Equipment Energy Efficiency

Consultation Regulation Impact Statement - Lighting

Regulatory reform opportunities and improving energy efficiency outcomes

November 2016

A joint initiative of Australian, State and Territory and New Zealand Governments.

This document is available at the Energy Rating website.

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Executive Summary

This consultation Regulation Impact Statement (RIS) considers policy proposals to improve the energy efficiency of residential and commercial lighting in Australia and New Zealand.

It considers four lighting products currently subject to energy efficiency regulations under the *Greenhouse and Energy Minimum Standards Act 2012* (Australia) and New Zealand *Energy Efficiency (Energy Using Products) Regulations 2002*, associated Australian Determinations and Australian/New Zealand Standards including:

- Incandescent[1] and halogen lamps (Australia only)
- Self-ballasted compact fluorescent lamps (CFLs)
- Double-capped fluorescent lamps (also referred to as linear fluorescent lamps)
- Ballasts for fluorescent lamps.

Further, it considers two products that are currently not subject to mandatory energy efficiency requirements:

- Light Emitting Diode (LED) lamp technology[2] – regulated for safety and electromagnetic compatibility
- Non-integrated Commercial luminaires.

Around 80 million lamps are sold in Australia per year, with an estimated installed stock of more than 400 million. A further 20 million lamps are sold in New Zealand each year, with an estimated installed stock of more than 90 million[3].

Individual lamps do not consume large quantities of electricity. However, the average Australian home has 37 lamps[4] and the average New Zealand home has 26 lamps[5]. When aggregated, lighting accounts for a significant proportion of the average household's electricity use in Australia and New Zealand - typically around 10-12 per cent[6]. For the

[1] The term "incandescent lamp" is used in this report to refer to tungsten filament incandescent lamps.

[2] Voluntary ENERGY STAR® labelling for high efficiency LED lamps and luminaires is available in New Zealand so that consumers can choose a high performance lamp.

[3] Of the lamp technologies referred in this RIS (LED, CFL, filament and linear fluorescent lamps)

[4] E3, *Residential Lighting Report*, prepared by Energy Efficient Strategies, 2016

[5] EECA, *BRANZ survey, 2016*

[6] E3, *Residential Baseline Study for Australia: 2000-2030,* prepared by Energy Consult, 2015*; EECA End Use Database, 2014*

commercial sector, lighting systems account for between 18–40 per cent of electricity end-use in Australia[7] and about 39 per cent in New Zealand[8].

This consultation RIS raises a number of problems that are restricting the uptake of energy efficiency lighting in Australia and New Zealand, which is resulting in the community consuming more energy and producing more emissions than is necessary to deliver our lighting needs.

The objective of the proposed government action is to address these existing regulatory and market failures. Problems include:

- Consumers being exposed to inferior LED products that are negatively impacting on consumer confidence and uptake of this more efficient technology
- Minimum energy performance standards (MEPS) have not kept pace with improvements in lighting technology and international best practice and therefore are no longer achieving their purpose of removing the least efficient lamps from the market
- Imperfect information, combined with an increased diversity of lighting alternatives, that makes it difficult for consumers to meaningfully compare the energy efficiency, quality and performance of lighting technologies or be motivated to do so given the low purchase price
- Split incentives whereby commercial and rental property owners and some builders have no incentive to purchase more efficient but higher upfront cost products as there is no incentive for them to reduce electricity or replacement costs.

[7] Pitt and Sherry, *Baseline Energy Consumption and Greenhouse Gas Emissions in Commercial Buildings in Australia – Part 1 – Report. Department of Climate Change and Energy Efficiency, 2012*

[8] EECA, *Linear fluorescent lamps - total sales and efficiency data*. Energy Efficiency and Conservation Authority, New Zealand, 2012

Six different options, consisting of four proposals in various combinations have been modelled and are summarised in Table 1 below.

Table 1: Policy options

Policy proposal	Options					
	A	B	C	D	E	F
1. **Introduce MEPS for LED lamps and integrated luminaires**. This includes requirements for efficacy[9] as well as a range of other performance parameters. Minimum performance levels would be based on available market analysis, product testing and expert advice, including the work of the International Energy Agency (IEA) 4E Solid State Lighting Annex. The MEPS will also specify a mandatory set of information to be included on product packaging with the option to introduce a standardised information label. Given the rapid improvements in LED lighting, this option includes a timetable of efficacy increases over several years. Specifications for testing of LED lighting will also be developed drawing upon international test standards.	X	X	X	X	X	X
2. **Introduce MEPS for non-integrated commercial luminaires**. This proposal would apply to standard linear commercial luminaires and recessed cans and will make use of a simple test based on photometry information already available to manufacturers in order to minimise compliance costs. This would achieve energy savings in the cheap end of the commercial market where fluorescent lighting is likely to be used as the least cost option in new builds for some years to come, as well as addressing a potential regulatory imbalance if MEPS is applied only to LED integrated luminaires.		X	X			X
3. **Increase incandescent and halogen MEPS (Australia only) to remove the most inefficient lamps** including a number of categories of halogen lamps (including mains voltage and low voltage), as well as additions to the categories of incandescent lamps subject to MEPS. This will involve revisions to the current incandescent MEPS to make adjustments to product definitions and scheduling of when these products will be phased out of the market.					X	X
4. Introduce **mandatory labelling** for lamp products primarily used in the residential sector including directional and non-directional lamps and small integrated luminaires. This would apply to all technologies.			X	X		

Option E and Option F are relevant to Australia only. The New Zealand Government does not wish to limit consumer choice across broader lamp categories, and prefers to provide energy efficiency information. For this reason incandescent lamps are likely to remain for sale in New Zealand at this time. However MEPS is supported for products where there is a range of efficiencies and room for improvement, as with CFLs and LEDs.

For Australia, all options would be supported by a broad education campaign to raise awareness of the benefits of efficient lighting and communicate the revised arrangements to consumers, industry, (suppliers, wholesalers, retailers) electricians and lighting

[9] Efficacy is a term used to describe the relative energy efficient of lighting products in lumens per watt.

designers. The New Zealand education campaign will be managed separately by the Energy Efficiency and Conversation Authority (EECA).

Research and prior consultation

As a result of the joint Australia-New Zealand Equipment Energy Efficiency (E3) Program, lighting has been extensively researched and the industry has been consulted. Recent activities include:

- Product Profile: Incandescent, Halogen and Compact Fluorescent Lamps (E3 2014)
- Product Profile: Commercial Lighting (E3 2015)
- Product Profile: Light Emitting Diodes (LEDs (E3 2015).

The product profiles reviewed the performance of technology, the lighting market and the effectiveness of existing regulation. It also signalled to stakeholders the opportunities and options that will likely form the policy options that would be subject to detailed investigation through this RIS.

Consultation sessions on the product profiles were held in several major capital cities of Australia and Auckland with 67 attendees. A total of 15 formal submissions were received and this formal and informal feedback has assisted in drafting of this RIS.

Further, the E3 Program commissioned the following reports to inform this RIS:

- Residential Lighting Report 2016, Energy Efficient Strategies
- Household Lighting Consumer Survey, E3 and CHOICE
- LED and Dimmer Compatibility Testing, National Electrical Communications Association (NECA)
- LED Testing 2016, Queensland University of Technology.

Product profiles and reports[10] are available at www.energyrating.gov.au/lighting

Existing regulations

Minimum Energy Performance Standards (MEPS) for incandescent lamps (Australia only) commenced in 2009 and were implemented in a staged approach through to 2012, resulting in the phase out of the majority of incandescent lamps in Australia. CFLs were subject to MEPS in Australia from 2009 and in New Zealand from 2012. This policy action, first announced in Australia by the then Minister for the Environment, the Hon Malcolm Turnbull MP in February 2007 was as a result of cheap inefficient incandescent lamps dominating the market and significant information failures and split incentives restricting entry of more efficient lamps such as CFL and halogens.

Double capped fluorescent lamps (or linear fluorescent lamps) and ballasts for fluorescent lamps have been subject to MEPS since 2004.

MEPS and technology improvements have increased the efficiency of lamps since 2009 with average Australian households now using 34 per cent less energy to light their home

[10] LED testing 2016 report is not published due to commercial in-confidence data

and average New Zealand households now using 14 per cent less energy to light their homes [11]. However, MEPS requirements have not kept pace with improvements in lighting technology and therefore are no longer achieving their purpose of removing the least efficient lamps from the market.

A significant number of consumers and businesses continue to be exposed to unnecessarily high lighting energy costs because their lamps and luminaires[12] are not as efficient as they could be.

Unlike other lighting technologies, there are no minimum energy performance standards for LED.

Emergence of LED technology

LED lamps are now widely available in Australia and New Zealand, with product range extending and prices continuing to decrease. Good quality LED lamps last 5 to 15 times longer than halogen and incandescent lamps and at most will consume approximately one-quarter of the energy to produce the same light output.

- LED lamps last on average between 15,000 to 30,000 hours
- CFLs last approximately 6,000 to 15,000 hours
- Halogen lamps last between 2,000 to 3,000 hours
- Incandescent lamps last up to 1,000 hours.

However, evaluation of LED products currently available in the marketplace indicates a wide variation in quality and efficacy[13]. The availability of poor quality LED products on the market risks a rejection or slower, less complete uptake by consumers of this technology as an effective efficient alternative to traditional technologies such as halogen lamps.

Cost benefit analysis

The estimated impacts of the options to 2030 are shown in Table 2 (Australia) and Table 3 (New Zealand) below in terms of costs/benefits, energy savings and greenhouse gas emission reductions. Full details are included at Attachment A.

Modelling is just one tool to help government decide how to proceed. Industry feedback is sought.

[11] E3, *Residential Baseline Study: 2000-2030,* prepared by Energy Consult, 2015; *EECA End Use Database*

[12] A luminaire is an apparatus which distributes, filters or transforms the light emitted from the lamp(s), and includes all parts necessary for supporting, fixing and protecting the lamps and ballast (where applicable), and to connect the lamps to the power supply.

Table 2: Cost benefit estimates – Australia (Real discount rate: 7%)

Option	Sector	Energy Saved (cumulative GWh)	GHG Emissions Reduction (cumulative Mt)	Total (Gross) Benefit (NPV, $M)	Total Investment (NPV, $M) [14]	Net Benefit (NPV, $M)	(Gross) Benefit to Cost Ratio	Cost of Abatement (NPV$/tonne)
A. LED MEPS	Res	1,841	1.0	255	29	226		
A. LED MEPS	Com	4,302	2.8	422	46	376		
A. LED MEPS	**All**	**6,143**	**3.8**	**677**	**75**	**602**	**9.02**	**-158**
B: LED MEPS + LOR MEPS[15]	Res	1,841	1.0	255	29	226		
B: LED MEPS + LOR MEPS	Com	8,890	5.5	838	93	745		
B: LED MEPS + LOR MEPS	**All**	**10,731**	**6.5**	**1093**	**122**	**971**	**8.96**	**-149**
C: LED MEPS + LOR MEPS + Labelling	Res	3,227	1.9	457	59	398		
C: LED MEPS + LOR MEPS + Labelling	Com	8,890	5.5	838	93	745		
C: LED MEPS + LOR MEPS + Labelling	**All**	**12,117**	**7.4**	**1295**	**152**	**1143**	**8.52**	**-154**
D: LED MEPS + Labelling	Res	3,227	1.9	457	59	398		
D: LED MEPS + Labelling	Com	4,302	2.8	422	46	376		
D: LED MEPS + Labelling	**All**	**7,529**	**4.7**	**879**	**105**	**774**	**8.4**	**-165**
E: LED MEPS + Phase out	Res	16,293	10.9	2517	447	2070		
E: LED MEPS + Phase out	Com	4,302	2.8	422	46	376		
E: LED MEPS + Phase out	**All**	**20,595**	**13.7**	**2939**	**493**	**2446**	**6.0**	**-178**
F: LED MEPS + LOR MEPS + Phase out	Res	16,293	10.9	2517	447	2070		
F: LED MEPS + LOR MEPS + Phase out	Com	8,890	5.5	838	93	745		
F: LED MEPS + LOR MEPS + Phase out	**All**	**25,183**	**16.4**	**3355**	**541**	**2815**	**6.2**	**-172**

Table 3: Cost benefit estimates - New Zealand (Real discount rate: 5%)

Option	Sector	Energy Saved (cumulative GWh)	GHG Emissions Reduction (cumulative Mt)	Total (Gross) Benefit (NPV, $M)	Total Investment (NPV, $M) [16]	Net Benefit (NPV, $M)	(Gross) Benefit to Cost Ratio	Cost of Abatement (NPV $/tonne)
A. LED MEPS	Res	360	0.02	55	5	50		
A. LED MEPS	Com	841	0.06	92	11	81		
A: LED MEPS	**All**	**1,201**	**0.08**	**147**	**16**	**131**	**9.2**	**-1637**
B: LED MEPS + LOR MEPS[15]	Res	360	0.02	55	5	50		
B: LED MEPS + LOR MEPS	Com	1,738	0.12	184	22	162		
B: LED MEPS + LOR MEPS	**All**	**2,098**	**0.14**	**239**	**27**	**212**	**8.9**	**-1514**
C: LED MEPS + LOR MEPS + Labelling	Res	583	0.17	90	7	83		
C: LED MEPS + LOR MEPS + Labelling	Com	1,738	0.12	184	22	162		
C: Option B + Labelling	**All**	**2,321**	**0.29**	**274**	**29**	**245**	**9.4**	**-845**
D: LED MEPS + Labelling	Res	583	0.17	90	7	83		
D: LED MEPS + Labelling	Com	841	0.06	92	11	81		
D: LED MEPS + Labelling	**All**	**1,424**	**0.23**	**182**	**18**	**164**	**10.1**	**-713**

[14] The Total investment column for Australia includes costs to consumers, product supply businesses and government to implement the option. Costs to business and government are included in the residential sector row of the table. See the impacts section for further information.

[15] LOR MEPS is MEPS for non-integrated commercial luminaires

[16] The Total investment column for New Zealand includes costs to consumers and product supply businesses to implement the option. The proportion of government costs to be incurred by the New Zealand Government has not been accounted for in this table, with all government costs included in the Australian table. See the impacts section for further information.

For Australia, option F (introduce LED and non-integrated Commercial Luminaire MEPS and increase incandescent MEPS) gives the greatest net benefit at an estimated $2.81 billion. This option would save approximately 25,000 giga-watt hours (GWh) and 16 million tonnes (Mt) of greenhouse gas (GHG) emissions cumulative to 2030. This option would require consumers to pay a little more upfront for light bulbs, but households will save money through reductions in electricity and replacement costs. Some households are likely to incur a one off upfront cost to resolve compatibility issues with existing lighting systems. The Department and Lighting Council Australia are jointly working to reduce the consumer cost of this option through wide promotion of compatible products and seeking industry solutions to reduce impacts.

The current preferred option for New Zealand is Option B (introduce LED and non-integrated Commercial Luminaire MEPS). This option would save 2,000 giga-watt hours (GWh) and 0.14 million tonnes (Mt) of greenhouse gas (GHG) emissions cumulative to 2030. This option provides a net benefit of an estimated $212 million.

Option C, which includes mandatory labelling in addition to LED and non-integrated Commercial Luminaire MEPS, provides the greatest net benefit for New Zealand, but is not considered feasible in the absence of introducing labelling in Australia. The size of the New Zealand market is considered too small to require lighting suppliers to amend product labelling specifically for New Zealand sale. Further, Australia and New Zealand seek to align product regulation where possible, to contribute to the objectives of the Trans-Tasman Mutual Recognition Arrangement (TTMRA).

Modelling for the mandatory labelling proposal was limited, due to the lack of data available on the effectiveness of light bulb labelling. For modelling purposes in this RIS, it is assumed that labelling will deliver a relatively small benefit of a 5 per cent improvement in the purchase of energy efficient light bulbs. The Department welcomes further information from stakeholders on research conducted on the effectiveness of light bulb labelling to further inform this estimate and validate accuracy of modelling.

All six options presented include LED MEPS on the basis that this policy response is necessary to address LED quality issues in the market. It is considered that these issues cannot be addressed by the Australian Consumer Law (ACL), or the New Zealand Consumer Guarantees Act, education or labelling given the complexity around lighting performance and the inability for a consumer to determine the quality of the product pre purchase.

The ACL does not provide the Australian Competition and Consumer Commission (ACCC) or state regulators with any role in determining which products make it to market from a quality perspective. The operation of the ACL and role of the ACCC is explained under 'Other policies that impact these problems' section.

The MEPS policy proposals are not expected to restrict competition in the lighting market or impose significant costs, with removal of the poorest performing products from the market.

- The LED MEPS proposal would apply to an estimated 255 suppliers selling LED lighting in Australia[17]. This includes the 66 lighting suppliers that have halogen, CFL and linear fluorescent lamps registered for sale in Australia and New Zealand[18].
- The traditional commercial luminaire market, in which the non-integrated commercial luminaire MEPS proposal would apply, is declining in sales with the commercial market largely moving to integrated LED luminaires.
- The proposal to increase the incandescent MEPS (Australia only) to remove the least energy efficient products from the market would result in increased demand for CFL and LED products. It is understood that all 24 suppliers who have registered halogen products proposed for removal from the Australian market are supplying CFL and/or LED products. This policy proposal would impose a barrier to the sale of filament lamps in Australia, removing this technology choice for consumers, although equivalent energy efficient lamps exist on the market and benefits to the community as a whole far outweigh the costs.

Summary of Costs and Benefits

Costs and benefits have been assessed to 2030. In order to show the impacts in each sector, residential and commercial (which includes industrial) sectors are modelled separately for the LED MEPS proposal. The other proposals largely apply to either primarily residential or commercial sectors and are modelled as such. The following costs and benefits are included in the financial modelling:

Costs:

- To the consumer, due to increases in the upfront price of products, reflecting costs passed on by suppliers
- To the consumer, due to transitional costs in upgrading existing lighting systems to be compatible with LED lighting (Australia only)
- To the product supply businesses for complying with the new or modified regulatory requirements
- To government for implementing and administering the requirements.

Benefits:

- To the consumer, due to improved energy efficiency of available products resulting in avoided electricity costs
- To consumers due to longer life of LEDs, leading to reduced replacement costs (not included in financial modelling)
- To suppliers, from simplifications to the regulatory framework.

The policy options can also reduce the cost to Australia and New Zealand of meeting greenhouse gas abatement targets by providing cost positive emission abatement. For

[17] Based on advice from Energy Safety Regulators

[18] Lighting Council Australia members, estimated to reflect 90 per cent of the market, are all supplying LED products only or in addition to other lighting products.

Australia, the cost of abatement for the recommended option is around $-174/tonne[19]. This abatement cost is much lower than the average price of around $12 that the Australian Government is paying for abatement under the Emissions Reduction Fund.

Cost benefit analysis is based on projected energy consumed for lighting stock in a Business as Usual (BAU) case, compared to each policy option. Energy savings are the difference between BAU and with-policy option energy consumption (the same applies for GHG savings). The annual energy consumed (by each type of lighting product) is essentially the multiplication of: the stock of the lighting product type; their average annual operating hours; and their average electricity input power. Refer to Attachment A for a detailed description of modelling.

The decline in energy use expected in the BAU case can be attributed to an expected slow increase in uptake of LED lighting over time and slow decrease in inefficient incandescent and halogen lighting. The analysis shows that introducing MEPS and labelling requirements significantly reduces the expected energy use, by increasing the average efficiency of LED lighting and speeding up uptake of energy efficient lighting.

Other options considered

In addition to options referred above, the product profiles also raised options in relation to the MEPS levels for linear fluorescent lamps, ballasts for linear fluorescent lamps and CFLs, as well as mercury levels for linear fluorescent lamps and CFLs.

In agreement with Office of Best Practice Regulation (OBPR), a proposal to reduce allowed mercury levels in CFL and linear fluorescent lamps in order to meet the requirement of the Minamata Mercury Convention and align with levels set by major markets will be managed in a separate consultation paper outside the RIS process in Australia. This is on the basis that it is anticipated that the proposed change will have a minor impact on industry and consumers[20].

MEPS levels for linear fluorescent lamps and ballasts are still under investigation and will not be examined in detail in this RIS.

While evaluation of the range of efficiency of CFLs in the Australian and New Zealand market indicates that some energy savings could be achieved by increasing the MEPS level, recent residential sales data from Australia, New Zealand and other countries indicate that CFLs are rapidly being replaced by equivalent or more efficient LED products and there may not be a need for further regulatory intervention. It is proposed that the market share of CFL products be monitored and this position be reviewed if residential market share for CFLs has not declined to 5 per cent or less by 2020.

An Australian tax on halogen light bulbs was explored with the Australian Treasury as an option to reduce sales of inefficient light bulbs and encourage greater uptake of energy

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[19] Based on the estimated net benefit, divided by the number of tonnes abated cumulative to 2030.

[20] Regulatory amendments to reduce mercury levels are currently proposed for Australia only. New Zealand amendments will be managed separately.

efficient CFLs and LED. The key advantage of imposing a tax on inefficient light bulbs is that it retains consumer choice, allowing consumers with a strong preference for halogen light bulbs to continue purchasing them, should their satisfaction from purchasing the product still exceed the now higher price. However, there are a number of disadvantages to pursuing increased energy efficiency by imposing a tax on halogen light bulbs, and Treasury considers these outweigh the advantage noted above.

Extension of the state white certificate schemes that facilitate LED lighting upgrades in New South Wales, Australian Capital Territory, Victoria and South Australia, was explored with Queensland, Tasmania, Western Australia and the Northern Territory. All jurisdictions advised that there is no plan to implement these arrangements in their jurisdiction.

Education was explored as a means to address the current information asymmetry and improve consumer knowledge of the efficiency, lifetime cost, and substitutability of different lighting technologies[21]. The New Zealand RightLight education campaign[22], adopted to improve sales of efficient light bulbs, demonstrates that education has an impact but can only achieve limited environment and financial benefits. New Zealand supermarket sales data shows a 15 per cent reduction in market share of incandescent light bulbs from 2009 to 2015[23].

Over this period in changing education in New Zealand, the market share of halogen increased to 12 per cent and LED to 3 per cent, with CFLs remaining steady at 14 per cent market share. Whilst anecdotal feedback suggests that the proportion of sales of efficient lamps is higher in trade stores, incandescent light bulbs continue to represent the bulk of sales. A 15 per cent reduction in market share of incandescent bulbs is a positive result from a public education campaign. However, it shows that even a well-designed voluntary programme will not have the same level of effect as regulation. The New Zealand RightLight campaign has recently finished. However, promotion of energy efficient light bulbs will continue as part of the guidance to consumers under New Zealand's overall energy efficiency information programme and retail partners are continuing to promote LED technology with their own marketing and promotions. Supermarket sales will continue to be monitored.

The potential benefits achieved through education (as demonstrated in New Zealand) fall short of the Council of Australian Governments' (COAG) Energy Councils expectations on savings to be achieved through the transition to more efficient lighting in Australia, as

[21] There are already some information programs in Australia via government websites but this is having limited impact

[22] RightLight commenced as a subsidy CFL programme from 2004 to 2009, than subsequently focused on education only from 2009 to 2015 with national television, in-store point of sale and an online presence.

[23] Incandescent sales represented 79 per cent of supermarket sales in 2006 and 83 per cent of supermarket sales in 2009. In 2015, incandescent sales represent 68 per cent of the supermarket sales.

defined in the E3 prioritisation plan[24]. Education is therefore presented as necessary to support implementation of the agreed option, but has been discounted as a standalone proposal.

The prioritisation of the E3 Program's activities is an important component of the National Energy Productivity Plan (NEPP), which was agreed by Energy Ministers on 4 December 2015. The NEPP is seeking to improve Australia's energy productivity by getting more value from the energy we consume and has set a target of increasing Australia's national energy productivity by 40 per cent by 2030. The residential sector is projected to achieve a significant proportion of the target, much of which will be delivered by the E3 Program[25].

The Prioritisation Plan has been developed to identify how the E3 work program can be aligned to accelerate policy development and focus on products that will deliver the most benefits including improved energy productivity, lowering greenhouse gas emissions, and reducing energy costs. The Prioritisation Plan identifies six priority areas (including lighting) for E3's immediate focus.

As a participant in the E3 Program, New Zealand also is progressing work streams identified in the Prioritisation Plan. In New Zealand, improving the efficiency of lighting products aligns with government policy directions. The Government has announced that it is considering new national energy targets and will refresh the New Zealand Energy and Efficiency Conservation Strategy (NZEECS). The focus of the new initiatives will be on improving energy productivity, reducing carbon emissions, and to broaden our renewable energy use beyond electricity and increase its use in the transport and industrial heat sectors. The proposed goal for the new NZEECS is for New Zealand to be a more energy efficient, productive and a low emissions economy.

Stakeholder feedback

Stakeholder feedback is sought on the policy options presented in this Consultation RIS. This is to ensure that any recommendation and/or decision to change the current energy efficiency requirements are based on an understanding of the full range of stakeholder views. Questions that stakeholders may wish to consider are included in the options section of the RIS and summarised in the consultation questions section.

Public consultation events on this RIS will be held (pending number of attendees) in:

- Brisbane– 31 January 2017
- Sydney – 1 February 2017
- Melbourne – 3 February 2017
- Auckland – 8 February 2017
- Adelaide – 10 February 2017

[24] COAG Energy Council Ministers approved the E3 Prioritisation Plan in May 2016.

[25] COAG Energy Council, *National Energy Productivity Plan*, 2015

To register your interest in attending an Australian consultation session, please email EERLighting@environment.gov.au by 12 January 2017, noting the names of attendees and the location of the meeting you wish to attend. For New Zealand participants, please email regs@eeca.govt.nz.

The closing date for written submissions is **5pm AEDT Friday 24 February 2017** and should include the subject: 'Consultation RIS – Lighting'.

Australian submissions should be sent via email to:

Email: EERLighting@environment.gov.au

New Zealand submissions should be sent via email to:

Email: regs@eeca.govt.nz

Note: Submissions will be published on the energy rating website, as will the names of all stakeholders who have made submissions. If you do not want your submission to be published, please advise in the covering email that the submission is to be treated as confidential.

Introduction

Background

This section provides background information about the lighting market and existing regulations in Australia and New Zealand.

A summary of the different lighting technologies is included at Attachment B. A Glossary of basic lighting terminology is included at Attachment C.

Market

Lighting is largely manufactured outside Australia and New Zealand. Products are sold in a range of outlets including hardware stores, supermarkets, general lighting retail, specialist lighting stores, and electrical retail suppliers, (many of which have online options for purchasing). In addition, online-only lighting retailers and direct manufacturer/suppliers also exist.

The Australian lighting market is estimated at around $1.5 billion in sales annually[26]. The New Zealand lighting market is estimated to be $336 million.[27] Of the installed product, approximately 13 per cent is found in non-residential (commercial/industrial) spaces and the remaining 87 per cent of lighting is used for residential purposes[28].

LED lighting market

There is an estimated 255 suppliers selling LED lighting in Australia[29] as at April 2016. Many of these suppliers may also be selling their LED lighting products in the New Zealand market. Market research conducted by E3 in 2015 found over 50 LED brands[30], with many brands new to the lighting industry and a reasonable range of products being provided for consumer choice.

Uptake of LED products is increasing. Trend data from Lighting Council Australia shows that LED non dimmable mains voltage lamps have increased from 1.7 per cent of sales in 2012 to 10.5 per cent in 2015. Similarly LED integrated downlights increased from 11 per cent in 2012 to 31 per cent in 2015[31].

[26] Lighting Council Australia estimate, 2016

[27] EECA estimate, 2016

[28] E3, *Commercial Product Profile*, 2015

[29] Based on advice from Energy Safety Regulators (no split available between lamps and luminaires)

[30] E3, *Product Profile Report – Light Emitting Diodes (LEDs)*, 2015

[31] Lighting Council Australia, 2016 Market trend data

In addition to traditional socket based lamps, LED lighting is also sold as a light source integrated with the luminaire as a single unit. These products are sold as alternatives to non-integrated commercial luminaires (holding linear fluorescent lamps), residential downlight reflector lamps, and decorative light fittings. Transition from a socket / lamp holder based lighting system to an integrated luminaire will usually require a qualified electrician and will most commonly occur in new builds or renovations.

Commercial luminaire market

Major brands of commercial luminaires include Cooper, Zumtobel, Thorn, Sylvania, Philips and Pierlite[32].

The main suppliers of commercial lighting products to the end-user are electrical/lighting manufacturers, wholesalers, electrical contractors, specialist lighting stores and energy efficiency programs.

In the commercial lighting sector, there is anecdotal evidence of an increasing prevalence of LEDs for lighting needs; in particular the choice of integrated LED downlights over traditional CFL cans. Linear fluorescent lamps, at this point in time, are more likely to be replaced with either more efficient fluorescent lamps or LEDs in existing installations. As the move to more efficient linear forms of LED technology occurs, products such as T8-T5 adapters and circular and U-shaped fluorescent lamps are likely to be phased out of the market.

Data provided by major commercial luminaire suppliers and wholesalers confirms that LED integrated luminaire sales are rapidly increasing and traditional non-integrated commercial luminaire sales are decreasing, but are still substantial. A major wholesaler indicated that of their commercial luminaire sales; batons, troffers, suspended luminaires and other fixtures which accept linear fluorescent lamps or equivalent linear retrofit LED lamps, made up approximately 18 per cent of sales.

Stock and Sales Estimates

The E3 Committee commissioned a comprehensive lighting audit of the residential sector in 2016 and purchased ten years of supermarket retail sales data up to 2015, in order to quantify the lighting stock and characteristics of lighting in Australian households. New Zealand commissioned a similar audit of households in 2016 and require regular reporting of sales data for regulated and voluntary programs. Import data for both countries was also used as an additional input to understand the market and validate stock estimates, noting that import data is currently not available for LED lighting[33]. Lighting Council Australia also provided aggregated sales trend data from their members.

[32] E3, *Commercial Product Profile*, 2015

[33] LED Import categories are expected to be available in Australia from January 2017. New Zealand is considering introducing the same codes for their imports.

Around 80 million lamps are sold in Australia per year, with an estimated installed stock of more than 400 million. A further 20 million lamps are sold in New Zealand each year, with an estimated installed stock of more than 90 million[34].

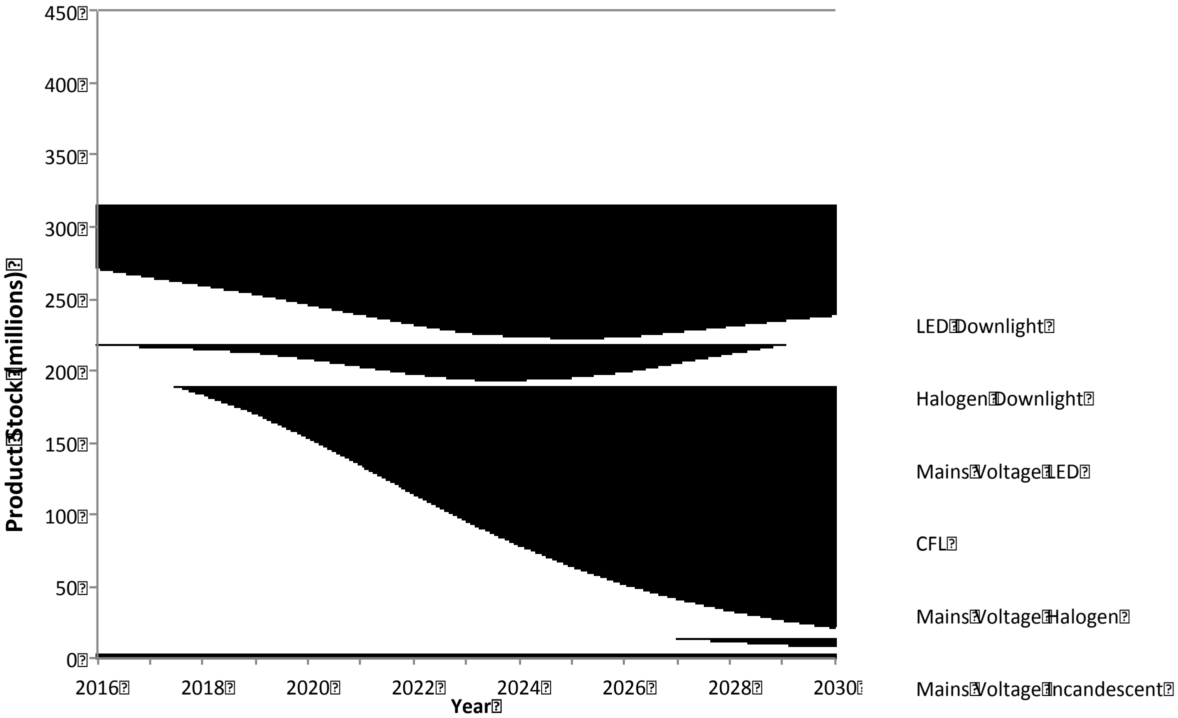
Current residential lighting energy consumption per dwelling for Australia is estimated at around 700 kilowatt-hours (kWh) per annum.

In Australia, more than 60 per cent of residential lighting energy consumption is estimated to come from incandescent and halogen lamps[35]. In New Zealand, the estimated level is higher at 80 per cent[36].

The stock of lighting is estimated to grow to approximately 500 million in 2030 in Australia. In New Zealand stock is expected to increase to approximately 100 million by 2030.

For Australia, the forecast BAU stock of residential lamps is shown in the figure below.

Figure 1: BAU stock of residential lamps in Australia



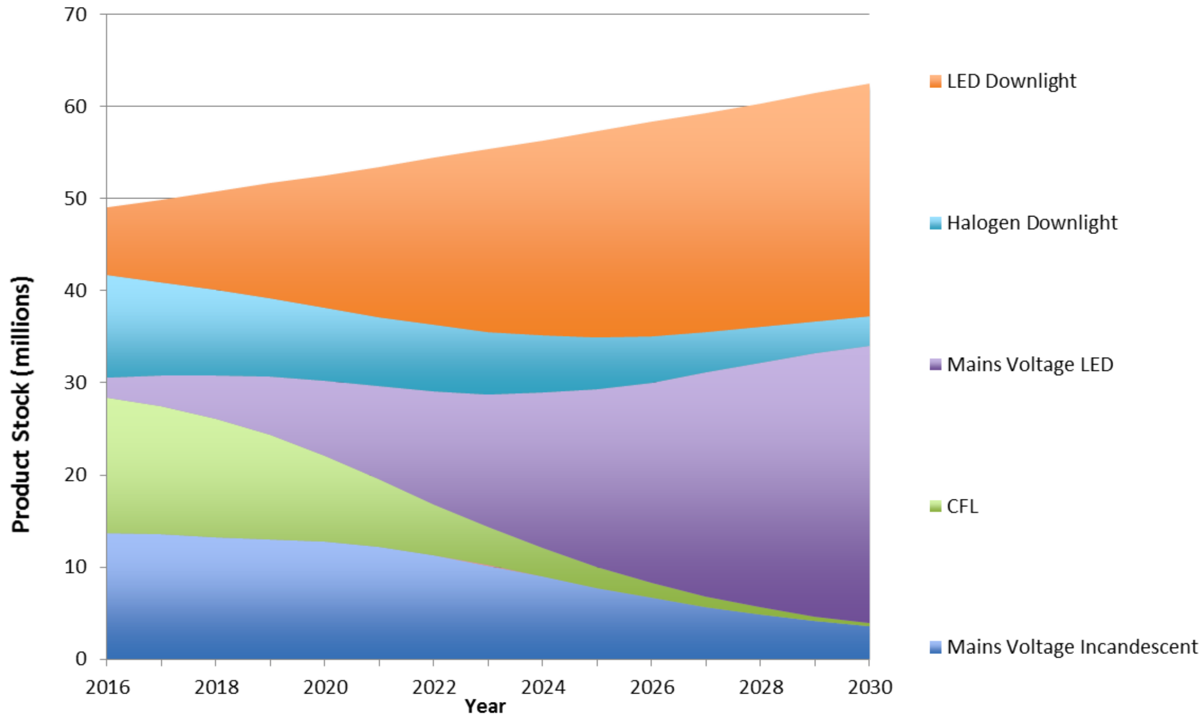
[34] Of the lamp technologies referred in this RIS (LED, CFL, filament and linear fluorescent lamps)

[35] E3, *2016 Residential Lighting Report*, prepared by Energy Efficient Strategies, 2016

[36] EECA, BRANZ survey, 2016

For New Zealand, the forecast BAU stock of residential lamps is shown in the figure below.

Figure 2: BAU stock of residential lamps in New Zealand



2016 Residential Lighting Audit - Australia[37]

Comparison of the 2016 residential lighting audit with the 2010 residential lighting audit shows that the installed stock of incandescent lamps have fallen significantly from 23 per cent to 13 per cent share while mains voltage halogen lamps share has increased from 9 per cent to 17 per cent. This shows that incandescent lamps have mostly been displaced by mains voltage halogen lamps since the last survey in 2010 (following the incandescent lamp phase-out in 2009). Mains voltage halogen lamps are 30 per cent more efficient when compared to incandescent. LED for general lighting (non-directional) still only makes up 3 per cent of the stock (this is included in the LED total share of 15 per cent) even though there has been a significant increase in available models in the market. This data suggests that there has been little improvement in lighting efficacy for general lighting over the past 6 years (noting that this is not representative of the full impact of lighting efficiency policy since 2007).

Low voltage halogen lamp share has fallen from 26 per cent to 15 per cent while LED lamp share has increased from 2 per cent to 15 per cent (12 per cent is LED directional). This data suggests that there has been a significant improvement in lighting efficacy for task and directional lighting due to the halogen to LED transition. LEDs are being installed in new homes/renovations but also under voluntary state downlight replacement programs.

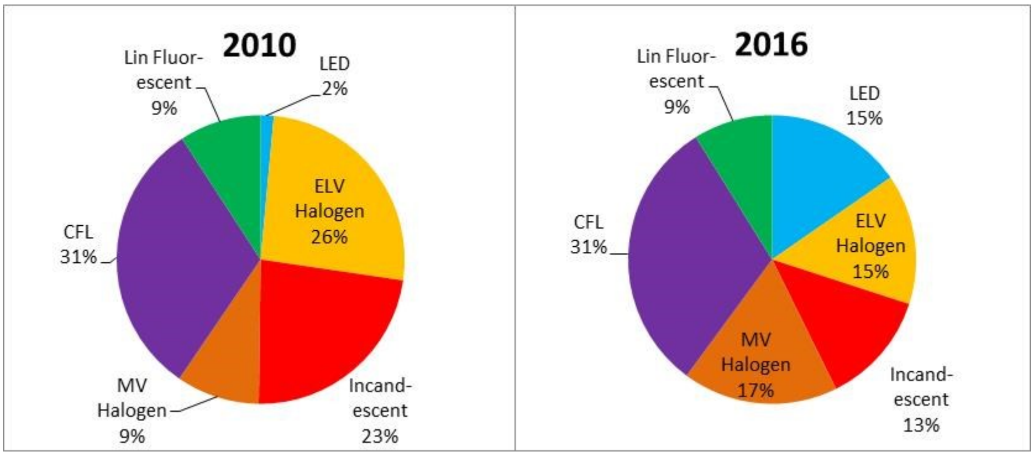
[37] E3, 2016 *Residential Lighting Report*, prepared by Energy Efficient Strategies, 2016

It is estimated that more than 30 per cent of Victorian households have participated in the downlight replacement program.

In overall terms, the share of linear fluorescents and CFLs has not changed in the past 6 years with a constant aggregate market share of 40 per cent for these two technologies.

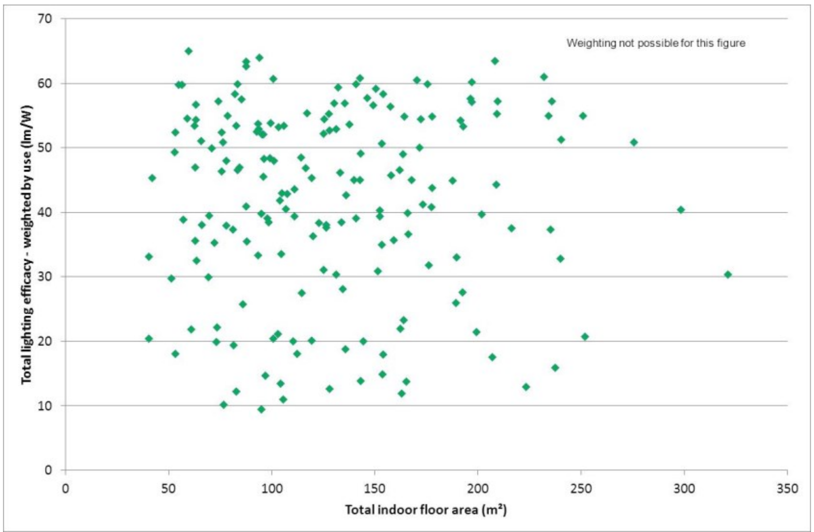
Whilst the physical share of efficient lighting (CFL, linear fluorescent and LED) has increased to 55 per cent, over 60 per cent residential lighting energy consumption is estimated to be from incandescent and halogen lamps.

Figure 3: Share of lighting technologies in 2010 and 2016 (Australia)



There is a large variation in the overall efficacy of lamps installed in households. Figure 4 shows the total lighting efficacy for each of the 180 homes. A value of less than 30 lumens per watt is poor while a value of over 55 lumens per watt is very good. This diagram shows the large potential in energy reduction still to be achieved through the installation of energy efficient lighting, across all sizes of dwellings.

Figure 4: House floor area versus total house lighting use weighted efficacy (Australia)

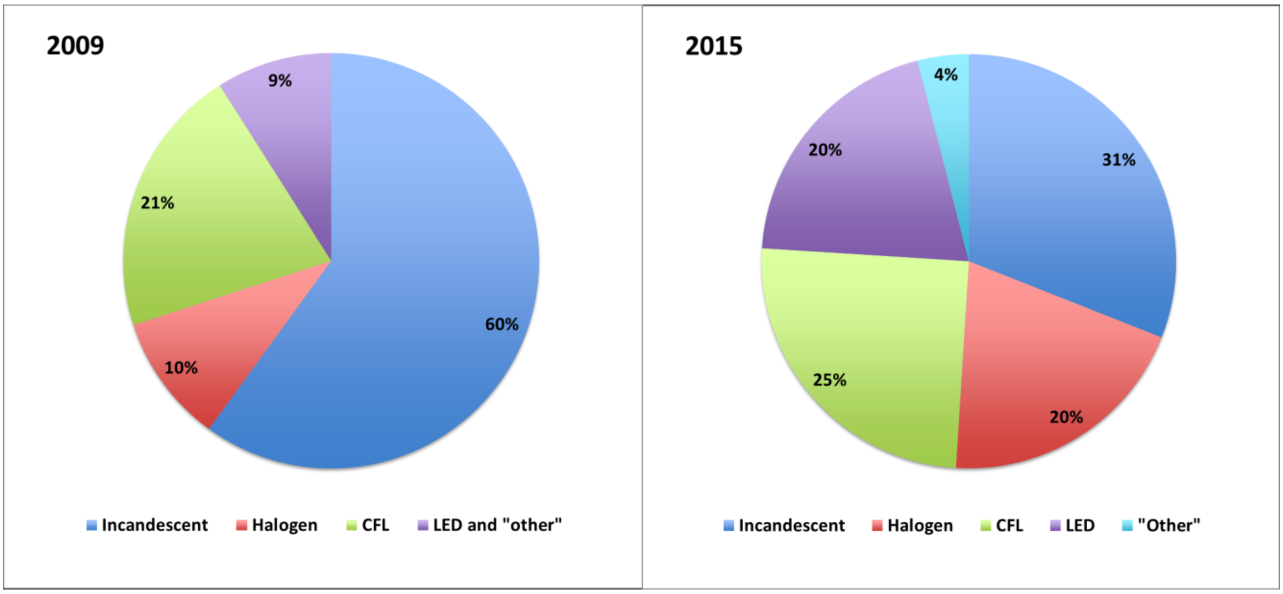


Note: Each point represents a participating household. Efficacy values are weighted by use – assumes all lamps are used as stated by householders. Demographic weightings are not applied to data in this figure.

2015 Residential Lighting Audit – New Zealand

Comparison of the 2015 residential lighting audit results with the 2009 audit results shows that incandescent lamps have fallen significantly from 60 per cent to 31 per cent share, while halogen lamp share increased from 8 per cent to 17 per cent. CFLs have slightly increased to 25 percent and LED has dramatically increased to 20 per cent. This data suggests an overall improvement from inefficient to efficient lighting stock of 20 per cent over the past 7 years. Whilst the physical share of efficient lighting (CFL and LED) has increased, over 80 per cent residential lighting energy consumption is estimated to be from incandescent and halogen lamps. [38]

Figure 5: Share of lighting technologies in 2009 and 2015 (New Zealand)



See Attachment A for more detailed information about Australian and New Zealand stock and stock analysis.

