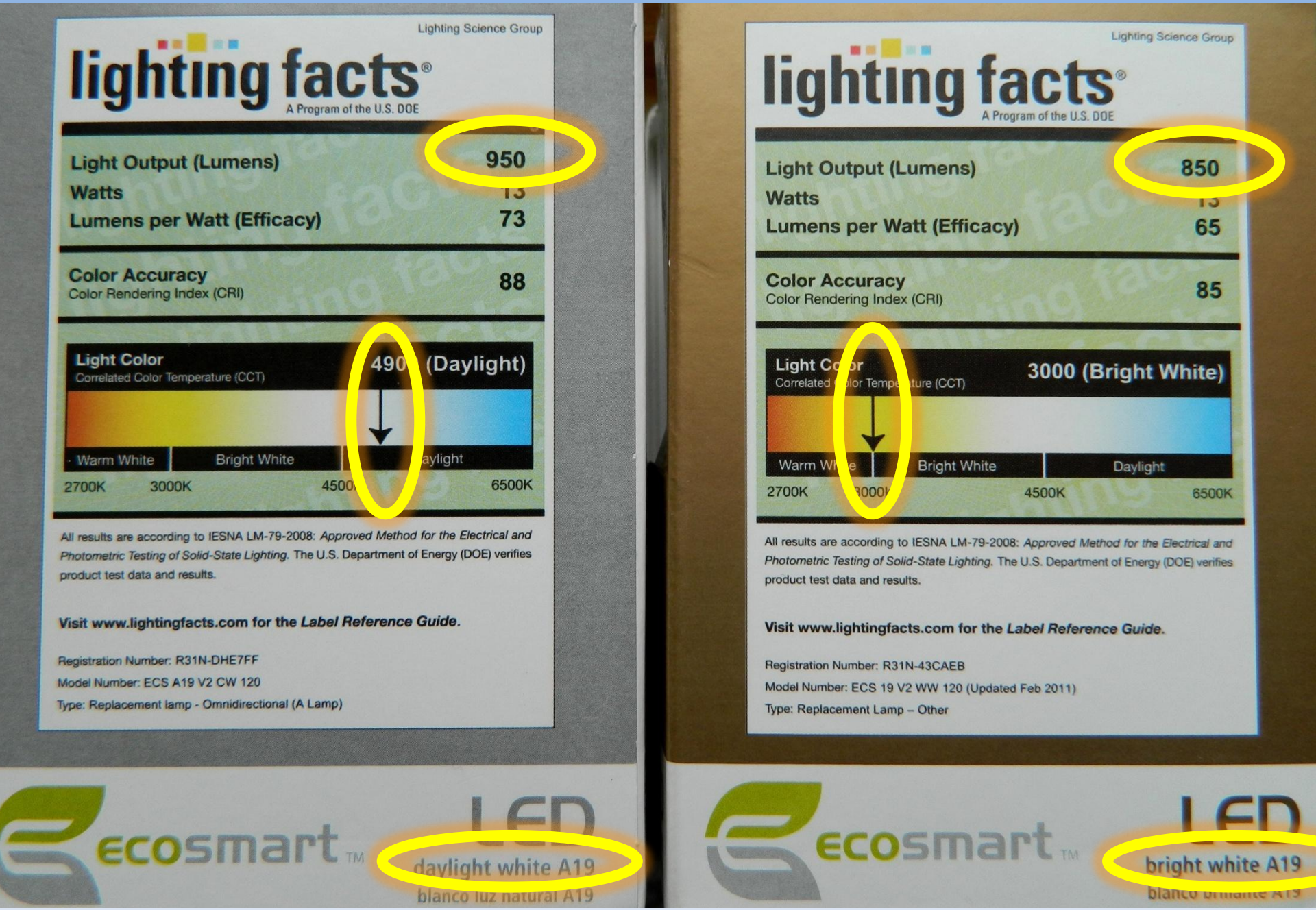


“Hurry, Just Show Me the Right Lamp!”

Singapore, 1-2 November 2011

What Do Consumers Need to Know ?

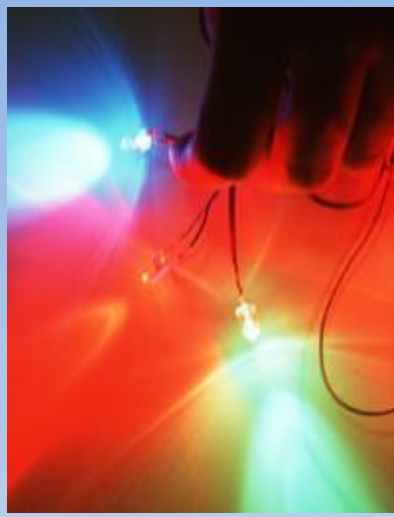
- **Need to know** what service and performance they can expect... they don't need a semiconductor graduate degree!
- Lamps are an **insignificant item**—not a big investment, like a car or computer.
- Describe these **characteristics:**
  - Form factor: shape, size, & lamp base;
  - Light distribution pattern and total luminous flux;
  - Color temperature and color rendering;
  - Useful hours (or years);
  - Wattage;
  - Warranty terms; and
  - Costs.
- **Info must be accurate:** consumers need third-party measurement, verification and enforcement!


Lighting Science Group
lighting facts®
A Program of the U.S. DOE
Light Output (Lumens) 950
Watts
Lumens per Watt (Efficacy) 73
Color Accuracy
Color Rendering Index (CRI) 88
Light Color
Correlated Color Temperature (CCT)
(Daylight)
Warm White
Bright White
2700K
3000K
6500K
All results are according to IESNA LM-79-2008: Approved Method for the Electrical and Photometric Testing of Solid-State Lighting. The U.S. Department of Energy (DOE) verifies product test data and results.
Visit www.lightingfacts.com for the Label Reference Guide.
Registration Number: R31N-DHE7FF
Model Number: ECS A19 V2 CW 120
Type: Replacement lamp - Omnidirectional (A Lamp)
ecosmart
LED
daylight white A19
Lighting Science Group
lighting facts®
A Program of the U.S. DOE
Light Output (Lumens) 850
Watts
Lumens per Watt (Efficacy) 65
Color Accuracy
Color Rendering Index (CRI) 85
3000 (Bright White)
Bright White
Daylight
2700K
4500K
6500K
All results are according to IESNA LM-79-2008: Approved Method for the Electrical and Photometric Testing of Solid-State Lighting. The U.S. Department of Energy (DOE) verifies product test data and results.
Visit www.lightingfacts.com for the Label Reference Guide.
Registration Number: R31N-43CAEB
Model Number: ECS 19 V2 WW 120 (Updated Feb 2011)
Type: Replacement Lamp – Other
ecosmart
LED
bright white A19

What Appeal & Benefits Do LED Lamps Offer?

- **High-tech appeal:** just like digital devices that are ubiquitous worldwide. Many consumers first get to know LEDs through their (or their friends') much-loved entertainment systems. ☺
- **Last a long time**... LED lamps may outlive the consumer!
- **Cost savings:** Substantial energy and operating cost reductions over the useful life of the lamp.
- **Eco-friendly:** contain no mercury, reduce energy use.
- **Good warrantees:** If consumers are unsatisfied with performance, they can get their money back.
- **Better color rendering (possibly):** Obvious enhancement ???

Light from LEDs



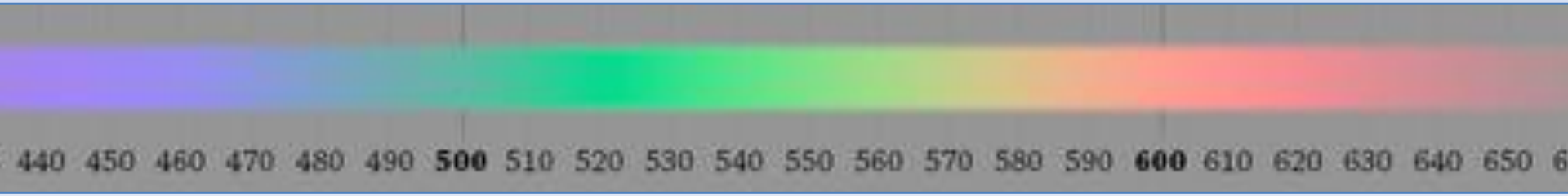
Color (hue) of light

- Each LED emits light in only one specific color per diode. Color is specified by wavelength, in nanometers (nm).
- Emissions from ultraviolet (UV) to infrared (IR).

"White" light: created several ways:

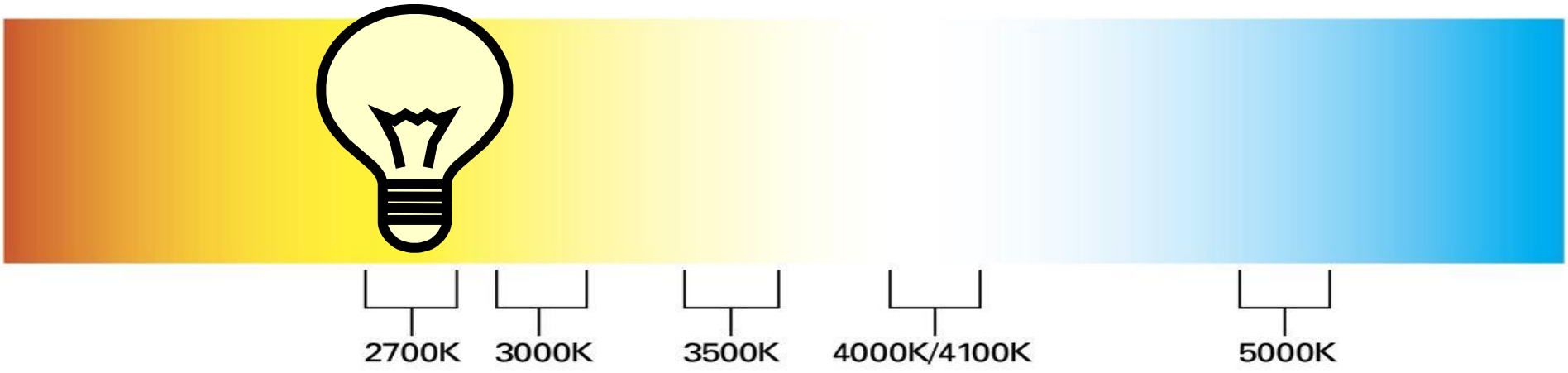
- RGB: red+green+blue chips
- Complementary: blue (or UV) chips + yellow phosphors.
- "Enhanced": add amber or red chips to above.

Human visual system integrates the intensities of all wavelengths to "see white."

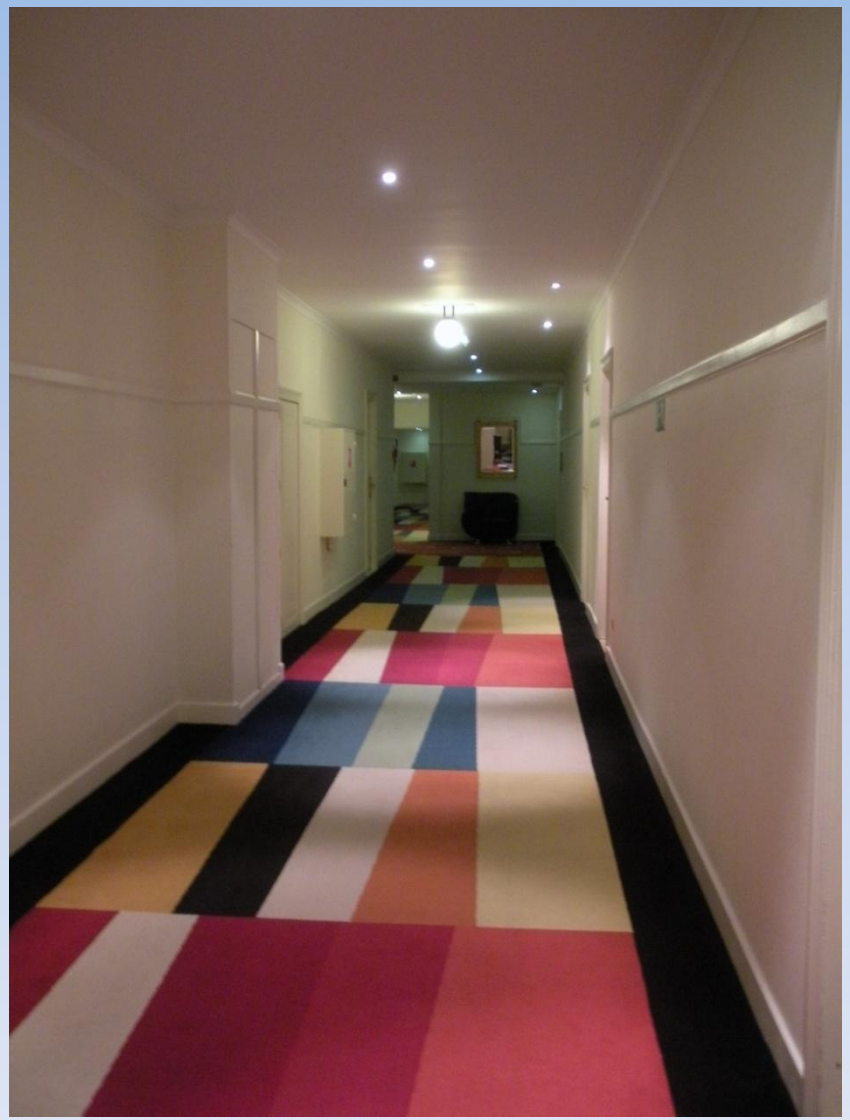


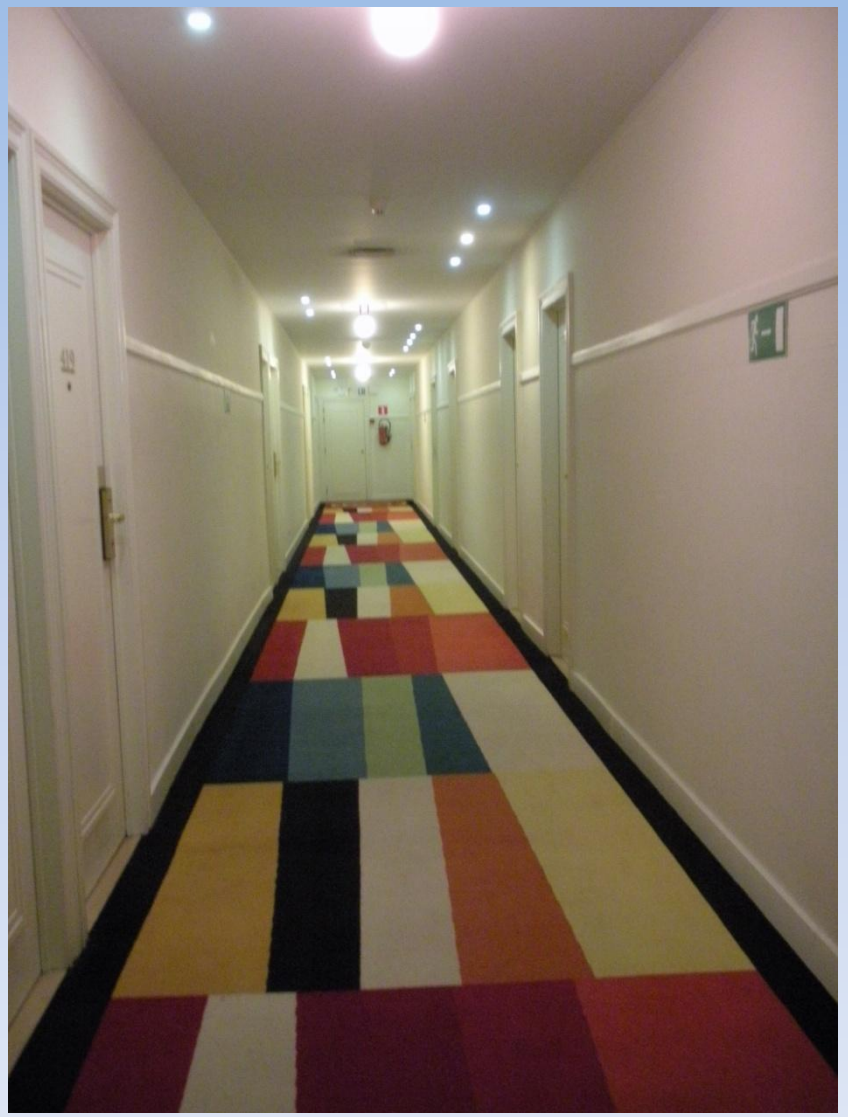
Correlated Color Temperature (CCT)

- Measured in degrees Kelvin (K).
- Indicates how “warm” or “cool” the white light is.
- Lower number means warmer white (like sunrise/sunset); higher number means cooler white (like a sunny noontime).
- Residential lighting is very personal, so consumers may have a strong, preconceived preference for warm or cool white.
- Marketers all over the world use *creative vocabulary* to describe white light. Instead, use a simple graphic to help consumers:



Color Appearance: Difficult to Quantify

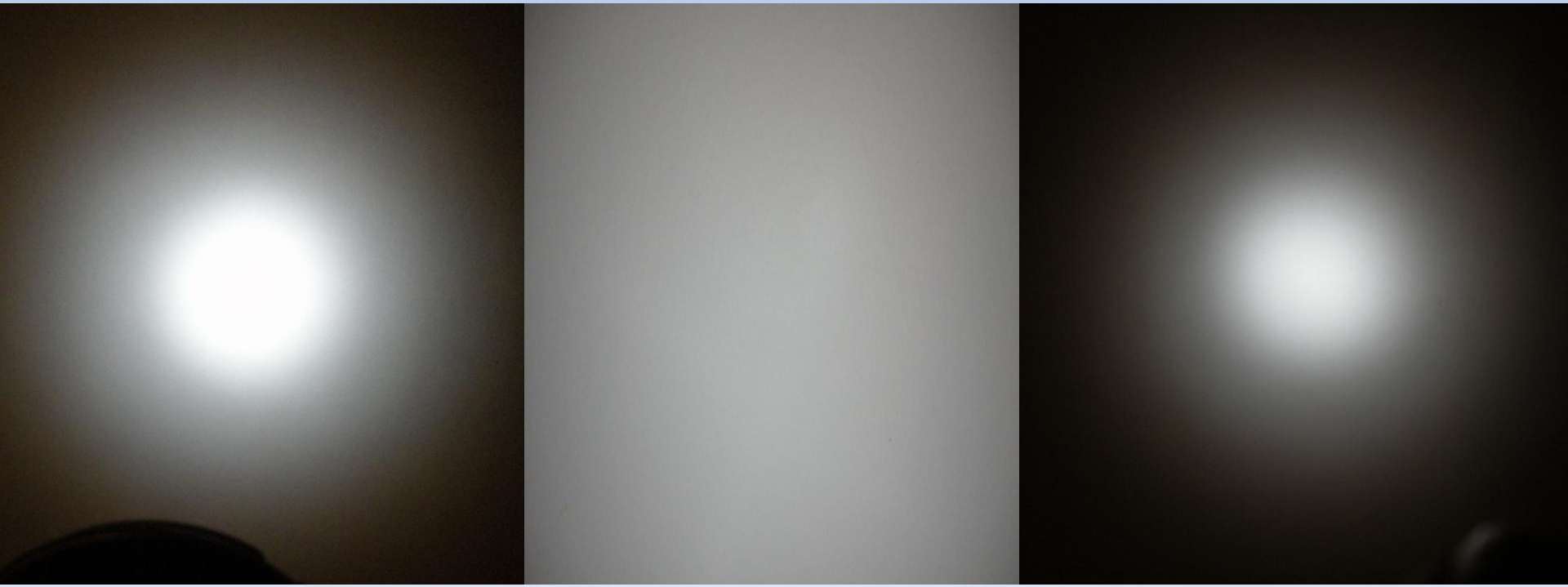




Temperature, Age and Poor Process Control Can Cause Phosphor-Converted Light to: "Color Shift" & Color Rendering to Decrease

