E3
Equipment Energy Efficiency

LED Product Profile Consultation

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On behalf of the E3 Committee

Lighting Efficiency - Current Status

- Minimum Energy Performance Standards (MEPS) are mandatory requirements for certain lighting products sold in Australia and New Zealand. Regulated via
  - Greenhouse and Energy Minimum Standards (GEMS) Act 2012 (AUS)
  - In New Zealand, by the Energy Efficiency Regulations 2002 (NZ)

Lighting Products Subject to MEPS

- Incandescent lamps (tungsten filament and halogen) (Australia only)

- Compact Fluorescent Lamps (integrated)

- Linear Fluorescent Lamps, Ballasts for Linear Fluorescent Lamps

- Transformers and Converters for Halogen Lamps.

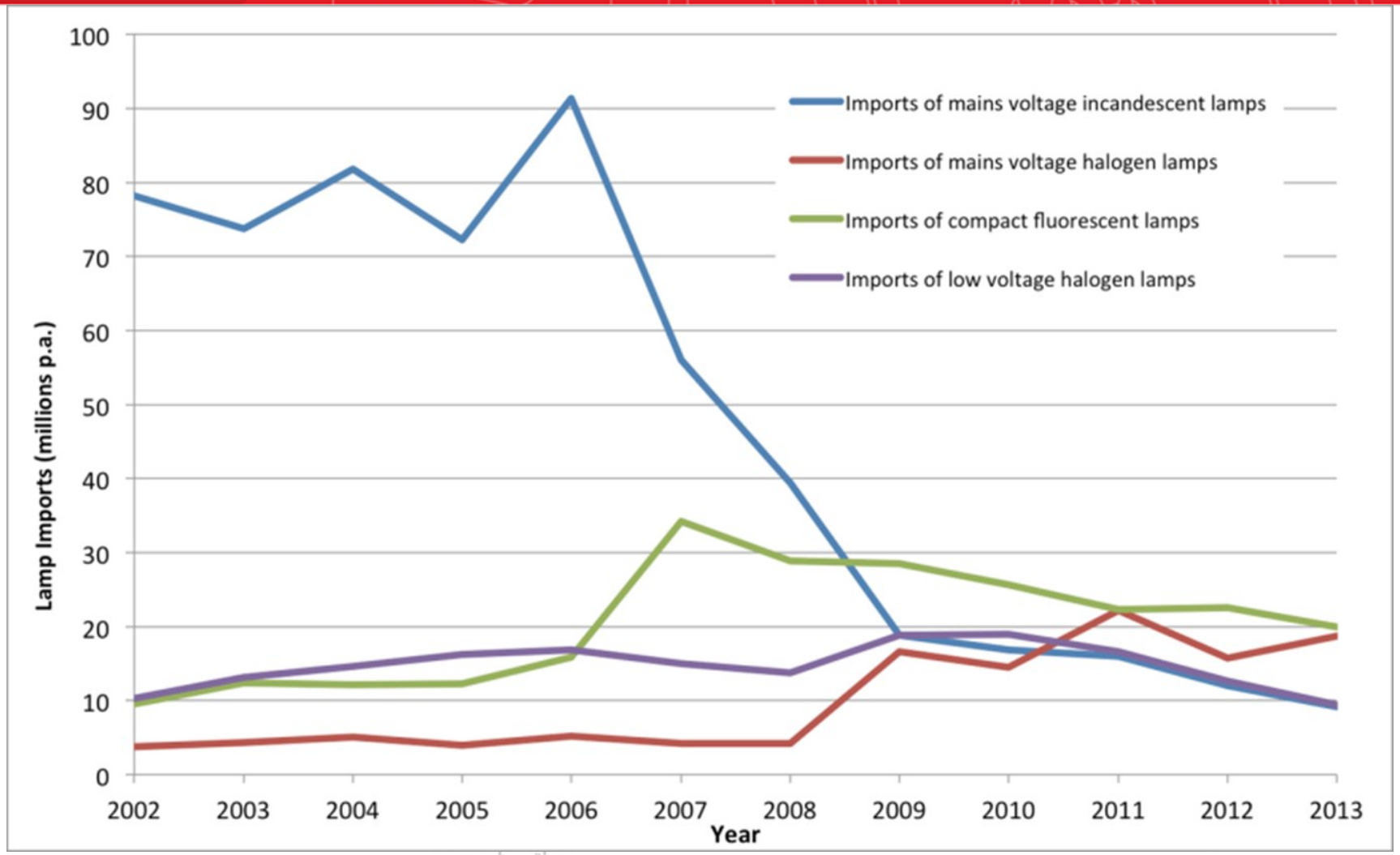
  - Requirements set out on the Energy Rating Website: www.energyrating.gov.au/

Purpose of Product Profile

- Report on the state of LED lamps, their capacity for energy efficiency and performance, and current and projected markets.
- To signal to stakeholders the opportunities and options that will likely form the policy options that would be subject to detailed investigation through a Regulation Impact Statement (RIS) before any government decision.

  - Product Profiles also released on Incandescent / CFL and commercial lighting.

Background - Phase-out Outcomes - Australia



Phase-out Outcomes

- Since the commencement of the phase-out of inefficient lighting in 2009:
  - Significant change in the make-up of lighting stock.
  - Average households now using 27% (300 kWh p.a.) less energy to light their homes.
  - In Australia, there are estimated savings of around 2.6 terawatt-hours (TWh) of electricity each year. Equivalent to the total annual electricity consumption of 150,000 homes.

Phase-out Outcomes

- However more than 75% of residential lighting energy consumption is estimated to still come from incandescent and halogen lamps.

LED Lighting – Ready or Not?

- Australia and New Zealand has been testing a range of LED lamps since 2009.

- We have also studied test results from other overseas government test programs and NGO testing.

- While the last several years have shown an improvement in tested LED performance, there are still significant quality problems in the market.
- Australia has participated in the IEA 4E SSL
  - international collaboration and joint activities relating to SSL performance and quality
  - Australia, Denmark, France, Korea, Netherlands, Sweden, UK, USA, China, (Japan)

