Market Update and Conclusions for Minimum Energy Performance Standards for Lighting Products

Report for

Department of Climate Change, Energy, the Environment and Water

28 June 2024

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Abbreviations

ABS	Australian Bureau of Statistics
AER	Australian Energy Regulator
AEMO	Australian Energy Market Operator
ACCU	Australian Carbon Credit Unit
CBD	Commercial Building Disclosure Scheme
CCT	Correlated Colour Temperature
CFL	Compact Fluorescent Lamp
CRI	Colour Rendering Index
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DRIS	Decision Regulatory Impact Statement
E3	Equipment Energy Efficiency program
EEIS	Energy Efficiency Improvement Scheme
ELV	Extra Low Voltage
ERAC	Electrical Regulatory Authorities Council
ERF	Emissions Reduction Fund
ESS	Energy Savings Scheme
EU	European Union
GEMS	Greenhouse and Energy Minimum Standards Act
GLS	General lighting service
HID	High Intensity Discharge
IEA	International Energy Agency
IPD	Illumination Power Density
LED	Light Emitting Diode
HVAC	Heating, Cooling and Ventilation
lm	Lumens
MEPS	Minimum Energy Performance Standard
NGER	National Greenhouse and Energy Reporting scheme
REES	Retailer Energy Efficiency Scheme
RIS	Regulatory Impact Statement
SSL	Solid State Lighting (LED lighting)
TLA	Tenancy Lighting Assessment
VEU	Victorian Energy Upgrades Program
W	Watts

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Executive summary

Background

In April 2018 a recommendation to further phase out incandescent lamps, phase out mains voltage halogen lamps and adopt MEPS (minimum energy performance standards) for LED lamps was provided to Australian Energy Ministers, following a regulatory impact analysis and discussions with the lighting industry. Considerable time has elapsed since Ministers deliberated on this issue, and various changes and issues have arisen. Thus, the objectives of this report are to:

- Summarise the key changes that have occurred in the lighting market since 2018
- Summarise the market's perceptions of the proposed regulations
- Assess other issues that have arisen, such as product registration and testing
- Inform a final decision of Energy Ministers regarding the proposed regulations
- Recommend lighting products to be investigated as part of a future work program.

Findings

The key findings from this report are summarised as follows:

- **Lighting regulations have evolved considerably in other parts of the world.**
    - The countries with LED MEPS in place or in development represent 79% of the world's population.
    - The EU, UK and USA are now planning for a second phase of MEPS for LEDs.
    - Australia / New Zealand currently lag behind much of the world's lighting regulations and risk becoming a dumping ground for inferior LED products.
    - The proposed phasing out of all fluorescent lamps by the Minamata convention will further increase the mandate for LEDs.
- **The overall market share of LEDs has increased and supermarkets' share of the lighting market has decreased.**
    - In recent years there has been a faster-than-anticipated reduction in the market share of incandescent and halogen lamps. Some of this is due to lamp suppliers and retailers anticipating the impending regulations and ceasing import and sale of these lamps early.
    - The supermarket share of lamps sales has declined in recent years, presumably in favour of online sales and sales via hardware and speciality stores. From 2019 onwards supermarket lamp sales declined markedly, primarily due to a significant reduction in halogen lamp sales (noting that some retailers de-stocked these lamps in anticipation of the regulations announced in 2018 and also responded to compliance action under the GEMS Act).
- **The proposed lighting regulations have been relatively well received.**
    - 2021 market research indicates that the proposed regulations were well received by Australian consumers, with around two-thirds responding positively to all aspects of the planned phase out and LED MEPS, with roughly a third neutral on the topic.

- Of the 14 submissions to the public consultation process for draft GEMS determinations, 10 supported the phaseout of halogen lamps and 9 supported MEPS for LEDs (2 conditionally). Lighting Council Australia supported the phaseout but provided conditional support for LED MEPS.
- Dimmer compatibility did not surface as a significant issue during market research and public consultation.

- **The economic and climate change benefits from phasing out halogen lamps and adopting LED MEPS are significant.**
  - Electricity prices have risen significantly in recent years.
  - Individual households that still use mains voltage halogen lamps can gain significantly from the phaseout. For example, a household that changes 10 halogen lamps to LED would save more than $2000 over ten years and 3 tonnes of greenhouse gas emissions.
  - Household benefits from LED MEPS are smaller but still positive (when viewing only LED efficacy improvements due to MEPS).
  - A business operating LED tubes, changing from poor LED tubes (that would not meet the proposed MEPS) to significantly more efficient LED tubes, would gain significantly from improvements in efficacy due to LED MEPS. For example, a business operating 1,000 LED tubes would save more than $30,000 and 85 tonnes of greenhouse gas emissions over ten years.
  - Scaling LED MEPS to the national level, a combined benefit of around $1bn was calculated over ten years, with greenhouse gas abatement estimated at 1.5 million tonnes (noting that the improvement in LED tube efficacy, for the business sector, is based on testing of a relatively small sample group).
  - If a further stage 2 LED MEPS were to be implemented now (e.g. similar to those proposed in the EU or USA) then benefits would be around 4 times higher than those predicted for the stage 1 MEPS.
- **Using a broad definition of product families, the number of registrations that would be required are modest.**
  - A 2018 dataset of 1600 LED lamp models was analysed and this showed that the largest number of families that a supplier would be required to register was 24. The total number of families required to be registered across all suppliers was 185. The average number of families per supplier was 9.
  - A case study of one of the largest <u>single-capped</u> LED lamp suppliers in Australia for their current catalogue was undertaken and it was found that 22 families would be required to be registered. This increased to 37 if no grouping of CRI and lifetime were permitted.
  - A case study of one of the largest <u>double-capped</u> LED lamp suppliers in Australia for their current catalogue was undertaken and it was found that 15 families would be required to be registered. This increased to 31 if no grouping of CRI and lifetime were permitted.
- **Using a broad definition of product families, the registration costs to industry would be modest.**
  - A calculation of industry registration costs was undertaken. The total industry costs for year 1 were calculated to be in the range $275,000 to $1.4m and this decreases in subsequent years. Passing these costs on to consumers would increase lamp costs by

between 0.7c and 6c per lamp (a percentage increase of 0.1% to 1.1% for a $6 LED lamp) across the full 5-year regulatory cycle.

- **Testing of various attributes on a sample of 35 lamps in Australia in 2017/18 revealed a MEPS failure rate of around 50%**.

Discussion and conclusions

Phaseout of incandescent and halogen lamps

The faster-than-anticipated reduction in the sales of incandescent/halogen lamps is tempered by the fact that some of this was due to market anticipation. Consumer and stakeholder support for this policy is strong, and dimmer compatibility does not appear to be a critical issue. Electricity prices have risen significantly, meaning that households that still use mains voltage incandescent or halogen lamps can gain significantly from the phaseout of incandescent and halogen lamps.

Conclusion: due primarily to recent increases in electricity costs, there are significant financial benefits for households who have not yet transitioned to LED to do so. Thus, it is concluded that the case for the phaseout of incandescent and halogen lamps remains strong.

MEPS for LEDs

Reaching a conclusion regarding MEPS for LED lamps is more complex. This policy was well received by Australian consumers, with support from more than half of the stakeholders responding to the recent public consultation. Lighting Council Australia had significant concerns regarding product registration costs – they predicted that registration costs would result in consumer prices rises for LED lamps of 10-15%. Our calculations predict 0.1% to 1.1%.

The recent decision under the Minamata Convention to ‘phase out’ (i.e. prohibit the import, export and manufacture) all fluorescent lamps by 2027 will further increase the mandate for LEDs. This presents an opportunity for MEPS to remove lower performing LEDs from the (particularly commercial) market in advance of the fluorescent phase out. This will avoid businesses ‘locking in’ to less efficient lighting products during that transition.

Based purely on an increase in LED lamp efficacy, the national financial case for LED MEPS remains reasonable, considering the current climate and the need to accept lower overall energy savings from product policies. Improvements in product quality and subsequent health benefits, add to the case. Once incandescent, halogen, CFL and fluorescent lamps are actively phased out, it is the responsibility of industry and regulators to ensure that the remaining LED lamps are of high quality, so that consumer confidence is maintained and a backlash against the phaseout of other lamps is prevented. Consumers with lighting health concerns also deserve consideration via MEPS and education.

When incandescent lamps were phased out in Australia in 2009, quality requirements for CFLs were seen as a vital intervention to ensure a smooth transition away from incandescent. This kind of thinking is supported by regulators representing 79% of the world’s population, as well as organisations such as:

- The IEA - ‘p*hasing out incandescent, halogen and compact fluorescent and setting efficacy and quality (e.g. flicker and lifetime) requirements for LED lamps is critical for general lighting applications in both developed and developing countries*’.
- Clean Lighting Coalition – ‘*countries where we have been working that have not set product policy regulations typically suffer from having old or outdated lighting products dumped in their markets*’
- ECEEE – ‘*having no regulation on quality parameters related to performance will lead to imports of many products that are of poor quality and risks to eventually damage the reputation of LED technology. It is also likely to discourage suppliers from bringing in advanced products to the Australian market*’.
- DoSomething Foundation – ‘*The introduction of MEPS for LED lamps is also important as it ensures that these alternative products deliver energy and emissions savings (through greater efficiency), while also providing at least an equivalent lighting service*’.

The implementation of LED MEPS by such a large proportion of the world presents a ‘dumping ground’ risk to Australia and New Zealand. This is caused by manufacturers of inferior products continuing to seek a market for those products, once they become illegal in countries that have implemented MEPS for LEDs. Thus, if there is strong regulatory action covering LEDs globally but not Australia and New Zealand, these two countries could be at risk of continuously receiving substandard LEDs. This problem will be further exacerbated when economies such as the UK, EU and USA implement their second, more stringent, phases of LED MEPS.

Conclusion: it is concluded that the case for LED MEPS is strong, for the following reasons:

- Energy efficiency policies for appliances and equipment are in a mature phase. MEPS for equipment with high energy consumption and readily available savings have largely already been implemented. Extracting further energy savings from appliances and equipment in Australia and New Zealand requires accepting lower overall energy savings per category of equipment regulated.
- There is a reasonable economic case, which has been strengthened by significant increases in electricity costs.
- For larger suppliers of LED lamps, the number of families required to be registered is around 29.
- Registrations costs are reasonable – expected between 1c and 6c per lamp sold.
- There is a need to ensure that, once incandescent, halogen and fluorescent lamps are phased out, the remaining LED lamps are of high quality.
- There is a need to prevent Australia and New Zealand from becoming a ‘dumping ground’ for inferior LED products, particularly as regulators representing 79% of the world’s population are implementing or developing MEPS for LEDs. Some of these are now proposing a second phase of MEPS – with even higher efficacy and quality requirements.

Future lighting work program

Conclusion: It is concluded that it would be worthwhile to investigate a range of lighting products as part of a future work program. As other jurisdictions are proceeding with second phases of MEPS for LEDs, it is also concluded that it would be worthwhile to investigate second phases of MEPS for Australia and New Zealand, in light of the 'dumping ground' risks discussed in this report and further energy savings opportunities.

1 Introduction

1.1 Purpose of this report

In April 2018 a recommendation to further phase out incandescent lamps, phase out mains voltage halogen lamps and adopt MEPS (minimum energy performance standards) for LED lamps was provided to Australian Energy Ministers, following a regulatory impact analysis and discussions with the lighting industry. Considerable time has elapsed since Ministers deliberated on this issue, and various changes and issues have arisen. Thus, the objectives of this report are to:

- Summarise the key changes that have occurred in the lighting market since 2018
- Summarise the market's perceptions of the proposed regulations
- Assess other issues that have arisen, such as product registration and testing
- Inform a final decision of Energy Ministers regarding the proposed regulations
- Recommended lighting products to be investigated as part of a future work program.

This report does not replace the 2018 Decision RIS.

A number of contextual changes have occurred which have an impact on lighting, and these are analysed in this report as follows:

- The macroeconomic climate has changed – refer section 2.1
- LED lighting (as expected) has increased in popularity – refer sections 2.2 and 2.3
- The way lighting is purchased has changed – refer section 2.4 and 2.5
- Australia has introduced and removed other polices which affect lighting - refer section 2.6
- Other countries have moved to regulate lighting - refer section 2.8.

Chapter 0 discusses registration and compliance issues and chapter 0 examines the performance of current LED products. The quantifiable issues, including increases in electricity prices, are brought together with other calculations in chapter 3. Chapter 0 presents a discussion and conclusions.

Note that some of the analysis in this report applies to Australia only, however due to the similarities between the Australian and New Zealand markets, the findings and conclusions will apply to both countries (noting that New Zealand does not plan to phase out incandescent and halogen lamps).

1.2 Policy context

The Australian and New Zealand governments collaborate through the Equipment Energy Efficiency (E3) program on minimum energy performance and labelling requirements for appliances and equipment. In Australia, the Greenhouse and Energy Minimum Standards (GEMS) Act 2012 contains provisions which allow MEPS to change over time in order to encourage greater efficiency, reduced energy use and emissions abatement. For further background on the GEMS Act and E3 refer to the energy rating website[1].

[1] https://www.energyrating.gov.au

In addition to energy savings and associated reductions in greenhouse gas emissions, improvements in lighting energy efficiency will support the broader Australian goals of demand side management under the National Energy Transformation Partnership. As governments work to deliver secure and affordable low-emission energy supply, there is a need to accelerate demand-side action to support an efficient, least-cost pathway through the energy transformation. The new National Energy Transformation Partnership was established on 12 August 2022 by Commonwealth, state and territory Energy Ministers. This partnership is a framework for national alignment and cooperative action by governments to support the smooth transformation of Australia's energy sector. One of the priority areas identified for cooperation is demand evolution and regional level scenario planning due to increasing electrification, and demand management opportunities including energy efficiency, distributed energy resources, electric vehicles and demand response.

The EU has been progressively strengthening its energy efficiency targets to reduce costs and meet its 2030 emissions reduction goals (refer section 2.8.1) and in our region similar action is being pursued by countries such as South Korea and Japan. The International Energy Agency (IEA) has made it clear that without early action on energy efficiency, the transition to net zero emissions will be more expensive and more difficult. Energy efficiency policies will reduce energy costs for households and businesses, reduce pressure on the energy system and assist governments to meet emissions reduction goals.

Australia (and to a lesser extent, New Zealand) lags behind international counterparts on energy efficiency and performance. At the time of writing of this report, the Climate Change Performance Index[2], an independent monitoring tool presented at the annual UN Climate Change Conference, ranked Australia 55 and New Zealand 33 out of 63 countries for energy performance per capita.

It is also worth noting that energy efficiency policies for appliances and equipment are in a mature phase. MEPS for equipment with high energy consumption and readily available savings have largely already been implemented. Examples include refrigerators, electric motors, air conditioners and the phasing out of incandescent lamps. Put simply, the 'low hanging fruit' has been exhausted. Extracting further energy savings from appliances and equipment in Australia and New Zealand requires accepting lower overall energy savings per category of equipment regulated. We now need to target the 'high hanging fruit'. This approach is reflected in many other countries including the European Union[3] and the United States[4] who are implementing exhaustive regulatory work programs for MEPS and energy labelling.

The CLASP Report *Net Zero Heroes*[5] maps out a path for household appliances and equipment to take their part in meeting the IEA's net zero target by 2050. It states that '*to realise the appliance sector's mitigation and adaptation potential, governments and manufacturers must rapidly supercharge the efficiency of ten key appliances: the Net Zero Heroes. This group comprises LED lighting, air conditioners, comfort fans, refrigerator- freezers, heat pump space heating, heat pump*

[2] https://ccpi.org
[3] https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products_en
[4] https://www.energy.gov/eere/buildings/standards-and-test-procedures
[5] https://www.clasp.ngo/report/net-zero-heroes/

water heaters, electric motors, electric cookers, televisions, and solar water pumps'. For lighting it recommends that fluorescent lighting should be completely phased out by 2025 and that the efficacy of LEDs should be doubled.

1.3 Objective and aims of the regulations proposed in 2018

The objective of the 2018 DRIS is to "remove inefficient and poor quality LED lamps from the Australian and New Zealand market. For Australia, the objective is also to accelerate the transition to efficient lighting, by removing the least efficient lamps from the market and deliver cost effective energy savings. An important part of achieving this is to minimise compliance costs for suppliers, including through close alignment with lighting regulations in major economies and markets."

The regulations proposed in 2018, as embodied in the published DRIS, aimed to:

- Reduce electricity consumption (note that these savings have already been factored into AEMO consumption forecasts)
- Reduce greenhouse gas emissions
- Reduce peaks in electricity consumption
- Facilitate more energy efficient lighting options for consumers and reduce energy bills for consumers
- Provide lighting equipment suppliers with a baseline for both energy efficiency and lighting quality, for example:
    - Set a lower limit for lamp lifetime – since 2018 this has been expressed as '$L_{70}B_{50}$' which is the internationally recognised calculation for ensuring the time in hours between the start of a lamps use and the time at which, for 50% of a population of LED lamps of that model, the light output has degraded to a value below 70% of the initial luminous flux.
    - Set limits for health-related attributes, such as ultraviolet radiation, blue light emission and flicker (visible and non-visible).

1.4 Benefits of lighting policies for LED product innovation

In a 2019 paper, Impact of Domestic Energy-Efficiency Policies on Foreign Innovation: The Case of Lighting Technologies[6], authors Kim and Brown analysed the effect of MEPS policies on lighting patents between 1992 and 2007 using data from 19 OECD countries. Looking at levels of RD&D expenditures (representing a technology-push approach to innovation) and the stringency of energy performance standards (representing a demand-pull approach) the authors found strong correlational evidence that both approaches positively affected domestic lighting patenting. Furthermore, they found strong correlational evidence that MEPS positively affected foreign lighting patenting. The authors suggest that this analysis shows that MEPS policies can help to simulate energy efficient product innovation.

This idea is consistent with market-based evidence immediately following the introduction of the revised lighting energy label scale introduced with the EU Ecodesign and Energy labelling regulation

[6] https://ueaeprints.uea.ac.uk/id/eprint/70572/1/Accepted_Manuscript.pdf

in 2021. In this update, the new best-in-class luminous efficacy target (for an A-class rating) was 210 lm/W, was immediately met by a new Philips LED A-class bulb[7]. The required minimum EU efficacy is around 90 lm/W, which is a class F lamp under the EU energy labelling regulation.

[7] https://www.signify.com/global/our-company/news/press-releases/2021/20210830-signify-introduces-philips-leds-first-most-energy-efficient-a-class-bulbs

2 Market changes and market perceptions of proposed regulations

2.1 Macroeconomic changes and the climate transition

Since the DRIS was published in 2018, the Australian economy and its energy sector have changed dramatically. Australia and much of the world have entered a cost of living crisis triggered by intense inflation following the COVID19 pandemic. The OECD October 2023 Economic survey of Australia[8] sums this up:

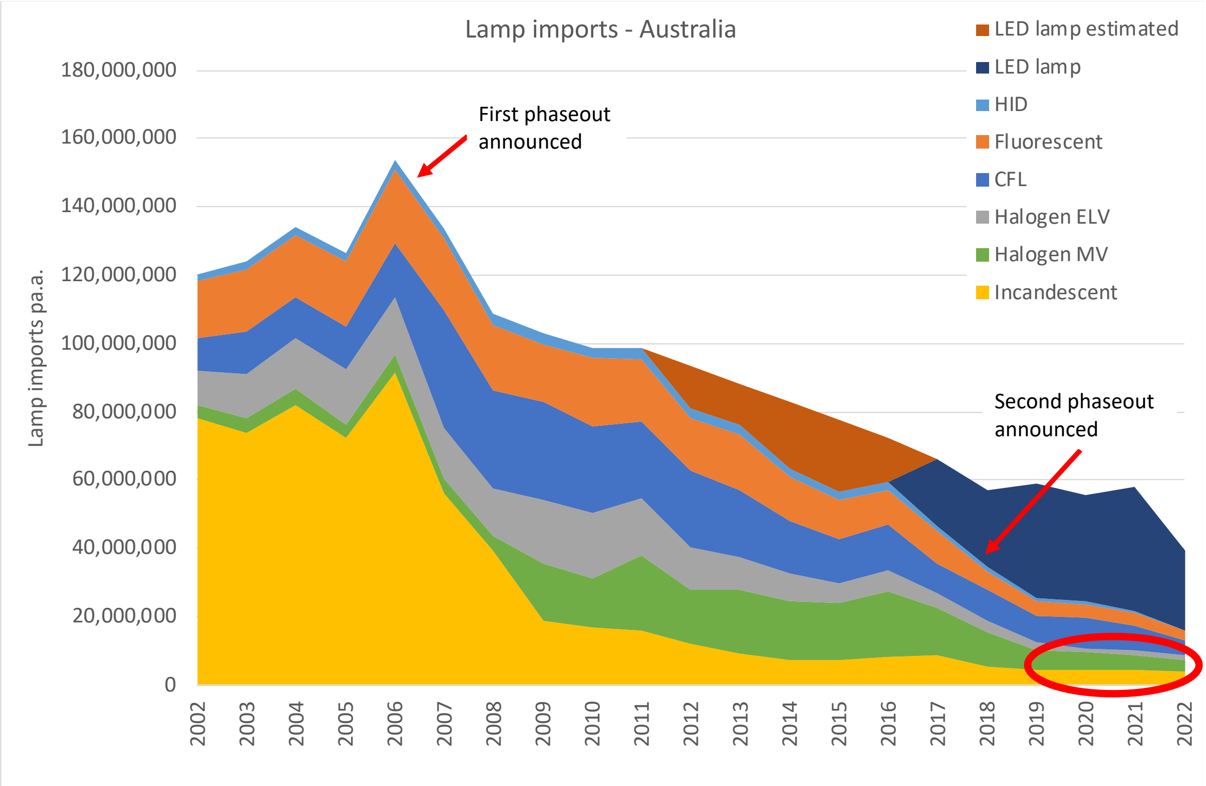
> *The Australian economy rebounded robustly in the wake of the pandemic. However, inflation has risen and fiscal pressures are on the horizon due to population ageing and climate change. Monetary policy should remain restrictive until underlying inflation is clearly on track to meet the central bank target, while fiscal buffers need to be rebuilt through reducing tax exemptions and improving public spending efficiency in areas such as health. In the medium-term, achieving inclusive and sustainable economic growth requires an ongoing focus on key social objectives such as reducing gender inequality and achieving the climate transition.*

2.2 Technology penetration

As predicted in the consultation and decision RISs prepared for the proposed lighting regulations, sales of incandescent and halogen lamps have continued to decline. Figure 1 graphs lamp imports entering Australia since 2002. Note in the early 2000s lamps were still manufactured in Australia, however from around 2006 onwards only imported lamps were available. Therefore, the imports of lamps represent an excellent proxy for lamp sales since 2006, as there were no other sources of lamps.

