Australian Update

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Regulation of Lighting Energy Efficiency in Australia

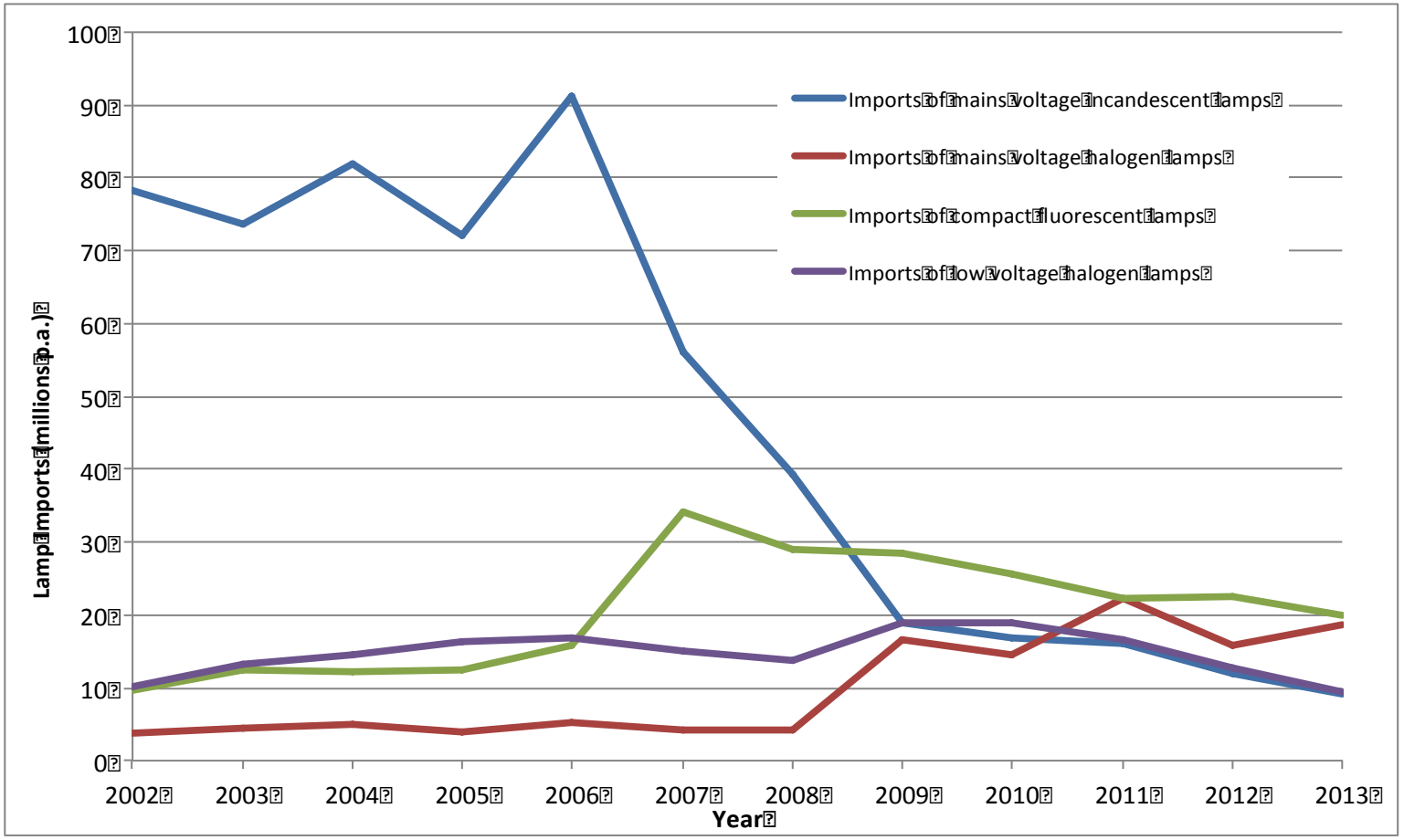
- Minimum Energy Performance Standards (MEPS) programs are mandatory requirements for certain lighting products sold in Australia.
  - Enforced by legislation with reference to the relevant Australian or Australia/New Zealand Standards.
  - Regulations specify the requirements for MEPS for lighting, including offences and penalties if a party does not comply with the requirements.
  - Technical requirements for MEPS are set out in Determinations which usually reference the relevant appliance standard.
  - Phase-out announced in 2007 and commenced in 2009 with a staged approach to introduction of regulation for products.

Lighting Products Subject to MEPS

Lighting MEPS specify efficacy levels for lamps in lumens/watt, + performance requirements

- Incandescent lamps (tungsten filament and halogen)
- Compact Fluorescent Lamps (integrated)
- Linear Fluorescent Lamps
- Ballasts for Linear Fluorescent Lamps
- Transformers and Converters for Halogen Lamps
- Requirements set out on the Energy Rating Website: www.energyrating.gov.au/

Outcomes – Lamp Imports (ABS data)