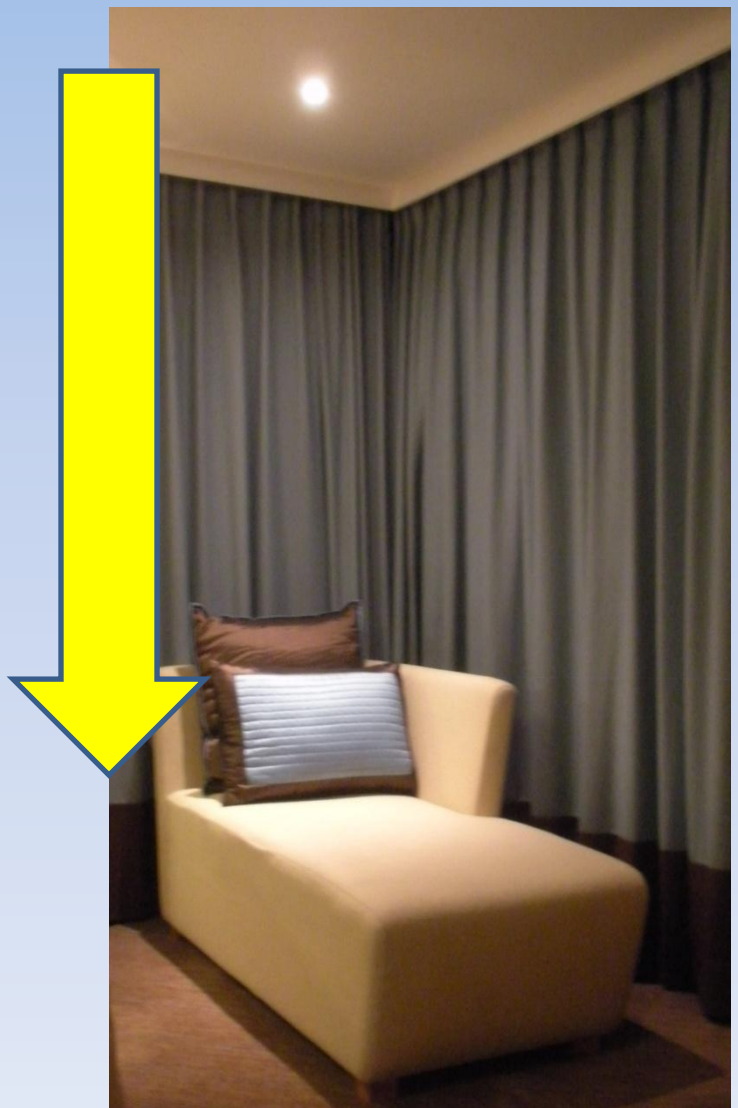
Light Patterns

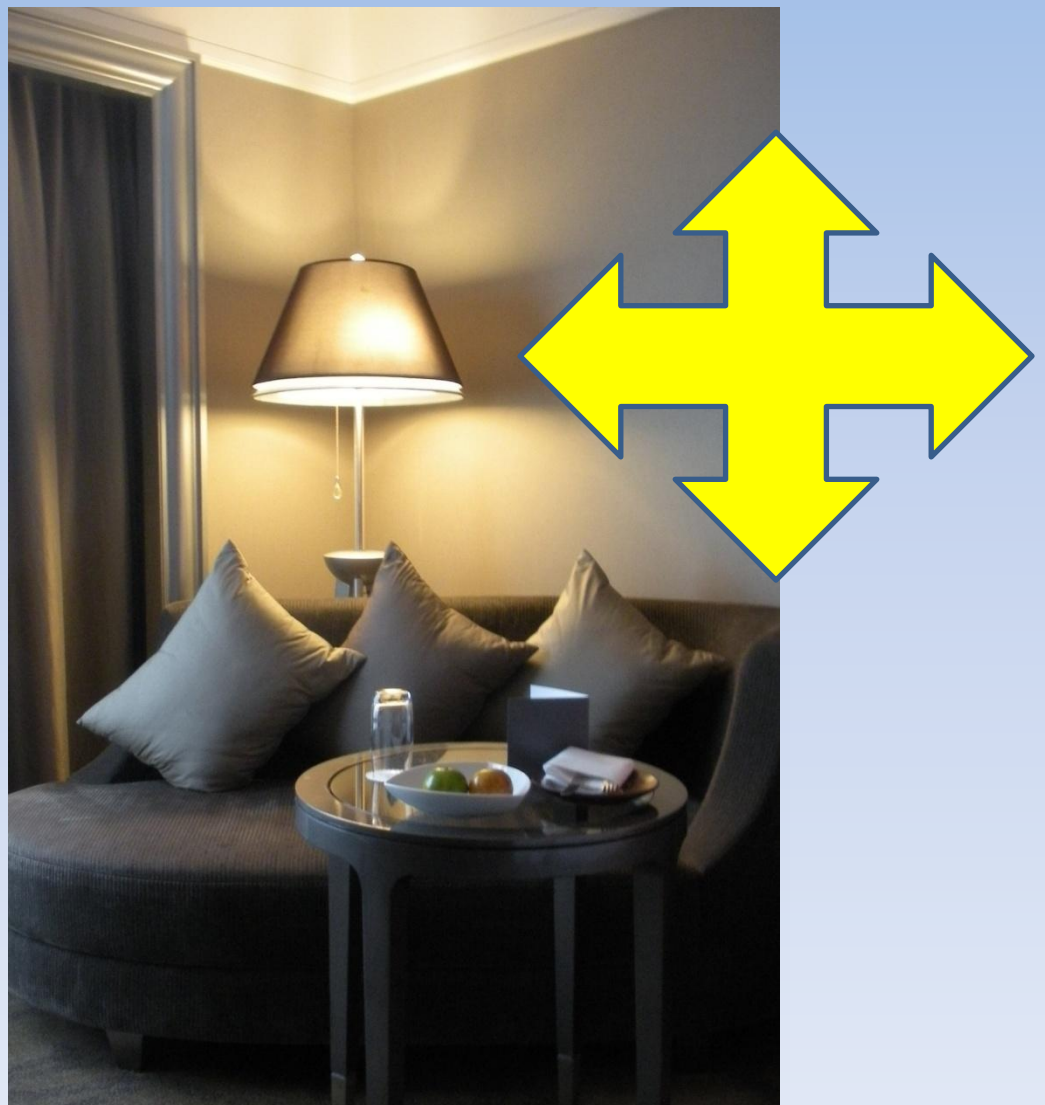
- The same amount of light delivered to a similarly-sized area (from lamps at the same distance from the surface) can give radically different-looking results.
- The optics of the lamp determine the result.
- Thus, initial light output (lumens) is not sufficient info for buyers.



Lamp Beam Patterns:
Directional, or, Omnidirectional

(More Useful Than “Bulb-Type” Naming Methods)





Who Should Provide LED Lamp Information?

- **Manufacturers, retailers and advertisers:** standardized, model-specific technical and performance info.
- **Government and independent, third parties:** general education and motivation (for energy & environmental benefits); product-specific performance evaluations.
- **Electric utilities:** Be ready to explain how LEDs can reduce demand, lower operating costs, and deliver good service. Consider demonstrations, providing leased products, offering rebates, or providing other incentives.

Best Ways to Deliver LED Product Information

- **Social media:** Peer-to-peer communication is very important, and too often underestimated. Lighting is a social enabler... and an aesthetic means of communication. People will like what their friends and family like, so try to educate "social influencers."
- **Product labels:** Best if standardized, with a clear and common vocabulary and graphics.
- **Point-of-purchase:** Have answers ready when consumers have questions! Use displays, and allow customers to compare effects.
- **Warning:** Negative info has much greater impact than positive... and is difficult to "undo."

Consumer Warranty

- **Social signal** that manufacturer/retailer wants to have an ongoing relationship with consumer/user of lighting services.
- Increases consumers' willingness to **try a new product** by decreasing economic risk.
- Gives manufacturer **more credibility,** and also limits damages if consumer has a problem.
- Offers a **legal process** for delivering "justice" if product is unsatisfactory or harmful.
- **Eases burden on third-parties** that are promoting energy-efficiency and environmental objectives via lighting programs.

Thank You!

Performance Standards – Parameters

Possible Key Performance parameters
Concept of a Tiered Approach

Steve Coyne

Asia-Pacific Economic Cooperation

Australian Government
Department of Climate Change and Energy Efficiency

PERFORMANCE PARAMETERS

There are numerous parameters which relate to different aspects of LED lighting products.

These can be broadly categorised into:

- electrical safety
- photobiological safety
- power quality
- Photometric
- light quality

Most of the parameters within each are covered well for existing lamp technologies but LED lighting products present some imminent challenges.

Performance Parameters

Electrical Safety

Power Quality

- Power factor
- Harmonic distortion
- Electrical interference

Photometrics

- Total light output
- Efficacy
- Light distribution
- Beam angle
- Lifetime
- Light depreciation

Photobiological safety

- UV
- Blue light
- Radiance levels

Light Quality

- Start time
- Colour temp (colour of light)
- Colour consistency (between products)
- Colour rendering (colour of illuminated objects)
- Colour uniformity (spatially)
- Colour stability (with time)
- Dimming
- Flicker

Basic Consumer Expectations

- Truth in claim
  - An equal replacement to particular incandescent/halogen product
  - Efficacy
  - Lifetime
  - Colour temp
- Similar or better performance qualities as replaced lamp
  - Colour consistency
  - Colour rendering
  - Light distribution
  - Dimming
  - Start time
  - Efficacy
  - Sustained light output
- Assumed to be covered under generic consumer protection
  - Electrical safety
  - Photobiological safety
  - Power quality

Key Performance Parameters to be considered

Electrical Safety

Power Quality

Photobiological safety

Photometrics

- Total light output & Efficacy
- Light distribution & Beam angle
- Lifetime & Light depreciation

Light Quality

- Start time
- Colour temp & Consistency
- Colour rendering
- Dimming & Flicker

DO WE NEED STANDARDS ?

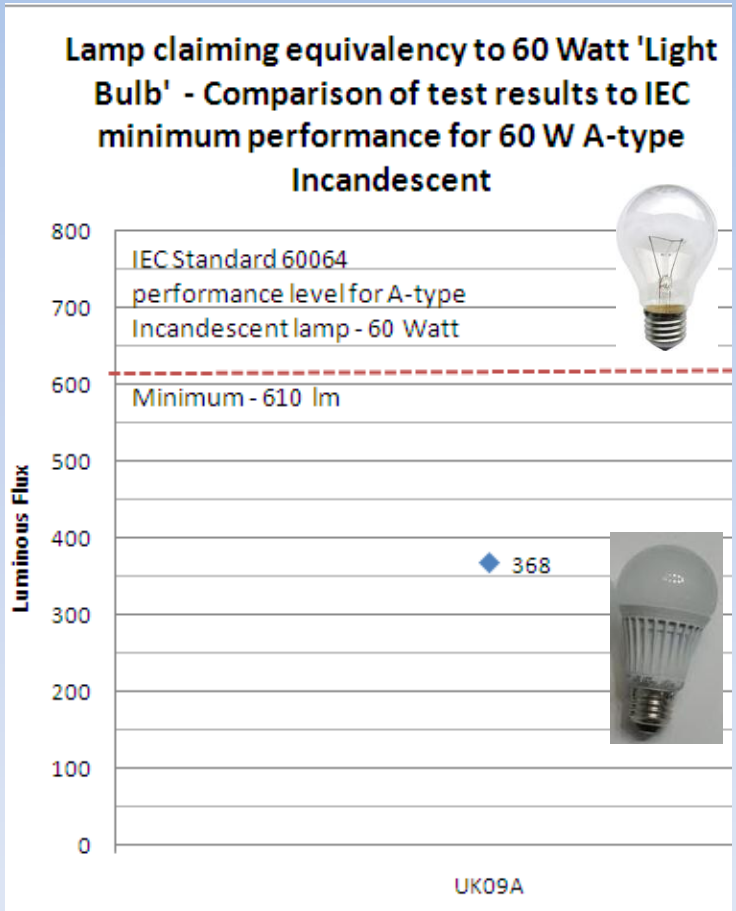
Results from testing products from the market

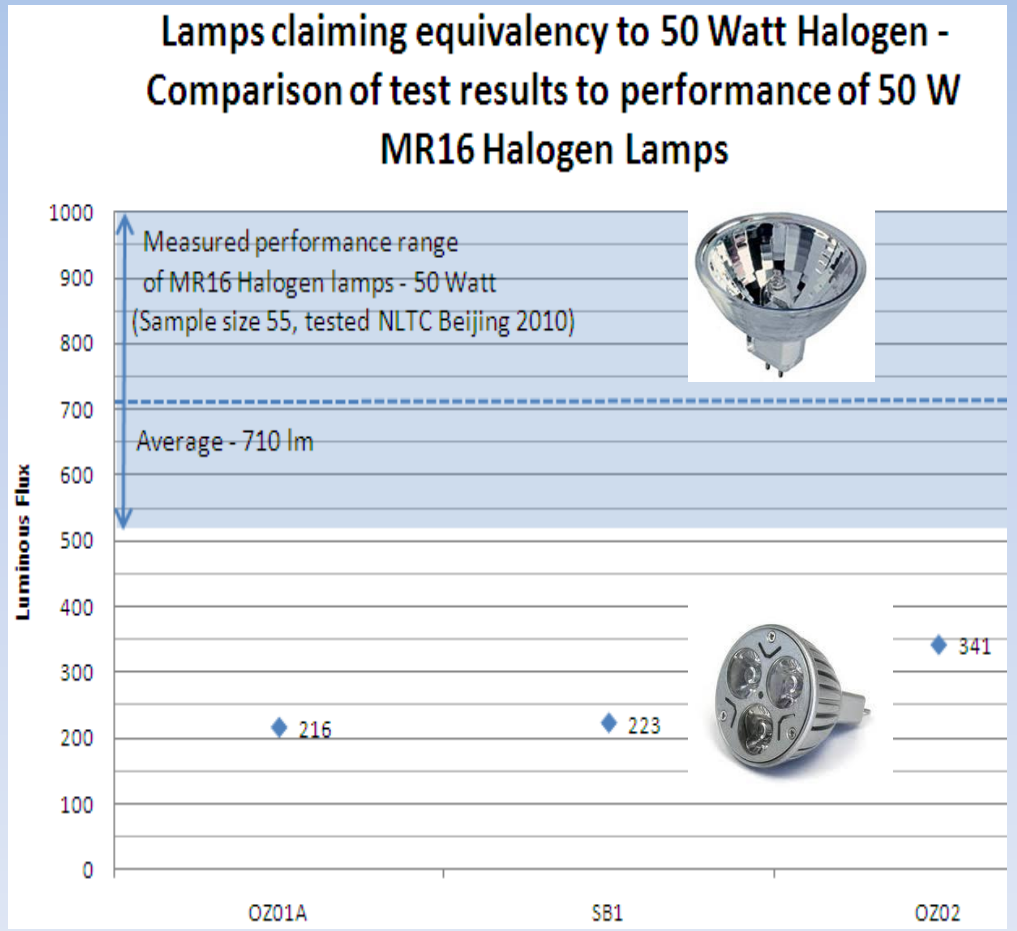
CLAIMS

LIGHT OUTPUT

Light Output

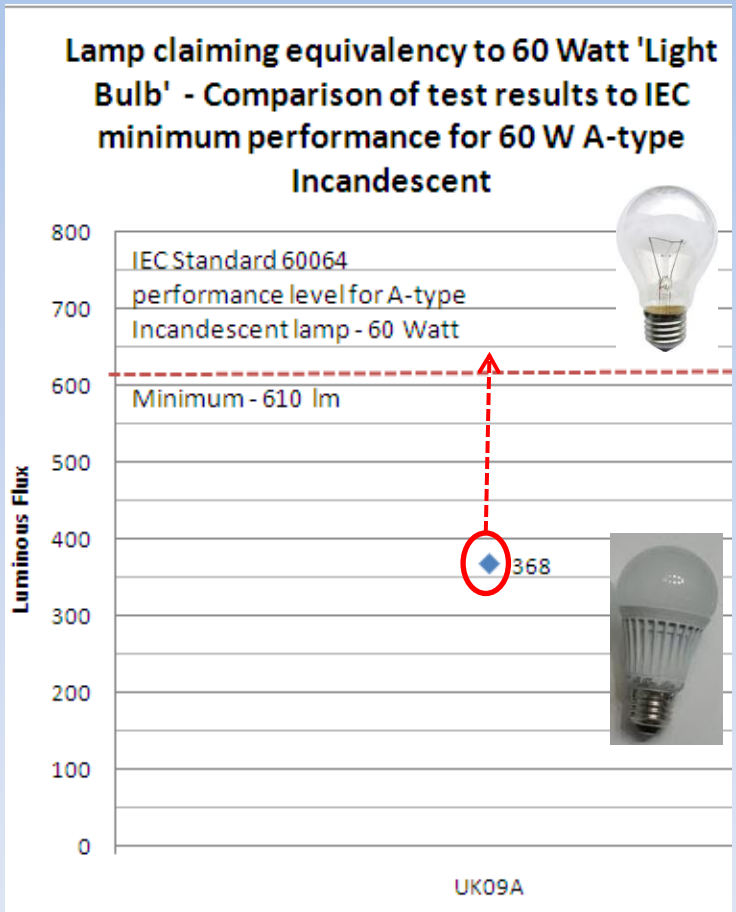
- Packaging that suggests replacement wattage for incandescent/halogen lamps is not achieving like-for-like lumen output.

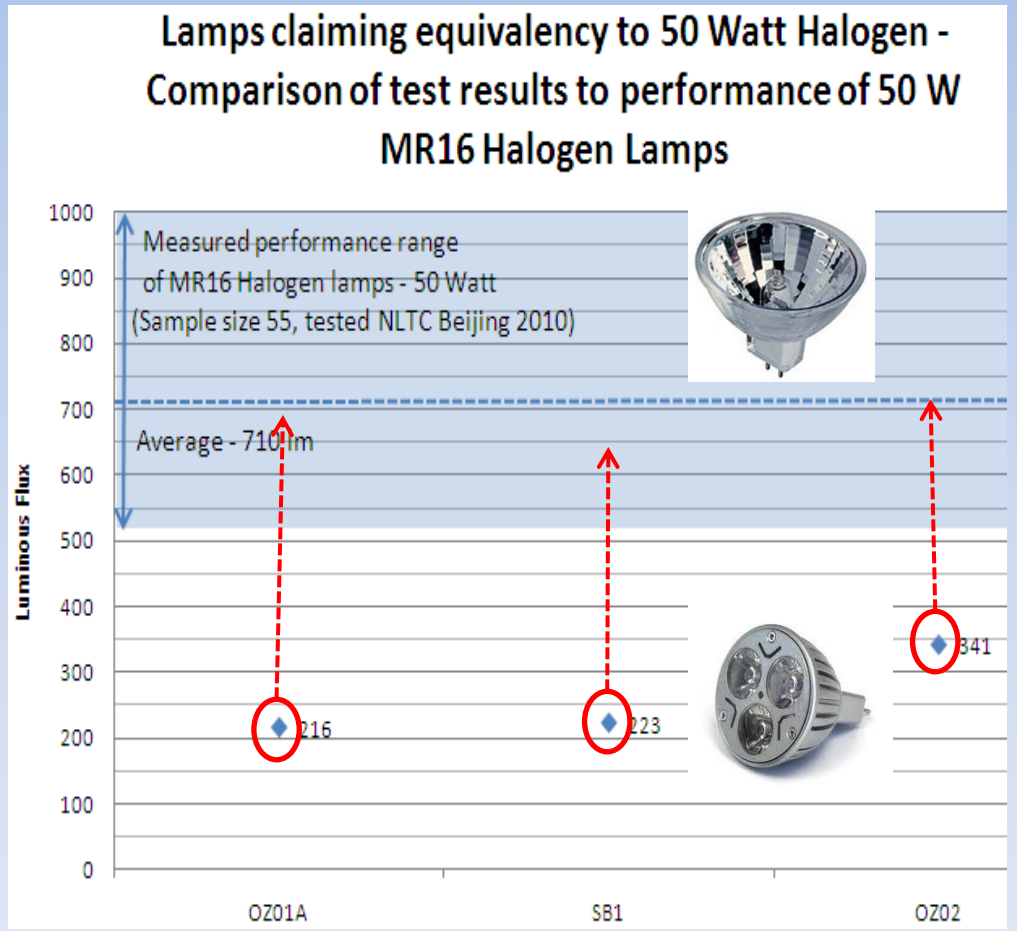




Equivalence Claims – Light Output

- Packaging that suggests replacement wattage for incandescent/halogen lamps is not achieving like-for-like lumen output.