[38] EECA BRANZ survey 2015, EECA BRANZ survey 2009

Current requirements

The following technologies are currently subject to energy efficiency regulations under the *Greenhouse and Energy Minimum Standards Act 2012* (Australia) and New Zealand *Energy Efficiency (Energy Using Products) Regulations 2002*, and associated Australian Determinations and Australian/New Zealand Standards:

- Incandescent lamps (tungsten filament and halogen) for general lighting services (Australia only), as set out in AS 4934.2 and test procedures in AS/NZS 4934.1. Note mains voltage reflector lamps are currently not subject to regulation
- Self-ballasted compact fluorescent lamps for general lighting services, as set out in AS/NZS 4847.2 and test procedures in AS/NZS 4847.1 and AS/NZS 4847.3
- Double-capped fluorescent lamps (also referred to as linear fluorescent lamps), as set out in AS/NZS 4782.2 and test procedures in AS/NZS 4782.1 & AS/NZS 4782.3[39]
- Ballasts for fluorescent lamps, as set out in AS/NZS 4783.2 and test procedures in AS/NZS 4783.1
- Magnetic isolating transformers and electronic step-down converters (for use with extra-low voltage (ELV) lighting), as set out in AS/NZS 4879.2 and test procedure in AS/NZS 4879.1. This does not include products intended for LED lamps.

Voluntary ENERGY STAR® labelling for high efficiency CFL and LED lamps is available in New Zealand so that consumers can choose a high performance lamp.

The table below summarises the lighting products registered under GEMS in Australia. There are 24 halogen providers (selling mains voltage or low voltage halogen products) and 66 suppliers.

Table 4: Number of lighting products registered in Australia as at June 2016

Product type	Registered suppliers	Registered models
Halogen Mains Voltage	21	203
Halogen Low Voltage	15	92
Transformers	6	23
CFL	39	448
Linear fluorescent	18	160
Ballasts	15	44

[39] Non-integrated compact fluorescent lamps, circular and U-shaped fluorescent lamps are currently not subject to MEPS.

New Zealand lamp registrations include 98 CFLs (5 suppliers) and 33 linear fluorescent lamps (33 suppliers).

The current Australian regulations for incandescent and halogen lamps (collectively referred to as filament lamps) and Australian and New Zealand regulations for CFLs and linear fluorescent lamps have largely achieved their objective of promoting the development and adoption of energy efficient lighting. In Australia, the purpose of the minimum energy performance standards was to remove the least efficient incandescent lamps from the Australian market and facilitate use of more efficient CFLs and halogen lamps. New Zealand's approach of education rather than regulation of filament lamps also contributed to a reduction (albeit less than Australia) of these lamps in the market.

Figure 6: Imports of incandescent, halogen and CFLs into Australia [40]

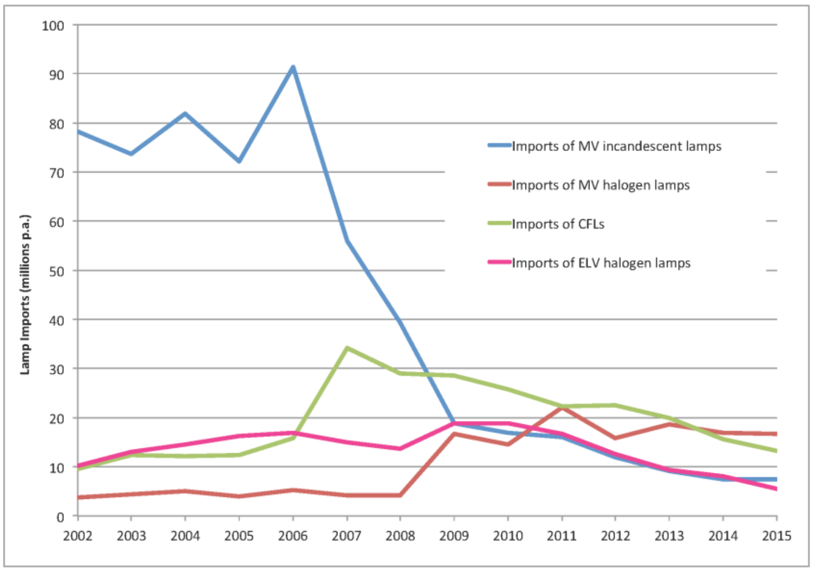
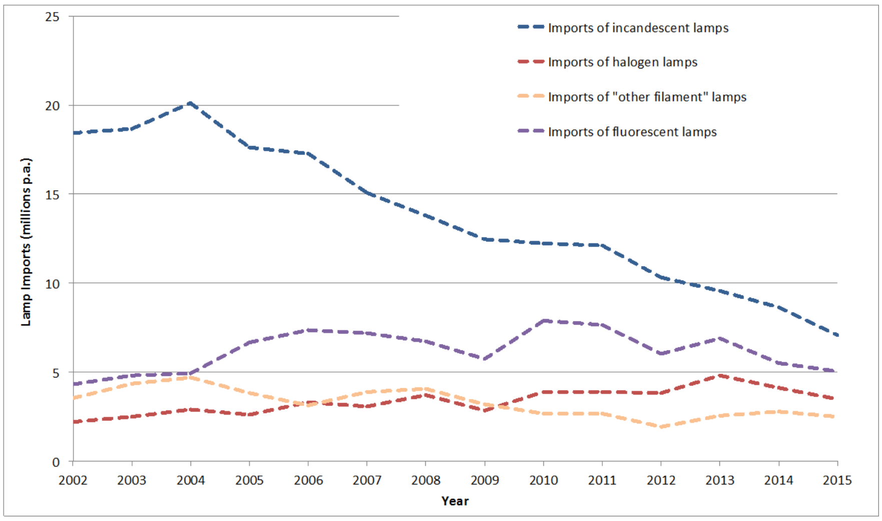


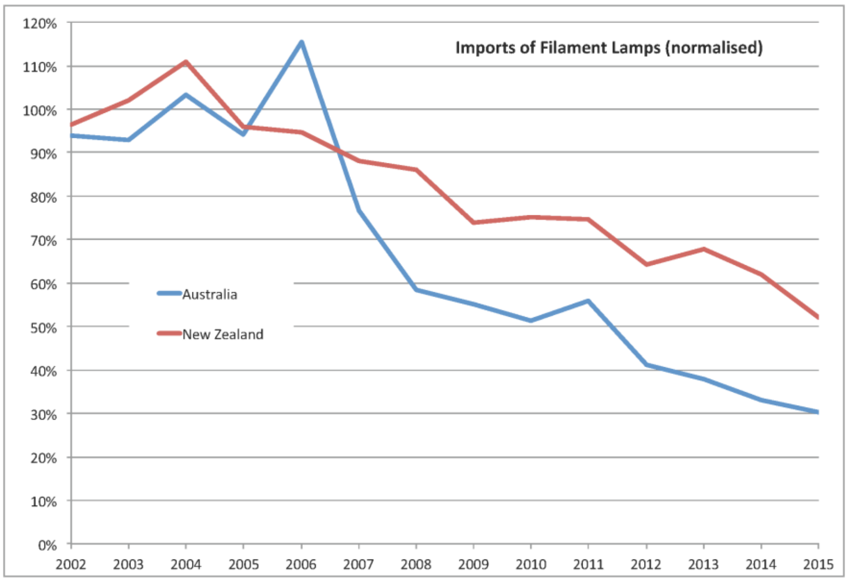
Figure 7: Imports of incandescent, halogen, "other filament" and fluorescent lamps New Zealand[41]



[40] The decline of CFL lamps since 2009 reflects the extended lifetime of these products, as well as more recently a transition to LED lighting for which import data is not available.

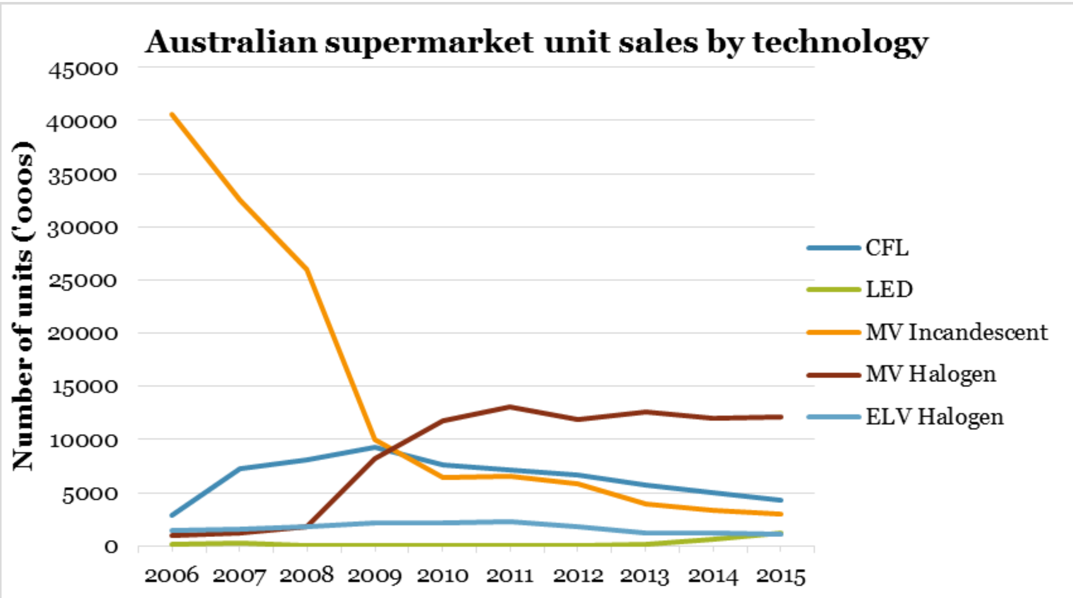
[41] CFL and linear fluorescent lamps are reported together under fluorescent lamps. Other filaments are decorative and unusual lamps.

Figure 8: Imports of all filament lamps (incandescent and halogen) into Australia and New Zealand (normalised)



Lighting technology has changed markedly since regulation was introduced in 2009. Halogen and to a lesser extent CFL lighting have become dominant products and the prevalence of LED lighting is increasing (Figure 9 and Figure 10), whereas incandescent lighting was the dominant product type for residential lighting in the early 2000s[42].

Figure 9: Australian supermarket unit sales by technology

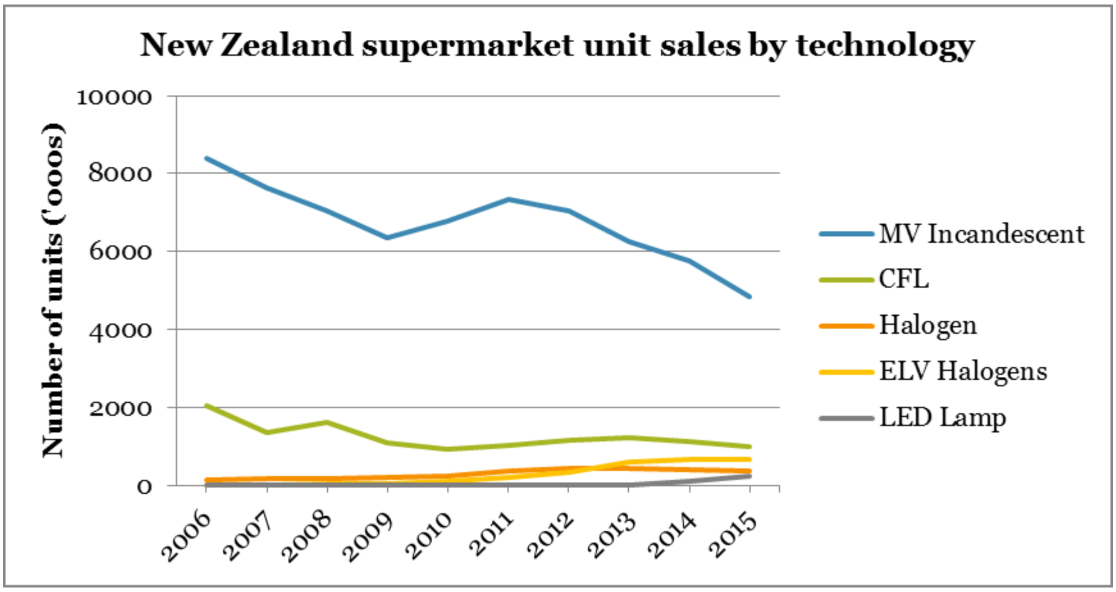


Halogen and incandescent lamps represent 74 per cent of sales, CFL 20 per cent and LED 6 per cent[43].

42 State and territory incentive schemes and building code requirements have contributed to the increase in uptake of CFL and LEDs.

43 Supermarket sales for Australia and New Zealand are a subset of the overall import figures. Note that due to significant differences in product lifetime, sales do not accurately reflect installed stock. A halogen lamp will be replaced at least three times as often as a CFL or LED lamp.

Figure 10: New Zealand supermarket unit sales by technology



Halogen and incandescent lamps represent 82 per cent of sales, CFL 14 per cent and LED 4 per cent in 2015.

Since the last revision to MEPS in 2012, a significant body of knowledge has accumulated about the MEPS program. The global lighting market has also changed considerably, particularly with the introduction of LED lighting.

Internationally, many other countries have adopted regulations which emulate the Australian inefficient incandescent lamp phase out. The European Union has a revised MEPS level that will apply from September 2016, which will remove mains voltage incandescent and mains voltage halogen reflector lamps from the market. They are currently consulting on a draft universal MEPS level to apply to all light source technologies from 2018 (including LED lamps and luminaires) that will remove the majority of remaining incandescent and halogen lamps from the market. China has commenced phasing out incandescent lamps and developed mandatory performance requirements for LED lighting, which commenced in September 2014. The US is also reviewing their lighting policy with MEPS for omni-directional LEDs under development and is expected to phase out filament lamps in 2020 (timing determined by Congress).

Energy efficiency remains as a widely accepted low cost approach to reducing greenhouse gas emissions. Recent modelling by the International Energy Agency (IEA) Energy Efficient End-use Equipment (4E) Annex supports this claim, with standards and labelling programs achieving at least a three to one benefit cost ratio[44]. Improvements to energy efficiency can also help to reduce demand on electricity supply systems with consequent savings in peak load capacity requirements.

[44] IEA, *Achievements of appliance energy efficiency standards and labelling programs: A global assessment, 2015.*

The independent review of the E3 Program in 2015 identified that it is contributing, in avoided energy costs, more than $1 billion to the Australian economy and $114 million to the New Zealand economy annually. Combined, this is an estimated 11.8 million tonnes of carbon emissions avoided per annum[45].

The Problem

Consumers and businesses are exposed to unnecessarily high lighting electricity costs because their lighting is not as efficient as it could be. MEPS and technology improvements have increased the efficiency of lamps since 2009 with average Australian households now using an estimated 34 per cent less electricity to light their homes. Similarly, improvements have occurred in New Zealand although to a lesser extent with the average household using 14 per cent less electricity to light their homes[46]. However, MEPS requirements have not kept pace with improvements in lighting technology and therefore are no longer achieving their purpose of removing the least efficient lamps from the market.

Inefficient incandescent and halogen lamps (representing 73 per cent of supermarket sales in Australia and 82 per cent of sales in New Zealand) dominate sales, are cheap to purchase at around $3 each for a standard bulb, but are a more expensive choice than the more energy efficient CFL and LED lamps when accounting for electricity, lifetime and replacement costs.

Good quality LED lamps currently exceed the efficacy of CFLs, with the additional advantages of being mercury free, long lasting and being available in a versatile range of colour temperatures and configurations to replace filament lamps (particularly reflector types). However LED technology, while offering significant electricity savings opportunities and being offered alongside regulated CFL and filament products, is currently not subject to MEPS requirements.

Unfortunately the availability of poor quality LED lamps on the market has the potential to quash consumer confidence in the technology (as happened previously with CFLs) and reduce the energy and dollar savings that could be realised through the transition to this technology.

A recent Australian consumer survey[47], jointly conducted by CHOICE and the former Department of Industry Innovation and Science, identified that 19 per cent of consumers in the CHOICE sample and 9 per cent of consumers in the i-VIEW sample have experienced issues with poorer quality LED lamps, including early failure, glare, flickering, colour and compatibility. Further, 12 per cent of CHOICE respondents and 8 per cent of i-VIEW respondents indicated they were not likely to buy LEDs in the future, with many stating they did not believe the claims of lifetime and energy efficiency, or they did not like

[45] E3, *Greenhouse and Energy Minimum Standards (GEMS) Review 2015 Report*, prepared by Databuild, 2015.
[46] E3, Residential Baseline Study 2015, based on improvements in the period 2009 to 2015
[47] E3 and Choice, *Household Lighting Consumer Survey Report*, 2016

the quality of light from LEDs (colour temperature, brightness, light output and spread of light were mentioned). The majority of complaints received by the ACCC relating to LED lighting between 2010 and 2016 relate to early failure of LED lamps[48].

Information failures on lamp packaging are resulting in consumers being unable to easily obtain the information they need to make an informed decision in relation to the comparative electricity use, lifetime and lighting service provided by the product, thus losing out on the opportunity to reduce electricity and replacement costs. Retail lighting shelves are dominated by halogen lamps, limiting space for consumers' more efficient options.

The low unit cost of lamps also makes it less likely that consumers will invest the time required to properly understand the full lifetime cost implications of their purchase decision. The New Zealand RightLight programme showed that while some consumer behaviours changed, many consumers continued to purchase the cheapest product on the market, despite a broad education campaign promoting the benefits of more efficient lighting. Consumer research in Australia and the United States provides further support that with such a small up-front cost, a significant portion of the population are not motivated to spend time thinking about their lighting purchase decision and remain with the status quo.

Consumers and businesses are often faced with the problem of split incentives. Cheap, inefficient, potentially low quality lamps with short lifetimes are purchased by builders, owners and short-term renters of commercial and rental properties as there is no long-term incentive to reduce frequency of lamp replacement or electricity usage costs.

Problems with the current regulations

MEPS requirements have not kept pace with improvements in lighting technology and therefore are no longer achieving their purpose of removing the least efficient lamps from the market.

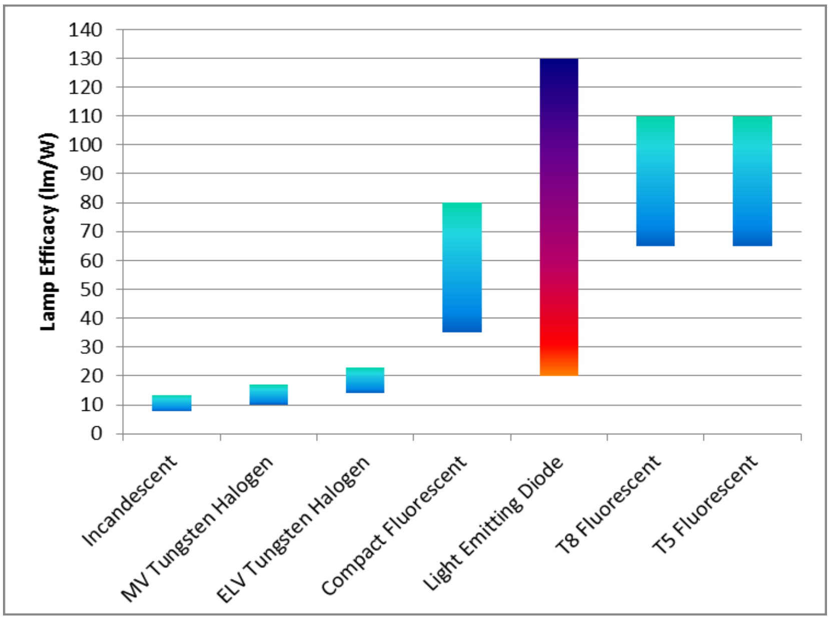
Figure 11 below shows the large difference in lamp efficacy between different lighting technologies based on market data. Lamp efficacy is a measure of efficiency, in lumens of light output (brightness) from a lamp per Watt of electricity. In order of increasing efficacy, lamps are typically as follows (efficacy shown for a typical 700 lm lamp):

- Incandescent: ~11 lm/W
- MV halogen: ~14 lm/W
- ELV halogen: 14-25 lm/W
- CFL: 50-75 lm/W and largely static (possibly some minor improvements being made, although this is a mature technology – research and development investment is now primarily going into LED technology)

[48] ACCC received 67 complaints about LED products in the period 2012 to 2016

- LED: 50-125 lm/W and increasing[49]
- Linear fluorescents: 65 to 110 lm/W

Figure 11: Typical efficacies of lamp technologies



It is expected that there will be no increase in efficacy or performance characteristics of incandescent and halogen lamps on the Australian or New Zealand market. Lighting Council Australia and Lighting Council New Zealand feedback on the Incandescent, Halogen and CFL product profile[50] is that halogen lamp efficacy is state of art (considering the balance between commercial reality, technical feasibility, product quality and reliability) and there is not expected to be any further research and development on halogen lamps, rather investment is focused on LED lighting.

Unlike other lighting technologies, LED are not currently subject to MEPS requirements in Australia or New Zealand. Energy consumption by LED lamps is currently a small percentage of overall lighting energy use, and the efficacy of LED lighting is expected to continue to improve over the next several years. The primary opportunity in achieving energy savings with LED lighting technology is through the replacement of less efficient technologies with LED lighting. Continued savings could also be made by removing poorer performing LED lighting from the market as the technology improves. There is evidence of poor quality LED products on the market which is discussed below.

While the product profile did identify some potential further savings that could be achieved through increasing the MEPS for CFLs, industry stakeholders have not been

[49] E3, 2014

[50] E3, *Product Profile Report – Incandescent, Halogen and Compact Fluorescent Lamps*, 2014

supportive of regulatory changes for a product they believe will rapidly be replaced by LED equivalents in the market.

LED Reputation

Good quality LED lamps currently exceed the efficacy of CFLs. Testing in Australia, New Zealand and overseas show that LED products continue to improve in terms of light output, efficacy and compatibility, while rapidly reducing in price. However, evaluation of LED products currently available in the marketplace indicates a wide variation in quality and efficacy.

The LED Product Profile[51] evaluated the quality and performance of LED lighting available in the market, referencing test results of a range of LED testing commissioned by E3 in 2009, 2010, 2012, 2013, 2014 and 2016[52], as well as overseas testing. Based on these test results, the product profile identified key quality and performance challenges for LED lighting including:

- Significant variations in lamp efficacy – some LED products would fail the current MEPS for CFLs (Figure 12)
- Significant variations from tested versus labelled wattage with differences of 20-50 per cent
- Inaccurate equivalency claims
- The lumen (light) output of some lamps was close to half of that claimed
- Some lamps exceeded the allowable colour deviation, although test results in this area has improved
- Many lamps had significant variation between claimed and tested correlated colour temperature (CCT; the colour of light produced), with some of lamps claiming to be a cool white light (6000 Kelvin) but when tested were actually a warm white light (3000 Kelvin) (Figure 13)

[51] E3, *Product Profile Report – Light Emitting Diodes (LEDs),* 2015
[52] Lamp testing was undertaken by an independent accredited test laboratory

Figure 12: Variance between labelled and tested LED lamp efficacy (lamps purchased in Australia 2009-2016). The solid black line is the Aus/NZ MEPS for CFLs (bare).

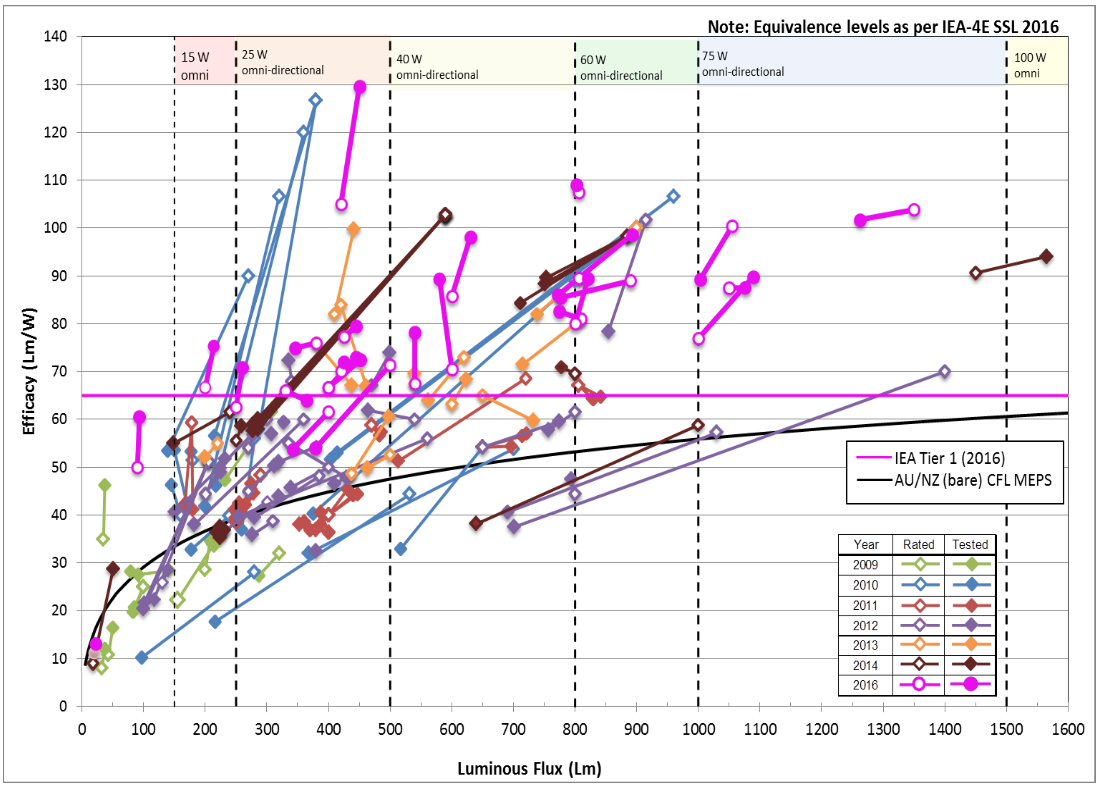
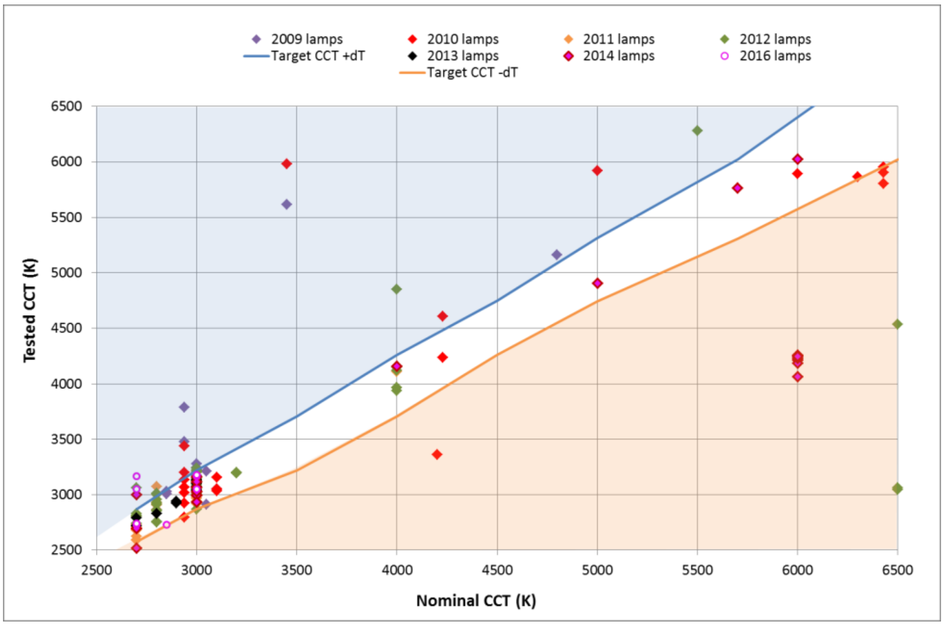


Figure 13: Tested versus manufacturers nominal CCTc (with ANSI C7.377 nominal target CCT tolerance levels). Data points within the white section of the graph are within the target CCT.



- Colour rendering index (CRI)[53] issues, with 10 of the 18 products tested in 2014 found to have a CRI of below 80 (the level generally recommended for office and residential applications)
- Some lamps with a power factor[54] below 0.5 (0.5 is the minimum for CFLs)

53 An indicator of how accurately colours can be distinguished under different light sources

54 Power factor is the ratio of the real power flowing to the load over the apparent power of the circuit.

- Challenges with lumen maintenance, with nearly half the product models tested by the USA Department of Energy (DOE) in 2014 predicted to have failed lumen maintenance requirements by their rated lifetime
- Energy use impacts of 'Smart' lighting, with standby power use accounting for half or more of a lamp's total annual energy use (based on one hour light on and 23 hours on standby mode per day), resulting in LED lamps that consume more power than CFLs, and in some cases are closer to incandescent lamps in terms of efficacy[55].

A recent CLASP report[56] found that there were significant quality issues for colour and lumen maintenance of LEDs sold in Australia, the EU and the USA. Lumen maintenance of some products did not meet the requirements for CFLs of most economies and was far below the requirements for LEDs where regulations exist.

Poor quality LED lamps affect individuals, suppliers and the general community.

- Individuals purchasing relatively expensive poor quality LEDs are disappointed with the quality of the lamp – the product fails prematurely and/or light output and quality expectations are not met
- Suppliers providing quality LED products are negatively impacted due to lower sales, with consumer uptake constrained or decreasing due to negative experiences, or they lose market share to inferior products as they are unable to compete on price
- Overall community benefits of reducing energy use, emissions and waste is reduced as inferior LED products use more energy than necessary, fail early and do not provide a satisfactory alternative to inefficient filament lighting. Consumers begin to transition back to inefficient, short life lamps and, as indicated by the consumer survey, are unwilling to transition to LED in the future.

Whilst Australia and New Zealand operate in a global market, standards and labelling schemes in other countries do not prevent Australia or New Zealand from receiving inferior LED products, as evidenced by the LED testing outlined above. A similar conclusion was drawn by the CLASP report on poor quality CFLs infiltrating the Asian lighting market. The report concludes that stringent performance requirements, combined with effective monitoring, verification and enforcement programs are an effective means to bring high efficiency products into the market.[57] This CLASP report and quality issues only being addressed in CFLs following MEPS regulation in Australia, supports the view that quality issues in the LED market will not self-correct.

Advice from Lighting Council Australia is the emergence of LED lighting as an electronic lighting technology has led to a significant expansion in the number of individual lighting product manufacturers globally, from several hundred manufacturers of traditional lighting technologies to now over 14,000 manufacturers of LED lighting in China alone.

[55] IEA 4E Solid State Lighting Annex, *Task 7: Smart Lighting – New Features Impacting Energy Consumption, 2016*

[56] CLASP, *Mapping & Benchmarking of General Service Lamps, 2015.*

[57] CLASP, *Mapping & Benchmarking of General Service Lamps, 2015.*

The influx of electronics manufacturers with limited background and understanding of the provision of lighting services has contributed to the manufacture and availability of poor quality products.

The Australian Consumer Law (ACL) does not provide the ACCC and state regulators with any role in determining which products make it to market from a quality perspective. Thus this law will not address LED quality issues and the resulting decline in consumer confidence and take-up. The operation of the ACL and role of the ACCC is explained under 'Other policies that impact these problems' section.

In response to the LED product profile, Lighting Council Australia, Lighting Council New Zealand and the Illumination Engineering Society Australia and New Zealand supported MEPS for LED lamps and luminaires, recommending that test standards should be aligned with international tests to reduce regulatory costs for industry.

Imperfect information

Information failure is a problem as buyers are not able to easily compare the lifetime costs or comparative quality and performance of different lamp technologies, and therefore are missing out on electricity and replacement savings.

Market research has shown that consumers often lack knowledge about estimating the electricity use, equivalency and running costs for different lighting technologies. They may also make decisions based on incorrect or implied marketing information or limited understanding, for example that low voltage halogen lighting is efficient ("low energy") [58]. This problem is exacerbated by labelling on packaging. For example, some halogen products currently being sold in Australia and New Zealand are marketed as energy efficient.

The 2016 Australian consumer survey found that only 55 per cent of i-VIEW respondents (sample considered to be representative of the general public) identified LEDs as the most energy efficient form of lighting, with 10 per cent considering that halogen lighting was the most energy efficient compared to 15 per cent who selected CFLs, and 12 per cent did not know. Similarly, only 50 percent of i-VIEW respondents identified LED lighting as having the longest lifetime, with 14 per cent who did not know, 14 per cent selecting CFL and 8 per cent selecting halogen[59].

Australian import and sales data (Figure 6 and Figure 9) shows that with the introduction of minimum standards for incandescent lamps in 2009, approximately 50 per cent of consumers shifted to halogens which whilst slightly more efficient than incandescent are relatively inefficient in comparison to CFLs available at that time.

[58] Winton Sustainable Research Strategies, 2011
[59] E3, Consumer Household Survey, 2016

Consumer research undertaken in Australia in 2010, to evaluate the education campaign that ran from 2008 to 2010[60], assists in understanding why consumers transitioned to halogen with the removal of the least efficient incandescent lamps.

- Halogens were seen as the improved incandescent; many people preferred the overall physical shape, colour and brightness of halogen and the familiarity with incandescent lamps was seen as a reason why people may increasingly purchase them in preference to CFLs
- many respondents expressed issues with the light characteristics or compatibility issues of CFLs.

The research also found that many consumers still lacked confidence in choosing the right light bulb in terms of brightness, colour and differences between technologies. To address this issue in the future, the evaluation recommended that clear messaging on packaging would be valuable, provided it appears on all packaging.

Finally, the evaluation identified that 80 per cent of respondents said that energy efficient lighting is very or quite important to them. At that time halogen was presented as a more efficient option than incandescent and as such many of those who transitioned to halogen may have considered that this was an energy efficiency choice.

The Consumer Household survey 2016 provides more recent insight to why consumers are still purchasing halogen. Of the 608 CHOICE respondents who had halogen installed in their homes, 41 per cent identified this was because they are replacing like for like based on what they have in their home, 21 per cent because they prefer their light output, 19 per cent because they work best with their dimmer and 7 per cent identified purchase price as the reason.

In New Zealand, (which adopted an education approach to transition away from incandescent lamps while later putting in place a MEPS for CFLs only), the majority of consumers chose to remain with incandescent lamps while some responded to education by moving to mostly halogen.

The New Zealand survey of consumers in December 2015[61] shows that around 53 per cent of respondents agreed that LED light bulbs would reduce household energy costs, with 40 per cent neither agreeing nor disagreeing.

Recent research in the United States has highlighted that lighting can face a higher barrier than other technologies in regards to the perception of operating cost information and potential reductions in energy bills[62]. Results suggest consumers are pessimistic about (or

[60] Winton Sustainable Research Strategies, 2010

[61] EECA, LED Lighting consumer survey, Ipsos, 2015

[62] 'Perception' was determined by conducting a field experiment with 183 participants and using the implicit discount rate (IDR) method. IDR is a method used by researches to measure the relative priority consumers place on energy efficiency verses upfront cost when making technology purchases.

pay little attention to) future economic savings delivered from the energy efficient alternatives[63].

New Zealand supermarket sales and consumer research support the view that with such a small up-front cost, a significant portion of the population do not spend time thinking about their lighting purchase decision and remain with the status quo.

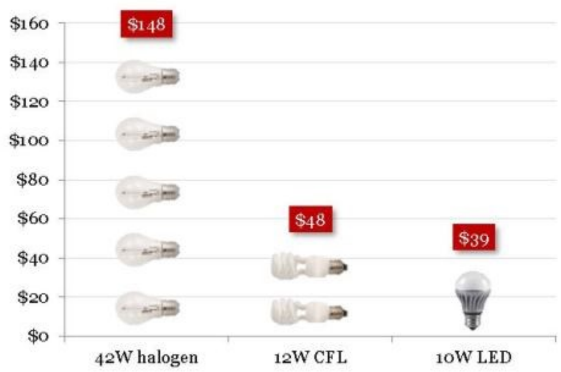
Lifetime cost

The lifetime cost (purchase price, replacement frequency and electricity charges) to light our homes and businesses is often not clear.

- The consumer needs to first identify the equivalent LED lamp, then calculate or otherwise identify the amount of electricity consumed by the alternative lamps and, using their marginal electricity tariff, calculate the electricity costs of the alternative lamps. Electricity usage and associated costs from lighting is combined with other electrical appliances on electricity bills and provided on a periodic basis, meaning that lighting electricity costs are not easily identified and the effectiveness of investing in energy saving lamps not well understood.
- The consumer requires a good basis for either trusting the sources of such information or verifying the promised performance, and the ability to do the calculations.
- In the Household survey 80 per cent of respondents indicated that they would be more likely to buy LEDs when the lifetime cost was explained[64]

Two of the main differences between lighting technologies are lifespan and efficiency. For example, while a halogen light bulb is cheaper to buy than an LED, a good quality LED lasts 5 to 15 times longer and consumes a quarter of the energy. For example, a lamp (running 3 hours per day) that produces 800 lumens has a lifetime cost over 10 years of $39 for LED, in contrast to $48 for CFL and $148 for halogen[65].

Figure 14: Lifetime costs of halogen, CFL and LED lamps over 10 years, with 800 lumen output



[63] J Min, I Azevedo, J Michalek and Wändi Bruine de Bruin, 'Labelling energy cost on light bulbs lowers implicit discount rates', *Ecological Economics, vol. 97, 2014, pp. 42-50.*

[64] E3, 2016

[65] Based on lifetimes of 6000 hours for CFL, 2000 hours for halogen and 15000 hours for LED; an LED purchase price of $10, CFL price of $6 and halogen price of $3; electricity tariff of 28.55c/kWh

At the home level, an average Australian home with 37 lights with good quality LED installed would spend $81 annually in electricity for lighting, in comparison to a home with poor quality LED spending $129, CFL spending $102 and halogen spending $310[66]. New Zealand homes on average have 26 lights, predominantly GLS incandescent or halogen, costing $245 per annum in electricity. Replacing the incandescent and halogen lamps with good quality LED lighting would reduce spending to $79 annually on electricity[67].

However, the amount of information and calculations required to compare the lifetime cost of different lamps, contrasted with the small up-front purchase cost, makes it less likely that consumers will invest the time required to make an informed decision on this cost. This is supported by the 2016 Australian consumer survey i-VIEW results which found that whilst 47 per cent were familiar with the claim that LEDs use less electricity than halogen lamps, and 43 per cent were familiar with the claim that LEDs last longer than halogen lamps, only 25 per cent were familiar with the claim that LEDs are cheaper overall than halogen lamps. Consumer research in New Zealand[68] indicates that although the majority of people agreed that LEDs would significantly reduce household energy bills (53 per cent) and are overall better value for money (52 per cent), a large proportion (40 per cent) neither agreed nor disagreed.

These surveys suggest that consumers are not being provided with the information they need to make an informed decision on lifetime cost, or are not motivated to do so given the low purchase price of light bulbs and light bulbs being one of many purchases made at the supermarket or trade store.

Many retailers in Australia and New Zealand are continuing to promote LED technology with their own marketing and promotions. This includes charts displayed in-store to assist customers in finding a more energy efficient replacement lamp, highlighting information on 'lumens', differences in energy use and lifetime. The fact that in New Zealand, with a broad government campaign, supplemented by retailer communication, a significant portion of consumers have remained with the cheapest tungsten filament alternative rather than even making the change to halogen lighting, supports that whilst consumers may identify energy efficiency as important, most consumers are not motivated to spend time on lamp purchase decisions and remain with the status quo.

Quality and performance criteria

In addition to difficulty in calculating lifetime costs, buyers are unable to easily compare quality and performance criteria for different lighting technologies. Halogen lamps (in Australia only) and CFLs are required to display watts, lumens, lifetime (and mercury for CFLs) on product packaging and be accurate in any claims of incandescent equivalency. However, there are no mandatory labelling requirements for LED lamps. The absence of efficacy (lumens/watt) from all lighting technologies makes the comparison of efficiency

[66] Based on average usage and national tariff of 28.55c/kWh
[67] Based on average usage and a national consumer tariff of 24c/kWh
[68] EECA, Consumer Monitor survey, Ipsos, 2015

within and between lighting technologies more difficult. The majority of consumers (55 per cent) use equivalence claims as a guide to lamp brightness, while 18 per cent use wattage and only 15 per cent use lumens (light output) as a guide[69]. Some manufacturers are also continuing to highlight watts on packaging as opposed to lumens, which makes the comparison of lamp technologies more challenging for consumers.

Compatibility concerns

The Australian consumer household survey suggests that some consumers are purchasing halogen lamps due to compatibility concerns with LED lamps. Reasons provided by the 10 per cent of survey respondents who stated that they would not buy LED lamps in the future included transformer or dimmer compatibility concerns and the belief that their light fitting would need to be changed over to fit an LED. Other reasons were upfront cost, light quality and they did not believe claims of lifetime and energy efficiency. Of the sample, 43 per cent of households had a dimmer in their home and of these 62 per cent advised they had experienced issues with compatibility with certain lamps – 59 per cent CFL and 42 per cent LED.

As part of the 2016 residential lighting audit, 16 per cent of respondents with dimmers in their homes reported compatibility issues in using LED lamps with their dimmers.

Compatibility is further explored under the options section of this RIS.

Split incentives

Principal-agent problems exist in both the commercial and residential market. Cheap inefficient lamps are purchased for commercial and rental properties and new properties for sale as there is no incentive to reduce replacement or electricity costs. For example, a builder or property owner (the agent) may choose cheaper, less efficient lighting to minimise their build costs. Even in cases where the agent may select LED lighting, they may choose relatively cheaper models that are comparatively less efficient or of poor quality and reliability when compared to other efficient lighting alternatives. This is not always in the best interest of the building occupant (the principal) who is exposed to the operating costs and quality of the lighting system installed. In the case of LED lighting, the exposure to higher operating costs or poor quality may occur over a long lifetime.

The Commercial Lighting Product Profile[70] also identified significant variations in the efficacy (judged by the light output ratio) of commercial luminaires[71] in the market, demonstrating that whilst more efficient products exist, due to split incentives there remains demand for cheap poor, inefficient, quality products.

Although the energy efficiency of linear fluorescent lamps and ballasts are already regulated through MEPS in Australia and New Zealand, neither the efficiency of light

[69] E3, Consumer Household Survey, 2016

[70] E3, 2015

[71] A luminaire includes all the parts necessary for supporting, fixing and protecting lamps, but not the lamps themselves.

distribution by the luminaire or the total energy performance of the luminaire-lamp-ballast combination is regulated. Market research of luminaires currently sold on the international market, including Australia and New Zealand, has showed a wide variation in efficacy. For example, while the average luminaire efficiency of commercial troffer luminaires is between 50 and 60 lumens per watt, some products offered 90 to 100 lumens per watt while other products were available with a luminaire efficiency of 10 lumens per watt, effectively converting the light from an efficient linear fluorescent lamp that complies with regulations into one of the most inefficient light sources available.

Short term renters may consider that the higher purchase price of efficient lamps may not be worth the investment if they intend not to live at the same address for long enough to fully benefit from long life efficient lamps. A similar disincentive may affect owner-occupiers who intend to sell or rent the property. Australians and New Zealanders are highly mobile – according to the 2011 Australian Bureau of Statistics (ABS) census, 15 per cent of individuals were at a different address 12 months earlier[72] and 39 per cent were at a different address 5 years earlier[73]. Similarly, Statistics New Zealand found that in 2013 that 50.6 per cent of people were in a different address to five years previously.[74] In part, the reluctance of renters to invest in LED may be information failure. An incandescent 60 watt bulb in a higher usage area has an electricity cost of approximately $17 annually, in comparison to purchase and annual electricity costs of an equivalent CFL bulb of $9.[75]As stock is upgraded to CFL or LED, renters will also benefit through savings in replacement costs.

Recent New Zealand consumer research identified the purchase cost of LEDs as a barrier for 24 per cent of consumers[76]. Similarly, in the 2016 Residential Lighting Audit (Australia), about 20 per cent of respondents identified LEDs are still too expensive.

While the cost of LED lighting is still significantly higher than halogen or even CFL products, this cost has reduced rapidly over the last several years and is predicted to continue[77]. Of products tested by the Australian Government, the unweighted average cost per 100 lumens of light output has reduced from $33 in 2009 to $7 in 2014 to $3 in 2016. Of the 5 non-directional non-dimmable lamps with lumen output above 760 lumen (equivalent to a 60W incandescent) the cost per 100 lumens is $1.60 in 2016. Retail sales data for 2015 indicates that the average price for a typical omni-directional GLS LED (600-700 lumens) was $11.90[78].