IEA 4E SSL Product categories focus

- **Non-directional lamps (Residential)**
- **Directional lamps (Residential)**

- < 63.5 mm Diameter

- > 63.5 mm Diameter

- **Downlight Luminaires**
- **Linear LED tubes**

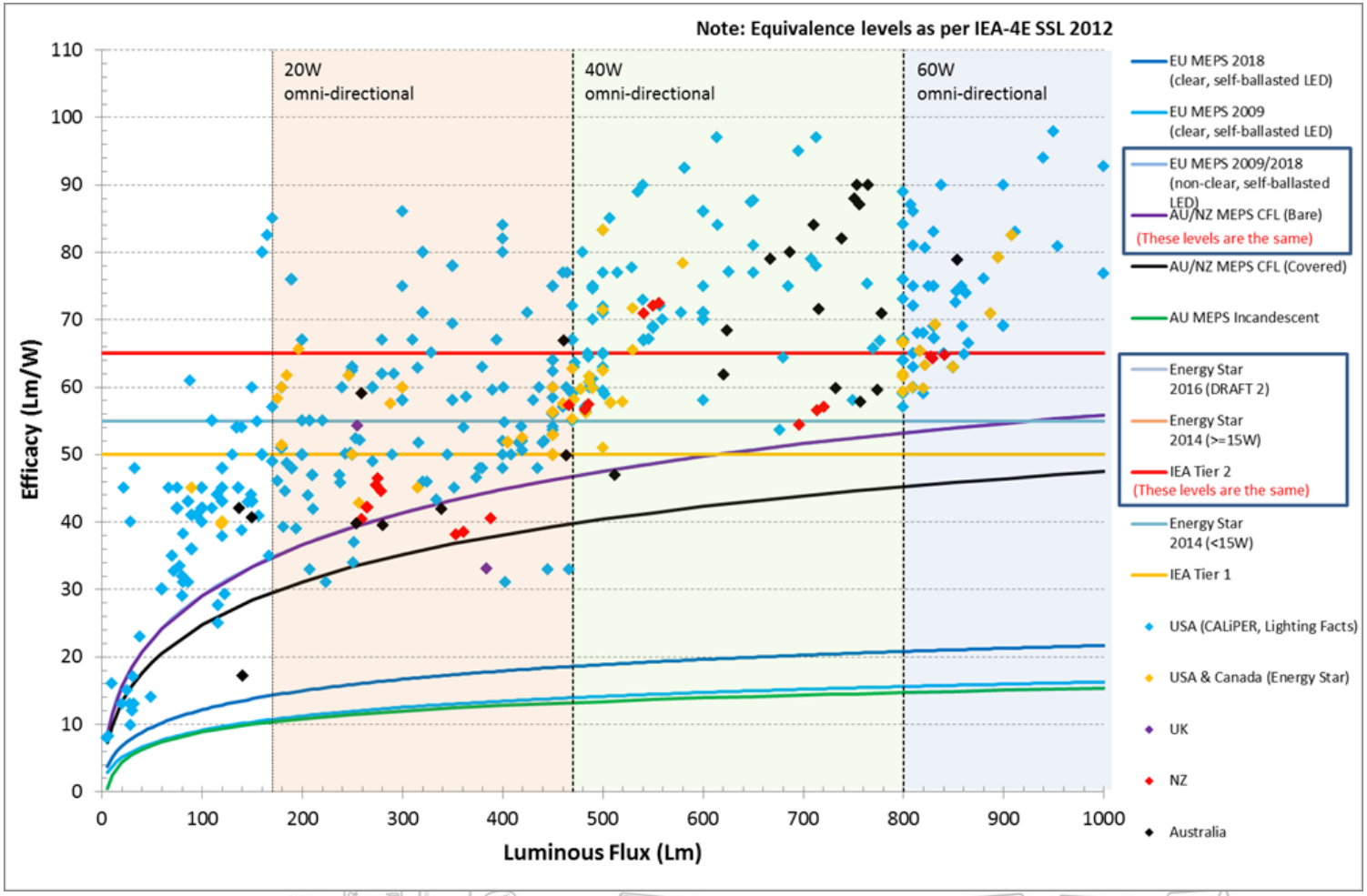
- Non retrofit

- Retrofit (360°)

- **Street/Outdoor luminaires**

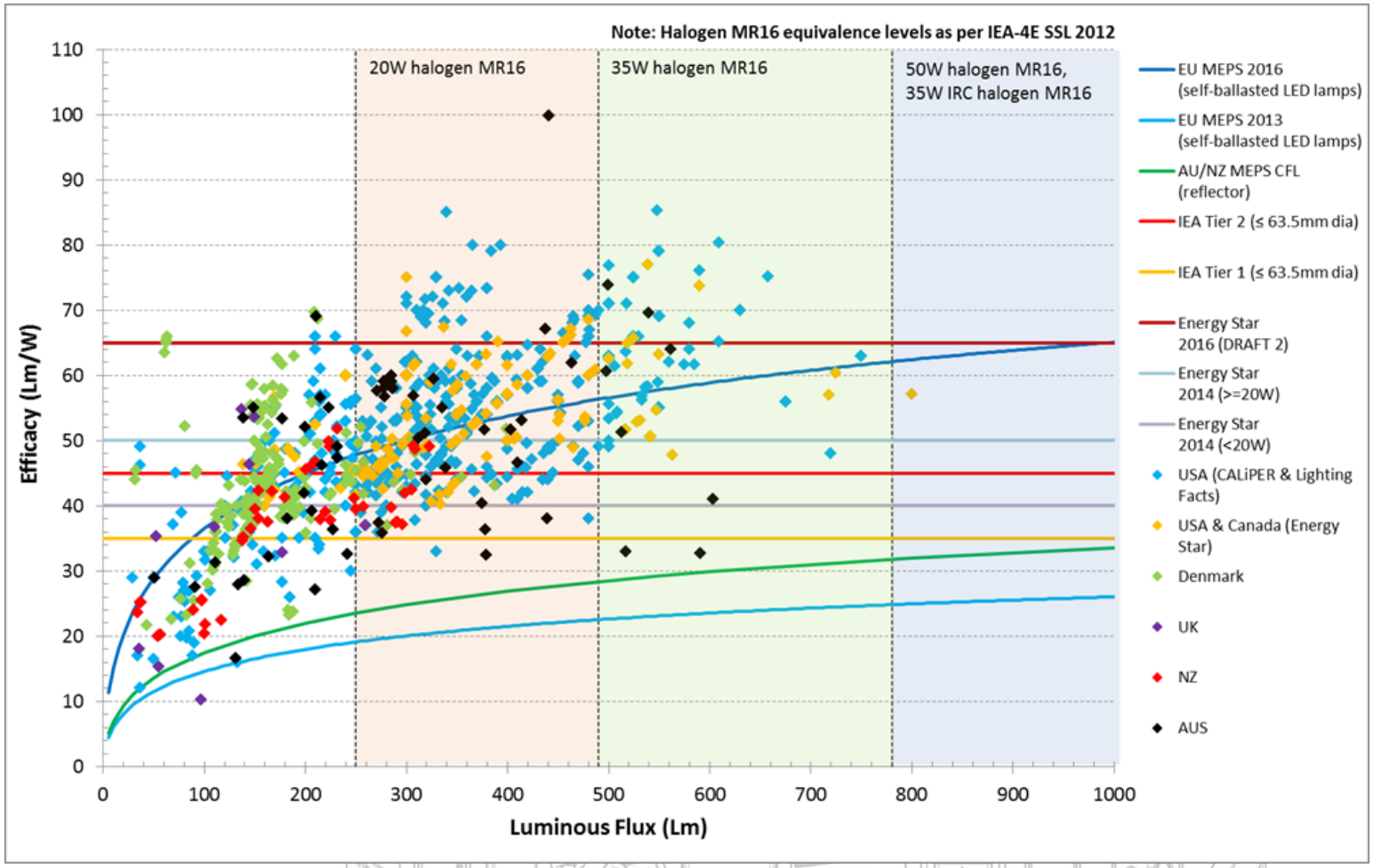
Improved Lumens and Efficacy

Lamp Performance (luminous Flux and Efficacy) of Omnidirectional Purchased in Australia 2009-2014



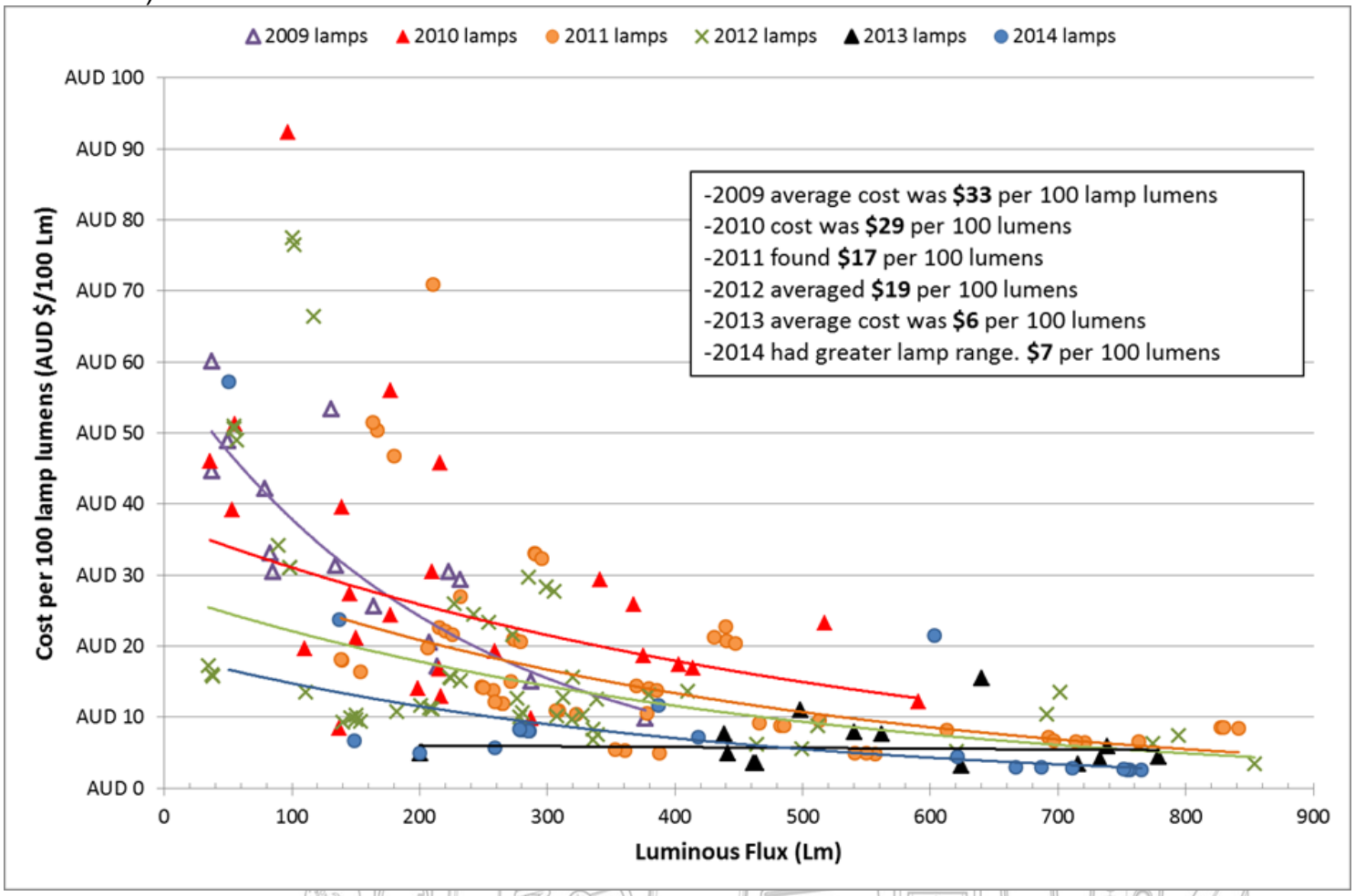
Directionals … nearly there?