[8] https://www.oecd.org/economy/australia-economic-snapshot/

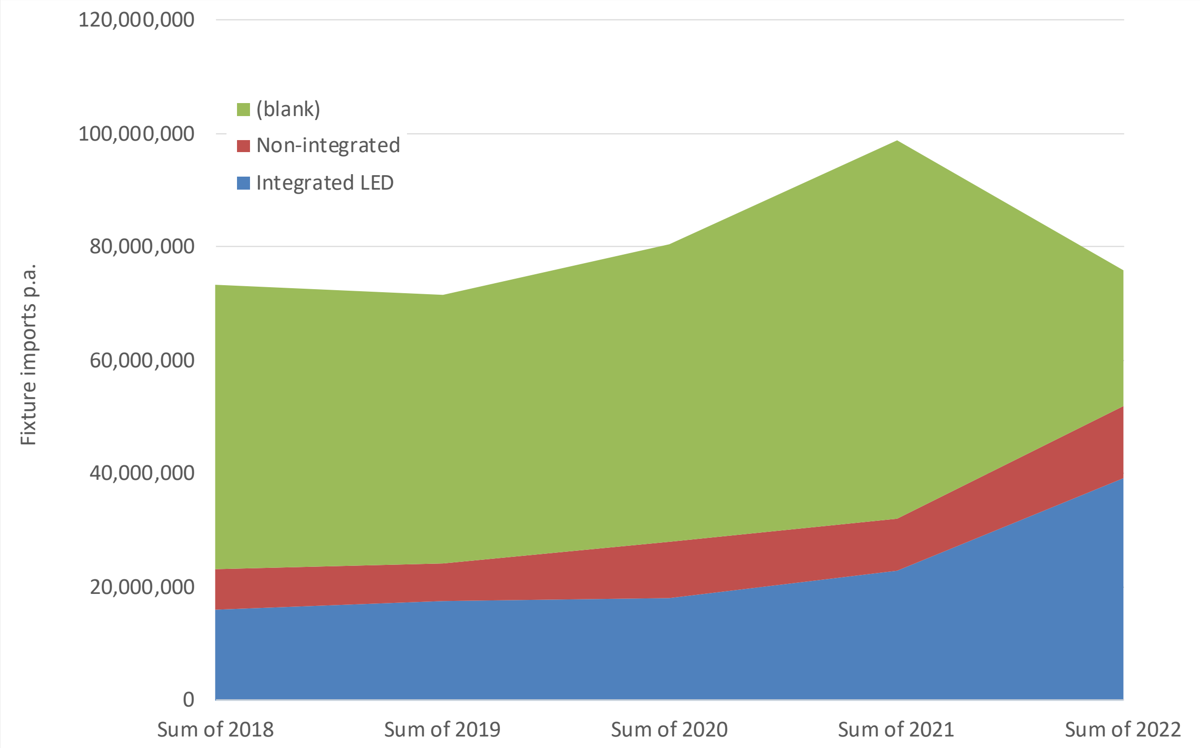
Figure 1: Lamp imports into Australia



In Figure 1 above we can see ongoing declines in incandescent, halogen, fluorescent and high intensity discharge (HID) lamp imports from around 2007, which is when the phaseout of incandescent lamps was announced (February). Note the phaseout was implemented as an import ban in February 2009 and then as a conventional MEPS in November 2009. Also, LED lamp imports have only been recorded by Customs since 2017, hence an estimate has been made of LED lamp imports prior to this. The red oval in this figure highlights the persistent use of incandescent and halogen lamp sales.

Figure 2 shows lighting fixture imports to Australia over the past few years. Note that the categorisation of fixtures by importers may be subject to come confusion, as evidenced by the large number of fixtures being categorised as ’other’. For this reason, breaking these imports down into more detailed categories has not been done.

Figure 2: Fixture imports into Australia



Interestingly, the transition to LED lamps cannot be explained by a reduction in price, at least over the past few years. Figure 3 below shows that the sales-weighted average LED lamp price (lamps sold in supermarkets) has remained stable since 2017, although it did reduce dramatically over 2014-2017.

Note also that lamp imports have likely decreased in response to a transition to integrated LED luminaires (e.g. for new builds and renovations) and the fact that LEDs have a longer life (less need for replacements).

Figure 3: Sales-weighted lamp retail price per bulb (supermarkets)

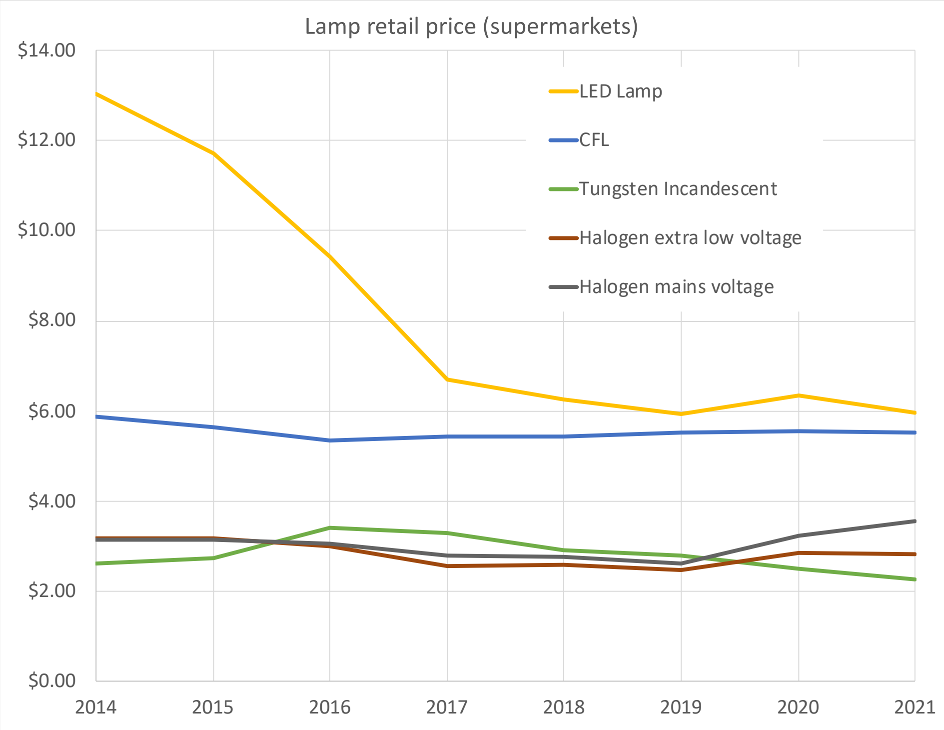


Figure 4 below shows lamp imports into New Zealand. Note that lamp categories for New Zealand are less granular than for Australia, and also that all LED imports are estimated (LED lamp imports not recorded in New Zealand in detail).

Figure 4: Lamp imports to New Zealand

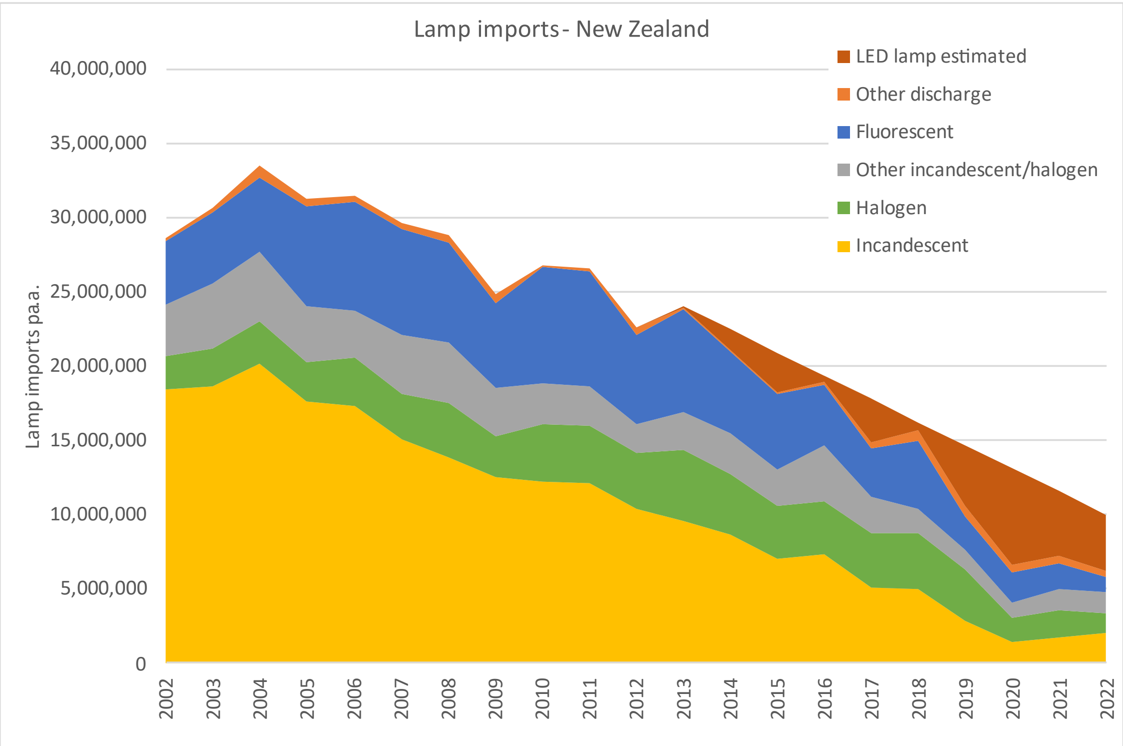
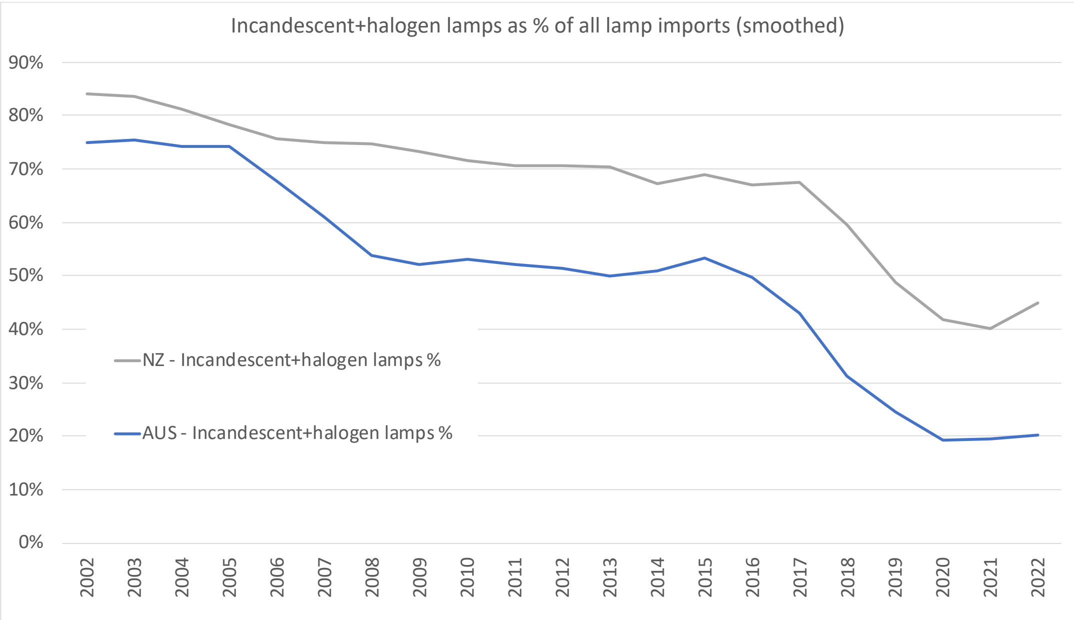


Figure 5 below compares the percentage of incandescent/halogen lamp imports for Australia and New Zealand. In this figure we can see that Australia has a consistently lower use of incandescent/halogen lamps than New Zealand, and this difference became more marked in 2007 when the incandescent lamp phaseout was announced for Australia. However, the shapes of the curves are remarkably similar after around 2008.

Figure 5: Comparison of percentage of incandescent/halogen lamp imports to Australia and New Zealand



These issues along with increases in the retail price of electricity (refer chapter 3) place a heightened focus on energy consumption and the need to reduce energy costs for households and businesses.

2.3 Market changes in anticipation of regulations

Despite the DRIS being published in 2018, the proposed regulations to phase out mains voltage halogen lamps and implement MEPS for LED lamps in Australia have not yet been implemented. As part of the DRIS, Energy Minister's agreed that Australian regulations would align with the (then) forthcoming European Union regulations. Those EU regulations were expected in 2020 but were delayed until 2021. Some of the delay in the deployment of regulations in Australia and the EU was due to Covid19.

In recent years there has been a faster-than-anticipated reduction in the sales of incandescent and halogen lamps, in favour of LED lamps (refer section 2.2). One possible explanation for this is that some lamp importers and retailers anticipated the impending regulations and ceased import and sale of incandescent and halogen lamps early. Multiple media articles reflect this[9, 10, 11] and Figure 1 is an example of a media headline from 2018. This phenomenon was also observed to occur in 2007,

[9] https://www.lucesco.com.au/2018/05/17/halogen-lights-set-to-disappear-from-retail-shelves-says-lighting-industry-peak-body/
[10] http://www.xinhuanet.com/english/2018-05/28/c_137211993.htm
[11] https://www.devdiscourse.com/article/agency-wire/9239-australia-to-phase-out-halogen-bulbs-for-energy-efficient-led-bulbs-by-2020

when a pre-emption of the phaseout of incandescent lamps was observed – regulations were not implemented until in February 2009 (import ban) and November 2009 (MEPS applied at point of sale). This can be seen in Figure 6.

Figure 6: Media headline from May 2018[12]


Halogen light bulbs could disappear from Australian stores within two years

Manufacturers will act early on September 2020 ban as LED already the preferred option

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Note also that halogen lamp check-testing and resultant regulatory action around this time caused the withdrawal of a significant number of halogen models from the market. This may have had the effect of hastening the withdrawal by retailers of halogens from the market.

As a result of the early exit of halogen lamps from the market, any quantitative analysis of regulation that were to be imposed today, would provide a misleading result, because some of the savings have already occurred as a result of market anticipation of the (delayed) regulation which was announced in 2018. This certainly applies to the phase out of halogen lamps, however the effect on LEDs (due to impending MEPS) is unclear, i.e. if the announcement of regulations caused an improvement in the performance of LED lamps and an increase in the range of LED lamps available.

2.4 Changes in the retail lamp market

2.4.1 Australian retail sales of lamps

Supermarket sales dropped off markedly from 2019 onwards, and this can be seen in Figure 7. This is due to a significant reduction in halogen lamp sales – presumably as several retailers de-stocked these lamps in anticipation of the regulations announced in 2018 and also some compliance issues where halogen lamps failed to meet MEPS requirements. Discussions with the lighting industry also suggest that the supermarket share of halogen sales dropped markedly in 2022 and these sales were taken up primarily by hardware stores.

[12] https://www.theguardian.com/environment/2018/may/28/halogen-light-bulbs-could-disappear-from-australian-stores-within-two-years

Figure 7: Australian supermarket lamp sales

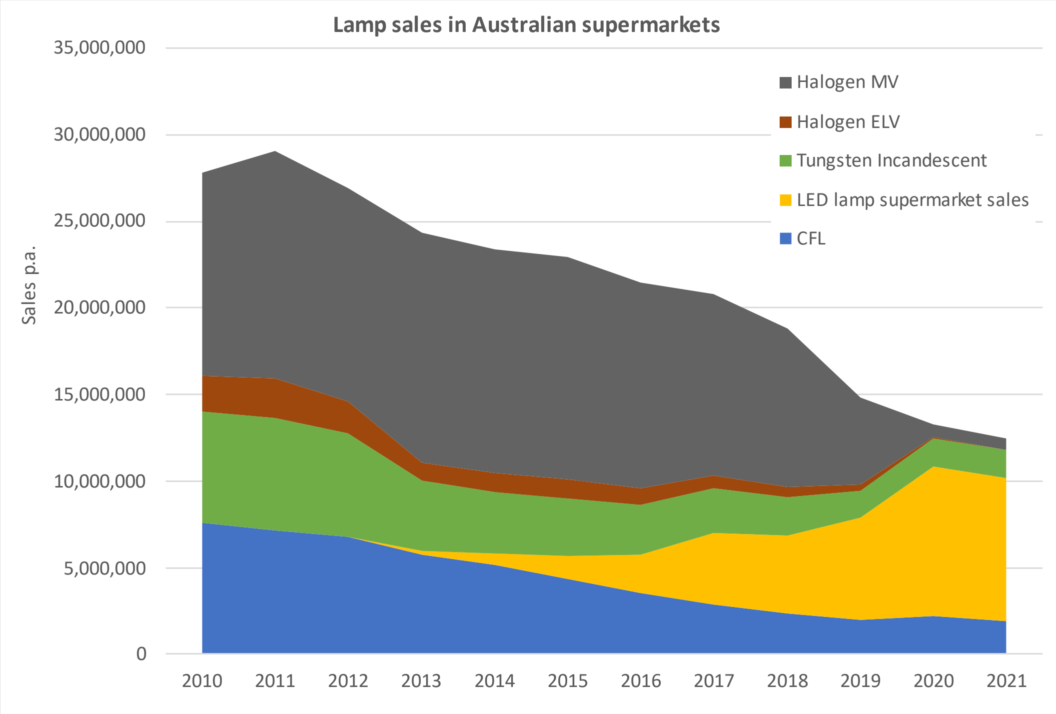


Figure 8 below graphs data for Australian supermarket sales versus total lamp imports. It shows that in recent years there has been a decline in the supermarket share of lamp sales, presumably in favour of online sales and sales via hardware and speciality lighting stores, possibly also due to state-based energy efficiency incentive schemes that resulted in significant subsidies for CFL and LED lamps. The gap between retail sales and total lamp imports is wide in early years, and this is difficult to explain (possibly supermarket data is unreliable in earlier years).

Figure 8: Australian supermarket lamp sales vs total lamp imports

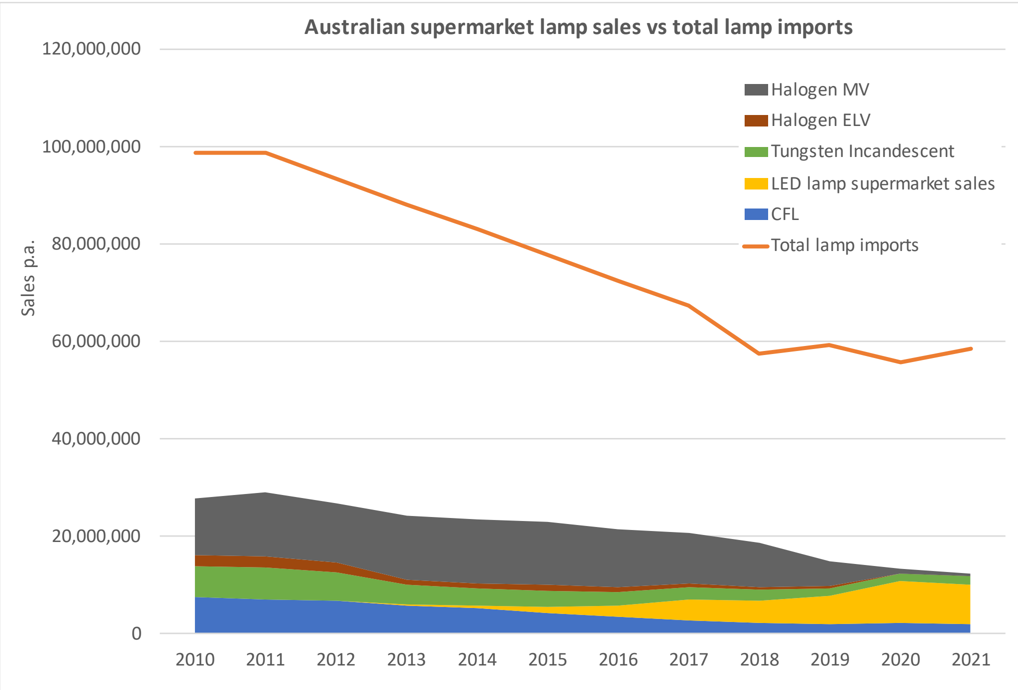
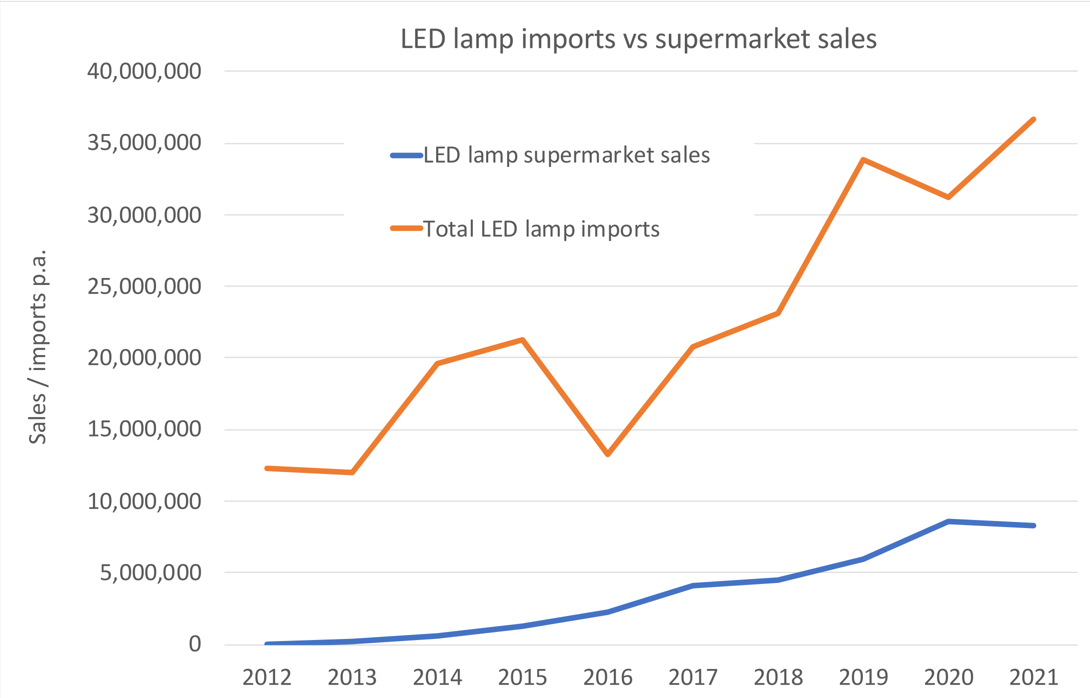


Figure 9 below graphs LED lamp supermarket sales, against total LED lamp imports. The percentage share of supermarket LED sales appears to reduce in later years, again presumably this is due to increasing sales of LED lamps via online, specialist and hardware stores, as well as possibly state-based incentive schemes.