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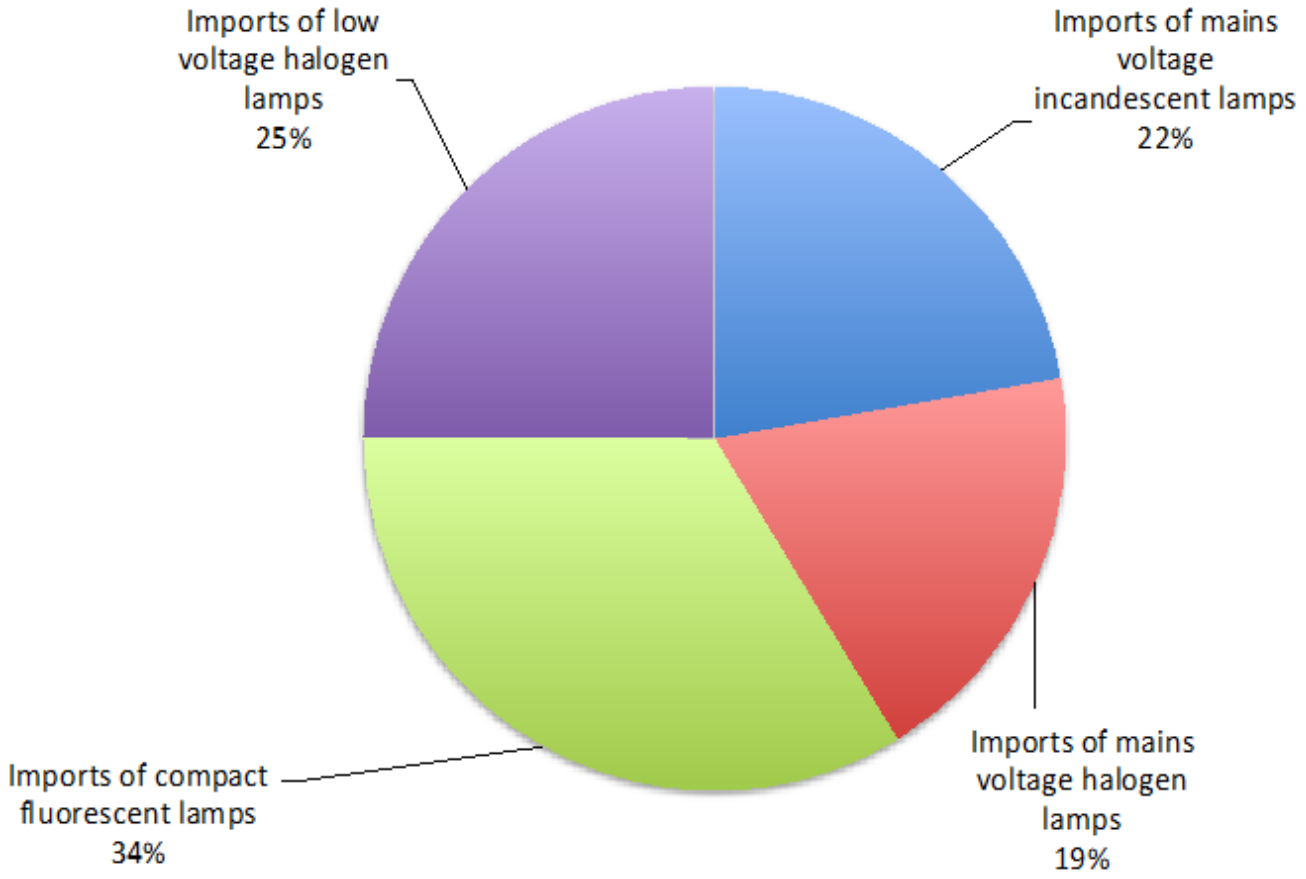
Outcomes – lamp types

- The phase-out of incandescent light bulbs is helping to save around 2.6 terawatt-hours of electricity each year.
- Imports of mains voltage tungsten filament incandescent lamps reduced from about 80 million per annum (2002–2006) to around 9 million in 2013.
- Imports of mains voltage halogen lamps were steady at around 5 million per annum over the period 2002–2008 and jumped to 17 million in 2009. In 2011 imports had increased to 22 million and remain at just under 20 million in 2013.
- Mains voltage Halogen lamps have replaced a little under half of the phased out tungsten filament lamps

Outcomes – lamp types

- Imports of CFLs climbed from 10 million in 2002 to around 34 million in 2007. Since then, imports have steadily declined to around 20 million in 2013, with some of this decline likely to be due to winding back of CFL giveaway programs and the longer life of CFLs.
- ELV halogen lamp imports rose from 10 million in 2002 to 19 million in 2010. Since 2010 imports of these lamps have halved.
- Anecdotal evidence suggests that LEDs are becoming increasingly popular as a replacement for ELV halogen lighting. However no reliable data is currently available for imports or sales of LED lighting.

Relative share of lamps imported into Australia in 2010 (source: ABS import data)



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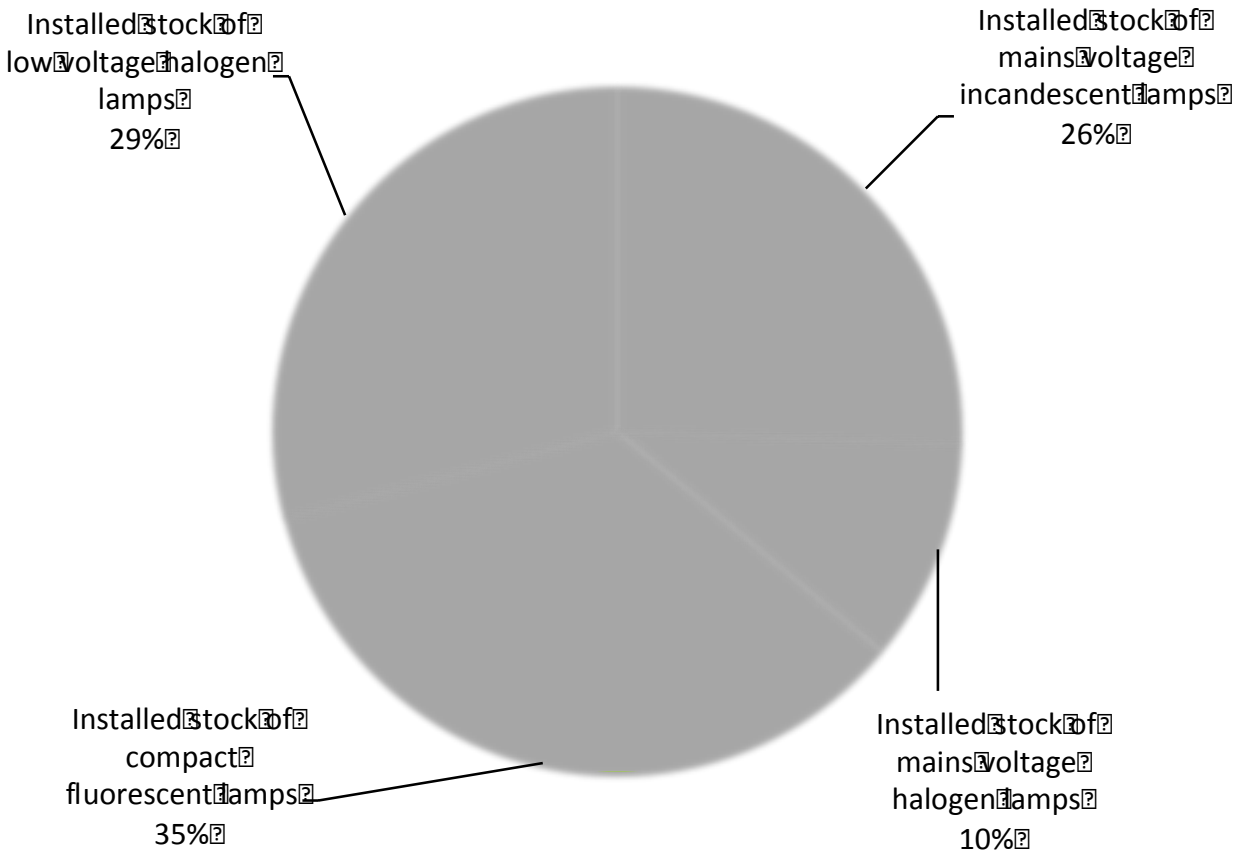
Household lighting survey results – relative share of lamp stock in 2010