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72 www.abs.gov.au/websitedbs/censushome.nsf/home/statementspersonpur1p?opendocument&navpos=450.
73 www.abs.gov.au/websitedbs/censushome.nsf/home/statementspersonpur5p?opendocument&navpos=450.
74 www.statistics.org.nz
75 Based on 3 hours of use per day at $0.29 per kWh
76 EECA Consumer Monitory survey, Ipsos, 2015.
77 McKinsey & Company, *Lighting the way: Perspectives on the global lighting market*, 2012.
78 Typical omni-directional halogen lamp cost is approximately $3

Other policies that impact these problems

The problems outlined above relate to problems with current regulations, information failures and principal-agent problems that are restricting the uptake of more energy efficient long life lamps. Although these issues cannot be specifically addressed by other policies, other Australian or New Zealand government programs that promote energy efficient lighting are discussed.

Further, the operation of the Australian Consumer Law (ACL) and the role of the ACCC is explained. This content has been provided by the ACCC. New Zealand's Commerce Commission and Fair Trading Act perform similar functions in New Zealand. This is not discussed in detail below, however further information about consumer law in New Zealand is available from the Commerce Commission website[79].

Interior lighting

The AS/NZS 1680 series for interior lighting contains minimum recommended illumination levels for performing a range of visual tasks efficiently and without visual discomfort. While the AS/NZS 1680 series itself is not mandatory, parts of the Standard are referred to in other legislation as a mandatory requirement (e.g. *1680.0:2009 Interior lighting - safe movement* is mandatory as required by the Building Code of Australia). There is no recommendation on efficiency of lighting products within this standard series.

Australia

Incentive schemes

These schemes act alongside current GEMS Act lighting MEPS to reduce energy used by residential and commercial lighting. Currently these programs extend beyond the proposed phase out date for additional incandescent and halogen lamps.

The New South Wales Energy Savings Scheme includes lighting retrofits in residential, commercial or industrial facilities. For commercial projects, evidence is collected on the lighting configuration before and after an upgrade, and testing is conducted to ensure that the final lighting configuration meets relevant lighting standards so output and service levels are maintained. The Commercial Lighting Energy Savings Formula is used to calculate energy savings from an upgrade of general lighting in commercial premises. Energy savings certificates are created, which electricity retailers then buy. Over 2.1 million certificates for commercial lighting upgrades have been surrendered since 2009, representing 2.1 million tonnes of CO_2e that has been abated.

Households and small businesses are able to access energy efficiency retrofits. Eligible residential lighting activities include replacing halogen downlights with LED lamps or luminaires. The Home Energy Efficiency Retrofits (HEER) method is used to calculate

[79] www.comcom.govt.nz/fair-trading/

energy savings and requires a minimum customer co-payment of $90 (excluding GST). The Scheme is legislated to continue until 2025[80].

The Victorian Energy Efficiency Target (VEET) scheme is a white certificate scheme that commenced on 1 January 2009. It comprises 36 individual activities that may be undertaken to increase the efficiency of Victorian residential and non-residential premises. Since 2012, approximately 21 million Victorian energy efficiency certificates (VEECs)[81] have been created in residential premises, with almost 37 per cent for residential lighting upgrades. Of the approximate 1.3 million VEECs created in commercial premises, almost 80 per cent have been for commercial lighting upgrades. The Scheme is legislated to continue in three-year phases until 1 January 2030[82].

The Australian Capital Territory Energy Efficiency Improvement Scheme began on 1 January 2013 and sets a Territory-wide energy savings target, including obligations for ACT electricity retailers to meet an individual Retailer Energy Savings Obligation (RESO). The program includes upgrades of halogen downlights to LED which are currently offered free of charge to residents. The scheme was recently extended to include ACT business premises and currently extends to 2020[83].

The South Australian Retailer Energy Efficiency Scheme (REES), began on 1 January 2009 as a residential only scheme, but was expanded from 1 January 2015 to include the commercial sector. Commercial lighting upgrades follow those specified under the NSW and Victorian schemes and the REES calculates energy savings using the NSW energy savings lighting calculator. The scheme obligation is on energy retailers who meet certain eligibility requirements, and does not currently include trading of certificates. The Scheme is approved to 31 December 2020[84].

Emissions Reduction Fund

The Emissions Reduction Fund (ERF) commenced in late 2014. The ERF is designed to provide incentives for achieving lowest cost emissions reduction activities across the Australian economy. A number of methods have been approved for use under the ERF, including commercial lighting which allows for upgrades to commercial lighting to implement energy efficient technology[85].

National Construction Code and Building Code of Australia

The National Construction Code (NCC) applies to building work such as new builds and major renovations, thus restricting influence on lighting efficiency to certain stages in the building lifecycle, whereas product based regulation relates to replacement products used

[80] www.ess.nsw.gov.au

[81] 1 VEEC = 1 deemed tonne of greenhouse gas abated)

[82] www.veet.vic.gov.au

[83] www.environment.act.gov.au

[84] www.sa.gov.au

[85] www.environment.gov.au

at all stages. Administration of the NCC is the responsibility of the states and territories under their various building and plumbing Acts and Regulations.

Volumes One and Two of the NCC detail technical provisions for building design and construction including energy efficiency. For artificial lighting there is a maximum illumination power density requirement (Watts/m²) for new construction or significant renovation. The purpose is to avoid over-installation and excessive use of lighting, and improve the use of efficient lights and fittings.

The maximum aggregated lamp power density of hard-wired electric residential lighting is:

- 5 Watts/m² for internal areas
- 4 Watts/m² for exterior areas
- 3 Watts/m² for garages.

Table 5 specifies the requirements for spaces in commercial buildings. The NCC as of 2016 is on a 3 year cycle, which means levels will not revised until 2019.

Table 5: Building Code Australia maximum illuminated power densities for select spaces in commercial buildings, and corresponding AS 1680 lighting levels and lumens per watt (NCC 2016)

Building Space	W/m²	Recommended Lux Level (as per AS/NZS 1680 Interior Lighting)	lm/W
Board room and conference room	10	240	24
Corridors	8	160	20
Entry lobby from outside the building	15	160	11
Office – artificially lit to an ambient level of 200 lux or more	9	320	33
Office – artificially lit to an ambient level of less than 200 lux	7	160	23
School – general purpose learning areas and tutorial rooms	8	320	40

The NCC (Clause J6.3) contains provisions for the switching and control of lighting in commercial buildings, with the intention that 'rooms are not unnecessarily lit or using power when vacant'. Appropriate design requirements for lighting and power control devices are contained in the Specification to Part J6. This includes corridor lighting timers, time switches, motion detectors, daylight sensors and dynamic control devices[86].

Commercial Building Disclosure (CBD)

The CBD program is a national initiative designed to improve the energy efficiency of Australia's large office buildings. The program requires a current Building Energy Efficiency Certificate (BEEC) to be obtained and disclosed at the sale or lease of

[86] National Construction Code, 2016

commercial office space of 2000 m^2 or more. From 1 July 2017, the threshold will be lowered to 1,000 square metres. The BEEC is comprised of a National Australian Built Environment Rating System (NABERS) energy star rating for the building, and an assessment of tenancy lighting in the area of the building that is being sold or leased, and general energy efficiency guidance[87].

The Australian Consumer Law (ACL)

The Australian Consumer Law is the uniform Commonwealth, state and territory consumer protection law that commenced on 1 January 2011. It forms part of the national consumer policy framework which also includes a national product safety regime and improved enforcement, cooperation and information sharing arrangements between Commonwealth, state and territory consumer protection agencies.

Relevantly to consumer protection for poor-quality LED products, the ACL contains prohibitions on misleading and deceptive conduct and false representations, a system of consumer protections and remedies in relation to defective goods and services (the 'consumer guarantees') and a harmonised national product safety and enforcement system.

Misleading and deceptive conduct

It is illegal for a business to engage in conduct that misleads or deceives or is likely to mislead or deceive consumers or other businesses. In addition to the prohibition against misleading or deceptive conduct, it is unlawful for a business to make false or misleading claims about goods or services.

While consumer protection agencies including the ACCC may take an action for breach of the ACL where suppliers are misrepresenting the nature of their goods and obtain penalties against these traders, the ACL does not provide these regulators with any role in determining which products make it to market from a quality perspective (whereas there is legislative recourse to intervene where unsafe products are detected in the market – see below).

Product safety

Traders cannot sell banned products and must ensure that products or product-related services comply with relevant mandatory standards before they are offered for sale.

Under the ACL's product safety provisions, Commonwealth, state and territory ministers can regulate consumer goods and product-related services by issuing safety warning notices, banning products on a temporary or permanent basis, imposing mandatory safety standards or issuing a compulsory recall notice to suppliers.

[87] www.cbd.gov.au

Consumer guarantees

The ACL sets out consumer rights that are called consumer guarantees. These include rights to a repair, replacement or refund as well as compensation for damages and loss and being able to cancel a faulty service.

The ACCC

The ACCC cannot pursue all the complaints it receives or issues that come to its attention about the conduct of traders or businesses and the ACCC rarely becomes involved in resolving individual consumer or small business disputes. While all complaints are carefully considered, the ACCC's role is to focus on those circumstances that will, or have the potential to, harm the competitive process or result in widespread consumer detriment. The ACCC therefore exercises its discretion to direct resources to matters that provide the greatest overall benefit for competition and consumers. The ACCC's compliance and enforcement policy sets out how the ACCC prioritises matters.

The ACCC has received 67 complaints about LED Products in the period 2012 to 2016. The ACCC has not taken any specific enforcement actions with regard to LED products. The ACCC has had previous active engagement with the Department on topics including consumer information issues in the (then) emerging LED market.

Specialist regimes

The ACCC considers that ACL regulators cannot replicate the focus and expertise that specialist regulators deliver. Parliaments have identified enhanced public risk or the need for particular expertise and established specialist regulators in several industries including electrical safety and energy efficiency. While ACL regulators can and do provide strategic interventions in important matters and while the ACL provides an important role to assist with emerging practices, they are not substitutes for specialist regulators[88].

New Zealand

Building energy ratings and audits

EECA Business in New Zealand have developed the NABERSNZ™ (National Australian Built Environment Rating System New Zealand) programme, administered by the New Zealand Green Building Council (NZGBC). Commercial buildings can gain a certified rating to benchmark the building or tenancy for its energy efficiency. Along with energy audits, this can encourage building owners to improve the energy efficiency of their lighting systems.

Energy Efficiency and Conservation Act 2000

The *Energy Efficiency and Conservation Act 2000* provides the legislative framework for the New Zealand Energy Efficiency and Conservation Strategy (NZEECS), EECA and regulations pertaining to energy using products and services.

[88] ACCC, 2016

The NZEECS states the Government's policies, objectives, targets and the means to achieve those policies and objectives with respect to energy efficiency, energy conservation and the use of renewable sources of energy.

The New Zealand Government is considering new national energy targets and has announced it will refresh the New Zealand Energy and Efficiency Conservation Strategy (NZEECS). The new energy targets would be complementary to the existing energy strategy and supported by the new NZEECS. The new strategy will replace the current 2011-2016 NZEECS and is due for release in 2017. The focus of the new initiatives will be on improving energy productivity, reducing carbon emissions, and to broaden renewable energy use beyond electricity and increase its use in the transport and industrial heat sectors. The proposed goal for the new NZEECS is for New Zealand to be more energy efficient, productive and a low emissions economy. It is also proposed to structure the Strategy around practical actions that businesses, consumers and communities and public sector agencies can take to improve their energy efficiency and make greater use of renewable energy. This structure is designed to make the Strategy accessible to different stakeholders and recognises that each actor has different levels of influence and is often responsible for making different types of decisions.

Building Act 2004 and Building Code

The Building Act 2004 sets out the rules for the construction, alteration, demolition and maintenance of new and existing buildings in New Zealand. The regulations under the Act prescribe the Building Code, which all building work must comply with. Performance standards that must be met include energy efficiency (Building Code H). Building Code Clause H1.3.5. states that artificial lighting fixtures must:

(a) be located and sized to limit energy use, consistent with the intended use of space; and

(b) be fitted with a means to enable light intensities to be reduced, consistent with reduced activity in the space.

Artificial lighting energy consumption in commercial, communal non-residential buildings with a net lettable area greater than 300 m^2 must comply with NZS 4243.2 section 3.3 or section 3.4 to satisfy the requirements of New Zealand Building Code H1.3.5.

A lighting power allowance based on the illumination power density (watts per square metre) is set out in AS/NZS 4243.2:2007 Table 1 Lighting Power Density Limit.

ENERGY STAR

The ENERGY STAR program is a voluntary scheme which provides endorsement labelling for high efficiency products. New Zealand adopted the ENERGY STAR specification for lamps which came into effect in November 2012 and was amended in December 2013. The requirements are identical to those in the US ENERGY STAR specification, with the exception of some amendments (additional lamp holder types and changes to the downlight types to meet New Zealand electrical safety requirements). Recently New Zealand has implemented

ENERGY STAR for luminaires (not based on the USA version). A new office lighting/retail LED specification was released in May 2016.

The program uses an endorsement mark to indicate those models produced by participating manufacturers and suppliers that are performing at a high-efficiency level (top 25 per cent most energy efficient products), as defined under the relevant specification. This provides an independent verification of energy efficiency to consumers, and provides a selling point that manufacturers, suppliers and retailers can use in their promotion of lighting products.

Why is government action needed?

This Consultation RIS raises a number of problems that are restricting the uptake of energy efficiency lighting in Australia and New Zealand, which is resulting in the community consuming more energy and producing more emissions than is necessary to deliver our lighting needs.

These problems include regulatory failure due to existing regulations not keeping pace with improvements in lighting technology, information failure as consumers are not provided with the information they need make an informed purchasing decision or not motivated to do so, and split incentives whereby commercial and rental properties have no incentive to purchase more efficient but higher upfront cost products.

The objective of the proposed government action is to improve the energy efficiency of lighting in Australia and New Zealand, while maintaining lighting quality, by addressing the issues that are restricting the purchase of efficient effective long life lighting products in Australia and New Zealand. This objective is consistent with the Australian and New Zealand government's policies to reduce greenhouse gas emissions and improve energy productivity.

To ensure options will be effective and practical, the Department has consulted extensively with the lighting industry and undertaken consumer research to inform analysis.

The objectives of this RIS are consistent with the principles of best practice regulation as defined in the COAG RIS Guidelines, including Principle 4 which requires that "In accordance with the Competition Principles Agreement, legislation should not restrict competition unless it can be demonstrated that the benefits of the restrictions to the community as a whole outweigh the costs; and the objectives of the regulation can only be achieved by restricting competition".[89]

Without government action, the transition to efficient lighting in Australia and New Zealand will be slow and incomplete, with more energy being consumed and higher electricity costs for consumers than is necessary.

[89] The COAG RIS guidelines are broadly consistent with the New Zealand Government RIS guidelines.

Policy options under consideration

The following policy options are considered to address the problems identified in this RIS:

- No changes to the existing requirements - **Business as Usual** (BAU)
- **Option A** involves implementing MEPS for LED lamps and integrated luminaires to address efficacy and quality issues
- **Option B** builds on option A by also applying MEPS to non-integrated Commercial Luminaires to address any regulatory imbalance and achieve further energy efficiency savings. In doing this, option B involves higher costs for suppliers compared with option A but will provide greater benefits in terms of energy savings than option A
- **Option C** is the same as option B, as well as introducing mandatory labelling on remaining incandescent, halogen, CFL and LED lamp and small LED luminaire packaging to address information failures for consumers. Labelling would enable consumers to easily compare lamps and select a suitable energy efficient replacement lamp, at point of purchasing, providing long term education post the campaign[90].
- **Option D** includes option A and mandatory labelling

Australia only

- **Option E** includes option A, as well as increasing incandescent and halogen MEPS (Australia only) to remove the most inefficient lamps, consisting of categories of halogen and incandescent lamps
- **Option F** includes option B, as well as increasing incandescent and halogen MEPS (Australia only) to remove the most inefficient lamps, consisting of categories of halogen and incandescent lamps

[90] This option would require regulation to be introduced in New Zealand for incandescent and halogen lamps. Currently only CFL and linear fluorescent lamps and ballasts are subject to MEPS in New Zealand.

Table 6: Policy Options

Policy proposal	Options					
	A	B	C	D	E	F
1. **Introduce MEPS for LED lamps and integrated luminaires**. This includes requirements for efficacy[91] as well as a range of other performance parameters. Minimum performance levels would be based on available market analysis, product testing and expert advice, including the work of the International Energy Agency (IEA) 4E Solid State Lighting Annex. The MEPS will also specify a mandatory set of information to be included on product packaging with the option to introduce a standardised information label. Given the rapid improvements in LED lighting, this option includes a timetable of efficacy increases over several years[92]. Specifications for testing of LED lighting will also be developed drawing upon international test standards.	X	X	X	X	X	X
2. **Introduce MEPS for non-integrated commercial luminaires**. This proposal would apply to standard linear commercial luminaires and recessed cans and will make use of a simple test based on photometry information already available to manufacturers in order to minimise compliance costs. This would achieve energy savings in the cheap end of the commercial market where fluorescent lighting is likely to be used as the least cost option in new builds for some years to come, as well as addressing a potential regulatory imbalance if MEPS is applied only to LED integrated luminaires.		X	X			X
3. **Increase incandescent and halogen MEPS (Australia only) to remove the most inefficient lamps** including a number of categories of halogen lamps (including mains voltage and low voltage), as well as additions to the categories of incandescent lamps subject to MEPS. This will involve revisions to the current incandescent MEPS to make adjustments to product definitions and scheduling of when these products will be phased out of the market.					X	X
4. Introduce **mandatory labelling** for lamp products primarily used in the residential sector including directional and non-directional lamps and small integrated luminaires. This would apply to all technologies.			X	X		

Other options considered

Increasing MEPS for CFLs

While the Incandescent, Halogen and Compact Fluorescent Lamps Product Profile identified some capacity to achieve further energy savings by increasing the minimum efficacy levels for CFLs[93], industry stakeholders are not supportive. They consider CFLs as a product with a limited future once LEDs become an affordable alternative. Industry has advised that the number of manufacturers producing CFLs is decreasing and retailers are also starting to reduce CFL shelf space. Based on trend data provided by Lighting Council Australia, Australian sales of CFLs has declined from 27 per cent market share in 2012 to

[91] Efficacy is a term used to describe the relative energy efficient of lighting products in lumens per watt.
[92] The timetable will be specified in regulation up-front. Updates to the regulation timetable would be made if market monitoring and stakeholder feedback indicates this is necessary
[93] E3, Incandescent, Halogen and Compact Fluorescent Lamps Product Profile, 2014

12 per cent in 2015, and is forecast to decline further to 5 per cent in 2017[94]. New Zealand supermarket sales of CFLs have remained steady at 14 per cent of market share in the three years between 2013 and 2015. It is expected that consumers and the market that already use CFLs will readily transition to LEDs without the need for regulatory intervention (unlike filament lamps). Current MEPS will be retained and sales monitored, with the MEPS to be reviewed should CFL sales unexpectedly increase or fail to decline to less than 5 per cent of the market by 2020.

Increase MEPS for linear fluorescent lamps

Similarly, whilst the Commercial Product Profile identified capacity to achieve further energy savings by increasing the MEPS for linear fluorescent lamps[95], this option is not proposed at this time.

Industry (Australia and New Zealand) has advised that new commercial buildings and refurbishments have largely transitioned to LED and linear fluorescents are most likely to be limited to replacement in existing luminaires (apart from some cheaper commercial new builds and renovations). This anecdotal information is consistent with trend market data provided by Lighting Council Australia, which shows a decrease in linear fluorescent sales and an increase in LED commercial lighting products. Australian sales of linear fluorescent T8s has declined from 13.4 per cent market share in 2012 to 5.2 per cent in 2015, and is forecast to decline further to 3.8 per cent in 2017. Similarly sales of T5 lamps has declined from 6.1 per cent in 2012 to 3.5 per cent in 2015[96]. Sales of LED lamps in New Zealand increased from 1.3 per cent of market share in 2014 to 3.4 per cent in 2015, with linear fluorescents decreasing in sales volume by 8.4 per cent over the same period[97].

Further, industry have argued that in existing buildings, linear lamps tend to be replaced like for like (products compliant with an increased MEPS would have same wattage but more light) thus a reduction in energy is not achieved, just more light output is being produced in existing installations constrained by the distribution of installed luminaires), largely offsetting any benefits.

Current MEPS will be retained and sales monitored, with the MEPS to be reviewed in 2019.

Inclusion of circular fluorescent lamps within the current MEPS, which would allow the phase out of inefficient halophosphor circular lamps has been discounted on the basis that sales volumes are low at 1.3 per cent of the market and expected to further decline below 1 per cent in 2017[98]. These figures support the expectation that circular fluorescent lamps will naturally be removed from the market (replaced with LED alternatives) without regulatory intervention.

[94] Lighting Council Australia, 2016, Market trend data
[95] E3, Commercial Lighting Product Profile, 2015
[96] Lighting Council Australia, 2016, Market trend data
[97] EECA, 2015, sales data
[98] Lighting Council Australia, 2016

For linear fluorescent lamps, there is an alternative option to set a timetable to increase MEPS to phase out the least efficient linear fluorescent lamps in Australia. The initial proposed dates were T12 2018 (already phased out in New Zealand), T8 2020 and T5 2025. This option has not been pursued for this RIS. This option (and opportunities to improve the energy efficiency of ballasts) will be examined separately before or in conjunction with the review of linear MEPS in 2019.

In agreement with Office of Best Practice Regulation (OBPR), a proposal to reduce allowed mercury levels in CFL and linear fluorescent lamps in Australia in order to meet the requirement of the Minamata Mercury Convention and align with levels set by major markets will be managed in a separate consultation paper outside the RIS process. This is on the basis that it is anticipated that the proposed change will have a minor impact on industry and consumers.

Tax on halogen light bulbs

An Australian tax on halogen light bulbs was explored with the Australian Treasury as an option to reduce sales of inefficient light bulbs and encourage greater uptake of energy efficient CFLs and LED. The key advantage of imposing a tax on inefficient light bulbs is that it retains consumer choice, allowing consumers with a strong preference for halogen light bulbs to continue purchasing them, should their satisfaction from purchasing the product still exceed the now higher price. However, there are a number of disadvantages to pursuing increased energy efficiency by imposing a tax on halogen light bulbs, and Treasury considers these outweigh the advantage noted above.

Key problems in moving consumers away from inefficient light bulbs include imperfect consumer information about the efficiency and lifetime costs of different lighting options, and the incentive for landlords and builders to opt for lighting with the cheapest upfront, rather than lifetime, cost.

A tax would therefore have to increase the price of halogen light bulbs such that it is at least equal to the price of the more efficient light bulbs. Anything less than this and the incentive for landlords and builders to purchase the cheaper halogen product would remain, while other consumers' imperfect information would likely also lead to continued preference for the option with the lower upfront cost. Given indicative pricing of halogen light bulbs at $3 and LED lights at $10, a tax that would increase the price of halogen bulbs above the price of LEDs would need to be in excess of 300 per cent, a rate well beyond what is considered reasonable for a tax.

The 2016 Consumer Household survey suggests some inelasticity in the demand for halogen light bulbs, indicating that 41 per cent of halogen consumers simply replace like for like based on what they have in their home. This again suggests that a tax rate would have to be very high in order to stimulate behavioural change.

Further, a tax on such a narrow base is administratively burdensome for businesses and carries high inefficiencies relative to a broad-based consumption tax. In addition, if the tax were effective in reducing consumption of halogen light bulbs it would quickly become obsolete: the revenue base would go into structural decline, and a new means of incentivising increased energy efficiency in lighting would be required. These features contravene the tax policy principles of sustainability, efficiency and simplicity.

A halogen light bulb tax has therefore not been developed as an option for consideration.

Extension of state white certificate schemes

Extension of the state white certificate schemes that facilitate LED lighting upgrades in New South Wales, Australian Capital Territory, Victoria and South Australia, was explored with Queensland, Tasmania, Western Australia and the Northern Territory. All jurisdictions advised that there is no plan to implement these arrangements in their jurisdiction. Thus the option to extend state white certificate programs to increase the uptake of energy efficient lighting in Australia has not been included.

Business as Usual

Business as usual assumes no changes to existing requirements in Australia and New Zealand.

The natural improvement of energy efficiency lighting is projected to continue as industry focusses more on LED technology and consumers transition to LEDs. However, consumers would still be exposed to high variation in product quality and performance, which will constrain uptake. Information failures will remain, meaning consumers will have difficulty in making informed decisions to select more efficient, cost-effective alternative products.

The transition would be slow and incomplete with unsatisfied consumers that are exposed to poor quality LED products. Consumers and businesses would continue to pay more on replacement and electricity, losing out on savings.

The IEA 4E 2015 Lighting Benchmarking review looked at the status of lighting energy efficiency in a range of countries that had put in place efficiency measures (Australia, Austria, Canada, Denmark, Japan, Korea, UK, and USA)[99]. It found that while intervention had led to a significant reduction in market share of incandescent lamps, the anticipated increase in the average efficacy had not been as high as expected (Australia more effective than all but Republic of Korea). The study identified that the relatively small increases in efficacy appears simply to be that consumers are migrating from the purchase of incandescent lamps to the purchase of marginally more efficient halogen products, resulting in the risk that halogens become the new 'default' lamp of choice for consumers.

LEDs will continue to operate in an unregulated market with no mandatory program for performance standards or labelling. New Zealand runs an ENERGY STAR voluntary energy efficiency scheme, originally established by the U.S. Environment Protection

[99] IEA 4E, 2015

Agency, for a number of electrical appliances including CFLs and LEDs and a range of luminaires. This scheme provides a way for consumers and businesses to identify the most efficient and best performing products. This is a voluntary industry labelling programme, which addresses performance at the high end of the scale. It identifies the top 25 per cent of the energy efficient LED lamps, and therefore will not act to remove poorly performing products from the market. There are currently 205 registered LED luminaires registered with NZ ENERGY STAR.

The Solid State Lighting (SSL)[100] Quality Scheme is a voluntary industry labelling program operated by Lighting Council Australia for SSL lamps and luminaires, with only members of Lighting Council Australia or Lighting Council New Zealand being eligible to participate. The SSL Quality Scheme is based on the U.S. Department of Energy 'Lighting Facts' label. The label is intended to provide the market with confidence that a lamp or luminaire with the scheme label matches the performance claims made by the supplier – however it does not set minimum performance requirements like MEPS schemes or ENERGY STAR. There are currently 238 products registered. The Scheme currently extends to 30 June 2017.

Subsidy programs in VIC, NSW, ACT and SA continue to accelerate the replacement of incandescent and halogen lamps with LED, reducing energy and emissions, but this replacement is limited by demand within states offering subsidy programs, with progress remaining slow in those states where subsidiary programs are not in place.

[100] SSL is an alternative name used to describe LED lighting.

LED MEPS

Set a minimum efficacy level (or levels) for LED lamps (non-directional, directional and linear), and integrated LED luminaires and a range of performance criteria to ensure that LED lighting provides an effective as well as efficient lighting alternative. This will prevent the sale of low quality products, increasing overall energy savings, giving rise to consumer confidence in efficient LED lighting technology.

The MEPS will focus on high volume LED products for residential, commercial and industrial applications and include a timetable to increase minimum efficacy levels, potentially every three years, accommodating the rapid improvements in LED lighting technology.

The minimum performance levels will be based on existing international work, primarily from the IEA 4E Solid State Lighting Annex. The work of the IEA 4E Solid State Lighting Annex, supported by 9 countries, including Australia, provides a source of technical and policy guidance relating to performance levels and testing of LED products[101].

Testing specifications will draw on established international test standards from the International Commission on Illumination (CIE), the International Electrotechnical Commission (IEC), the Illuminating Engineering Society of North America (IESNA) and National Standards organisations (Standards Australia, Standards New Zealand).

To assist consumers in selecting replacement lamps and comparing LED products, proposed mandatory marking requirements will also apply, similar to those in place for CFLs and halogen lamps.

- Consumer testing and consultation with industry on the final marking, including the need and support for a consistent label for directional and non-directional LED lamps and small LED luminaires (should option E or option F be approved), will be undertaken prior to the decision RIS.

The Department is liaising with Lighting Council Australia, Lighting Council New Zealand, and industry representatives on the product scope, definition of family of models and the registration process to reduce regulatory burden for industry.

Proposed timing

If approved, the regulation is planned to commence in January 2018, with the Australian determination, and the test standard to be published six months prior to provide time for industry to implement this change. New Zealand will implement the MEPS by

[101] IEA performance levels are expected to be officially released by December. LED MEPS levels implemented (or proposed) in the EU, Mexico, Malaysia and the USA have also been reviewed in drafting AU/NZ levels.

incorporation into the Energy Efficiency (Energy Using Products) Regulations around this time.

Implementation is proposed to be staged according to the following LED product categories[102]:

- Non-directional lamps; directional lamps; linear LED lamps; and integrated LED luminaires (directional, small) (January 2018)
- Planar luminaires, integrated battens and troffers; integrated LED luminaires (non-directional, small) (2019)
- Integrated LED luminaires (large) (2020)

Table 7: Timeline for LED MEPS and Efficacy Levels (coloured boxes indicate MEPS commencement)

Product Scope	2018	2019	2020	2021	2022	2023
Lamp Non Directional	65 lm/W		85 lm/W			100 lm/W
Lamp Directional	65 lm/W		85 lm/W			100 lm/W
Lamp Linear	100 lm/W		110 lm/W			120 lm/W
Luminaire Small Directional	65 lm/W		85 lm/W			100 lm/W
Luminaire Small Non Directional		65 lm/W		85 lm/W		100 lm/W
Luminaire Planar etc		90 lm/W		110 lm/W		120 lm/W
Luminaire Large			110 lm/W			120 lm/W

Alternatively, MEPS for all LED product categories could commence on the same date (proposed for January 2018). The Department requests feedback on preferred approach.

Scope and parameters

Attachment H includes the proposed draft LED MEPS scope, performance and test parameters and mandatory marking requirements. This has been developed based on the international sources outlined above, in consultation with a technical working group including experts from industry, government, test laboratories and lighting designers from Australia and New Zealand.

Figure 15 and Figure 16 show the 2016 IEA Tier 1 level for non-directional and directional lamps against products tested by E3. Testing of LED products available in the market has shown significant improvements in efficacy over the last few years, as seen with 2016 results. MEPS levels implemented or proposed for the EU and USA are also shown (with dashed lines used to show future performance levels). The Australian/New Zealand CFL MEPS has been included for reference.

[102] These introduction dates will be specified in regulation up-front. Updates to the regulation timetable would be made if market monitoring and stakeholder feedback indicates this is necessary.

Figure 15: IEA Tier 1 level for non-directional lamps against products tested by E3

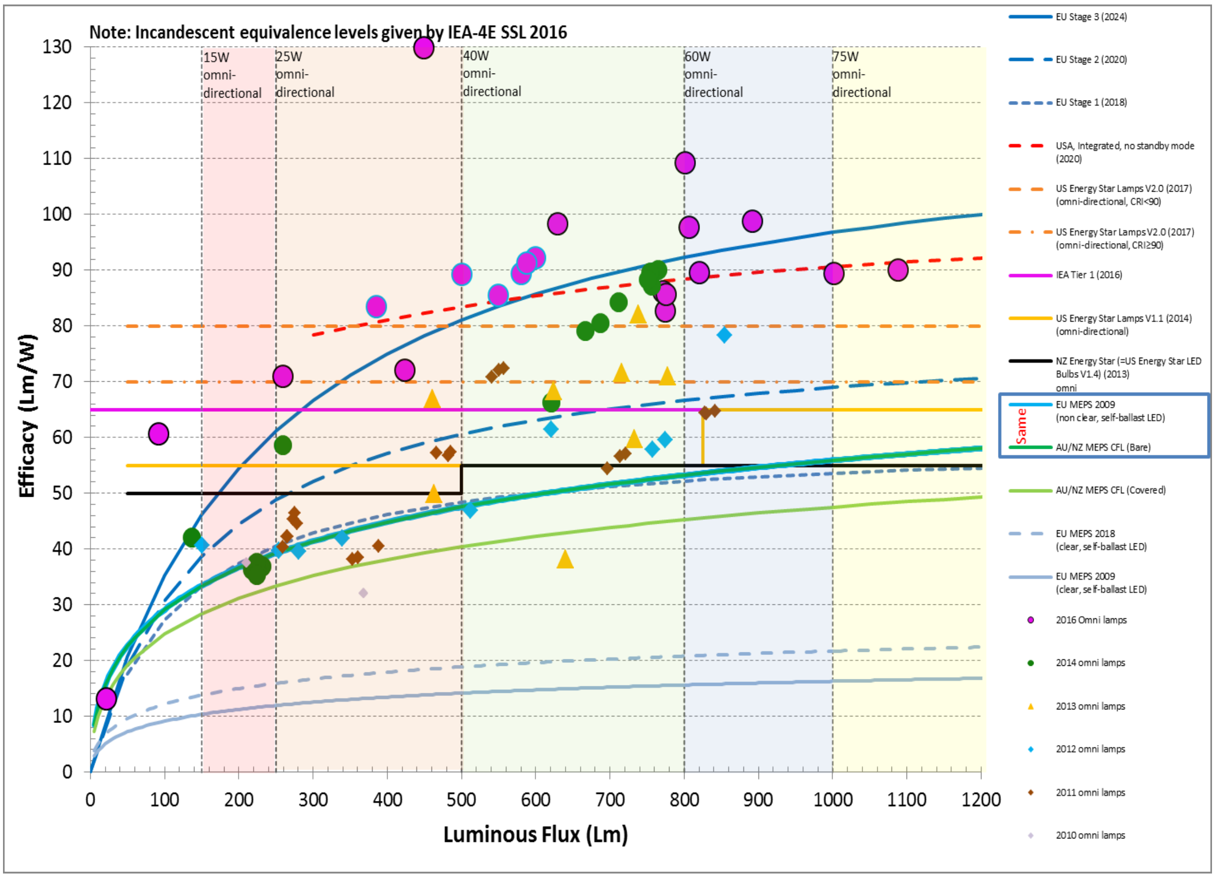


Figure 16: IEA Tier 1 level for directional lamps against products tested by E3

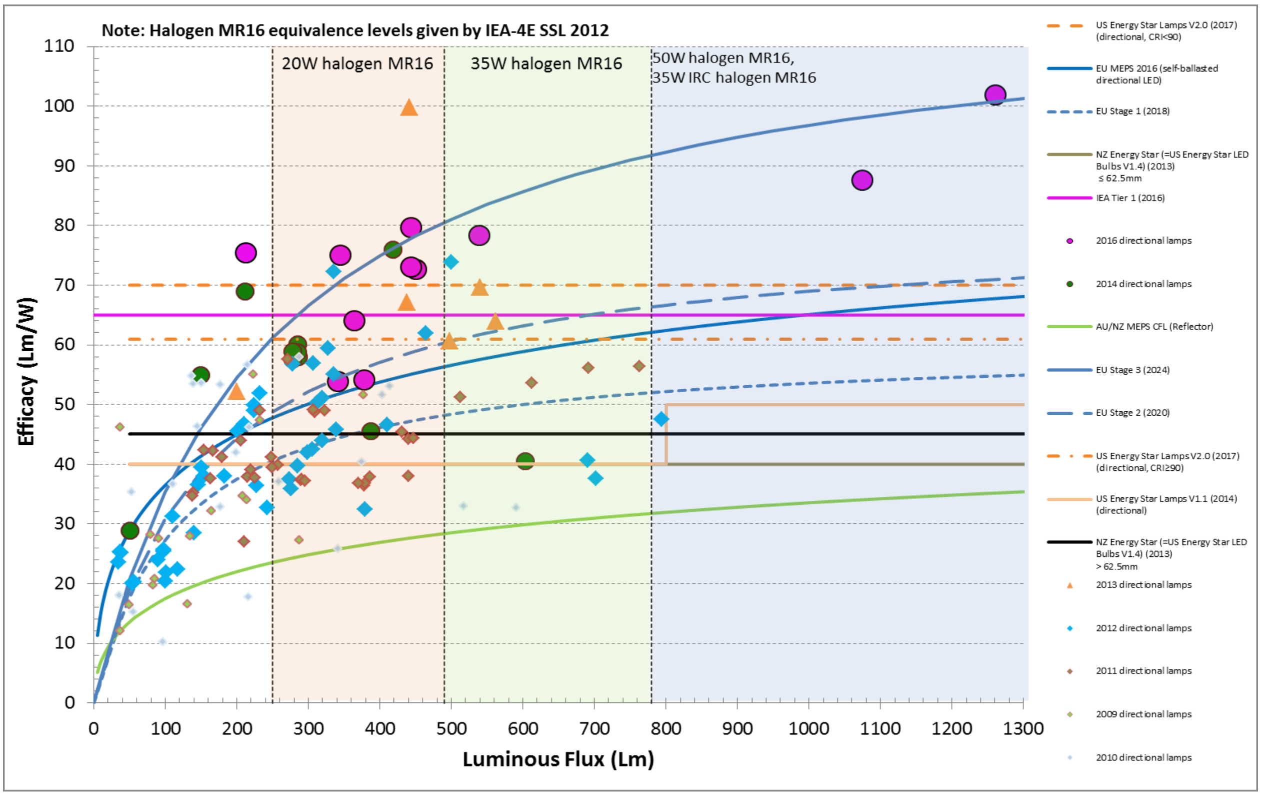
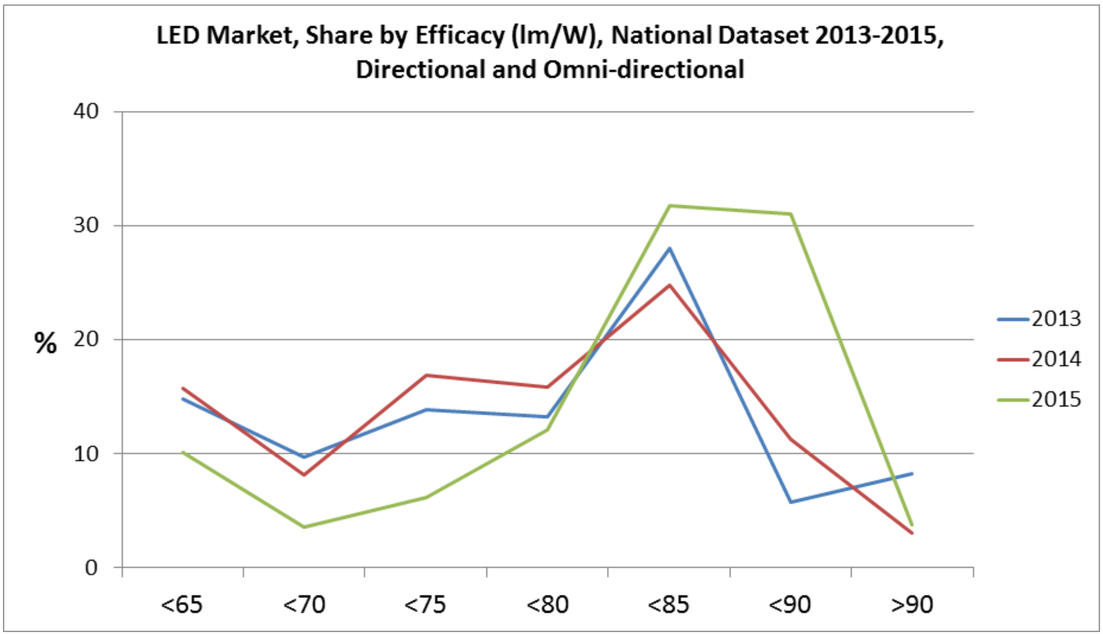


Figure 17 below shows the market share of LEDs by efficacy for the last three years, based on rated values of products included in Australian supermarket sales data.

In general, it demonstrates a fall in market share for lamps with <75 lumens per watt, which has been picked up mostly in the 85-90 lumens per watt efficacy range.

In particular from a regulatory standpoint, it demonstrates that market share of 65 lumens per watt lamps has reduced to 10 per cent, and so consideration should be given to setting a MEPS level higher than 65 lumens per watt.

Figure 17: Market share of LED by efficacy



Questions
Do you consider that the proposed MEPS efficacy level for 2018 is appropriate? If not please explain your rationale with suggested alternative. The proposed level is based on the 2016 IEA4ESSL recommended level (present), noting that suppliers will be required to test at least 10 lamp products (or 4 small, 2 large luminaires) to demonstrate that the mean of the sample of their model meets the minimum efficacy level.
Do you agree with the proposed mandatory minimum performance standards, outlined in Attachment H? If not please advise of alternative approach with supporting rationale.
Do you agree with the proposed test methods, outlined in Attachment H? If not please advise of alternative approach with supporting rationale.
Do you agree with the proposed staging of implementation by product category? If not please advise of alternative approach with supporting rationale.
Do you agree with the proposed definition of family of models outlined in Attachment H? If not please advise of alternative approach with supporting rationale.
Do you agree with the proposed mandatory marking requirements outlined in Attachment H? If not please advise of alternative approach with supporting rationale.

Please provide indicative costs to implement proposed marking requirements.

Please provide indicative costs to implement proposed marking requirements in a standardised format (i.e. consistent mandatory labelling).

Do you support consistent mandatory labelling on LED packaging, to make it easier for consumers to compare key characteristics of LED products?

Please provide an estimate on the cost imposed on suppliers to undertake proposed LED testing.

Non-integrated Commercial luminaire MEPS

For commercial lighting, introduce MEPS for standard non-integrated commercial luminaires (troffers, batons and recessed cannisters), usually fitted with fluorescent lamps.

This would serve the dual purpose of achieving energy savings in the lower end of the commercial market where there is no incentive for the agent to install efficient luminaires, as well as addressing a potential regulatory imbalance if MEPS is applied only to LED integrated luminaires.

The concern is that if MEPS is applied to LED integrated luminaires only, LED will be competing against poor performing non-integrated luminaire product that is being supplied based on cost alone. Having similar requirements on commercial luminaire products independent of technology will prevent the uneven market situation where legacy commercial luminaires using older technologies without MEPS, co-exists with LED luminaires that are MEPS compliant.

The MEPS will make use of a simple test based on photometry information already available to manufacturers in order to minimise compliance costs.

Proposed timeline

If approved, the regulation is planned to commence in 2019 (with LED MEPS for planar luminaires, integrated batons and troffers) with the Australian determination and test standard to be published six months prior to provide time for industry to implement this change. New Zealand will implement the MEPS by incorporation into the Energy Efficiency (Energy Using Products) Regulations around this time.

Scope

The following luminaires are in scope:

- All linear troffers, batons, suspended luminaires and other fixtures which accept linear fluorescent lamps or equivalent linear retrofit LED lamps
- All downlight luminaires which accept non-integral-ballast compact fluorescent lamps or equivalent LED retrofit lamps.

Note: for clarity, the following luminaire types are included in the above scope: ultra-low brightness, direct/indirect, wall wash, single-lamp, multi-lamp, specialty, flush-mount, surface mount and suspended luminaires, luminaires with and without control gear.

The following are excluded from scope:

- Luminaires which accept circular fluorescent lamps or equivalent circular retrofit LED lamps. Sales volumes of these are currently very low
- Emergency lighting. Lighting Council Australia are currently working with the Department of the Environment and Energy to eliminate inferior battery technologies from this market. E3 can comment on standard AS 2293 in order to ensure energy efficiency is included in this standard

- Integrated LED luminaires. These will be covered by MEPS for LEDs
- High-bay and low-bay luminaires
- A simplified registration for limited production run luminaires may be allowed.

MEPS Metric

The proposed MEPS metric is total light output ratio (LOR), which includes light emitted in all directions from the luminaire (upwards and downwards). This metric, although somewhat simplistic, has been chosen for several reasons:

- Many of the lamps and ballasts used with these luminaires will be covered by MEPS, and thus the only aspect missing from MEPS is the photometric performance of the luminaire itself, which is really the weak link in the efficiency of the lamp/ballast/fitting.
- The LOR should also be readily available from manufacturer-supplied IES files* and therefore no additional testing should be required in order to register luminaires for MEPS
- Use of LOR is agnostic to the type of lamp fitted (fluorescent or LED of various models) and thus lamp choice is eliminated as a variable. This will simplify registration and testing processes, and also suits cases where luminaires are sold with no lamp in place.

Use of total lamp/ballast/fitting performance is possible (using the luminaire efficiency rating or LER) but this holds no real advantages over LOR, given the points made above.

*Note however that the current approach to allowable tolerances in IES files is likely to require some further examination - it is possible that IES files are quoting LOR values which are overly generous with respect to the actual measured LOR performance of the fitting.

For luminaires able to accept either LED or fluorescent lamps, the LOR used to assess compliance with MEPS shall be the worst case, i.e. the luminaire fitted with the lamp type that results in the lowest LOR (expected in most cases to be a fluorescent lamp, due to the fact that it emits light in all directions).

MEPS Levels

Minimum MEPS levels of 80 per cent LOR for linear luminaires and 70 per cent LOR for downlight luminaires are proposed (see figures below). These levels have been chosen to allow only the most efficient luminaires to remain on the market.