Figure 9: LED lamp imports vs supermarket sales



Discussions with the lighting industry suggest that the retail share of LED residential lamp sales is around 40% for supermarkets, 40% for hardware stores and 20% for speciality lighting stores (keeping in mind that Figure 9 also includes commercial LED lamps). Unfortunately, no information is available for online sales, however a rough calculation from available data would suggest the following for the total LED lamp market (residential + business markets):

- Supermarket sales: around 8m p.a.
- Hardware stores: around 8m p.a.
- Speciality lighting stores: around 4m p.a.
- Online sales plus commercial product sales: around 15m p.a.

2.4.2 Global issues affecting supply of LEDs

Discussions with the lighting industry highlighted some interesting changes that have occurred, or are occurring, in the lighting market. At least two of the European lighting brands have sold their LED manufacturing capability to Chinese interests, and these brands now consist only of brand/sales/marketing operations. In other words, Chinese interests now own the factories and technologies, rather than just providing labour as was the case in the past when large European/American lighting companies owned factories in China.

The Chinese government also tends to set the direction for manufacturing in many industries in China, including renewable energy technologies and LED lighting (LED chip manufacturing more so than fixture manufacturing). Note also that China has national standards in place for LED lamps. Chinese manufacturing was significantly scaled back due to the COVID19, taking some time to ramp back up again afterwards. There was also a shortage of container ships which caused shipping prices to skyrocket, although these are now reducing.

2.5 Consumer preferences and feedback from consultation

2.5.1 Market research

Australian lighting market research (unpublished) was undertaken by a specialised market research firm in 2021 for DCCEEW (n = 2500 participants) and the results are summarised as follows:

Results from market research

Consumers generally know that:

- Lighting is important, but not something they think about a lot
- Technology has changed over time and become more efficient
- There is a wide variety of lighting options available
- Light bulbs are more expensive than they used to be
- The type of lighting used in rooms can affect peoples' moods.

Australians believe they have a fairly good understanding of the term 'watts' and how to tell if a light bulb is energy efficient or not. However, when push comes to shove, there is still uncertainty and a lack of understanding around key lighting terms.

Unprompted consumer knowledge about energy efficiency is moderate, with LEDs top of mind.

Qualitatively there are seven key factors that consumers consider:

- Energy efficiency
- Lifespan
- Upfront cost
- Brightness/watts/lumens
- Colour temperature
- Familiarity
- Size and shape (e.g. correct cap type)

Energy efficiency and cost are the top two factors impacting the light bulb purchase decision, behind the practical choice of correct cap type. Quantitatively, the proposed lamp regulations were well received by Australians. Approximately two-thirds responded positively to all aspects of the planned phase out and LED MEPS, with roughly a third neutral on the topic. LEDs using less energy than

2.5.2 Public consultation

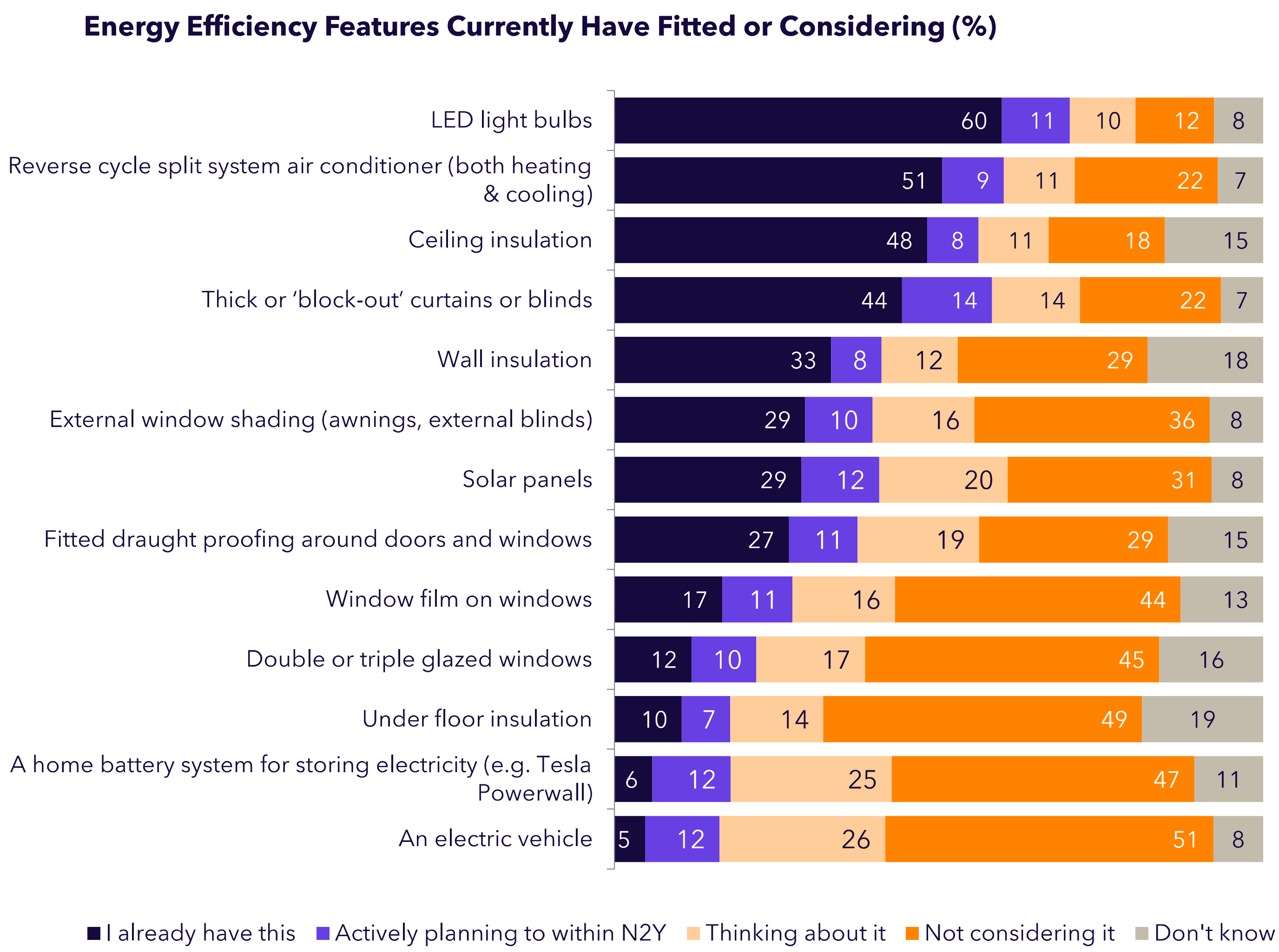
Following the publication of draft determinations in Australia, for the phaseout and LED MEPS, a public consultation process was undertaken in 2023. The submissions received[13] during this process are summarised in Annex A and further summarised here as follows:

- 14 submissions were able to be published.
- 10 supported the phaseout of halogen lamps.
- 9 supported MEPS for LEDs (of these 2 provided conditional support).
- 3 supported further action to phase out fluorescent lamps (note this was out of scope of the consultation).
- 3 raised health concerns regarding LEDs (note that addressing health concerns is however an important aim of LED MEPS and detailed advice on these matters has been received from the IEA SSL Annex and other bodies).
- Lighting Council Australia supported the phaseout but provided conditional support for LED MEPS.

Research on energy efficient housing[14] prepared for Energy Consumers Australia & RENEW in August 2022 also found that most consumers associate energy efficiency with LED lighting and energy efficient appliances. Results can be seen in Figure 10 which shows LED lighting as the most widely considered energy efficiency upgrade.

13 https://consult.dcceew.gov.au/proposed-lighting-regulations/new-survey/list
14 https://energyconsumersaustralia.com.au/publications/20208

Figure 10: Results from market research - energy efficiency features currently installed or considering installing



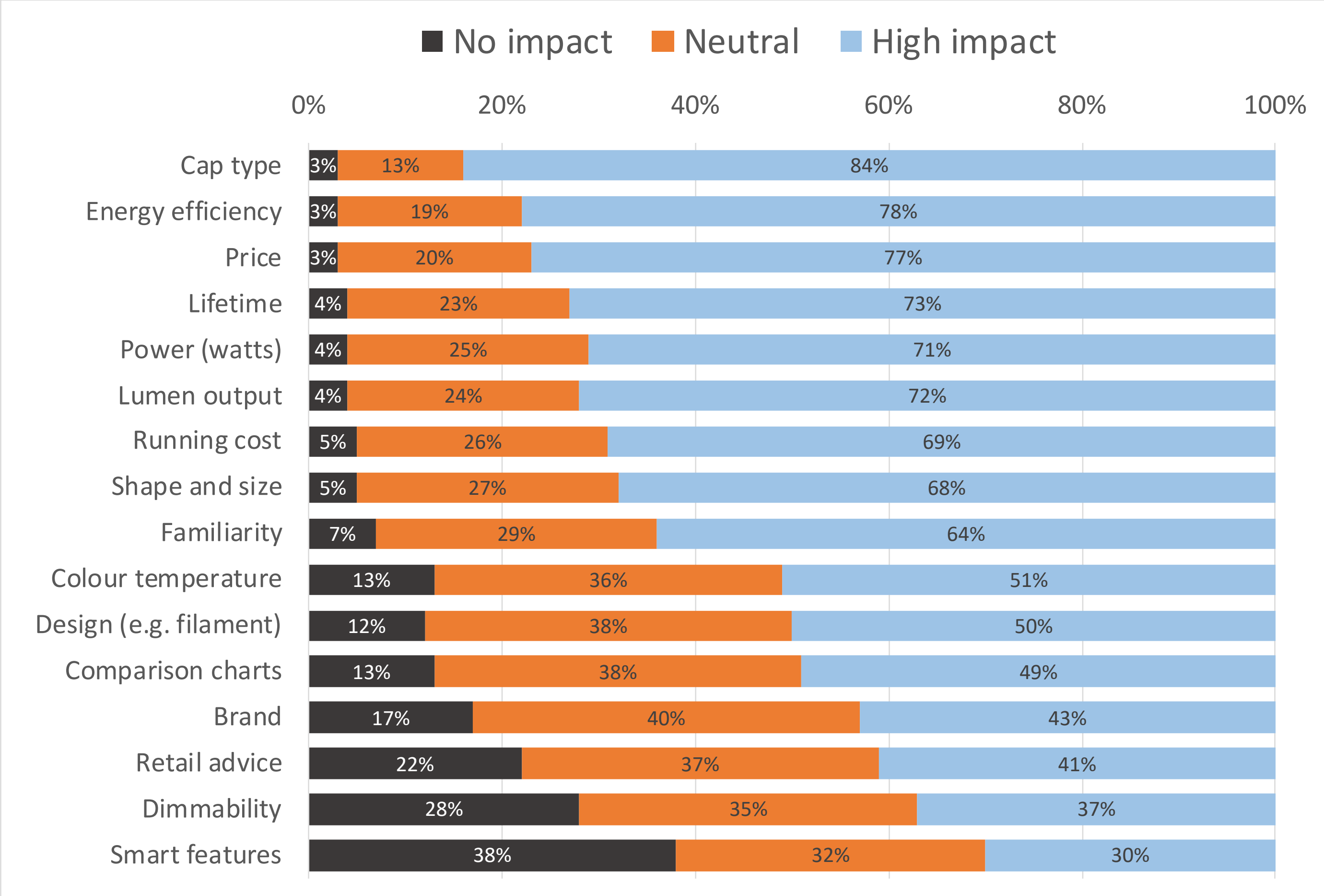
Note that consumer knowledge of the fact that some LEDs are more energy efficient than others remains unexplored.

2.5.3 Dimmer compatibility

Compatibility with dimmers was not raised as an issue in the submissions to draft determinations, although one submission[15] raised the potential for LED flicker during dimming. During market research, participants were asked about dimmability (not dimmer compatibility) and this received a low priority amongst other issues – refer Figure 11.

[15] https://consult.dcceew.gov.au/proposed-lighting-regulations/new-survey/view/4

Figure 11: Factors that impact lighting decision making – results from market research



Responses to the public consultation process, market research and the recent rapid popularisation of LED lamps all support a hypothesis that dimmer compatibility is not a critical issue. In addition, modern Australian houses are more likely to use extra low voltage (ELV) halogen downlights in living and sleeping areas - i.e. rooms where dimmers are more prevalent. These ELV halogen lamps are not proposed to be phased out at this stage (due to the additional complexity for consumers), thus dimmer compatibility is not an issue here.

In addition, recently built/renovated houses are more likely to use LED lights with either an appropriate dimmer installed or with dimming undertaken using a phone app. 'Dimmable' mains voltage LED bulbs can be purchased, although conversations with lighting experts suggest that some of these are compatible only with new models of dimmers that are specially designed to be LED compatible.

Testing undertaken by DCCEEW demonstrated that quite a few dimmable LEDs were compatible with at least some legacy dimmers, and that even if legacy dimmers are not compatible with some LED lamps, many will continue to operate as long as the dimmer is set to 100%.

2.7 Evolution of lighting policies in Australia

Australia is a ratified Party to the Minamata Convention on Mercury, under which high pressure mercury vapour lamps have now been phased out[16]. Parties to the Convention have also agreed to a staggered series of phase out dates for different varieties of fluorescent lamps through to 2027. Phase out dates under the Convention require countries to prohibit the import, export and manufacture of specified lighting products. As there are currently 148 countries who are Parties to the Minamata Convention, the phasing out of these lamps globally will further increase the mandate for LEDs and subsequently their market share.

Due to the increasing popularity of LEDs, there are a number of state-based energy efficiency incentive schemes that have either eliminated lighting upgrades as methods for generating energy savings, or significantly reduced the energy savings available from these upgrades. The Emissions Reduction Fund (ERF) retired its Commercial and Public Lighting Method in April 2022. In 2023 the Victorian VEU removed incentives for all residential lighting upgrades and removed/reduced incentives for commercial lighting activities. The South Australian REPS scheme is also transitioning away from lighting activities. The NSW ESS scheme has also reduced incentives and plans to do this again in the near future.

2.8 Evolution of lighting policies in other countries

Australia and New Zealand are committed to harmonising product energy efficiency policies with their major trading partners. The E3 Prioritisation Plan Stage 2 Report[17] states:

> *One keyway to achieve these objectives is through a closer alignment with energy efficiency regulations amongst our major trading partners, in particular with the United States, Europe and South-East Asia. The E3 Program has been pursuing closer alignment for several years as a means to reduce the costs of doing business for product suppliers and to enhance compliance. Now that several major economies regulate a wider selection of products than Australia and New Zealand, in many cases it is possible to increase energy savings by aligning product scopes with these economies. Product suppliers have indicated a clear preference for aligning with standards published by international standards organisations and international regulatory levels, especially those operation in the European Union (EU).*

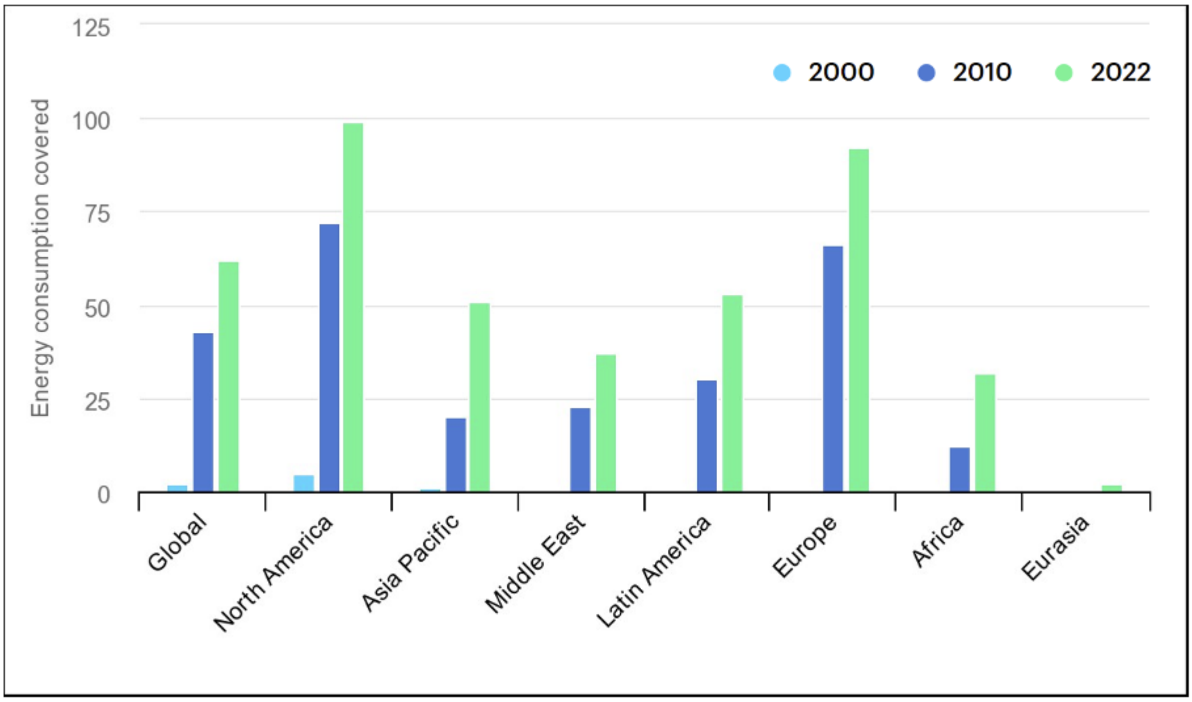
Actions by Australia and New Zealand are also viewed by our Pacific Island neighbours as integral to their climate goals. It is particularly important for the Pacific nations to reflect Australia / New Zealand policies, as historically we know they, in turn, can become dumping grounds for products that cannot be sold in Australia and New Zealand.

The IEA recently produced an overview of lighting policy worldwide[18] which cites MEPS as the key driver for efficiency improvements. Figure 12 is from this overview, and shows the proportion of

[16] https://www.dcceew.gov.au/environment/protection/chemicals-management/mercury/sector-specific-guidance
[17] https://www.energyrating.gov.au/industry-information/publications/equipment-energy-efficiency-e3-prioritisation-plan-stage-2-report
[18] https://www.iea.org/energy-system/buildings/lighting

lighting electricity use which is now covered by a MEPS of some kind. Of note in this figure is that North America and Europe are each now approaching 100% of their lighting being covered by MEPS.

Figure 12: Percentage of lighting electricity use covered by MEPS, by region



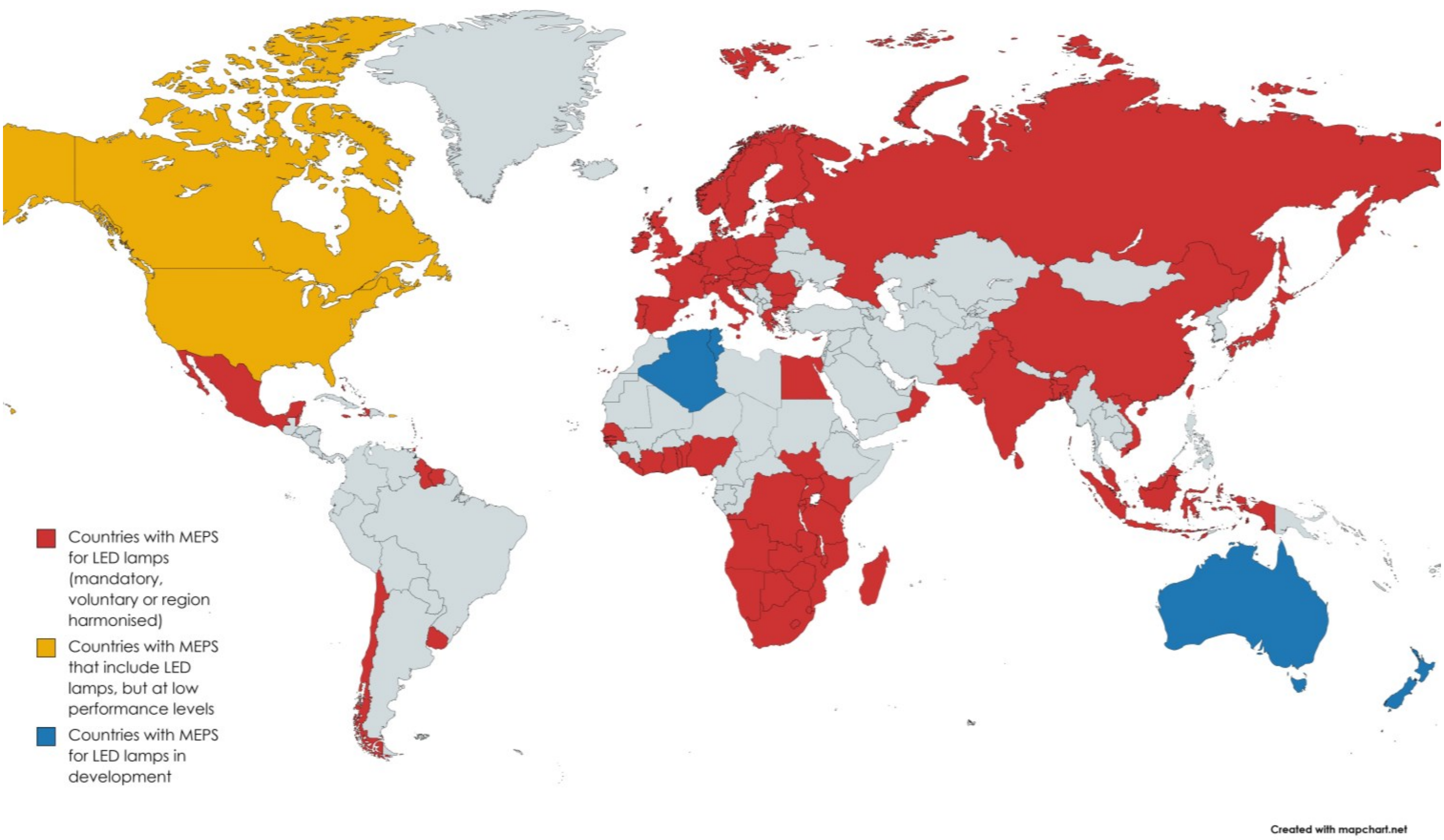
The IEA lighting report recommends that countries "***Expand the use and increase the stringency of MEPS****: Governments should take advantage of the growing LED market (and lower LED costs) to raise minimum performance and quality requirements for lighting products. In addition to updating standards, further effort is needed to expand lighting policy coverage to markets that are still unregulated, as almost one quarter of global energy use for lighting in the residential sector is not yet covered by MEPS. Phasing out incandescent, halogen and compact fluorescent and setting efficacy and quality (e.g. flicker and lifetime) requirements for LED lamps is critical for general lighting applications in both developed and developing ad countries. Countries may consider using model lighting regulations developed by U4E*".