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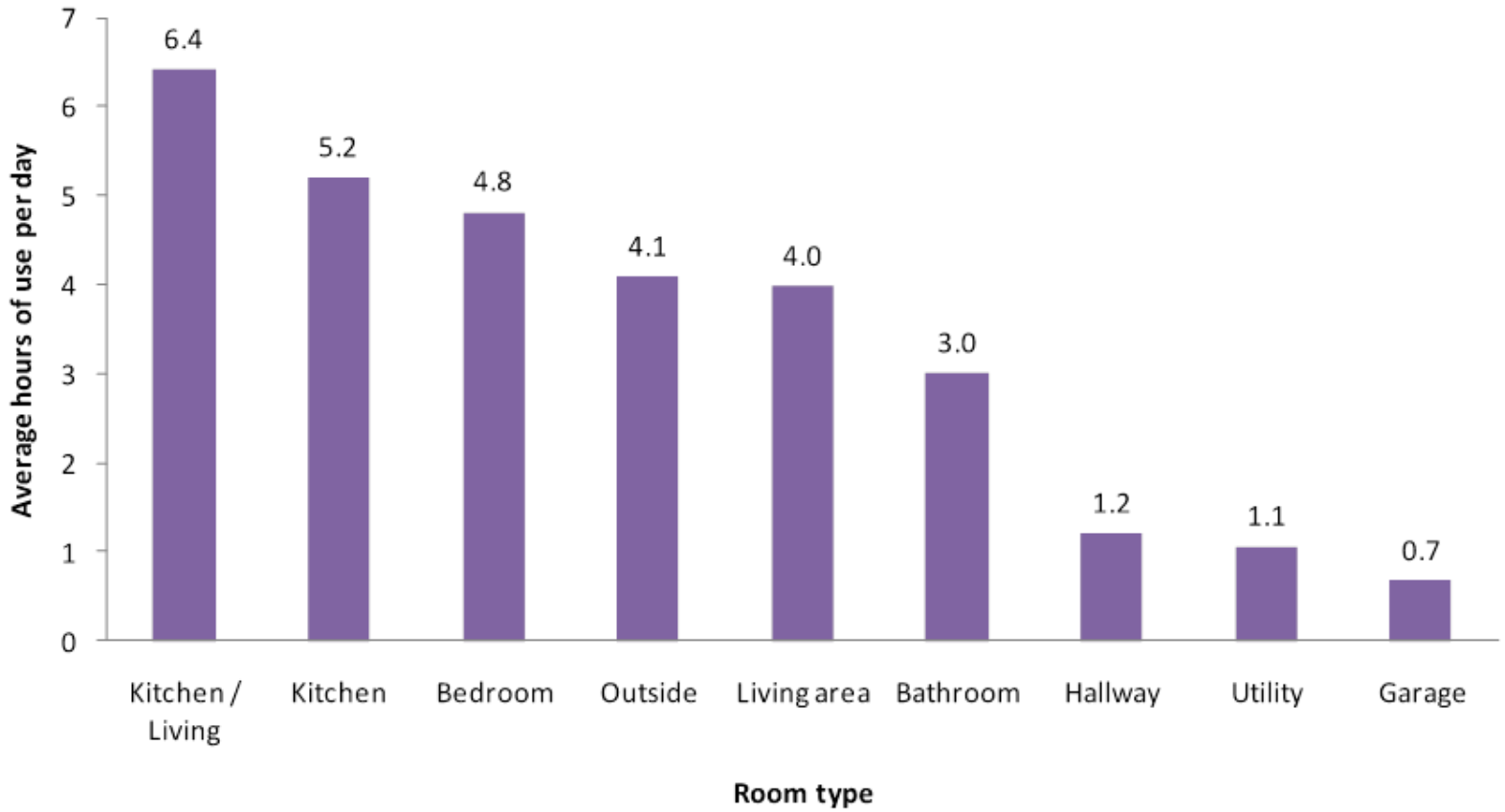
Average hours of use per weekday, from the E3 Australian Residential Lighting Survey



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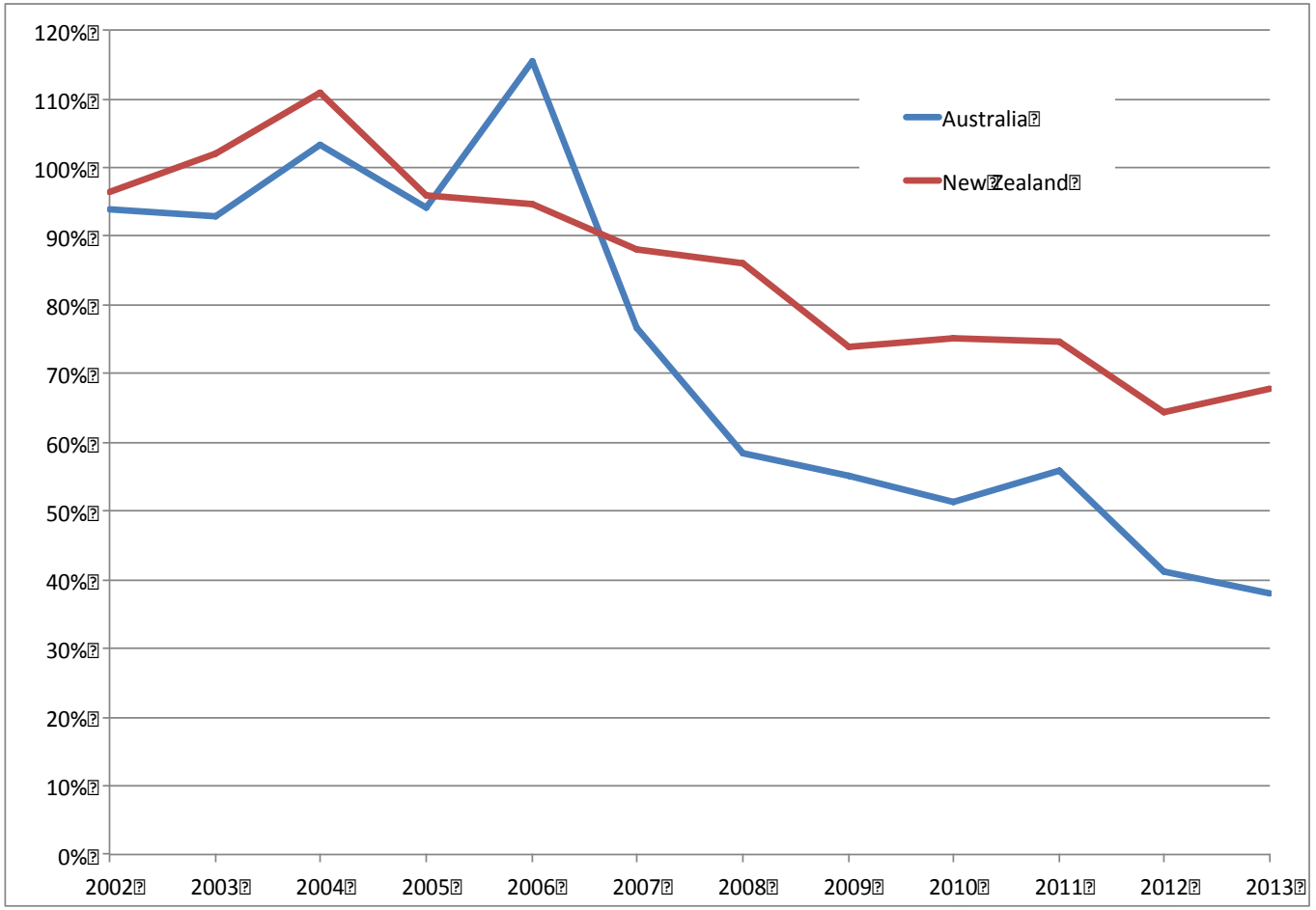
Imports of all types of filament lamps into Australia and New Zealand (normalized)