Figure 18: LOR for linear fluorescent luminaires (derived from manufacturer-supplied IES files)

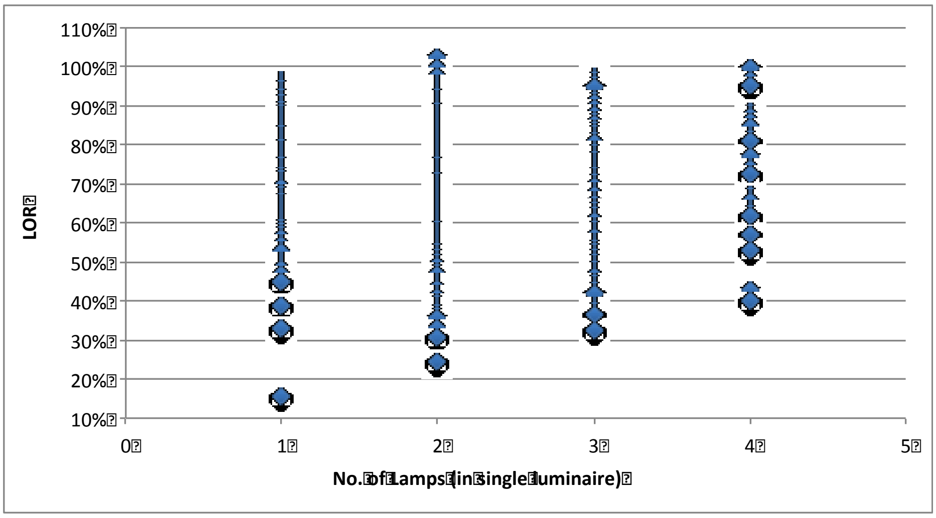
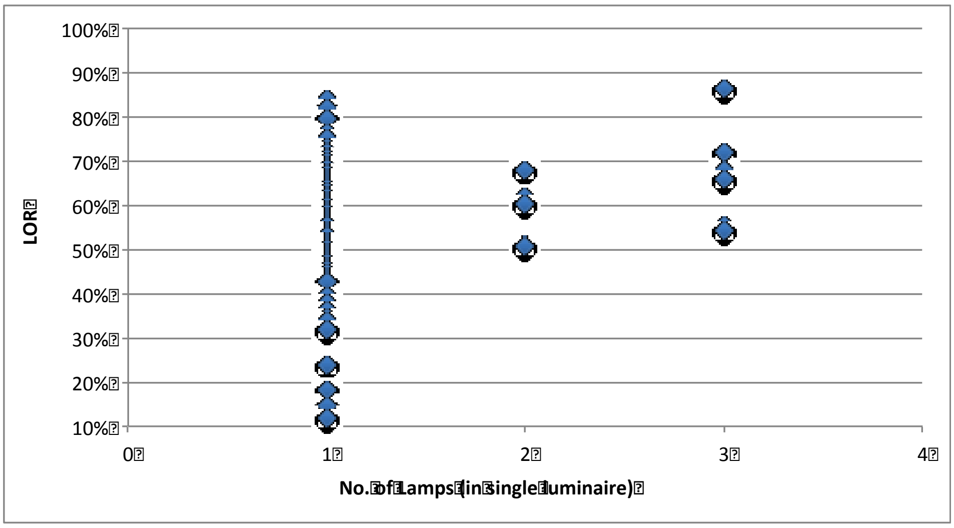


Figure 19: LOR for CFLn luminaires (derived from manufacturer-supplied IES files)



Note in the above figure that there is a lack of data for 2-lamp CFLn luminaires. It is expected that better performing 2-lamp luminaires are available than those graphed (as evidenced by the 3-lamp data points).

Test Method

As noted above, it is envisaged that no additional testing will be required for MEPS registration. Check testing will be undertaken using AS/NZS 1680.3-Interior Lighting-Part 3 Measurement, Calculation and Presentation of Photometric Data.

Market impact of proposed MEPS

The 2015 Commercial Lighting Product Profile expressed the efficiency of luminaires in terms of luminaire efficacy rating (LER) and contains market research data pertaining to LER for many luminaire models. LER is a measure of the system as a whole (lamp, ballast, luminaire) and is measured in total light output divided by total electrical input power. The CLASP linear fluorescent study[103] demonstrates that:

[103] Beletich S, Page E and Brocklehurst F, *Mapping & Benchmarking of Linear Fluorescent Lighting, 2014*

- *LER = BLE × lamp efficacy × LOR*
  where ballast luminous efficacy (BLE) is the lamp power divided by the ballast plus lamp power,
  and light output ratio (LOR) is a measure of the optical efficiency of the luminaire's reflector(s) and lens(es) - it is the light output of the luminaire divided by the light output of the lamp, expressed as either a fraction or a percentage.

If we assume a lamp efficacy of 90 lm/W (typical for linear fluorescent lamps subject to MEPS) and BLE of 0.85 (typical for an electronic ballast) we can approximately convert LER to LOR as follows:

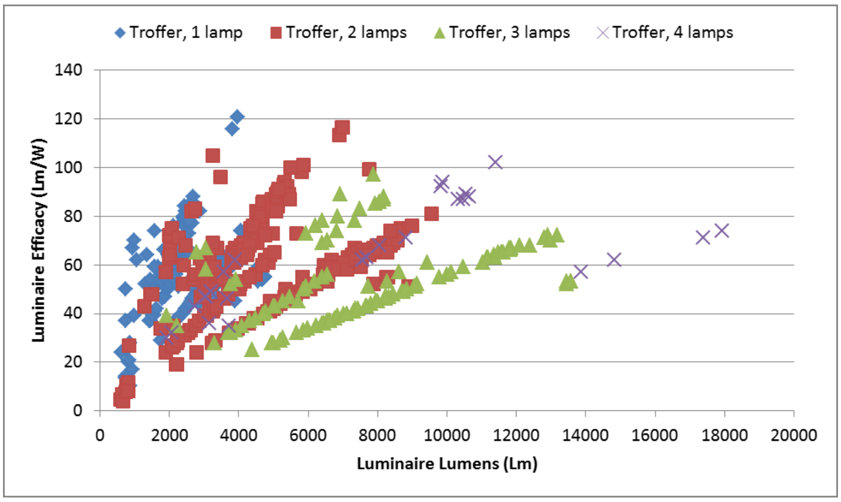
- *LOR = LER / (BLE × lamp efficacy)*
- *LOR = LER / (0.85 × 90)*
- *LOR = LER / 76.5*

This conversion is used to *approximately* convert the LER values in the Commercial Lighting Product Profile to LOR, allowing this luminaire market data to be used to assess the impact of the proposed commercial MEPS on the market.

Troffers

The Commercial Lighting Product Profile found that average LER is between 50 and 60 lm/W for both T5 and T8 troffers. A proposed MEPS at an LOR of 0.8 would translate, *approximately*, to an LER MEPS of around 60 lm/W. The effect of this can be imagined in the figure below, i.e. a horizontal MEPS line at around 60 lm/W - likely to eliminate some half of the market (caution re uncertainties described above).

Figure 20: Linear fluorescent troffers LER versus luminaire lumens

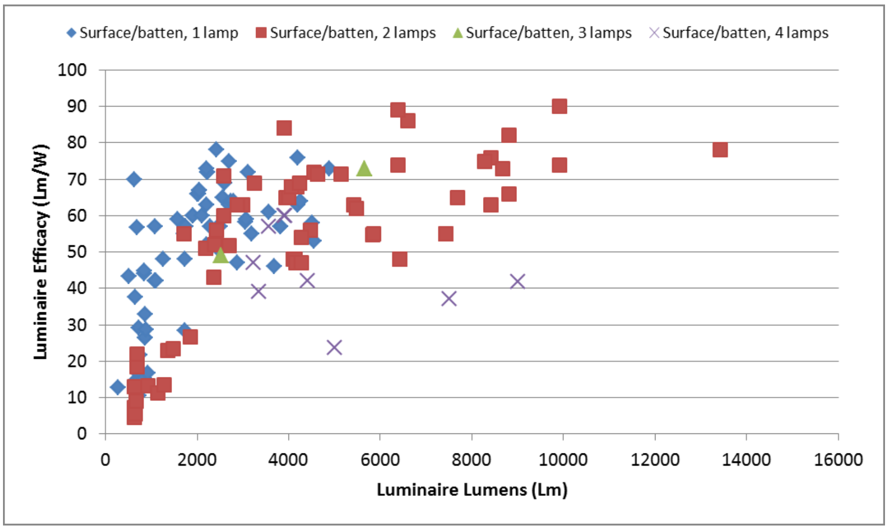


Battens

The Commercial Lighting Product Profile found that the average LER of battens available on the market is 45–55 lm/W, slightly lower than that for troffers. A particular range of T5 three-lamp battens have a much higher average efficiency at 72 lm/W, while a range of T8 four-lamp battens have a lower average of around 38 lm/W.

As for troffers, a proposed MEPS at an LOR of 0.8 would translate, *approximately*, to an LER MEPS of around 60 lm/W. The effect of this can be imagined in the figure below, i.e. a horizontal MEPS line at around 60 lm/W - likely to eliminate some half of the market (caution re uncertainties described above).

Figure 21: Linear fluorescent battens LER versus luminaire lumens (approximate efficacy of integrated LED luminaires)



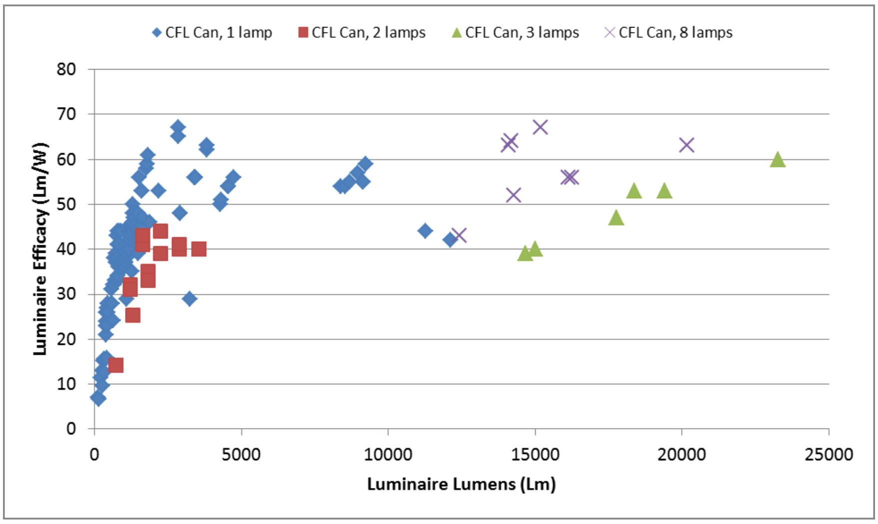
CFL cans

CFLs, being smaller, have lower efficacy than linear fluorescent lamps. If we assume a typical efficacy of 70 lm/W then the LER-LOR conversion becomes:

- *LOR = LER / (BLE × lamp efficacy)*
- *LOR = LER / (0.85 × 70)*
- *LOR = LER / 60*
- *LER = LOR × 60*

A proposed MEPS at an LOR of 0.7 would translate, *approximately*, to an LER MEPS of around 42 lm/W. The effect of this can be imagined in the figure below, i.e. a horizontal MEPS line at around 42 lm/W - likely to eliminate some half of the market (caution re uncertainties described above).

Figure 22: CFL can LER versus luminaire lumens



The proposed MEPS levels are considered appropriate on the basis that with the emergence of integrated LED luminaires, the non-integrated luminaires will effectively become the middle to bottom end of the product efficacy range. Therefore whilst a MEPS is usually set in order to remove the bottom 20-30 percent of the market, it is reasonable in this case to remove a higher portion of this less efficient subset of a broader market.

Market analysis

The cheap upfront cost of traditional luminaires means they will continue to sell in several product categories. In terms of purchase price, T5 high end louvered fittings still sell well at approximately $120, in comparison to an equivalent LED at approximately $240. LED flat panel fittings, selling below $50 have largely replaced twin 36W T8 luminaires selling at around $50 to $60. Bare batten twin T8/T5s remain cheap at approximately $30 in comparison to bare batten LED 40W at around $50 to $60.

The proposed MEPS are expected to have a relatively minor impact on purchase price of traditional luminaires. With the removal of the cheapest poor performing products, and introduction of regulatory requirements, a short term average price increase is expected. As discussed in Attachment A, the price increase, due to MEPS, used for non-integrated luminaires is the same as is used for LED MEPS: 0.5 per cent price increase per 1 per cent increase in efficacy.

Questions

Do you identify any concerns with the proposed LOR test approach?

Do you agree that the testing proposed would result in little to no additional testing for suppliers who are already conducting testing for linear lamp registrations?

Do you agree that non-integrated commercial luminaires will remain in the market in Australia and New Zealand as products are installed in some new or renovated commercial and industrial buildings in the next five years? Please provide estimates of future market share of these products.

Do you agree that MEPS on commercial luminaires is warranted if MEPS is introduced for LED luminaires, to prevent the regulatory imbalance described above? If not, please explain your rationale.

Are there any gaps or issues with the proposed scope definition for commercial luminaires to be subject to MEPS?

Do you consider that the proposed MEPS level is appropriate to achieve energy savings at the cheap end of the commercial market?

As a supplier, do you consider that MEPS on commercial luminaires would have a minor, moderate or major impact on your business? What, if any, concerns do you have with this option? Please provide estimates of any reduction in overall sales – where you are currently selling commercial luminaires that will be below the proposed MEPS.

Are there any significant product categories that may be removed from the market as a result of the proposed MEPS levels?

With the removal of the poorest performing luminaires, do you agree that there are adequate replacement products at a relatively similar price, resulting in a minor impact on the end user consumer?

Limited data is available to assess the impact of the proposed MEPS on price. Modelling has assumed a 0.5 per cent increase in price with a 1 per cent increase in efficacy relationship. Is this assumption broadly reasonable? If not, please advise of alternative with supporting rationale. The E3 Program would welcome price data on commercial luminaires sold with associated efficacy to substantiate the accuracy of modelling (to be held in-confidence).

Mandatory labelling – all lighting technologies

The mandatory labelling options discussed in this section in effect go beyond the proposed mandatory marking requirements already in place for CFL and halogen lamps and proposed for LEDs, the difference being that while mandatory marking requires specific information to be included on the packaging, it does not specify how the information is to be presented nor does it include a product rating system.

It is proposed to introduce mandatory labelling for remaining incandescent, halogen, CFL and LED lamp and small LED luminaire products primarily used in the residential sector including directional and non-directional products. This would achieve consistency in information, making it easy for consumers to meaningful compare the energy efficiency, quality and performance of lighting technologies.

This RIS does not propose mandatory labelling for commercial products on the basis that these customers and specifiers are generally well informed, and the commercial market is largely moving to LED.

A number of countries have introduced comparative, endorsement or information only labels for lighting products including the EU, US, New Zealand, Malaysia, Hong Kong, Korea, China and Japan. The Malaysian label is very similar to the Energy Rating Label displayed on a range of appliances in Australia and New Zealand. Types of labelling programs are summarised in Attachment D.

Lighting Council Australia currently administers a voluntary information label for LED lamps and luminaires, open to members only. This label has been well supported by members (predominately being displayed on LED luminaire products). Lighting Council Australia has advised that the voluntary label will continue in its current form to June 2017, at which time it is proposed to cease.

In the absence of option E or F being approved, leaving a broad range of efficacy levels in the market, mandatory labelling of remaining incandescent, halogen, CFL and LED lamps would highlight the relative differences between lamp technologies and may encourage some consumers to purchase CFL and LED lamps over halogen to save energy and money.

For consumers that purchase lamps at supermarkets, this is one of many purchasing decisions they make, often with limited time. Providing a consistent label will simplify the purchasing decision and thereby increase the likelihood of consumers purchasing energy efficient long life lamps.

Labelling introduction and information displayed would be promoted to consumers through the education campaign, along with robust monitoring, verification and enforcement.

Label requirements for LEDs and CFLs in New Zealand would co-exist with the ENERGY STAR labelling for high performance products, as is the case in the US.

Post the 2009 Australian education campaign, research found that consumers still lacked knowledge with choosing the right light bulb in terms of brightness, colour, differences between technologies, noting that clear messaging on packaging would be valuable to address this.[104]

Expected benefits

While the introduction of labelling in Australia and New Zealand would assist with the transition to more efficient lighting, the estimated benefits are expected to be relatively small, and additional measures would be required to achieve greater savings.

Comparative analysis in the IEA 4E 2015 Lighting Benchmarking report showed that for countries who phased out incandescent lamps through regulation, (irrespective of whether a label was in place), sales have been largely replaced by the marginally more efficient halogen products (Australia, EU, Japan, UK and Canada, who phased out incandescent in 2014 following a similar trend)[105].

[104] Winton Sustainable Research Strategies (for Department of Climate Change and Energy Efficiency), 2011
[105] IEA 4E, Benchmarking Document Impacts of 'Phase Out" Regulations on Lighting Markets, 2015

The EU, with a combination of both a mandatory phase out of incandescent lamps and a comparative energy rating label, had less of a move to efficient CFL and LEDs and a higher market share of halogens, in comparison to Australia[106]. This suggests that the EU comparison label has had little impact in transitioning consumers to more efficient products, and most consumers simply defaulted to halogen as the most familiar alternative lighting product to incandescent lamps.

The effectiveness of the US Federal Trade Commission (FTC) Label, introduced in 2012, is difficult to determine given other energy efficiency measures taken by USA since the labels implementation. In January 2012, mandatory requirements for the US FTC label coincided with the commencement of a staged phase out of inefficient GLS lamps, starting with 100W. In 2013, 75W GLS lamps were phased out, and in 2014, 60 and 40 W GLS lamps were phased out.

US lamp indices data between the period of 2012 and 2016 shows an overall 12 per cent shift from inefficient to efficient lamps, suggesting that the US FTC label is having some positive impact. Over this period, the LED market share grew from 0.2 per cent to 26 per cent, while CFLs decreased from 31 to 19 per cent. GLS incandescent lamps decreased from 66 to 8 per cent, with halogen dramatically increasing from 2.5 per cent to 46 per cent[107].

Recent research has highlighted that lighting in the US can face a higher barrier than other technologies in regards to the perception of operating cost information and potential reductions in energy bills[108]. Results suggest consumers are pessimistic about (or pay little attention to) future economic savings delivered from the energy efficient alternatives. It also considers that while disclosing operating cost information on the US FTC label would contribute significantly to further adoption of efficient lamps (as consumers tend to pay more attention to the implications of lifetime and power when operating cost information is displayed) it alone would not likely to be sufficient, and other policies with minimum efficiency standards would be needed to achieve greater savings[109].

It is difficult to quantify the benefits of mandatory labelling, due to the lack of data to measures benefits. For modelling purposes in this RIS, it is assumed that labelling will deliver a five per cent improvement in the purchase of energy efficient light bulbs. The

[106] IEA 4E, Benchmarking Report: Impacts of 'Phase-Out" Regulations on Lighting Markets, 2015

[107] Lamp indices data are composite measures of the National Electrical and Manufacturers Association (NEMA) member companies' U.S. shipments of a variety of lamp types - http://www.nema.org/Intelligence/Pages/Lamp-Indices.aspx

[108] 'Perception' was determined by conducting a field experiment with 183 participants and using the implicit discount rate (IDR) method. IDR is a method used by researches to measure the relative priority consumers place on energy efficiency verses upfront cost when making technology purchases.

[109] J Min, I Azevedo, J Michalek and Wändi Bruine de Bruin, 'Labeling energy cost on light bulbs lowers implicit discount rates', *Ecological Economics, vol. 97, 2014, pp. 42-50.*

Department welcomes further information from stakeholders on research conducted on the effectiveness of light bulb labelling to further inform this estimate.

Proposed Labelling Approach

In terms of approach, it is proposed that the Australian and New Zealand label is based on a shortened version of the US Federal Trade Commission (FTC) Label.

A comparative label (e.g. Australian Energy Rating label or EU label) is not recommended for lighting on the basis that it is difficult to present information on more than one parameter. In addition to efficacy, other factors such as lifetime are considered important to highlight on light bulb packaging.

An Endorsement label such as ENERGY STAR is not recommended on the basis that it only covers the high efficiency products (typically the top 25 per cent of the market) which are labelled and, while it makes it easier for consumers to identify these products, they are not be able to compare the performance and benefits with the lower efficiency products. In other words, endorsement labels only convey good news. Consumers are not able to know what products are poor quality. For a mandatory label, full coverage of the range of products available is preferred.

An information label would provide consumers with easy to access information for a range of important energy efficiency and product quality attributes to help them select the right product. This would address the wide variance in current product labelling in the Australian market (summarised in Attachment E).

Suppliers are already required to provide tailored package information for the Australian and New Zealand market. For example, to display the Regulatory Compliance Mark. The Department would consult closely with industry to agree on a suitable label design, seeking to minimise the space required for the label to ensure sufficient space remained available for companies to utilise for their own marketing purposes.

A mandatory lighting facts information label would focus on the key attributes required by consumers to easily select a lamp. Consumer research will be undertaken to determine precisely which attributes should be included and how they should be displayed. The intent would be to keep the label as simple as possible as additional information can make the label more complex and may discourage use.

The following attributes are initially proposed for inclusion (final attributes to be market tested and discussed with industry):

Front pack

- Brightness in Lumens (as a consistent range to be used by all suppliers)
- Incandescent/halogen watt equivalency
- Lifetime (presentation to be determined)
- Energy use (presentation to be determined)

Other mandatory marking requirements would be required however suppliers would have flexibility to determine how and where this information was displayed on packaging.

Brightness is considered the most important attribute when selecting a lamp. Incandescent watt equivalency is proposed to be included alongside 'lumens' on the basis that market research in 2010 and 2016 reinforces consumers continue to identify brightness by the wattage of incandescent bulbs. The majority of the population were bought up to understand this, so it makes sense to continue to provide this reference point for the present, while educating consumers to make the transition to selecting lamps based on lumens. This rationale is supported by industry, with a market scan showing that 90 per cent of CFL products include an equivalency, despite this being a voluntary field under MEPS. Including lumens in larger font than equivalency (and Watts) may assist in the transition to lumens. For downlights, halogen watt equivalency is proposed.

Lifetime and energy use (expressed as lumens per watt or cost over time) are the two key differences between halogen and CFL and LED lamps and based on research findings are considered to be the most effective in influencing consumers to purchase CFL or LED over halogens. Thus, these values are considered important to display on the front of the package.

Proposed timing

If approved the proposed mandatory labelling would be scheduled to commence in January 2018, with determinations published 6 months prior to provide time for industry to implement this change.

Questions

Please provide indicative costs to implement proposed label requirements

Do you consider in the absence of the further phase-out of incandescent and halogen lamps, that mandatory labelling across remaining incandescent, halogen, CFL and LED lamp and small luminaire products primarily used in the residential sector would assist consumers in selecting a light bulb to meet their needs?

How long would industry require to implement proposed label requirements? Please provide rationale.

Do you consider that an information label, similar to the US FTC, would be most suitable for the Australian market? If not, please provide alterative suggestion with supporting rationale.

Do you consider that incandescent watt equivalency should be included as a mandatory attribute? Alternatively should this attribute be voluntary, allowing suppliers to transition away from this equivalency as consumers become more informed about lumens?

Do you agree with our assertion that implementing labelling independently in New Zealand would be difficult?

Do you consider that mandatory labelling will significantly increase the purchase of energy efficient light bulbs in Australia? If yes, please provide research to support your claims.

Increase incandescent MEPS (Australia only) to remove the most inefficient lamps

This option would increase minimum energy performance standards for incandescent and halogen lamps in Australia to CFL MEPS levels. Based on currently available technology, incandescent and halogen lamps would not meet the increased MEPS level, leading to the removal of these products from the market.

As outlined above, these lamps are significantly less efficient than LED and CFL alternatives. This option would prevent consumers and businesses from being exposed to unnecessarily high electricity lighting costs and significantly reduce Australia's energy use and emissions for the benefit of current and future generations. Under this option, consumers would be required to pay a little more upfront but would save money due to a significant reduction in their electricity costs and less frequent bulb replacement costs.

The introduction of the MEPS increase across different product categories could, if necessary, be staged over time based on product type and only applied where an equivalent replacement exists. This will involve revisions to the current incandescent MEPS to make adjustments to product definitions and scheduling.

Greater demand for LED lamps would be generated with the market driving more choice in terms of LED products available on the shelf at a reduced price.

Understanding the costs of this option include analysis of the extent of compatibility of LED lamps with existing dimmers, transformers and sensors installed in Australian homes. This level of compatibility will also be taken into account when scheduling MEPS increases.

Lighting Council Australia, in their formal response to the LED product profile supported the proposal to increase MEPS for incandescent and halogen lamps to remove the least efficient products from the market, noting that potential issues on consumers in terms of compatibility during the transition would need to be worked through.

Internationally there is a move to further transition to efficient lighting through the phase out of incandescent and halogen lamps. The EU has commenced a phased approach with mains voltage halogen reflector lamps and remaining halogen lamps proposed to be phased out in 2018. The US is expected to phase out non-directional filament lamps in 2020.

Proposed timeline

If approved, the regulation is planned to commence in November 2018, conditional on the introduction of LED MEPS (allowing time to address LED quality issues) and the replacement Incandescent MEPS determination being released six months earlier, allowing time for industry to alter supply chains and minimise wastage of materials that are no longer needed.

Suppliers could continue to import products and distribute for sale up until the start date of the new MEPS level. Previously imported products could continue to be sold on the market until stock is depleted.

Scope

The table below provides information on the proposed phase out for different lamp technologies and the EU position. Note: Class refers to the product classes referenced in the GEMS Incandescent Determination (extract included at Attachment F).

Exceptions listed in sub section 23(2) of the Determination are proposed to remain (traffic lights, lamps used for air and sea navigation, oven lamps, infra-red heat lamps) with the exception of rough use or vibration lamps, on the basis that LED are superior under these conditions and thus the exception is no longer necessary (EU phasing out in 2016).

Table 8: Proposed phase-out of halogen and incandescent lamps

Technology and/or type	Proposal	Timing
Pilot lamps	Aus: Greater or equal to 10w to be phased out EU position: Small pilot lamps (below 60lm, approx. equivalent to 10w) exempt from new and existing EU regs.	2018
Incandescent lamps 25W and below (candle, fancy round decorative) (Class 3,4,5) Caps: E14, E26, E27, B15 or B22d	Aus: Greater or equal to 10w to be phased out EU position: All lamps >=60lm will be in scope for phase out.	2018
Mains voltage halogen non-reflector (class 6) Caps: E14, E26, E27, B15 or B22d	Aus – Greater or equal to 10w to be phased out EU positon – phase out in 2018	2018
Mains voltage reflector incandescent lamps (includes halogen) Caps: E14, E26, E27, B15, B22d or GU10	Aus - Currently unregulated, amend definition to include in scope with MEPS increase to apply from 2018 EU position: phased out in 2016	2018
Extra low voltage reflector incandescent & halogen lamps (Class 7) Caps: Bi-pin	Aus: increase MEPS in 2018 EU position: phase out in 2018	2018
ELV omnidirectional (product class 2) Caps: Bi-pin	Aus: increase MEPS in 2020, delay due to limited product on the market at high lumen output EU position: phase out in 2018	2020

When the minimum performance standards were increased in 2009 for pear shaped General Lighting Service incandescent lamps (to remove the least efficient technology from the market), an import ban was applied to these products before the MEPS took effect at point of sale (at the request of the lighting industry). An import ban is not proposed in this RIS as the GEMS compliance program is considered adequate to address risks of non-compliance. There were a small number of illegal imports identified by the Australian Border Force (ABF) with the import ban on incandescent lamps. The GEMS program now has a national compliance program in place to discourage non-compliance and take action where non-compliance occurs. There is also a facility in place that allows intelligence data to be requested from ABF where risk profile increases to target non-compliant activity. Given this, an import ban is considered to be unnecessary.

The current import prohibition on GLS incandescent lamps is being considered as part of a broader review of prohibited import regulations underway by the Department of Immigration and Border Protection. The Department of the Environment and Energy will continue to provide input to this review.

Transitional issues

The 'Impacts' section of this document summarises the consumer benefits and costs of this option. Below is a summary of transitional issues under investigation and proposed controls to manage.

Compatibility of LED lamps to replace extra low voltage halogen downlights

When a 12V halogen downlight fails and the householder purchases a 12V LED MR16 replacement lamp, the LED lamp may in some cases not be compatible with the existing transformer and thus not operate satisfactorily (does not illuminate or flickers). Options where incompatibility occurs includes trying another model of LED lamp (preferably with advice from a lighting retailer or supplier), or engaging a qualified electrician to upgrade the lighting system. It can be difficult for a consumer to identify the model of installed transformers (as they are often installed in ceiling cavities).

The extent of transformer compatibility to enable the replacement of 12V MR16 (35 or 50W) halogen downlights with 12V MR16 LED lamps is understood to be high, with an anticipated 98 per cent compatibility by 2018.

The VEET scheme successfully managed transformer compatibility with LED lamps as part of their halogen downlight replacement program, reporting that 98 per cent of installs allowed a direct replacement with LED lamps. This has been achieved through identification of a small number of quality LED products that have high compatibility with a large range of transformers found in the installed stock. This product selection has meant that there are high levels of consumer satisfaction and very low levels of lamp/transformer non-compatibility. ACT and SA have reported similarly high compatibility levels.

Discussions with industry representatives suggest that whilst the general level of compatibility may not be at the 98 per cent level, it is anticipated that this level will be achieved by 2018 resulting in a very small number of transformers requiring replacement. Commercially it is in the interests of lighting manufacturers to maximize compatibility levels.

Approved providers installing LED MR16 retrofit products under VEET (and other state schemes) have established product and procedures resulting in low installation costs and high compatibility. Product installs under VEET at an approximate cost of $15 per lamp indicates that the market will adapt and make high compatibility products available for consumers to easily transition.

Controls to manage

LED MEPS would require suppliers who claim compatibility of LED lamps with transformers, to ensure the product combination operates in a stable manner without observable flicker, light fluctuation or audible noise
Also the manufacturer shall:

(a) declare which ELV conditions (e.g. minimum/maximum number of lamps connected to ELVC (Extra-low voltage converter)) under which the lamp will operate.
(b) provide a webpage address that lists compatible ELV converter makes and models including ELVCs available in the local market.

The E3 Program is liaising with Lighting Council Australia and industry stakeholders to develop and promote an LED lamp and transformer compatibility tool. This will allow electricians and homeowners to enter their transformer model and identify compatible LED products. This may also encourage industry to develop highly compatible retrofit lamps to address the estimated non-compatibility. The tool is expected to be available in 2017. The E3 Program will also be working closely with state white certificate programs and industry to identify those transformers where an LED compatible lamp does not current exist and seek solutions to address.

<u>Dimmer compatibility with LED</u>

Some LED lamps may not be compatible with existing lighting systems that include a dimmer circuit, resulting in the LED lamp not operating satisfactorily (flickers, restricted dimming). Options where incompatibility occurs includes trying another model of LED lamp (preferably with advice from a lighting retailer or supplier), or engaging a qualified electrician to upgrade the dimmer system.

Feedback from lamp and dimmer manufactures indicated that older dimmers (using leading edge technology) are likely to be the most problematic, with more recent models using trailing edge technology having a high level of compatibility with LED dimmable lamps. Similar to transformer compatibility, there is a commercial interest for manufacturers to maximize the compatibility with existing dimmer stock.

Leading edge dimmers were designed to work with filament lamps and magnetic transformers and are generally not recommended for LED lamps. Trailing edge dimmers were developed for compatibility with electronic transformers (introduced in late 1990s) and this dimmer type is generally regarded as the better type to operate with LED lighting loads. Universal dimmers have the ability to identify the type of load connected in the circuit to work with a magnetic or electronic transformer.

The useful life of a dimmer is 15-20 years. It is estimated that there are approximately 9 million dimmers installed. For houses with at least one dimmer, the average number of dimmers installed was 2.6.[110] It is estimated that existing stock consists of 25 per cent leading edge dimmers and 75 per cent trailing edge dimmers[111].

Whilst manufacturers provide compatibility information with dimmers on the market, information on legacy products is not maintained. To understand the level of compatibility of dimmers installed and LED dimmable lamps on the market, the E3 Program engaged NECA to conduct compatibility testing for the purpose of:

- identifying the extent of compatibility to inform consumer impacts for this option
- compiling the test results to produce a compatibility chart for distribution to electricians, to enable them to assist households in identifying a suitable LED dimmable light bulb that will work with their existing dimmer system.

Dimmers were tested with a range of LED dimmable lamps on the market (both omni-directional and directional (mains voltage and low voltage, connected to combinations of the most common transformer types in the market). Lamps that did not achieve a dimming level (measured light level) of 30 per cent of full light output were deemed to be not suitable. Further, lamps that displayed any degree of flicker or shimmer in light output were failed.

Overall, results from LED dimmer compatibility testing found:

- There are LED dimmable lamps on the market, that matched with a compatible dimmer, perform effectively, with no flicker and full dimming range, meaning that consumers who value the ability to dim their lamps are able to continue to access this product range
- Leading edge dimmers are generally found to be non-compatible when used with LED omni-directional and directional downlights (ELV and MV)
- Trailing edge dimmers had mixed results working with some LED lamps whilst others flickered, highlighting that care must be taken when selecting and matching dimmer products for compatibility between brands and LED lamp types
- When an LED light source has been dimmed to a low level and then switched off some product configurations did not allow the LED to switch back on until the dimmer has been manually re-set to a range of greater than 50 per cent of the maximum dimmer setting (occurred with both leading and trailing edge dimmers)
- Specifications for dimming performance of LED lamps varies across manufacturers, meaning that a households with different brands of LED lamps connected to the same dimmer, may notice a difference in their light output.

NECA concluded that the combination of existing legacy transformers and dimmers which were designed for high wattage resistive loads, as opposed to digital LED light source, will continue to pose challenges when current generation LED lamps are installed.

[110] Based on the 2016 residential lighting audit

[111] Based on advice from NECA

Further the report notes that whilst testing outcomes provide a realistic indicator of compatibility, performance may vary in real world applications due to external variables such as the quality of the local power network.

Controls to manage

Existing dimmer stock

The Compatibility working group, (that includes representation from Lighting Council Australia (LCA), Illuminating Engineering Society of Australia and New Zealand (IESANZ), lighting and dimmer manufacturers, state and commonwealth officials), agreed that there would be merit in developing a resource that allows an electrician or consumer to 'find an LED dimmable lamp that works with an installed dimmer'.

Consumers with compatibility problems could then potentially identify a compatible LED lamp. Communication material would highlight that it may not be possible to identify a compatible LED lamp due to the type of dimmer installed or other characteristics within their homes electrical or lighting system that affect performance. It is expected that in most cases an electrician will be required to identify the type of dimmer installed due to the absence of unique labelling on the dimmer control.

It is hoped that this resource will also encourage industry to develop LED dimmable lamps that are highly compatible with existing dimmer stock installed in Australian homes, further reducing transitional costs of this option.

The Department is setting up the process in consultation with stakeholders, including product nomination, testing, appeal, display method and dissemination. This will be a voluntary process where lighting and dimmer manufacturers will have the opportunity to submit their product for inclusion. This resource is expected to be available in 2017 and will be updated over time as new products are released on the market.

Compatibility of LED and dimmer products

LED MEPS would require that suppliers only claim compatibility of LED lamps with dimmers for product combinations that dim smoothly to 30% of light output with no observable flicker and no audible noise. In addition when a dimmer is set to 100%, the light output must be ≥ 90% of lamp without dimmer. For dimmable products, the manufacturer shall:

(a) declare the conditions under which the lamp will dim
(b) provide a webpage address that lists compatible dimmer makes and models including (for ELV lamps) compatible makes and models of ELVCs available in the local market; and
(c) for each compatible dimmer, the number of luminaires that can be dimmed and the range of luminous flux levels a given dimmer-lamp combination can achieve.

The International Electrotechnical Commission (IEC), international standards organization, is currently working through revisions to LED standards that may help resolve compatibility issues between LED dimmable lamps and dimmer systems on the market in the future.

Role of subsidy programs

By wanting to complete 'simple and easy' upgrades first (a quick halogen-out/LED-in lamp swap), accredited person (APs) in Victoria have driven technology development and installation processes to a point where many upgrades are now effectively 'free' (that is, covered by the generated VEEC value – approximately $15). Similarly, downlight replacements in the ACT are free.

However this focus on a rapid high volume transition has meant that installers under state government programs have generally not upgraded households with more complex compatibility issues (or offered to carry out the upgrade at an additional cost to the household). To date, only a small number of product upgrades for dimmable lighting products have been undertaken.

These products, while allowed under the Regulations for Schedule 21 in Victoria, cost more to manufacture (and thus may require a consumer to co-fund the installation) and have other compatibility issues for an approved provider to deal with (i.e. replacing existing dimmers), so have had almost no uptake.

The E3 Program will be liaising with state subsidy programs on dimmer compatibility issues and the potential for these schemes to offer households the option of LED dimmable lamps and new dimmer if necessary as part of their downlight programs. This is likely to involve a small cost for the homeowner but would be at a reduced rate under the scheme.

Two wire devices

Some LED lamps may not be compatible with existing light fixtures that have a sensor function (a two wire device), resulting in the LED lamp operating unsatisfactorily (lamp stays on in off state, flickers).

There is a large range of lighting products available with sensors. Motion sensors are generally installed on lights for security or ease of use reasons including outdoor lighting. The sensors are usually sold as a package with one or more lamps controlled by a single sensor. Advice from the Compatibility working group is that some LED lamps do work with two wire devices. Non-compatibility can be resolved through purchase of a new unit or alternatively an electrician can modify the load so the existing unit works satisfactorily.

Informal advice from industry is that manufacturers of these sensor products moved to three wire designs from 2010, making these more recent products highly compatible with LED. Outdoor sensor lights are often exposed to the elements and therefore have a shorter life span of between 5 to 10 years. On the assumption that many products will be due for replacement by 2018, the costs of upgrading sensor lights have not been accounted for. New LED outdoor sensor lights cost approximately $60.

Controls

For impacted households, options include:

- Deferring costs in the short term by keeping spare halogen lamps on hand
- Replacing the sensor or timer or modifying the load, seeking to incorporate this job with the next electrician visit to reduce costs

Lamps on dual switch circuit

For some lamps on a dual-switch circuit (e.g. lamp in the middle of hallway with switch at either end) the capacitance of the wiring can cause current bleed which makes the LED (and some CFLs) flicker (when in the off state).

It is understood that this issue is not widespread/common and requires a number of variables to trigger this issue. It is currently resolved by the household calling an electrician to install a capacitor load.

Electricians are best placed to continue to manage this existing issue.

Ripple control filtering

Some consumers in certain geographic areas in Australia may notice that their LED lamps flicker for a short period (approximately 2-3 minutes), as ripple control signals are sent several times a day from distribution network service providers to control off peak tariff hot water, street lamps and space heating. The impact may vary due to the strength of the ripple current signals experienced, which can be locally amplified due to resonance in the network resulting from reactive loads.

The problem may occur in LED lighting due to their electronic design, possibly combined with an increase in the signal strength being experienced in the network. This is an existing issue that has also been reported to affect other household electrical products (including humming in electric fans, fast electric clocks and unintended operation of ovens).

The Department has established a Ripple Control working group that includes membership from LCA, Lighting Council New Zealand, Energy Network Association, University of Wollongong and energy network and lighting manufacturers, to understand the geographical areas affected, conditions when this can occur and options to resolve.

MR16 LED lamps that don't fit into halogen downlight housing

This issue has been raised by NECA re electricians advising that some replacement LED lamp are physically too large to fit into some existing housing for MR16 halogen lamps. This issue has also been raised by retailers where suppliers are incorrectly claiming compatibility where the size of the lamp is not compatible with the standard MR16 or GU10 fittings.

Should this problem occur, the Australian Consumer Law 2011 (ACL)112 contains 'consumer guarantees' which provide consumers with a comprehensive set of rights for the goods they acquire. If a good fails to meet a guarantee, a consumer has rights against the supplier, and in some cases the manufacturer, who will have to provide a 'remedy' to the consumer (such as repair, refund or replacement).

It is expected that the market would largely address this issue through competition or alternatively should inaccurate claims be made regarding a product, then the issue can be referred to the ACCC or state fair trading agencies for potential follow up enforcement action under the ACL which prohibits misleading and deceptive conduct and false representations.

To highlight this compatibility issue, it is proposed to include in the LED MEPS a requirement that where lamps claim compatibility, the dimensions of the lamp must

[112] The ACL came into force on 1 January 2011 and replaced the Trade Practices Act 1974 and previous Commonwealth, state and territory consumer protection legislation. It is contained in Schedule 2 to the Competition and Consumer Act 2010 (Cth) (CCA) and is applied as a law of each state and territory by state or territory legislation.

comply with equivalent lamp's requirements in the relevant IEC lamp performance specification standard.

Suitability of LED with table lamps

Anecdotal feedback has also been received from electricians that LED lamps do not work well in table lamps or pendant shades compared to an omnidirectional filament lamp due to the base of the LED that restricts light distribution to a half hemisphere, which becomes more apparent behind a lamp shade, causing consumer dissatisfaction. The proposed MEPS for LED lamps will specify the light distribution required in order for a LED to claim to be omnidirectional (such LED lamps are available). Educational resources will then encourage consumers to look for lamps with an omnidirectional claim when needed for lamp shades. There are now more omni-directional forms of LED lamps on the market that would better suit these applications.

Suitability of LED lamps in enclosed luminaires

Informally concerns have been raised by some lighting suppliers with replacing halogen and CFL lamps with LED lamps in enclosed luminaires, such as fanlights, due to the potential impact of operating temperatures on the life of the LED. To date requests for data and further information to support claims has not been provided.

Fanlights are currently being advertised and sold with CFL and LED lamps with warranties of at least two years on the product. However the default position of CFL and LED lamps is generally that the product is for use in an open fitting only. This puts consumers in a position where they are unable to replace a lamp in an enclosed luminaire without voiding the warranty of the replacement lamp.

It is understood that an LED lamp sold in a luminaire is accepted on the basis that the dimensions of the luminaire are known and tested with the LED lamp. Generally the same LED lamp included in the luminaire kit are otherwise recommended for open use only (not enclosed) and products are marketed in this way as the dimensions of the enclosed luminaire are unknown and thus may affect the life of the product. This is not a safety issue rather depending on heat in the enclosure, it can result in early failure of the lamp.

The E3 Program is aware that some suppliers are considering revising their marketing to note that the life of the lamp may be shortened when installed in an enclosed luminaire. The market may also resolve this problem by developing an LED suitable for high temperatures in most enclosed luminaires.

IESANZ concerns re ability of LED to fully replace halogen

The Illuminating Engineering Society of Australia and New Zealand (IESANZ) has raised some concerns that LED lighting does not currently provide a light source which produces the highest level of colour rendering and characteristics found in halogen light sources and used in some lighting design applications.

In relation to healthcare, it is proposed that the LED MEPS exclude from the scope of the regulation lamps and luminaires compliant with cyanosis observation index and colour temperature requirements of AS/NZS 1680.2.5:1997 Interior lighting Part 2.5: Hospital and Medical tasks, where the package is marked ‘For Medical Use Only’. Noting also that alternative electronic monitoring equipment is mostly used in current practice.

In terms of LED lamps not having sufficient red light content to produce the full range of colour dispersion, the content of red light in LEDs has been low in the past but has been increased in some products by advances in phosphors and also by the inclusion of a red light LED chip in combination with the phosphor coated blue light LED chip.

Concerns regarding colour temperature consistency are proposed to be addressed by performance requirements within the MEPS on the acceptable variations in colour appearance and colour maintenance.

In terms of the ability for LED to provide the same ‘sparkle’ effect produced by small point source lamps such as filament-based candles, testing conducted by Light Naturally found that there are now LED clear lamps with relatively small point sources which do replicate the sparkle effect. The Department is discussing findings of this testing with IESANZ.

The IESANZ are considering developing a high performance LED specification for professional lighting applications which would assist lighting designers in selecting suitable LED lighting.

Exemptions would be available under the GEMS Act for the import of lighting products for any essential lighting applications that were not able to be fulfilled by LED lighting at the time of a halogen phase-out. Consideration will also be given to the inclusion of a simplified (and minimal fee) registration option for LED models with a limited production run for any product type within MEPS scope. Registration would require annual submission of sales data.

Questions

Can you advise of existing electronic transformers installed that are not compatible with any LED MR16 lamps on the market and if possible estimated number of installs.

The Department requests further advice to confirm the assumption that sensors and timers sold post 2010 are generally three wire.

Please advise if you consider if there are moisture ingress concerns with LED under certain conditions, including data/evidence to support your claims.

Please advise of any conditions (heat/moisture/other) where LED would not be a suitable replacement with data to support claims.