The IEA also maintain a policy database[19] which contains a complete list of existing MEPS and labelling policies by region, including for lighting. Annex B contains a comprehensive list of countries regulating MEPS for LEDs.

Figure 13 illustrates the coverage of MEPS legislation for LED lamps around the world. The US and Canada both have technology neutral MEPS for lamps, which include LED products, however the performance standard is as low as 45 lm/W and 15 lm/W (respectively) for some commonly used LED GLS-type lamps. For this reason, these countries are highlighted separately (yellow) as having MEPS that cover LED lamps, albeit at relatively low efficacy levels.

[19] https://www.iea.org/policies?qs=buil&technology%5B0%5D=Lighting%20technologies&status=In%20force

Figure 13: Worldwide coverage of MEPS legislation for LED lamps (source: refer Annex B)



Note that the countries with LED MEPS in place or in development represent 79% of the world's population. The IEA lighting policy overview[20] also mentions the following upcoming lighting policies:

- The East African Community (EAC), in July 2022, adopted a regionally harmonised quality and performance standard that will phase out conventional and fluorescent lamps in favour of LED lamps.
- India's Electric Lamp and Component Manufacturers Association (ELCOMA), an industry association for lamps and components manufacturers, recently published their Vision 2024 Roadmap[21] to transition their lighting market to LED by 2024. One of the key imperatives noted in this document, was to *"create green and Indian Centric standards for products and applications and ensure implementation by making standards mandatory"*.
- In July 2022 an Indonesian Ministerial Decree[22] was released by the Ministry of Energy and Mineral Resources stipulating MEPS for self-ballasted LED bulbs at 80 lm/W, self-ballasted LED tubes 100 lm/W, and LED luminaires (street lighting, high bay, floodlight, etc) at 120 lm/W, in line with the ASEAN harmonization target[23] set for 2023. These LED MEPS and associated labelling policy were due to come into force in July 2023.

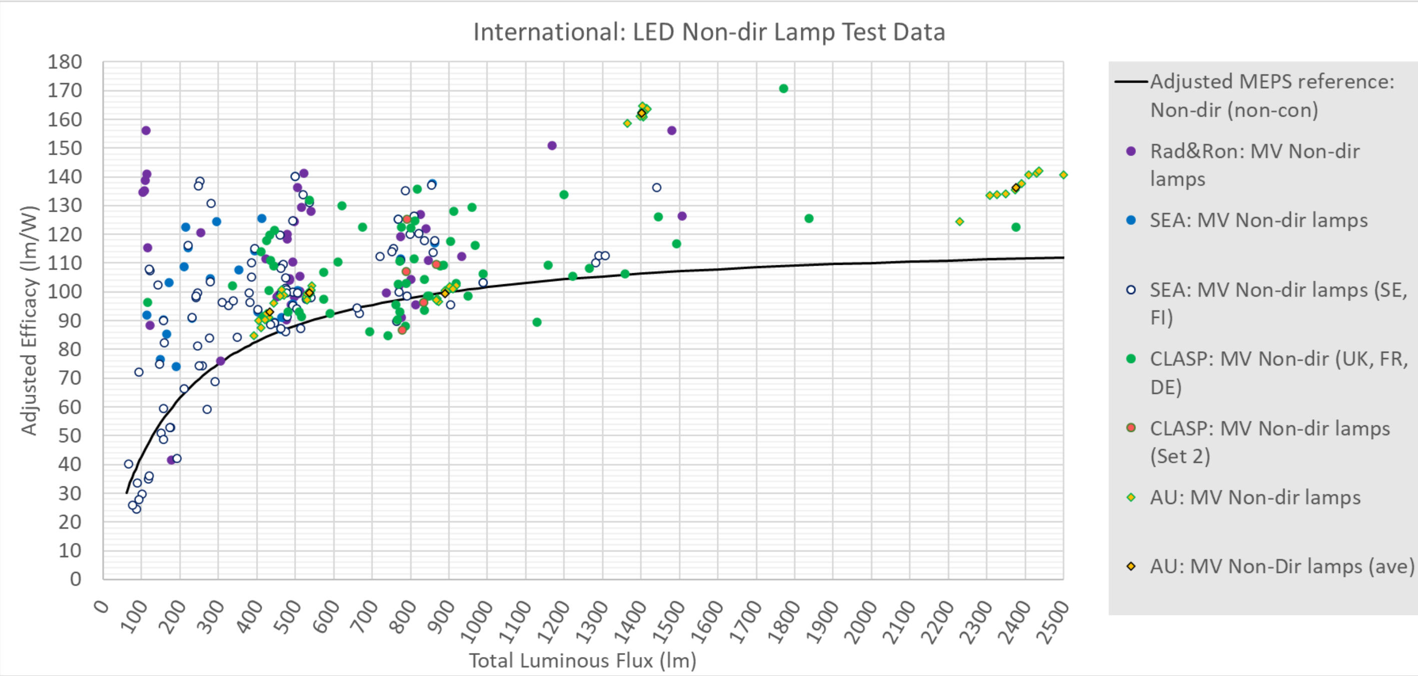
[20] https://www.iea.org/energy-system/buildings/lighting
[21] http://www.elcomaindia.com/wp-content/uploads/ELCOMA-Vission-2024.pdf
[22] https://united4efficiency.org/major-milestone-in-indonesias-transition-to-energy-efficient-lighting-achieved/
[23] https://united4efficiency.org/wp-content/uploads/2022/02/Harmonisation-of-Energy-Performance-Standards-for-Lighting_Regional-Policy-Roadmap-2019-1.pdf

- South Africa published on 24 May 2023 new efficiency requirements for all General Service Lamps (GSLs) to meet at least 90 lm/W.

2.8.1 European Union, UK and USA

In 2018 Lighting Council Australia suggested that Australia / New Zealand MEPS for LED lamps should be based on the current EU MEPS for light sources, and this was agreed by governments (note that the product scope of EU regulation is much broader than proposed for Australia and New Zealand). The proposed AU/NZ efficacy requirements (similar to EU) are shown in Figure 14 below for non-directional lamps. This figure shows the efficacy requirement is around 80-100 lm/W for typical household lamps.

Figure 14: Proposed LED MEPS for non-directional lamps



The European Commission are required by law to review their EcoDesign regulation for light sources by December 2024, and it is widely anticipated that the efficacy and other requirements will increase following this review.

The EU efficacy classes for energy labelling of light sources are shown in Figure 15. Note that the currently proposed Australian MEPS requirements (non-directional lamps) is fits within the EU class F range.

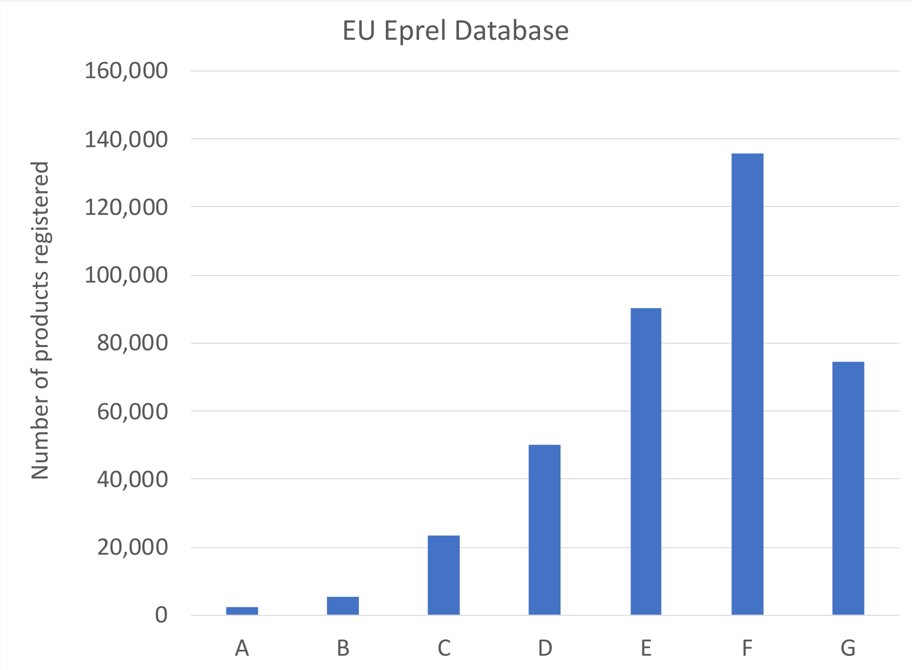
Figure 15: EU efficacy classes for energy labelling

Energy efficiency classes of light sources

Energy efficiency class	Total mains efficacy η_{TM} (lm/W)
A	$210 \le \eta_{TM}$
B	$185 \le \eta_{TM} < 210$
C	$160 \le \eta_{TM} < 185$
D	$135 \le \eta_{TM} < 160$
E	$110 \le \eta_{TM} < 135$
F	$85 \le \eta_{TM} < 110$
G	$\eta_{TM} < 85$

Figure 16 below shows the registered light sources in the EU, by energy label class. In this figure we can see that the almost half of the products are class E and above (>110 lm/W).

Figure 16: Light sources registered in EU Eprel database, by energy label class



In the UK regulations are proposed[24] that will require light sources to meet MEPS of 120 lm/W from late 2023 and 140 lm/W from September 2027. The US has also proposed[25] a MEPS for LED lamps of ~124 lm/W for GLS lamps and ~190 for linear LED lamps, to come into force in 2028.

[24] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1132532/new-ecodesign-requirements-for-lighting-products.pdf

[25] https://www.regulations.gov/document/EERE-2022-BT-STD-0022-0005 see MEPS formulae in Section 430.32, in the table at the bottom of page 1718 with additional functional requirements in table on page.

Given the delays experienced in Australia / New Zealand, and the second phase proposals outlined above for the EU, UK and USA, it is increasingly apparent that Australia / New Zealand will lag behind these countries, even if the current MEPS proposal is implemented.

2.9 Findings from this chapter

The relevant findings from this chapter are as follows:

- **Lighting regulations have evolved considerably in other parts of the world.**
    - The countries with LED MEPS in place or in development represent 79% of the world's population.
    - The EU, UK and USA are now planning for a second phase of MEPS for LEDs.
    - Australia / New Zealand currently lag behind much of the world's lighting regulations and risk becoming a dumping ground for inferior LED products.
    - The proposed phasing out of all fluorescent lamps by the Minamata Convention will further increase the mandate for LEDs.
- **The overall market share of LEDs has increased and supermarkets' share of the lighting market has decreased.**
    - In recent years there has been a faster-than-anticipated reduction in the market share of incandescent and halogen lamps. Some of this is due to lamp suppliers and retailers anticipating the impending regulations and ceasing import and sale of these lamps early.
    - The supermarket share of lamps sales has declined in recent years, presumably in favour of online sales and sales via hardware and speciality stores. From 2019 onwards supermarket lamp sales declined markedly, primarily due to a significant reduction in halogen lamp sales (noting that some retailers de-stocked these lamps in anticipation of the regulations announced in 2018 and also responded to compliance action under the GEMS Act).
- **The proposed lighting regulations have been relatively well received.**
    - 2021 market research indicates that the proposed regulations were well received by Australian consumers, with around two-thirds responding positively to all aspects of the planned phase out and LED MEPS, with roughly a third neutral on the topic.
    - Of the 14 submissions to the public consultation process for draft GEMS determinations, 10 supported the phaseout of halogen lamps and 9 supported MEPS for LEDs (2 conditionally). Lighting Council Australia supported the phaseout but provided conditional support for LED MEPS.
    - Dimmer compatibility did not surface as a significant issue during market research and public consultation.

3 Changes in the quantifiable benefits from lamp efficacy improvements

Since the decision RIS was published, electricity prices have risen substantially. Annex C contains information on AER reference pricing for electricity in Australian households, as well as a wide range of recent retail market offers. As can be seen in the AER information, residential electricity prices rose by between 15% and 29% between 2022 and 2023. For this report, a national average residential electricity price of 37c per kWh has been used. This compares to 28c which was used in the 2018 decision RIS for Australia (a nominal rise of 32% over 5 years). For business, an estimated average of 20c per kWh has been used.

The consultation RIS for electronic displays[26] uses a value for peak demand reductions of $500/kW and this has been used in modelling for this report. A social cost of carbon of AUD $84 has been used, taken from the RIS for electronic displays, which relied on the National Construction Code DRIS for this figure (table 5.25). Also of interest is that renewable energy is more prominent in the electricity system mix during the middle of the day, and less so at night. As residential lighting is predominantly used at night, it relies on electricity that is more emissions intensive. The opposite applies to commercial lighting which is mostly used during the day. Note this effect has not been modelled.

3.1 Phase out of halogen lamps

In recent years, sales of incandescent/halogen lamps have declined and LED lamp sales have increased. Nationally, on face value this means that energy savings from the phaseout (if it were to be implemented now) will be lower than expected. However further investigation suggests that some of the market changes observed were due to the market reacting *before* regulations were enacted (discussed also in section 2.3). It is not possible to estimate how much of an impact this had, but the fact that Woolworths and Coles supermarkets eliminated incandescent and halogen lamps from their shelves some years ago suggests that it was significant. Thus, a national calculation for the phaseout has not been undertaken – this has been modelled simply, at the household level. There are still households that have incandescent and halogen lamps installed, and they will now be paying considerably more for electricity than was estimated in the decision RIS.

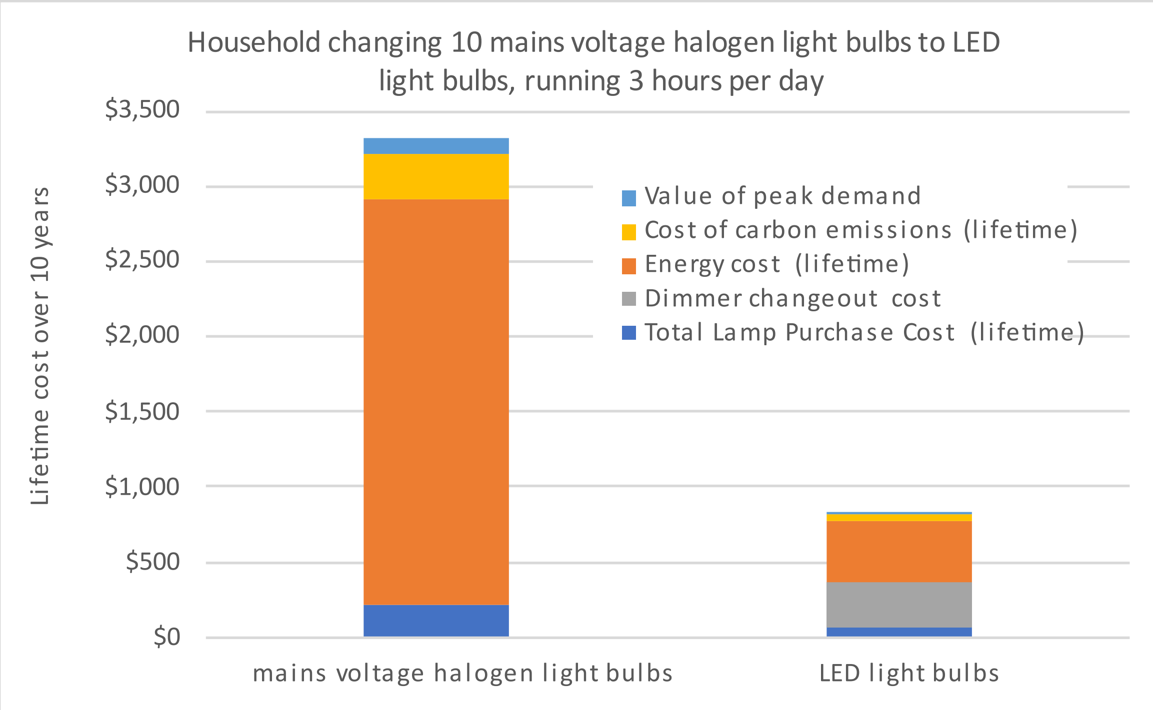
Figure 17 shows the benefits (from phaseout) of changing 10 halogen lamps to LED in a single household (a survey in 2016 found the average Australian house has 37 lamps[27]). Note that this includes the costs of engaging an electrician to change dimmers to LED compatible units, although as discussed in section 2.5.3 this is not likely to be required in the majority of cases.

[26] https://consult.dcceew.gov.au/cris-electronic-displays

[27] www.energyrating.gov.au/industry-information/publications/2016-residential-lighting-report

Figure 17: Phaseout - household benefit from changing 10 halogen bulbs to LED (with LED MEPS in place)

Household changing 10 mains voltage halogen light bulbs to LED light bulbs, running 3 hours per day
Estimated net benefit of $2138 over 10 yrs
A Household which has 10 mains voltage halogen light bulbs, which then transitions to LED light bulbs, will spend
$25 additional to what they would have spent to purchase the bulbs initially.
To change 3 dimmers to LED-compatible dimmers cost an estimated $300.
Energy savings will be $229 each year.
Over 10 years the household will be $2138 better off, including any benefits from having to replace light bulbs less frequently.
The value to the grid of peak demand reductions is $94.
The lifetime value of carbon abatement is $260.
Assumptions
existing/new lamp light output 1000 lumens; existing lamp efficacy 15 lm/W; new lamp efficacy 98 lm/W;
existing lamp power 66.7W; new lamp power 10.2W;
existing bulb cost $3.5 each; new bulb cost $6 each; existing lamp life 2000 hrs; new lamp life 15000 hrs.
bulb operating hours of 3 hours per day (high use areas); Electricity tariff of $0.37 per kWh.



If the household in Figure 17 did not have to replace dimmers, their net benefit would be $2438. Note that peak time power prices in some states can be significantly higher – up to $0.62 per kWh (e.g. Alinta Energy, Adelaide). Using this figure, the household above would be enjoy a net benefit of $3700 over 10 years. Greenhouse gas abatement for the household above was estimated at 3 tonnes CO_2e over 10 years.

3.2 LED MEPS

For LED lamps, national sales quantities will be higher than was expected in the DRIS, and this is partially due to the market reacting before phaseout regulations were enacted, as discussed in this report. Following the phaseout, LED sales would be expected to be at the same level as was forecast in the DRIS – in other words all incandescent and halogen lamp sales (apart from some specialist products) will have been usurped by LEDs. Efficacy increases due to MEPS have been modelled and, based on information from chapter 0 and Annex D, the average efficacy increases due to MEPS were calculated as follows:

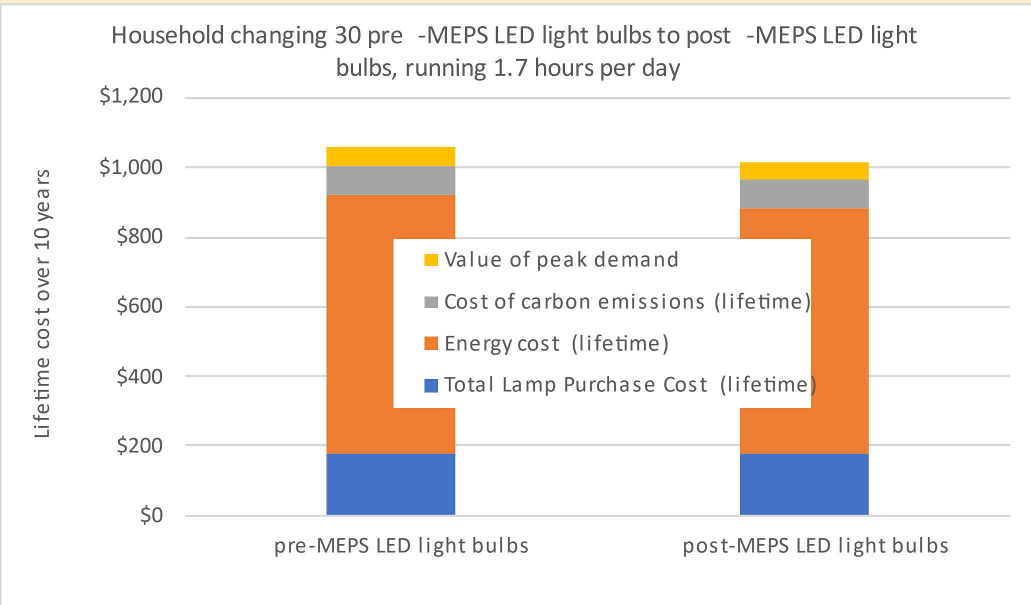
- Omni-directional and directional LED lamps: +5 lm/W
- Linear LED lamps: +30 lm/W (noting that this is based on a relatively small sample size).

Figure 18 and Figure 19 show individual household and (hypothetical) business customer benefits from LED MEPS. Note that Figure 18 (a household) depicts the average change in LED efficacy. Note also that an increase in lifetime from LED MEPS has not been modelled – along with improvements in other quality parameters, this is difficult to model accurately.

Different operating hours for households switching from halogen/incandescent lamps to LEDs to households switching from less efficient LEDs to more efficient LEDs have been used. This is because if all bulbs in the house change (from pre-MEPS LEDs to post-MEPS LEDs) the average operating hours of all these bulbs (1.7 hours per day) will be lower than the case where only 10 bulbs change (i.e. these are likely to be the most frequently used bulbs in the house, which will have longer operating hours - 3 hours per day).