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Outcomes – Australia and New Zealand

- Sales of filament lamps fell around 62% in Australia and around 32% in New Zealand from the period 2002/2006 to 2013.
- Australia announced phase-out of inefficient incandescent lamps in 2007 and introduced regulation in 2009.
  - invested in point of sale consumer education in the first years of phase-out (but did not continue further as evaluation of consumers indicated this was not required).
- New Zealand has not introduced regulation for incandescent lamps (but has introduced MEPS for CFLs).
  - New Zealand invested significant resources in consumer education and has also introduced Energy Star for some products.

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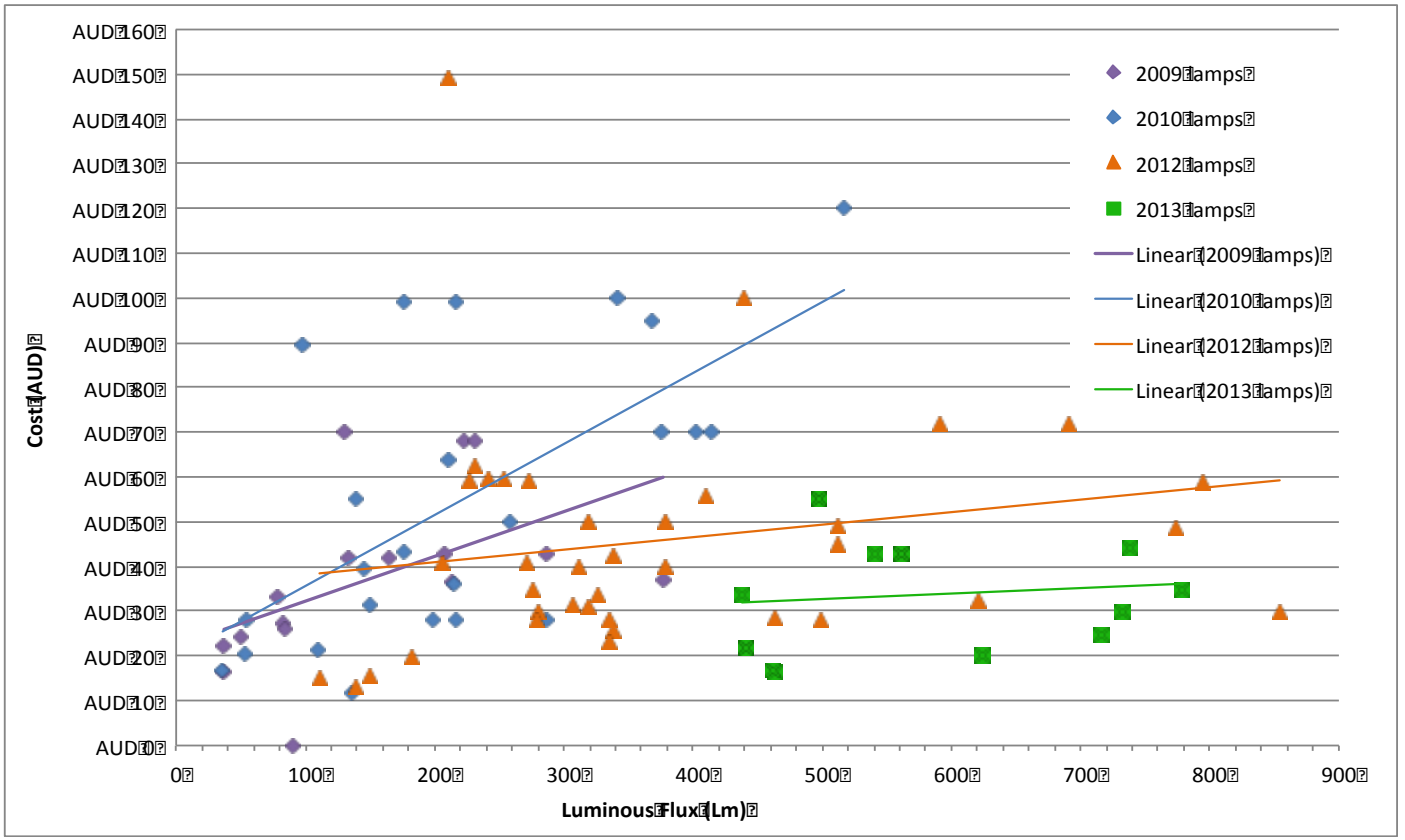
What Next?

- With the removal of tungsten filament lamps from the market, halogen lamps are now the least efficient light source
- A full transition from halogen lighting to energy efficient lighting such as CFL and LED would offer significant further energy savings of up to 85%
- This requires an evaluation of the ability for LED and CFL lamps to serve as an effective replacement for the range of applications where halogen lamps are currently used (and at a suitable price point).
- CFLs can serve as a replacement technology – in particular for omnidirectional lighting. LED lighting is emerging to serve as replacements for directional and omnidirectional lighting.