Is the exception for traffic lights necessary or are LED now considered superior under these conditions and thus the exception is no longer necessary?

Do you have any concerns with the proposed timetable to phase out halogen lamps? Is there any halogen type lamps on the market where there is no LED suitable replacement?

Are there additional costs to industry or consumers that need to be considered with this option, not already specified in the Impacts section of this RIS?

Do you consider that the estimated costs of this option are realistic, please explain with supporting data if possible.

Please suggest options to assist households with incompatible legacy lighting systems to make the transition to LED lighting.

Information and education campaign

The option to phase-out halogen lamps and the introduction of MEPS for LED lamps, will require a broad education campaign to further raise awareness of the benefits of energy efficient lighting and communicate the revised arrangements to consumers, industry, (suppliers, wholesalers, retailers) electricians, lighting designers and other relevant professions.

Information and education is the easiest and earliest policy response to address energy related issues. The E3 Program, state and territory efficiency schemes and many retailers and manufacturers already provide a range of information products to encourage consumers to purchase energy efficient lamps (as referred in Table 9).

A broad education campaign would be necessary to make information more accessible and targeted to meet the needs of the various stakeholders and support stakeholders with the transition. The campaign would involve media advertising across multiple communication channels and will seek to reach an agreement with major retailers to have instore material for a period leading up to and following implementation of changes to assist consumers in transition to CFL or LED.

Timing the media advertising campaign is important to prepare the community and signal to industry that the changes are on the way. It is anticipated that some level of education and awareness raising will be conducted over the course of the transition period.

Industry demand for detailed guidance on the application of the changes is expected to be high, particularly at the beginning. The Department will provide guidance through a range of mediums including the Energy Rating website, industry presentations, webinars, through industry associations and the Energy Efficiency newsletter.

Following agreement on the preferred option, a communication strategy will be drafted in consultation with stakeholders identifying key messages for each stakeholder group, communication products to be developed, communication channels to reach the target audience, associated costs and timing. The Department will also seek to form a Communication Committee with representation across the stakeholders groups to oversee the design and implementation.

The implementation plan will vary for Australia and New Zealand, with the Department being responsible for delivery in Australia, and EECA being responsible for New Zealand.

The campaign for New Zealand will be more targeted in nature than what is described below.

Funding for the Australian campaign would be sought by the Department. A broad communication campaign is expected to cost approximately $2M[113]. In the event that this cannot be covered under the E3 funding arrangements with States and Territories, separate appropriations would be sought.

To reduce Government costs, the Department will seek free TV and Radio cover via News, Morning Shows. Messages will also be communicated through existing channels such as state subsidy programs, industry newsletters, magazines and trade publications.

Table 9: Existing lighting information products

For Electricians and Lighting Designers: The Australian government has previously worked with the NECA in developing an Energy Efficient lighting training resource as part of their EcoSmart Electricians Program. This has also been used as a resource document in other programs including training courses run by the IESANZ. This document is currently being updated with the revised publication expected by December 2016.
For Retailers: A specialist lighting retailer training package has also been released by E3 which is intended to help retailers and consumers achieve improved energy efficiency outcomes through the selection of more efficient lighting and understanding better lighting design. The New Zealand government has also developed the Energywise website, which includes tips on lighting design and a virtual designer tool. E3, in conjunction with NSW and VIC Smarter Choice Programs have also recently delivered a lighting online training module for retailers.
For Consumers: E3 lighting products available on energyrating.gov.au include a guide to purchasing LEDs, Light Bulb Buyers Guide and Light Bulb Saver App (interactive conversion guide). Retailers and manufacturers also have material available on their websites and some instore. A number of jurisdictions have incentive schemes to promote the uptake of efficient lighting. A New Zealand version of the Light Bulb Saver App is currently under development.
In New Zealand: Energywise website information is available to compare running costs of lamps, there have been point of sale promotions, TV commercials and ENERGY STAR labelling to promote efficient lighting.

[113] The “Change the Globe” education campaign to support the original incandescent phase out in 2009 cost approximately $1.2m. Learnings from the 2009 campaign and initial costings of the broad strategy indicate that approximately $2M would be required to achieve the desired outcome.

Campaign

For Consumers

The campaign would help consumers understand the differences between halogen and CFL and LED lamps, in particular that:

CFL and LEDs are 'better value' than halogen and provide the same or better quality of light.

- whilst the upfront cost of a CFL or LED is more than a halogen light bulb, the long life and efficiency of the light bulb means that the CFL or LED is much better value. Examples would be provided to clearly explain costs in one year, three years, five years and ten years.
- in terms of quality, consumers will be reassured that minimum performance standards are in place that require products to meet a minimum level of efficiency as well as a range of quality criteria. Consumers will be advised on what they can expect from an LED light bulb and how to seek a replacement should a problem occur.

'Long life' would also be a key focus for consumers, highlighting that light bulbs would not need to be replaced as frequently and what they can expect if the light bulb does fail earlier than claimed on the packaging. Less frequent replacement of light bulbs would particularly be beneficial for older or impaired people who find the task of replacing a light bulb difficult.

Environmental benefits including less waste (including mercury where LEDs are purchased instead of CFL), and significantly less energy used for the same amount of light output would be highlighted. Examples would be included to demonstrate the difference in energy use with this compounded by the number of households to identify the community benefits.

Key information on light bulb packaging or the new label would be highlighted, explaining how consumers identify a suitable light bulb for their needs and compare the qualities of different light bulbs on the market to help them make an informed purchasing decision.

Should the option to further phase out inefficient lamp technology be adopted, the campaign will ensure consumers who are used to purchasing halogen lamps, have the information they need to purchase a CFL or LED lamp suitable for their needs and understand the benefits that this will provide.

- Information would be provided to help a consumer find a suitable CFL or LED lamp to work with their existing dimmer, transformer or outdoor sensor light
- Information would be provided to consumers on how to get help if they encounter an issue.

The Light Bulb Saver app and Light Bulb Buying Guide, two products recently released by the E3 program will be enhanced as required and featured in the campaign, with additional resources created to meet the needs of all end users.

Lighting suppliers

The campaign would also target LED lighting suppliers, who with the introductory of LED MEPS, would be required to register their product prior to sale in Australia and New Zealand.

- It is estimated that there are 255 suppliers selling LED lighting products on the Australian market and New Zealand market. Currently there are approximately 70 suppliers who have registered incandescent (including halogen), CFLs and linear fluorescents under GEMS. Thus, the campaign will seek to reach and educate a large number of suppliers who have previously not been required to comply with the GEMS Act.

A suite of guidance and information products will be made available for suppliers to help them get up to speed with the new requirements.

The Energy Rating website already has comprehensive guidance on the use of the online product registration system and this will be updated as necessary for the new product categories.

Key messages will focus on understanding supplier obligations and how to source further information.

The Department will work closely with Lighting Council Australia and Lighting Council New Zealand to facilitate timely two way communication with the lighting industry.

For industry, it will be important that businesses understand how the new and amended regulations apply to their circumstances and to implement measures to meet their obligations before the new rules take effect. The campaign will assist by providing an understanding of what the changes mean for them and how they might need to change their business processes.

Lighting wholesalers and retailers

Messages will also be developed for wholesalers and retailers focused on their obligations under the GEMS Act and the Energy Efficiency (Energy Using Products) Regulations. They will need to be aware of products that can no longer be sold, rules for existing stock and new regulations affecting LED lighting.

Retailer material, including training packages, online tools and factsheet resources will be updated and promoted to retailers, to assist them in helping consumers effectively transition leading up to and follow commencement of new regulations.

Electricians

Electricians will be central in helping the community smoothly transition to efficient lighting. Messages for electricians will focus on the changes and what it will mean for how they install lighting in residential and commercial buildings. Information will be provided on the compatibility of legacy products and lighting systems with CFLs and LEDs, common issues that may be encountered in a residential or commercial property and troubleshooting tips to resolve.

The campaign will provide information and tools to assist them with providing advice to consumers to meet their lighting needs.

Further it will advertise a feedback and escalation channel to allow any unexpected issues to be raised and solutions identified to minimise any impact on the community.

The Department will work closely with NECA and Master Electricians, the two peak electrician bodies in Australia, and the Electrical Contractors Association of New Zealand (ECANZ) in New Zealand, to facilitate timely two way communication with electricians.

Lighting Designers

Similar to electricians, messages for lighting designers will focus on the changes and what it will mean for how they design and install lighting in residential and commercial buildings. Information will be provided on the compatibility of legacy products with CFLs and LEDs, common issues that may be encountered in a residential or commercial property and troubleshooting tips to resolve.

The campaign will provide information and tools to assist them with providing advice to consumers to meet their lighting needs.

The Department will work closely with the IESANZ, peak lighting design body in Australia and New Zealand, to facilitate timely two way communication with lighting designers.

Other related trades and professions

The campaign will also reach out via industry and professional associations to other related trades and professions such as builders, engineers and architects.

Health concerns

Factsheets will be developed on health and environmental issues that may cause unwarranted concern for a minority of the community. This material will be developed in consultation with the Department of Health.

Questions

Do you think a broad education campaign would be beneficial to raise awareness of changes and assist in the transition?

Would your organisation like to be involved in the development of the communication strategy and rollout?

Do you have any feedback/suggestions on how communications could be best approached, drawing on any experience through the ‘Change the Globe’ campaign or New Zealand Rightlight education campaign?

Impacts

This section identifies who in the community is likely to be affected by each option. It outlines the costs and benefits for each option, as well as the distribution of these costs and benefits.

The full methodology and analysis, including modelling assumptions, is available at Attachment A.

Costs and benefits have been assessed to 2030. In order to show the impacts in each sector, residential and commercial (which includes industrial) sectors are modelled separately for the LED MEPS proposal. The other proposals largely apply to either primarily residential or commercial sectors and are modelled as such. The following costs and benefits are included in the financial modelling:

Costs:

- To the consumer, due to increases in the upfront price of products, reflecting costs passed on by suppliers
- To the consumer, due to transitional costs in upgrading existing lighting systems to be compatible with LED lighting
- To the product supply businesses for complying with the new or modified regulatory requirements
- To government for implementing and administering the requirements.

Benefits:

- To the consumer, due to improved energy efficiency of available products resulting in avoided electricity costs
- To consumers due to longer life of LEDs, leading to reduced replacement costs (not included in financial modelling)
- To suppliers, from simplifications to the regulatory framework.

The policy options can also reduce the cost to Australia and New Zealand of meeting greenhouse gas abatement targets by providing cost positive emission abatement. For Australia, the cost of abatement for the recommended option is around $-174/tonne[114]. This abatement cost is much lower than the average price of around $12 that the Australian Government is paying for abatement under the Emissions Reduction Fund.

The benefits to society from reduced GHG emissions have not been accounted for in the financial modelling.

[114] Based on the estimated net benefit, divided by the number of tonnes abated cumulative to 2030.

Cost benefit analysis is based on projected energy consumed for lighting stock in a Business as Usual (BAU) case, compared to each policy option. Energy savings are the difference between BAU and with-policy option energy consumption (the same applies for GHG savings). The annual energy consumed (by each type of lighting product) is essentially the multiplication of: the stock of the lighting product type; their average annual operating hours; and their average electricity input power. Refer to Attachment A for a detailed description of modelling.

The decline in energy use expected in the BAU case can be attributed to an expected slow increase in uptake of LED lighting over time and slow decrease in inefficient incandescent and halogen lighting. The analysis shows that introducing MEPS and labelling requirements significantly reduces the expected energy use, by increasing the average efficiency of LED lighting and speeding up uptake of energy efficient lighting.

Costs to the taxpayer

Government administration costs are made up of salary, program administration, check testing, consumer information/education and miscellaneous (market research, etc.). Total incremental cost to Government per annum for Australia and New Zealand are estimated at $200,000 per annum. Establishment costs to government in Australia and New Zealand to prepare the RIS and introduce the new regime are assumed to be $350,000.

An additional $2 million over a three year period is included to deliver the supporting communication campaign in Australia (2017/18, 2018/19, 2019/20).

This adds up to total taxpayer costs of $4.35 million over the ten-year assessment period.

Impacts on consumers

The introduction of MEPS for residential lighting products is not expected to increase the purchase price of LED lamps for consumers. Should the option to increase MEPS to remove incandescent and halogen products from the market be approved, consumers will be required to pay a little more upfront for light bulbs, but households will save money through reductions in electricity and replacement costs. A number of case studies are presented under option F below.

Some consumers are likely to incur a one off upfront cost to resolve compatibility issues with existing lighting systems. Case studies are presented under option F below. The E3 Program and Lighting Council Australia are jointly working to reduce the consumer cost of this option through wide promotion of compatible products and seeking industry solutions to reduce impacts.

Regulatory cost on Australian companies

Registration costs for new products within the scope of the proposals are estimated at $440/model, based on the current registration fee for lighting models. This is treated as an income to the government for modelling purposes as partial cost recovery for government of administering the regulations in Australia (registration and compliance activity). There are no registration fees in New Zealand.

The estimated number of suppliers for LED MEPS is 255 and estimated number of product registrations is 10,200 over the 10 year period. The estimated number of suppliers for the commercial luminaire MEPS is 40 and estimated number of product registrations over the 10 year period is 600.

LED MEPS lamp model estimates have been based on equivalent lamp registrations (CFL, halogen or linear) for each product category and increased to account for more frequent release of LED products over a 10 year period and expansion of product suppliers. It is understood that LED luminaire product range will be significantly larger than LED lamp products due to the greater variation in form. However for modelling purposes, numbers have been matched with lamp estimates to avoid inflation of regulatory burden, recognising that the Department is working with industry to broaden the definition of family of models, review scope, simplify registration and potentially alter associated fees for luminaire products.

Other costs of compliance (for example testing, staff education, record keeping) are accounted for using the Regulatory Burden Measurement tool (for Australia) and are included as a component of the cost benefit analysis.

The estimated 'regulatory cost burden' on Australian companies is required to be shown (Table 10). The **extra** costs are shown for the six regulatory proposals versus Business as Usual.

The table shows the annual total regulatory costs per business and per product. Regulatory costs consist of the additional cost for administration including time spent to register a product, additional testing costs etc., and capital costs to meet the new MEPS; it does not include the cost of registration itself. Capital costs account for the extra cost incurred to source products to meet the new MEPS level and is treated as a one off cost.

Table 10: Estimated regulatory burden cost – for Australian businesses

Option	Per Business Cost - Annualised	Costs per registered model
Lighting BAU	$13,019.73	$885.88
A. LED MEPS	$13,187.90	$582.94
B. LED MEPS + Commercial luminaire MEPS	$14,576.16	$583.50
C. LED MEPS + Commercial luminaire MEPS + Labelling	$24,437.44	$978.26
D. LED MEPS + Labelling	$23,744.29	$997.49
E. LED MEPS + Phase-out	$13,757.15	$607.46
F. LED MEPS + Commercial luminaire MEPS + Phase-out	$14,457.09	$606.84

Since the suppliers who are affected by LED MEPS are also affected under commercial Luminaire MEPS, inclusion of the luminaire MEPS results in very little additional total regulatory cost for the same supplier since they are already devoting resources to address LED MEPS. The combination of more registered models and little additional regulatory cost produces only a slight variation in cost per model.

Similarly, whilst the all business cost for LED MEPS and phase out (Option E) is less than LED MEPS (Option A), due to reduced regulation, the cost per business is slightly higher under Option E than Option A due to capital costs for suppliers in replacing halogen with LED or CFL products.

Regulatory cost on New Zealand companies

It is estimated that an additional 50 suppliers[115] are selling LED products into the New Zealand market. The incremental cost per LED supplier per year is estimated to be $10,000.

[115] Based on 20% of LED suppliers selling in Australia. Proportion reflective of linear fluorescent lamp registrations in Australia and New Zealand.

Business as Usual

Under BAU, there will be no change to the current requirements for lighting products. However, the energy efficiency benefits arising from the existing regulatory requirements will continue to accrue.

Figure 23 and Figure 24 below shows the annual energy consumption for all types of lighting under the existing requirements with no policy intervention for Australia and New Zealand.

Figure 23: BAU Residential Lighting Energy Consumption (Australia)

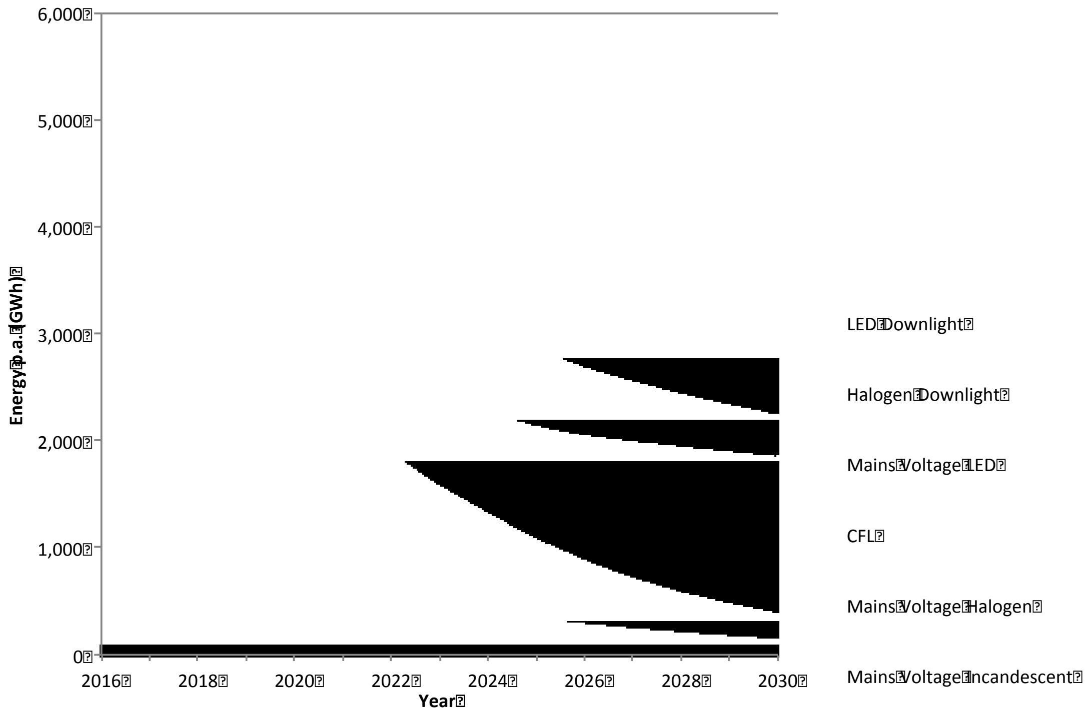
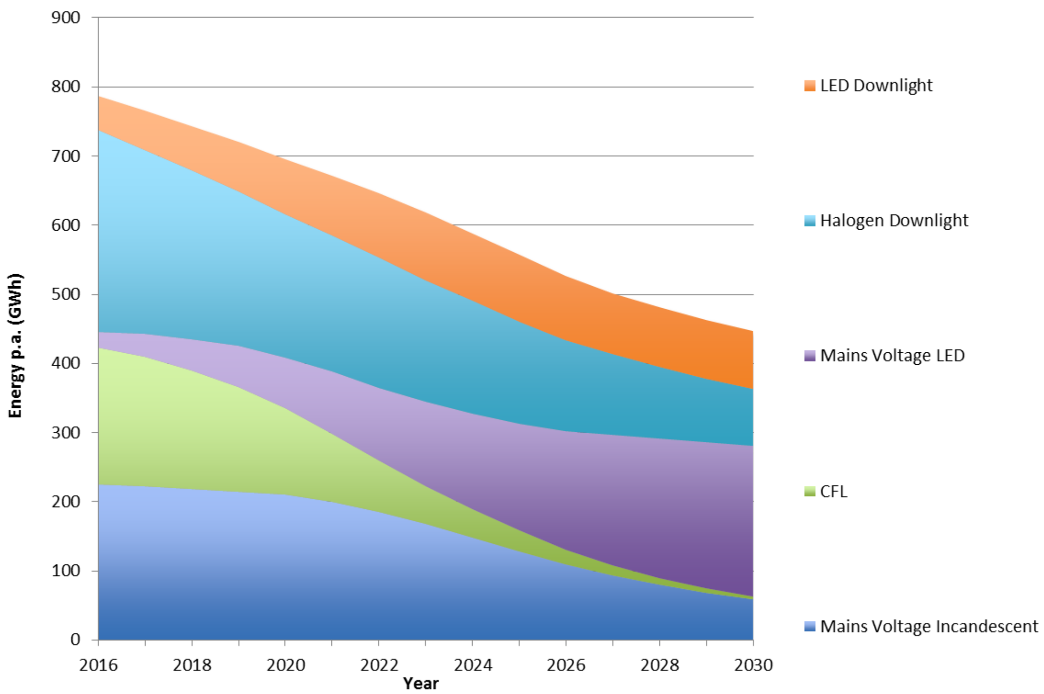


Figure 24: BAU Residential Lighting Energy Consumption (New Zealand)



However, under BAU the regulatory and information failure costs arising from the current requirements continue, which may be harming overall economic efficiency. These include:

- The outdated MEPS levels that currently apply will continue. Consumers purchasing inefficient incandescent and halogen lamps are subject to low upfront costs but higher electricity running costs and replacement costs than necessary. For suppliers of products not currently within the scope of the requirements or suppliers that would need to take action to comply with any revised MEPS levels, costs will remain unchanged.
- Poor quality LEDs on the market, result in unsatisfied consumers as the product does not perform as claimed, fails early or uses more electricity than necessary to light their home. Suppliers providing quality LED products are negatively impacted due to being unable to compete with cheap inferior products on the market or a reduction in uptake due to reputation issues with the technology.
- Due to split incentives, cheap commercial fit outs and rental properties continue to install poor quality lighting, wasting energy and money for the lessee.
- The lack of clear information on lamp packaging to allow a consumer to make an informed purchasing choice remain. Consumers remain uninformed about the benefits of efficient lighting and lose out on electricity and replacement costs.

This RIS therefore considers policy options to address these issues and improve the requirements, consistent with COAG Best Practice Regulations Principle 6 “ensuring that regulation remains relevant and effective over time”.

Option A – LED lamp and luminaire MEPS

Under option A, the impacts of the individual policy proposals will be:

- For consumers this will prevent the sale of low quality products by ensuring that LED lighting provides an effective as well as efficient lighting solution, giving rise to consumer confidence in efficient LED lighting technology and ensure that potential energy savings are realised. Consumers will also benefit through consistent information on LED lamp packaging, making it easier to purchase a replacement lamp and compare LED products, resulting in better purchasing decisions.

It is expected that there will be no price increase of LED lamps and small luminaires used in the residential sector, given the continued forecast decline in price. Larger LED luminaires may incur a small increase in the upfront cost in the short term as implementation costs borne by suppliers are passed on to commercial lighting consumers.

- For suppliers, the minimum standards will provide a level playing field, removing inferior products that are unable to meet minimum efficacy and quality criterion.

Suppliers will be required for the first time to register LED lamp and luminaire products under the GEMS Act / Energy Efficiency (Energy Using Products) Regulations before being able to sell these products in Australia and New Zealand (approximately 30 per cent of

LED lamps suppliers already register other lighting technology under existing regulations). Providers are already required to meet electrical safety and electromagnetic compatibility regulations.

Compliance with MEPS will require testing of products and registration, including a fee to register each LED model or family of models[116]. Test standards will be aligned with international approaches where possible to reduce implementation costs for suppliers. Advice from the lighting industry is that products are usually tested for most if not all of the parameters proposed for LED MEPS. It is proposed that the definition of 'family of models' is broadened to allow variation in colour temperature, colour rendering index, or beam angles, as well as variations in mounting brackets and other casing or luminaire surround variations that do not change the size, shape and reflectivity of the light emitting components of the product [117]. Cap shapes and associated sizes currently count as the same model for the purposes of registration.

Suppliers will be required to undertake one off changes to their labelling processes to meet the new product and package requirements. Suppliers are already required to make some changes to packaging for the Australian and New Zealand market to meet other regulatory requirements and information required for the label is already available to manufacturers.

<u>Information and Education Campaign</u>

Consumers will benefit from a broad communication campaign that will assist them in understanding the differences between lighting technologies and the benefits of energy efficient bulbs, case studies relevant to their circumstances will be provided so consumers can understand expected savings, the Lighting App and other resources will be provided to help consumers identify a replacement bulb and how to access more information and support to assist in the transition. Product information on compatibility of products will also be made available.

Electricians and lighting designers will have access to resources to help them assist consumers in finding suitable replacement lamps compatible with dimmers and sensors in their home, as well as troubleshooting information to assist in resolving issues.

Costs of the education campaign will be paid by the Government. It is estimated that the campaign will be a one off cost of approximately $2 million.

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[116] A family of models allows a number of lamps to be treated as a grouped registration on the basis that the main characteristics of the lamps are the same.

[117] It is proposed that this change also be applied to CFL and linear lamps.

Option B – option A plus non-integrated Commercial Luminaire MEPS

In addition to the impacts of option A, option B includes:

- For property owners this will prevent the installation of low quality luminaires in new builds or major refurbishments, by ensuring that commercial luminaires meet a minimum standard for light output, thereby avoiding undue electricity costs through loss of light.

The average upfront cost of luminaires for property owners will increase with this option, but will be offset by a reduction in electricity costs with less luminaires required to light an area.

- For suppliers, the minimum standards will provide a level playing field, removing inferior products that are unable to meet efficacy and quality criterion.

Suppliers will be required for the first time to register luminaire products to comply with MEPS, including a registration fee (Australia only), before being able to sell these products in Australia and New Zealand. This may result in a small increase in upfront cost in luminaires in the short term as there will be implementation costs borne by suppliers. However, test standards will incorporate tests already undertaken by suppliers of lamps and include a basic light output ratio measurement to minimise regulatory costs for suppliers.

Option C – option B plus mandatory labelling

Option C is the same as option B, plus introducing mandatory labelling on halogen, CFL and LED lamp and small LED luminaire product packaging to address information failures for consumers.

Labelling would enable consumers to easily compare lamps and identify an energy efficient replacement lamp, at point of purchasing, providing long term education post the campaign. Presenting key information in a consistent way would save consumers time in comparing products and would increase the likelihood of them purchasing a more energy efficient lamp to save money on electricity and replacement costs, and a lamp more suitable for their needs.

Suppliers would be required to make one off changes to their labelling processes to implement this change for LED, CFL and halogen directional and omni-directional lamps and small LED integrated luminaires for the Australian and New Zealand market.

Suppliers are already required to make some changes to packaging for the Australian market and information required for the label is already available to manufacturers.

For LED, many suppliers are releasing new models of LED lamps every six months so could incorporate this change into their release cycle to reduce implementation costs.

Suppliers selling filament and CFL lamps would be required to update their packaging, which is likely to require a one off change for this purpose given manufacturers are no longer investing in this technology. Suppliers are currently required to display light output in lumens, power in watts and average lamp lifetime, and mercury for CFLs.

Option D: option A and mandatory labelling

This option includes LED lamp and luminaire MEPS (option A) and mandatory labelling.

Australia only

Option E: option A and incandescent MEPS to CFL levels

Option E includes LED Lamp and luminaire (option A), as well as increasing incandescent MEPS to remove the most inefficient lamps, consisting of categories of halogen and incandescent lamps.

Consumers would be required to pay slightly more upfront for either an LED or CFL replacement. However, this upfront cost would be more than offset over the time of the lamp (due to reduced electricity consumption and less frequent bulb replacement).

Some consumers would also require an electrician to upgrade existing lighting equipment (some dimmers, transformers and motion sensors) due to incompatibility with LED technology.

This option will remove regulatory requirements for suppliers of incandescent and halogen lamps, as the products will no longer be able to be sold in Australia.

Renters may consider that they are disadvantaged by this option as they may move before obtaining the full benefits of long life energy efficient light bulbs. Whilst renters would be required to pay more for a light bulb, they will also benefit from energy efficient light bulbs already installed at their next rental property. That is, as rental property lighting is replaced the next renter is unlikely to incur any replacement costs and will benefit from reduce electricity and lamp replacement costs.

Property owners, as opposed to renters, would be responsible for upgrading the lighting system if compatibility issues occurred with the existing transformer or dimmer system. For tax purposes these costs can be claimed as a ‘repair’ or ‘capital expense’ depending on the circumstances. As part of communication material, the Department will work with the Tax Office to develop guidance around this subject.

The household case studies below show that the higher upfront costs of upgrading to LED are returned within a two year period through energy savings, based on all lights being turned on for 1.5 hours per day and current LED prices which are forecast to decline. Renters, as opposed to home owners, are more likely to replace lights on failure, as opposed to upgrading all lights to reduce energy costs, particularly where short term leases apply. Renters may adopt an approach of swapping out halogen or incandescent lamps in high usage areas and replacing with LED or CFL lamps to reduce upfront costs. An incandescent 60 watt bulb has an electricity cost of approximately $17 annually, in comparison to purchase and annual electricity costs of an equivalent CFL bulb of $9.[118] Given the above, it is considered that renters are not negatively impacted by this policy option.

Consumer Benefits

The case studies below provide a summary of expected savings for consumers upgrading from halogen to LED technology[119].

Omni-directional halogen to LED

A home fitted with 37 mains voltage halogen light bulbs which transitions to LED light bulbs will spend $444 more than what they would have spent on buying halogens and will save $253 each year on energy costs. Over 10 years they will be $2419 better off, including the benefits from replacing fewer light bulbs.

Assumptions: 37 bulbs replaced; bulb operating hours of 621 p.a. (average use area); Electricity tariff of $0.29 per kWh; existing bulb cost $3 each; new bulb cost $15[120] each; existing lamp power 52W; new lamp power 14W; existing lamp life 2,000 hrs; new lamp life 15,000 hrs

Mains voltage halogen downlights to LED

A home fitted with 15 mains voltage halogen downlights which transitions to LED downlights today will spend $90 more than what they would have spent to purchase halogen light bulbs and will save $116 each year on energy costs. Over 10 years they will be $1251 better off, including the benefits from replacing fewer light bulbs.

Assumptions: 15 bulbs replaced; bulb operating hours of 621 p.a.(average use area); Electricity tariff of $0.29 per kWh; existing bulb cost $4 each; new bulb cost $10 each; existing lamp power 50W; new lamp power 7W; existing lamp life 2,000 hrs; new lamp life 15,000 hrs.

Extra low voltage halogen downlights to LED

A home fitted with 15 extra low voltage halogen downlights which transitions to LED downlights today will spend $68 more than what they would have spent to purchase halogen light bulbs initially, and will save $76 each year on energy costs. Over 10 years they will be $778 better off, including the benefits from replacing fewer light bulbs.

Assumptions: 15 bulbs replaced; bulb operating hours of 621 p.a.(average use area); Electricity tariff of $0.29 per kWh; existing bulb cost $3 each; new bulb cost $7.50 each; existing lamp power 35W; new lamp power 7W; existing lamp life 3,000 hrs; new lamp life 15,000 hrs.

[118] Based on 3 hours of use per day at $0.29 per kWh

[119] Many consumers will choose to not upgrade all lights as a one off upfront cost, rather replace on failure.

[120] Note LED lamp prices expected to decrease over time. Replacements are likely to be spaced over several years as bulbs fail.

Consumer Costs

Compatibility of LED to replace extra low voltage halogen downlights

- When the extra low voltage halogen downlight fails and the householder purchases a replacement LED light bulb, the light bulb may in some cases not be compatible with the existing electronic or magnetic transformer (required to convert mains voltage to low voltage) and thus not operate satisfactorily.
- To resolve the householder may either attempt to find another compatible LED themselves or require an electrician to remove transformers and update their lighting system. By using integrated luminaires, one new product can replace the lamp, light fitting, and transformer. Costs can be deferred in the short term by keeping spare halogen downlights on hand.
- This is estimated to affect two per cent of households with extra low voltage halogen downlights, approximately 60,000 households[121] , reducing 10 year household savings from converting to LED lighting from $778 to $117 over ten years.
- It is estimated that this issue may affect 10,000 low income households[122].

Extra low voltage halogen downlights to LED luminaires

A home fitted with 15 extra low voltage halogen downlights which transitions to integrated LED luminaires today will spend $1080 more than what they would have spent to purchase halogen light bulbs initially, and will save $111 each year on energy costs. Over 10 years they will be $117 better off, including the benefits from replacing fewer light bulbs.

Assumptions: 15 lights replaced; light operating hours of 621 p.a.(average use area); Electricity tariff of $0.29 per kWh; existing bulb cost $3 each; new luminaire cost $75[123] each (including install); existing lamp and transformer power 48W; new luminaire power 7W; existing lamp life 3000 hrs; new lamp life 30,000 hrs.

Total estimated upfront costs of transformer non-compatibility:

Total 60,000 households x $1080 = $65m.

Low income households subset of this: 10,000 x $1080 = $10.8m.

This estimate may be overly pessimistic. The LED lamp and transformer compatibility tool will assist electricians and households in identifying a suitable LED lamp for existing transformer stock. Promotion of this tool may also encourage industry to develop highly

[121] Based on data from state government replacement programs and industry feedback it is estimated that compatible LEDs area available for 98% of current ELV downlight installations. E3 Lighting Audit 2016: 33% of all houses audited had ELV halogen downlights. Thus houses affected = 33% x Australian stock x 2% incompatibility (from VEET program) = 60,000.

[122] E3 Lighting Audit 2016: of all houses audited, 6% had ELV halogen downlights fitted and were classified as low income. Thus houses affected = 6% x Australian stock x 2% incompatibility (from VEET program) = 10,000 low income houses fitted with ELV halogen lamps, who have transformer incompatibility problem.

[123] Note that prices are expected to decrease.

compatible retrofit lamps to address the estimated non-compatibility. The tool is expected to be available in 2017.

<u>Compatibility of LED dimmable lamp with existing dimmer</u>

Some LED lamps may not be compatible with existing lighting systems that include a dimmer circuit, resulting in the LED lamp not operating satisfactorily (flickers, restricted dimming). Problems are more likely to occur when dimmers are combined with low voltage transformers.

To resolve this issue, the householder will need to identify a compatible LED lamp or upgrade their dimming system. Households with dimmers installed that do not have a record of the model will require assistance from an electrician to identify as there are no unique model characteristics visible on the outside of the dimmer. Costs can be deferred in the short term by keeping spare halogen lamps on hand or in some cases using a non-dimmable LED and dialling to 100 per cent.

The estimated dimmer incompatibility rate is approximately 60 per cent of installed stock.

- This is estimated to affect 20 per cent of households, approximately 2 million households[124] , reducing 10 year savings from converting to LED from $778, to $428

It is estimated that this issue may affect 400,000 low income households[125].

New dimmers (estimated cost to install 3)

If a household installs 3 dimmers compatible with LED (and ELV transformer if applicable):

Cost: dimmer purchase ($165) plus install ($140) = $305

Assumptions: dimmer cost $55 each, average house has 3 dimmers[126]

[124] Estimate number of households with dimmer installed, based on E3 Lighting Audit 2016. 68 of the 180 houses surveyed has at least 1 dimmer. Extrapolating to the entire Australian housing stock, it is estimated that 3.4 million houses have at least one dimmer. Worst case scenario estimates that 60% will require upgrade (to be validated with industry).

[125] E3 Lighting Audit 2016: of all houses audited, 8% had dimmers fitted and were classified as low income. Thus houses affected = 8% x Australian stock x 60% incompatibility = 400,000 low income houses fitted with dimmers, who have dimmer incompatibility problem.

[126] E3 Lighting Audit 2016: for houses fitted with a dimmer, the average was 3.

Total estimated upfront costs of dimmer non-compatibility:

3.4m households[127] x 60% incompatibility rate x 70% dimmer retain rate x $305 = $436m.

Low income subset of this: 400,000 households x 70% dimmer retain rate x $305 = $85m.

This estimate may be overly pessimistic for two main reasons:

- The success of Accredited Persons to source highly compatible non-dimmable LED lamps with existing transformer stock in Victoria under the VEET scheme indicates that the market may largely address the dimmer compatibility problem.
- Phasing out halogen will present an opportunity in the market for suppliers to source or design LED dimmable product that is highly compatible with a range of legacy dimmer systems installed in Australian homes. The volume of potential sales is likely to make this financially viable, as has occurred in Victoria with non-dimmable lamps under VEET.
- Experience with state subsidy programs indicates that many consumers will be satisfied with leaving their dimmer set to 100 per cent (effectively forgoing dimmer operation) and not incur the expense of installing new dimmers. Recent consumer surveys undertaken by E3 also shows a variation in usage of existing dimmer stock (less dimmers used for equivalent LED lighting), suggesting that some consumers may choose to avoid this cost.

Option F: option B and incandescent MEPS to CFL levels

Option F is the same as option E, plus Commercial Luminaire MEPS.

Cost Benefit Analysis

The cost benefit analysis has considered six options. The analysis compared the BAU scenario with the six regulatory options, each of which showed reductions in energy emissions when compared with existing regulation. Full details are included at Attachment A.

Summary of cost-benefit analysis of regulatory options for Australia and New Zealand (from 2016 to 2030)

[127] E3 Lighting Audit 2016: 68 of the 180 houses surveyed has at least 1 dimmer. Extrapolating to the entire Australian housing stock, it is estimated that 3.4 million houses have at least one dimmer.

Table 11: Cost benefit estimates – Australia (Real discount rate: 7%)

Option	Sector	Energy Saved (cumulative GWh)	GHG Emissions Reduction (cumulative Mt)	Total (Gross) Benefit (NPV, $M)	Total Investment (NPV, $M) [128]	Net Benefit (NPV, $M)	(Gross) Benefit to Cost Ratio	Cost of Abatement (NPV$/tonne)
A. LED MEPS	Res	1,841	1.0	255	29	226		
A. LED MEPS	Com	4,302	2.8	422	46	376		
A. LED MEPS	**All**	**6,143**	**3.8**	**677**	**75**	**602**	**9.02**	**-158**
B: LED MEPS + LOR MEPS[129]	Res	1,841	1.0	255	29	226		
B: LED MEPS + LOR MEPS	Com	8,890	5.5	838	93	745		
B: LED MEPS + LOR MEPS	**All**	**10,731**	**6.5**	**1093**	**122**	**971**	**8.96**	**-149**
C: LED MEPS + LOR MEPS + Labelling	Res	3,227	1.9	457	59	398		
C: LED MEPS + LOR MEPS + Labelling	Com	8,890	5.5	838	93	745		
C: LED MEPS + LOR MEPS + Labelling	**All**	**12,117**	**7.4**	**1295**	**152**	**1143**	**8.52**	**-154**
D: LED MEPS + Labelling	Res	3,227	1.9	457	59	398		
D: LED MEPS + Labelling	Com	4,302	2.8	422	46	376		
D: LED MEPS + Labelling	**All**	**7,529**	**4.7**	**879**	**105**	**774**	**8.4**	**-165**
E: LED MEPS + Phase out	Res	16,293	10.9	2517	447	2070		
E: LED MEPS + Phase out	Com	4,302	2.8	422	46	376		
E: LED MEPS + Phase out	**All**	**20,595**	**13.7**	**2939**	**493**	**2446**	**6.0**	**-178**
F: LED MEPS + LOR MEPS + Phase out	Res	16,293	10.9	2517	447	2070		
F: LED MEPS + LOR MEPS + Phase out	Com	8,890	5.5	838	93	745		
F: LED MEPS + LOR MEPS + Phase out	**All**	**25,183**	**16.4**	**3355**	**541**	**2815**	**6.2**	**-172**

Table 12: Cost benefit estimates - New Zealand (Real discount rate: 5%)

Option	Sector	Energy Saved (cumulative GWh)	GHG Emissions Reduction (cumulative Mt)	Total (Gross) Benefit (NPV, $M)	Total Investment (NPV, $M) [130]	Net Benefit (NPV, $M)	(Gross) Benefit to Cost Ratio	Cost of Abatement (NPV $/tonne)
A. LED MEPS	Res	360	0.02	55	5	50		
A. LED MEPS	Com	841	0.06	92	11	81		
A: LED MEPS	**All**	**1,201**	**0.08**	**147**	**16**	**131**	**9.2**	**-1637**
B: LED MEPS + LOR MEPS[129]	Res	360	0.02	55	5	50		
B: LED MEPS + LOR MEPS	Com	1,738	0.12	184	22	162		
B: LED MEPS + LOR MEPS	**All**	**2,098**	**0.14**	**239**	**27**	**212**	**8.9**	**-1514**
C: LED MEPS + LOR MEPS + Labelling	Res	583	0.17	90	7	83		
C: LED MEPS + LOR MEPS + Labelling	Com	1,738	0.12	184	22	162		
C: Option B + Labelling	**All**	**2,321**	**0.29**	**274**	**29**	**245**	**9.4**	**-845**
D: LED MEPS + Labelling	Res	583	0.17	90	7	83		
D: LED MEPS + Labelling	Com	841	0.06	92	11	81		
D: LED MEPS + Labelling	**All**	**1,424**	**0.23**	**182**	**18**	**164**	**10.1**	**-713**

[128] The Total investment column for Australia includes costs to consumers, product supply businesses and government to implement the option. Costs to business and government are included in the residential sector row of the table. See the impacts section for further information.

[129] LOR MEPS is MEPS for non-integrated commercial luminaires

[130] The Total investment column for New Zealand includes costs to consumers and product supply businesses to implement the option. The proportion of government costs to be incurred by the New Zealand Government has not been accounted for in this table, with all government costs included in the Australian table. See the impacts section for further information.

For Australia, option F (introduce LED and Commercial Luminaire MEPS and increase incandescent MEPS) gives the greatest net benefit at an estimated $2.81 billion. This option would save approximately 25,000 giga-watt hours (GWh) and 16 million tonnes (Mt) of greenhouse gas (GHG) emissions cumulative to 2030. This option would require consumers to pay a little more upfront for light bulbs, but households will save money through reductions in electricity and replacement costs. Some households are likely to incur a one off upfront cost to resolve compatibility issues with existing lighting systems. The Department and Lighting Council Australia are jointly working to reduce the consumer cost of this option through wide promotion of compatible products and seeking industry solutions to reduce impacts.

The current preferred option for New Zealand is Option B (introduce LED and Commercial Luminaire MEPS). This option would save 2,000 giga-watt hours (GWh) and 0.14 million tonnes (Mt) of greenhouse gas (GHG) emissions cumulative to 2030. This option provides a net benefit of an estimated $212 million.

Option C, which includes mandatory labelling in additional to LED and Commercial Luminaire MEPS, provides the greatest net benefit for New Zealand, but is not considered feasible in the absence of introducing labelling in Australia. The size of the New Zealand market is considered too small to require lighting suppliers to amend product labelling specifically for New Zealand sale. Further, Australia and New Zealand seek to align product regulation where possible, to contribute to the objectives of the Trans-Tasman Mutual Recognition Arrangement (TTMRA).

Modelling for the mandatory labelling proposal was limited, due to the lack of data available on the effectiveness of light bulb labelling. For modelling purposes in this RIS, it is assumed that labelling will deliver a relatively small benefit of a 5 per cent improvement in the purchase of energy efficient light bulbs. The Department welcomes further information from stakeholders on research conducted on the effectiveness of light bulb labelling to further inform this estimate and validate accuracy of modelling.

All six options presented include LED MEPS on the basis that this policy response is necessary to address LED quality issues in the market. It is considered that these issues cannot be addressed by the Australian Consumer Law (ACL), education or labelling given the complexity around lighting performance and the inability for a consumer to determine the quality of the product pre purchase.

The ACL does not provide the Australian Competition and Consumer Commission (ACCC) or state regulators with any role in determining which products make it to market from a quality perspective. The operation of the ACL and role of the ACCC is explained under 'Other policies that impact these problems' section.

The MEPS policy proposals are not expected to restrict competition in the lighting market or impose significant costs, with removal of the poorest performing products from the market.

- The LED MEPS proposal would apply to an estimated 255 suppliers selling LED lighting in Australia[131]. This includes the 66 lighting suppliers that have halogen, CFL and linear fluorescent lamps registered for sale in Australia and New Zealand[132].
- The traditional commercial luminaire market, in which the commercial luminaire MEPS proposal would apply, is declining in sales with the commercial market largely moving to integrated LED luminaires.
- The proposal to increase the incandescent MEPS (Australia only) to remove the least energy efficient products from the market would result in increased demand for CFL and LED products. It is understood that all 24 suppliers who have registered halogen products proposed for removal from the Australian market are supplying CFL and/or LED products. This policy proposal would impose a barrier to the sale of filament lamps in Australia, removing this technology choice for consumers, although equivalent energy efficient lamps exist on the market and benefits to the community as a whole far outweigh the costs.

Sensitivity analysis – what if costs increase?

Various sensitivity analyses were undertaken to show the impact of changing costs on the modelling outcomes. Full details are included at Attachment A.