Figure 18: Household benefits from LED MEPS

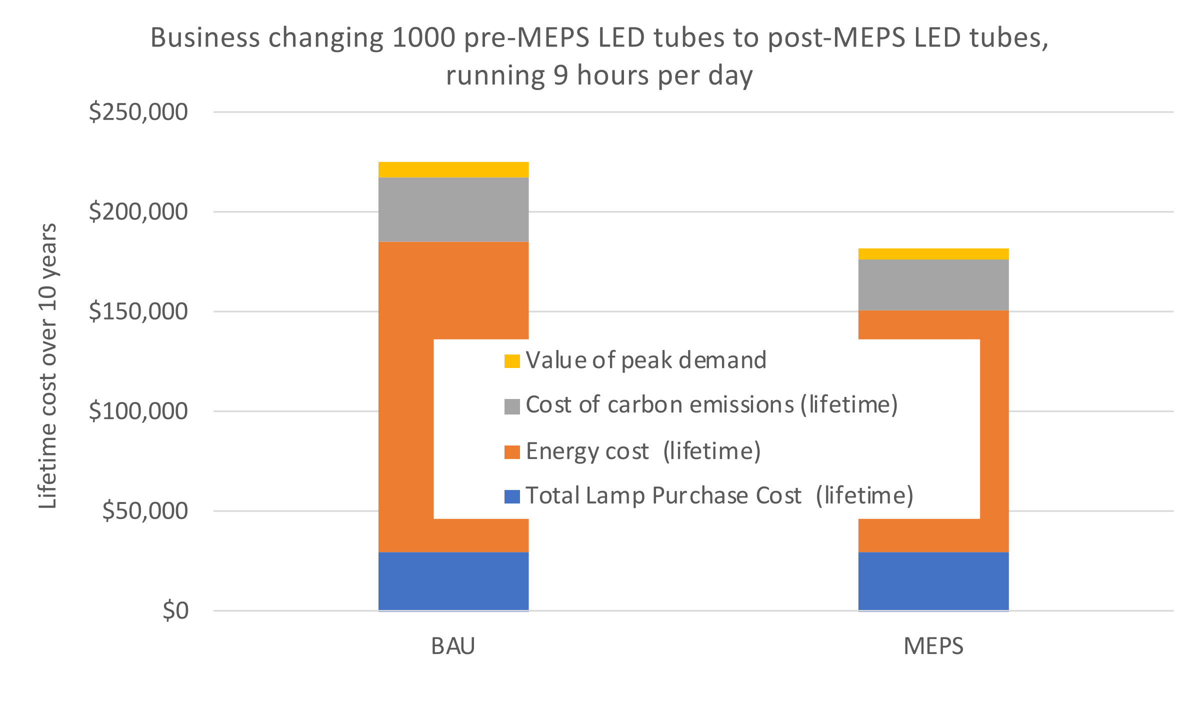
Household changing 30 pre-MEPS LED light bulbs to post-MEPS LED light bulbs, running 1.7 hours per day
Estimated net benefit of $38 over 10 yrs
A Household which has 30 pre-MEPS LED light bulbs, which then transitions to post-MEPS LED light bulbs, will save $4 each year on energy costs.
Over 10 years they will be $38 better off.
The value to the grid of peak demand reductions is $3.
The lifetime value of carbon abatement is $4.
Assumptions
Existing/new lamp light output 1000 lumens; existing lamp efficacy 93 lm/W; new lamp efficacy 98 lm/W;
existing lamp power 10.8W; new lamp power 10.2W;
existing bulb cost $6 each; new bulb cost $6 each; existing lamp life 15000 hrs; new lamp life 15000 hrs.
Bulb operating hours of 1.7 hours per day (average use for all bulbs in house); Electricity tariff of $0.37 per kWh;



Greenhouse gas abatement for the household above was estimated at 0.1 tonnes CO_2e over 10 years. A household which replaced very poor performing LEDs (e.g. 30% below MEPS) would have significantly higher savings – around $300 over 10 years.

Figure 19: Commercial benefits from LED MEPS

Business changing 1000 pre-MEPS LED tubes to post-MEPS LED tubes, running 9 hours per day
Estimated net benefit of $34181 over 10 yrs
A Business which has 1000 pre-MEPS LED tubes, which then transitions to post-MEPS LED tubes, will save $3418 each year on energy costs.
Over 10 years they will be $34181 better off, including any benefits from having to replace light bulbs less frequently.
The value to the grid of peak demand reductions is $1734.
The lifetime value of carbon abatement is $7178.
Assumptions
Existing/new lamp light output 2500 lumens; existing lamp efficacy 106 lm/W; new lamp efficacy 136 lm/W; existing lamp power 23.6W; new lamp power 18.4W;
existing bulb cost $15 each; new bulb cost $15 each; existing lamp life 20000 hrs; new lamp life 20000 hrs.
Bulb operating hours of 9 hours per day; Electricity tariff of $0.2 per kWh;



Greenhouse gas abatement for the business above was estimated at 85 tonnes CO_2e over 10 years. This represents a business changing from poor LED tubes (that would not meet the proposed MEPS) to significantly more efficient LED tubes.

Applying LED MEPS at a national (Australian) level, the net benefits from improvements in LED efficacy can be seen in Figure 20 and Figure 21 below. These are based on the previous individual customer calculations above, upscaled to the national level. The household model was upscaled by multiplying by 10 million households. The business model was upscaled by assuming that 15% of Australian businesses utilise LED tubes (no data is available on this – LED tube import data is unreliable due to perceived miscategorisation of products). Note however that the improvement in LED tube efficacy is based on testing of a relatively small sample group, and the upscaling of energy savings should be cognisant of this.

Figure 20: National lifetime residential costings for LED MEPS

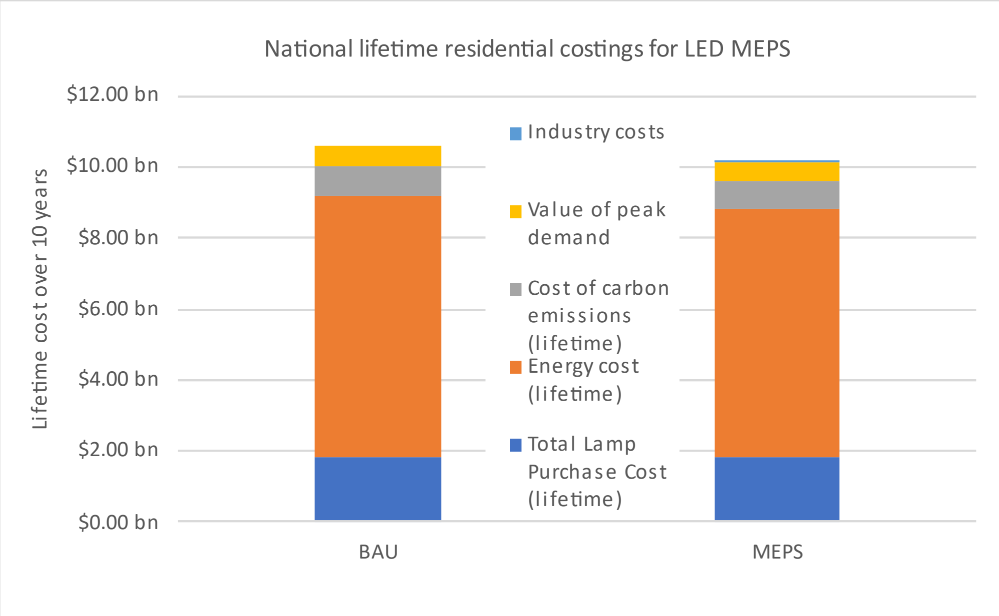
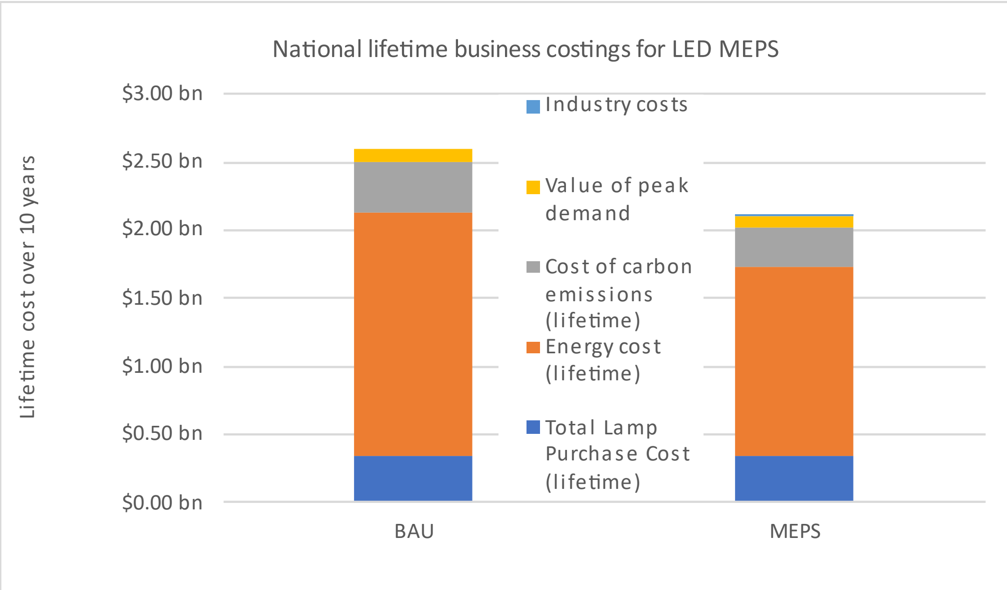


Figure 21: National lifetime business costings for LED MEPS



In Figure 20 and Figure 21 above the net financial benefits (savings) over 10 years are around 0.5bn for each of residential and commercial sectors, giving a combined benefit of around $1bn (noting that the improvement in LED tube efficacy, for the business sector, is based on testing of a relatively small sample group). These results are significantly higher than those calculated in the DRIS, and the reasons for this are as follows:

- This model assumes a static baseline for the BAU efficacy of LED lamps, whereas the DRIS assumed a significant increase in BAU LED performance over time. Note however that the rate of improvement in LED efficacy has not kept pace with that predicted in the DRIS.
- This model does not discount future financial benefits, whereas the RIS did.

Lifetime (10 years) greenhouse gas abatement for LED MEPS was estimated at 1.5 million tonnes.

Rough calculations estimate that, if a further stage 2 MEPS were to be implemented now (e.g. similar to those proposed in the EU or USA) then net financial benefits (savings) over 10 years would be around 4 times higher than those predicted above – around $4bn. Similarly, lifetime (10 years) greenhouse gas abatement would be around 6 Mt.

A sophisticated, discounted cashflow model was not developed for this report (as was undertaken for the RIS and DRIS). However, even given the limitations of the model, the financial benefits (savings) from improvements in efficacy of LED lamps appear to be positive and significant.

3.3 Findings from this chapter

The relevant findings from this chapter are as follows:

- **The economic and climate change benefits from phasing out halogen lamps and adopting LED MEPS are significant.**
  - Electricity prices have risen significantly in recent years.
  - Individual households that still use mains voltage halogen lamps can gain significantly from the phaseout. For example, a household that changes 10 halogen lamps to LED would save more than $2000 over ten years and 3 tonnes of greenhouse gas emissions.
  - Household benefits from LED MEPS are smaller but still positive (when viewing only LED efficacy improvements due to MEPS).
  - A business operating LED tubes, changing from poor LED tubes (that would not meet the proposed MEPS) to significantly more efficient LED tubes, would gain significantly from improvements in efficacy due to LED MEPS. For example, a business operating 1,000 LED tubes would save more than $30,000 and 85 tonnes of greenhouse gas emissions over ten years.
  - Scaling LED MEPS to the national level, a combined benefit of around $1bn was calculated over ten years, with greenhouse gas abatement estimated at 1.5 million tonnes (noting that the improvement in LED tube efficacy, for the business sector, is based on testing of a relatively small sample group).
  - If a further stage 2 LED MEPS were to be implemented now (e.g. similar to those proposed in the EU or USA) then benefits would be around 4 times higher than those predicted for the stage 1 MEPS.

4 Issues arising from product registration

The purpose of this chapter is to examine the likely number of product registrations, the treatment of families and the resultant cost impact on industry.

In order to minimise the regulatory costs imposed on suppliers, the DRIS proposed that suppliers be able to register products for MEPS regulations when registering them for electrical safety, using the Electrical Equipment Safety System. This report assumes that the GEMS registration system will be used.

Under GEMS, registering multiple products in family groups is one means of reducing the fees charged to applicants. DCCEEW has been working closely with the lighting industry to develop a suitable, GEMS-compliant proposal for product families, which will reduce registration costs for suppliers.

Under the exposure draft of the GEMS Determination for LED MEPS, it is possible to group LED lamp models into families, rather than registering each model separately (NOTE: it is still possible to register a model separately if the supplier chooses to). The following attributes were required to be the same/similar, in order for a number of LED lamp models to be classified into a single family:

- Product class (single or double capped)
- Rated voltage (mains voltage or extra low voltage)
- Rated $L_{70}B_{50}$ lifetime
- Rated CRI
- Cap size (for double-capped G13 and G5 LED lamps only)
- Dimmability (dimmable or non-dimmable)
- Directionality (directional or non-directional)
- Filament type (with LED filament or without LED filament)
- Reference control settings, if applicable (the default settings for tuneable lamps).

Since the public consultation process of the exposure draft of the LED Determination, some changes have been made on advice from technical experts,

- 'geometric form factor' is not an attribute currently being considered. In other words, lamp models can have differing shapes and still be members of the same family.
- Upper limit of 100 models in a family (increased from 50).
- Removed the requirement for same tube length in a family for double-capped lamps.
- Refinements to the miscellaneous selection of LED lamps (for example special purpose lamps) to be grouped into a family, in order to reduce the number of families that a supplier is required to register. It is proposed that one such miscellaneous family may be registered by each supplier for both product classes (limit of 10 models per family).
- Allowing models (that would otherwise qualify to be in the same family) to be included in the same family if their rated performance characteristics for the parameters of colour rendering index (CRI) and $L_{70}B_{50}$ lifetime fall within one of three specified ranges.

- For CRI the ranges are: ≥ 70 and < 80[28]; ≥ 80 and < 90; ≥ 90.
- For single capped lamps the $L_{70}B_{50}$ ranges are: ≤ 15,000 hrs; > 15,000 and ≤ 30,000 hrs; > 30,000 hrs.
- For double-capped G13 and G5 LED lamps the $L_{70}B_{50}$ ranges are: ≤ 30,000 hrs; > 30,000 and ≤ 60,000 hrs, > 60,000 hrs.

In order to calculate registration costs, a key unknown variable is the number of families that would be required to be registered, using the above definition for a family. This question can be expressed as – how many realistic permutations are there, of the various values for the above listed attributes? Each of the following three sections contains a case study which attempts to answer this question. For the case studies, the following were used to group models into families:

- Single capped LED lamps:
  - Voltages – either 230v or 12v
  - Directionality – either directional or non-directional
  - Dimmability – either dimmable or non-dimmable
  - Filament or non-filament lamps
  - CRI – 3 different values (noting this is for a single supplier, within a family where all other attributes are the same)
  - Lifetime –3 different values (as above, this is within a single supplier, within a family where all other attributes are the same)
- Double capped LED lamps:
  - Caps – either G5 or G13
  - Dimmability – either dimmable or non-dimmable
  - CRI – 3 different values (noting this is for a single supplier, within a family where all other attributes are the same)
  - Lifetime – 3 different values (noting this is for a single supplier, within a family where all other attributes are the same)

4.1 Case study 1 – hypothetical lamp supplier

This case study did not use real market data, rather a calculation was undertaken for a hypothetical supplier who supplied every realistically possible permutation of lamp attributes. All of the possible permutations are listed in Figure 22 and Figure 23 below. In Figure 22 the following permutations are unlikely, and so these have been greyed out and not counted in the 'family count':

- Directional filament lamps
- 12v non-directional lamps
- 12v filament lamps.

[28] Note the determination specifies limitations on the type of lamps that may be sold with CRI ≥ 70 and < 80

Figure 22: Calculation of number of families, using permutations of attributes (single capped lamps)

						Family count
Voltage 230v	Non-directional	Dimmable	Non-filament	CRI A	Lifetime A	1
					Lifetime B	2
					Lifetime C	3
				CRI B	Lifetime A	4
					Lifetime B	5
					Lifetime C	6
				CRI C	Lifetime A	7
					Lifetime B	8
					Lifetime C	9
			Filament	CRI A	Lifetime A	10
					Lifetime B	11
					Lifetime C	12
				CRI B	Lifetime A	13
					Lifetime B	14
					Lifetime C	15
				CRI C	Lifetime A	16
					Lifetime B	17
					Lifetime C	18
		Non-dimmable	Non-filament	CRI A	Lifetime A	19
					Lifetime B	20
					Lifetime C	21
				CRI B	Lifetime A	22
					Lifetime B	23
					Lifetime C	24
				CRI C	Lifetime A	25
					Lifetime B	26
					Lifetime C	27
			Filament	CRI A	Lifetime A	28
					Lifetime B	29
					Lifetime C	30
				CRI B	Lifetime A	31
					Lifetime B	32
					Lifetime C	33
				CRI C	Lifetime A	34
					Lifetime B	35
					Lifetime C	36
	Directional	Dimmable	Non-filament	CRI A	Lifetime A	37
					Lifetime B	38
					Lifetime C	39
				CRI B	Lifetime A	40
					Lifetime B	41
					Lifetime C	42
				CRI C	Lifetime A	43
					Lifetime B	44
					Lifetime C	45
			Filament			
		Non-dimmable	Non-filament	CRI A	Lifetime A	46
					Lifetime B	47
					Lifetime C	48
				CRI B	Lifetime A	49
					Lifetime B	50
					Lifetime C	51
				CRI C	Lifetime A	52
					Lifetime B	53
					Lifetime C	54
			Filament			

						Family count
Voltage 12v	Non-directional					
	Directional	Dimmable	Non-filament	CRI A	Lifetime A	55
					Lifetime B	56
					Lifetime C	57
				CRI B	Lifetime A	58
					Lifetime B	59
					Lifetime C	60
				CRI C	Lifetime A	61
					Lifetime B	62
					Lifetime C	63
			Filament			
		Non-dimmable	Non-filament	CRI A	Lifetime A	64
					Lifetime B	65
					Lifetime C	66
				CRI B	Lifetime A	67
					Lifetime B	68
					Lifetime C	69
				CRI C	Lifetime A	70
					Lifetime B	71
					Lifetime C	72
			Filament			

Figure 23: Calculation of number of families, using permutations of attributes (double capped lamps)

				Family count
Linear G5	Dimmable	CRI A	Lifetime A	1
			Lifetime B	2
			Lifetime C	3
		CRI B	Lifetime A	4
			Lifetime B	5
			Lifetime C	6
		CRI C	Lifetime A	7
			Lifetime B	8
			Lifetime C	9
	Non-dimmable	CRI A	Lifetime A	10
			Lifetime B	11
			Lifetime C	12
		CRI B	Lifetime A	13
			Lifetime B	14
			Lifetime C	15
		CRI C	Lifetime A	16
			Lifetime B	17
			Lifetime C	18
Linear G13	Dimmable	CRI A	Lifetime A	19
			Lifetime B	20
			Lifetime C	21
		CRI B	Lifetime A	22
			Lifetime B	23
			Lifetime C	24
		CRI C	Lifetime A	25
			Lifetime B	26
			Lifetime C	27
	Non-dimmable	CRI A	Lifetime A	28
			Lifetime B	29
			Lifetime C	30
		CRI B	Lifetime A	31
			Lifetime B	32
			Lifetime C	33
		CRI C	Lifetime A	34
			Lifetime B	35
			Lifetime C	36

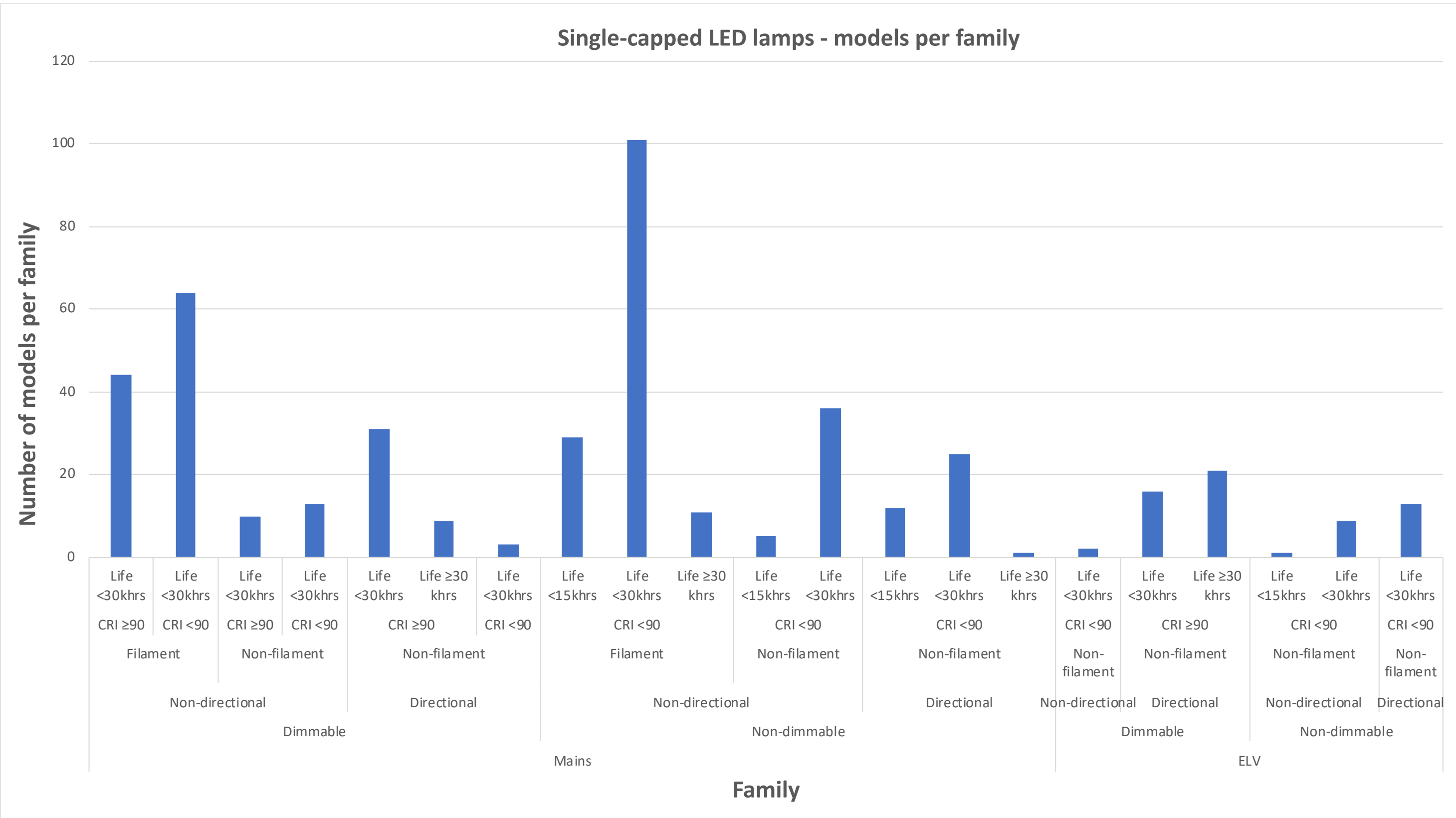
The above analysis aims to determine the likely worst case number of product families, for a single supplier. In the above figures we can see that there were 72 possible permutations for single capped LED lamps and 36 for double capped LED lamps. So, for both lamp classes the combined maximum total of permutations is 108. In other words, if a theoretical supplier had lamps that slotted into in every single possible permutation of lamp type, they would need to register 108 families.