What Next? – LED Pricing Evolution

Cost of LEDs compared to luminous flux 2009 to 2013



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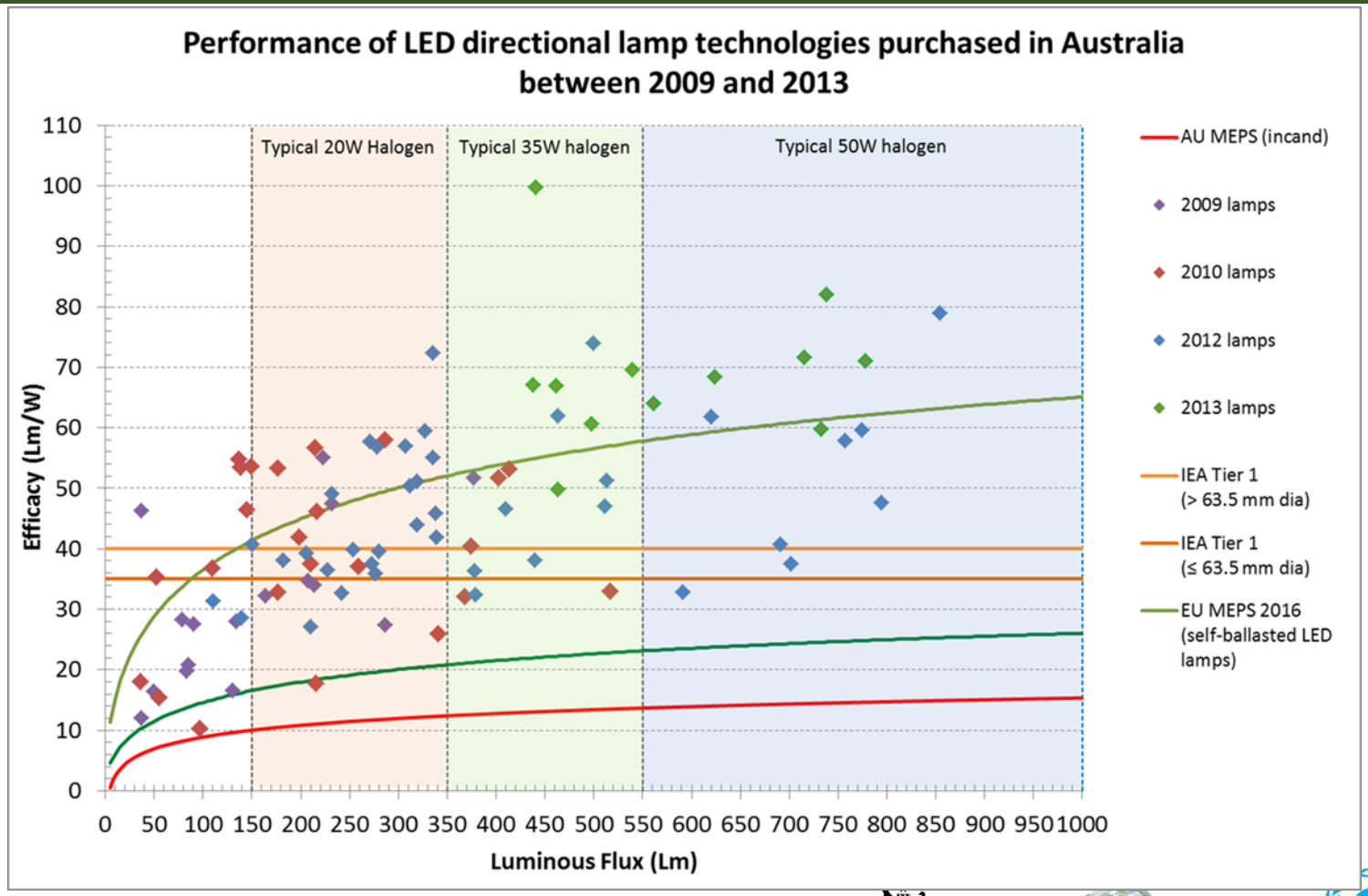
What Next?



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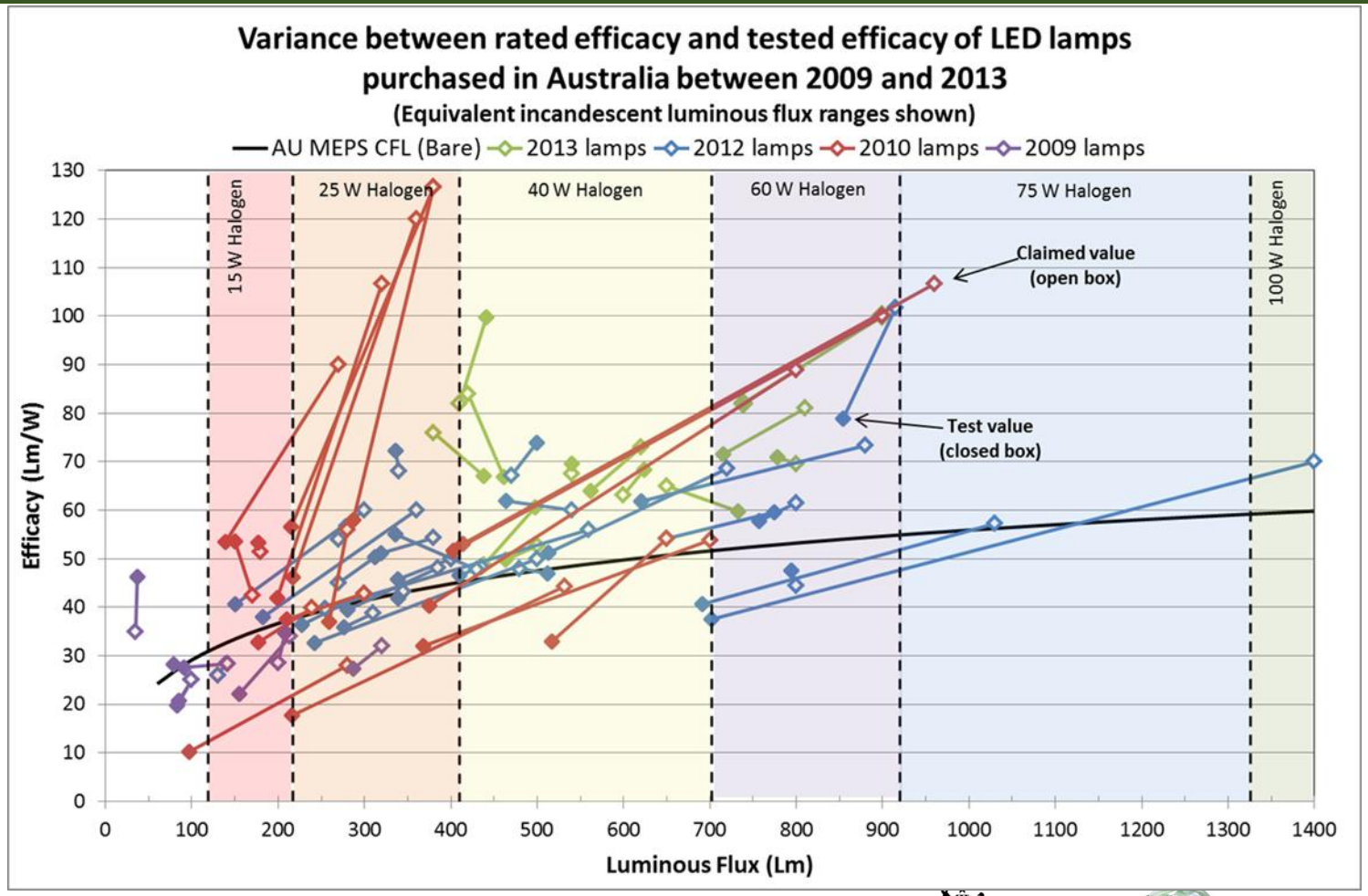
Options for further improvements

- No scope to increase MEPS efficacy requirements for incandescent lamps if they are to remain in the market
- Some scope to increase MEPS for CFLS to gain further savings
- Application of MEPS level that would remove incandescent lamps from the market
  - Potentially in a staged approach as alternatives are available
  - Potentially commencing with MR16 reflector lamps and then progressing to mains voltage lamps.