Lamp Performance (luminous Flux and Efficacy) of Directional lamps of diameter ≤ 63.5mm tested internationally between 2010 and 2014.



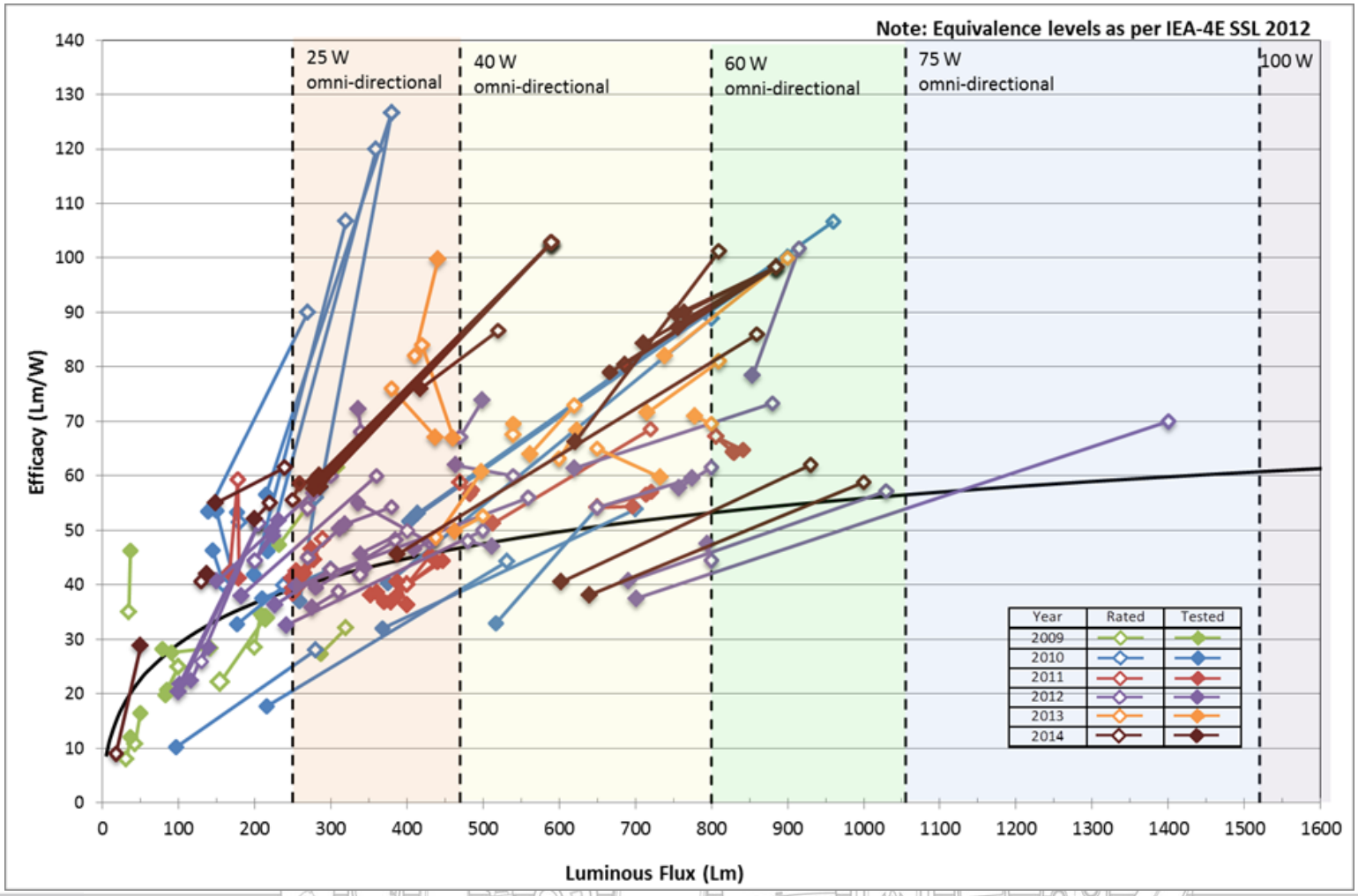
Prices down

LED Lamp normalised cost per 100 Lumens (lamps purchased in Australia, New Zealand, United Kingdom and United States 2009-2014)



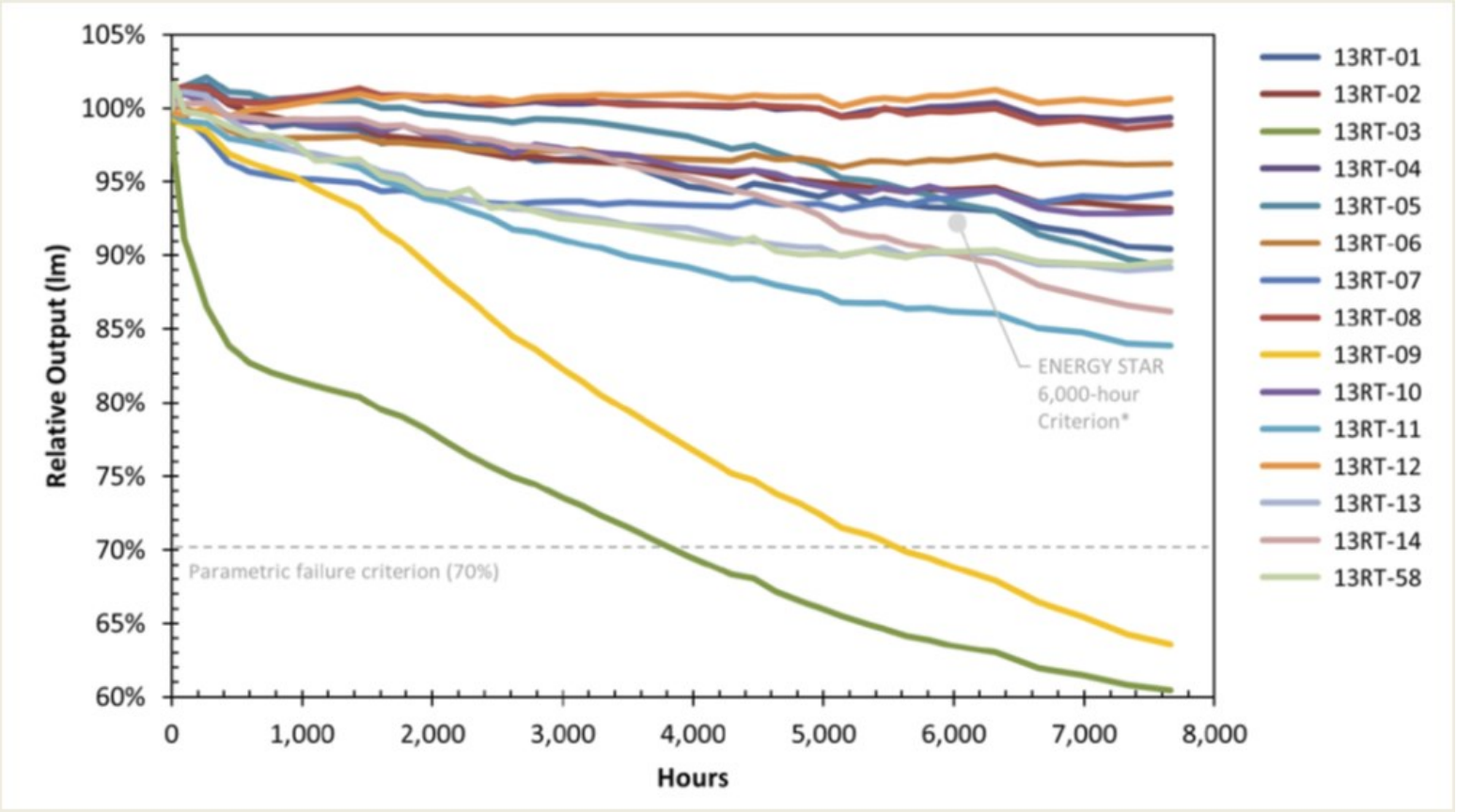
Rated Lumens and Equivalency

Variance Between Rated and Tested LED Lamp Efficacy (lamps Purchased in Australia 2009-2014)