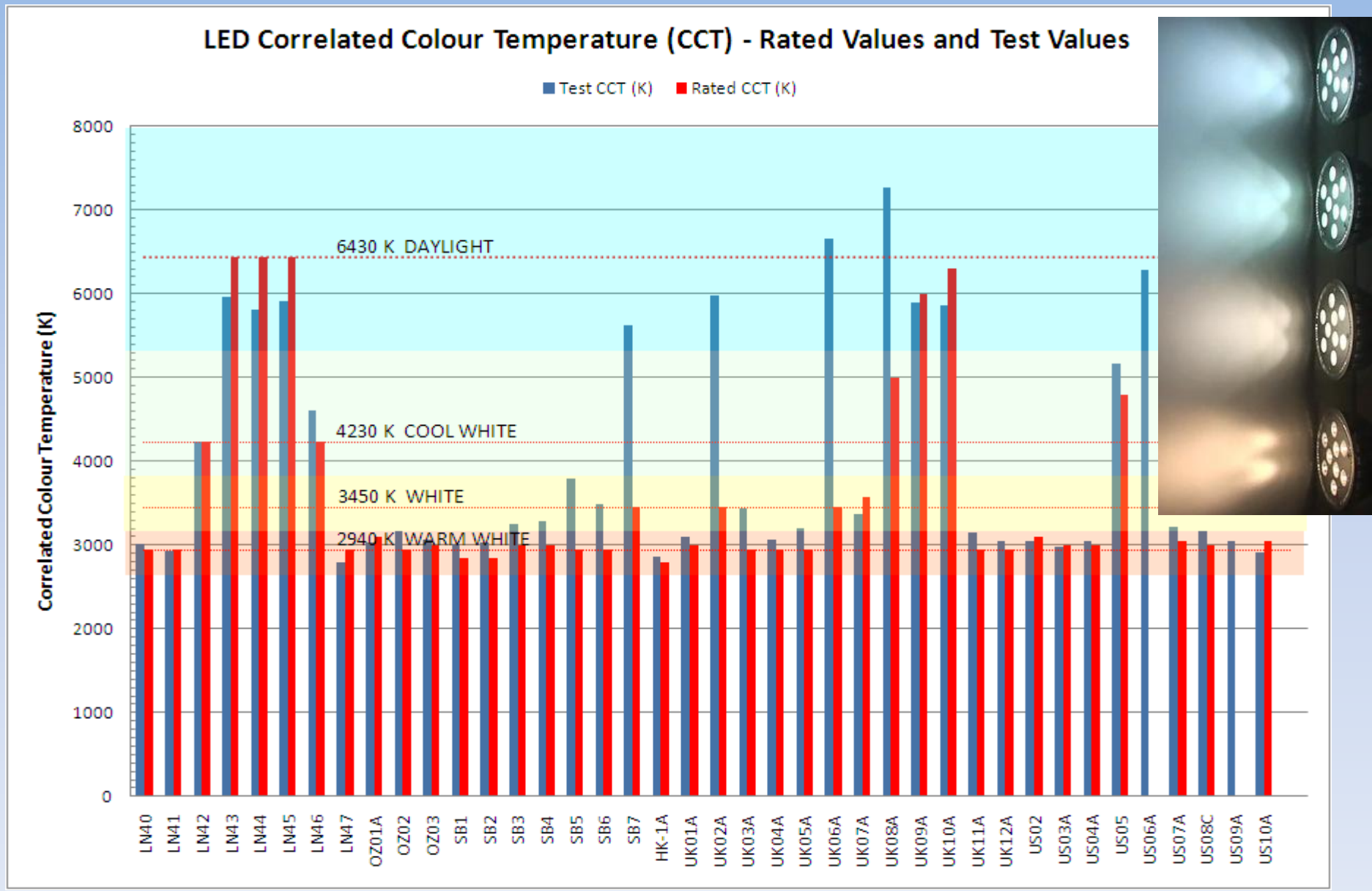




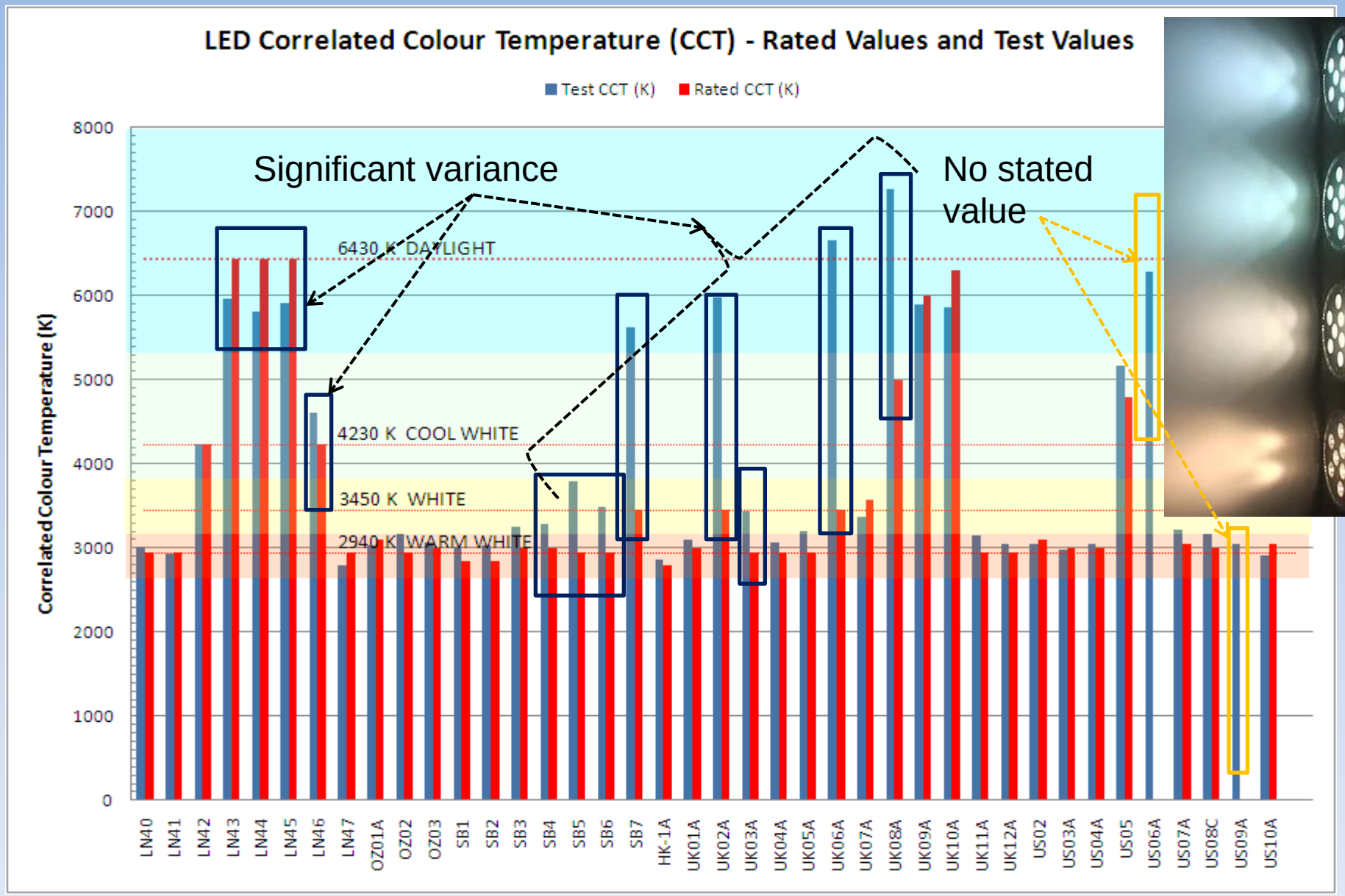
CLAIMS

COLOUR TEMPERATURE

Colour Temperature



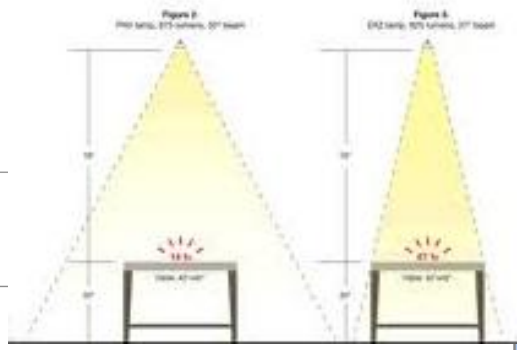
Colour Temperature

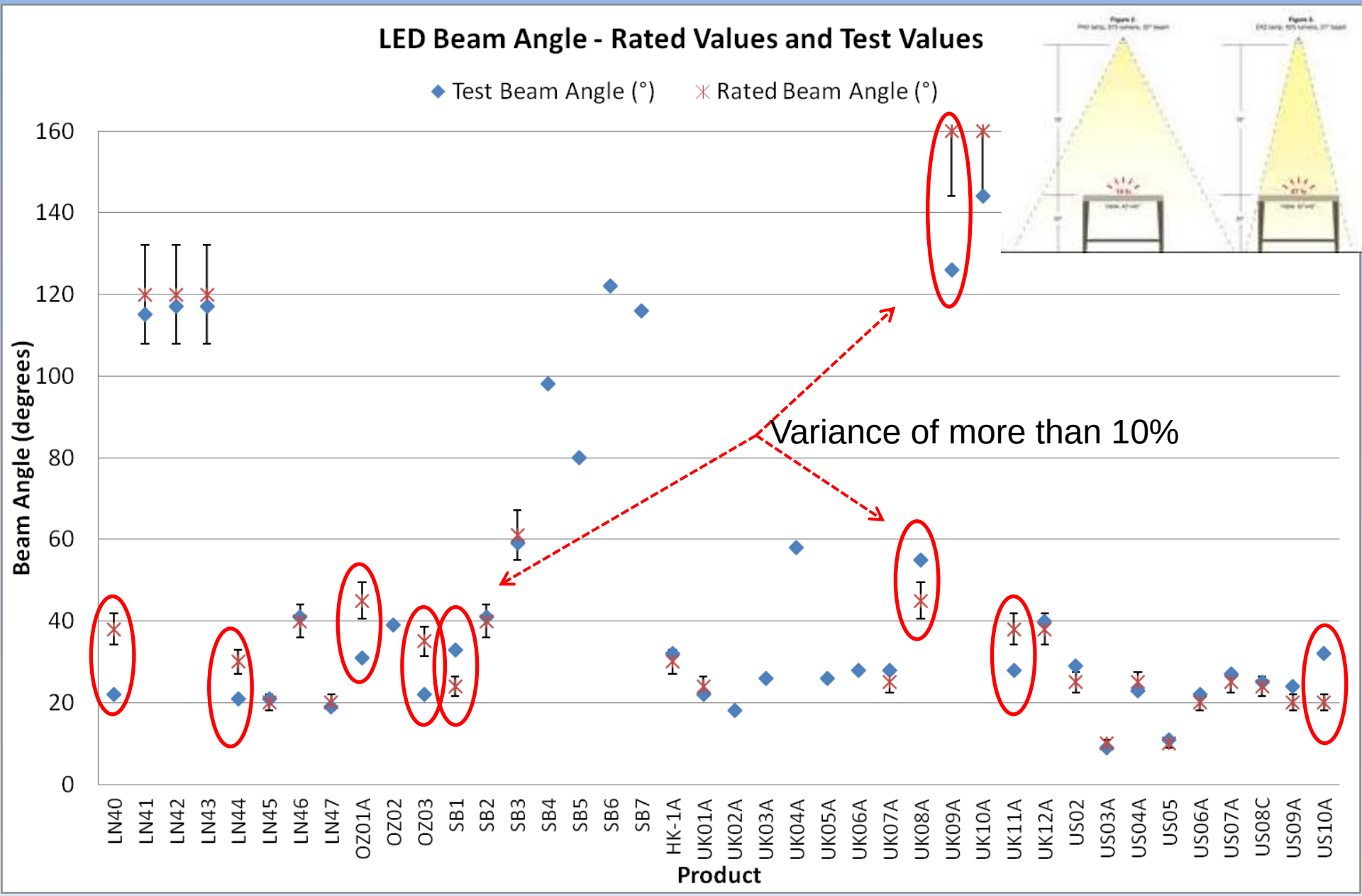


CLAIMS

BEAM ANGLE

LED Beam Angle - Rated Values and Test Values




LED Beam Angle - Rated Values and Test Values
Test Beam Angle (°)
Rated Beam Angle (°)
Beam Angle (degrees)
0
20
40
60
80
100
120
140
160
Variance of more than 10%
LN40
LN41
LN42
LN43
LN44
LN45
LN46
LN47
OZ01A
OZ02
OZ03
SB1
SB2
SB3
SB4
SB5
SB6
SB7
HK-1A
UK01A
UK02A
UK03A
UK04A
UK05A
UK06A
UK07A
UK08A
UK09A
UK10A
UK11A
UK12A
US02
US03A
US04A
US05
US06A
US07A
US08C
US09A
US10A
Product

CLAIMS

LIFETIME

Claimed Lifetime of LED Products

- Within lamp cap types, *claimed* life times vary significantly.
- Little similarity between cap groups in quoted life time bands

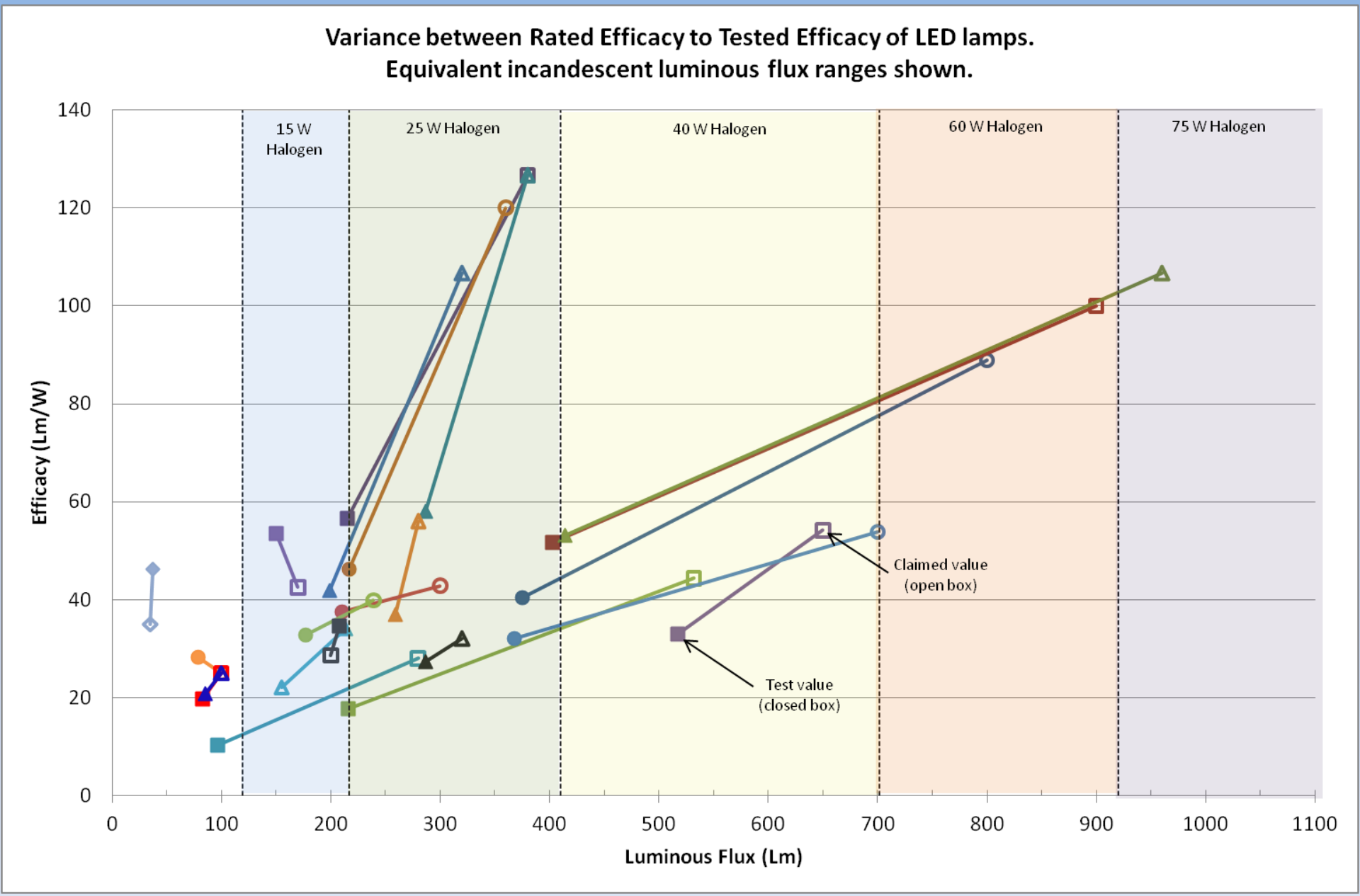


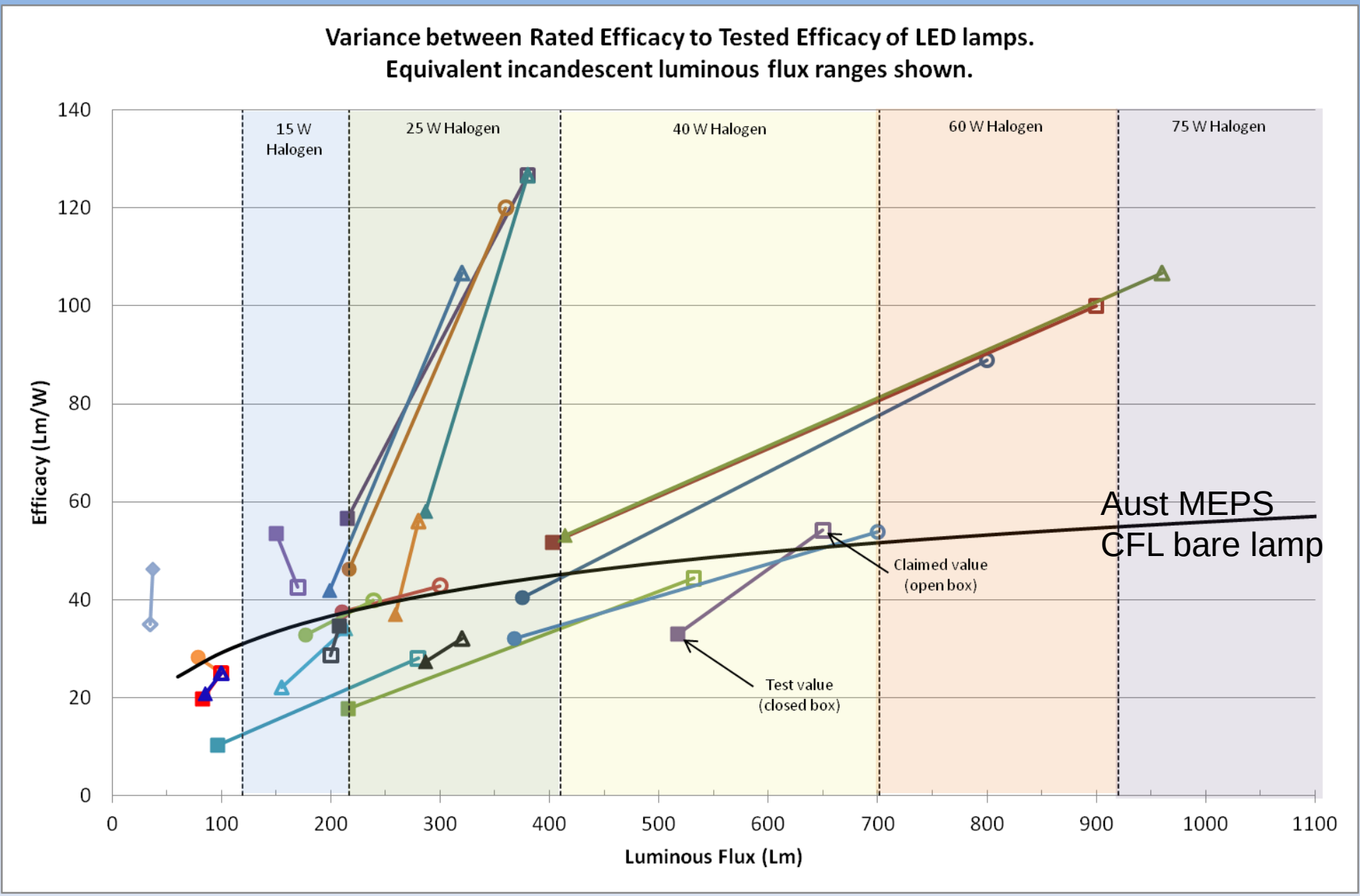

claimed

Lamp Cap	E26/E27	GU10	GU5.3	Fixture
Lifetime (hrs)	**No of Lamps**	**No of Lamps**	**No of Lamps**	**No of Lamps**
12 000		1		
15 000	1	2		
20 000	3		1	
25 000		5		
35 000		1	4	
40 000	1			
45 000			1	
50 000	3	3	2	2
100 000				1

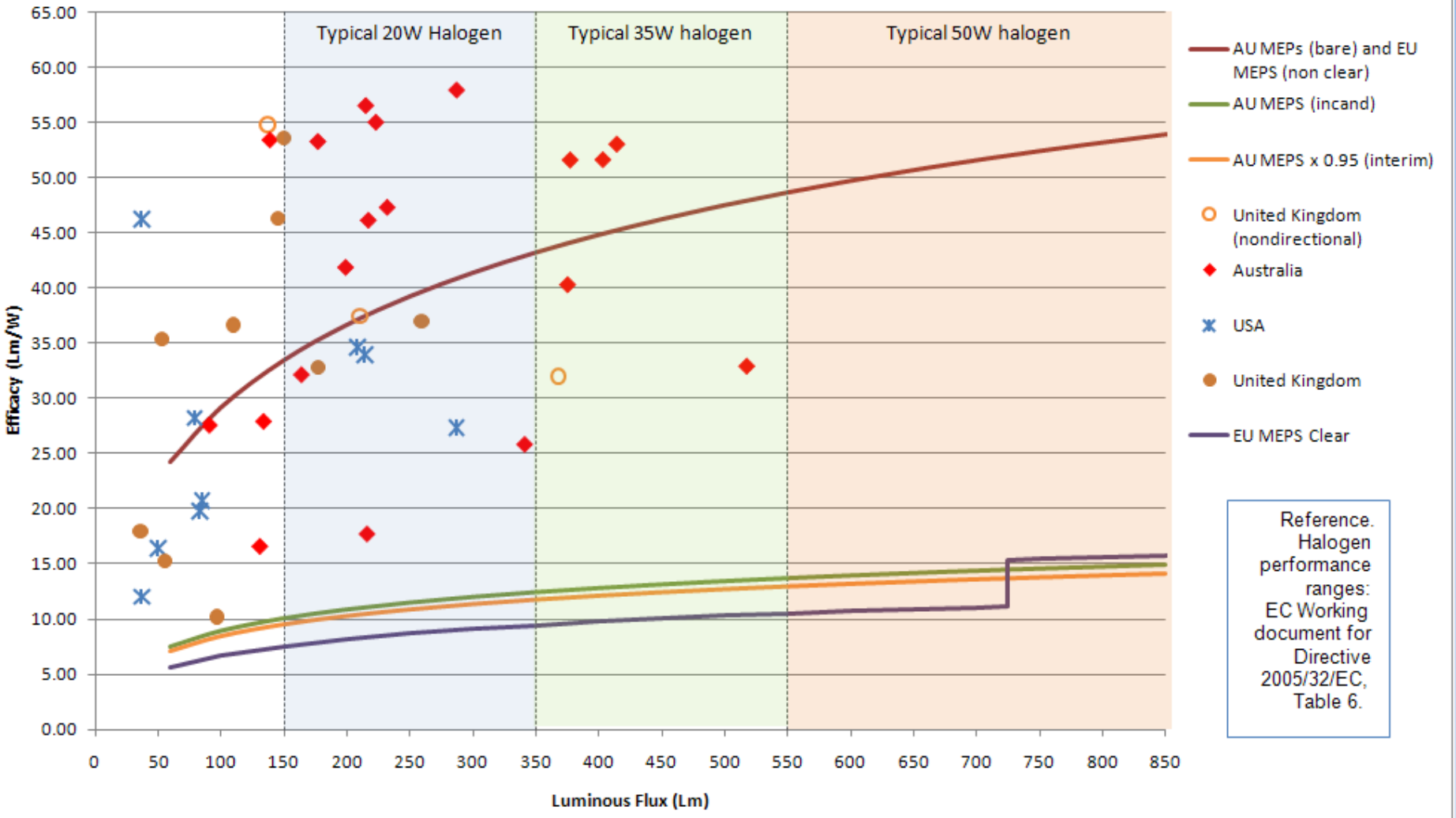
CLAIMS

ENERGY EFFICIENCY


Variance between Rated Efficacy to Tested Efficacy of LED lamps.
Equivalent incandescent luminous flux ranges shown.
15 W Halogen
25 W Halogen
40 W Halogen
60 W Halogen
75 W Halogen
Claimed value (open box)
Test value (closed box)
Efficacy (Lm/W)
Luminous Flux (Lm)
0
20
40
60
80
100
120
140
0
100
200
300
400
500
600
700
800
900
1000
1100