Options for Further improvements

- While the market may make a natural shift towards LEDs over the next few years, the experience with CFLs has shown that there is a risk of a consumer backlash due to variation in quality, performance, lifetime, light output and inaccurate equivalency claims.
- If this occurs, the transition may remain incomplete (as it did with CFLs).
- An efficacy and performance MEPS similar to that in place for CFLS may be appropriate to protect consumers from poor quality products and misleading equivalency claims.
- Discussion papers will soon be released in Australia to seek stakeholder input on these options.

LED Performance – Claim and Test



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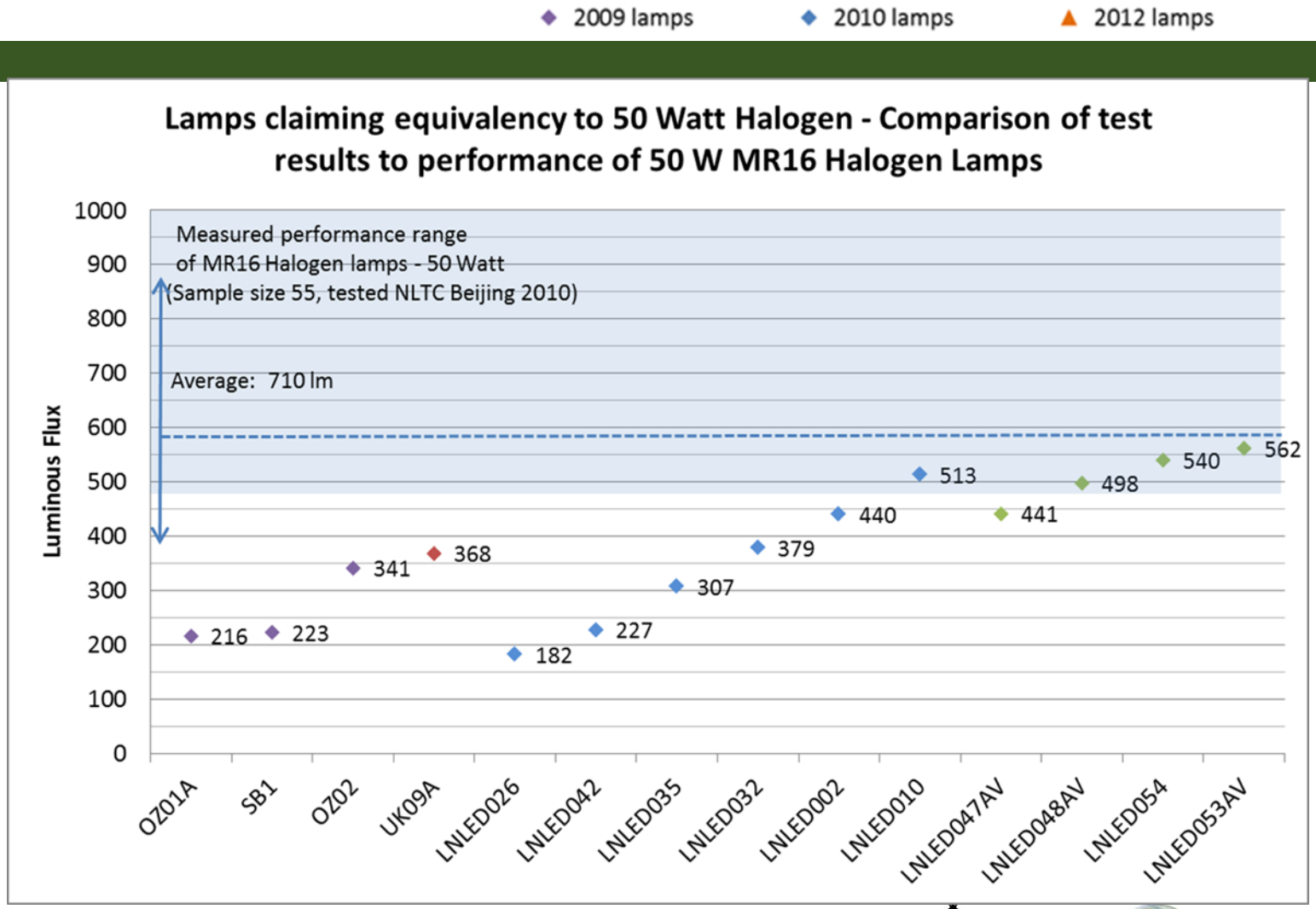

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LED Challenges

We need to:

- Ensure accurate information on product performance and equivalence is available so that consumers understand what they are buying.
- Provide guidance on acceptable minimum performance levels.
- Discourage the least efficient LEDs that may potentially be less efficient alternatives to more efficient LEDs and already proven efficient lighting (such as CFLs) for uninformed consumers
- Recognise that LED lighting performance and quality is complex and truth in claim will not in itself ensure consumers have access to quality products.

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Information Sources

- IEA 4E Solid State Lighting Annex work on LED performance parameters and testing (http://ssl.iea-4e.org/)
- IEC and CIE LED standards
- Conduct testing against the draft CIE test standard now available
- Continue monitoring (testing) LED product performance
- Evaluate actions by other countries
- SEAD Lighting Awards (www.superefficient.org/awards)

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Status of Minimum and High Performance Requirements

	EU		Germany		Hong Kong		Chile		China		India		Japan		Korea		Malaysia		Mexico		Nigeria		UK		US	
Parameters	MEPS	HEPS	MEPS	HEPS	MEPS	HEPS	MEPS	HEPS	MEPS	HEPS	MEPS	HEPS	MEPS	HEPS	MEPS	HEPS	MEPS	HEPS	MEPS	HEPS	MEPS	HEPS	MEPS	HEPS	MEPS	HEPS
Energy Efficiency																										
Efficacy (lumens per Watt)	■	■																	■							
Power limit (Watt) – maximum for a product type	■																									
Light quality parameters																										
Luminous flux																			■							
Correlated Colour temperature	■	■																	■							
Colour rendering index	■	■																	■							
Colour shift – spatial and temporal																										
Colour difference	■	■																	■							
Centre beam intensity equivalence	■	■																								
Beam angle	■	■																								
Lumen maintenance	■	■																	■							
Start time	■	■																								
Runup time	■	■																								
Electrical quality parameters																										
Power factor	■	■																								
Harmonic distortion																										
Dimmability																										
EMC																										
Transient overvoltage																			■							
Product quality parameters																										
Lifetime	■	■																								
Premature failure rate	■																									
Switching withstand	■	■																	■							
Operating temperatures																			■							
Photobiological hazard class (UV & blue light)		■																								
Flicker		■																								
Glare		■																								