Lumen Depreciation

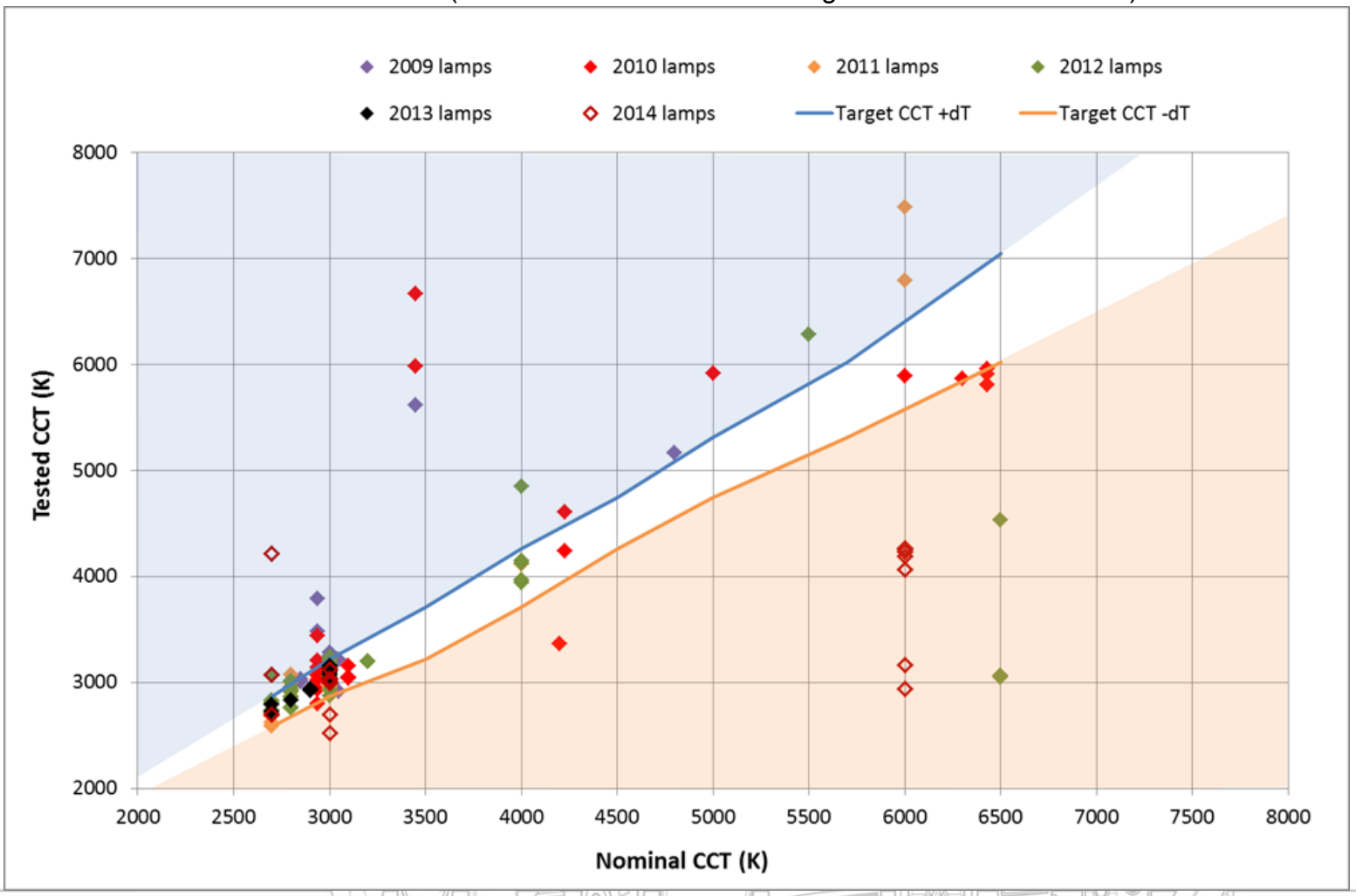
Average lumen maintenance for each of the 15 LED lamp models tested for CALiPER (US DOE Dec 2014)



Two tested products end the 7,500 hr test with average lumen maintenance below 65%, constituting a failure within the test period. In nearly half of the products tested, the lumen maintenance was sufficiently low at 6,000 hours to indicate that a further seven of the products were unlikely to have lumen maintenance above 70% at their rated lifetime

Colour Temperature

Tested vs Manufacturer's Nominal CCT (with ANSI C7.377 nominal target CCT tolerance levels).

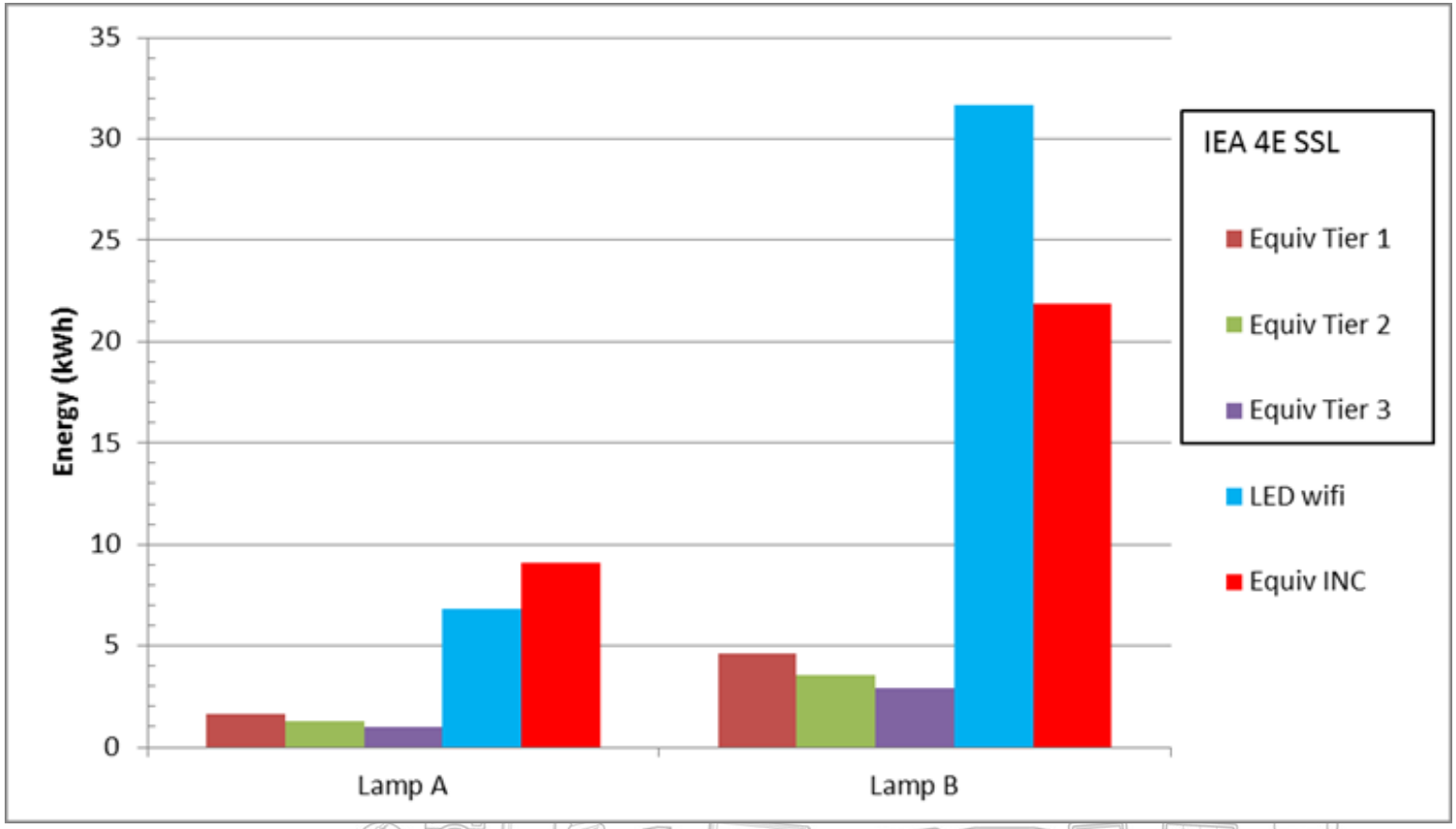


LED Performance – other issues

- More than half of products tested in Australia in 2014 had CRI below 80,
- Rated power up to 50% different to tested power,
- Some lamps with a power factor below 0.5,
- Up to 60% variation from rated beam angle,
- French testing observed light flickering behaviour at twice the mains frequency (equal to 100 Hz – Kitsinelis 2013, Zissis 2013),
- Dimmer and low voltage compatibility,
- Retinal exposure to LED blue light at short distances with some lamps,
- Chromaticity Tolerance

Smart Lighting – standby power

- Annual power consumption for 1 hour per day ON, including standby mode for the two LED lamps, compared with the equivalent lumen output incandescent lamp and hypothetical LED lamps at the IEA 4E Tier levels.