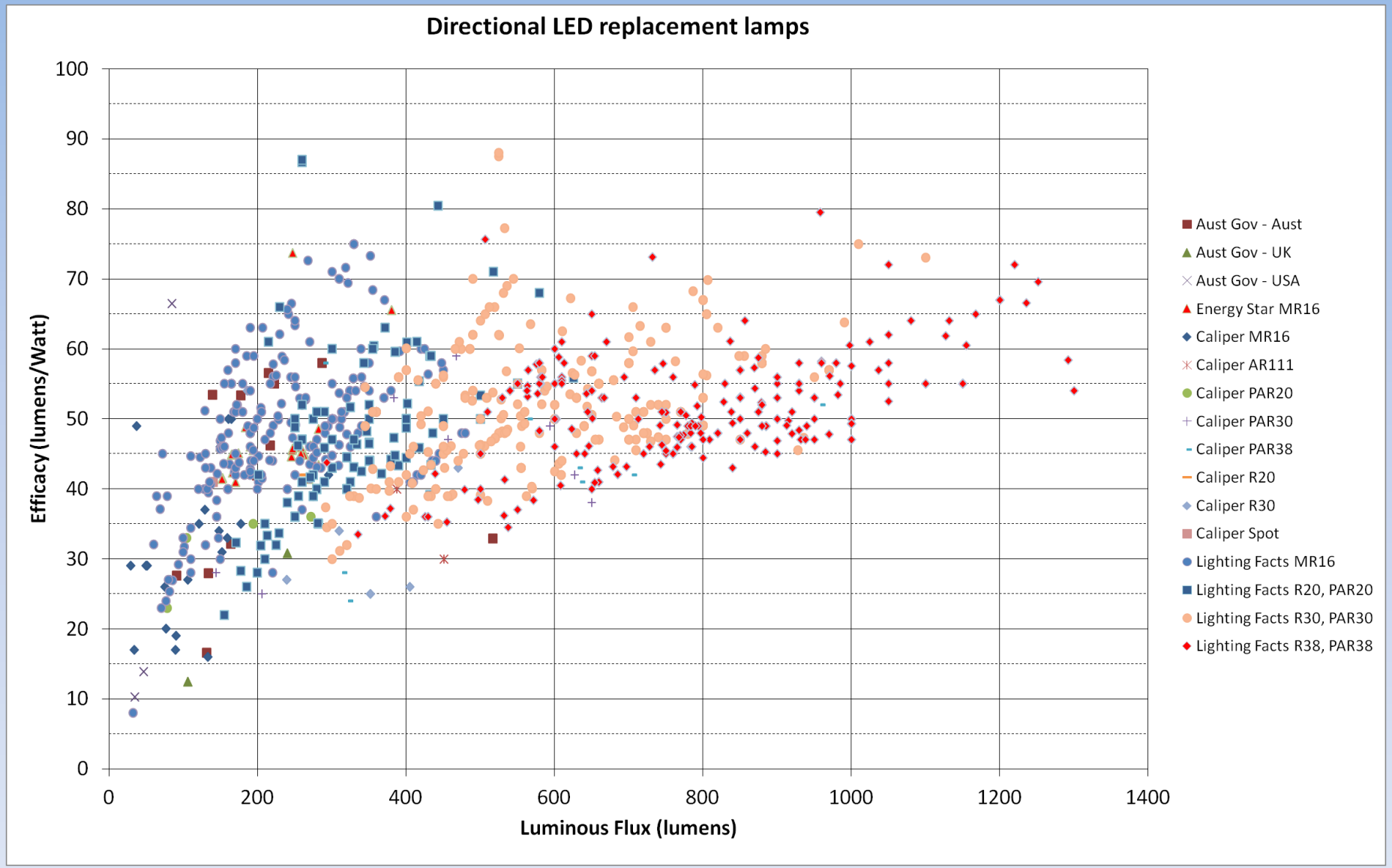

Variance between Rated Efficacy to Tested Efficacy of LED lamps.
Equivalent incandescent luminous flux ranges shown.
15 W Halogen
25 W Halogen
40 W Halogen
60 W Halogen
75 W Halogen
Aust MEPS
CFL bare lamp
Claimed value
(open box)
Test value
(closed box)
Efficacy (Lm/W)
Luminous Flux (Lm)
0
20
40
60
80
100
120
140
0
100
200
300
400
500
600
700
800
900
1000
1100

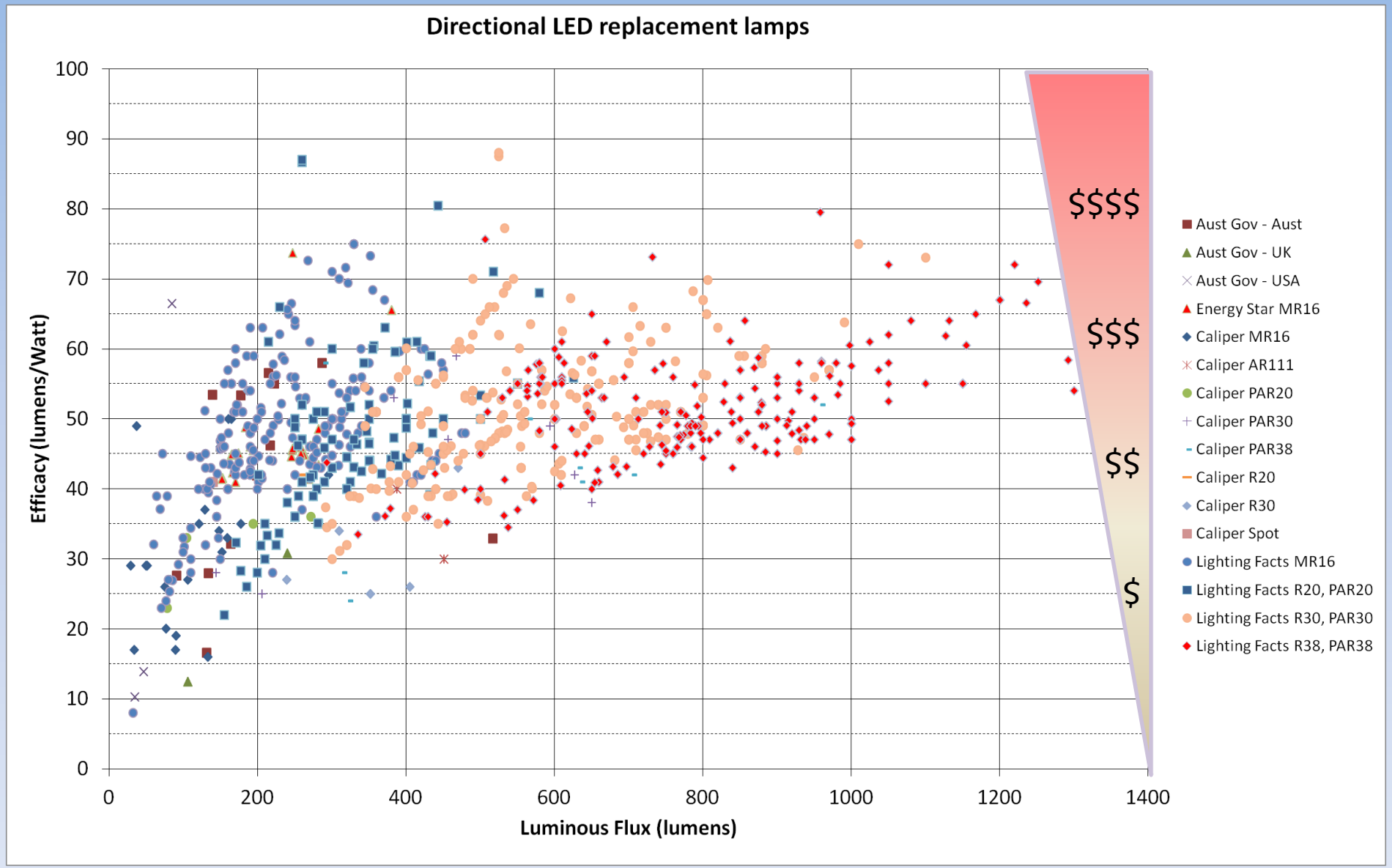
Performance of LED lamp technologies purchased from UK, USA, and AUS



WHAT LEVELS SHOULD BE SET FOR PERFORMANCE PARAMETERS ???

Product benchmarking



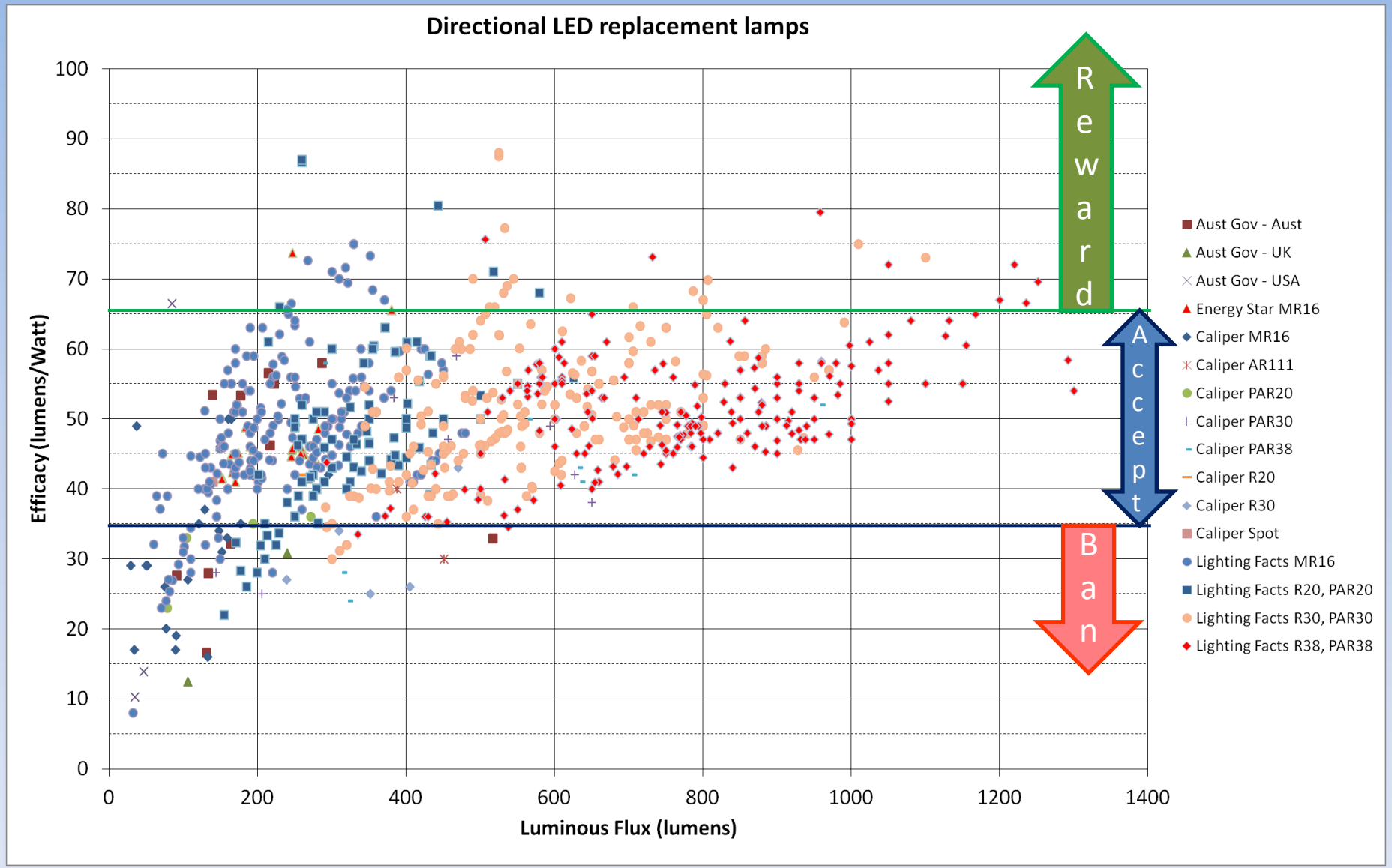

Directional LED replacement lamps
Efficacy (lumens/Watt)
Luminous Flux (lumens)
0
10
20
30
40
50
60
70
80
90
100
0
200
400
600
800
1000
1200
1400
$$$$
$$$
$$
$
Aust Gov - Aust
Aust Gov - UK
Aust Gov - USA
Energy Star MR16
Caliper MR16
Caliper AR111
Caliper PAR20
Caliper PAR30
Caliper PAR38
Caliper R20
Caliper R30
Caliper Spot
Lighting Facts MR16
Lighting Facts R20, PAR20
Lighting Facts R30, PAR30
Lighting Facts R38, PAR38

Is there a case for a multilevel performance approach?

- Economic situations of different countries and the affordability of a LED products by consumers

- Governments wanting:
  - a Minimum Energy Performance level (MEPS), and
  - a Higher Energy Performance label (HEPS)

  Investigate this idea for efficacy


Directional LED replacement lamps
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Luminous Flux (lumens)
0
10
20
30
40
50
60
70
80
90
100
0
200
400
600
800
1000
1200
1400
Reward
Accept
Ban
Aust Gov - Aust
Aust Gov - UK
Aust Gov - USA
Energy Star MR16
Caliper MR16
Caliper AR111
Caliper PAR20
Caliper PAR30
Caliper PAR38
Caliper R20
Caliper R30
Caliper Spot
Lighting Facts MR16
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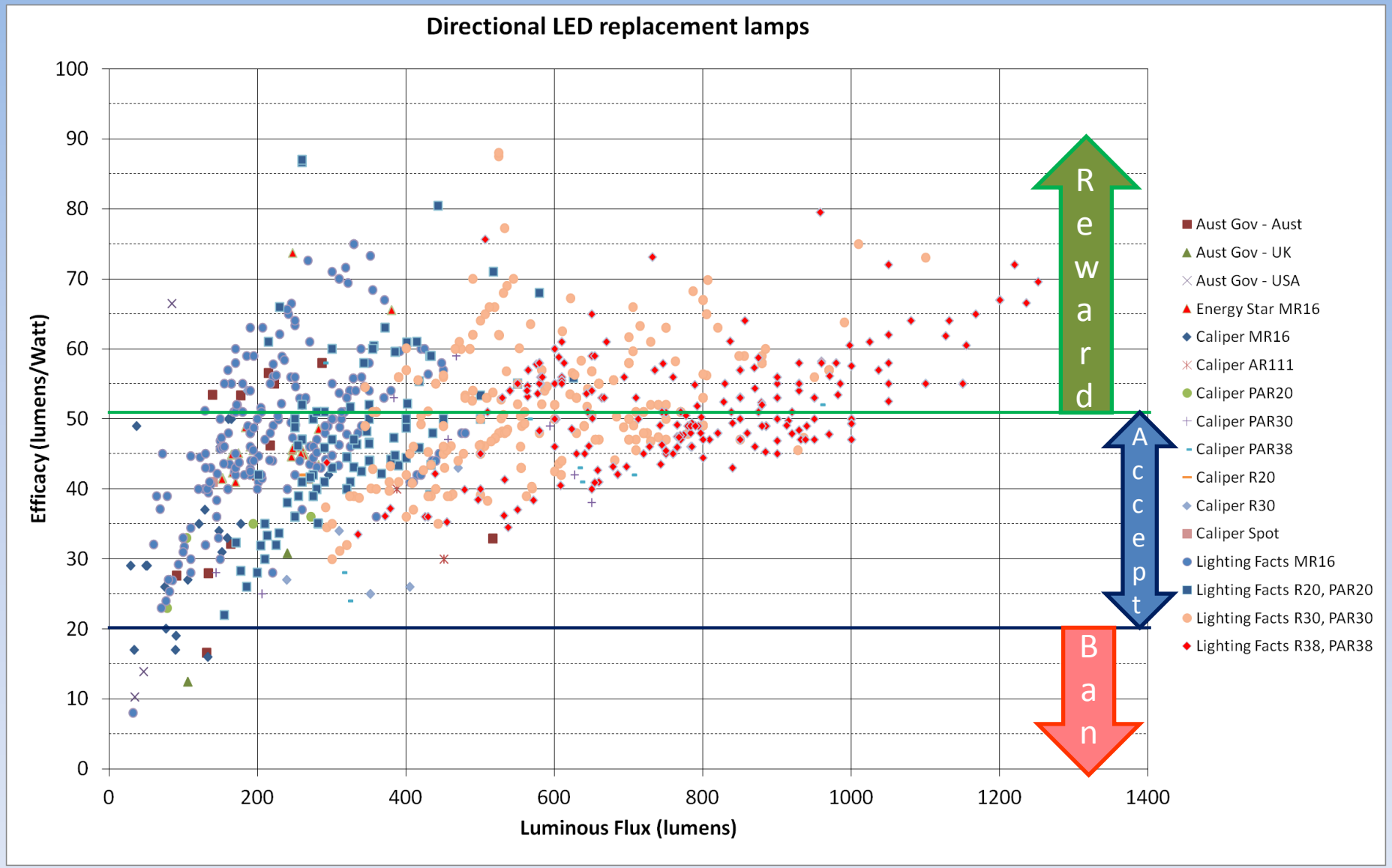
Lighting Facts R38, PAR38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Luminous Flux (lumens)
0
10
20
30
40
50
60
70
80
90
100
0
200
400
600
800
1000
1200
1400
Reward
Accept
Ban
Aust Gov - Aust
Aust Gov - UK
Aust Gov - USA
Energy Star MR16
Caliper MR16
Caliper AR111
Caliper PAR20
Caliper PAR30
Caliper PAR38
Caliper R20
Caliper R30
Caliper Spot
Lighting Facts MR16
Lighting Facts R20, PAR20
Lighting Facts R30, PAR30
Lighting Facts R38, PAR38

IT'S TIME TO HARMONISE !

Some Elements of a Harmonized Test Methodology

My Ton

APEC LED Workshop

Policies to Protect and Educate Consumers

Asia-Pacific Economic Cooperation

Australian Government

Department of Climate Change and Energy Efficiency

Presentation Overview

- *Short overview of objectives, key issues relating to methodology, round robin testing, and accreditation*

- Methodology Issues:
  - Challenges of applying existing test methodologies and characteristics to LEDs
  - Challenges of testing LEDs
- Round-robin testing
- Accreditation
- The way forward

Lighting testing: objectives

- *Testing is needed in order to perform general comparison of lighting products.*
- *Traditionally, measured lamps and luminaires characteristics include:*
  - Luminous flux
  - Life
  - CRI
  - CCT
  - Lumen depreciation
  - Distribution

- *Some key parameters for ascertaining energy efficiency of lighting products are total flux and luminous efficacy*

Challenges of testing leds

- *The arrival of LEDs presents the industry (and governments) with great opportunities, but also significant challenges for those responsible for setting lighting standards and measuring lighting performance.*

- *Challenges in applying traditional metrics to LEDs include:*

  - **Energy efficiency**: LEDs are directional as compared to conventional sources (GLS), which are omnidirectional.
  - **Rated life**: LEDs have the potential to last 10x longer or more as compared to conventional sources.
  - **Useful life**: LEDs have different failure modes.

Challenges of testing leds

- *The arrival of LEDs presents the industry (and governments) with great opportunities, but also significant challenges for those responsible for setting lighting standards and measuring lighting performance.*

- *New measurement challenges include:*
  - **Heat effects**: LEDs light output decrease with junction temperature
  - **Performance degradation**: LEDs package and driver electronics also need to be tested
  - **Color Preference**: CRI and even CCT are not adequate to describe LEDs light quality.
  - **Intensity distribution**: LEDs sources are directional, not point sources.
  - **Color shift**: LEDs can change color over time.

LEDs-specific testing Methodology

- *It has taken the lighting industry some time to understand how to develop a set of metrics to properly represent the nuances of this light source in architectural lighting applications. Efforts are still on-going*
- *A number of IES (North America) test methods have been developed*:
  - **LM-79-08**: "IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products,"
  - **LM-80-08**: "Approved Method for Measuring Lumen Maintenance of LED Light Sources,"
  - **TM-21**: "Lumen Depreciation Lifetime Estimation Method for LED Light Sources."
  - Others are under development by IES, ANSI, NIST, etc.

LEDs-specific testing Methodology

- *It has taken the lighting industry some time to understand how to develop a set of metrics to properly represent the nuances of this light source in architectural lighting applications. Efforts are on-going.*

- *The IEC recently published two Public Available Specification (PAS) performance requirement documents.*

  - **IEC/PAS 62717:** Performance requirements – LED modules for general lighting.
  - **IEC/PAS 62722:** Performance requirements – LED luminaires for general lighting.
  - Others are also under development. CIE is also developing a number of light-related standards.

Testing Methodology for lamps

- *For LEDs GLS replacement, other metrics are also needed, as well as test methodologies for them.*

- *For direct comparison of GLS performance:*
  - **Luminous intensity distribution**. Spatial distribution of the luminous flux graphically depicted in a luminous intensity distribution curve.
  - **Rated chromaticity coordinate**: The measured initial and maintained chromaticity coordinates of a LED module.