The sensitivity of the results was tested under the following cases:

- Discount rates (real) –
  Australia = 0%, 3%, 7%, 11%
  New Zealand = 0%, 3%, 5%, 8%
- Price efficiency ratios – 0.25, 0.5, 0.75 (percent price increase per percent efficacy increase, used for MEPS)
- Price of LED lights – 25% less and 25% more compare to assumed values (used for phase out)

Sensitivity tests on discount rates show that all proposals considered for Australia and New Zealand will have substantial positive net benefit in terms of energy use reduction leading to reduced running cost for consumers, regardless of the discount rates selected. For example, the net benefit for Proposal E in Australia is projected to be between AU$5420 million (0 per cent discount rate) and AU$1634 million (11 per cent discount rate), with benefit cost ratio between 9.6 and 4.8. This means the benefits from projected energy use reduction and related reduction in running cost for consumers will likely exceed the costs of implementing proposal by at least 4.8 times.

Sensitivity analyses on the price impact of improved lighting products (due to MEPS) were conducted to test the robustness of modelled net benefits. A price/efficiency ratio of 0.5 was

[131] Based on advice from Energy Safety Regulators

[132] Lighting Council Australia members, estimated to reflect 90 per cent of the market, are all supplying LED products only or in addition to other lighting products[132].

used in analysis for larger luminaires, meaning the price of lighting product will increase by 0.5 per cent for every one per cent increase in efficacy. Price efficiency ratios of 0.25 and 0.75 were used for testing sensitivity.

For phase out options, sensitivity was tested by varying the price of LEDs - up and down by 25 per cent from the assumed values. The sensitivity analysis on price also reveals that all proposals will have substantial positive net benefits.

Even in the most extreme test, where price efficiency ratio increases by 50 per cent and LED price increases by 25 per cent, it is still cost effective to regulate – with net benefit of AU$2346 million for Proposal E in Australia and net benefit of AU$231 million for Proposal C in New Zealand.

1. Consultation Questions

Guiding Questions

You are invited to give us feedback on this Consultation RIS, and any matter referred to in it, or arising from previous consultation on the product profile, including whether your position has changed (and why). This will help us develop a robust and useful regime.

These questions are designed to enable us to better understand the impact of our market and modelling assumptions, analysis and impacts on industry, energy use, greenhouse gas emissions and trade implications. We would be grateful if you could provide us with any relevant data or evidence that you may have to support your submissions.

General

1. We have estimated that 10,200 lamp and LED luminaire product types would be covered by the proposed LED MEPS over a 10 year period. Do you agree with this product estimate, noting the LED product scope, exemptions and proposed definition of family of models in Attachment H? If not please provide a revised estimate with supporting evidence.

2. We have estimated that 600 traditional commercial luminaires, being supplied by 40 entities, would be covered by the proposed Commercial Luminaire MEPS. Do you agree with this supplier and product estimate, referencing the proposed definition of family of models in Attachment H? If not please provide a revised estimate with supporting evidence.

3. We assume that the price of LED lamps and small LED luminaires won't increase, and there will only be a small short term price increase for larger LED luminaires, as a result of proposed changes to regulation. Do you agree with this assumption? If not why not? Please explain.

4. We assume that the price of traditional commercial luminaires won't change significantly from proposed changes to regulation. Do you agree with this assumption? If not why not? Please explain.

5. What, if any, unintended outcomes might arise from implementing the policy options? Please explain and give examples if possible.

6. What might help you easily comply with the proposed regulations? Do you have any suggestions to simplify or streamline the registration process?

7. If approved, the regulation for LED and Commercial Luminaire MEPS is planned to commence in January 2018, with the determination and test standard to be

published six months prior. Noting that existing stock will still be able to be sold after that date, do you consider that this timing is sufficient to allow time for industry to implement this change?

8. If approved, the regulation to increase MEPS for incandescent lamps, is planned to commence in November 2018, conditional on the introduction of LED MEPS (allowing time to address LED quality issues) and the replacement Incandescent MEPS determination being released six months prior, to allow time for industry to alter supply chains and minimise wastage of materials that are no longer needed. Noting that existing stock will still be able to be sold after that date, do you consider that this timing is sufficient to allow time for industry to implement this change?

9. If you consider that timing of proposed regulatory change is inadequate, can you give us details on alternative ways and means that you could comply with regulations.

LED MEPS

10. Do you consider that the proposed MEPS efficacy level for 2018 is appropriate? If not please explain your rationale with suggested alternative. The proposed level is based on the 2016 IEA4ESSL recommended level (present), noting that suppliers will be required to test at least 10 lamp products (or 4 small, 2 large luminaires) to demonstrate that the mean of the sample of their model meets the minimum efficacy level.

11. Do you agree with the proposed mandatory minimum performance standards, outlined in Attachment H? If not, please advise of alternative approach with supporting rationale.

12. Do you agree with the proposed test methods, outlined in Attachment H? If not please advise of alternative approach with supporting rationale.

13. Do you agree with the proposed staging of implementation by product category? If not, please advise of alternative approach with supporting rationale.

14. Do you agree with the proposed definition of family of models outlined in Attachment H? If not, please advise of alternative approach with supporting rationale.

15. Do you agree with the proposed mandatory marking requirements outlined in Attachment H? If not, please advise of alternative approach with supporting rationale.

16. Please provide indicative costs to implement proposed marking requirements.

17. Please provide indicative costs to implement proposed marking requirements in a standardised format (i.e. consistent mandatory labelling).

18. Do you support consistent mandatory labelling on LED packaging, to make it easier for consumers to compare key characteristics of LED products?
19. Please provide an estimate on the cost imposed on suppliers to undertake proposed LED testing.

Commercial luminaire MEPS

10. Do you identify any concerns with the proposed LOR test approach?
11. Do you agree that the testing proposed would result in little to no additional testing for suppliers who are already conducting testing for linear lamp registrations?
12. Do you agree that non-integrated commercial luminaires will remain in the market in Australia and New Zealand as products are installed in some new or renovated commercial and industrial buildings over the next five years? Please provide estimates of the future market share of these products.
13. Do you agree that MEPS on commercial luminaires is warranted if MEPS is introduced for LED luminaires, to prevent the regulatory imbalance described above? If not, please explain your rationale.
14. Are there any gaps or issues with the proposed scope definition for commercial luminaires to be subject to MEPS?
15. Do you consider that the proposed MEPS level is appropriate to achieve energy savings at the cheap end of the commercial market?
16. As a supplier, do you consider that MEPS on commercial luminaires would have a minor, moderate or major impact on your business? What, if any, concerns do you have with this option? Please provide estimates of any reduction in overall sales – where you are currently selling commercial luminaires that will be below the proposed MEPS.
17. Is there any significant product categories that may be removed from the market as a result of the proposed MEPS levels?
18. With the removal of the poorest performing luminaires, do you agree that there are adequate replacement products at a relatively similar price, resulting in a minor impact on the end user consumer?
19. Limited data is available to assess the impact of the proposed MEPS on price. Modelling has assumed a 0.5 per cent increase in price with a 1 per cent increase in efficacy relationship. Is this assumption broadly reasonable? If not, please advise of alternative with supporting rationale. The E3 Program would welcome price data on

commercial luminaires sold with associated efficacy to substantiate the accuracy of modelling (to be held in-confidence).

Mandatory labelling – all lighting technologies

29. Please provide indicative costs to implement proposed label requirements.

30. Do you consider in the absence of the further phase-out of incandescent and halogen lamps, that mandatory labelling across remaining incandescent, halogen, CFL, LED lamp and small LED luminaire products primarily used in the residential sector would assist consumers in selecting a light bulb to meet their needs?

31. How long would industry require to implement proposed label requirements? Please provide rationale.

32. Do you consider that an information label, similar to the US FTC, would be most suitable for the Australian market? If not, please provide alterative suggestion with supporting rationale.

33. Do you consider that incandescent watt equivalency should be included as a mandatory attribute? Alternatively should this attribute be voluntary, allowing suppliers to transition away from this equivalency as consumers become more informed about lumens?

34. Do you agree with our assertion that implementing labelling independently in New Zealand would be difficult?

35. Do you consider that mandatory labelling will significantly increase the purchase of energy efficient light bulbs in Australia? If yes, please provide research to support your claims.

Increase incandescent MEPS (Australia only) to remove the most inefficient lamps

36. Can you advise of existing electronic transformers installed that are not compatible with any LED MR16 lamps on the market and if possible estimated number of installs.

37. The Department requests further advice to confirm the assumption that sensors and timers sold post 2010 are generally three wire.

38. Please advise if you consider if there are moisture ingress concerns with LED under certain conditions, including data/evidence to support your claims.

39. Please advise of any conditions (heat/moisture/other) where LED would not be a suitable replacement with data to support claims.
40. Is the exception for traffic lights necessary or are LED now considered superior under these conditions and thus the exception is no longer necessary?
41. Do you have any concerns with the proposed timetable to phase out halogen lamps? Are there any halogen type lamps on the market where there is no LED suitable replacement?
42. Are there additional costs to industry or consumers that need to be considered with this option, not already specified in the Impacts section of this RIS?
43. Do you consider that the estimated costs of this option are realistic? Please explain with supporting data, if possible.
44. Please suggest options to assist households with incompatible legacy lighting systems to make the transition to LED lighting.

Information and education campaign

45. Do you think a broad education campaign would be beneficial to raise awareness of changes and assist in the transition?
46. Would your organisation like to be involved in the development of the communication strategy and rollout?
47. Do you have any feedback/suggestions on how communications could be best approached, drawing on any experience through the ‘Change the Globe’ campaign or New Zealand’s Rightlight education campaign?

Conclusion

Based on the current analysis and feedback obtained to date, our recommended policy option is option F for Australia and option B for New Zealand. This involves implementing MEPS for LED lamps and LED luminaires (including associated test method) and traditional commercial luminaires, from January 2018, for Australia and New Zealand. For Australia, it also involves increasing MEPS for incandescent lamps to remove the least energy efficient lamps from the market, from November 2018. Exact dates would be dependent on timing of approval of the Decision RIS.

For Australia, the recommended option provides the greatest net benefit of an estimated $2.81 billion. This option would require households to pay a little more upfront for light bulbs, but will save consumers money through reductions in electricity and replacement costs. Some consumers are likely to incur a one off upfront cost to resolve compatibility issues with existing lighting systems. The Department and Lighting Council Australia are jointly working together to reduce the consumer cost of this option through wide promotion of compatible products and seeking industry solutions to reduce impacts.

By implementing Option B, New Zealand would obtain an estimated net benefit of $212 million. Option C, which includes mandatory labelling in additional to LED and Commercial Luminaire MEPS, provides the greatest net benefit for New Zealand, however this option is not recommended in the absence of introducing labelling in Australia.

In addition to achieving significant gains in energy savings and greenhouse gas reductions for both governments, option F for Australia and option B for New Zealand is considered the best option to address the problems identified in this consultation RIS – a combination of regulatory failure due to existing regulations not keeping pace with improvements in lighting technology, information failure as consumers are not provided with the information they need make an informed purchasing decision or are not willing to invest the time to understand whole of life costs for a low priced product, and split incentives whereby commercial, new build residential and rental properties have no incentive to purchase more efficient but higher upfront cost products.

Consultation with stakeholders through this RIS process may identify issues not yet considered in relation to the individual aspects of the proposals. This may result in changes to the recommendations to be made in a Decision RIS (proposal put to ministers). Any significant changes may need further consultation with industry.

2. Implementation and review

Implementation - next steps

Once submissions have been gathered from this consultation process, they will be analysed with any new data assessed. Fundamental changes as a result of comments or new data can be discussed again with industry.

The technical working group(s) will continue to draft performance standards and associated test methods as input to legal instruments. At this stage it is proposed that LED MEPS and test requirements will be included directly in the Determination under the GEMS Act (which is then referenced by New Zealand regulation), with direct reference to international standards, rather than undertaking the development of a new Australian and New Zealand standard. We seek expressions of interest from experienced technical members of industry, to contribute to this working group/s including relating to the development of MEPS for LEDs, non-integrated commercial luminaires, and compatibility and staging strategies for the phase-out of halogen lighting. Please email EERLighting@environment.gov.au.

The Decision RIS will be considered by Energy Ministers in both New Zealand and Australia. It will outline relevant issues raised by industry and how government can/should address them. Industry will be informed on recommended option(s) and expected implementation dates and any changes decided by Ministers.

Australia

- Following stakeholder feedback on this Consultation RIS, the comments and feedback received will be considered before proceeding to a Decision RIS.
- If it is resolved to proceed, a Decision RIS (incorporating feedback on the Consultation RIS policy proposals) will be submitted to the COAG Energy Council.
- If a policy proposal in the Decision RIS is approved by the COAG Energy Council, the legal instruments (referred to as GEMS Determinations) will be created or revised.
- Once Ministerial approval is provided for the revised Determinations, there will be a period before any policy change comes into force.

New Zealand

- The New Zealand Minister of Energy and Resources will vote the policy proposed by any resulting Decision RIS through the COAG Energy Council.
- Any policy proposals will be approved by Cabinet before being adopted under the *Energy Efficiency (Energy Using Products) Regulations 2002*.

- Approval of Cabinet is required for any proposed regulatory option. For these sorts of changes, there is a requirement to wait for 6 months after they are written into law, before they can come into force.

Given the E3 Program's experience with implementing or revising energy efficiency requirements, the risks associated with implementation are considered low. Any transitional arrangements will be developed in close consultation with industry.

Review

In Australia, once the changes are in force:

- Lighting products imported or manufactured prior to the law change that don't meet the new requirements may still be supplied until stock is depleted. Their registrations will be grandfathered (status changed to "Superseded" in the registration system). Evidence of date of import may be requested for compliance purposes. New import or manufacture of these products from the date of the law change is not permitted.
- Registered lighting products imported or manufactured prior to the law change that already meet the new requirements, may continue to be supplied. Their registrations will be re-validated and updated to the new GEMS determination.
- Suppliers wishing to import or manufacture models that are not already registered, but meet the new requirements, will need to complete a registration application, pay the registration fee and lodge the application with the GEMS Regulator.
- Unregistered products that fall within the scope of the law are not permitted to be supplied, or used for any commercial purpose at any time.

In New Zealand, once the changes are in force:

- Registered lighting products imported or manufactured prior to the law change that don't meet the new requirements may only be sold until stock is depleted. New import or manufacture of these products is not permitted.
- Registered products imported or manufactured prior to the law change that already meet the new requirements, may continue to be supplied. Their registrations will be re-validated and updated.
- Suppliers wishing to import or manufacture models that are not already registered, but meet the new requirements, will need to complete a registration application and lodge it with the New Zealand Regulator (EECA).
- Unregistered lighting products that fall within the scope of the law, are not permitted to be supplied at any time.

Australian and New Zealand regulators undertake compliance activities, involving education, surveys, store inspections and checking claims in media. They also purchase lighting products using a risk based approach, for the purpose of laboratory check testing, to assess whether efficiency claims made in registrations are accurate.

Evaluation

The E3 Program uses various sources of information to evaluate both the effectiveness of the program and product category requirements. This includes retrospective reviews to compare the effect of policies versus what was projected in RIS analysis; analysing sales data to understand changes in product market share, consumer awareness and usage of energy efficiency labelling; tracking the hits on the Energy Rating website; and utilising ABS and other surveys of consumer intent and consideration of energy efficiency in purchase decisions.

In New Zealand, after a year of trading under these new laws, lighting suppliers are requested for sales data on how many lighting products they have sold and various energy efficiencies, so that energy savings can be tracked against predictions.

Attachment A: Modelling

Purpose

The purpose of this attachment is to provide supporting technical and modelling outputs for the 2016 Consultation Regulation Impact Statement (RIS) affecting lamps and lighting equipment.

i. Methodology and key inputs

Calculation methodology

Cost benefit analysis

A financial analysis has been conducted on the societal costs and benefits for the policy proposals being considered, with the cost-benefit analysis conducted at the national level. At the state level, any differences in lighting usage, for example due to climatic differences, are significantly less pronounced than for say heating and cooling. Thus a state-level analysis was not considered worthwhile, and this would also add significant complexity to what is already a very complex model.

In order to better show the impacts in each sector, residential and commercial (which includes industrial) sectors are however modelled separately for the LED MEPS proposal. The other proposals largely apply either primarily to one of either the residential or commercial sectors and are modelled as such. In section ii of this attachment, the sectoral split for each proposal can be seen. In addition, the lighting products are modelled as either residential or commercial (or both, as required) and this detail can be seen in the Product Attributes table later in this section.

In the analysis the following costs and benefits are included in financial modelling:

Costs:

- To the consumer, due to increases in the upfront price of products, reflecting costs passed on by suppliers;
- To the consumer, due to transitional costs in upgrading existing lighting systems to be compatible with LED lighting; and
- To the product supply businesses for complying with the new or modified regulatory requirements (e.g. product testing, product registration, administration of new product categories, etc.).
- To government for implementing and administering the requirements.

Benefits:

- To the consumer, due to improved energy efficiency of available products resulting in avoided electricity purchase costs; and
- To suppliers, from simplifications to the regulatory framework.

The following **cost and benefits** are **not included** in financial calculations:

- Benefits to the consumer, due to longer life of LEDs, leading to reduced replacement costs;
- Benefits to the consumer, due to reduced heat load on air conditioning systems;
- Benefits to society, from reduced GHG emissions; and

- Benefits to society, due to reduced peak demand on electricity networks.

Note that rebound is treated as zero in relation to energy use - this phenomena (increased usage due to lower energy costs or increased comfort) does not typically apply to lighting.

In terms of an approach for the cost-benefit analysis, this could be done from a consumer or societal perspective. The societal approach is the preferred method for a RIS, however the consumer approach can be used where it approximates the results that would be obtained from the societal perspective. A societal perspective would include health benefits from reducing energy costs, benefits from reduced greenhouse gas emissions and reduced electricity network or renewable generation costs. Since these benefits are difficult to quantify and will increase the overall benefit from the regulation, not considering them and using the consumer approach is a reasonable and conservative proxy for the societal analysis.

An analysis from a consumer perspective involves the use of retail product prices and marginal retail energy prices. Since the objective is to assess whether product buyers (consumers) as a group would be better off, transfer payments such as taxes are included. The analysis includes retail mark-ups and taxes that will be passed onto the consumer and including these in the costs will simplify the analysis process, while still remaining appropriate.

The consumer approach is also recommended for the development of RISs associated with the E3 Program (NAEEEP 2005). The alternative analysis approach, of assessing from a resource perspective, would require a new set of factors and assumptions to be introduced to the analysis, particularly regarding manufacturing costs, and would also mean the impact of varying discount rates would be very much more difficult to assess.

Greenhouse gas emissions and energy consumption

Greenhouse gas (GHG) emissions due to lighting are calculated by multiplying energy consumed (by lighting products at end-use) and GHG emissions intensity factors (as determined by the electricity generation mix). The GHG emissions factors used in this RIS are given in Attachment A1.

Total energy consumption was determined for a BAU and a policy scenario, for each policy proposal. Energy savings are the difference between BAU and with-policy energy consumption (the same applies to GHG savings).

The annual energy consumed (by each type of lighting product, at end-use) is essentially the multiplication of:

- The stock of the lighting product type;
- Their average annual operating hours; and
- Their average electrical input power.

The stock of lamps and luminaires, for all BAU and policy scenarios, is calculated using a sophisticated stock and sales model, that was developed for this RIS. This model calculates stock, using sales as the key input data. This is because there are significantly more time-series data available for sales than there are for stock (e.g. household surveys) and regulations also affect sales directly, rather than stock. An explanation for how all key model parameters were derived is provided in the table below.

Key model parameters

Explanations for the derivation of all key model parameters are detailed in the table below. These are all derived from available data, information obtained from industry, or where necessary realistic assumptions.

PARAMETER	EXPLANATION
Proposals	The following proposals were modelled: • **Proposal #1, MEPS for LEDs**. This would apply in Australia and New Zealand, phased to commence in 2018, with increased MEPS in 2020 and 2023. • **Proposal #2, LOR MEPS for non-integrated luminaires**. This would apply in Australia and New Zealand, with MEPS commencing in 2018. • **Proposal #3, phase-out of halogen and incandescent lamps**. This would apply only in Australia, in 2018. • **Proposal #4, energy labelling**. This would apply in Australia and New Zealand, commencing in 2018.
Options	Several combination of the above proposals were modelled: • **Option A**, consisting of proposal #1 (MEPS for LEDs). This would apply in Australia and New Zealand, phased to commence in 2018, with increased MEPS in 2020 and 2023. • **Option B**, consisting of proposal #1 (MEPS for LEDs, as above) and proposal #2 (LOR MEPS for non-integrated luminaires). This would apply in Australia and New Zealand, with LOR MEPS commencing in 2018 and LED MEPS phased as described above. • **Option C**, consisting of proposal #1 (MEPS for LEDs) and proposal #2 (LOR MEPS for non-integrated luminaires), with the addition of proposal #4 (lamp labelling). This would apply in Australia and New Zealand. • **Option D**, consisting of proposal #1 (MEPS for LEDs) and proposal #4 (lamp labelling). This would apply in Australia and New Zealand. • **Option E**, consisting of proposal #1 (MEPS for LEDs) and proposal #3 (phase-out of halogen and incandescent lamps). This would apply only in Australia. • **Option F**, consisting of proposal #1 (MEPS for LEDs), proposal #2 (LOR MEPS for non-integrated luminaires) and proposal #3 (phase-out of halogen and incandescent lamps). This would apply only in Australia. MEPS is modelled to materially impact the market in the year MEPS is introduced. The above MEPS are described in detail in the main body of the RIS. For each policy, a BAU and a Policy Scenario have been modelled, for both Australian and New Zealand (where required). Key assumptions and parameters for each scenario are detailed in section ii of this Attachment.
Product Types	There are many products that need to be modelled for this RIS (around 28 in total). The modelled attributes for all products and scenarios can be seen in section ii of this Attachment. Note that these describe *average* values for each product type, and some are differentiated between residential and commercial sectors.
Financial Parameters	The financial modelling undertaken for the RIS is couched in *real terms*. All financial parameters in the model are expressed either in real 2016 Australian dollars or in real 2016 New Zealand dollars. The conversion rate from Australian to New Zealand dollars used is AUD $1 = NZD $1.10. Where conversion to or from a nominal value is required, a nominal inflation rate of 2.6% has been used for Australia, and 2.1% for New Zealand. These are the average (annual) national CPI changes over the past 10 years, for each economy respectively. Discount rates for NPV calculations are expressed in real terms: 7% for Australia and 5% for New Zealand. These convert to nominal discount rates of 9.6% and 7.1% respectively. Sensitivity tests are conducted at 0%, 3% and 11% for Australia and 0%, 3% and 8% for New Zealand (all in real terms). To test sensitivity, average incremental costs due to efficiency improvements are increased and decreased by 50%.
Projection Period	The lighting market is modelled over a period of 15 years (2016-2030). This approach has been used to capture the ongoing savings of policy-induced market changes in the period up to 2030. Energy and financial benefits (from reduced energy consumption) for products installed up to 2030, that persist beyond 2030, have been

<table>
<tr><th>PARAMETER</th><th>EXPLANATION</th></tr>
<tr><td></td><td>modelled (to 2040) however greenhouse gas abatement has not been modelled beyond 2030, due to uncertainties related to the greenhouse intensity of electricity this far into the future.</td></tr>
<tr><td>Sales</td><td>Historical lamp and luminaire sales, for the period 2002-2015, are based primarily on lamp import data from the Australian Bureau of Statistics (ABS), Statistics New Zealand, aggregated Australian and New Zealand national supermarket data, and estimates provided by Lighting Council Australia (from their members in aggregated form showing percentage of sales by product type).

Forecast future sales are based on projected trends and reasonable assumptions and estimates where required. Forecast sales for all scenarios modelled can be seen in section ii of this Attachment. Industry feedback on these trends is sought during the consultation phase of this RIS.</td></tr>
<tr><td>Stock</td><td>Lamp and luminaire stock is calculated as the sum of sales over X preceding years, where X corresponds to the average lifetime (in years) of the lamp or luminaire type.

In order to validate the model's stock estimates, the resultant stock levels (for residential) were compared to household survey results in the table below, for Australia. These show that the two methods derive similar values.

Note this comparison is not undertaken for New Zealand as it is only required for the halogen phase out policy, where all lamp technologies in residential dwellings need to be modelled (New Zealand is not contemplating this phase out policy). The modelled stock levels (and all other attributes including lifetimes) for all products and scenarios can be seen in section ii of this Attachment.

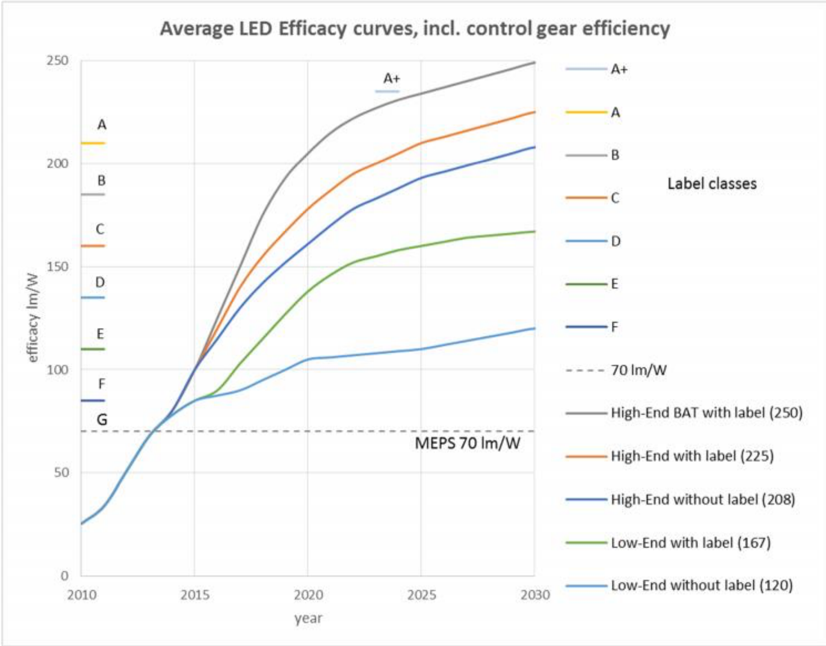
Comparison of Australian residential lamp stock levels (proportions) from 2016 household survey and this RIS model:
<table>
<tr><th></th><th>Survey 2016</th><th>Model 2016</th></tr>
<tr><td>#1: Lamp-MV-Incandescent-Residential</td><td>14%</td><td>14%</td></tr>
<tr><td>#2: Lamp-MV-Halogen-Residential</td><td>18%</td><td>17%</td></tr>
<tr><td>#3: Lamp-MV-CFL-Residential</td><td>33%</td><td>34%</td></tr>
<tr><td>#9: Lamp-MV-LED-Residential (No MEPS)</td><td>3%</td><td>4%</td></tr>
<tr><td>#4: Lamp-Downlight-Hal-Residential</td><td>17%</td><td>16%</td></tr>
<tr><td>#11: Lamp-Downlight-LED-Residential (No MEPS)</td><td>15%</td><td>15%</td></tr>
</table></td></tr>
<tr><td>Product Lifetime</td><td>The key variable that is used to calculate stock, from sales, is the average product lifetime (in years - the total number of years that the product survives before failure or removal). Note that lifetime has been capped at 15 years, in order to reflect the fact that building renovations will also tend to limit the lifetime of products. The average lifetime of all products modelled can be seen in the Product Attributes table below.

Lifetime (in years) is a function of lamp/luminaire operating life (in hours - the rated average total number of hours that a product should operate for before failure) divided by the annual operating hours (how many hours per year that it is turned on).</td></tr>
<tr><td>Annual Operating Hours</td><td>The average annual operating hours, for each product type, have been derived largely from the 2016 Australian household survey (for the residential sector). An average of 3000 hours p.a. has been used for the commercial sector (60 hours per week x 50 weeks).</td></tr>
<tr><td>Electrical Input Power</td><td>The average electrical input power, for each product type, is the estimated average rated power of various types of lamps and luminaires. This is in turn a function of the product's efficacy - its light output per unit of electrical input power (lumens per Watt or lm/W). More efficient lamps and luminaires, for a given light output, will have lower input power.</td></tr>
<tr><td>Efficacy</td><td>For incandescent, halogen and fluorescent light sources, average efficacies and other attributes are assumed to remain static over time, as these are mature technologies (and essentially at the commercial or technological limits of performance). For LEDs however, efficacy is improving rapidly and this trend is predicted to continue for some years.

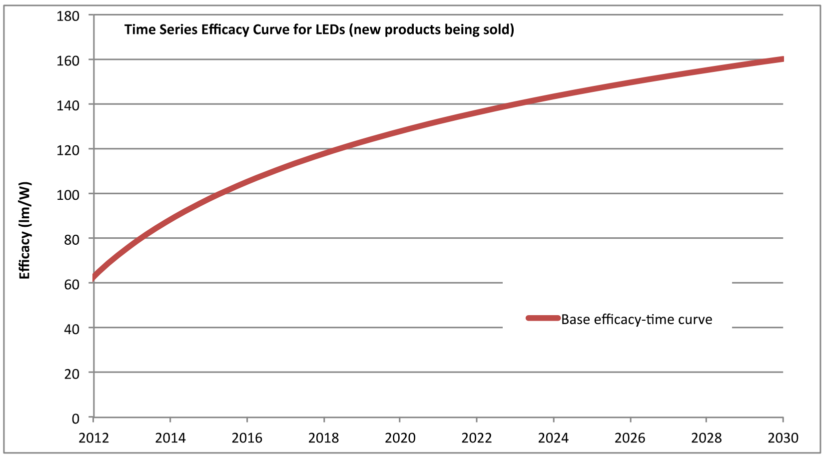
A time-based LED efficacy "base" curve was developed for this RIS, which is in turn based on the 2015 European Preparatory Study on Light Sources (EC 2015, figure 10 - reproduced below). This European curve is based on forward-looking studies by the US Department of Energy (USDOE 2014) and McKinsey & Co (McKinsey 2012).

The "base" curve used as the basis for the RIS modelling is based on the "low-end with label" European curve - the green curve in the figure below (from EC 2015) which forecasts average efficacy reaching around 160 lm/W by 2030. This curve was chosen as it effectively represents what is predicted to occur in the absence of policy intervention. Note that on the graph below, and with some US efficacy forecasts, LED efficacies of 200 lm/W are forecast. For the sake of conservatism, we have opted to use one of the lower forecast curves - it is possible that LED efficacies will ultimately be higher than what we have assumed here.</td></tr>
</table>

<table>
<tr><th>PARAMETER</th><th>EXPLANATION</th></tr>
<tr><td></td><td>



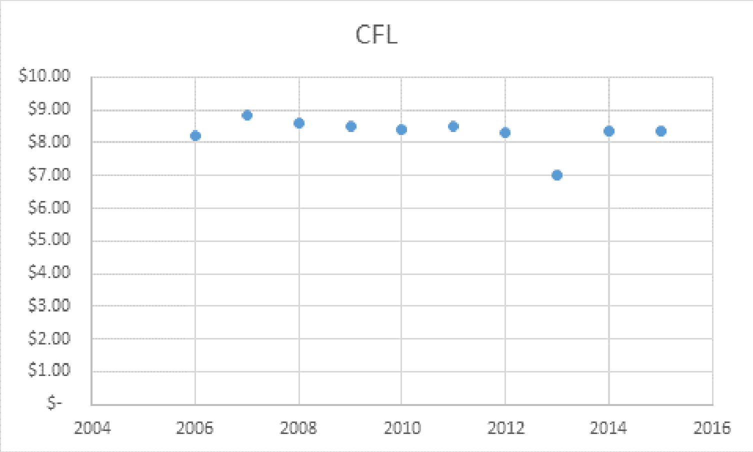
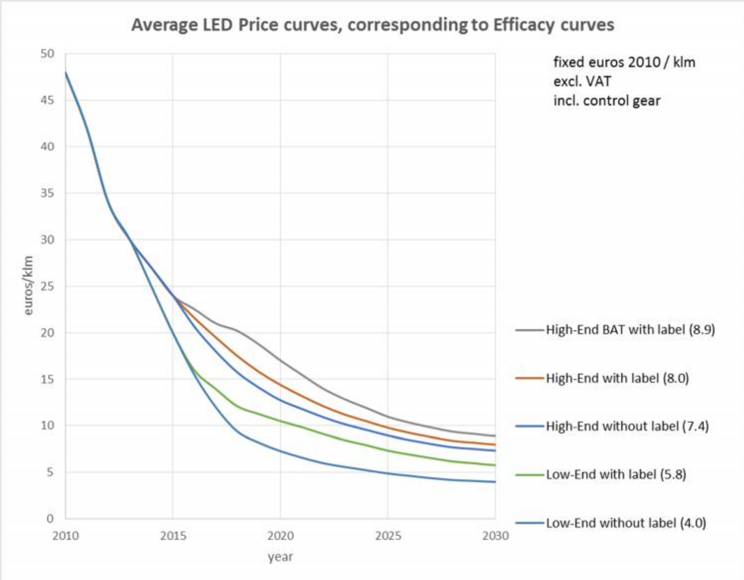
The "base" curve used for RIS modelling is shown in the figure below - as mentioned it follows the “low-end with label” European curve - the green curve - shown above. <u>Again, it is possible that LED efficacies will ultimately be higher than what we have assumed here.</u>

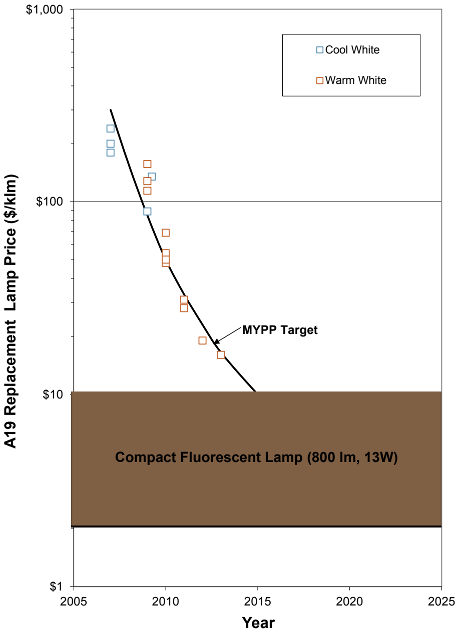


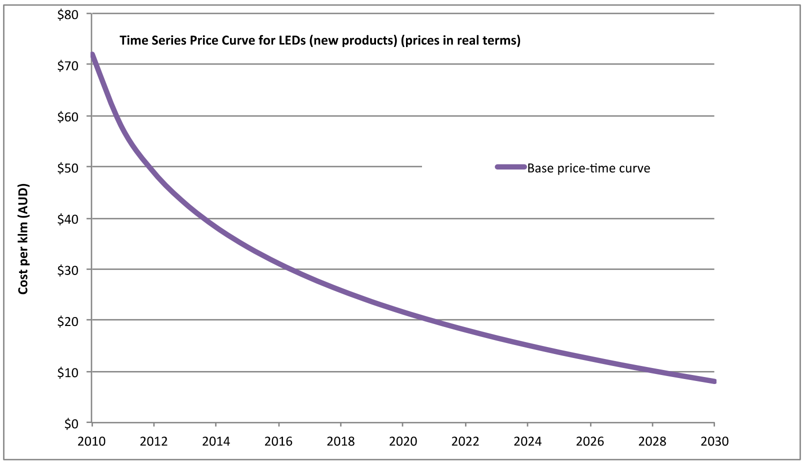
In the RIS model, this base curve is <u>linearly scaled up or down, to suit the LED product (lamp or luminaire) being studied</u>. Thus it is primarily the *shape* of this curve that is important, rather than its absolute values. The predicted efficacy curves for all products modelled can be seen in section ii of this Attachment. Nine different LED products are modelled, as follows:

- #9: Lamp-MV-LED-Residential
- #11: Lamp-Downlight-LED-Residential
- #13: Lamp-Downlight-LED-Commercial
- #15: Lamp-Tubular-LED-Residential
- #17: Lamp-Tubular-LED-Commercial
- #19: Luminaire-Small-LED-Residential
- #21: Luminaire-Small-LED-Commercial
- #23: Luminaire-Linear/planar-LED-Commercial
- #25: Luminaire-Large-LED-Commercial.

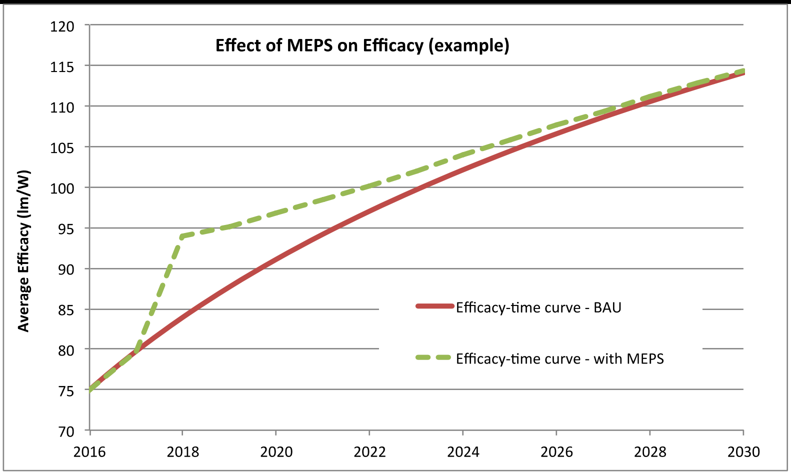
</td></tr>
<tr><td>Capital Costs</td><td>For incandescent, halogen and fluorescent light sources, product prices are assumed to remain static (in real terms) over the period 2016-2030. This conclusion was reached after examining average supermarket halogen</td></tr>
</table>

PARAMETER	EXPLANATION
	and CFL prices from 2006 to 2015. For example, the chart below shows the average cost of buying a CFL from Australian supermarkets over the period 2006 to 2016.  For LEDs, prices are decreasing. The figure below shows the predicted European curves (from EC 2015).  The figure below shows the US Department of Energy's price projection for LED lamps (from USDOE 2014).

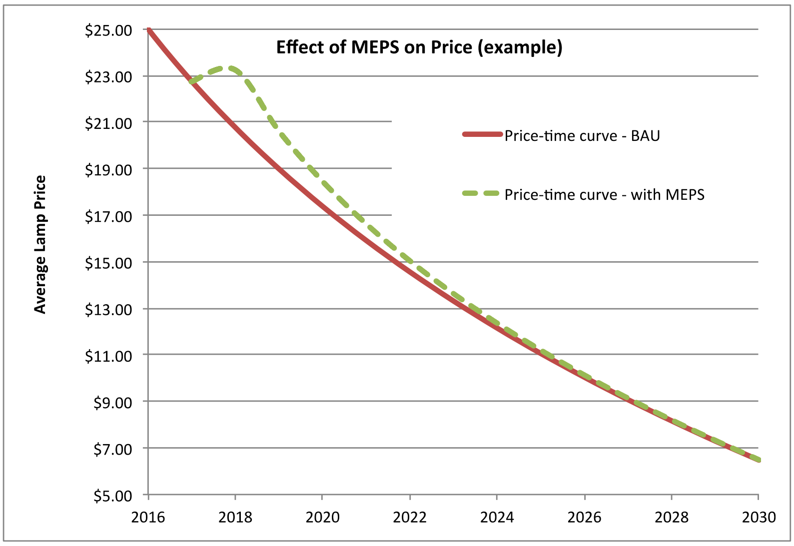
<table>
<tr><th>PARAMETER</th><th>EXPLANATION</th></tr>
<tr><td></td><td>


For this RIS, the "base" curve follows the “low-end without label” European curve - the green curve - shown two figures above. The US curve is lower, although the US market is thought to be significantly more competitive. For the sake of conservatism, the European curve is used as the basis for this RIS, shown in the figure below (in AUD).


Again, the base curve graphed above is <u>linearly scaled up or down to suit the LED product (lamp or luminaire) being studied</u>, and the resulting product prices can be seen in section ii of this Attachment. Again, it is primarily the shape of this curve that is important, rather than the absolute values.
</td></tr>
<tr><td>Cost Impact of MEPS</td><td>
For LEDs, the introduction of MEPS is likely to increase the prices of some models, which assumed to be passed on to the consumer.
Australian supermarket lamp price data was analysed in order to develop an efficacy versus price relationship for LEDs lamps. Broadly speaking there was a negative relationship between price and efficiency of about -0.6 (% price increase per % efficacy increase). Thus, for the sake of conservatism, for lamps and small luminaires MEPS is assumed to have zero impact on price (rather than -0.6). For larger luminaires +0.5 was used. These same pricing assumptions were also used for New Zealand modelling.
In the RIS model, MEPS is assumed to increase the average efficacy of LEDs. However this increase gets slowly overtaken by the natural market increase in LED efficacy, over time (at least until another tranche of MEPS is implemented). For example, if the first tranche of MEPS increases the average efficacy of lamps by 10 lm/W, in the first year of MEPS, this 10 lm/W improvement is reduced in the second year of MEPS, and so on. An example of this can be seen in the figure below - showing the BAU and MEPS efficacy of new products sold, over time. Note that this graph shows a hypothetical example only - each of the product types modelled uses an adaptation of this curve. The modelled attributes for all products and scenarios can be seen in section ii of this Attachment.
</td></tr>
</table>

<table>
<tr><th>PARAMETER</th><th>EXPLANATION</th></tr>
<tr><td></td><td>


Using the efficacy versus price relationship described previously, and forecast price-time curve for LEDs, this efficacy increase can be converted to a price increase, and the effect of this is shown in the graph below. Note that both of these graphs, above and below, use an exaggerated *hypothetical example* in order to illustrate the effect of MEPS on efficacy and on price. The modelled efficacy and price curves can be seen for all scenarios modelled, in section ii of this attachment.



</td></tr>
<tr><td>Government Admin costs</td><td>
Government administration costs are made up of salary, program administration, check testing, consumer information/education and miscellaneous (market research, etc.).

Total incremental cost to Government per annum for Australia and New Zealand are estimated at $200,000 per annum. Establishment costs to government in Australia and New Zealand to prepare the RIS and introduce the new regime are assumed to be $350,000.

An additional $2 million over a three year period is included to deliver the supporting communication campaign in Australia (2017/18, 2018/19, 2019/20).

This adds up to total taxpayer costs of $4.35 million over the ten-year assessment period.
</td></tr>
<tr><td>Industry Compliance Costs</td><td>
Registration costs for new products within the scope of the proposals are estimated at $440/model, based on the current registration fee for lighting models. This is treated as an income to the government for modelling purposes as partial cost recovery for government of administering the regulations in Australia (registration and compliance activity). There are no registration fees in New Zealand.

The estimated number of suppliers for LED MEPS is 255 and estimated number of product registrations is 10,200 over the 10 year period. The estimated number of suppliers for Commercial luminaire MEPS is 40 and estimated number of product registrations over the 10 year period is 600.
</td></tr>
</table>

PARAMETER	EXPLANATION
	It is estimated than an additional 50 suppliers[133] are selling LED products into the New Zealand market. LED MEPS lamp model estimates have been based on equivalent lamp registrations (CFL, Halogen or linear) for each product category and increased to account for more frequent release of products over a 10 year period and expansion of product suppliers. It is understood that LED luminaire product range will be significantly larger than LED lamp products due to the greater variation in form. However for modelling purposes, numbers have been matched with lamp estimates to avoid inflation of regulatory burden, recognising that the Department is working with industry to broaden the definition of family of models, review scope, simplify registration and potentially associated fees for luminaire products. Other costs of compliance (for example testing, staff education, record keeping) are accounted for using the Regulatory Burden Measurement tool (for Australia) and are included as a component of the cost benefit analysis.
Energy Prices	Energy Prices are modelled as: • Australia - residential: based on residential electricity price index from AEMO 2014, and electricity price forecasts 2015 report by Frontier Economics. • Australia - commercial: based on NEM data, average commercial electricity costs were around 55% of residential. • New Zealand - residential: based on Ministry of the Environment 2015 Reporting Data. • New Zealand - commercial: similar to Australia, average commercial electricity costs were around 55% of residential (same source as NZ residential costs).

[133] Based on 20 per cent of LED suppliers selling in Australia. Proportion reflective of linear fluorescent lamp registrations in Australia and New Zealand.

Product Attributes

A library of average lamp and luminaire types was developed for use in the model. This is reproduced in the table below, which also lists the parameters assigned to each product. Note that lifetime has been capped at 15 years, in order to reflect that fact that building renovations will also tend to limit the lifetime of products.