LED Benefits

- Further transition to high efficiency lamps would:
  - reduce residential lighting energy use in Australia by approximately 65% ($180 p.a. per household) and
  - reduce greenhouse gas emissions by up to 2219 kilotonne CO2-e p.a. for Australia and 966 kilotonne CO2-e p.a. for New Zealand.
- The level and timing of energy productivity benefits of the transition to LED lighting will in part depend upon the speed at which lighting consumers make the transition from less efficient lighting such as the remaining incandescent and halogen lamps.

Phase-out – Further Transition (Australia)

Product Category	Possible Phase-out Date
Decorative, fancy round and candle incandescent and halogen lamps ≥10W	2017
GLS mains voltage omnidirectional halogen lamps	2018
Mains voltage reflector incandescent and halogen lamps < 150W	2018
Extra low voltage halogen reflector lamps	2018
Extra low voltage halogen omnidirectional lamps	2018
Luminaires – may not be supplied with an incandescent or halogen lamp	2017

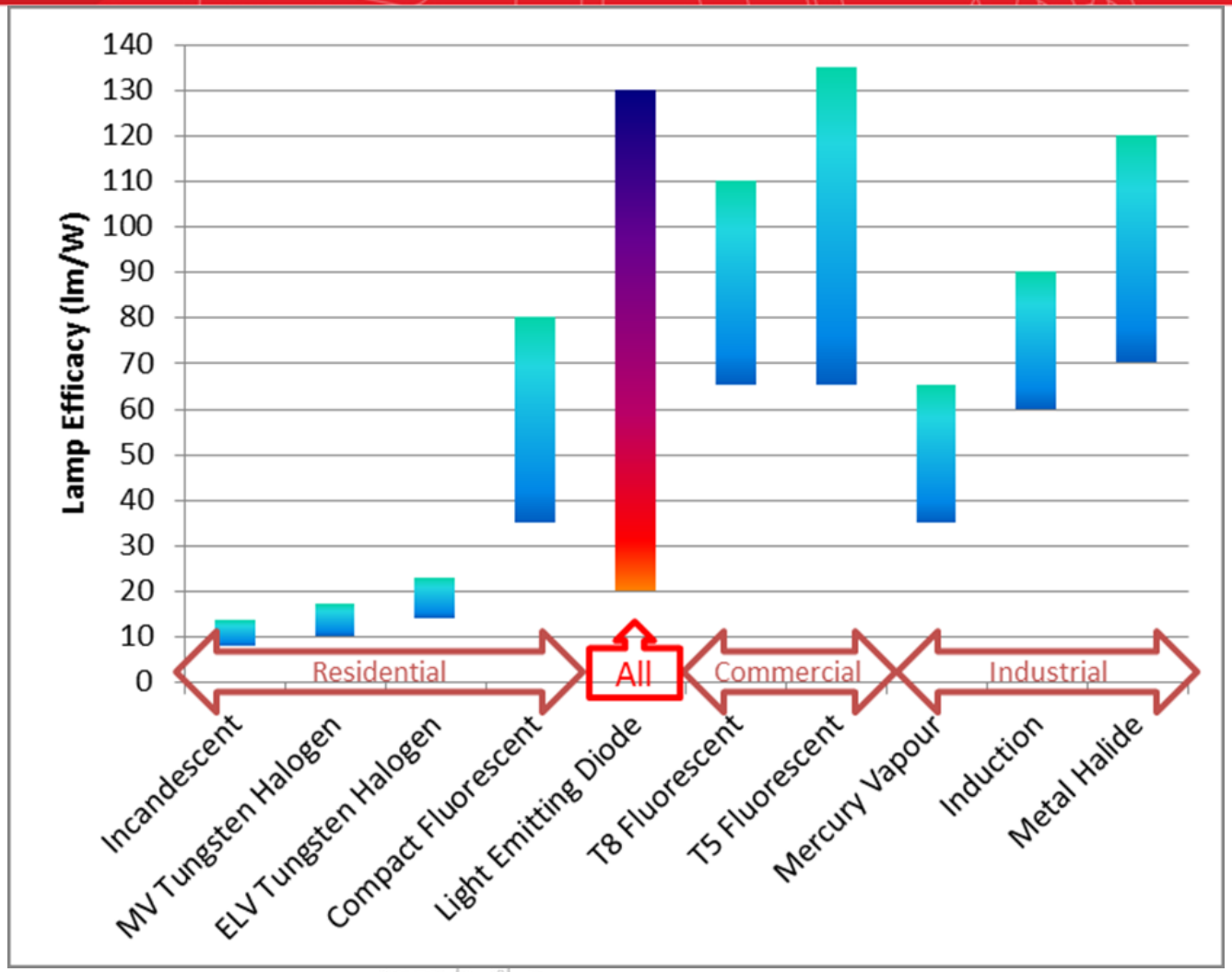
LED Benefits - MEPS

- LED MEPS would ensure consumers do not lose some of the energy saving benefits available through uptake of less efficient LED products in the market.
- Could deliver an estimated increase the energy savings of a household with 75% LED lighting installed from 25% to 29% dependent upon MEPS level.
  - In Australia, the additional saving, would be 91.8 kWh per year (25%) for each home and 837 GWh per year nationally;
  - For New Zealand, the additional energy saving, would be 69.8kWh per year (25%) for each home and 122 GWh per year, nationally.

Is Action Required?

- Experience of transition to halogen and CFL alternatives indicate that a voluntary transition to efficient lighting could be slow and incomplete and result in significant lost savings opportunities.
- Barriers to the uptake of LED products include the presence of poor quality models in the market and inaccurate performance and equivalency claims.
- The continued presence of lower efficacy LED models in the market and a potential lack of consumer trust with new technology is likely to result in lost energy savings opportunities.

Is Action Required?