LED Test methods: Steps to harmonization

- *Test methods have different levels of accuracy and precision and costs. Developed and accepted methods should seek to balance the needs of:*
  - Manufacturers
  - Designers and consumers
  - Governments (benchmarking, compliance)

- *Since test procedures are the technical foundations of standards, their alignment is necessary in order to harmonize other elements, such as efficiency levels. This challenge is best approached as a regional, not national issue.*

Remaining test methodology challenges

- *Challenges remain in how each published method addresses some outstanding issues:*

- *A complex example: luminous flux over time:*
  - **IEC**: A general method of projecting measurement data beyond limited test time is under consideration.
  - **IES**: Method for extrapolation based on LM-80 test data will be described in IES TM-21.

- *A simple example: sample size:*
  - 10, 20, or 30 test samples?

round robin: objectives

The main reason for performing a Round Robin test is to verify a test method or laboratory performance:

- **Verification of a new method**: If a method of analysis has been developed, a Round Robin test involving proven methods would verify whether the new method produces results that agree with the established method.

- **Inter-laboratory verification**: to determine the performance of individual laboratories for specific test and to monitor laboratories' continuing performance. In this specific case, all participants actually evaluating or testing the exact same test object.

Regional round robin needed for leds methods

- *Why round-robin tests are needed with LEDs:*
  - A number of LEDs test methods are newly developed.
  - Laboratories participating in Round Robin tests receive valuable information about the technical capability of their laboratories.
  - Results and conclusions can be used to diagnose and address deviating results if present.
  - The performance of a laboratory participating in the Round Robin test may be taken into account with confidence.
  - Laboratories have the chance to upgrade their performance by learning from other laboratories and refine their protocols.

Accreditation: Objectives

- *Accreditation defines a laboratory's scope in terms of p aspects of performance it is qualified to test against.*

- *Laboratories can be classified into broad types based on their level of accreditation:*
  - Unaccredited
  - National accreditation
  - Regional/International accreditation

Example of international Accreditation and requirements

- *Regional/International accreditation indicate testing facilities that are able to test products against national and international standards. It also means that the laboratory may have the ability to certify the quality of products for registration at an international level.*
- International accreditation will normally require that the national accreditation body awarding the accreditation has been accredited to the international standard, ISO/IEC 17011:2005.
- This indicates that the individual accreditation bodies can provide a comparable accreditation service and can recognise each other's accreditations.
- *ISO/IEC 17025 is a recognition of demonstrated testing competence.*

Mutual recognition agreements on Accreditation

- *ILAC (International Laboratory Accreditation Cooperation) is an organization that aims to develop a global network of accredited testing, calibration and inspection facilities that can be relied on to provide accurate data.*

- *These mutual recognition agreements should lead to the mutual acceptance of test results across the regions, and include:*

- European Co-operation for Accreditation (EA)
- Asia Pacific Laboratory Accreditation Cooperation (APLAC)
- Southern African Development Community Accreditation (SADCA)
- Inter-American Accreditation Cooperation (IAAC)

CONCLUSIONS AND RECOMMENDATIONS

Establishing reliable laboratory capacity from the ground up is very expensive and time consuming:

- Set up time and cost
- Time and cost needed to build up a test history and experience.
- Time and cost needed to obtain accreditation at the local, national, or international level.

CONCLUSIONS AND RECOMMENDATIONS

A number of considerations need to be taken into account when developing testing capacity, especially if these capacities do not previously exist:

- The anticipated frequency and volume of testing required (to support MEPS, labeling, or check testing)
- The level of testing required (national, regional, or international standards)

It is important to note that developing testing capacity for one type of lighting product, such as CFLs, may not help ease the shift to another type of lighting product such as LEDs.

Conclusions and recommendations

Considerations should be given to:

- The adoption of an existing internationally acceptable testing protocol for measuring the performance criteria for energy efficient lighting
- Regional or cross-border harmonization or agreements for mutual acceptance of results.
- Provide input to the international process of developing a systematic approach to international testing.
- Ways to coordinate and share data and experience regionally or internationally

Conclusions and recommendations

- *Considerations should be given to:*

  - A regional network of laboratories can reduce non-compliance & increase consumer confidence.
  - Sharing of capacities is easier with accredited laboratories.
  - Accredited laboratories also facilitate the mutual recognition of test results.
  - A regional network of laboratories reduces non-compliance & increases consumer confidence.

THANK YOU

DISCUSSION

Parameters – finding a consensus

Working with stakeholders:
Communicating with consumers, industry, test laboratories and other stakeholders

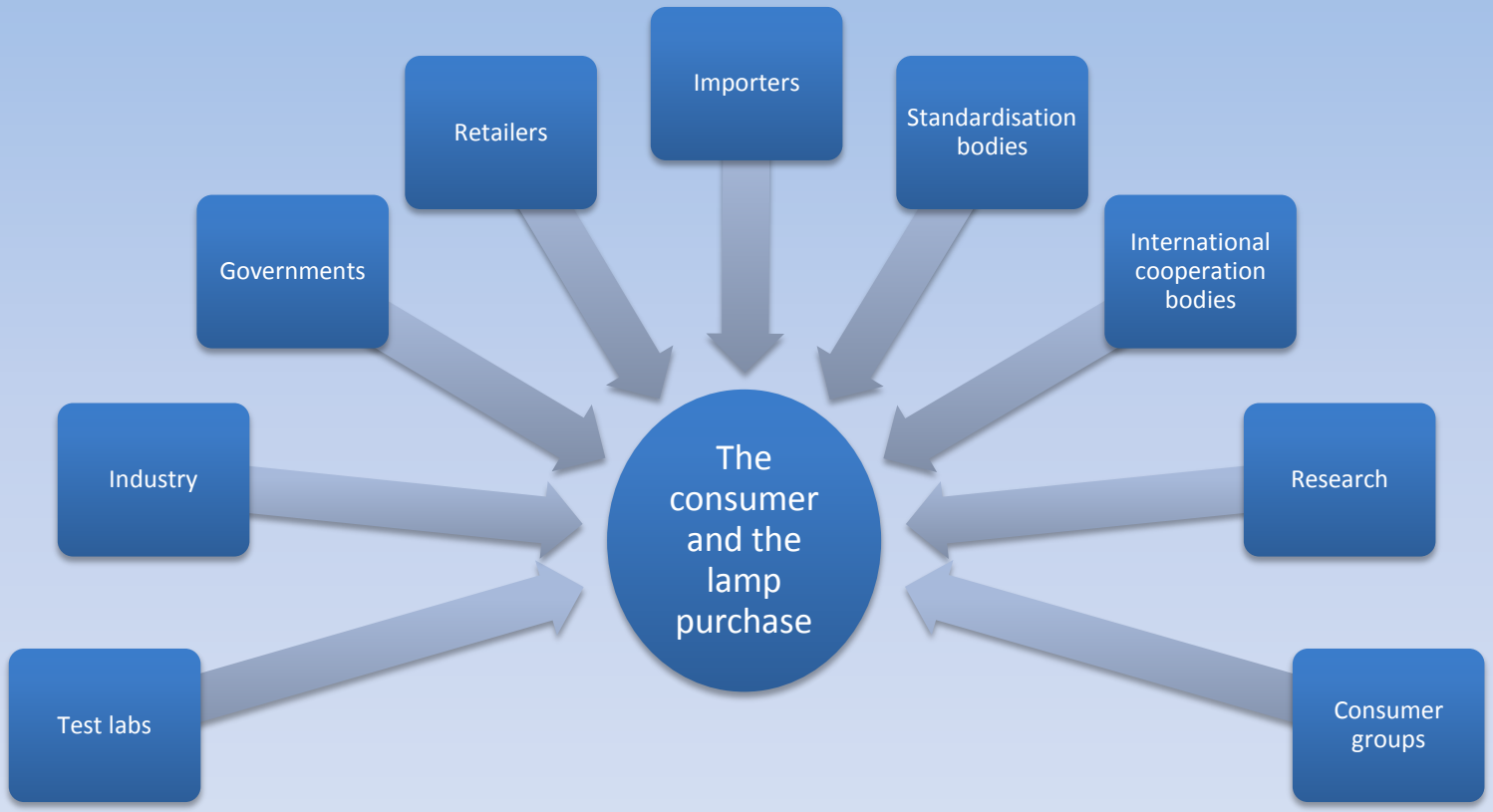
Nils Borg, Borg & Co
Stockholm, Sweden
Singapore 2 November 2011

Asia-Pacific Economic Cooperation

B ● R G ● C ●

Australian Government
Department of Climate Change and Energy Efficiency

How many … does it take to replace a bulb?



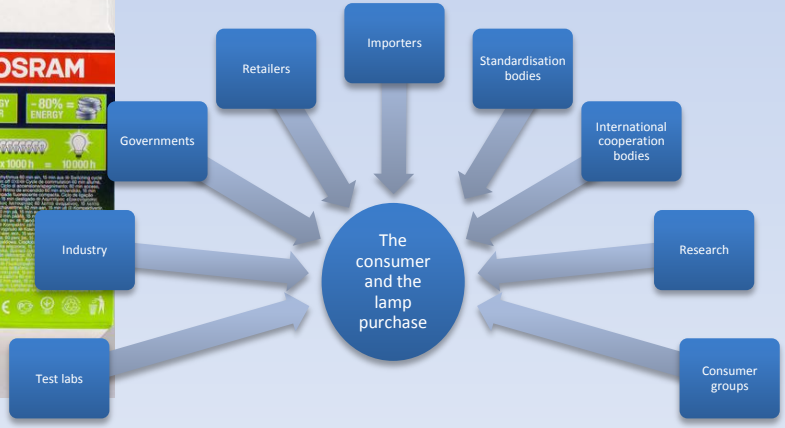
Information to consumer is not just - information

- Primary focus for this talk is consumer information
- Lamp packages, etc.

  → BUT: All actors in the chain need to understand and agree (or at least comply) with what is being told

So in order to get the package right…

All of these needs to get it right



The Scope of information on packages

- Primarily consumer information, but some of the information is very useful for commercial and OEM buyers as well
- Consumer information is competing with brand information and manufacturers' own way of explaining things
- There is *mandatory* and *voluntary* information
- Even voluntary information can be subject to regulation and agreements (CF EU ecodesign requirements for lamps).
- All labelling and marking needs specification, testing and verification.
  - → Not only to verify the product to understand what we are talking about

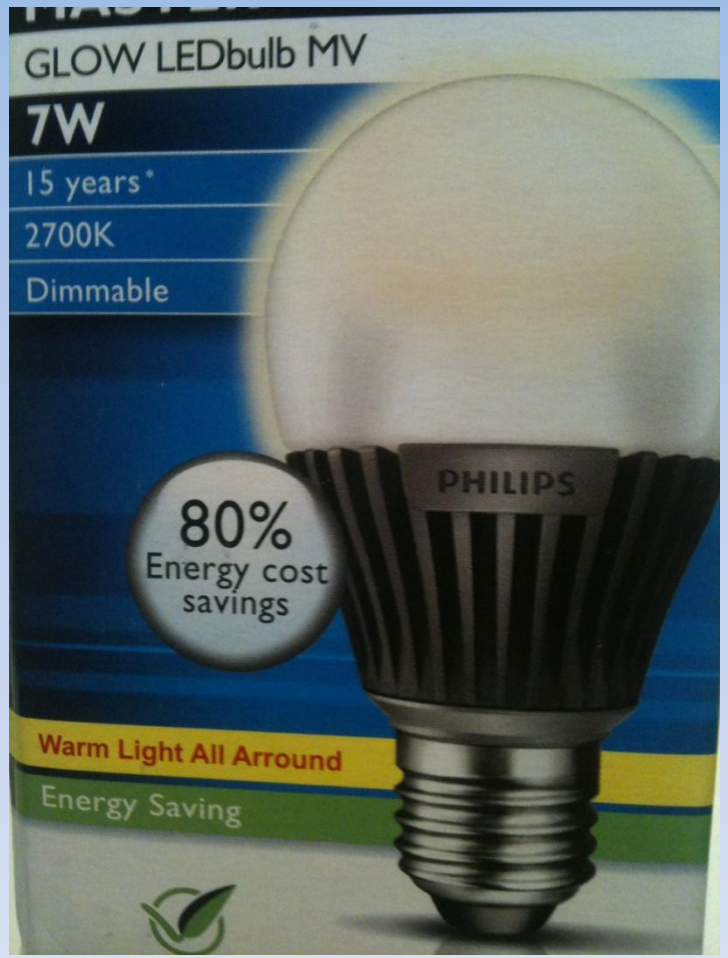
Labelling, Packaging and Marking – What is the Difference?

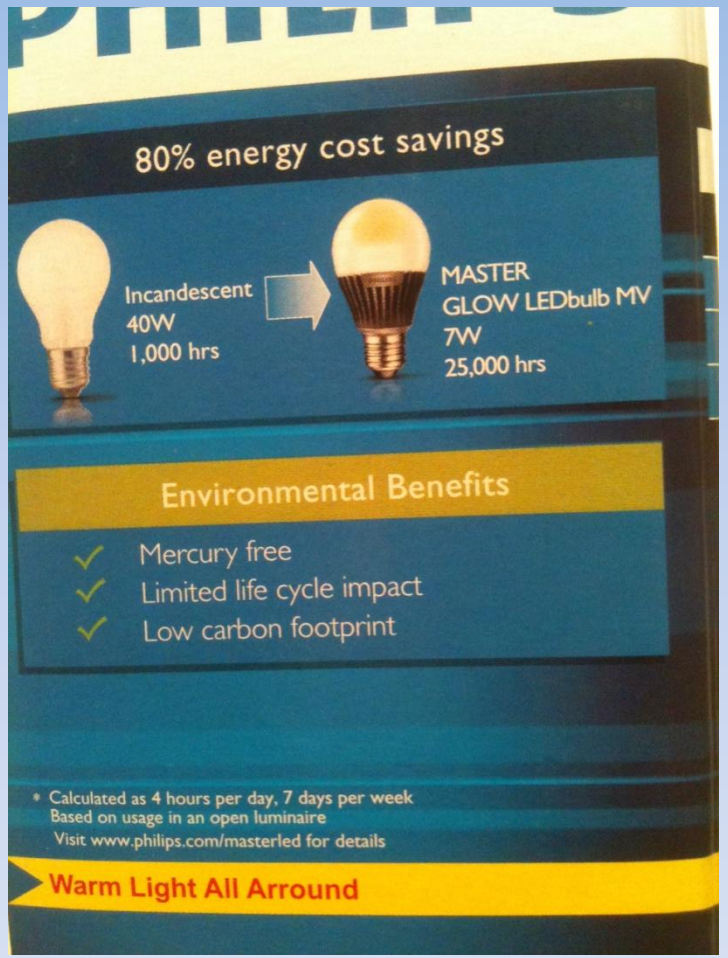
- The following definitions are used here:
  - **Comparative Labelling**: Some method of demonstrating the relative performance of a lamp
    - X is “better” than Y which is “better” than Z
  - **Endorsement Labelling:** Some method of demonstrating the product has passed some absolute level of performance
    - X is “good”
  - **Packaging:** Requirement for other specific information to be displayed on the product package.
  - **Marking (on the lamp):** Some method of marking the product (and with some or all of the information repeated on the packaging) to demonstrate compliance with predefined criteria

It was already difficult – even more so with LEDs!

- LED industry originally no lighting business
  - Various ways to define how much light an LED produced
  - Little understanding of basic lighting parameters
- Example: Color temperature
  - Warm white 2700 – 3000K
  - But a halogen lamp with 3000K can be marketed as a lamp with “crisp light”, alluding to its cooler light. But it is still warm!
- Perhaps a combination of minimum quality requirements and simplified information on the packaging can work?
- Standards can replace the need for some information and make it easier to focus on other important issues needed to overcome consumer hesitance
- EU faces big challenge in introducing requirements for directional lamps

Example of incandescent replacement LED-lamp





Example of incandescent replacement LED-lamp (2)

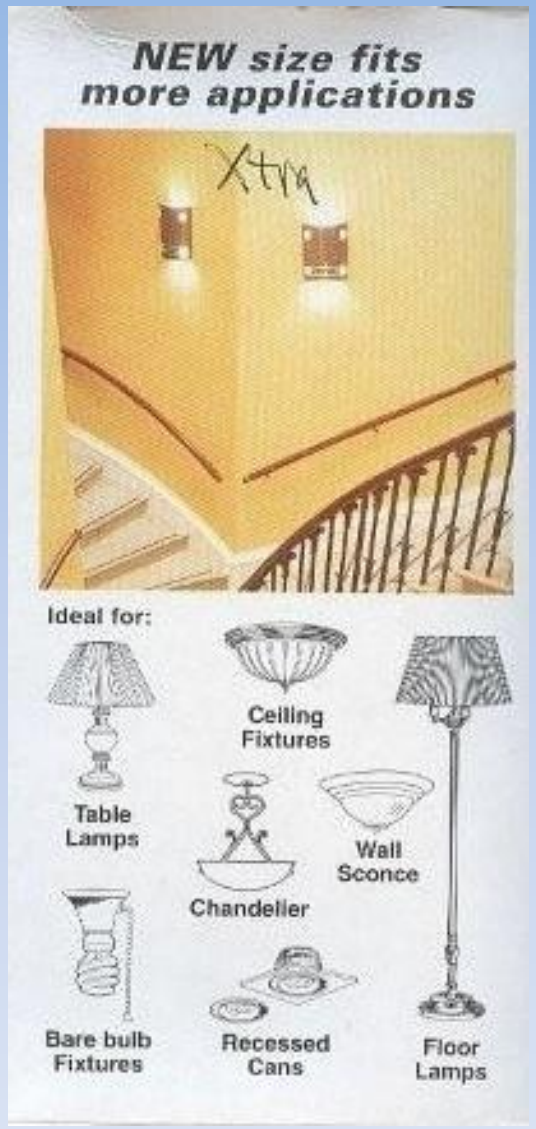
Packaging: comparing light output, life and money saved

The big question: How do we compare light output when there are no more GLS lamps left for reference?

- Lumens?

- A combination of lm and W?

Packaging: explaining what sort of light colour, application etc…

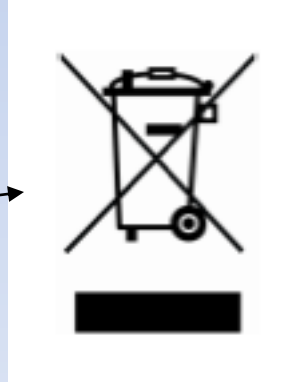


Mandatory information that needs to be there (some of this also appears as marking…)

CE says it fulfills all manadatory requirements (EuP, EMC, etc. etc)

US says: Hg, treat according to law…

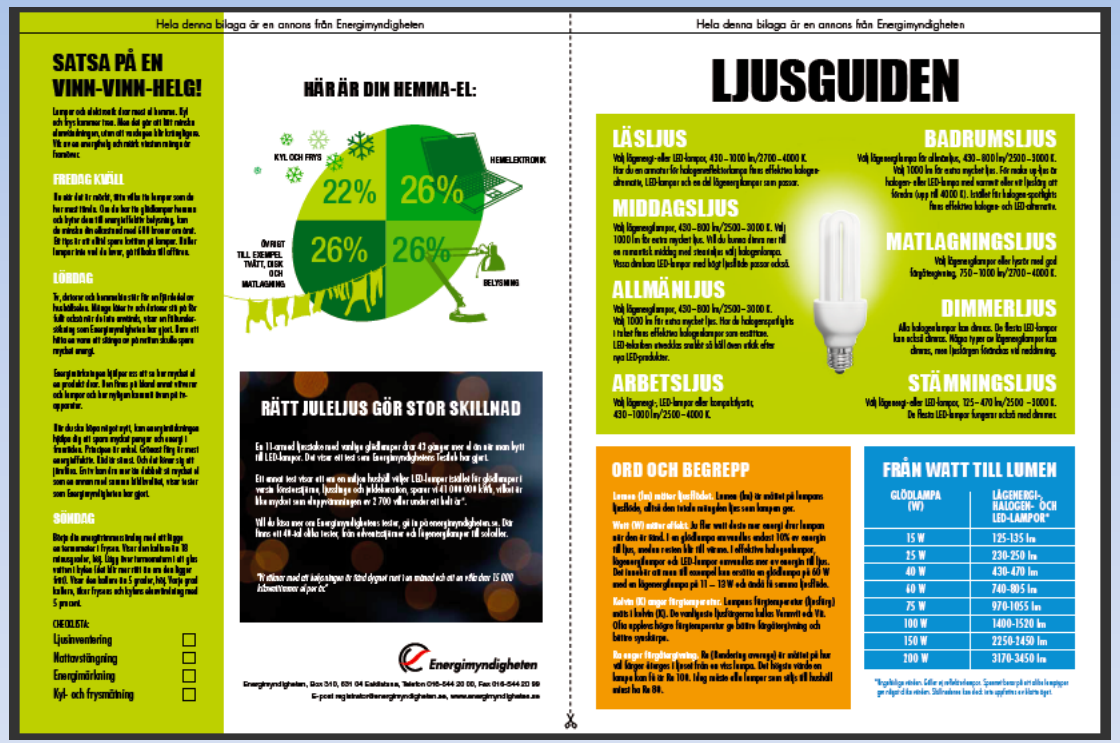
WEEE says: Don't throw in the dustbin



And sometimes the information is too complicated

Sweden: A comprehensive example

- 8-page newspaper supplement to go in all newspapers (Nov 2011)
- 60-W incandescent (by far most common) is being phased out
- Much less focus on consumer finances



Hela denna bilaga är en annons från Energimyndigheten

SATSA PÅ EN VINN-VINN-HELG!