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Status of Labelling Schemes

	EU		Germany		Hong Kong		Chile		China		India		Japan		Korea		Malaysia		Mexico		Nigeria		UK		US	
Parameters	Compa	Endorse	Compa	Endorse	Compa	Endorse	Compa	Endorse	Compa	Endorse	Compa	Endorse	Compa	Endorse	Compa	Endorse	Compa	Endorse	Compa	Endorse	Compa	Endorse	Compa	Endorse	Compa	Endorse
Energy Efficiency																										
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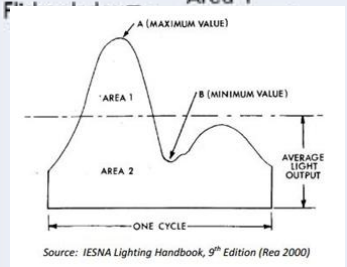
Which Parameters?

- IEA 4E SSL has identified a range of performance parameters and levels that can assist in identifying and guiding the quality of LED lighting.
- This is important as the performance against these parameters influence the efficacy and quality of the lighting service a product provides.
- Challenge for regulators is to identify which parameters to refer to in MEPS, HEPS and labels.
- While also taking into account:
  - Cost of compliance for industry and monitoring and enforcement for regulators – testing can be expensive and time consuming.
  - need for a range of products to be available in the market.

Criterion	Description	Why it is important	Existing Standards	Test Method	Testing cost (low 200/ med1000/ high>1000)
Minimum light output (lm) and Equivalent wattage	Luminous flux (measured in lumens) quantifies the total amount of light emitted by a light source or product. The minimum light output requirement ensures that the LED product produces at least the same amount of light as an incandescent light source of a given wattage; these levels assist in evaluating manufacturer claims of equivalence.	Acceptable light output levels are of highest importance for safe working and living conditions. Accurate equivalency comparison with the products that are being replaced is also important, though this will diminish over time as manufacturers stop selling products according to claimed equivalencies and consumers select lamps on the basis of light output (lumens) rather than wattage.	IEC/PAS 62612 (Self ballasted LED) IEC/PAS 62717 (LED modules)	CIE TC2.71 IES LM79-08	Sphere = low Gonio = med
Minimum luminous efficacy (lm/W)	Ratio of total light output of a lamp to the power consumed in producing it (lumens/watt). The higher the efficacy value, the more energy efficient the lighting product.	This criterion informs the consumer and society on how well the light source produces visible light. An important indicator for saving energy and money.	IEC/PAS 62612 (Self ballasted LED) IEC/PAS 62717 (LED modules)	CIE TC2.71 IES LM79-08	Sphere = low Gonio = med
Minimum fixture efficiency	Ratio of total light output of an entire fixture compared to the power consumed (lumens/watt) Calculated as Luminous efficacy x Light output ratio (LOR)	Very important: an efficient light source installed within an inefficient light fixture will result in high losses inside the fixture, and thus en inefficient system. Ie. no energy savings.	IEC/PAS 62722	CIE TC2.71	Gonio = med
Luminous intensity distribution	The measured distribution of light output for a lighting product	High importance for consumers, for both directional and non-directional lamps (which have a partially directional beam due to cap position). Lighting design requires specific light distribution into a space; in either new installations or retrofit it is necessary that the specifications closely approximate the light distribution properties of the lamp (which has been shown through testing not to be the case).	IEC/PAS 62612 (Self ballasted LED) IEC/PAS 62717 (LED modules)	CIE TC2.71 IES LM79-08	Gonio = med

Criterion	Description	Why it is important	Existing Standards	Test Method	Testing cost (low 200/ med1000/ high>1000)
Zonal lumen density	The spatial distribution of light into particular angular zones.	Important for consumers; avoids products having too much light distribution in zones other than where designated by their status. Ie. directional lamps to have majority of light in forward direction; while typical non-directional lamps to have a more consistent light spread through most zones.	Energy Star Ecodesign	CIE TC2.71 IES LM79-08	Gonio = med
Centre beam luminous intensity	The measured intensity of light output on the optical beam axis for directional lamps (with beam angle < 65°)	Important in accurately evaluating the performance of directional lamps/products	IEC/PAS 62612 (Self ballasted LED) IEC/PAS 62717 (LED modules)	CIE TC2.71 IES LM79-08 IEC 61341	Gonio = med
Colour rendering index (CRI)	A measure of the ability of a light source to reveal the colours of various objects faithfully in comparison with an ideal or natural light source (such as sunlight). The highest CRI attainable is 100, with the scale dropping to negative values for some light sources. Typical LEDs have about 80+ CRI.	Colour rendering if important for consumer satisfaction with a lighting product. High CRI of 90+ is necessary for specialised tasks where colour is important (eg. food preparation, applying makeup, painting). For general use in residential and office locations, a CRI of 80 is recommended.	IEC/PAS 62612 (Self ballasted LED) IEC/PAS 62717 (LED modules)	CIE TC2.71 CIE 13.3:1995 IES LM79-08	
Correlated colour temperature (CCT) in Kelvin (K)	Specifies the colour ‘shade’ of white light emitted by a lamp, relating to the colour of light from a reference source when heated to a particular temperature, measured in Kelvin. Spectrally, “warm” shades contain more red light content and are at lower Kelvin (2700-3500 K), while “cool” shades contain more blue (4000-6500+ K) to create their appearance.	CCT helps consumers select the appropriate product depending on their light colour preference and match light colour across different manufacturer lighting products. This way, when lighting products from different manufacturers are used in the same space there is not an unintended mix of cool white with warm white lighting.	ANSI C78.377 defines target colour temperatures and allowable tolerances (below) IEC/PAS 62612 (Self ballasted LED) IEC/PAS 62717 (LED modules)	CIE 15:2004 CIE TC2.71	Sphere = low
Colour spatial uniformity	The maximum allowable variation in the colour of light emitted over an angular range	High importance for consumers: ensures that there are no extreme, perceptible colour variations in light output of a lamp. (Colour blotches are often		CIE TC2.71 IES LM79-08	Goniocolourimeter or Goniospectrom