Product Name	Sector	Product Type	Product Sub-Type	Light Source	Description	Av Light Output (lumens)	2016 Av Power (W)	Av Efficacy in 2016 or MEPS improvement wrt BAU (lm/W)	Op Hours per Day	Annual Op Hours	Op Life (hrs)	Lifetime (yrs) (max 15)	Av Price in 2016 (AUD)	MEPS Proposed
#1: Lamp-MV-Incandescent-Residential	Residential	Lamp	MV	Incandescent	Mains voltage incandescent lamp (directional and non-directional, not downlight)	800	75	10.7	0.6	219	1,150	5.3	$2	
#2: Lamp-MV-Halogen-Residential	Residential	Lamp	MV	Halogen	Mains voltage halogen lamp (directional & non-directional, not downlight)	800	52	15.4	1.0	365	1,250	3.4	$3	
#3: Lamp-MV-CFL-Residential	Residential	Lamp	MV	CFL	Mains voltage CFL lamp (directional & non-directional)	850	16	53.1	2.3	840	6,000	7.1	$4	
#4: Lamp-Downlight-Hal-Residential	Residential	Lamp	Downlight	Hal	Halogen downlight lamp (note power includes transformer losses)	625	48	13.0	1.5	548	3,500	6.4	$3	
#5: Lamp-Tubular-Fluorescent-Residential	Residential	Lamp	Tubular	Fluorescent	Fluorescent tubular lamp (residential)	2,000	30	66.7	1.6	584	10,000	15.0	$10	
#6: Lamp-Tubular-Fluorescent-Commercial	Commercial	Lamp	Tubular	Fluorescent	Fluorescent tubular lamp (commercial)	3,000	36	83.3	8.2	3,000	10,000	3.3	$5	
#9: Lamp-MV-LED-Residential (No MEPS)	Residential	Lamp	MV	LED	Mains voltage LED lamp (directional & non-directional, not downlight)	850	12	73.9	2.3	840	15,000	15.0	$15	(No MEPS)
#10: Lamp-MV-LED-Residential (MEPS)	Residential	Lamp	MV	LED	Mains voltage LED lamp (directional & non-directional, not downlight) (with MEPS)	850		+5, +10, +10	2.3	840	15,000	15.0		(MEPS)
#11: Lamp-Downlight-LED-Residential (No MEPS)	Residential	Lamp	Downlight	LED	LED downlight lamp (residential) (no MEPS)	500	6.6	76	1.8	657	15,000	15.0	$10	(No MEPS)
#12: Lamp-Downlight-LED-Residential (MEPS)	Residential	Lamp	Downlight	LED	LED downlight lamp (residential) (with MEPS)	500		+5, +10, +10	1.8	657	15,000	15.0		(MEPS)
#13: Lamp-Downlight-LED-Commercial (No MEPS)	Commercial	Lamp	Downlight	LED	LED downlight lamp (commercial) (no MEPS)	500	6.3	79	8.2	3,000	15,000	5.0	$8	(No MEPS)
#14: Lamp-Downlight-LED-Commercial (MEPS)	Commercial	Lamp	Downlight	LED	LED downlight lamp (commercial) (with MEPS)	500		+5, +10, +10	8.2	3,000	15,000	5.0		(MEPS)
#15: Lamp-Tubular-LED-Residential (No MEPS)	Residential	Lamp	Tubular	LED	LED tubular lamp (residential) (no MEPS)	1,700	20.0	85	1.6	584	15,000	15.0	$20	(No MEPS)
#16: Lamp-Tubular-LED-Residential (MEPS)	Residential	Lamp	Tubular	LED	LED tubular lamp (residential) (with MEPS)	1,700		+10, +10, +10	1.6	584	25,000	15.0		(MEPS)
#17: Lamp-Tubular-LED-Commercial (No MEPS)	Commercial	Lamp	Tubular	LED	LED tubular lamp (commercial) (no MEPS)	1,700	19.5	87	8.2	3,000	15,000	5.0	$12	(No MEPS)
#18: Lamp-Tubular-LED-Commercial (MEPS)	Commercial	Lamp	Tubular	LED	LED tubular lamp (commercial) (with MEPS)	1,700		+10, +10, +10	8.2	3,000	15,000	5.0		(MEPS)
#19: Luminaire-Small-LED-Residential (No MEPS)	Residential	Luminaire	Small	LED	LED luminaire small (residential) (no MEPS)	1,200	15.5	77	1.8	657	25,000	15.0	$50	(No MEPS)
#20: Luminaire-Small-LED-Residential (MEPS)	Residential	Luminaire	Small	LED	LED luminaire small (residential) (with MEPS)	1,200		+5, +10, +10	1.8	657	30,000	15.0		(MEPS)
#21: Luminaire-Small-LED-Commercial (No MEPS)	Commercial	Luminaire	Small	LED	LED luminaire small (commercial) (no MEPS)	1,200	14.5	83	8.2	3,000	25,000	8.3	$50	(No MEPS)
#22: Luminaire-Small-LED-Commercial (MEPS)	Commercial	Luminaire	Small	LED	LED luminaire small (commercial) (with MEPS)	1,200		+5, +10, +10	8.2	3,000	25,000	8.3		(MEPS)
#23: Luminaire-Linear/planar-LED-Commercial (No MEPS)	Commercial	Luminaire	Linear/planar	LED	LED luminaire linear/planar/batten/troffer (commercial) (no MEPS)	5,000	56	90	8.2	3,000	25,000	8.3	$150	(No MEPS)
#24: Luminaire-Linear/planar-LED-Commercial (MEPS)	Commercial	Luminaire	Linear/planar	LED	LED luminaire linear/planar/batten/troffer (commercial) (with MEPS)	5,000		+5, +5, +5	8.2	3,000	25,000	8.3		(MEPS)
#25: Luminaire-Large-LED-Commercial (No MEPS)	Commercial	Luminaire	Large	LED	LED luminaire large (commercial) (no MEPS)	14,000	152	92	8.2	3,000	25,000	8.3	$350	(No MEPS)
#26: Luminaire-Large-LED-Commercial (MEPS)	Commercial	Luminaire	Large	LED	LED luminaire large (commercial) (with MEPS)	14,000		+5, +5, +5	8.2	3,000	25,000	8.3		(MEPS)
#30: Luminaire-Linear-Non-integrated-Commercial (No MEPS)	Commercial	Luminaire	Linear	Non-integrated	Linear non-integrated luminaire (no LOR MEPS)	5,280	88	60	8.2	3,000	50,000	15.0	$100	(No MEPS)
#31: Luminaire-Linear-Non-integrated-Commercial (MEPS)	Commercial	Luminaire	Linear	Non-integrated	Linear non-integrated luminaire (with LOR MEPS)	5,808	88	+20	8.2	3,000	50,000	15.0		(MEPS)
#32: Luminaire-Canister-Non-integrated-Commercial (No MEPS)	Commercial	Luminaire	Canister	Non-integrated	Canister non-integrated luminaire (no LOR MEPS)	1,440	36	40	8.2	3,000	50,000	15.0	$40	(No MEPS)
#33: Luminaire-Canister-Non-integrated-Commercial (MEPS)	Commercial	Luminaire	Canister	Non-integrated	Canister non-integrated luminaire (with LOR MEPS)	1,800	36	+20	8.2	3,000	50,000	15.0		(MEPS)

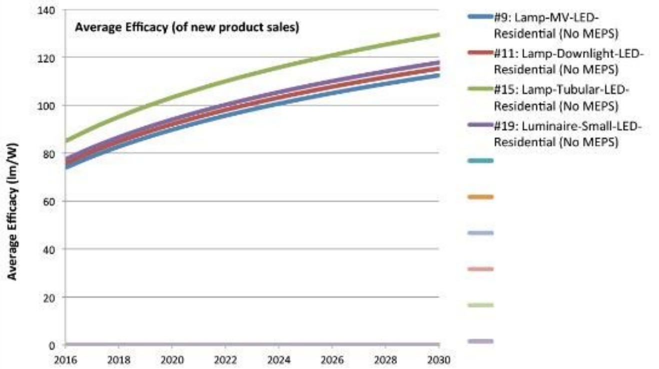
ii. Proposal modelling

In the sections below, sales, stock, pricing and other intermediate outputs from the model can be seen, along with accompanying notes and assumptions for each policy modelled (refer notes below each graph).

Proposal 1. LED MEPS (Australia) (Residential)

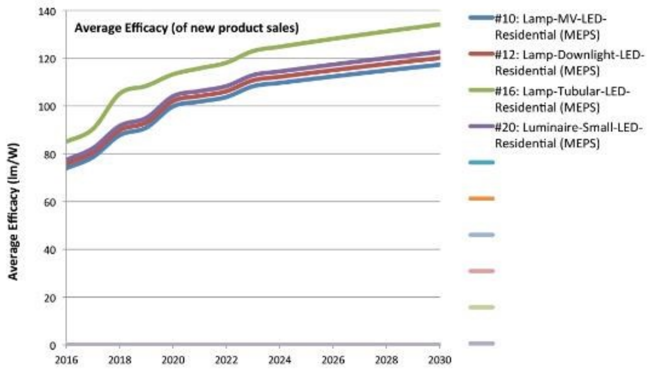
On this page the key metrics for the LED MEPS proposal are displayed, with the BAU scenario graphed on the left, and MEPS scenario on the right of the page. These can be compared side-by-side. Below each graph are notes which refer to the graph above. Note that for this policy option, the only differences that occur between the BAU and MEPS scenarios are for product efficacy - as can be seen in the graphs below.
This proposal, for Australia, involves placing MEPS on LED lamps and luminaires. In order to better show the impacts on each, the residential and commercial sectors are modeled separately. The residential sector is modeled on this page, and commercial sector the following page. The products modeled include residential LED lamps and luminaires.

BAU Scenario

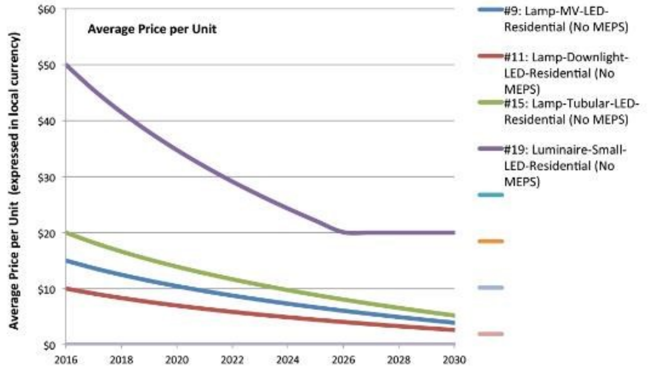


As discussed previously, the BAU average efficacy of LED lamps and luminaires increases over time.

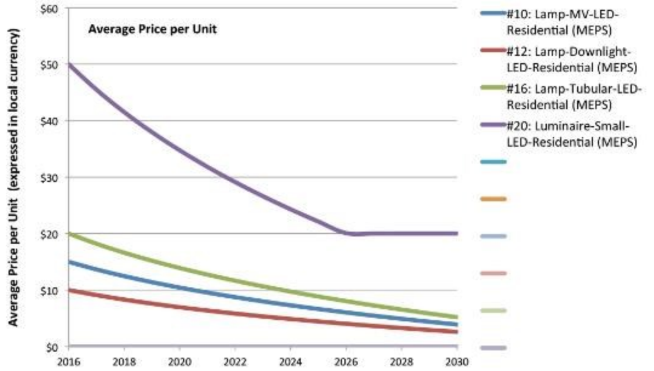
MEPS Scenario



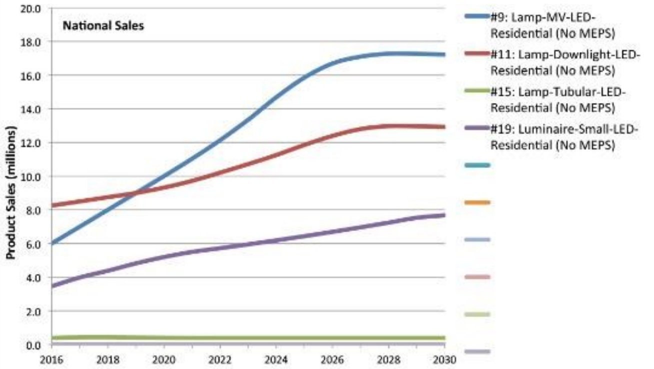
As discussed previously, each of the 3 tranches of LED MEPS results in increased efficacy of the LEDs sold. These can be seen above as the "kinks" in the efficacy curves for LEDs.



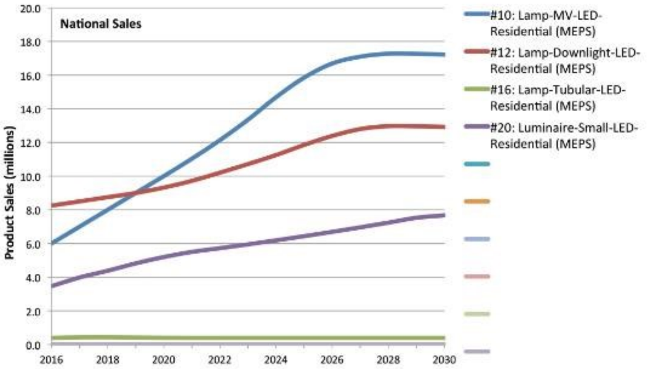
As discussed previously, LED lamp prices decrease over time. A floor price of $20 has been placed on LED luminaires.



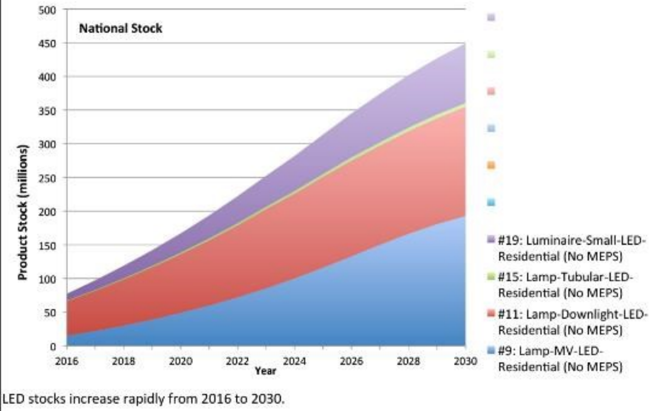
As discussed previously, increased efficacy of LEDs due to MEPS does not increase prices for LED lamps, which are same as for BAU.



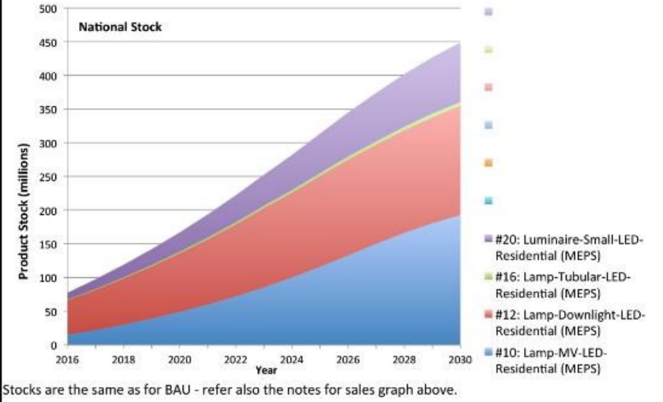
LED sales increase, with the exception of LED tubular lamps which are not expected to grow significantly in popularity in the residential sector. LED sales will level off and may decline, due to the longer life of LEDs.



Sales are modeled to be the same as the BAU scenario. Note however that sales of LEDs are likely to be higher with MEPS in place, as MEPS will increase LED quality, leading to higher consumer satisfaction with LEDs, and therefore presumably increased sales. Due to a lack of hard data to accurately quantify this (and for the sake of conservatism) this has not been modeled.



LED stocks increase rapidly from 2016 to 2030.

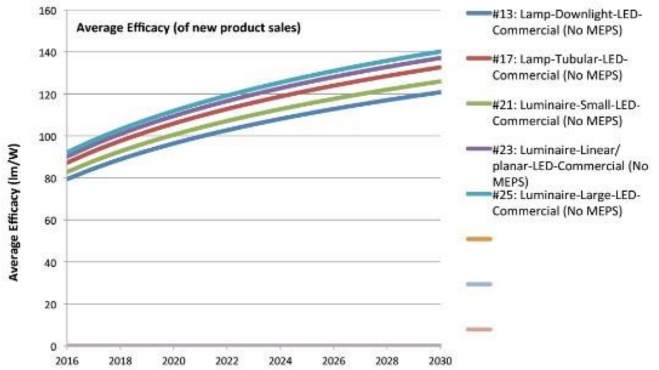


Stocks are the same as for BAU - refer also the notes for sales graph above.

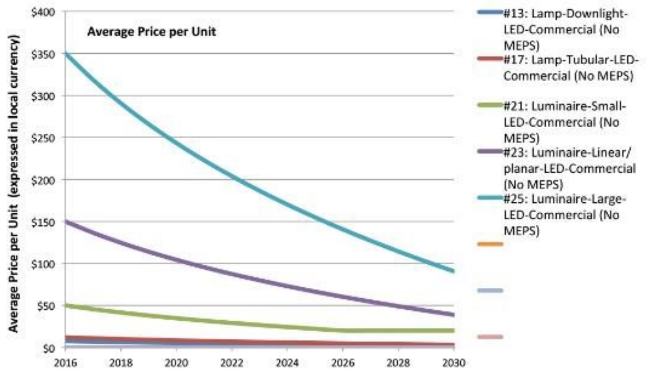
Proposal 1. LED MEPS (Australia) (Commercial)

On this page the key metrics for the LED MEPS proposal are displayed, with the BAU scenario graphed on the left, and MEPS scenario on the right of the page. These can be compared side-by-side. Below each graph are notes which refer to the graph above. Note that for this policy option, the only differences that occur between the BAU and MEPS scenarios are for product efficacy and for price - as can be seen in the graphs below. This proposal, for Australia, involves placing MEPS on LED lamps and luminaires. In order to better show the impacts on each, the residential and commercial sectors are modeled separately. The commercial sector is modeled on this page, and the residential sector the previous page. The products modeled include commercial LED lamps and luminaires.

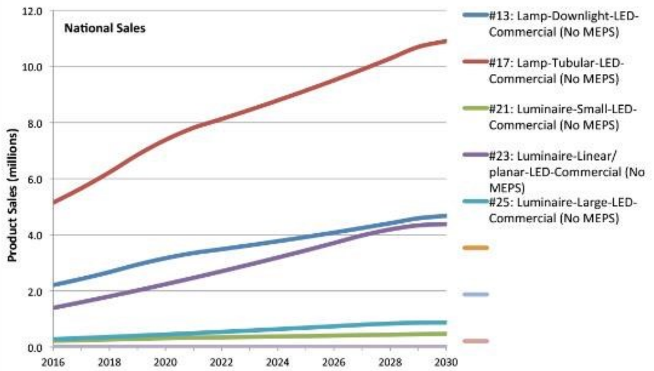
BAU Scenario



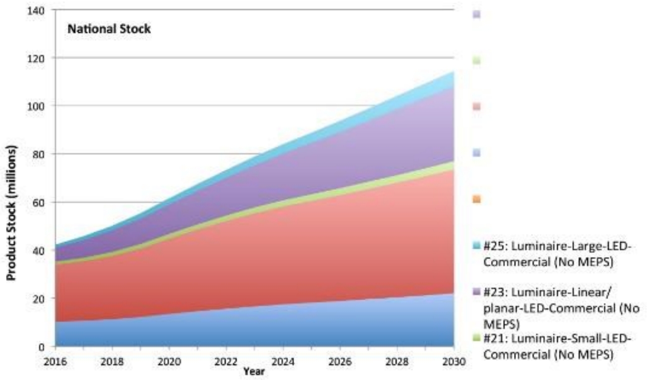
As discussed previously, the BAU average efficacy of LED lamps and luminaires increases over time.



As discussed previously, LED lamps prices decrease over time.

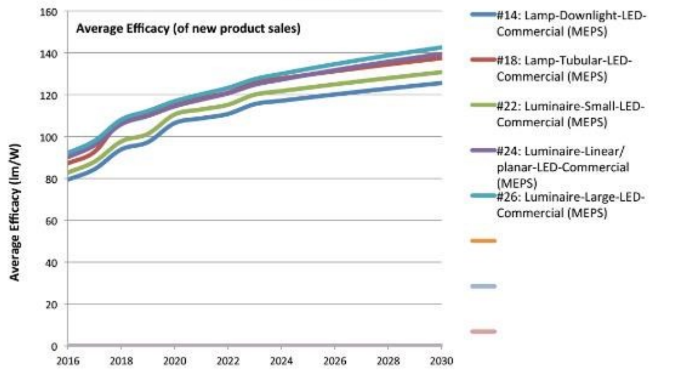


LED sales increase significantly over time. LED sales will level off and may decline, due to the longer life of LEDs.

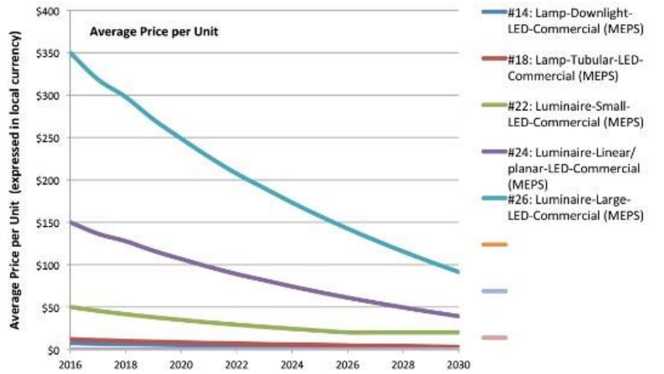


LED stocks increase rapidly from 2016 to 2030.

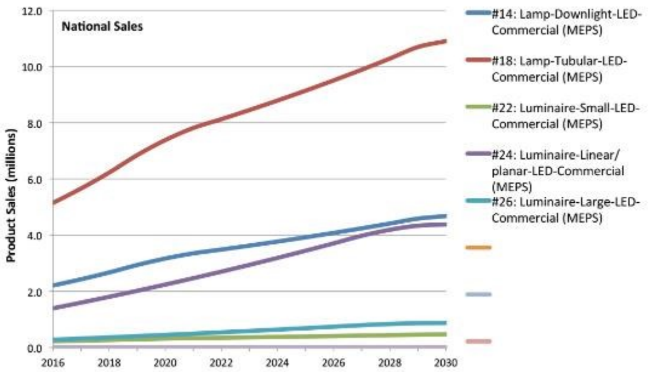
MEPS Scenario



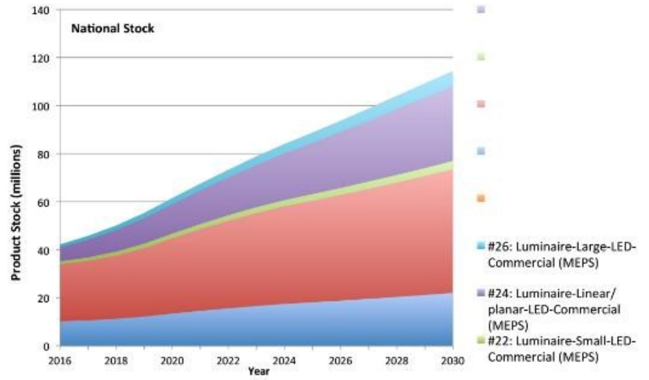
As discussed previously, each of the 3 tranches of LED MEPS results in increased efficacy of the LEDs sold. These can be seen above as the "kinks" in the efficacy curves for LEDs.



As discussed previously, increased efficacy, due to MEPS, results in price increases for commercial luminaires. These can be seen as the minor "kinks" in the price curves above - although difficult to detect on this graph, all luminaires graphed have these kinks.



Sales are modeled to be the same as the BAU scenario. Note however that sales of LEDs are likely to be higher with MEPS in place, as MEPS will increase LED quality, leading to higher consumer satisfaction with LEDs, and therefore presumably increased sales. Due to a lack of hard data to accurately quantify this (and for the sake of conservatism) this has not been modeled.



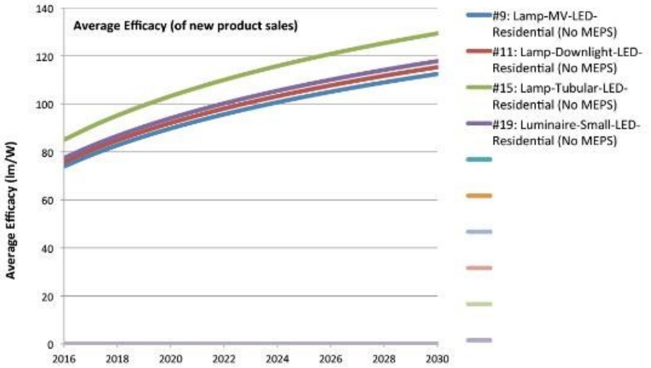
Stocks are the same as for BAU - refer also the notes for sales graph above.

Preopos

Proposal 1. LED MEPS (New Zealand) (Residential)

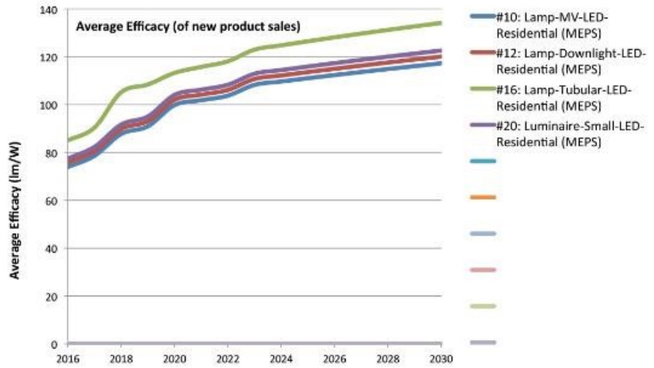
On this page the key metrics for the LED MEPS proposal are displayed, with the BAU scenario graphed on the left, and MEPS scenario on the right of the page. These can be compared side-by-side. Below each graph are notes which refer to the graph above. Note that for this policy option, the only differences that occur between the BAU and MEPS scenarios are for product efficacy - as can be seen in the graphs below.
This proposal, for New Zealand, involves placing MEPS on LED lamps and luminaires. In order to better show the impacts on each, the residential and commercial sectors are modeled separately. The residential sector is modeled on this page, and commercial sector the following page. The products modeled include residential LED lamps and luminaires.

BAU Scenario

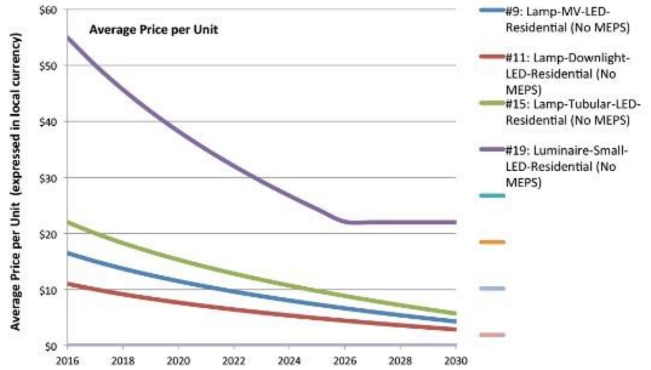


As discussed previously, the BAU average efficacy of LED lamps and luminaires increases over time.

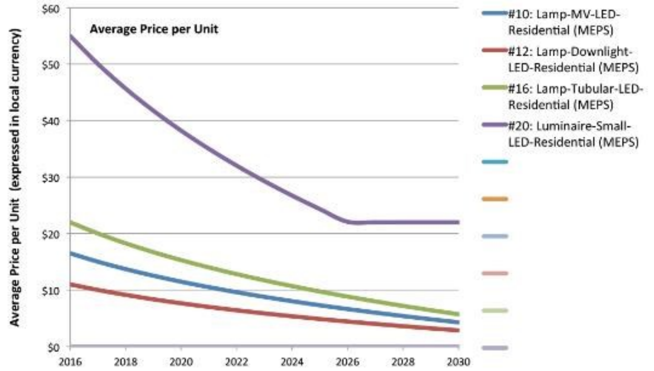
MEPS Scenario



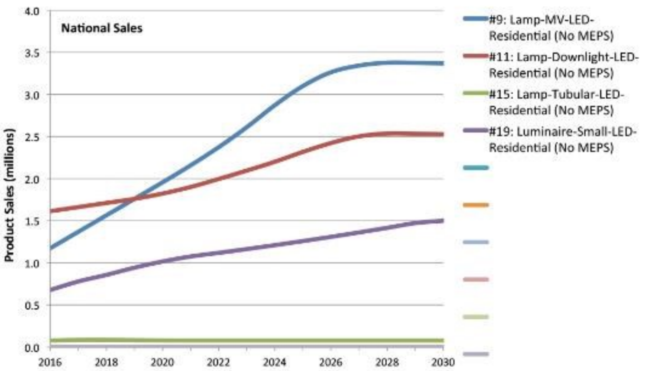
As discussed previously, each of the 3 tranches of LED MEPS results in increased efficacy of the LEDs sold. These can be seen above as the "kinks" in the efficacy curves for LEDs.



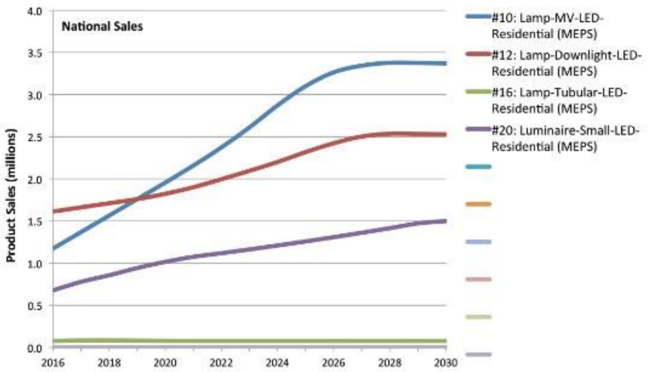
As discussed previously, LED lamp prices decrease over time. A floor price of $22 has been placed on LED luminaires.



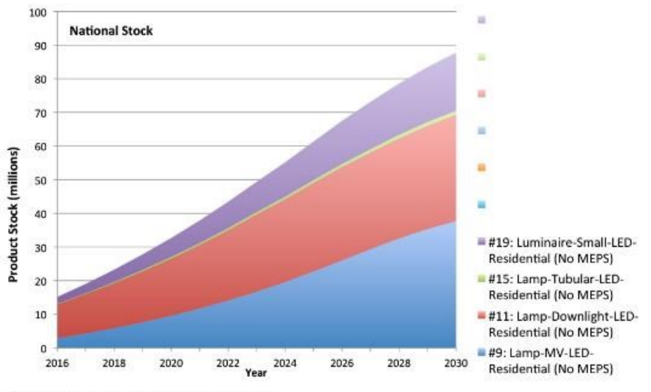
As discussed previously, increased efficacy of LEDs due to MEPS does not increase prices for LED lamps, which are same as for BAU.



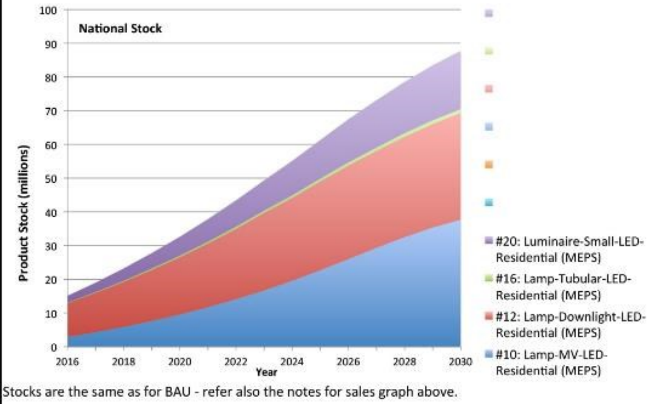
LED sales increase, with the exception of LED tubular lamps which are not expected to grow significantly in popularity in the residential sector. LED sales will level off and may decline, due to the longer life of LEDs.



Sales are modeled to be the same as the BAU scenario. Note however that sales of LEDs are likely to be higher with MEPS in place, as MEPS will increase LED quality, leading to higher consumer satisfaction with LEDs, and therefore presumably increased sales. Due to a lack of hard data to accurately quantify this (and for the sake of conservatism) this has not been modeled.



LED stocks increase rapidly from 2016 to 2030.

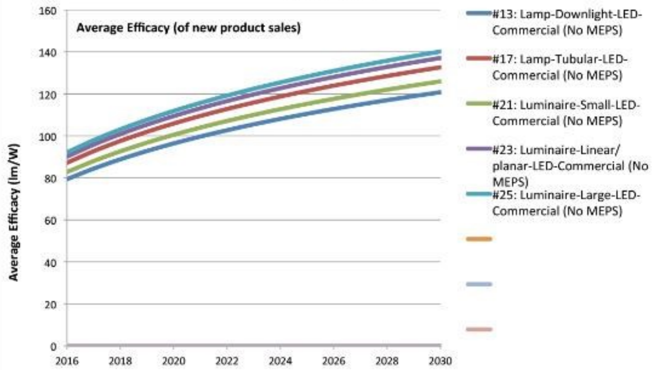


Stocks are the same as for BAU - refer also the notes for sales graph above.

Proposal 1. LED MEPS (New Zealand) (Commercial)

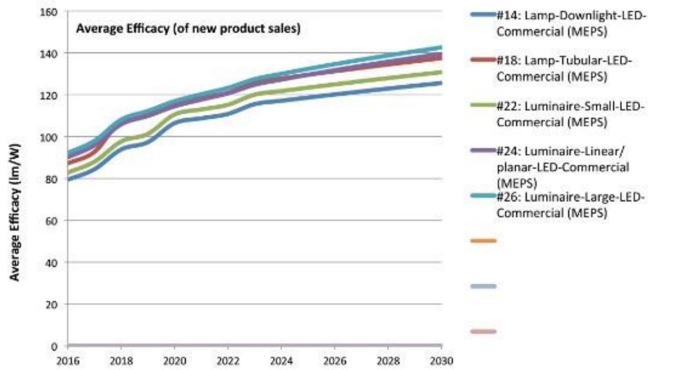
On this page the key metrics for the LED MEPS proposal are displayed, with the BAU scenario graphed on the left, and MEPS scenario on the right of the page. These can be compared side-by-side. Below each graph are notes which refer to the graph above. Note that for this policy option, the only differences that occur between the BAU and MEPS scenarios are for product efficacy and for price - as can be seen in the graphs below.
This proposal, for New Zealand, involves placing MEPS on LED lamps and luminaires. In order to better show the impacts on each, the residential and commercial sectors are modeled separately. The commercial sector is modeled on this page, and the residential sector the previous page. The products modeled include commercial LED lamps and luminaires.

BAU Scenario

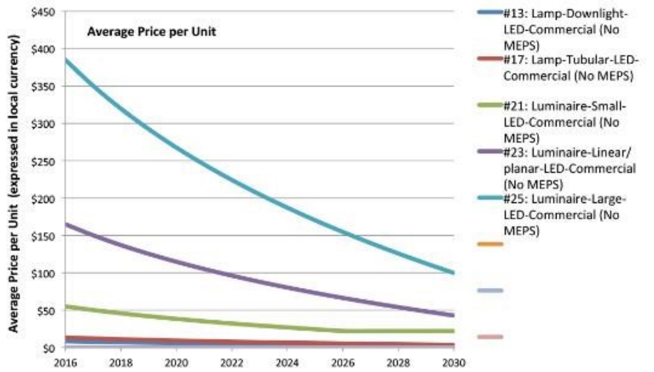


As discussed previously, the BAU average efficacy of LED lamps and luminaires increases over time.

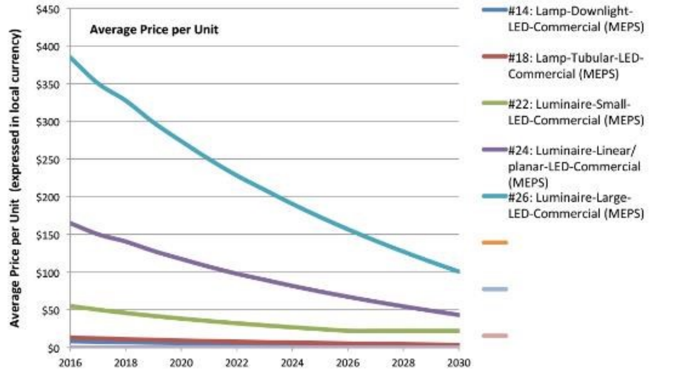
MEPS Scenario



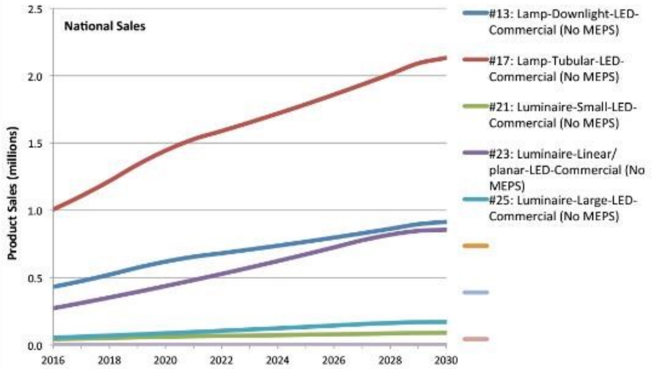
As discussed previously, each of the 3 tranches of LED MEPS results in increased efficacy of the LEDs sold. These can be seen above as the "kinks" in the efficacy curves for LEDs.



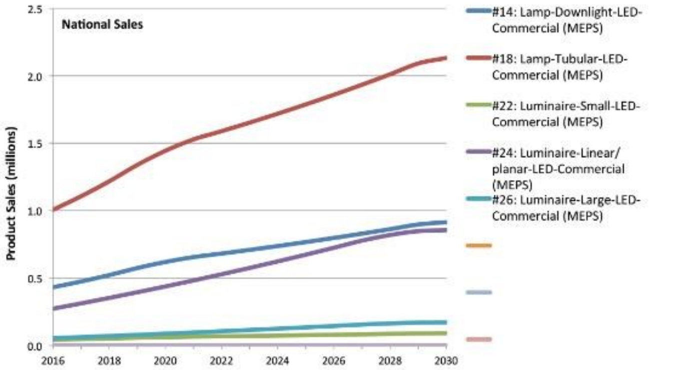
As discussed previously, LED lamps prices decrease over time.



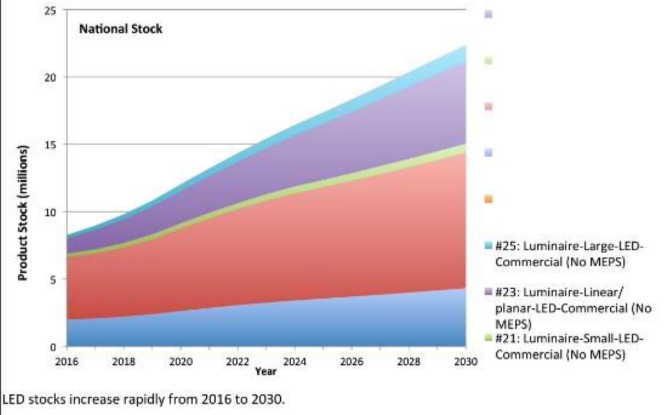
As discussed previously, increased efficacy, due to MEPS, results in price increases for commercial luminaires. These can be seen as the minor "kinks" in the price curves above - although difficult to detect on this graph, all luminaires graphed have these kinks.



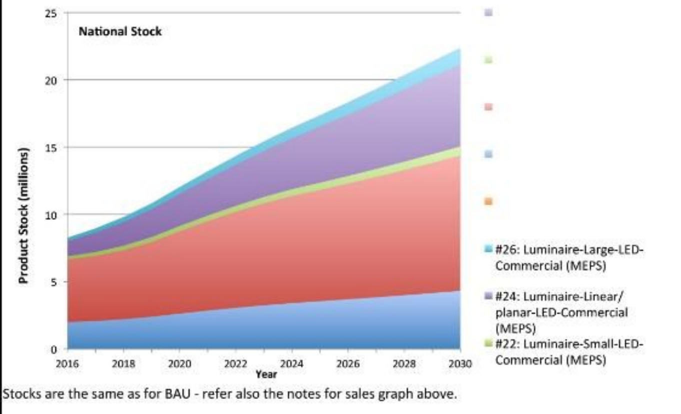
LED sales increase significantly over time. LED sales will level off and may decline, due to the longer life of LEDs.



Sales are modeled to be the same as the BAU scenario. Note however that sales of LEDs are likely to be higher with MEPS in place, as MEPS will increase LED quality, leading to higher consumer satisfaction with LEDs, and therefore presumably increased sales. Due to a lack of hard data to accurately quantify this (and for the sake of conservatism) this has not been modeled.



LED stocks increase rapidly from 2016 to 2030.



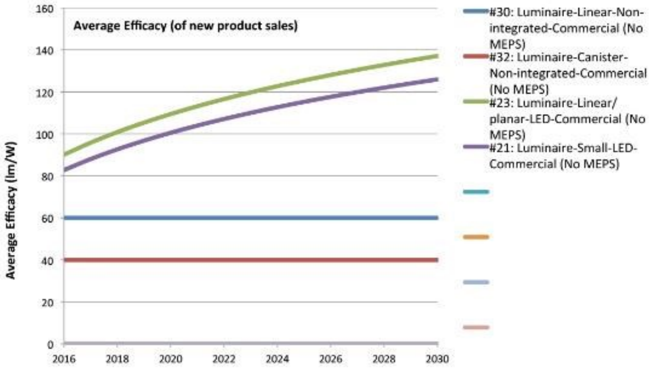
Stocks are the same as for BAU - refer also the notes for sales graph above.

Proposal 2. MEPS for Non-Integrated Luminaires (Australia)

On this page the key metrics for the non-integrated luminaire MEPS proposal are displayed, with the BAU scenario graphed on the left, and the MEPS scenario on the right of the page. These can be compared side-by-side. Below each graph are notes which refer to the graph above.

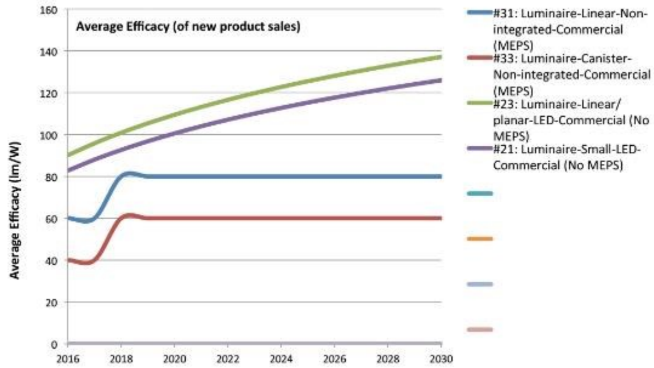
This proposal, for Australia, involves placing MEPS on non-integrated luminaires. Only the commercial sector is significantly affected and therefore modeled. The products modeled include non-integrated and integrated linear and canister-style luminaires.

BAU Scenario

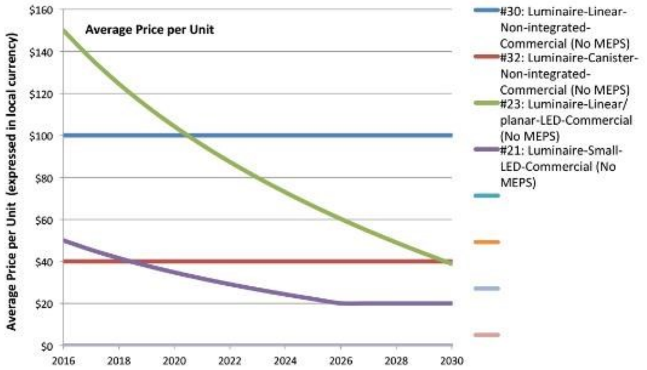


As discussed previously, the BAU average efficacy of LEDs increases over time, whilst the efficacy of non-integrated (fluorescent) luminaires remains static.

MEPS Scenario

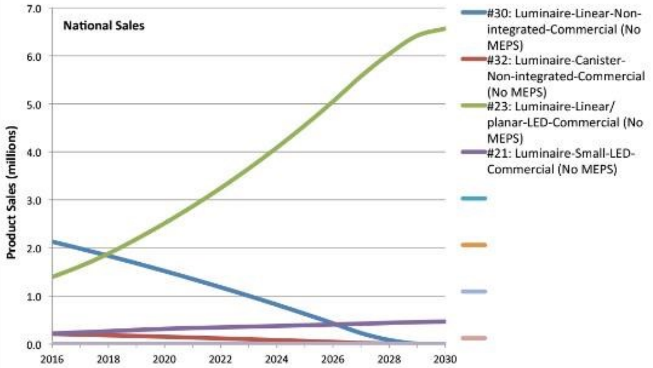


Due to MEPS, non-integrated luminaire efficacy improves, but there is no corresponding decrease in luminaire power - lamps and ballasts remain the same and higher optical efficiency results in more light output. The energy savings result from sales shifting to LEDs (refer sales graphs below).