FREDAG KVÄLL

LÖRDAG

SÖNDAG

CHECKLISTA:
- Ljusinventering
- Nattorstängning
- Energimärkning
- Kyl- och frysmätning

HÄR ÄR DIN HEMMA-EL:

RÄTT JULELJUS GÖR STOR SKILLNAD

Energimyndigheten

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LJUSGUIDEN

LÄSLJUS

ALLMÄNLJUS

ARBETSLJUS

MIDDAGSLJUS

BADRUMSLJUS

MATLAGNINGSLJUS

DIMMERLJUS

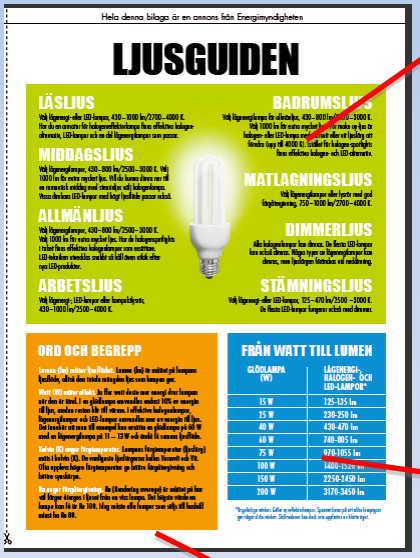
STÄMNINGSLJUS

ORD OCH BEGREPP

FRÅN WATT TILL LUMEN

GLÖDLAMPA (W)	LÅGENERGI-, HALOGEN- OCH LED-LAMPOR*
15 W	125-135 lm
25 W	230-250 lm
40 W	430-470 lm
60 W	740-805 lm
75 W	970-1055 lm
100 W	1400-1520 lm
150 W	2250-2450 lm
200 W	3170-3450 lm

- Guide to cut out and bring to the shop
- First attempt to market lumen instead of watt.
- Recommendations are based on Kelvin and lumen for various situations



Hela denna bilaga är en annons från Energimyndigheten

LJUSGUIDEN

LÄSLJUS
Välj lågenergi- eller LED-lampor, 430 – 1000 lm/2700 – 4000 K. Har du en armatur för halogenreflektorlampa finns effektiva halogenalternativ, LED-lampor och en del lågenergilampor som passar.

MIDDAGSLJUS
Välj lågenergilampor, 430 – 800 lm/2500 – 3000 K. Välj 1000 lm för extra mycket ljus. Vill du kunna dimra en rumsmanteldoning med vanligen valj halogenlampa. Vissa dimbara LED-lampor med högt ljusflöde passar också.

ALLMÄNLJUS
Välj lågenergilampor, 430 – 800 lm/2500 – 3000 K. Välj 1000 lm för extra mycket ljus. Har du halogenreflektorlampa i taket finns effektiva halogenlampor som ersättare. LED-tekniken utvecklas snabbt så läs även nästa efter nya LED-produkter.

ARBETSLJUS
Välj lågenergi-, LED-lampor eller lampa/armatur, 430 – 1000 lm/2500 – 4000 K.

BADRUMSLJUS
Välj lågenergilampor för allmänbelysning, 430 – 800 lm/2500 – 3000 K. Välj 1000 lm för extra mycket ljus. Har du halogenreflektorlampa i taket finns effektiva halogenlampor som ersättare. Lampor med IP 44/IP 65 är lämpliga för halogenspotlights finns effektiva halogen- och LED-alternativ.

MATLAGNINGSLJUS
Välj lågenergilampor eller kyrsta med god färgåtergivning, 750 – 1000 lm/2700 – 4000 K.

DIMMERLJUS
Alla halogenlampor kan dimras. De flesta LED-lampor kan också dimras. Några typer av lågenergilampor kan dimras, men ljusstyrkan förändras vid medelstyrka.

STÄMNINGSLJUS
Välj lågenergi- eller LED-lampor, 125 – 470 lm/2500 – 3000 K. De flesta LED-lampor lämpar sig också med dimmer.

ORD OCH BEGREPP

Lumen (lm) mäter ljusflödet. Lumen (lm) är måttet på lampans ljusflöde, alltså den totala mängden ljus som lampan ger.

Watt (W) mäter effekt. Ju fler watt desto mer energi drar lampan när den är tänd. I en glödlampa omvandlas endast 10% av energin till ljus, medan resten blir till värme. I effektiva halogenlampor, lågenergilampor och LED-lampor omvandlas mer av energin till ljus. Det innebär att man till exempel kan ersätta en glödlampa på 60 W med en lågenergilampa på 11 – 13 W och ändå få samma ljusflöde.

Kelvin (K) anger färgtemperatur. Lampans färgtemperatur (ljusfärg) mäts i kelvin (K). De vanligaste ljusfärgerna kallas Varmvit och Vit. Ofta ropar högre färgtemperatur på bättre färgåtergivning och bättre synskärpa.

Ra anger färgåtergivning. Ra (Rendering average) är måttet på hur väl färger återges i ljuset från en viss lampa. Det högsta värdet lampa kan få är Ra 100. Idag måste alla lampor som säljs ha minst Ra 80.

FRÅN WATT TILL LUMEN

GLÖDLAMPA (W)	LÅGENERGI-, HALOGEN- OCH LED-LAMPOR*
15 W	125-135 lm
25 W	230-250 lm
40 W	430-470 lm
60 W	740-805 lm
75 W	970-1055 lm
100 W	1400-1520 lm
150 W	2250-2450 lm
200 W	3170-3450 lm

*Ungefärliga värden. Gäller ej reflektorlampor. Spannet beror på att olika lamptyper ger något olika värden. Skillnaderna kan dock inte uppfattas av blotta ögat.

Only possible with common, agreed definitions and descriptions. But the solution can be tailored to the circumstances

Some experiences (not yet from consumer)

- Very difficult to get marketing people understand light and lighting
- Government takes a leading role and expertise is needed in client role
- How much do you highlight LED products that are still very expensive?
- Will people understand lumen? And if so when?
- Very difficult to understand heat (power) vs lumen in terms of maximum allowed power in a luminaire

Conclusions

- Information to consumers must be reasonably harmonised
- Information must be accurate and relevant
- Information must always be simplified. But simplification helps to create order in chaos

BUT:

- Not only consumers need to understand:
- Governments, regulators need to understand technology and standards – what they can achieve and what they can't
- Mandatory regulation can reduce need for information
- Retailers, importers etc need to understand what the purpose of the information is
- Test labs need to understand the purpose and scope of regulation
- Industry must understand what is being regulated, how and why?

Thank you!

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www.eceee.org

LED: Perspective from a Developing Economy

By
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Director
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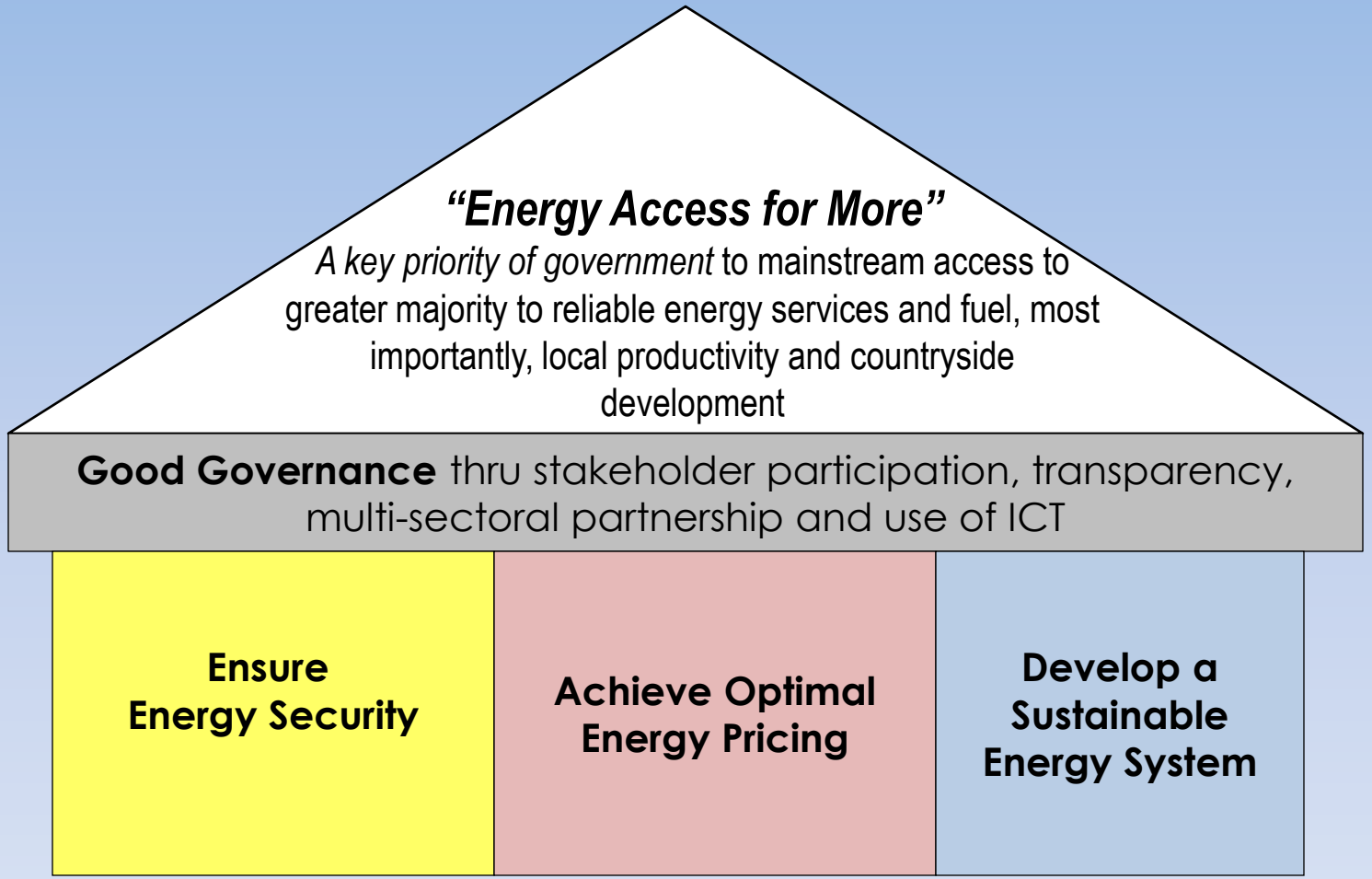
Department of Energy, Philippines

York Hotel, Singapore
2 November 2011

Asia-Pacific Economic Cooperation

Australian Government
Department of Climate Change and Energy Efficiency

PHILIPPINE ENERGY REFORM AGENDA



ERA vis-à-vis Major Programs

Major Programs	Energy Security	Optimal Energy Pricing	Sustainable Energy System
Energy Policy and Planning	√	√	√
Energy Resource Development ▪ *Fossil Fuels* ▪ *Renewable Energy*	 √ √	 √	 √ √
Downstream Oil	√		√
Downstream Natural Gas	√	√	√
Power and Electrification	√	√	√
Biofuels	√		√
Alternative Fuels for Transport	√	√	√
Energy Efficiency and Conservation	√	√	√
Energy Standards and Safety	√		√
Climate Change	√		√
Investment Promotion	√	√	√

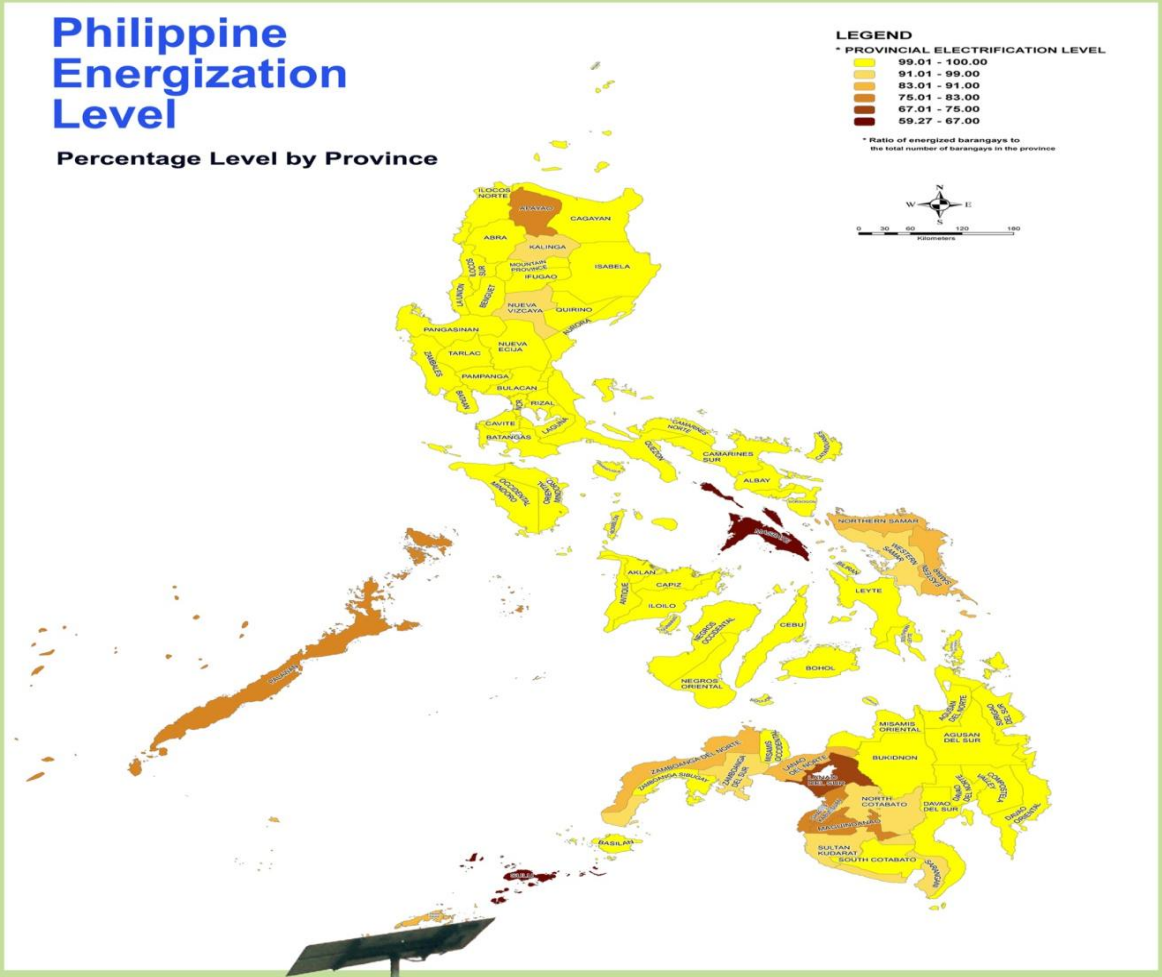
What have been done so far

- Diversified Energy Mix
- Enhanced Indigenous Energy Development
- Invested in Clean Energy
- Ensured Sufficient Supply
- Increased Energy Access for Household
- Promoted Energy Efficiency

Expanded Rural Electrification

Philippine Energization Level

Percentage Level by Province



Energy Access for Households

YEAR	TOTAL HOUSEHOLDS				% Electrified
	POTENTIAL	ANNUAL TARGET	SERVED	UNSERVED	Total
2011	17,594,474	323,233	14,715,279	2,879,195	83.636%
2012	17,788,496	370,900	15,086,179	2,702,317	84.809%
2013	17,986,021	370,900	15,457,079	2,528,942	85.939%
2014	18,193,402	370,900	15,827,979	2,365,423	86.998%
2015	18,403,128	370,900	16,198,879	2,204,249	88.022%
2016	18,612,755	370,900	16,569,779	2,042,976	89.024%
2017	18,822,959	370,900	16,940,679	1,882,280	90.000%

SOURCES: * Distribution Development Plan 2009-2018 , DOE-PPDD

Status of Energization by National Electrification Administration as of November 2010

Briefing Joint Congressional Power Commission by NEA February 2011

Electrification Projects

Increased Electrification for Households

Rural Electrification Program

Goal : To achieve 90% household electrification by 2017

Strategy:

Implement rural/missionary electrification with greater public sector participation in a holistic and sustainable manner

Increased Electrification for Households

Household Electrification Project

LED Applications

- Beneficiaries:

  Off-grid households
- Role of the DOE
  - Assessment of site, socio-economic conditions, acceptability of technology, support to the project
  - Facilitate trainings of beneficiaries/project technicians on the installation, operation and maintenance of the solar-LED home system
  - Facilitation of after-sales support

Household Electrification Project

LED Applications

- Beneficiaries:
  2,750 Off-grid households

- Summary of LED Lamps used in HEP 2010
  - 1-watt LED 2,756 units
  - 3-watt LED 8,262 units
  - 7-watt, linear LED 12 units
  - 15-watt LED for streetlights 40 units

3 watts x 3 units

1 watt x 1 unit

Promoting Lighting Energy Efficiency

LED Applications

- **Retrofit of Traffic Lights to LED in 159 Intersections in major Metro Manila roads**
- **On-going**

Traffic Lights

Programmed Activities for 2011-2012

Increased Electrification for Households

LED Applications

- Installation of PV-LED Home System in 223 households, 12 PV-LED streetlights, 2-75 Wp PV-LED ShS in 4 island barangays(Antique, Aklan, Palawan, Davao del Norte)
- Installation of PV-LED Home System (30 Wp) in 3,159 households
- Installation of 35 units of 75 Wp PV-LED Streetlights (15 W LEDS)
- Installation of 39 units 75 Wp PV Solar Home System

Programmed Activities for 2011-2012

- Installation of LED Traffic Lights in 88 Intersections of major Metro Manila roads

- Installation of PV-LED system in the Boni Tunnel, Mandaluyong, Metro Manila

Boni Tunnel

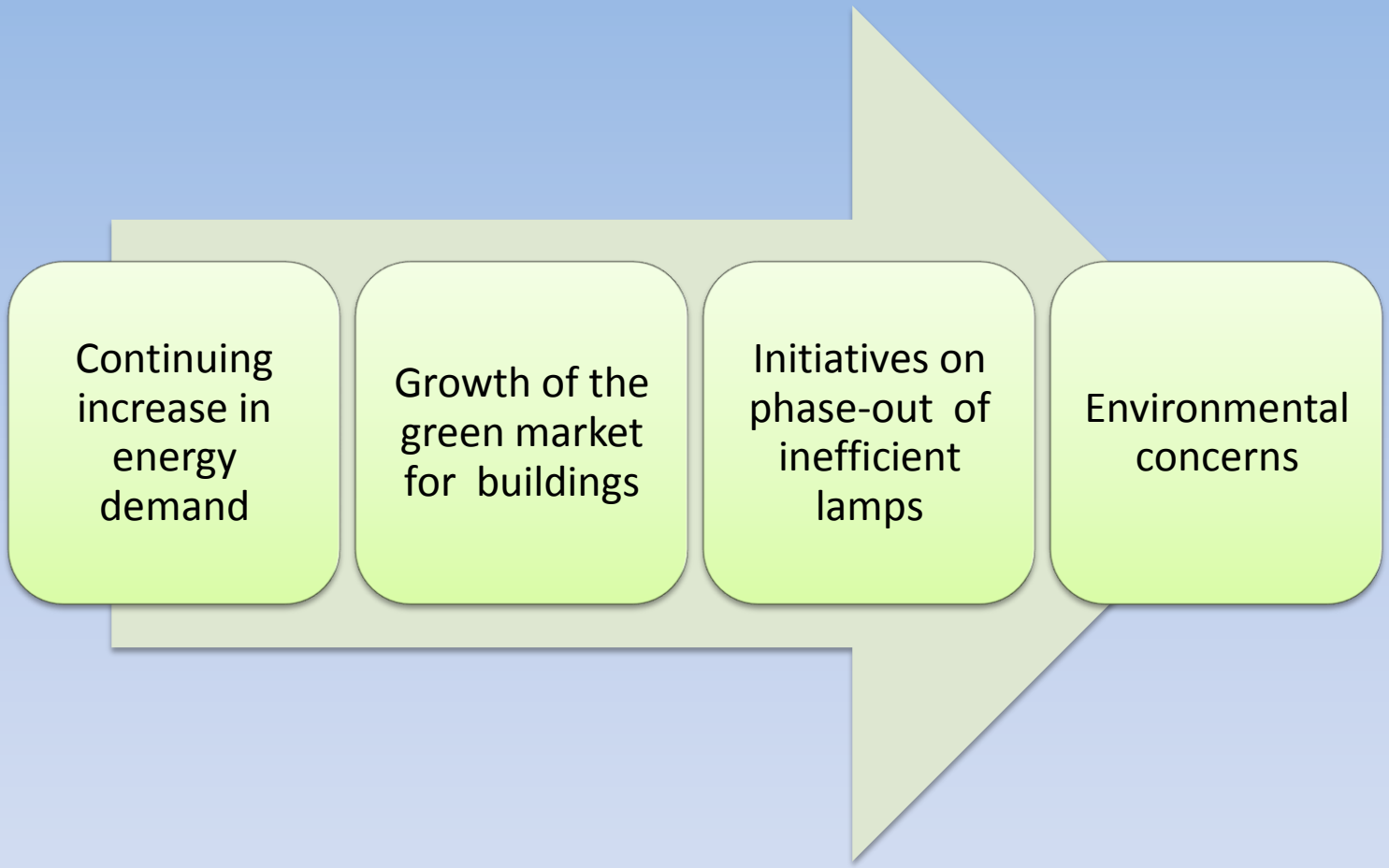
Master LED Tubes (94 pcs)
Long life
 30,000 burning hours
Aluminum heat-sink feature
70% lumen maintenance
22W
Pacific Luminaire (47 sets)

Philippine National Roadway Lighting Standard Development

120W LED
- **80,000 hours life span**

Road Board
Republic of the Philippines

What Drives the Growth of the LED Market?



Gaps

LED Roadmap

National Standard for LEDs

Availability/Accessibility

Technical expertise

Determining technology choices – balancing need with up-front cost of implementation

Gaps

- LED testing facility
- **Funding sources identification**
- **CDM process mentoring**
- **Information/Education/Communication Program**

Food for Thought

Why not……..