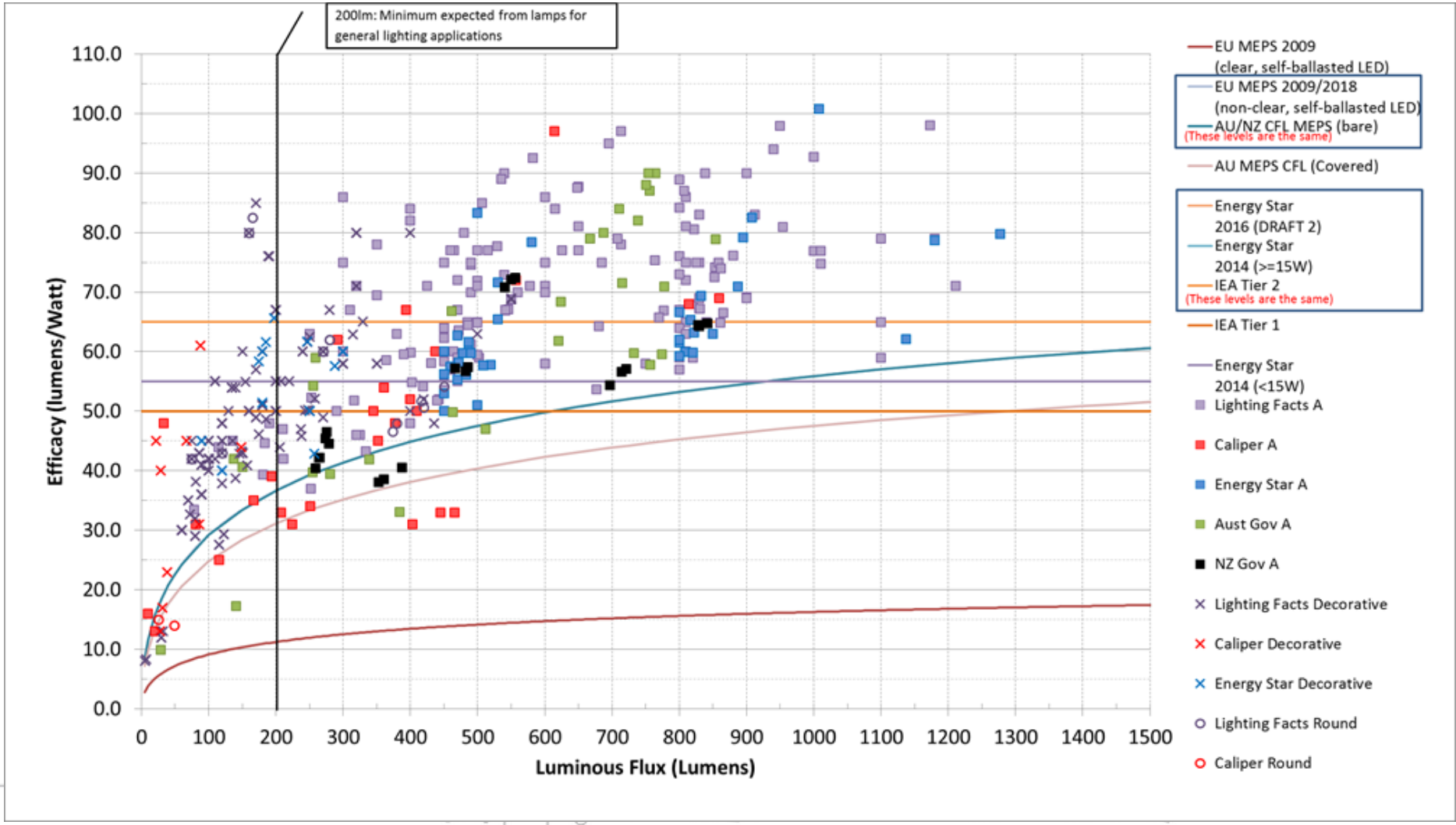


Policy Options – MEPS - Efficacy

- A range of minimum and high performance efficacy levels exist including EU, IEA 4ESSL and Energy Star.
  - A higher MEPS levels 60-70 Lm/W for omnidirectional lamps would be feasible and still retain approx 80% of lamps on the market.
  - Note that a MEPS level would not be in place immediately
- Given the rapid improvement in LED efficacy, a timetable of increases to MEPS levels would help realise energy savings as available.
- Question of the use of a lumen-dependent curve (as per EU MEPS, and AU CFL MEPS) or a static cut-off MEPS line (as per IEA, and Energy Star),

Policy Options – MEPS, Efficacy

- Tested Efficacy of Non-directional LED Lamps (USA, EU, Australia, New Zealand)



Policy Options – MEPS, Efficacy

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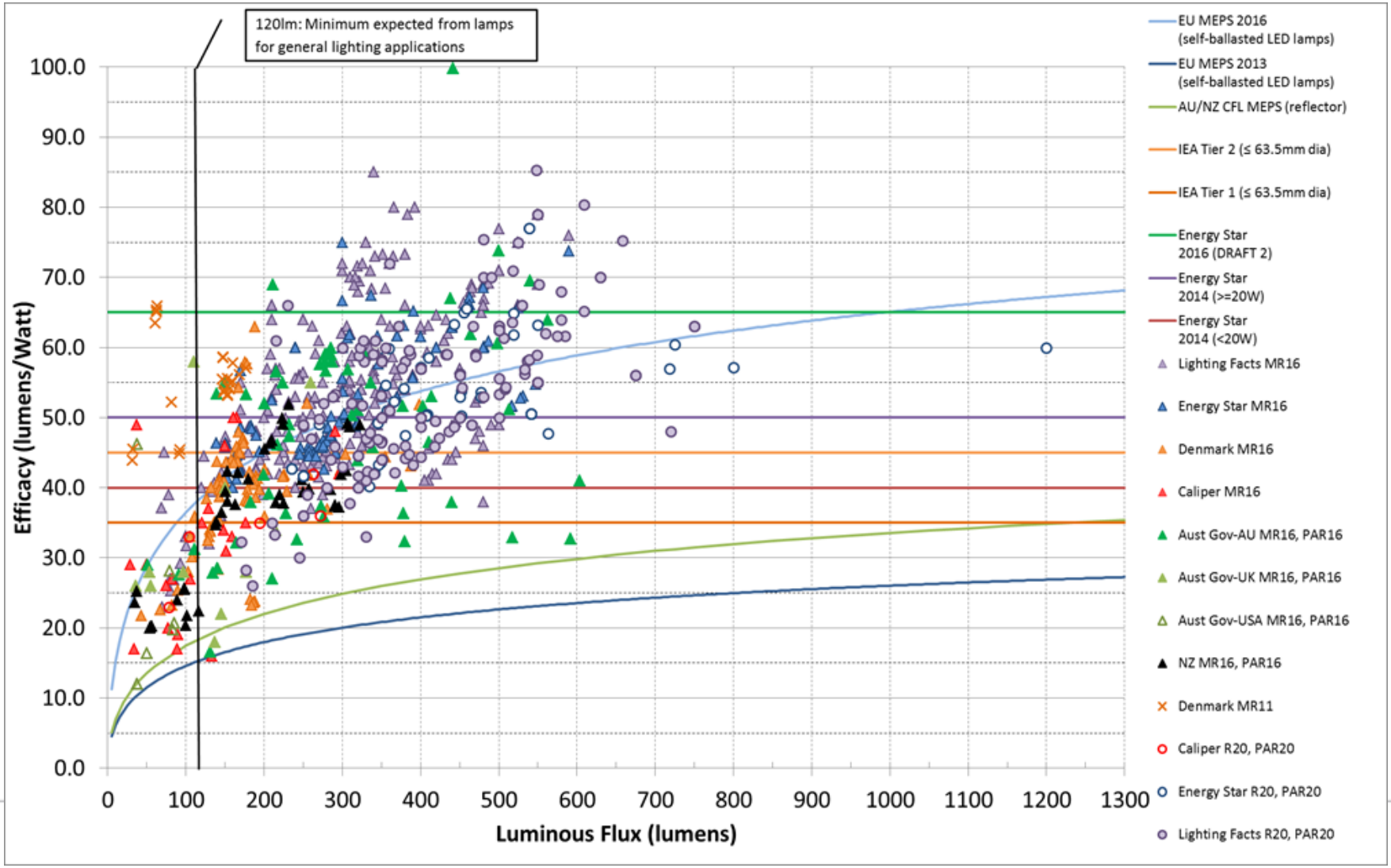
- Efficacy levels of directional LED lamps with face diameter up to 63.5 mm (20/8”),



MEPS – Other Parameters

- A range of other performance parameters could help to ensure that LED products are able to provide an effective lighting service.
  - If some parameters were seen as less critical, consideration could be given to those parameters being included in an Australian and New Zealand Standard as an additional voluntary parameter.

MEPS –Other Possible Parameters

- Claimed Equivalent wattage /minimum light output (lm)
- Luminous intensity distribution
- Zonal lumen density (standard only)
- Centre beam luminous intensity (directional lamps only)
- Colour rendering index (CRI)
- Correlated colour temperature (CCT) in Kelvin (K)
- Colour spatial uniformity (standard only)
- Chromaticity tolerance (Du'v')
- Colour maintenance (Δ u', v'at 6000 hours)
- Start time
- Minimum lumen maintenance (time to L70)

MEPS – Other Parameters

- Minimum lumen maintenance (time to L70)
- Flicker (flicker index)
- Minimum rated lamp life (B50) (practical test required)
- Maximum premature lamp failure rate
- Endurance test
- Warranty duration
- Photobiological hazard class (UV & blue light)
- Minimum power factor and Harmonic distortion
- Dimmer compatibility (product packaging requirement)
- Maximum standby power
- Optional tropical performance claim

Policy Options - Packaging

- A simplified range of luminous flux could assist the transition to efficient lighting.
- An IEC 62612 amendment states that for non-directional LED lamps, the rated luminous flux LED lamps be preferably one of the following values:
  - 100lm, 150lm, 250lm, 350lm, 500lm, 800lm, 1000lm, 1500lm, 2000lm, 3000lm
- May require each individual lamp in the measured sample to be within a specified range around the particular level (for example, not less than the rated luminous flux by more than 10%, and not be more than the rated luminous flux by more than 20%).

Policy Options - Packaging

- The availability of consistent energy use and performance specification on products and product packaging, backed up by further details on supplier websites can assist consumers in selecting the correct efficient lighting product for their needs and using it correctly.

Lumens	ELVC converter compatibility information
Efficacy (lumens per Watt)	Website link for compatibility and disposal information
Watts (in a smaller font than efficacy)	Linear LED retrofit statement
Lifetime	Standby energy use
Correlated colour temperature	Product identification number as used for product registration
Dimmer compatibility information	

Policy Options – Labelling / HEPS

- Product energy labelling can influence consumers at the point of purchase, thereby encouraging manufacturers to produce more efficient equipment.
  - New Zealand runs an active ENERGY STAR scheme for a number of electrical appliances; including CFLs and LEDs. An option would be for Australia to also support this label.
  - Apply the Australia New Zealand Energy Rating Label to a range of lighting products.
  - Establish a US Lighting Facts style labelling scheme to the Australian and New Zealand (Lighting Council Australia currently administers a similar scheme, open to Council members).