However, depending on the supplier's product portfolio, there may not be products matching the characteristics of some of the permutations listed above. Therefore, in practice, the number of product permutations may be lower than the theoretical minimum. This is shown in Case Studies 2 to 6 below.

4.2 Case study 2 – large lamp supplier – single capped lamps

This case study was conducted on publicly available catalogue data from a large lamp supplier, in order to compare to the hypothetical case study (case study 1). The catalogue contained 480 single capped models. Approximately 24 models appeared to not meet the proposed MEPS efficacy level (5 per cent of models in the current catalogue) leaving 456 models. The 456 remaining models were analysed and grouped into families. The results can be seen in Figure 24. In this figure we can see that the 456 models resulted in 22 families (21 families in the figure, with one family exceeding 100 models, which would require another family to be registered).

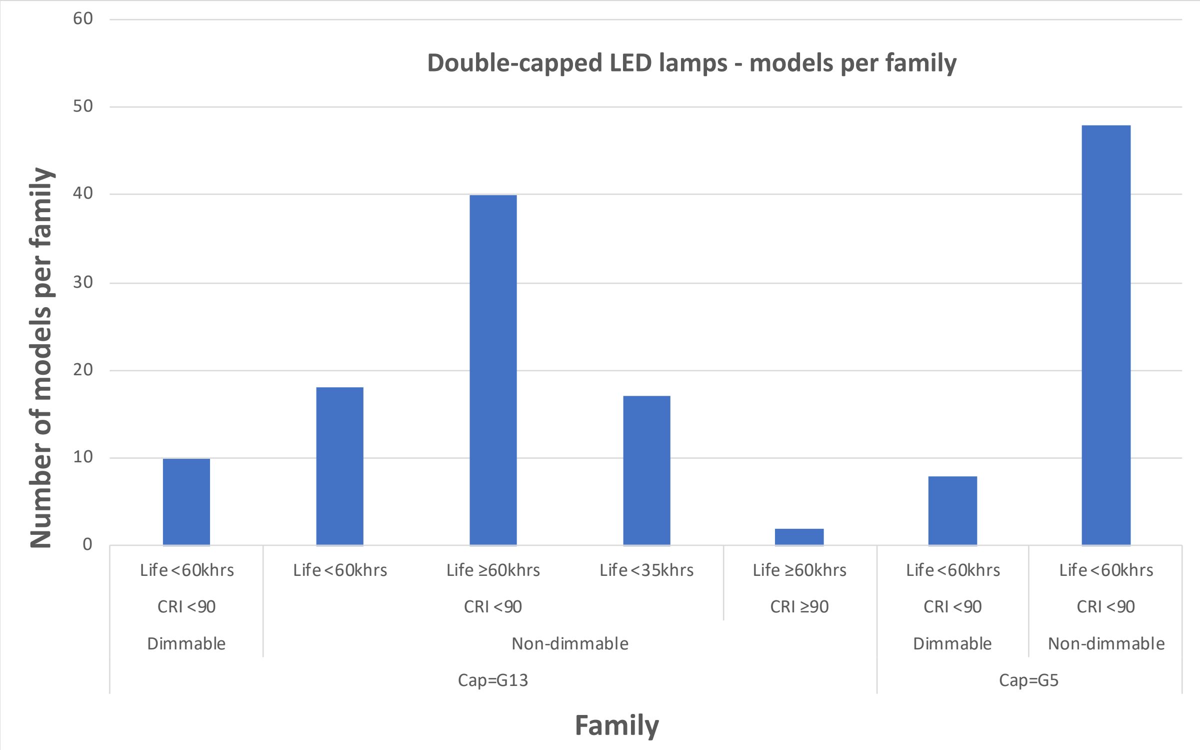
Figure 24: Family analysis for single-capped LED lamp catalogue from a large supplier



4.3 Case study 3 – medium-sized lamp supplier – double capped lamps

The same analysis was performed for a medium-sized supplier of double-capped LED lamps, and the results can be seen in Figure 25, where we can see 7 families being required, from a catalogue of 143 models.

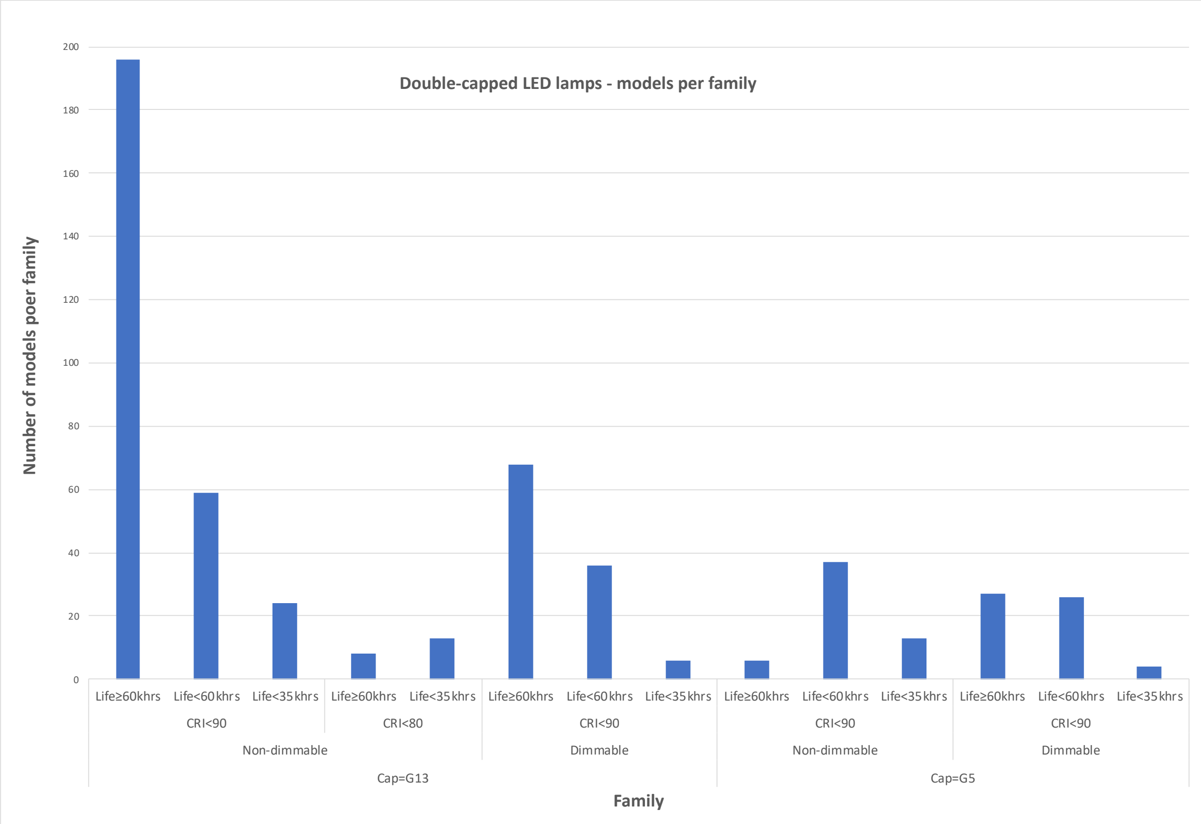
Figure 25: Family analysis for double-capped LED lamp catalogue



4.4 Case study 4 – large lamp supplier – double capped lamps

A further case study was undertaken for a large supplier of double capped lamps. The results can be seen in Figure 26, where we can see 15 families being required, from a catalogue of 523 models.

Figure 26: Family analysis for double-capped LED lamp catalogue (large supplier)



4.5 Case study 5 – no grouping of CRI and lifetime

For the large single and double capped suppliers an alternate analysis was also done, whereby CRI and lifetime were not grouped into ranges. For the large supplier of single-capped lamps (case study 2) the total number of families increased from 22 to 37. For the large supplier of double-capped lamps (case study 4) the total number of families increased from 15 to 31.

4.6 Case study 6 – whole market analysis

This case study was performed on actual market data, based on a database of LED lamp models compiled by DCCEEW in 2018. This consists of 1600 usable LED lamp models from 42 suppliers. The 2018 DCCEEW database contains all the information required to determine family groupings: class, supplier, dimmability, directionality, filament, lifetime and CRI, however it does not include double-capped lamps (G5 and G13) that are in scope of the proposed determination. Figure 27 shows the analysis for the number of models found to be in each family.

Figure 27: Numbers of models per family, per supplier (analysis of 2018 database of 1600 models)

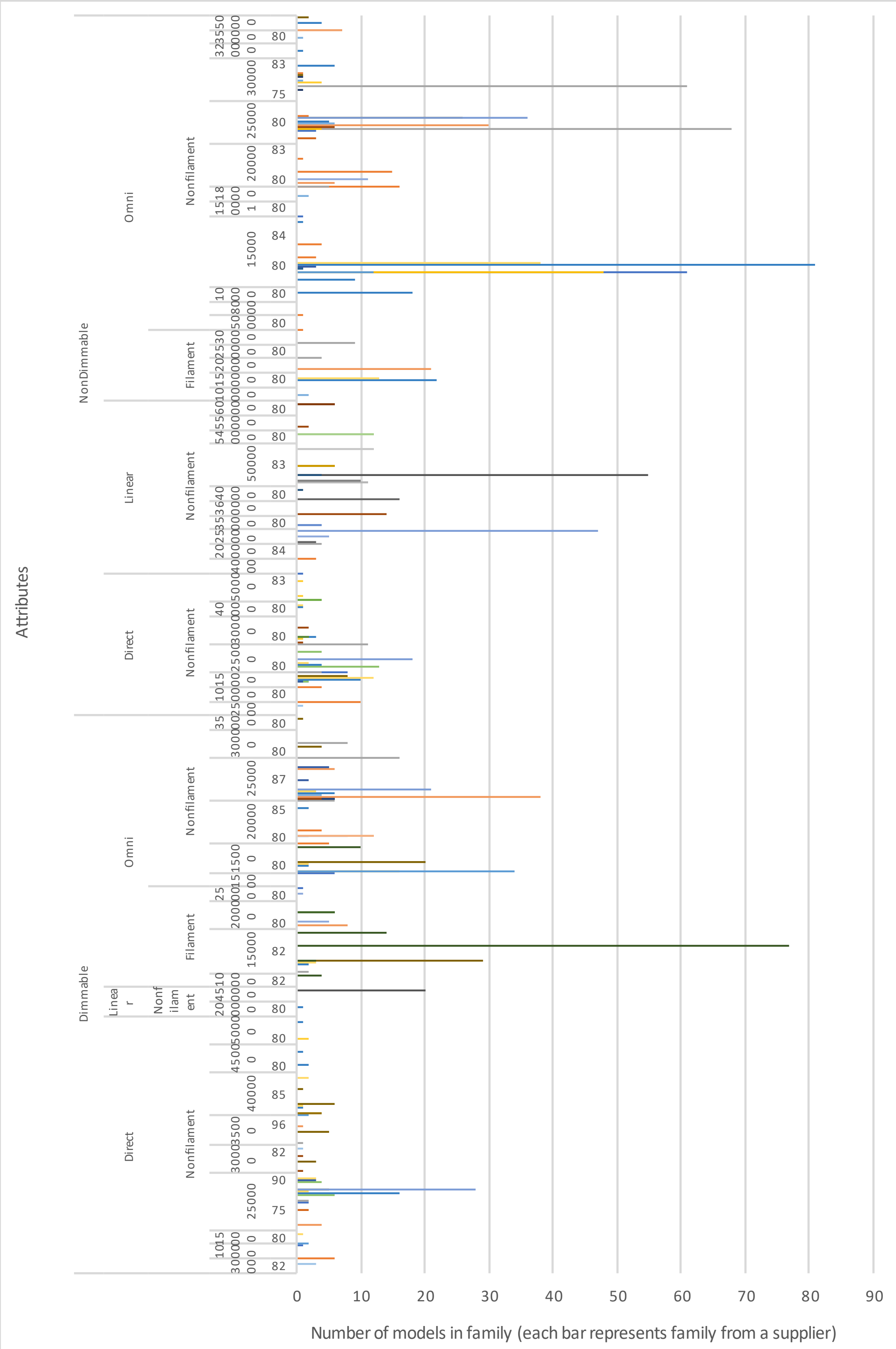
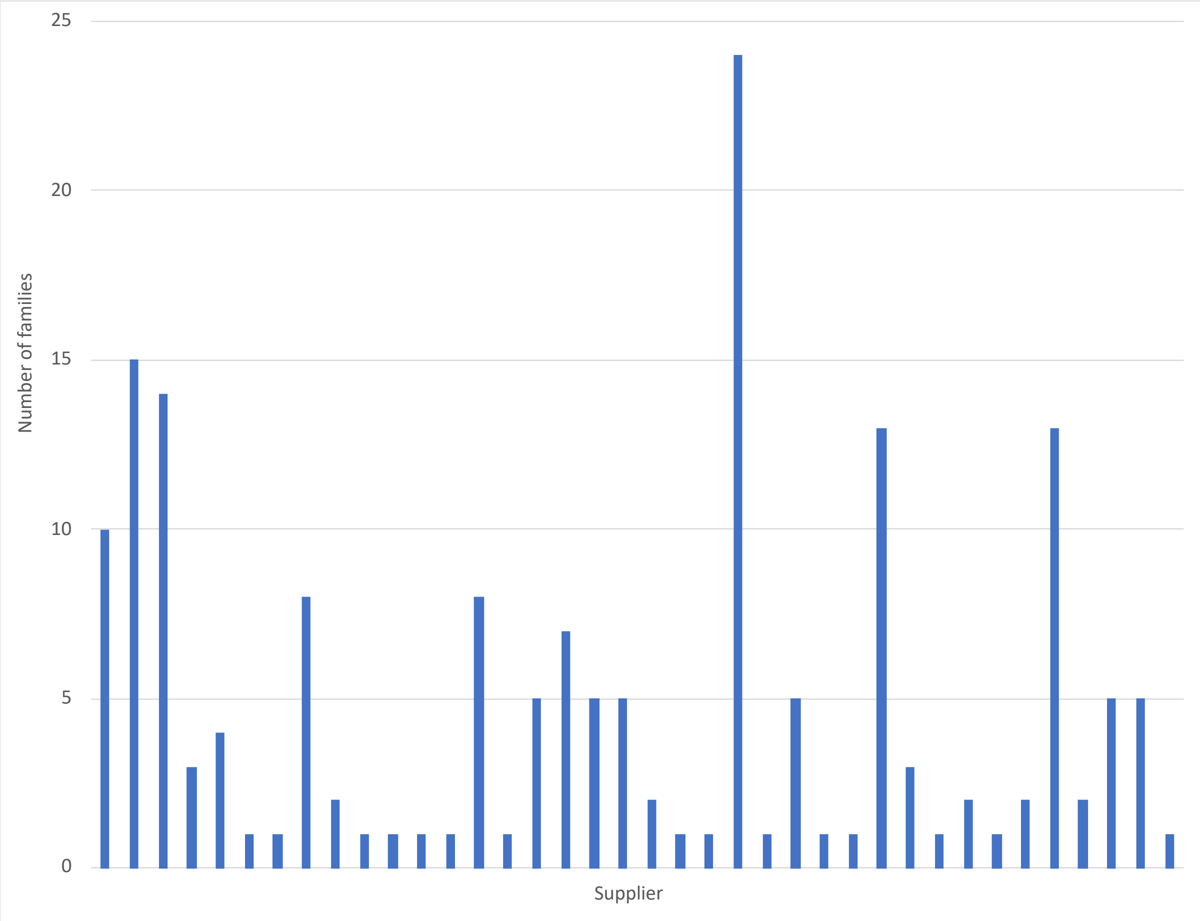


Figure 28 shows the number of families that would be required to be registered, for each supplier in the 2018 DCCEEW database. The maximum number was 24 families, which is significantly lower than the 108 families found in the theoretical analysis in case study 1. The total number of families required to be registered across all suppliers was 185. The average number of families per supplier was 9.

Figure 28: Number of families required to registered, for each supplier

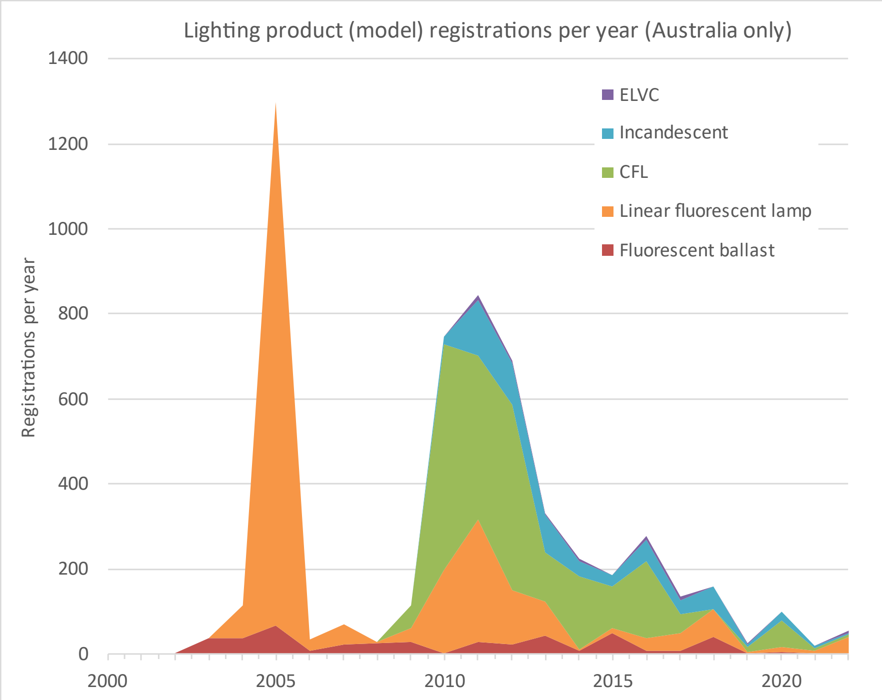


The 2018 dataset is likely to have several flaws, including its age, the fact that it is not likely to include special purpose LED lamps, and that it does not differentiate between lamp caps G5/G13 for double capped lamps. Going against this is the fact that some lamp suppliers/models may disappear from the market when MEPS is introduced – in other words product ranges are likely to consolidate.

Taking these things into account, it was assumed that the lower bound of number of families required to be registered (across the whole market, i.e. all suppliers) was 185. The upper bound was assumed to be double this – 370 families. This upper scenario represents the case that there might be many more suppliers, and also many more models and families, in 2024 compared to the 2018 analysis. These lower and upper bounds were used in the calculation of total registration costs – see section 4.7.

For comparison, Figure 29 shows historical registrations for all lighting products. This peaked at around 500 p.a. Note however these MEPS used very narrow definitions for families – using a broader definition (as is currently proposed) would serve to reduce the numbers of registrations significantly.

Figure 29: Historical model registrations per year (Australia only)



4.7 Calculation of total registration costs

The next step in the analysis was to estimate the likely total registration costs to be borne by industry,) based on what is known about today's lighting market and using the GEMS registration system. The 'low' scenario assumed 185 families and a range of other assumptions that would lead to lower industry costs. The 'high' scenario assumed 370 families and a range of other assumptions that would lead to higher industry costs. Two medium scenarios were also developed.

All assumptions and the results are shown in Table 1 and below the table is further explanation and discussion.