- Initiate a harmonized LED standard development for the region this early in the game?
- Create a framework for LED roadmap for countries clustered in accordance with similarities in economic and social backgrounds in the region?
- Create a training program for energy efficiency and renewable energy workers? For policy makers and movers?
- Help governments create small business energy programs that offer loans to small businesses for energy efficiency improvements?

Food for Thought

Why not .....

Consolidate information on funding sources for energy efficient lighting projects including information on getting CDM credits? (It's not as easy as it seems!)

"The significant problems we face today cannot be solved at the same level of thinking as when they were created."

Albert Einstein

Thank you!!!

raquelh@doe.gov.ph

DISCUSSION

How do we engage stakeholders locally and regionally?

What other capacity constraints exist?

What constraints are restricting policy makers?

Insert Mel's Presentation on Testing and Compliance

DISCUSSION

Regional cooperation and monitoring and compliance – what might be possible?

APEC SOLLIA

Street and Outdoor LED Lighting Initiative - Asia

Survey Findings

David Morgado

Environment and Energy Specialist

International Institute for Energy Conservation

Asia Regional Office (IIEC-Asia)

APEC LED Workshop, York Hotel, Singapore, 2nd November 2011

IIEC
International Institute for Energy Conservation

Asia-Pacific Economic Cooperation

Agenda for today

1. About IIEC
2. APEC's Street and Outdoor LED Lighting Initiative – Asia
3. International and APEC LED Standards
4. LED Street and Outdoor Lighting Projects in APEC
5. Best Practices in APEC
6. Questions and Discussion

IIEC
International Institute for Energy Conservation

International Institute for Energy Conservation (IIEC)

APEC
Asia-Pacific Economic Cooperation

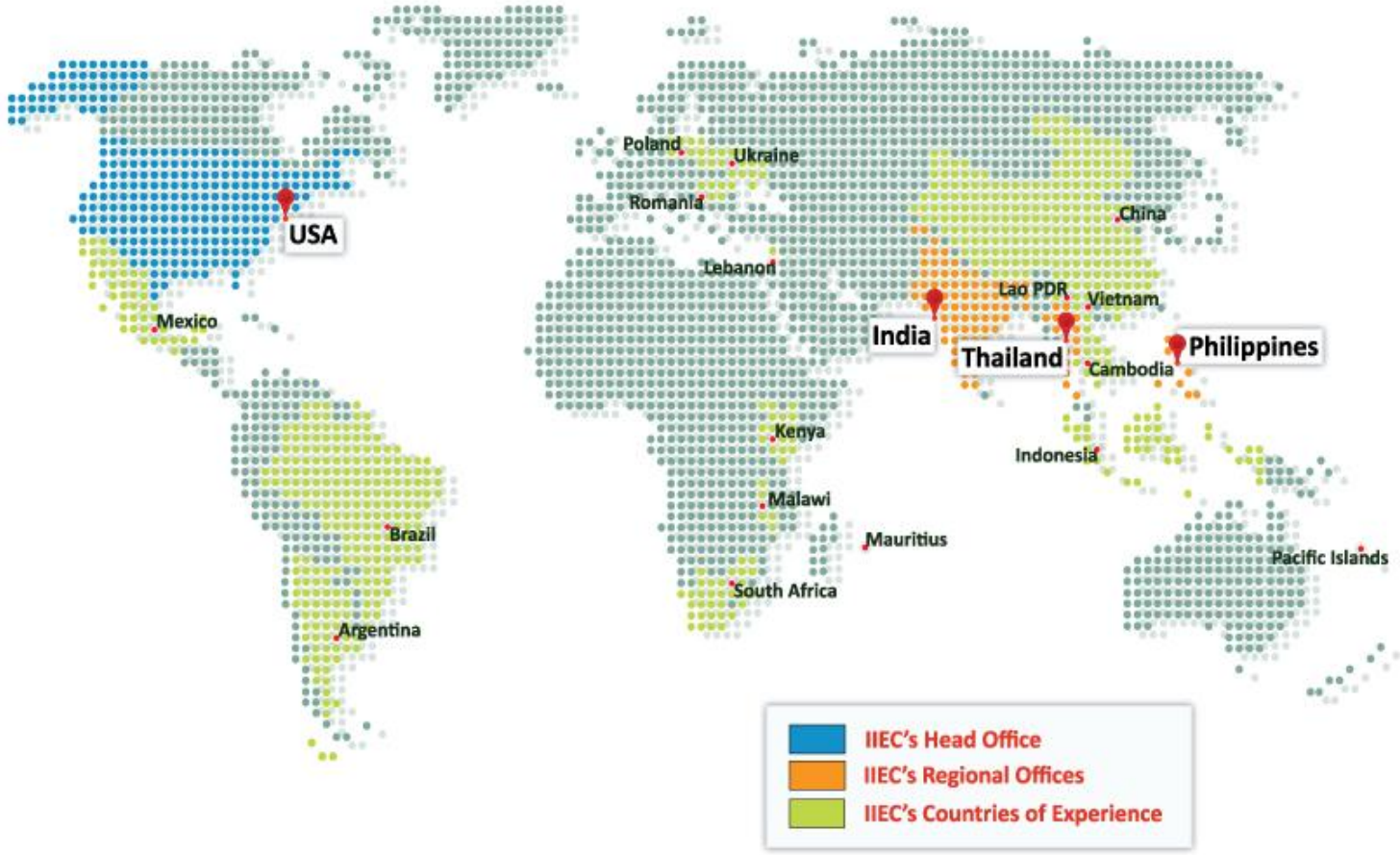
- *Energy Efficiency*
- *Demand-Side Management*
- *Distributed Generation & Renewable Energy*
- *Rural Electrification*
- *Renewable Energy*
- *Sustainable Habitat*

- *Market Studies & Assessment*
- *Technologies & Pilot / Demonstration Projects*
- *Policies, Programs, Plans*
- *Finance*
- *Communication & Outreach*
- *Training & Capacity Building*

IIEC
International Institute for Energy Conservation

APEC
Asia-Pacific Economic Cooperation

IIEC Offices & Projects



IIEC
International Institute for Energy Conservation

Asia-Pacific Economic Cooperation

About the Project

- APEC's Street and Outdoor LED Lighting Initiative – Asia:
  - *Best practices on LED street and outdoor lighting*
  - *LED street and outdoor lighting standards*
- Survey + Research in APEC Economies:
  - *Government regulatory departments*
  - *Standardization agencies*
  - *Municipalities and city councils*
  - *Utilities*
  - *Lighting industry associations and research institutes*

Purpose of Street and Outdoor Lighting

Allow users of vehicles to proceed safely

Allow pedestrians to see hazards, orientate themselves, recognize other pedestrians and give them a sense of security

Improve night-time appearance of the environment

Source: CIE 115:1995

IIEC
International Institute for Energy Conservation

Asia-Pacific Economic Cooperation

International LED Standards

- **Product Performance**
  - International Commission on Illumination (CIE)
  - International Electrotechnical Commission (IEC)
- **Street and Outdoor Lighting Applications**
  - International Commission on Illumination (CIE)
  - American National Standards Institute (ANSI)
  - lluminating Engineering Society of North America (IESNA)
- **CDM Methodology for Outdoor and Street Lighting**

International LED Product Standards

IEC 60598 series	Luminaire safety
IEC 60825-1	Safety of Laser Products – Part 1: Equipment classification and requirements. Applicable to LEDs.
IEC 60838-2-2:2006	Miscellaneous lamp holders – Part 2-2: Particular Requirements – connectors for LED modules.
IEC 61347-1:2007	Lamp control gear - Part 1: General and safety requirements
IEC 61347-2-13:2006	Lamp control gear – Part 2-13: Particular requirements for dc or ac supplied electronic control gear for LED modules.
IEC 62384:2009	Performance of control gear for LED modules dc or ac supplied electronic control gear for LED modules – performance requirements
IEC/PAS 62722-1:2011	Luminaire performance - Part 1: General requirements
IEC/PAS 62722-2-1: 2011	Luminaire performance - Part 2-1: Particular requirements for LED luminaires
CIE Publication No. 127-2007	Measurements of LEDs
CIE Publication No. 177-2007	Colour rendering of white LED Light Sources

International Guidelines/Standards for Street and Outdoor Lighting

- CIE 31-1976 – Glare and Uniformity in Road Lightings Installations
- CIE 22-1977 – Depreciation of Installation and their Maintenance (in Road Lighting)
- CIE 47-1979 – Road Lighting for Wet Conditions
- CIE 48-1980 – Light Signals for Road Traffic Control
- CIE 66-1984 – Road Surfaces and Lighting (Joint Technical Report CIE/PIARC)
- CIE 93-1992 – Road Lighting as an Accident Countermeasure
- CIE 132-1999 – Design Methods for Lighting of Roads
- **CIE 140-2000 – Road Lighting Calculations**
- CIE 136-2000 – Guide to the Lighting of Urban Areas
- CIE 144-2001 – Road Surface and Road Marking Reflection Characteristics
- **CIE 115-2007 – Recommendations for the Lighting of Motorized Traffic (updated)**
- **CIE 180-2007 – Technical Report: Road Transport Lighting for Developing Countries**
- **CIE 115-2010 – Lighting of Roads for Motor and Pedestrian Traffic**
- CIE 119-2010 - Recommended System for Mesopic Photometry Based on Visual Performance

- *CEN/TR 13201-1 - Road Lighting – Part 1: Selection of Lighting Classes*
- *ANSI/ESNA RP-8-00 - American National Standard Practice for Roadway*
- ***ANSI C136.37 - Solid State Light Sources Used in Roadway and Area Lighting***
- *AS/NZS 1158.1/1-1997 – Road Lighting – Vehicular Traffic Lighting*
- *AS CA19-1939 - Australian Standard Rules for Street Lighting*

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Who is taking the LEaD on LED Standards?

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Status of LED Standards for Street and Outdoor Lighting

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APEC Member Economy	LED Product	LED Module	LED Control Gear	LED Luminaire
Australia, Canada, People's Republic of China, China (Hong Kong), Chinese Taipei, New Zealand, The United States	X	X	X	X
Japan	X	X	X	UD
Republic of Korea	UD	X	UD	UD
Mexico	UD	X	X	X
Malaysia		X	X	
Singapore		X		X
The Philippines, Thailand, Vietnam				X*
Brunei Darussalam, Chile, Indonesia, Papua New Guinea, Peru, Russia				

X – Standard Developed; UD – Standard Under Development; X* - IEC 60598 (Luminaire Safety Standard);

Blank – Standard not developed or information unavailable

LED Standards in the People's Republic of China

GB/T 20145-2006	Photobiological safety of lamps and lamp systems
SJ/T 2355-2006	LED Measurement Methods
GB/T 9468-2009	General requirements for photometry and goniophotometry of luminaires
SJ/T 11399-2009	Measurement methods for LED chips
SJ/T 11394-2009	Measurement methods for LED modules
GB 19651.3-2008	Miscellaneous lamp holders – Part 2-2: Particular requirements – connectors for LED modules
GB 19651.3-2009	Lamp control gear – Part 14: Particular requirements for D.C. or A.C. supplied electronic control gear for LED
GB/T 24825-2009	D.C. or A.C. supplied electronic control gear for LED modules – Performance requirements
GB /T 24827-2009	Performance requirements of luminaires for road and street lighting
GB/T 24907-2010	**LED lamps for road lighting – performance specifications**

LED Standards in Chinese Taipei

CNS 14115	Radio disturbance limits for electrical lighting and similar equipment and measurement methods
CNS 14335	General requirements and tests for luminaires
CNS 14335-2-3	Luminaires - Part 2-3: Safety requirements for luminaires for road and street lighting
CNS 14676-5	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Part 5: Surge immunity test
CNS 15174	DC or AC supplied electronic control gear for LED module - Performance requirements
CNS 15233	**Fixtures of roadway lighting with LED lamps**
CNS 15248	Methods of measurement on LED components for thermal resistance
CNS 15249	Methods of measurement on LED components for optical and electrical characteristics
CNS 15250	Methods of measurement on LED modules for optical and electrical characteristics
Under Review	Optics measurement method for LED lighting system
Under Review	Environment and reliability testing method for LED devices
Under Review	Optical and electrical characteristics measurement method for LED chip
Under Development	Quality testing method for LED chip
Under Development	Accelerated life testing method for LED chip
Under Development	Accelerated life testing for LED device and module
Under Development	Thermal resistance measurement method for LED chip
Under Development	Power supply measurement method for LED lighting system
Under Development	Environment sustainability testing method for LED lighting system

LED Standards/Guidelines in The United States

IES LM-79-2008	Approved Method for the Electrical and Photometric Testing of Solid-State Lighting (SSL) Devices
IES LM-80-2008	Approved Method for Measuring Lumen Depreciation of LED Light Sources
IES RP-16	Nomenclature and Definitions for Illuminating Engineering (Addenda a and b)
IES G-2	Guideline for the Application of General Illumination (“White”) LED Technologies
ANSI C78.377-2008	Specifications for the Chromaticity of SSL Products
NEMA LSD 45-2009	Recommendations for SSL Sub-Assembly Interfaces for Luminaires
NEMA LSD 49-2010	SSL for Incandescent Replacement - Best Practices for Dimming
UL 8750	Safety Standard for LED Equipment for Use in Lighting Products
NEMA SSL-6-2010	SSL for Incandescent Replacement - Dimming
IES TM-21	Method for Estimation of LED Lumen Depreciation as a Measure of Potential LED Life

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WHAT ABOUT ON THE GROUND EXPERIENCE?

STREET AND OUTDOOR LIGHTING PROJECTS

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Supporting LED Projects and Industry

Chinese Taipei:

- *Ministry of Economic Affairs – Bureau of Energy*
- *Plan to accelerated LED R&D through demonstration projects*
- *Replace all traffic signal lamps with LED lamps by 2012*

Japan:

- *New Energy and Industrial Technology Development Organization (NEDO)*
- *Replace all the lightings in Japan with LED lightings by 2030*

Republic of Korea:

- *LED Lighting 2060 Project*
- *National LED lighting penetration rate of 60% by 2020*

New Zealand:

- *Energy Efficiency and Conservation Authority (EECA)*
- *Efficient Lighting Programme with local councils, New Zealand Transport Agency, New Zealand Institute of Highway Technology*

The United States:

- *Department of Energy - Municipal Solid-State Street Lighting Consortium*
- *Los Angeles Bureau of Street Lighting – LED Street Lighting Energy Efficiency Program.*

Types of Projects

Public Roads:

- *Australia, Canada, People's Republic of China, China (Hong Kong), Chinese Taipei, Republic of Korea, Mexico, New Zealand, Thailand, The United States*

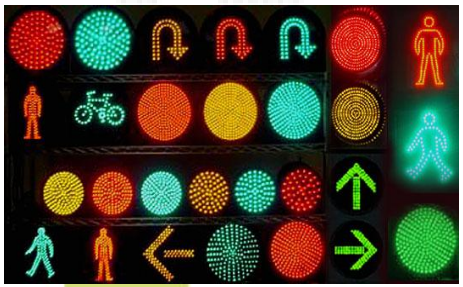
City of Sydney Council, 2011

Public Parks:

- *Australia, Chinese Taipei, Mexico, New Zealand, The United States*

Traffic Lighting:

- *China (Hong Kong), Chinese Taipei, Republic of Korea, The United States*



Inhabitat.com, 2011

Most projects triggered by Municipalities and City Councils:

- *Sydney (Au), Huizhou and Xiamen (China), Taipei (CT), Mexico City (MX), Waitakere and Hamilton (NZ), Los Angeles, Seattle and Chicago (US), and many more…*

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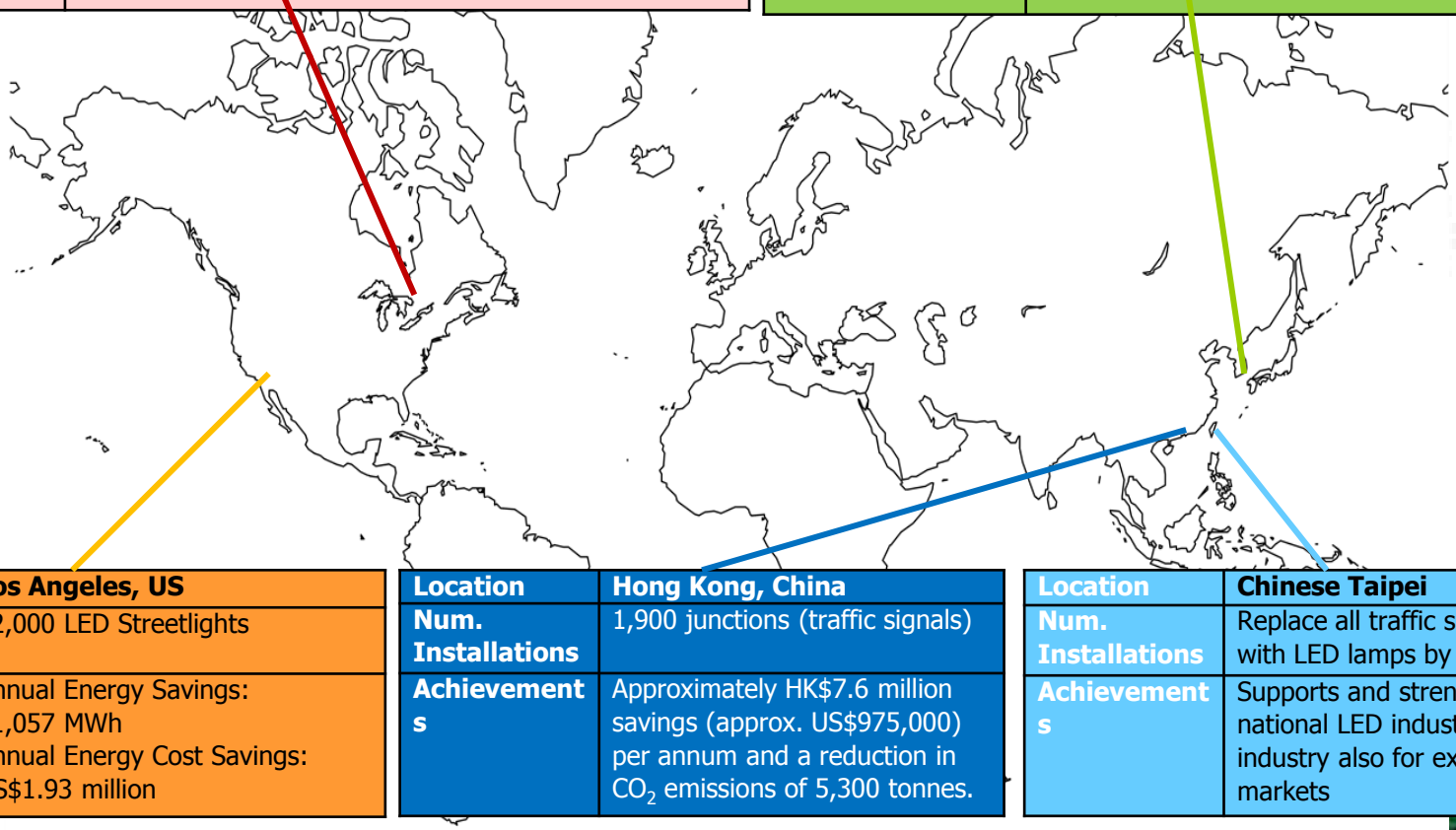
LED Street and Outdoor Lighting Projects

Location	Greater Toronto Area, Canada
Num. Installations	> 1,800 LED Luminaires (1,100 in Nova Scotia alone)
Achievements	Accelerate use of LED street and outdoor lighting and supporting municipalities in making the best choices and ensure public acceptance

Location	Suwon City, Republic of Korea
Num. Installations	4,000 LED traffic light units
Achievements	85% reduction in energy costs compared to previous technology and also a 30% reduction in traffic accidents



Location	Los Angeles, US
Num. Installations	52,000 LED Streetlights
Achievements	Annual Energy Savings: 21,057 MWh Annual Energy Cost Savings: US$1.93 million

Location	Hong Kong, China
Num. Installations	1,900 junctions (traffic signals)
Achievements	Approximately HK$7.6 million savings (approx. US$975,000) per annum and a reduction in CO_2 emissions of 5,300 tonnes.