Policy Options – Information and Education

- Campaigns could be put in place to influence consumer purchasing, product operation and or efficient lighting design.
- Products already in place include:
  - Energy Efficient lighting training resource (under review)
  - A specialist Lighting Retailer Training package
  - New Zealand Energywise website with virtual designer tool
  - LED purchase guide
- An active phase-out of halogen lamps (Australia only) would benefit from material to assist consumers make the transition.

Policy Options – Test Standard

- Manufacturers and test laboratories have until recently had to rely upon a range of national level test methods in order to determine product performance.
- The release of the international CIE S 025/E:2015: Test Method for LED Lamps, LED Luminaires and LED Modules offers an opportunity to establish a AS/NZS LED test standard with reference to CIE S 025.
  - This would give a common baseline for LED performance testing and validation of performance claims in the Australian and New Zealand market
  - Appendix C of the Product Profile sets out possible tests that could be included in an Australian and New Zealand LED performance test standard.

Next Steps

- Comment invited on the LED product Profile.
- Key Questions (section 2.2.3):
  - Market barriers
  - Impact of poor performing LEDs
  - Product description and scope
  - Identification of lamps for registration and compliance
  - LED market share and market trends
  - Information on development of smart lighting
  - Proposal for Australian Phase-out of halogen lamps

- Draft Regulation Impact Statement, released for comment prior to any government decisions

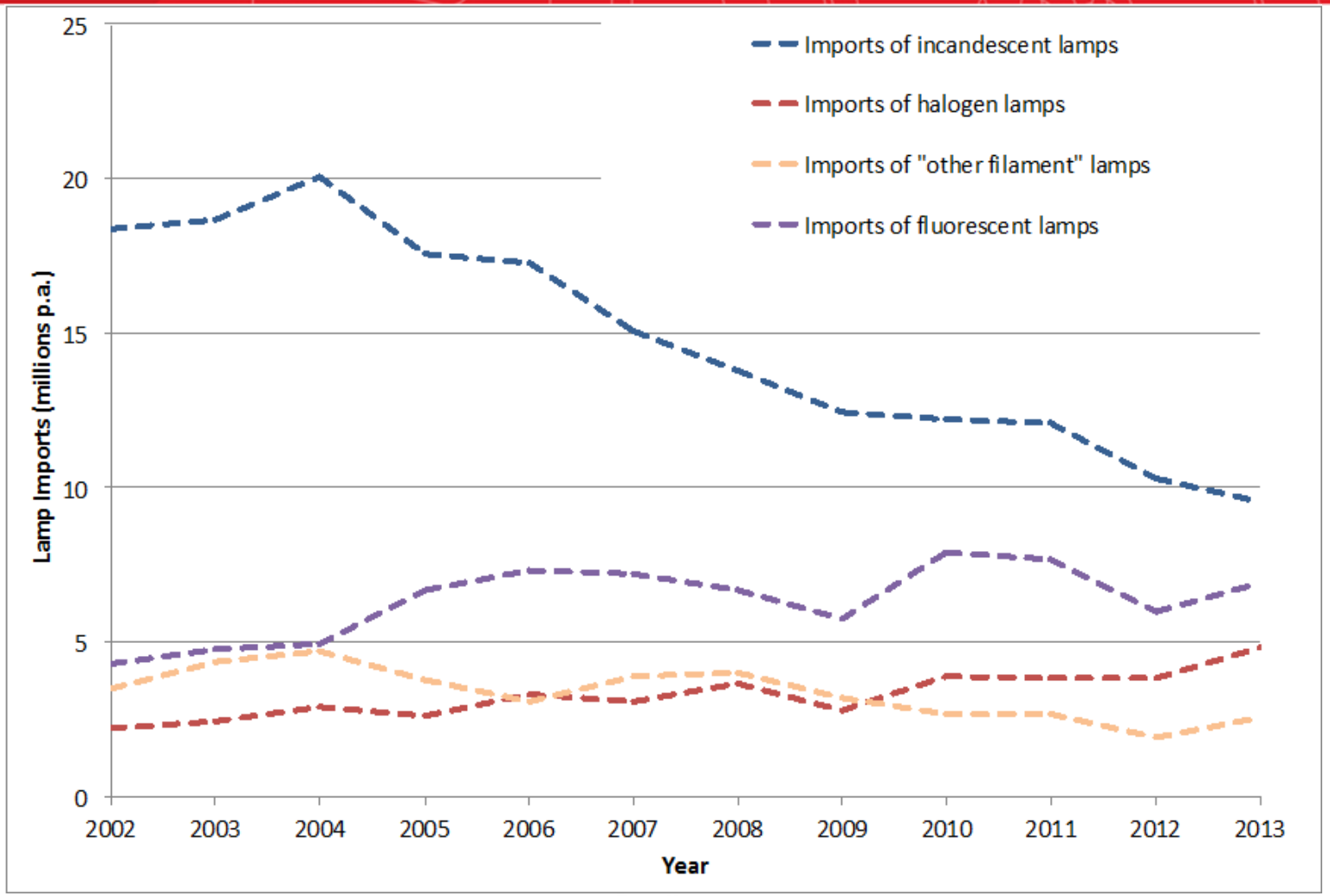
Questions

Questions?

Comments to:

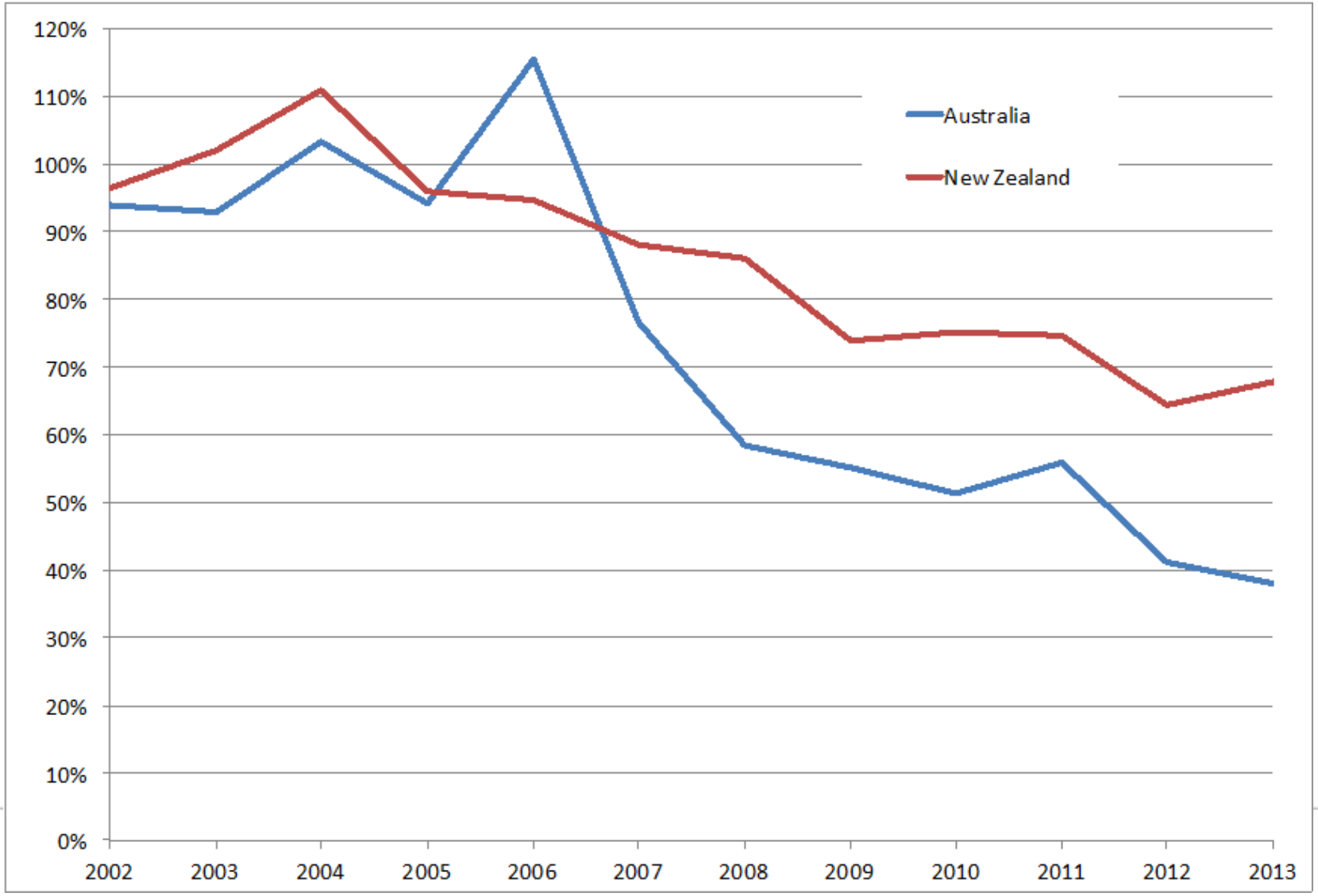
- Australia EER-Lighting@industry.gov.au
- New Zealand regs@eeca.govt.nz