Table 1: Assumptions and calculations for LED registration costs over 5 years

	Low	Medium 1	Medium 2	High
Families registered in year 1	185	247	308	370
Families registered in year 2	74	123	185	259
Families registered in year 3	74	123	185	259
Families registered in year 4	74	123	185	259
Families registered in year 5	74	123	185	259
Drop in registration quantities after year 1	60%	50%	40%	30%
Registration cost per family	$440	$553	$667	$780
Testing cost per family	$3,000	$3,667	$4,333	$5,000
% of families registered that need full testing	25%	33%	42%	50%
Admin cost per family - year 1	$300	$367	$433	$500
Reduction in admin costs each year (learning rate)	40%	33%	27%	20%
Registration fees in year 1	$81,400	$136,489	$205,556	$288,600
Registration fees in year 2	$32,560	$68,244	$123,333	$202,020
Registration fees in year 3	$32,560	$68,244	$123,333	$202,020
Registration fees in year 4	$32,560	$68,244	$123,333	$202,020
Registration fees in year 5	$32,560	$68,244	$123,333	$202,020
Industry costs - year 1	$275,650	$528,415	$895,880	$1,398,600
Industry costs - year 2	$101,380	$249,133	$516,150	$953,120
Industry costs - year 3	$96,052	$239,084	$500,473	$932,400
Industry costs - year 4	$92,855	$232,384	$488,976	$915,824
Industry costs - year 5	$90,937	$227,918	$480,546	$902,563
Industry costs - total over 5 years	**$656,874**	**$1,476,934**	**$2,882,025**	**$5,102,507**
LED lamps sold - year 1	20,000,000	20,000,000	20,000,000	20,000,000
LED lamps sold - year 2	20,000,000	20,000,000	20,000,000	18,000,000
LED lamps sold - year 3	20,000,000	20,000,000	20,000,000	16,000,000
LED lamps sold - year 4	20,000,000	20,000,000	20,000,000	14,000,000
LED lamps sold - year 5	20,000,000	20,000,000	20,000,000	12,000,000
LED lamps sold - total over 5 years	**100,000,000**	**100,000,000**	**100,000,000**	**80,000,000**
Industry cost per lamp sold - year 1	$0.014	$0.026	$0.045	$0.070
Industry cost per lamp sold - year 2	$0.005	$0.012	$0.026	$0.053
Industry cost per lamp sold - year 3	$0.005	$0.012	$0.025	$0.058
Industry cost per lamp sold - year 4	$0.005	$0.012	$0.024	$0.065
Industry cost per lamp sold - year 5	$0.005	$0.011	$0.024	$0.075
Industry cost per lamp sold - average over 5 years	**$0.007**	**$0.015**	**$0.029**	**$0.064**
% increase in lamp cost - year 1	0.23%	0.44%	0.75%	1.17%
% increase in lamp cost - year 2	0.08%	0.21%	0.43%	0.88%
% increase in lamp cost - year 3	0.08%	0.20%	0.42%	0.97%
% increase in lamp cost - year 4	0.08%	0.19%	0.41%	1.09%
% increase in lamp cost - year 5	0.08%	0.19%	0.40%	1.25%
% increase in lamp cost - average over 5 years	**0.1%**	**0.2%**	**0.5%**	**1.1%**

The assumptions in Table 1 are explained as follows:

- Drop in registration quantities after year 1: all models are registered in year 1, then a proportion of this is registered each subsequent year. See Figure 22 for historical drop-off rates for other lighting products.
- Registration cost per family: $440 - $780, which is the current fee range used in GEMS (theoretically these can be significantly higher).

- Testing cost per family: $3000 - $5000 (noting that third party accredited testing is not required, and alignment with EU MEPS will reduce the need for additional testing for some suppliers).
- % of families registered that need (new) full testing: a proportion of lamps require full testing, to reflect the fact that that many LED lamp products have test reports available from the OEM[29].
- Admin cost per family – year 1: cost of time taken to enter data into the product registry.
- Reduction in admin costs each year (learning rate): reduction in admin costs due to lamp suppliers becoming more familiar with the registration system, or as a result of regulatory requirements of another jurisdiction.
- Sales quantities: these reflect the total sales of LED lamps, through all channels (supermarket, hardware, electrical wholesale, etc.) and are analogous to lamp imports (e.g. Figure 1). In the high scenario, sales volumes reduce from 20 million in year 1 to 12 million in year 5 (i.e. falling at a rate of 2 million per year, likely due to increased product lifetimes and increase in popularity of integrated LED luminaires).

The results can be seen at the bottom of Table 1, which shows a broad range of potential costs. It is unlikely however that either the low or high case will eventuate – this is because it is unlikely that all the assumptions will end up being 'low' and it is similarly unlikely that all the assumptions will end up being 'high'. The result is likely to be somewhere in between these two extremes – the two medium scenarios represent a more likely range of values.

In Table 1 we can see that, using the GEMS registration system, total industry costs for year 1 are calculated in the range of $275,000 to $1.4m and this decreases in subsequent years. Passing these costs on to consumers would increase lamp costs by between 0.7c and 6c per lamp (a percentage increase of 0.1% to 1.1%). Note that the DRIS (using the equipment electrical safety system (EESS)) estimated industry costs at $1.8m per annum for Australia[30].

The analysis in Table 1 does not take into account two additional factors that would serve to further reduce registration costs for suppliers. Firstly, unlimited grandfathering allows suppliers more time to sell stock already in Australia before the determination is in place, and therefore also more time to register products (theoretically suppliers can sell non-compliant stock until depleted). Secondly, variations to family registrations (including adding further models below the limit) are allowed at a lower payment rate ($210 per change to a family).

4.8 Findings from this chapter

The relevant findings from this chapter are as follows:

- **Using a broad definition of product families, the number of registrations that would be required are modest.**

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[29] Note that each registration will require the supplier to state that the product is compliant and the claimed values are correct. The supplier will not know whether the GEMS Regulator will ask to see evidence until after the registration is submitted. Thus all registrations should be submitted on the basis that evidence of compliance is available.

[30] Several different figures are cited in the DRIS for industry costs. Table 2 cites an NPV of $11.7m ($1.8m/annum over 10 years) for 'regulatory burden'. Table 25 uses a figure of $769k p.a. for 'business costs'.

    - A 2018 dataset of 1600 LED lamp models was analysed and this showed that the largest number of families that a supplier would be required to register was 24. The total number of families required to be registered across all suppliers was 185. The average number of families per supplier was 9.
    - A case study of one of the largest single-capped LED lamp suppliers in Australia for their current catalogue was undertaken and it was found that 22 families would be required to be registered. This increased to 37 if no grouping of CRI and lifetime were permitted.
    - A case study of one of the largest double-capped LED lamp suppliers in Australia for their current catalogue was undertaken and it was found that 15 families would be required to be registered. This increased to 31 if no grouping of CRI and lifetime were permitted.
- **Using a broad definition of product families, the registration costs to industry would be modest.**
    - A calculation of industry registration costs was undertaken. The total industry costs for year 1 were calculated to be in the range $275,000 to $1.4m and this decreases in subsequent years. Passing these costs on to consumers would increase lamp costs by between 0.7c and 6c per lamp (a percentage increase of 0.1% to 1.1% for a $6 LED lamp) across the full 5-year regulatory cycle.

5 Issues arising from product testing

As stated in the E3 public consultation[31] paper published in December 2022, LEDs have achieved significant market penetration, however there are still LED lamps being supplied to the Australian and New Zealand markets which fail the proposed MEPS, either for efficacy (some exhibit efficacies 10 to 35% lower than MEPS) or for other 'quality' MEPS parameters. MEPS are now mandatory in Europe, implying that lamps available here are less efficient than those supplied in the EU. If a regulatory regime is not in place, it allows lower performing (non EU MEPS compliant) lamps to be sold in Australia and New Zealand, and also for products to carry unsubstantiated claims about performance.

The presence of relatively inefficient LED products on the Australian / New Zealand market is highlighted by the results from product testing of lamps (2017/2018) and luminaires (2020). These results are detailed below. It is important to note that, as discussed in section 6.2, improvements in product quality and subsequent health benefits add to the case for Led MEPS. However, further increases in MEPS efficacy levels (as expected in EU, UK etc.) would deliver more significant energy savings.

In 2017/2018, 35 LED lamp models (directional, non-directional and linear) were comprehensively tested at a NATA-accredited photometric laboratory. At that time, 18 of the 35 lamps tested failed on at least one tested characteristic when compared with the concomitant proposed EU regulation (characteristics including: luminous efficacy, CRI, or flicker). Figure 30 summarises the results of this testing, with red crosses indicating where products failed to meet the EU requirements.

[31] https://consult.dcceew.gov.au/proposed-lighting-regulations

Figure 30: Pass/fail results for Australian LED lamps tested in 2017/18

Lamp Type	Product number	Efficacy	Displacement Power Factor	Var. on claimed CCT	CRI	Pst or SVM	Overall Pass/Fail
Non-Directional	1	✗	✓	✓	✓	✓	Fail
	2	✗	✓	✓	✓	✓	Fail
	3	✓	✓	✓	✓	✓	Pass
	5	✓	✗	✓	✗	✗	Fail
	6	✗	✗	✓	✓	✓	Fail
	7	✓	✗	✓	✓	✓	Fail
	8	✓	✗	✓	✓	✓	Fail
	9	✓	✓	✓	✓	✓	Pass
	10	✓	✗	✗	✗	✓	Fail
	11	✓	✗	✓	✓	✓	Pass
	12	✓	✓	✓	✓	✓	Pass
	13	✓	✓	✓	✓	✗	Fail
	14	✓	✓	✓	✓	✓	Pass
	15	✓	✓	✓	✓	✓	Pass
	16	✓	✓	✓	✓	✓	Pass
	17	✓	✓	✓	✓	✓	Pass
	18	✓	✓	✓	✓	✓	Pass
	19	✓	✓	✓	✓	✓	Pass
	20	✓	✓	✓	✓	✓	Pass
	21	✓	✓	✓	✓	✗	Fail
	22	✓	✓	✓	✓	✓	Pass
	23	✓	✓	✓	✓	✓	Pass
Directional	4	✓	✗	✓	✓	✓	Fail
	24	✓	✓	✓	✗	✗	Fail
	25	✓	✓	✓	✓	✗	Fail
	26	✓	✓	✓	✓	✓	Pass
	27	✓	✓	✓	✓	✓	Pass
	28	✓	NA	✓	✓	✓	Pass
	29	✗	NA	✓	✓	✓	Fail
	30	✓	NA	✓	✓	✗	Fail
	31	✗	NA	✓	✓	✓	Fail
Linear	32	✓	✓	✓	✓	✓	Pass
	33	✓	✓	✓	✓	✗	Fail
	34	✗	✓	✓	✓	✓	Fail
	35	✗	✓	✓	✓	✓	Fail

In 2020 photometric testing was conducted on 29 LED luminaires. Although luminaires are not the subject of proposed MEPS, this data can give an indication of the quality of LED products available in the market - many suppliers of LED lamps also supply LED luminaires. Of the 16 LED downlights tested, 8 failed the EU MEPS for efficacy. The results of all LED luminaire testing conducted in 2020 are summarised in Figure 31ove, with red crosses indicating where products failed to meet the EU regulation’s requirements.

Figure 31: Pass/fail results for Australian LED luminaires tested against EU regulation in 2020

	Product Number	CCT	Efficacy	CRI	Pst	SVM	Standby	Harmonics	BLH	Lumen Maint.	Overall Pass/Fail
Downlights	1	3000	✓	✓	✓	✓		✓		✓	Pass*
	2	5000	×	✓	✓	✓		✓			Fail
	3	4000	×	✓	✓	×		✓		✓	Fail
	4	4000	×	✓	✓	✓		✓		✓	Fail
	5	4000	✓	✓	✓	✓		✓		✓	Pass
	6	3000	×	✓	✓	✓		✓		×	Fail
	7	4000	✓	✓	✓	×		✓		✓	Fail
	8	5500	✓	✓	✓	✓		✓		✓	Pass*
	9	3000	✓	✓	✓	✓		✓			Pass
	10	4200	✓	✓	✓	✓		✓			Pass
	11	4000	×	✓	✓	✓		✓		✓	Fail
	12	4000	✓	✓	✓	×		✓			Fail
	13	3000	×	✓	✓	✓		✓		✓	Fail
	14	3000	×	✓	✓	✓		✓		✓	Fail
	15	3000	✓	✓	✓	✓		✓		✓	Pass
	16	3000	×	✓	✓	✓		✓		✓	Fail
Panels, Battens & Troffers	17	4000	×	✓	✓	✓		✓			Fail
	18	6000	×	✓	✓	×		✓			Fail
	19	5000	×	✓	✓	✓		✓			Fail
	20	4000	×	✓	✓	×		✓			Fail
	21	4000	✓	✓	✓	×		✓			Fail
	22	3000	×	✓	✓	×		✓			Fail
	23	3000	×	✓	✓	✓		✓			Fail
	24	3000	×	✓	✓	✓		✓			Fail
	25	3000	×	✓	✓	✓		✓	✓@6000K		Fail
Smart Downlight	26	3000	✓	✓	✓	×	×	✓			Fail
	27	2700	✓	✓	✓	✓	×	✓			Fail
	28	4200	×	✓	✓	✓	×	×	✓@7700K		Fail
Smart Panel	29	6200	×	✓	✓	✓	✓	✓			Fail

5.1 Findings from this chapter

The relevant findings from this chapter are as follows:

- **Testing of various attributes on a sample of 35 lamps in Australia in 2017/18 revealed a MEPS failure rate of around 50%**.

6 Conclusions

6.1 Summary of findings

The findings from previous chapters are summarised as follows:

- **Lighting regulations have evolved considerably in other parts of the world.**
    - The countries with LED MEPS in place or in development represent 79% of the world's population.
    - The EU, UK and USA are now planning for a second phase of MEPS for LEDs.
    - Australia / New Zealand currently lag behind much of the world's lighting regulations and risk becoming a dumping ground for inferior LED products.
    - The proposed phasing out of all fluorescent lamps by the Minamata convention will further increase the mandate for LEDs.
- **The overall market share of LEDs has increased and supermarkets' share of the lighting market has decreased.**
    - In recent years there has been a faster-than-anticipated reduction in the market share of incandescent and halogen lamps. Some of this is due to lamp suppliers and retailers anticipating the impending regulations and ceasing import and sale of these lamps early.
    - The supermarket share of lamps sales has declined in recent years, presumably in favour of online sales and sales via hardware and speciality stores. From 2019 onwards supermarket lamp sales declined markedly, primarily due to a significant reduction in halogen lamp sales (noting that some retailers de-stocked these lamps in anticipation of the regulations announced in 2018 and also responded to compliance action under the GEMS Act).
- **The proposed lighting regulations have been relatively well received.**
    - 2021 market research indicates that the proposed regulations were well received by Australian consumers, with around two-thirds responding positively to all aspects of the planned phase out and LED MEPS, with roughly a third neutral on the topic.
    - Of the 14 submissions to the public consultation process for draft GEMS determinations, 10 supported the phaseout of halogen lamps and 9 supported MEPS for LEDs (2 conditionally). Lighting Council Australia supported the phaseout but provided conditional support for LED MEPS.
    - Dimmer compatibility did not surface as a significant issue during market research and public consultation.
- **The economic and climate change benefits from phasing out halogen lamps and adopting LED MEPS are significant.**
    - Electricity prices have risen significantly in recent years.
    - Individual households that still use mains voltage halogen lamps can gain significantly from the phaseout. For example, a household that changes 10 halogen lamps to LED would save more than $2000 over ten years and 3 tonnes of greenhouse gas emissions.
    - Household benefits from LED MEPS are smaller but still positive (when viewing only LED efficacy improvements due to MEPS).

- A business operating LED tubes, changing from poor LED tubes (that would not meet the proposed MEPS) to significantly more efficient LED tubes, would gain significantly from improvements in efficacy due to LED MEPS. For example, a business operating 1,000 LED tubes would save more than $30,000 and 85 tonnes of greenhouse gas emissions over ten years.
- Scaling LED MEPS to the national level, a combined benefit of around $1bn was calculated over ten years, with greenhouse gas abatement estimated at 1.5 million tonnes (noting that the improvement in LED tube efficacy, for the business sector, is based on testing of a relatively small sample group).
- If a further stage 2 LED MEPS were to be implemented now (e.g. similar to those proposed in the EU or USA) then benefits would be around 4 times higher than those predicted for the stage 1 MEPS.

- **Using a broad definition of product families, the number of registrations that would be required are modest.**
  - A 2018 dataset of 1600 LED lamp models was analysed and this showed that the largest number of families that a supplier would be required to register was 24. The total number of families required to be registered across all suppliers was 185. The average number of families per supplier was 9.
  - A case study of one of the largest single-capped LED lamp suppliers in Australia for their current catalogue was undertaken and it was found that 22 families would be required to be registered. This increased to 37 if no grouping of CRI and lifetime were permitted.
  - A case study of one of the largest double-capped LED lamp suppliers in Australia for their current catalogue was undertaken and it was found that 15 families would be required to be registered. This increased to 31 if no grouping of CRI and lifetime were permitted.
- **Using a broad definition of product families, the registration costs to industry would be modest.**
  - A calculation of industry registration costs was undertaken. The total industry costs for year 1 were calculated to be in the range $275,000 to $1.4m and this decreases in subsequent years. Passing these costs on to consumers would increase lamp costs by between 0.7c and 6c per lamp (a percentage increase of 0.1% to 1.1% for a $6 LED lamp) across the full 5-year regulatory cycle.
- **Testing of various attributes on a sample of 35 lamps in Australia in 2017/18 revealed a MEPS failure rate of around 50%**.

6.2 Discussion and conclusions

6.2.1 Phaseout of incandescent and halogen lamps

The faster-than-anticipated reduction in the sales of incandescent/halogen lamps is tempered by the fact that some of this was due to market anticipation. Consumer and stakeholder support for this policy is strong, and dimmer compatibility does not appear to be a critical issue. Electricity prices have risen significantly, meaning that households that still use mains voltage incandescent or halogen lamps can gain significantly from the phaseout of incandescent and halogen lamps.

Conclusion: due primarily to recent increases in electricity costs, there are significant financial benefits for households who have not yet transitioned to LED to do so. Thus, it is concluded that the case for the phaseout of incandescent and halogen lamps remains strong.

6.2.2 MEPS for LEDs

Reaching a conclusion regarding MEPS for LED lamps is more complex. This policy was well received by Australian consumers, with support from more than half of the stakeholders responding to the recent public consultation. The Lighting Council Australia had significant concerns regarding product registration costs – they predicted that registration costs would result in consumer prices rises for LED lamps of 10-15%. Our calculations predict 0.1% to 1.1%.

The proposed phasing out of all fluorescent lamps by the Minamata convention will further increase the mandate for LEDs. This presents an opportunity for MEPS to remove lower performing LEDs from the (particularly commercial) market in advance of the fluorescent phase out. This will avoid businesses 'locking in' to less efficient lighting products during that transition.

Based purely on an increase in LED lamp efficacy, the national financial case for LED MEPS remains reasonable, considering the current climate and the need to accept lower overall energy savings from product policies. Improvements in product quality and subsequent health benefits, add to the case. Once incandescent, halogen, CFL and fluorescent lamps are actively phased out, it is the responsibility of industry and regulators to ensure that the remaining LED lamps are of high quality, so that consumer confidence is maintained and a backlash against the phaseout of other lamps is prevented. Consumers with lighting health concerns also deserve consideration via MEPS and education.

When Australia led the way in phasing out incandescent lamps in 2009, quality requirements for CFLs were seen as a vital intervention to ensure a smooth transition away from incandescent. This kind of thinking is now supported by regulators representing 79% of the world's population, as well as organisations such as:

- The IEA - 'p*hasing out incandescent, halogen and compact fluorescent and setting efficacy and quality (e.g. flicker and lifetime) requirements for LED lamps is critical for general lighting applications in both developed and developing countries*'.
- Clean Lighting Coalition – '*countries where we have been working that have not set product policy regulations typically suffer from having old or outdated lighting products dumped in their markets*'
- ECEEE – '*having no regulation on quality parameters related to performance will lead to imports of many products that are of poor quality and risks to eventually damage the reputation of LED technology. It is also likely to discourage suppliers from bringing in advanced products to the Australian market*'.
- DoSomething Foundation – '*The introduction of MEPS for LED lamps is also important as it ensures that these alternative products deliver energy and emissions savings (through greater efficiency), while also providing at least an equivalent lighting service*'.

The implementation of LED MEPS by such a large proportion of the world presents a 'dumping ground' risk to Australia and New Zealand. This is caused by manufacturers of inferior products continuing to seek a market for those products, once they become illegal in countries that have implemented MEPS for LEDs. Thus, if there is strong regulatory action covering LEDs globally but not Australia and New Zealand, these two countries could be at risk of continuously receiving substandard LEDs. This problem will be further exacerbated when economies such as the UK, EU and USA implement their second, more stringent, phases of LED MEPS.

Conclusion: it is concluded that the case for LED MEPS is strong, for the following reasons:

- Energy efficiency policies for appliances and equipment are in a mature phase. MEPS for equipment with high energy consumption and readily available savings have largely already been implemented. Extracting further energy savings from appliances and equipment in Australia and New Zealand requires accepting lower overall energy savings per category of equipment regulated.
- There is a reasonable economic case, which has been strengthened by significant increases in electricity costs.
- For larger suppliers of LED lamps, the number of families required to be registered is around 29.
- Registrations costs are reasonable – expected between 1c and 6c per lamp sold.
- There is a need to ensure that, once incandescent, halogen and fluorescent lamps are phased out, the remaining LED lamps are of high quality.
- There is a need to prevent Australia and New Zealand from becoming a 'dumping ground' for inferior LED products, particularly as regulators representing 79% of the world's population are implementing or developing MEPS for LEDs. Some of these are now proposing a second phase of MEPS – with even higher efficacy and quality requirements.

6.3 Future lighting work program

Assuming that the phaseout of incandescent/halogen lamps and MEPS for LED lamps goes ahead, this still leaves gaps in lighting policies, that many other countries have filled or are planning to fill. Figure 17 illustrates the current situation for lighting regulations in Australia (assuming the phaseout of incandescent/halogen lamps and MEPS for LED lamps goes ahead). Green represents where regulations exist or are planned. Red represents where regulations do not exist, and orange represents where the Minamata Convention is expected to phase out mercury-containing lamps (however this is not a certainty, and these should remain on the radar for GEMS).

Figure 32: Scope of lighting regulations (Australia)

Lamps	Incandescent	Phase out almost complete
	MV halogen	Phase out proposed
	ELV halogen	MEPS in place
	CFL	MEPS in place / Phase out by Minamata
	Fluorescent	MEPS in place / Phase out by Minamata
	LED	MEPS proposed
	HID - mercury vapour	Phase out by Minamata
	HID - metal halide	Not in scope of phase out
	HID - sodium	Not in scope of phase out
Drivers	Fluorescent	MEPS in place
	ELV halogen	MEPS in place
	LED	Not in scope of MEPS
Luminaires	LED	Not in scope of MEPS

The E3 Prioritisation Plan Stage 2 Report[32] states:

> *Performance MEPS for integrated LED luminaires was not pursued as part of the current LED MEPS following negotiations with the Australian lighting industry (due to incompatibility with product registration under the current GEMS Act), however these products are regulated in Europe. This warrants revisiting following amendments to the GEMS Act. If the registration issue cannot be resolved, voluntary MEPS and registration could be an alternative.*
>
> *MEPS for LED drivers is considered worthy of further investigation. Since these products share some characteristics with external power supplies, these could be considered as part of the investigations into future regulations for external power supplies or as part of future lighting regulations. In the EU, regulations for these commenced in September 2021.*
>
> *High Intensity Discharge Lamps (HID) are often used for outdoor and industrial lighting. More efficient LED replacement lamps and luminaires are now available. A regulated phase-out of these products would accelerate and complete the transition.*
>
> *The EU also has energy labelling in place for lamps, and this is worthy of consideration for Australia, including possibly for luminaires.*

Conclusion: It is concluded that it would be worthwhile to investigate a range of lighting products as part of a future work program.