Criterion	Description	Why it is important	Existing Standards	Test Method	Testing cost (low 200/ med1000/ high>1000)
Chromaticity tolerance ($Du'v'$)	Specifies the allowable deviation in light colour; technically defined to be the distance of the light chromaticity from the Planckian (black body) locus as per ANSI C78.377	Ensures that all lamps of the same claimed colour temperature appear to be the same colour when installed. Protects consumers from LED products emit an unacceptable pink or green tint.	ANSI C78.377 IEC/PAS 62612 (Self ballasted LED) IEC/PAS 62717 (LED modules)	CIE TC2.71 IES LM79-08	
Flicker (flicker index)	Measures the perceived photometric flicker of a lamp. Presently defined: Area 1  Source: IESNA Lighting Handbook, 9th Edition (Rea 2000)	Important for consumer satisfaction and resultant acceptance of LED products. • Certain human health conditions are characterised by severe reactions to light sources that flicker at certain frequencies, with effects ranging from headaches to extreme seizures. • Flicker can make rapidly moving objects seem like they are stationary • Can also leave residual images of bright spots in the visual field Flicker requirements minimise these stroboscopic effects.	IEEE PAR 1789	No official test method. SEAD Lighting Awards have a procedure in place.	
Glare luminance (cd/m^2)	The threshold defines the total luminance level where visual contrast between the task and light source are so high that the task cannot be distinguished; or when the amount of light becomes physically painful to experience. Calculated from intensity distribution data.	Highly important for consumer health, productivity, security and comfort.		CIE TC2.71 IES LM79-08	
Start time	Amount of time for a lighting product to begin emitting light after power is turned on.	Important for consumers; short start times are necessary for emergency situations, and are preferable in tasks where the light will only be on briefly (ie. pantry, toilet, outdoor security). Also necessary for consumer acceptance.	Energy Star	Energy Star	
Minimum lumen maintenance (time to L_{70})	Indicates the amount of time it takes for a lighting product's total light output to degrade to 70% of initial lighting levels	Lumen maintenance helps the consumer determine the time it will take for the lighting product to degrade to the point that it is no longer usable. High lumen maintenance over time helps to justify higher initial cost of LED lighting	IEC/PAS 62612 (Self ballasted LED) IEC/PAS 62717	IES LM80-08 TM21-11	

Criterion	Description	Why it is important	Existing Standards	Test Method	Testing cost (low 200/ med1000/ high>1000)
Colour maintenance (Δ u', v'at 6000 hours)	The allowable colour shift of a lighting product as it ages.	Ensures that as the product ages, perceived colour of light does not shift from	Energy Star	LM79-08 CIE 15:2004	
Minimum rated lamp life (B_{50})	Typically defined as the amount of time that it takes for 50% of a statistically significant sample of lamps to fail.	It is unrealistic to physically measure very long lifetimes for LED products. Having a credible B_{50} estimation is very important, as longer LED lighting product lifetimes help to justify the high initial cost. Ultimately, if SSL products are able to meet their lifetime claims, they can cut long term energy consumption, save on manufacturing waste, and save money for consumers.	Energy Star	IES LM80-08 EPA Integral LED Lamps v 1.4 (Energy Star elevated temperature testing for integral LED lamps)	
Endurance test	Otherwise known as rapid cycle stress test/Switching test: Ability of LED product to be rapidly switched on and off, to simulate how the product will be used over its lifetime	This is a stress test conducted over a short period of time to determine failure rates of a product. Often, if one electronic subcomponent in an LED product fails, the whole product will fail. The stress test can help verify that an LED product will not failed when installed and used.	IEC 62612 Energy Star	IEC 62612 Energy Star	
Warranty duration	The duration in years from date of manufacture that the product has warranty cover for manufacturing faults	Important for consumers to have a guarantee of minimum amount of time that LED products will perform as claimed (justification of price).	SEAD: With rated life <15,000 hrs, min warranty 2 years Life ≥ 15,000 hrs, min warranty 3 years	n/a	
Safety requirements	Specifies that a product meets electrical safety and marking requirements in an economy.	All products must meet all safety regulations of the region in which it is sold and used. This is covered under Australian electrical safety standards.	IEC 61000.3	AS/NZS 61000.4	
Safety marking	Specifies that a product meets electrical safety requirements and marking requirements	Provides assurance that the product meets all safety regulations of the region.	ANSI/UL 1598 CE mark		

Criterion	Description	Why it is important	Existing Standards	Test Method	Testing cost (low 200/ med1000/ high>1000)
Photobiological hazard class (UV & blue light)	Ultraviolet (UV) and blue light hazard (BLH) classes as defined in AS/NZS 62471 specify the allowable amount of optical radiation emitted by an LED product in range of 100-400 nm 400-500 nm spectrums, respectively.	Important for consumer safety; UV light can cause irreparable damage to eyesight. Some human health conditions result in high sensitivity to these wavelengths. Products must be evaluated to determine their appropriate photobiological hazard class.	IEC 62471	CIE S 009 AS/NZS 62471	
Minimum power factor	The ratio of real power flowing to the load to the apparent power in the circuit	Of high importance to the electricity distributors as they must generate more than the minimum volt-amperes necessary to supply the real power, which increases generation and transmission costs.	AS/NZS 61000.3	AS/NZS 61000.4	
Electromagnetic Compatibility (EMC)			C tick		
Harmonic distortion	Harmonic distortion is the addition of non-linear overtones in the waveform of electrical supply. This metric indicates how the lighting product will affect the quality of the electrical utility's grid. The metric is the mathematic ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency.	Total harmonic distortion (THD) affects the quality of the electrical grid, causing a loss of reliability of switch pulse information. Therefore it must be kept as minimal as possible.	ANSI C82.77 Harmonic Emission Limits EN 61000-3-2 LED EMC/harmonics	IEC SC77A EN 61000-3-2 LED EMC/harmonics	
Dimmer compatibility	An evaluation of whether the LED lighting product will operate sufficiently well with installed dimmers used for incandescent light sources.	High importance for the consumer as many LED products are not completely compatible with commonly available dimmers. Though manufacturers are attempting to define	NEMA SSL 7A-2013		
Recyclability (%)	An indication of the proportion on an LED product which must be recyclable.	Important for management of electronic equipment waste so as to reduce the environmental burden of these products. Ideally products should be designed for easy of recyclability	ISO 14021		

Next Steps

- Product Profiles (discussion papers) will be released for stakeholder comment in the next few months on the following website: www.energyrating.gov.au/
  - Review of existing MEPS for CFLi, incandescent lamps,
  - Commercial Lighting -
    - Review of MEPS for Linear Fluorescent lamps and ballasts.
    - Circular Fluorescent Lamps?
    - Non-integrated CFLs?
    - Commercial Luminaires?
  - LED Lighting

Thank You