Phase-out Outcomes – New Zealand



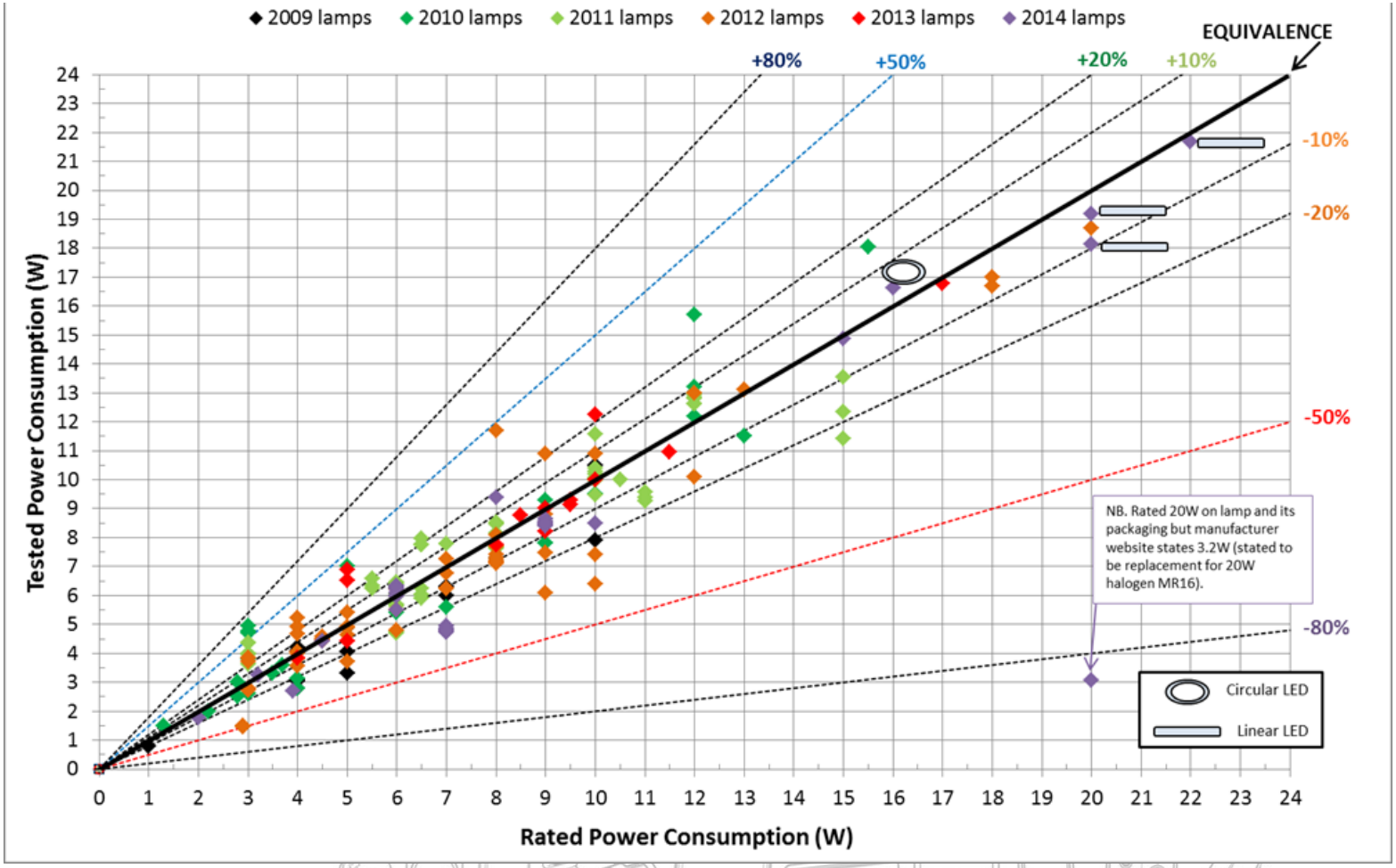
Australia /New Zealand - Comparison

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



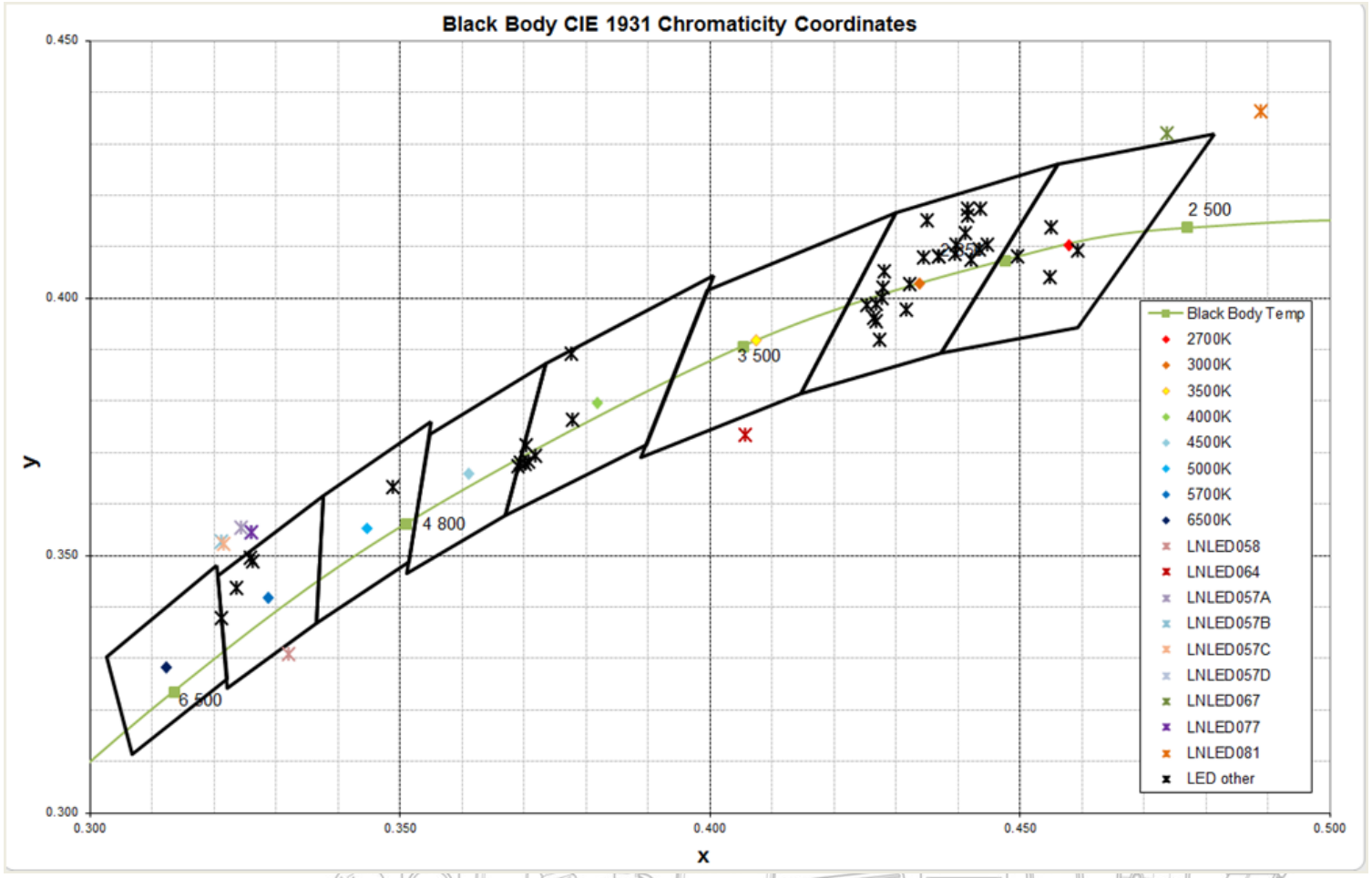
Innacuracies – Rated Power

LED Power Consumption – Variation between Rated and Test Values.



Chromacity Tolerance

Mapping of Chromaticity Tolerance for lamps purchased in Australia (2014). Those lamps shown outside of the black boundaries may display a noticeable green or pink tint.



Policy Options – MEPS, Efficacy

- Efficacy levels of directional LED lamps with face diameter greater than 63.5 mm (20/8”)