Location	Chinese Taipei
Num. Installations	Replace all traffic signal lamps with LED lamps by 2012
Achievements	Supports and strengthens national LED industry preparing industry also for external markets

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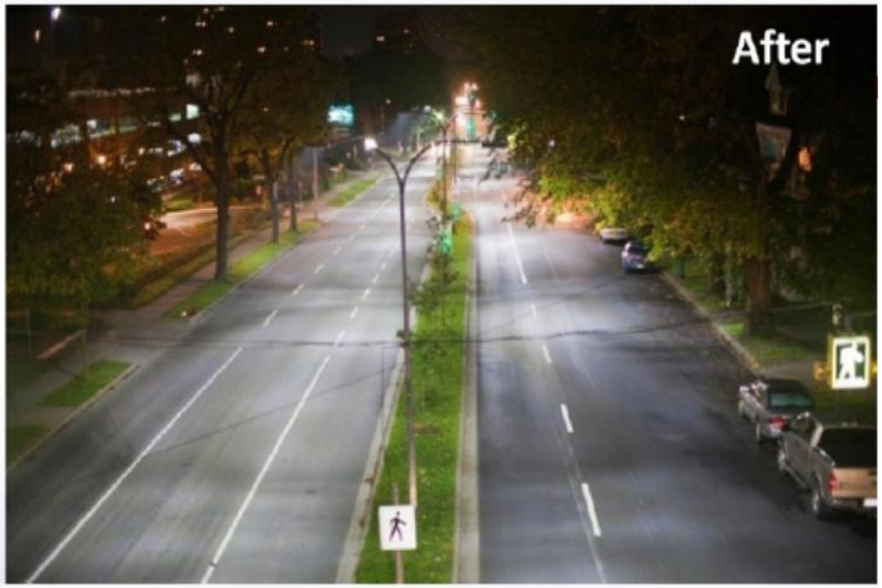
Nova Scotia, Canada



Lightsavers Program, 2011

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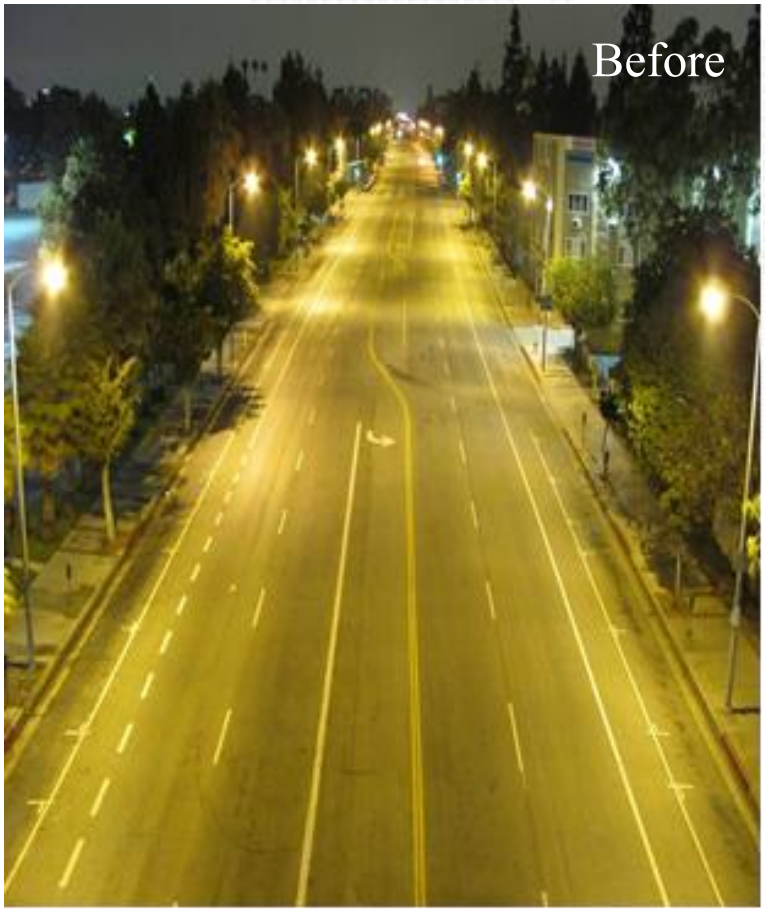
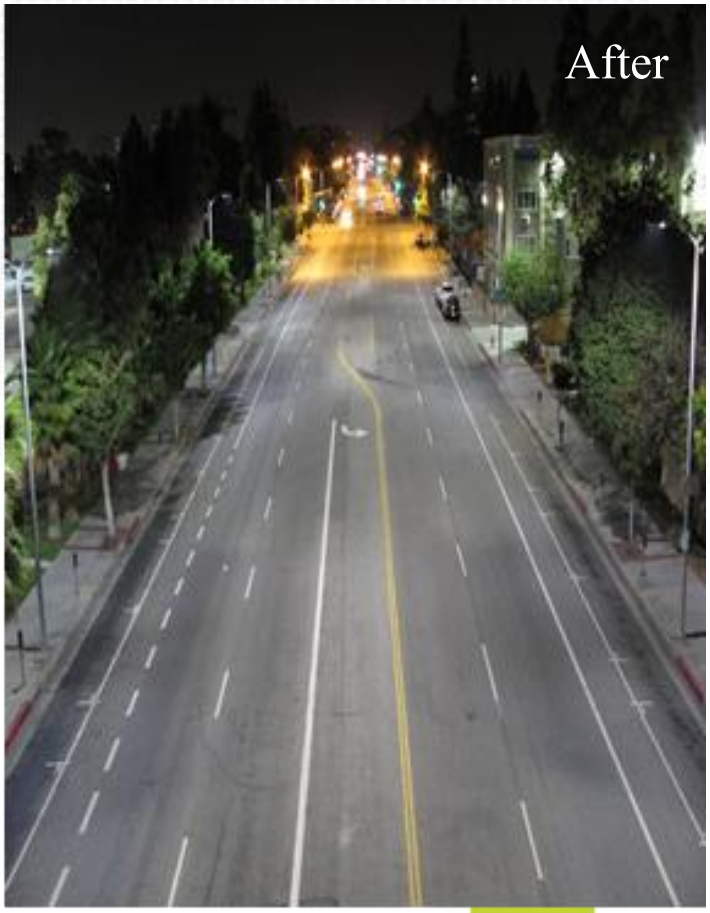
Los Angeles, US





BSL, 2011

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LESSONS FROM EXPERIENCE…

BEST PRACTICES

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Best Practices in APEC

- **Based on Survey and Research**
- **Purchase, Installation and Maintenance**
- **Target Audience?**
  - ***Towns and cities***
  - ***Local officials and municipal government***
  - ***Policy makers***

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7 Key Questions - Purchase

LED product specifications follow economy-wide standards?

Requirements of illumination quality included in the procurement specifications?

Preliminary field trial is a part of the evaluation and selection process?

Testing performed by third-party, accredited laboratories?

Warranty of LED products is at least 5 years?

Warranty bond and penalty included as parts of Warranty Terms and Conditions?

"Application Efficacy" considered as one of the selection criteria?

Standards and Specifications - Purchase

- **China** - GB/T 24907-2010: LED lamps for road lighting – performance specifications
- **Chinese Taipei** - CNS 15233: Fixtures of roadway lighting with LED lamps
- **Republic of Korea** - KS C 7528: LED Traffic Signals
- **Thailand** – Asian Development Bank project – General Specifications
- **The United States**:
  - *ANSI C136.37 - Solid State Light Sources Used in Roadway and Area Lighting*
  - *Bureau of Street Lighting – General Specifications*
    - Correlated Colour Temperature (CCT) and Colour Rendering Index (CRI)
    - Off-State and On-State Power Consumption
    - Luminaire Efficacy and Lumen Depreciation
    - Safety and Assembly
    - Warranty
  - *Municipal SSL Street Lighting Consortium - Model Specification for LED Roadway Luminaires*
    - System Specification (application efficacy)
    - Material Specification (luminaire efficacy)

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Ensuring Quality - Purchase

- **Voluntary Product Certification and Labeling Schemes:**
  - ***Australia*** *- SSL Quality Scheme*
  - ***Republic of Korea*** *– High Efficiency Certification Program for LED traffic lights*
  - ***Malaysia*** *- LED Certification Centre*
  - ***Mexico*** *- Label Scheme (Sello FIDE)*
  - ***The United States*** *- SSL Quality Advocates Scheme*
- **Guidelines:**
  - ***Hong Kong, China*** *- Guidelines for Specifying & Procuring LED Lighting Products for Lighting Projects*

Best Practices for Installation

- Location
- Purpose and Requirements
- Design in accordance with Standards and Specifications
- Installation
- Testing Performance
- **But…What Changes with LED?**
  - *Lights Levels and Uniformity*
  - *Proposed Visual Efficacy Systems*

Light Levels and Uniformity

- **International Standards for Street and Outdoor Lighting**
- **Light Levels and Uniformity based on:**
  - Type of traffic (motorized or pedestrian)
  - Traffic density
  - Conflict area
- **Defines:**
  - Lighting pole layout, span and height
  - Selection of light source, luminaire and electrical design works

Light Levels and Uniformity

CIE 115-2007 – Recommendations for the Lighting of Motorized Traffic (updated)

Lighting Class	Luminance (cd/m^2)	Uniformity (U_o)
M1	2.0	0.4
M2	1.5	0.4
M3	1.0	0.4
M4	0.75	0.4
M5	0.5	0.4

Lighting Class	Description of Road
M1, M2, M3	High speed roads with separate carriageways Traffic density and complexity of road layout
M1, M2	High speed roads with dual carriageway roads Traffic control level
M2, M3	Important urban traffic routes, radial roads, district distributor roads Traffic control level
M4, M5	Connecting less important roads, local distributor roads, residential major access roads Traffic control level

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Visual Efficacy Systems

Scotopic / Photopic Ratio of Commercially Available Light Sources

Low Pressure Sodium	0.25
High Pressure Sodium (HPS) 250 W clear	0.63
HPS 400 W clear	0.66
HPS 400 W coated	**0.66**
Mercury vapour (MV) 175 W coated	1.08
MV 400 W clear	1.33
Incandescent	1.36
Halogen headlamp	1.43
Fluorescent Cool White	1.48
Metal halide (MH) 400 W coated	1.49
MH 175 W clear	1.51
MH 400 W clear	1.57
MH headlamp	1.61
Fluorescent 5000 K	1.97
White LED 4300 K	**2.04**
Fluorescent 6500 K	2.19

Source: Table 2, ASSIST Publication on Outdoor Lighting: Visual Efficacy, Volume 6, Issue 2, January 2009

Values of Unified Luminance for Different Base Light Levels and Scotopic / Photopic Ratios

Base light level (photopic luminance (cd/m^2))

S/P	0.14	0.16	0.18	0.20	0.22	0.24	0.26	0.28	0.30	0.32
0.25	0.0573	0.0704	0.0849	0.1009	0.1184	0.1373	0.1574	0.1788	0.2012	0.2246
0.35	0.0728	0.0877	0.1037	0.1209	0.1392	0.1585	0.1787	0.1998	0.2217	0.2442
0.45	0.0864	0.1026	0.1197	0.1377	0.1565	0.1760	0.1963	0.2172	0.2387	0.2607
0.55	0.0983	0.1156	0.1335	0.1521	0.1713	0.1911	0.2113	0.2320	0.2532	0.2747
0.65	0.1092	0.1273	0.1459	0.1649	0.1844	0.2043	0.2245	0.2451	0.2659	0.2871
0.75	0.1191	0.1379	0.1570	0.1764	0.1961	0.2161	0.2363	0.2567	0.2773	0.2981
0.85	0.1283	0.1477	0.1672	0.1869	0.2068	0.2268	0.2470	0.2672	0.2876	0.3081
0.95	0.1368	0.1566	0.1765	0.1965	0.2165	0.2365	0.2566	0.2767	0.2969	0.3170
1.05	0.1448	0.1651	0.1853	0.2054	0.2255	0.2456	0.2656	0.2856	0.3055	0.3254
1.15	0.1523	0.1730	0.1935	0.2138	0.2339	0.2540	0.2739	0.2937	0.3135	0.3331
1.25	0.1593	0.1803	0.2010	0.2215	0.2417	0.2617	0.2816	0.3013	0.3208	0.3402
1.35	0.1661	0.1873	0.2082	0.2288	0.2491	0.2691	0.2888	0.3084	0.3277	0.3469
1.45	0.1724	0.1940	0.2150	0.2357	0.2560	0.2759	0.2956	0.3150	0.3341	0.3531
1.55	0.1785	0.2003	0.2215	0.2422	0.2625	0.2824	0.3020	0.3213	0.3402	0.3590
1.65	0.1843	0.2063	0.2276	0.2484	0.2687	0.2886	0.3081	0.3272	0.3460	0.3645
1.75	0.1899	0.2120	0.2335	0.2543	0.2746	0.2944	0.3138	0.3328	0.3514	0.3697
1.85	0.1952	0.2175	0.2391	0.2599	0.2802	0.3000	0.3193	0.3381	0.3566	0.3747
1.95	0.2003	0.2228	0.2444	0.2653	0.2856	0.3053	0.3244	0.3432	0.3615	0.3794
2.05	0.2053	0.2279	0.2496	0.2705	0.2907	0.3103	0.3294	0.3480	0.3661	0.3838
2.15	0.2100	0.2327	0.2545	0.2754	0.2956	0.3152	0.3341	0.3526	0.3706	0.3881

HPS Lamp

White LED

Best Practices for Maintenance Strategy

- **Purpose:**
  - Cleaning
  - Repairs
  - Replacement
  - Refurbishment
- **But…What Changes with LED?**
  - *Lumen Depreciation*
  - *Product Lifetime*

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Evaluating Lifetime of LEDs

- **LED maintenance strategy will depend on:**
  - ***Lumen-Maintenance Life (L_p)***
  - ***Rated Life or Statistically Measured Failures (B_p)***
- **Projecting for 30,000 hours and 50,000 hours?**
  - *Modelling and extrapolation methods under discussion*
  - *Lumen-maintenance projection curve*
    - Rule of Thumb - for each 10°C increase, LED lifetime falls by half
  - *Accelerated Life-Test Methods*

Hong Kong, China – Maintenance Guidelines

- **Guidelines for Specifying & Procuring LED Lighting Products for Lighting Projects:**

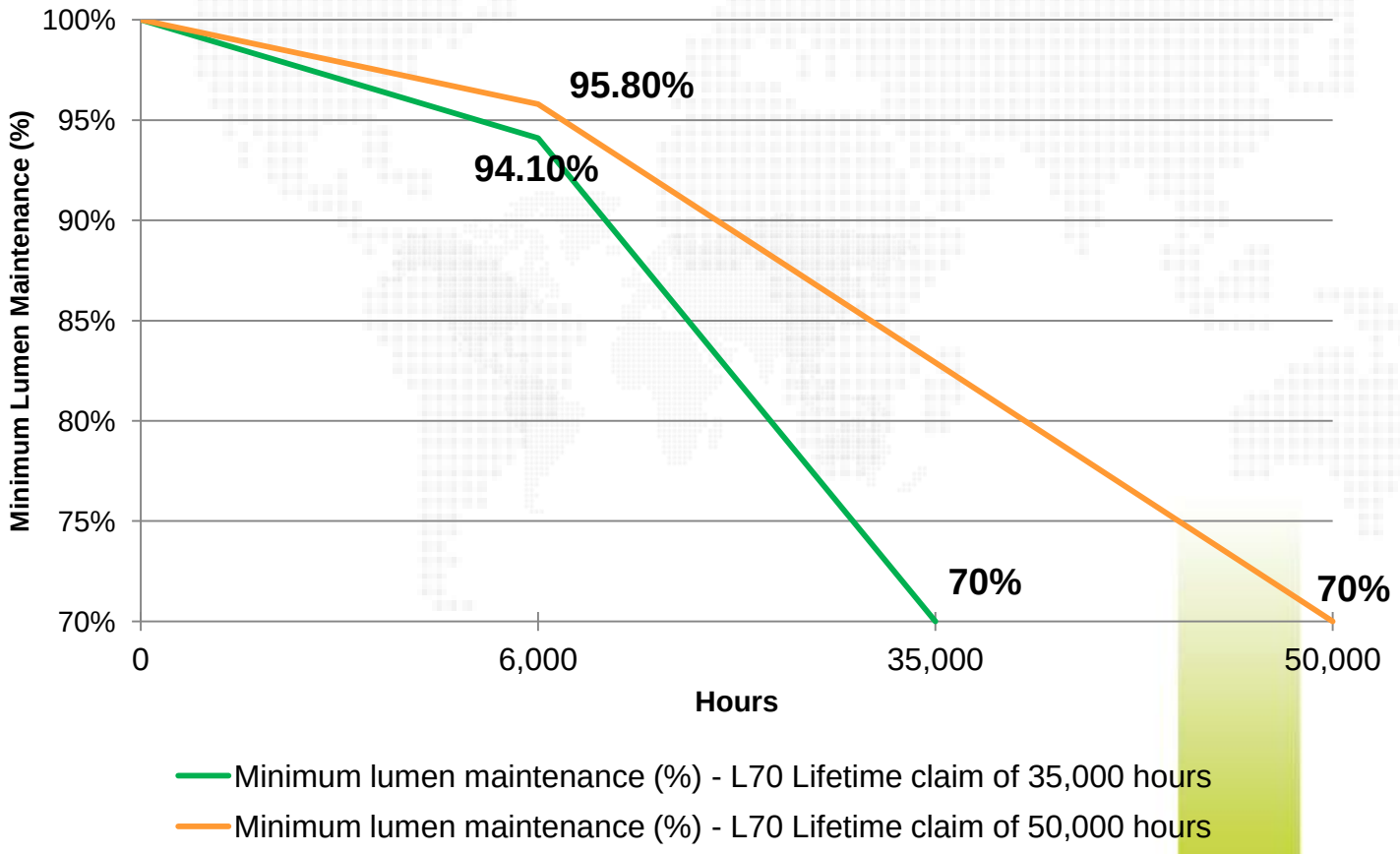
> ***Rated lifetime depends on lumen depreciation and failure rate***

- **Gather from Manufacturer:**
  - ***Lumen depreciation associated to estimated useful life:*** *70% lumen depreciation of the initial lumen output*
  - ***Electrical failure rate*** *under the claimed lifetime*
  - ***Failure of other components:*** *LED driver failure rate and lifetime compatible with the LED module*
  - ***Estimated lumen maintenance curve:*** *Initial lumen output and the lumen depreciation pattern during the useful life of the LED lighting under design and operating temperature conditions*

The United States – Maintenance

- **Replacement Strategies**
  - *National Cooperative Highway Research Program + Lighting Research Center – LED Traffic Signal Maintenance*
- **Lumen Maintenance**
  - *Los Angeles, Bureau of Street Lighting - Guide to Evaluating LED Lumen Maintenance*
  - *IESNA LM-80-08 – Approved method for measuring lumen maintenance of LED light sources*
    - Component Performance VS Luminaire Performance
  - *IESNA TM 21-11 - Projecting Long Term Lumen Maintenance of LED Light Sources*

IESNA LM-80-08



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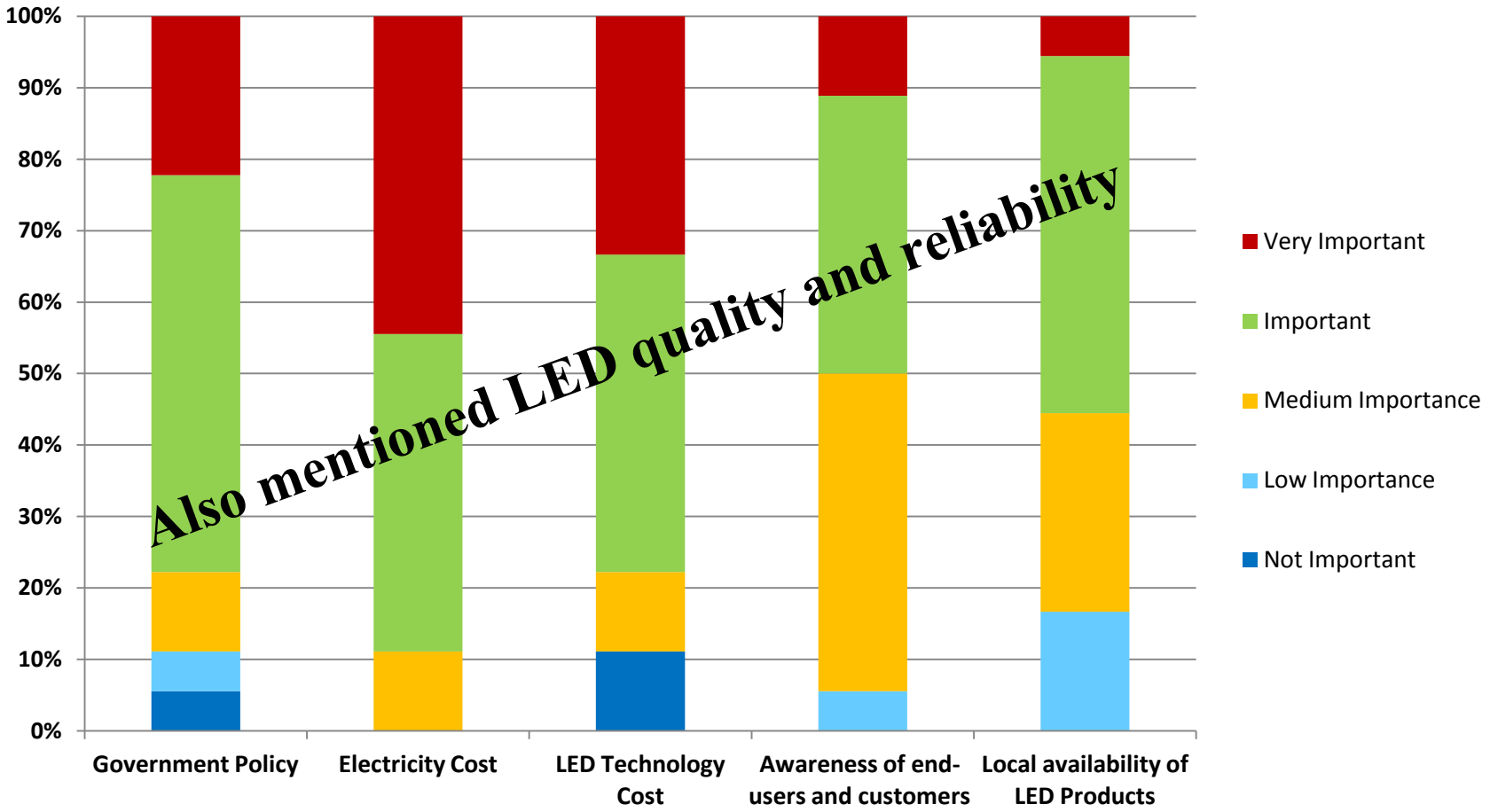
BEST PRACTICES….

What will drive LED uptake in APEC Member Economies?

Key Drivers


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Government Policy
Electricity Cost
LED Technology Cost
Awareness of end-users and customers
Local availability of LED Products
Very Important
Important
Medium Importance
Low Importance
Not Important
Also mentioned LED quality and reliability

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Thank You !

Any Questions?

Share your experience!