The recommended products are as follows:

- ELV halogen lamps – possible phase-out.
- CFL and fluorescent lamps – possible phase-out (to bring Australia into alignment with the Minamata Convention)
- HID metal halide lamps – possible phase-out

[32] https://www.energyrating.gov.au/industry-information/publications/equipment-energy-efficiency-e3-prioritisation-plan-stage-2-report

- HID sodium lamps – possible phase-out
- LED luminaires – possible MEPS
- LED drivers possible MEPS
- Given that the EU and USA are embarking on a second phase of MEPS for all lamps, control gear and luminaires, Australia should start to investigate this, and this work could take place alongside implementation of the recommended MEPS for LED lamps.
- Peak demand lighting and intelligent lighting control systems, noting to take into account standby power consumption.

These investigations would involve a detailed assessment of the current and future market for each product, the range of efficiency of products, international policy developments, and an economic conclusion regarding the case for proceeding with policy development.

Conclusion: other jurisdictions are proceeding with second phases of MEPS for LEDs, thus it is concluded that it would be worthwhile to investigate second phases of MEPS for Australia and New Zealand, in light of the 'dumping ground' risks discussed in this report and further energy savings opportunities.

Annex A – Summary of submissions to proposed lighting regulations

Below is a brief summary of submissions received to the proposed lighting regulations[33].

Respondent	Key quotes	Support halogen phaseout	Support LED MEPS	Support fluorescent phaseout	Health concerns	Concerns over registration costs
#16 Australian Retailers Association	"Supports the introduction of the proposed lighting regulations"	X	X			
#15 LightAware	"LED visual radiation has the potential to cause significant health impacts and is emerging as a public health risk"				X	
#14 Clean Lighting Coalition	"strongly supports the Department's proposal as our review of lighting markets around the world has clearly shown that where governments have established well drafted policy measures like your proposal, products have improved and consumers / businesses in those markets benefit" "countries where we have been working that have not set product policy regulations typically suffer from having old or outdated lighting products dumped in their markets" "Our one major concern with your lighting regulation is the omission of fluorescent lamps – both compact fluorescent and linear fluorescent lamps. As you will be aware, there are many governments around the world who are adopting policy measures to phase-out fluorescent lighting"	X	X	X		
#13 eceee	"strongly supports regulation for LED products and the phase out of incandescent lamps in Australia. This happened more than a decade ago in Europe and LED technology is now very mature. There is, however, still a signific potential for further development in efficiency and system integration, and this will be supported by a regulation aimed at promoting LEDs and phasing out incandescents" "Having no regulation on quality parameters related to performance will lead to imports of many products that are of poor quality and risks to eventually damage the reputation of LED technology. It is also likely to discourage suppliers from bringing in advanced products to the Australian market" "disappointed that there seems to be no obvious effort to phase of fluorescent lighting"	X	X	X		

[33] https://consult.dcceew.gov.au/proposed-lighting-regulations/new-survey/list

Respondent	Key quotes	Support halogen phaseout	Support LED MEPS	Support fluorescent phaseout	Health concerns	Concerns over registration costs
#12 DoSomething Foundation	"The proposed phase-out of halogen lamps offers a further opportunity for energy and greenhouse gas emissions savings, and significant reductions in energy bills" "The introduction of MEPS for LED lamps is also important as it ensures that these alternative products deliver energy and emissions savings (through greater efficiency), while also providing at least an equivalent lighting service" "further opportunities for energy and emissions savings. This includes: • Further tightening of the efficacy levels for LED lamps as performance improves. • Expansion of the LED MEPS to include commonly used integrated LED luminaires. • A phase-out of fluorescent lamps that contain mercury. As mercury free LED alternatives are now available, this needs implementing at some point."	X	X	X		
#11 Energy Efficiency Council	"strongly supports the Government's proposed changes to the regulation of LED, incandescent and halogen lights"	X	X			
#10 Lighting Council Australia	"We agree the phase out of traditional lighting technologies, such as halogen lamps, will save energy and reduce emissions – Albeit not nearly to the extent outlined in the Decision RIS: Lighting 2018 due to the significant voluntary market transformation that has occurred since 2018" "Lighting Council Australia is not opposed to complying with Australian LED MEPS regulation - Our members report that 95 – 100% of their residential lamp sales are now LED, 90% - 100% of their LED lamp models are already compliant with the proposed LED minimum energy performance standard (MEPS) and the majority of the remaining LED lamps are planned to be updated (to compliant with proposed LED regulation) within the next 12 months" "urge caution regarding the compliance costs associated with LED lamp regulation, due to the negative unintended consequences that are likely to occur if compliance costs increase" "Urge Government to take the following approach: • Update the regulatory cost benefit case to reflect the current market. • Phase out halogen lamps as planned.	X	conditional			X

Respondent	Key quotes	Support halogen phaseout	Support LED MEPS	Support fluorescent phaseout	Health concerns	Concerns over registration costs
	• Develop very low compliance cost LED MEPS regulation that follows the European Commission approach. i.e. no registration costs or supplier based registration instead of model registration. Urgent amendment to the GEMS Act would seem to be required. • As per European Commission regulation, the allowance to use engineering analysis and extrapolation instead of full product testing should be allowed. • The addition of check testing tolerances that mirror the European Commission regulation should be included" "continues to support the phase out of the majority of halogen and incandescent lamps" "the case for LED lamp MEPS is not compelling and, in the form currently proposed, will have unintended negative consequences on LED lamp efficacy and innovation"					
#8 International Institute for Energy Conservation (IIEC)	"IIEC is promoting energy efficiency in the Pacific and we are excited to see the proposed lighting regulations. We hope that the regulations will soon be approved and effective in Australia and New Zealand"	X	X			
#7 United Nations Environment	"Regulation is vital and harmonization of regulations with other regions such as the EU, and internationally on LED lighting is the right approach. In due course we would like to see the regulations go further and eliminate incandescent light sources altogether as sustainable high efficiency LED sources have the capability to replace nearly all shapes and sizes as long as proper regulation is in place"	X	X			
#6 CESA	"market forces are driving a phase out" "CESA therefore has no issue with the proposal to phase out these products" "high efficiency LED globes are available at premium prices, but consumers are generally unaware of the benefits. CESA therefore supports efficacy labelling on packaging as a means of informing the public and to encourage sale of these products. This would give a net benefit to both suppliers and consumers"	X	conditional			
#5 Anonymous	"the RIS assumes that no rebound effect will occur"				X	

Respondent	Key quotes	Support halogen phaseout	Support LED MEPS	Support fluorescent phaseout	Health concerns	Concerns over registration costs
	"Even if LEDs do offer efficiency in the aggregate (an assumption), they are considered e-waste" "Spectral Power Density (SPD) should be included in all labelling" "There really isn't much of a reason to allow for CCT above 5000k (and really even 3000-4000K) for common household luminaires"					
#4 Soft Lights Foundation	"LEDs emit an entirely different type of visible radiation compared to incandescent light bulbs and that the type of spatially non-uniform directed energy from LEDs is toxic to human health"				X	
#3 Anonymous	"agree with the removal of incandescent light sources" "regulation of LED globes is not justified and appears to be proposed just for the sake of it. LED technology is inherently efficient. Regulation will not result in huge energy savings - it may have the opposite effect due to raised costs related to the regulation"	X				
#2 Anonymous	"While Australia Nominal Voltage is 230V, the Common Voltage throughout Australia is 240V actual and with Solar Penetration 250v is not uncommon" "LED should have an Energy Efficiency Star rating, not all LED are as Energy Efficient"					

Annex B – Countries regulating LED performance

The tables below list countries that have some form of MEPS legislation (mandatory, voluntary, in development or harmonised at a regional level) for LED lamps.[34, 35]

Country	Policy Approach
AFRICA	
Algeria	In development
EAC (East African Community)	Harmonised
Burundi	
Kenya	
Rwanda	
South Sudan	
Tanzania	
Uganda	
ECOWAS	Harmonised
Benin	
Cape Verde	
Gambia	
Ghana	
Guinea-Bissau	
Ivory Coast	
Liberia	
Nigeria	
Senegal	
Sierra Leone	
Togo	
Egypt	Mandatory
SADC (Southern African Development Community)	Harmonised
Angola	
Botswana	
Comoros	
Democratic Republic of Congo	
Eswatini	
Lesotho	
Madagascar	
Malawi	
Mauritius	
Mozambique	
Namibia	
Seychelles	
South Africa	
United Republic Tanzania	

[34] https://cprc-clasp.ngo/policies
[35] https://www.iea.org/policies?qs=buil&technology%5B0%5D=Lighting%20technologies&status=In%20force

Country	Policy Approach
Zambia	
Zimbabwe	
Tunisia	In development
AMERICAS	
Brazil	In development
Canada*	Mandatory
CARICOM	Harmonised (Voluntary)
Antigua and Barbados	
The Bahamas	
Barbados	
Belize	
Dominica	
Grenada	
Guyana	
Haiti	
Jamaica	
Montserrat	
Saint Kitts and Nevis	
Saint Lucia	
Saint Vincent and the Grenadines	
Suriname	
Trinidad and Tobago	
Chile	Mandatory
Dominican Republic	Voluntary
Mexico	Mandatory
Panama	Mandatory
Paraguay	Mandatory
United States of America*	Mandatory
Uruguay	Mandatory
ASIA & PACIFIC	
Bangladesh	Voluntary
China	Mandatory
Hong Kong SAR of China	Mandatory EE labelling
India	Mandatory
Indonesia	Mandatory
Japan	Mandatory
Malaysia	Mandatory
Pakistan	Mandatory
Philippines	Mandatory
Russia	In development
Singapore	Mandatory
Sri Lanka	Mandatory
Thailand	Voluntary
Taiwan of China	Mandatory
Vietnam	Mandatory

Country	Policy Approach
EUROPE	
European Union	Mandatory
Austria	
Belgium	
Bulgaria	
Croatia	
Cyprus	
Czech Republic	
Denmark	
Estonia	
Finland	
France	
Germany	
Greece	
Hungary	
Ireland	
Italy	
Latvia	
Lithuania	
Luxembourg	
Malta	
Netherlands	
Poland	
Portugal	
Romania	
Slovakia	
Slovenia	
Spain	
Sweden	
Norway	Mandatory
Switzerland	Mandatory
United Kingdom	Mandatory
MIDDLE EAST	
Bahrain	Mandatory
Jordan	Mandatory
Kingdom of Saudi Arabia	Mandatory
Oman	Mandatory
United Arab Emirates	Mandatory

Annex C – Retail electricity prices

AER reference prices[36] from July 2023 are shown in the table below.

AER final DMO prices – 1 July 2023 (includes change year-on-year)

Distribution zone	Residential without Controlled Load*	Residential with Controlled Load	Small business without Controlled Load
Ausgrid (NSW)	**$1,827 (3,911 kWh)** +$315 (20.8%)	**$2,562 (Flat rate 4,813 kWh + CL 2,005 kWh)** +$440 (20.7%)	**$4,999 (10,027 kWh)** +$639 (14.7%)
Endeavour (NSW)	**$2,228 (4,913 kWh)** +$392 (21.4%)	**$2,977 (Flat rate 5,214 kWh + CL 2,206 kWh)** +$594 (24.9%)	**$4,598 (10,027 kWh)** +$816 (21.6%)
Essential (NSW)	**$2,527 (4,613 kWh)** +$435 (20.8%)	**$2,977 (Flat rate 4,613 kWh + CL 2,005 kWh)** +$487 (19.6%)	**$5,761 (10,027 kWh)** +$860 (17.5%)
Energex (SE QLD)	**$1,969 (4,613 kWh)** +$349 (21.5%)	**$2,363 (Flat rate 4,412 kWh + CL 1,905 kWh)** +$402 (20.5%)	**$4,202 (10,027 kWh)** +$756 (21.9%)
SAPN (SA)	**$2,279 (4,011 kWh)** +$439 (23.9%)	**$2,787 (Flat rate 4,212 kWh + CL 1,805 kWh)** +$512 (22.5%)	**$5,849 (10,027 kWh)** +$1,310 (28.9%)

* CL or Controlled Load: these are separately metered tariffs used for appliances such as electric hot water storage systems, pool pumps or underfloor heating.

Below are the results of calculations electricity process, based on AER reference prices:

	Ref	**kWh p.a.**	**Est day chg**	**Est usage chg**	**Est c / kWh**
Ausgrid	$1,827	3,911	$365	$1,462	$0.374
Endeavour	$2,228	4,913	$365	$1,863	$0.379
Essential	$2,527	4,613	$365	$2,162	$0.469
Energex	$1,969	4,613	$438	$1,531	$0.332
SAPN	$2,279	4,001	$438	$1,841	$0.460

Below are electricity retail offers as at 31 August 2023[37]:

36 https://www.aer.gov.au/retail-markets/guidelines-reviews/default-market-offer-prices-2023–24
37 https://wattever.com.au/compare-best-electricity-rates/

NSW	Retailer	c /kWh	Daily charge (c)	Compare to ref price
	Simply Energy	33.17	89.79	22% less than
	Dodo	32.3	79.41	18% less than **
	Origin Energy	33.8	88.02	16% less than
	Amber	28.32	144.7	15% less than **
	Nectr	30.64	96.77	15% less than
	Energy Locals	33.5	111.2	14% less than **
	AGL	34.19	83.85	14% less than
	GloBird Energy	32.89	80.03	13% less than
	Powershop	32.26	136.9	12% less than
	Red Energy	32.95	85.58	12% less than
	OVO Energy	34.32	79.8	11% less than
	CovaU	33.71	88.02	10% less than
	EnergyAustralia	33.98	86.13	10% less than
	Momentum Energy	28.6	142.4	10% less than
	Tango Energy	34.98	78.1	10% less than
	Kogan Energy	32.26	136.9	9% less than
	Sumo	35.9	92.93	7% less than **
	Alinta Energy	36.62	92.82	3% less than
	1st Energy	35.97	112.2	1% less than
	Diamond Energy	32.08	75.46	1% less than
	Future X Power	37.98	93.48	0% less than
	Next Business Energy	38.34	88	0% less than
	Average	**$0.34**	**$0.98**	

Qld	Retailer	c /kWh	Daily charge (c)	Compare to ref price
	GloBird Energy	26.46	103.5	19% less than
	Ampol Energy	25.74	119.3	18% less than
	Nectr	27	106	17% less than
	Dodo	30.02	87.93	16% less than **
	Energy Locals	27.5	131	14% less than **
	Amber	25.88	170.4	12% less than **
	Powershop	29.43	145.5	12% less than
	Origin Energy	30.44	127.2	10% less than
	Kogan Energy	29.43	145.5	9% less than
	OVO Energy	31.41	93	9% less than
	Red Energy	29.72	115.4	9% less than
	AGL	30.49	126.6	9% less than
	Sumo	31.9	106.7	8% less than **
	CovaU	30.31	120.6	7% less than
	Alinta Energy	30.71	118.6	6% less than
	EnergyAustralia	31.84	109.7	5% less than
	Momentum Energy	28.6	150.2	5% less than
	Simply Energy	31.94	108.5	5% less than
	Diamond Energy	31.91	117.5	1% less than
	1st Energy	32.12	132	0% less than
	Future X Power	32.51	128.7	0% less than
	Next Business Energy	33.99	108.9	0% less than
	Average	**$0.30**	**$1.21**	

SA	Retailer	c /kWh	Daily charge (c)	Compare to ref price
	Amber	32.73	166.9	19% less than **
	Origin Energy	43.61	101	11% less than
	Energy Locals	42.5	132.2	10% less than **
	iO Energy	40	145	9% less than **
	GloBird Energy	42.36	103.5	9% less than
	Dodo	39.02	157.6	8% less than **
	CovaU	43.32	101	8% less than
	Kogan Energy	41.16	147	8% less than
	OVO Energy	42.35	106.2	8% less than
	AGL	43.51	102.2	8% less than
	Circular Energy	42	121	7% less than
	Lumo Energy	43.6	100.9	7% less than
	Red Energy	43.98	100.9	6% less than
	Simply Energy	43.5	114.7	5% less than
	Momentum Energy	39.05	169.2	4% less than
	Powershop	41.16	147	4% less than
	Sumo	46.2	116.6	2% less than **
	Diamond Energy	46.35	86.24	1% less than
	EnergyAustralia	47.28	104.5	1% less than
	1st Energy	46.75	110	0% less than
	Alinta Energy	47.52	101.7	0% less than
	Future X Power	46	118.8	0% less than
	Nectr	43.85	142.1	0% less than
	Next Business Energy	48.13	93.5	0% less than
	Zen Energy	42.97	151.7	0% less than
	Average	**$0.43**	**$1.22**	

Vic	Retailer	c /kWh	Daily charge (c)	Compare to ref price
	Amber	21.05	110	26% less than **
	Nectr	21.56	86.55	25% less than
	1st Energy	19.45	114.4	24% less than
	AGL	22.67	91.05	23% less than
	Lumo Energy	20.41	109.9	22% less than
	CovaU	22.65	91.05	21% less than
	Origin Energy	22.69	91.05	21% less than
	OVO Energy	22.55	90.69	21% less than
	Red Energy	22.2	97.79	21% less than
	EnergyAustralia	22.97	92.2	20% less than
	Energy Locals	27.5	101.7	16% less than **
	Dodo	27.27	80.67	15% less than **
	Powershop	26.48	119	14% less than
	GloBird Energy	25.52	98.16	11% less than
	Kogan Energy	26.48	119	11% less than
	Momentum Energy	24.64	114	11% less than
	Simply Energy	25.84	103.7	10% less than
	Alinta Energy	26.98	108.3	6% less than
	Arcline by RACV	27.5	101.7	6% less than
	Circular Energy	27.01	110	6% less than
	Sumo	28.49	110	5% less than **
	Pacific Blue	27.31	111.1	5% less than
	Tango Energy	27.31	111.1	5% less than
	Diamond Energy	28.11	112.9	1% less than
	Average	**$0.25**	**$1.03**	

ACT	Retailer	c /kWh	Daily charge (c)	Compare to ref price
	Origin Energy	19.87	80.27	30% less than
	ActewAGL	21.17	100.1	23% less than
	Red Energy	21.17	100.1	23% less than
	Amber	22.52	146.2	15% less than **
	CovaU	24.68	103.1	15% less than
	Energy Locals	26.5	113.2	8% less than **
	EnergyAustralia	28.01	90.66	5% less than
	Nectr	27.59	98.65	5% less than
	Next Business Energy	30.25	82.5	0% less than
	Average	**$0.25**	**$1.02**	

Tas	Retailer	c /kWh	Daily charge (c)	Compare to ref price
	Energy Locals	24.5	143.2	14% less than **
	1st Energy	28.72	113.7	4% less than
	CovaU	28.44	113.7	4% less than
	Aurora Energy	29.95	108.2	1% less than
	Average	**$0.28**	**$1.20**	

NT	Retailer	c /kWh	Daily charge (c)	Compare to ref price
	Jacana Energy	28.11	0.00c	N/A
	Rimfire Energy	27.37	53.96	N/A
	Average	**$0.28**	**$0.54**	

WA	Retailer	c /kWh	Daily charge (c)	Compare to ref price
	Synergy	30.81	110.4	N/A
	Average	**$0.31**	**$1.10**	

Annex D – Analysis of potential impact of MEPS on average luminous efficacy of LED lamps on AU market

Two data sets of LED lamps available on the Australian retail market between 2017 and 2018 were evaluated to estimate the average luminous efficacy increase that the introduction of MEPS would effect.

The first data set is taken from a retail survey of LED lamps available for sale online between July 2017 and February 2018. This set consists of 3,097 LED lamps (by category: 2141 omnidirectional and 597 directional lamps for the residential market, and 359 linear lamps). For these lamps, luminous efficacy is based on claimed data at point of sale, either directly claimed luminous efficacy or calculated based on claimed power and claimed lumen output. For analysis, all products were assessed for their target MEPS luminous efficacy and deemed to pass or fail based on comparison with their claimed efficacy. Average luminous efficacy of the passing population was compared with the average efficacy for all of the lamps (by category).

The second data set is photometric test results of LED lamps purchased on the Australian market (online and in-store) between 2017 and 2018. The set contains 34 LED lamps (by category: 22 residential omnidirectional, 8 residential directional and 4 linear lamps). These products were tested for a range of photometric and electrical properties, so the luminous efficacy data is based on (NATA-accredited) laboratory test results. For analysis, each product was deemed as passing or failing MEPS based on the range of all tests conducted (including luminous efficacy, CRI, CCT, displacement power factor, PstLM, SVM, claimed equivalence). Similar to the analysis for the retail survey data, the average luminous efficacy of the passing population was again compared with the average efficacy for all of the lamps (by category). However; the failing lamp population of the test data set included products that failed for reasons other than low luminous efficacy.

A summary of average luminous efficacies before and after application of MEPS is presented below.

Lamp Category	**Retail Market Survey (2017/18)**			**Photometric Test Data (2017/18)**		
	avg. efficacy before MEPS (lm/W) *count*	avg. efficacy if MEPS introduced (lm/W) *count*	efficacy increase if MEPS introduced	avg. efficacy before MEPS (lm/W) *count*	avg. efficacy if MEPS introduced (lm/W) *count*	efficacy increase if MEPS introduced
Omnidirectional	88	95	**+7 lm/W**	93	98	**+5 lm/W**
	n=2141	*n=1313*	*(+8%)*	*n=22*	*n=12*	*(+5%)*
Directional	73	78	**+5 lm/W**	80	82	**+2 lm/W**
	n=597	*n=463*	*(+7%)*	*n=8*	*n=5*	*(+3%)*
Linear	104	119	**+15 lm/W**	106	138	**+32 lm/W**
	n=359	*n=200*	*(+14%)*	*n=4*	*n=1*	*(+30%)*

Of note:

- It was observed at the time of the retail survey that the general efficacies of linear lamps available on the AU market in 2017/2018 were lower (relative to the international market) than the residential omnidirectional and directional lamps products surveyed.
- This is the most recent comprehensive data on LED lamps for sale in Australia. Increases to luminous efficacy at both the lower and higher (quality) ends of the market will act to increase the average efficacy of the “before MEPS” scenario. Average efficacy would still increase in the “after MEPS” scenario, but the increase may be less than estimated here. More recent photometric testing of LED luminaire products (2020) indicated that there were still a significant proportion of LED products on the Australian market that do not have luminous efficacy meeting EU MEPS requirements.