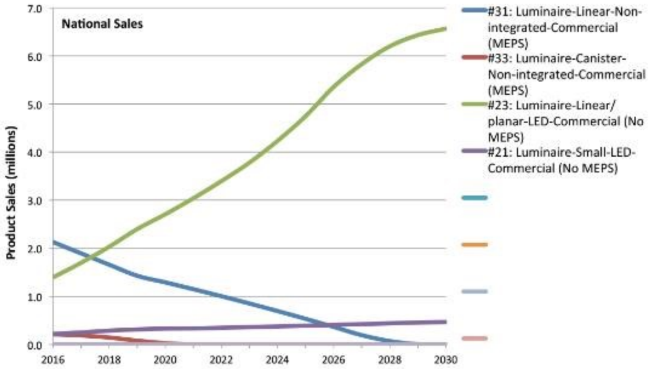


As discussed previously, LED lamp prices decrease over time, with non-integrated luminaire prices remaining static. A floor price of $20 has been placed on small (integrated) LED luminaires.

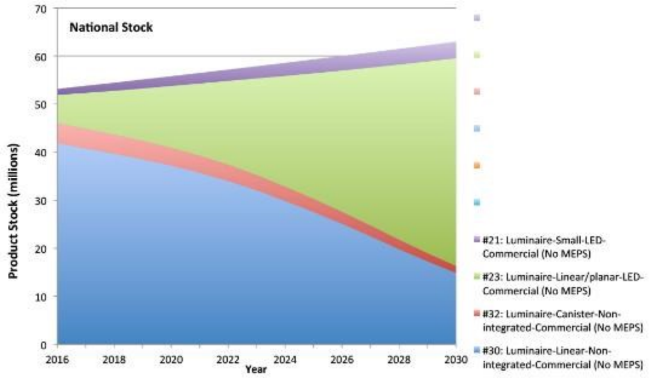
As discussed previously, increased efficacy, due to MEPS, results in price increases for commercial non-integrated luminaires. No MEPS for integrated LED luminaires has been modeled here - thus no impact on LED luminaire prices.

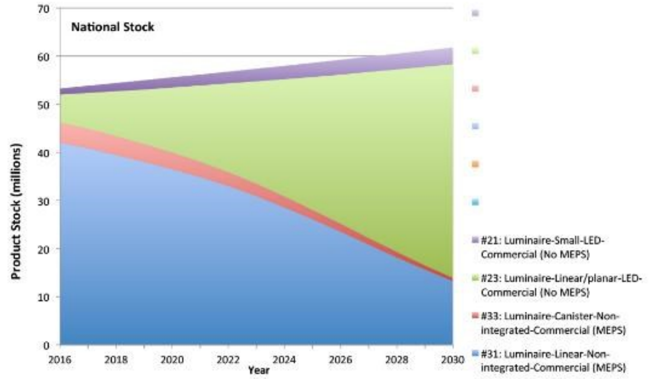


Non-integrated linear and canister luminaire sales decline in favour of (integrated) LED.



Linear non-integrated luminaire sales assumed decline by 15% from BAU, and these sales switch to LED. All non-integrated canister sales assumed to switch to LED. Note that is some cases, where sales do not switch to LED, it is likely that fewer non-integrated luminaires will be required to be fitted (due to luminaires emitting more light as discussed above) - however for the sake of conservatism this has not been modeled.





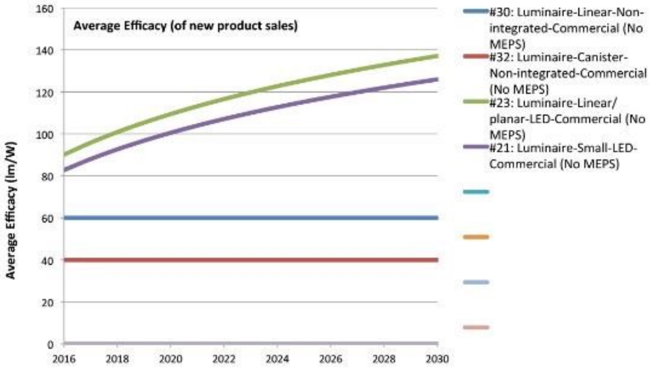
See notes for sales - note that differences in stock are difficult to detect on this graph.

Proposal 2. MEPS for Non-Integrated Luminaires (New Zealand)

On this page the key metrics for the non-integrated luminaire MEPS proposal are displayed, with the BAU scenario graphed on the left, and the MEPS scenario on the right of the page. These can be compared side-by-side. Below each graph are notes which refer to the graph above.

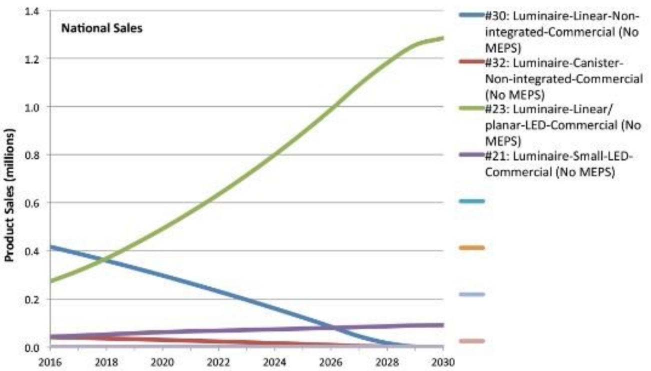
This proposal, for New Zealand, involves placing MEPS on non-integrated luminaires. Only the commercial sector is significantly affected and therefore modeled. The products modeled include non-integrated and integrated linear and canister-style luminaires.

BAU Scenario

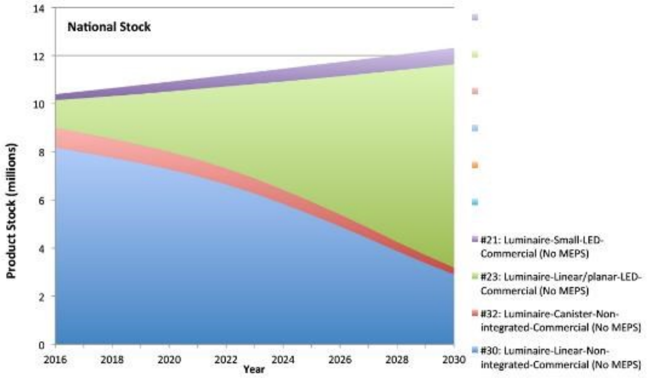


As discussed previously, the BAU average efficacy of LEDs increases over time, whilst the efficacy of non-integrated (fluorescent) luminaires remains static.

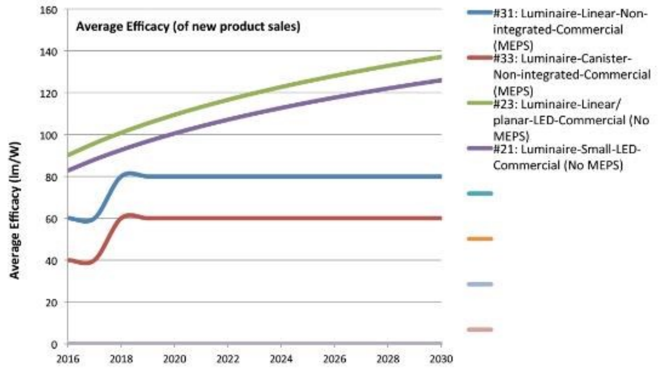
As discussed previously, LED lamp prices decrease over time, with non-integrated luminaire prices remaining static. A floor price of $22 has been placed on small (integrated) LED luminaires.



Non-integrated linear and canister luminaire sales decline in favour of (integrated) LED. The NZ market is assumed to be around 1/5 of the Australian market.

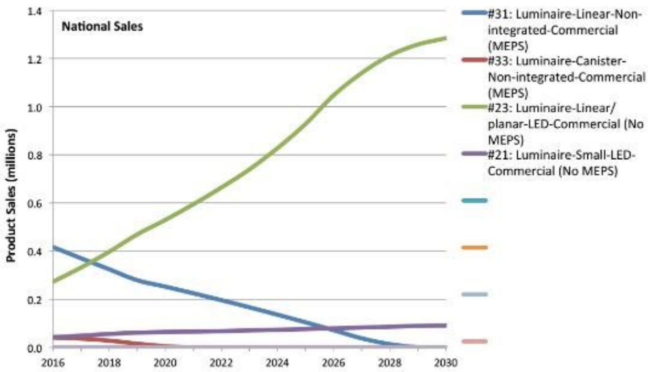


MEPS Scenario

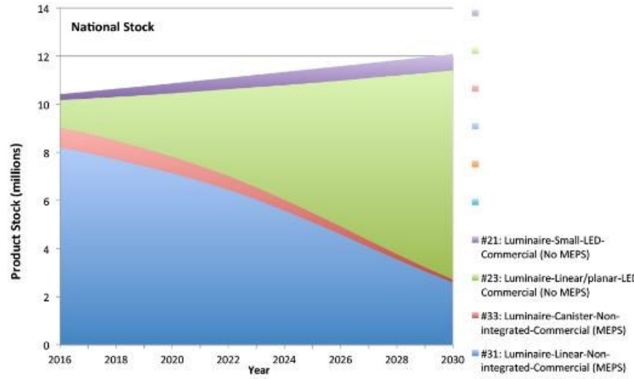


Due to MEPS, non-integrated luminaire efficacy improves, but there is no corresponding decrease in luminaire power - lamps and ballasts remain the same and higher optical efficiency results in more light output. The energy savings result from sales shifting to LEDs (refer sales graphs below).

As discussed previously, increased efficacy, due to MEPS, results in price increases for commercial non-integrated luminaires. No MEPS for integrated LED luminaires has been modeled here - thus no impact on LED luminaire prices.



Linear non-integrated luminaire sales assumed decline by 15% from BAU, and these sales switch to LED. All non-integrated canister sales assumed to switch to LED. Note that is some cases, where sales do not switch to LED, it is likely that fewer non-integrated luminaires will be required to be fitted (due to luminaires emitting more light as discussed above) - however for the sake of conservatism this has not been modeled.



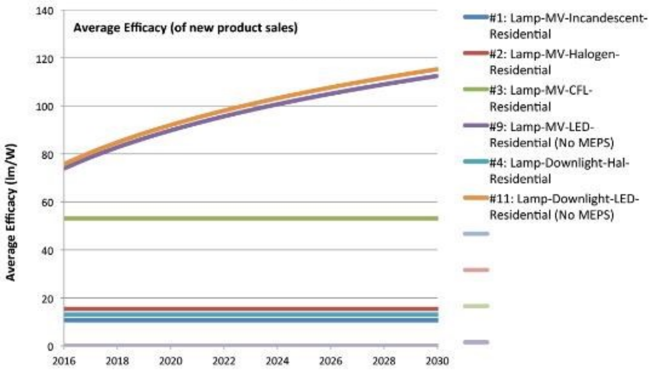
See notes for sales - note that differences in stock are difficult to detect on this graph.

Proposal 3. Phase Out of Halogen & Incandescent Lamps (Australia)

On this page the key metrics for the phase out proposal are displayed, with the BAU scenario graphed on the left, and phase out scenario on the right of the page. These can be compared side-by-side. Below each graph are notes which refer to the graph above.

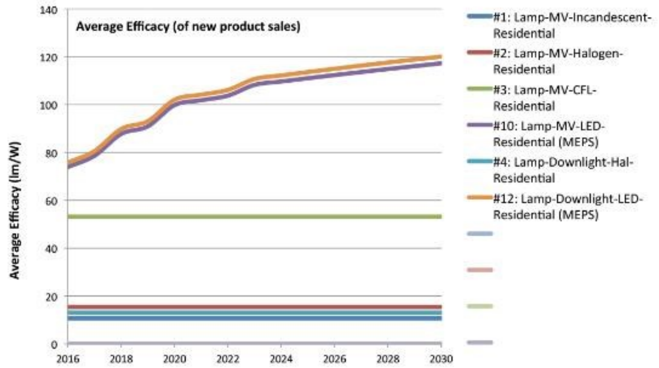
This proposal, for Australia only, involves phasing out the remaining incandescent and halogen lamps, and placing MEPS on LED lamps. It affects primarily the residential sector, which is modeled. The lamps modeled are MV incandescent, MV halogen, CFL and MV LED, as well as halogen downlight lamps and LED downlight lamps.

BAU Scenario

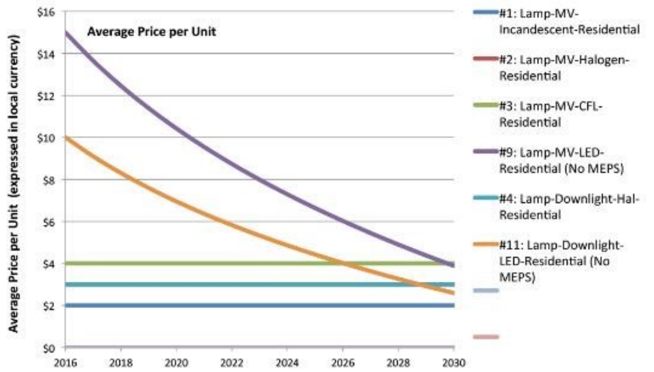


As discussed previously, the BAU average efficacy of LED lamps and luminaires increases over time, with efficacy of other lamps remaining static. Note that halogen downlight efficacy includes the transformer losses.

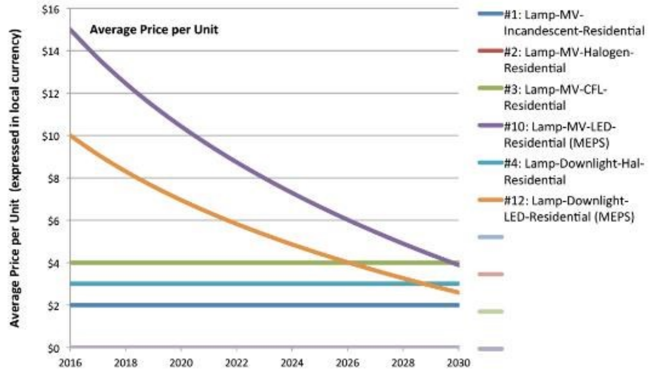
PHASEOUT Scenario



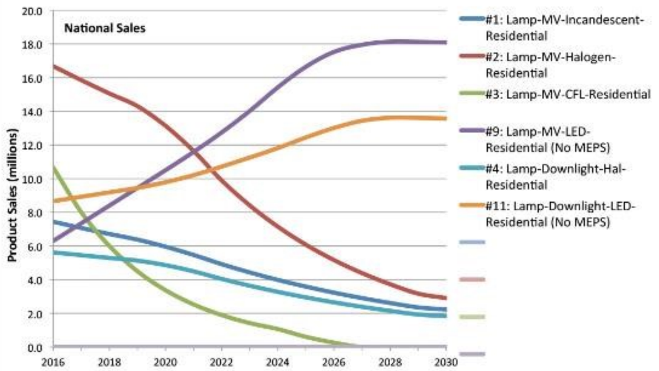
As discussed previously, each of the 3 tranches of LED MEPS results in increased efficacy of the LEDs sold. These can be seen above as the "kinks" in the efficacy curves for LEDs.



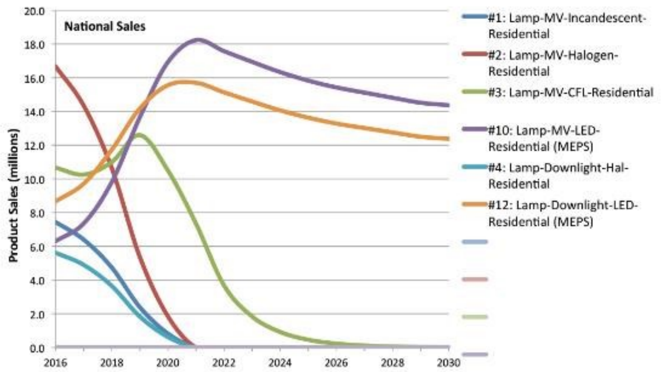
As discussed previously, LED lamps prices decrease over time, with other lamp prices remaining static over time (in real terms).



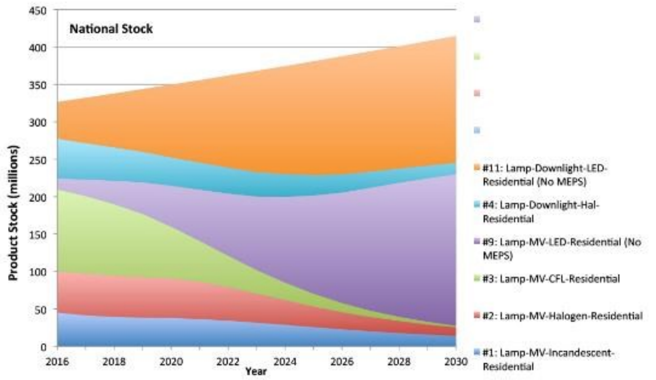
As discussed previously, increased efficacy of LEDs due to MEPS does not increase prices for LED lamps, which are same as for BAU. Removal of halogen lamps from the market does not impact the price of LEDs - the presence of CFL and competition in the LED market continues to drive prices down.



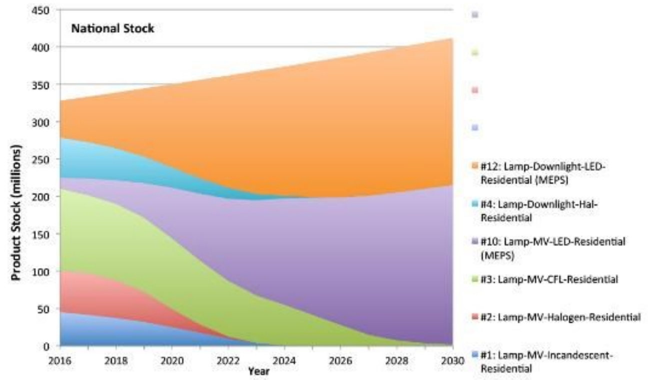
LED sales increase as other lamps decline. LED sales will level off (due to long life of LEDs). Some residual sales of incandescent and halogen lamps can be seen. Total LED sales of 372 million over the period 2016 to 2030.



Incandescent and halogen lamp sales decline over 3 years following MEPS (due to grandfathering).
LED lamp sales increase significantly following the phase out, then likely to decline (due to long life of LEDs).
CFL sales also increase after phase out, then decline and disappear from the market, in favour of LED.
Total LED sales of 410 million over the period 2016 to 2030, with sales occurring significantly earlier than BAU.



Increase in LED stocks are clearly visible, with incandescent and halogen stocks declining.
Overall lamp stock growth is due to building stock growth.

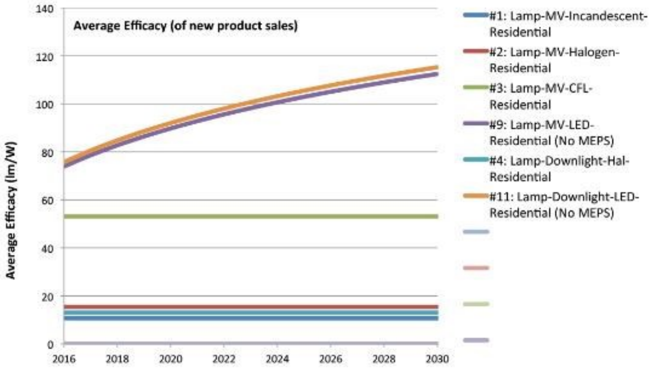
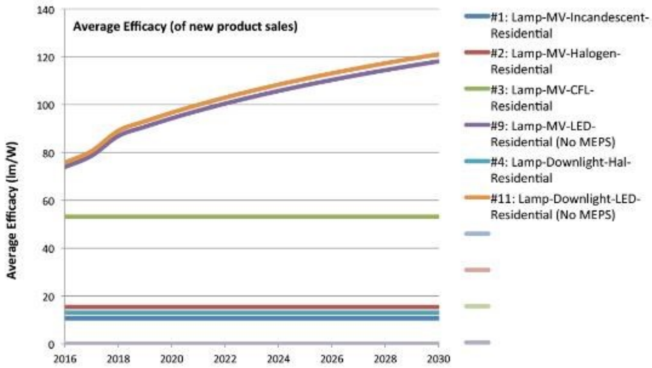
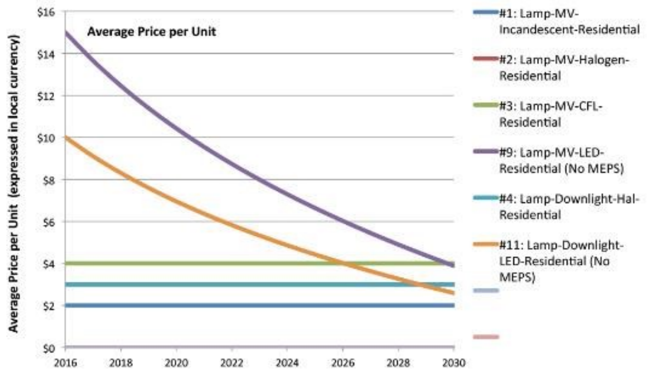
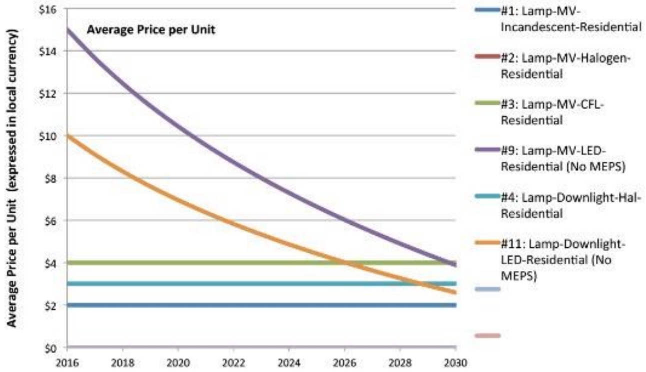
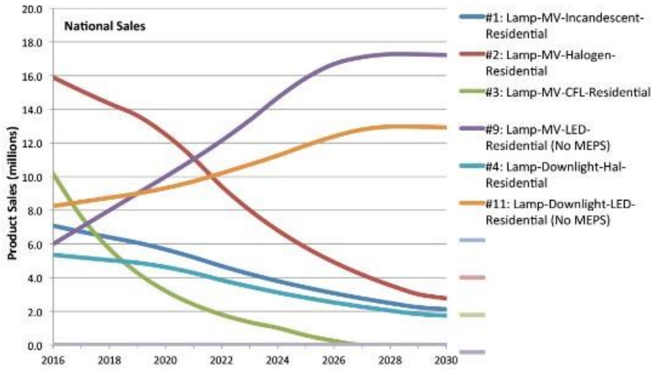
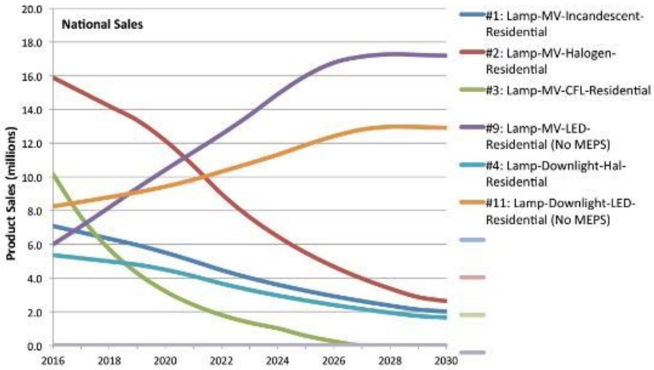
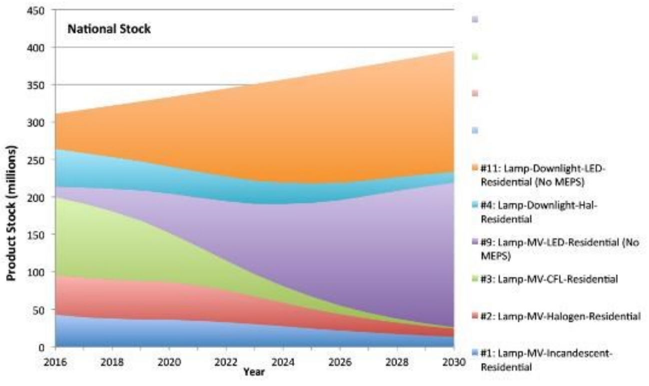
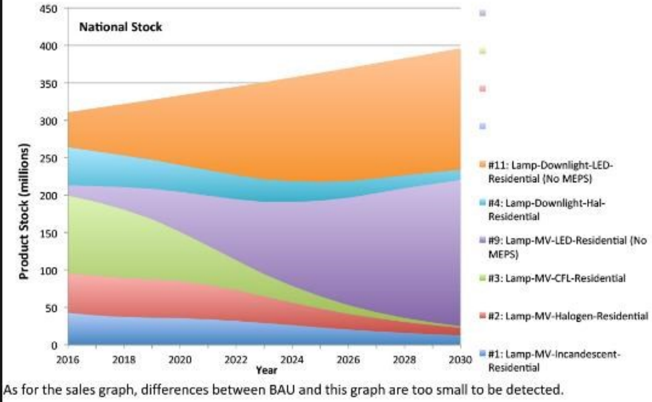


Incandescent and halogen stocks decline rapidly, as these lamp types are phased out.

Proposal 4. Labeling (Australia)

On this page the key metrics for the labelling proposal are displayed, with the BAU scenario graphed on the left, and the labelling scenario on the right of the page. These can be compared side-by-side. Below each graph are notes which refer to the graph above.

This proposal, for Australia, involves placing energy labels on halogen, CFL and LED lamps and small LED luminaires primarily used in the residential sector (only the residential sector is modeled). For simplicity, luminaires are not modeled - lamps represent the largest contributor to financial impacts, as they are consumable items and more likely to be influenced by a label.

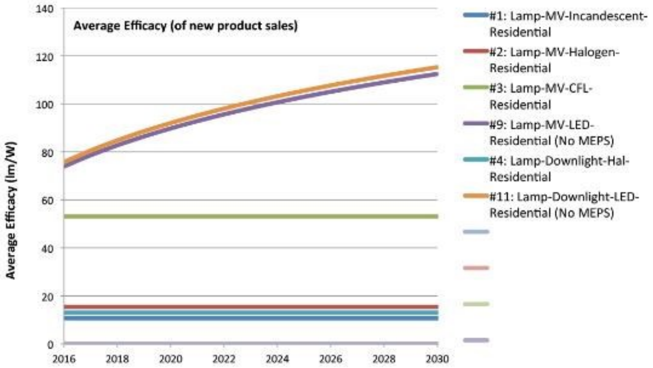
BAU Scenario	LABEL Scenario
	
As discussed previously, the BAU average efficacy of LED lamps increases over time, with efficacy of other lamps remaining static. Note that halogen downlight efficacy includes the transformer losses.	Labelling is assumed to improve LED efficacy by 5%, and this can be seen in the graph above.
	
As discussed previously, LED lamps prices decrease over time, with other lamp prices remaining static over time (in real terms).	Lamp labelling is assumed to have no impact on price, thus price curves as the same as BAU.
	
LED sales increase as other lamps decline. LED sales will level off (due to long life of LEDs). Some residual sales of incandescent and halogen lamps can be seen.	Assumed that labelling results in a total of 5% of annual halogen and incandescent lamp sales transitioning to LED (1% each year for first 5 years of labelling regulations). Note that these changes are too small to be detected on this graph (i.e. difference between BAU and this graph).
	
Increase in LED stocks are clearly visible, with incandescent and halogen stocks declining. Overall lamp stock growth is due to building stock growth.	As for the sales graph, differences between BAU and this graph are too small to be detected.

Proposal 4. Labeling (New Zealand)

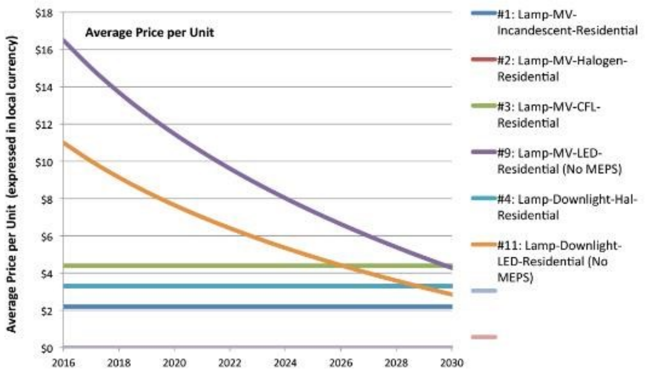
On this page the key metrics for the labelling proposal are displayed, with the BAU scenario graphed on the left, and the labelling scenario on the right of the page. These can be compared side-by-side. Below each graph are notes which refer to the graph above.

This proposal, for New Zealand, involves placing energy labels on halogen, CFL and LED lamps and small LED luminaires primarily used in the residential sector (only the residential sector is modeled). For simplicity, luminaires are not modeled - lamps represent the largest contributor to financial impacts, as they are consumable items and more likely to be influenced by a label.

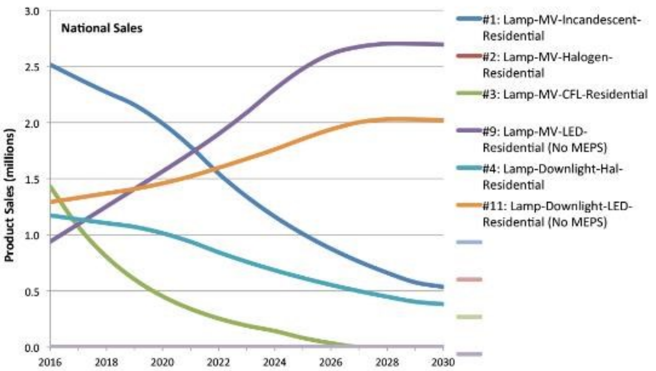
BAU Scenario



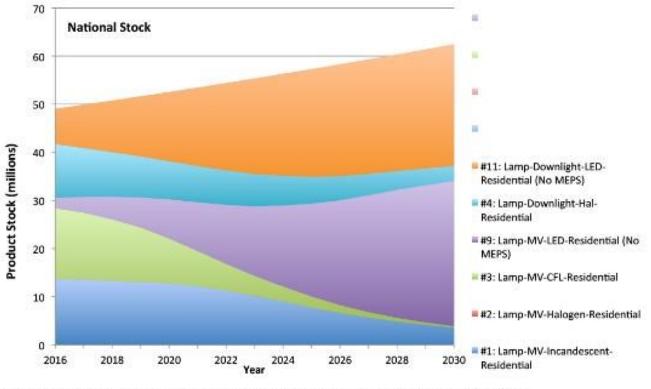
As discussed previously, the BAU average efficacy of LED lamps increases over time, with efficacy of other lamps remaining static. Note that halogen downlight efficacy includes the transformer losses.



As discussed previously, LED lamps prices decrease over time, with other lamp prices remaining static over time (in real terms).

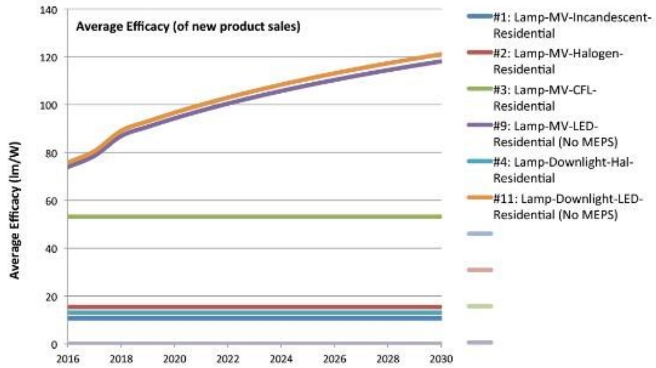


LED sales increase as other lamps decline. LED sales will level off (due to long life of LEDs). Some residual sales of incandescent and halogen lamps can be seen. Note no significant MV halogen sales in New Zealand (incandescent lamps not phased out).

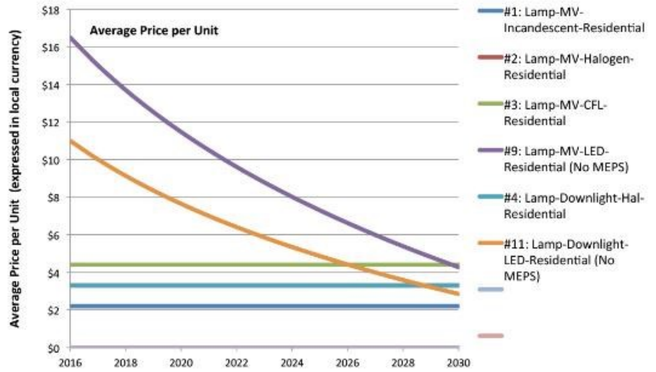


Increase in LED stocks are clearly visible, with incandescent and halogen stocks declining. Overall lamp stock growth is due to building stock growth.

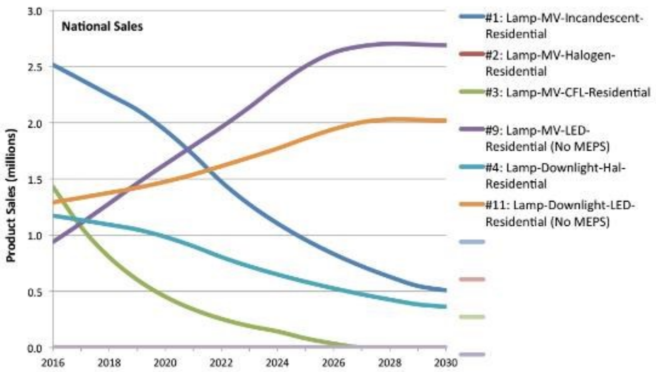
LABEL Scenario



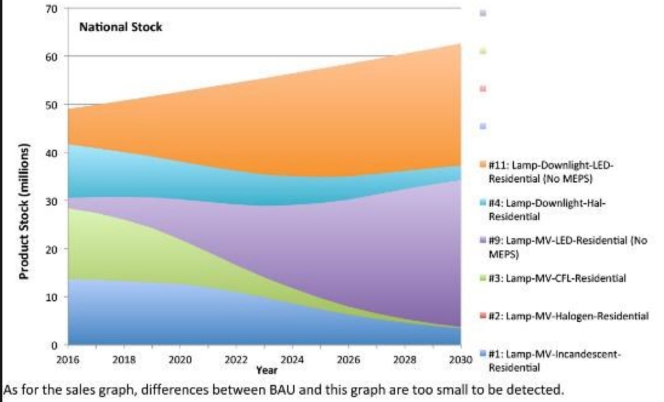
Labelling is assumed to improve LED efficacy by 5%, and this can be seen in the graph above.



Lamp labelling is assumed to have no impact on price, thus price curves as the same as BAU.



Assumed that labelling results in a total of 5% of annual halogen and incandescent lamp sales transitioning to LED (1% each year for first 5 years of labelling regulations). Note that these changes are too small to be detected on this graph (i.e. difference between BAU and this graph).



As for the sales graph, differences between BAU and this graph are too small to be detected.

iii. Policy option impacts – energy and cost/benefit

Summary of key energy/emission impacts and cost benefits by proposal

The tables below summarise the key financial results for Australia and New Zealand. These are also split by residential and commercial (including industrial) sectors. The 'Total Investment' column includes costs to consumers, product supply businesses and government to implement the option. Costs to business and government are included in the residential sector row of the table.

Australia - Results by Option

Option	Sector	Energy Saved (cumulative GWh)	GHG Emissions Reduction (cumulative Mt)	Total (Gross) Benefit (NPV, $M)	Total Investment (NPV, $M) [134]	Net Benefit (NPV, $M)	(Gross) Benefit to Cost Ratio	Cost of Abatement (NPV$/tonne)
A. LED MEPS	Res	1,841	1.0	255	29	226		
A. LED MEPS	Com	4,302	2.8	422	46	376		
A. LED MEPS	**All**	**6,143**	**3.8**	**677**	**75**	**602**	**9.02**	**-158**
B: LED MEPS + LOR MEPS[135]	Res	1,841	1.0	255	29	226		
B: LED MEPS + LOR MEPS	Com	8,890	5.5	838	93	745		
B: LED MEPS + LOR MEPS	**All**	**10,731**	**6.5**	**1093**	**122**	**971**	**8.96**	**-149**
C: LED MEPS + LOR MEPS + Labelling	Res	3,227	1.9	457	59	398		
C: LED MEPS + LOR MEPS + Labelling	Com	8,890	5.5	838	93	745		
C: LED MEPS + LOR MEPS + Labelling	**All**	**12,117**	**7.4**	**1295**	**152**	**1143**	**8.52**	**-154**
D: LED MEPS + Labelling	Res	3,227	1.9	457	59	398		
D: LED MEPS + Labelling	Com	4,302	2.8	422	46	376		
D: LED MEPS + Labelling	**All**	**7,529**	**4.7**	**879**	**105**	**774**	**8.4**	**-165**
E: LED MEPS + Phase out	Res	16,293	10.9	2517	447	2070		
E: LED MEPS + Phase out	Com	4,302	2.8	422	46	376		
E: LED MEPS + Phase out	**All**	**20,595**	**13.7**	**2939**	**493**	**2446**	**6.0**	**-178**
F: LED MEPS + LOR MEPS + Phase out	Res	16,293	10.9	2517	447	2070		
F: LED MEPS + LOR MEPS + Phase out	Com	8,890	5.5	838	93	745		
F: LED MEPS + LOR MEPS + Phase out	**All**	**25,183**	**16.4**	**3355**	**541**	**2815**	**6.2**	**-172**

[134] The Total investment column for Australia includes costs to consumers, product supply businesses and government to implement the option. Costs to business and government are included in the residential sector row of the table. See the impacts section for further information.

[135] LOR MEPS is MEPS for non-integrated commercial luminaires

New Zealand - Results by Option

Option	Sector	Energy Saved (cumulative GWh)	GHG Emissions Reduction (cumulative Mt)	Total (Gross) Benefit (NPV, $M)	Total Investment (NPV, $M) [136]	Net Benefit (NPV, $M)	(Gross) Benefit to Cost Ratio	Cost of Abatement (NPV $/tonne)
A. LED MEPS	Res	360	0.02	55	5	50		
A. LED MEPS	Com	841	0.06	92	11	81		
A: LED MEPS	**All**	**1,201**	**0.08**	**147**	**16**	**131**	**9.2**	**-1637**
B: LED MEPS + LOR MEPS[137]	Res	360	0.02	55	5	50		
B: LED MEPS + LOR MEPS	Com	1,738	0.12	184	22	162		
B: LED MEPS + LOR MEPS	**All**	**2,098**	**0.14**	**239**	**27**	**212**	**8.9**	**-1514**
C: LED MEPS + LOR MEPS + Labelling	Res	583	0.17	90	7	83		
C: LED MEPS + LOR MEPS + Labelling	Com	1,738	0.12	184	22	162		
C: Option B + Labelling	**All**	**2,321**	**0.29**	**274**	**29**	**245**	**9.4**	**-845**
D: LED MEPS + Labelling	Res	583	0.17	90	7	83		
D: LED MEPS + Labelling	Com	841	0.06	92	11	81		
D: LED MEPS + Labelling	**All**	**1,424**	**0.23**	**182**	**18**	**164**	**10.1**	**-713**

[136] The Total investment column for New Zealand includes costs to consumers and product supply businesses to implement the option. The proportion of government costs to be incurred by the New Zealand Government has not been accounted for in this table, with all government costs included in the Australian table. See the impacts section for further information.

[137] LOR MEPS is MEPS for non-integrated commercial luminaires

Sensitivity tests: discount rates

Sensitivity tests: discount rates - Australia

Summary Australia	NPV Nil (0%)	NPV Low (3%)	NPV Med (7%)	NPV High (11%)
Proposal A				
Total Costs	115	95	75	61
Total Benefits	1,467	1,033	677	464
Net Benefits	1,352	939	602	403
Benefit Cost Ratio	12.8	10.9	9.0	7.6
Proposal B				
Total Costs	181	151	122	102
Total Benefits	2,413	1,686	1,093	742
Net Benefits	2,232	1,535	971	640
Benefit Cost Ratio	13.3	11.1	8.9	7.3
Proposal C				
Total Costs	223	188	152	127
Total Benefits	2,856	1,997	1,296	879
Net Benefits	2,632	1,809	1,143	752
Benefit Cost Ratio	12.8	10.6	8.5	6.9
Proposal D				
Total Costs	157	131	105	86
Total Benefits	1,910	1,344	879	602
Net Benefits	1,753	1,213	775	516
Benefit Cost Ratio	12.2	10.3	8.4	7.0
Proposal E				
Total Costs	631	568	494	430
Total Benefits	6,052	4,361	2,939	2,064
Net Benefits	5,420	3,793	2,445	1,634
Benefit Cost Ratio	9.6	7.7	6.0	4.8
Proposal F				
Total Costs	697	625	541	471
Total Benefits	6,997	5,014	3,355	2,341
Net Benefits	6,300	4,389	2,814	1,871
Benefit Cost Ratio	10.0	8.0	6.2	5.0

Sensitivity tests: discount rates - New Zealand

Summary New Zealand	NPV Nil (0%)	NPV Low (3%)	NPV Med (5%)	NPV High (8%)
Proposal A				
Total Costs	22	18	16	13
Total Benefits	257	182	147	109
Net Benefits	235	164	131	95
Benefit Cost Ratio	11.8	10.1	9.2	8.1
Proposal B				
Total Costs	36	30	27	23
Total Benefits	424	298	239	176
Net Benefits	388	268	212	152
Benefit Cost Ratio	11.8	9.9	8.9	7.6
Proposal C				
Total Costs	38	32	29	25
Total Benefits	487	341	274	201
Net Benefits	448	309	245	176
Benefit Cost Ratio	12.7	10.6	9.4	8.0
Proposal D				
Total Costs	24	20	18	15
Total Benefits	320	226	182	134
Net Benefits	295	205	164	119
Benefit Cost Ratio	13.2	11.2	10.1	8.8

Sensitivity tests: higher and lower incremental costs

The direct incremental costs of each proposal were tested for sensitivity. These costs are the incremental product costs required to meet the required efficiency improvement associated with the proposal.

Australia – MEPS: increase incremental costs by 50%. Phaseout & Labelling: increase LED price by 25%

Proposal	Energy Saved (cumulative GWh to 2030)	GHG Emission Reduction (cumulative) Mt	Total Benefit ($M)	Total Investment ($M)	Net Benefit ($M)	BCR
Proposal A	6,142	3.9	677	98	579	6.9
Proposal B	10,731	6.5	1,093	177	917	6.2
Proposal C	12,117	7.3	1,296	212	1,084	6.1
Proposal D	7,528	4.7	879	133	746	6.6
Proposal E	20,594	13.7	2,939	592	2,346	5.0
Proposal F	25,183	16.4	3,355	671	2,684	5.0

Note: This table uses discount rates of 7% (real) for Australia

Australia – No Sensitivity

Proposal	Energy Saved (cumulative GWh to 2030)	GHG Emission Reduction (cumulative) Mt	Total Benefit ($M)	Total Investment ($M)	Net Benefit ($M)	BCR
Proposal A	6,142	3.9	677	75	602	9.0
Proposal B	10,731	6.5	1,093	122	971	8.9
Proposal C	12,117	7.3	1,296	152	1,143	8.5
Proposal D	7,528	4.7	879	105	775	8.4
Proposal E	20,594	13.7	2,939	494	2,445	6.0
Proposal F	25,183	16.4	3,355	541	2,814	6.2

Note: This table uses discount rates of 7% (real) for Australia

Australia – MEPS: decrease incremental costs by 50%. Phaseout & Labelling: decrease LED price by 25%

Proposal	Energy Saved (cumulative GWh to 2030)	GHG Emission Reduction (cumulative) Mt	Total Benefit ($M)	Total Investment ($M)	Net Benefit ($M)	BCR
Proposal A	6,142	3.9	677	52	625	13.1
Proposal B	10,731	6.5	1,093	68	1,025	16.0
Proposal C	12,117	7.3	1,296	93	1,203	13.9
Proposal D	7,528	4.7	879	76	803	11.5
Proposal E	20,594	13.7	2,939	395	2,544	7.4
Proposal F	25,183	16.4	3,355	411	2,944	8.2

Note: This table uses discount rates of 7% (real) for Australia

New Zealand – MEPS: increase incremental costs by 50%. Labelling: increase LED price by 25%

Option	Energy Saved (cumulative GWh to 2030)	GHG Emissions Reduction (cumulative Mt to 2030)	Total (Gross) Benefit (NPV, $M)	Total Investment (NPV, $M)	Net Benefit (NPV, $M)	(Gross) Benefit to Cost Ratio
Proposal A	1,201	0.08	147	21	125	6.8
Proposal B	2,098	0.14	239	40	199	6.0
Proposal C	2,321	0.29	274	43	231	6.4
Proposal D	1,424	0.23	182	25	157	7.4

Note: This table uses discount rates of 5% (real) for New Zealand

New Zealand – No Sensitivity

Option	Energy Saved (cumulative GWh to 2030)	GHG Emissions Reduction (cumulative Mt to 2030)	Total (Gross) Benefit (NPV, $M)	Total Investment (NPV, $M)	Net Benefit (NPV, $M)	(Gross) Benefit to Cost Ratio
Proposal A	1,201	0.08	147	16	131	9.2
Proposal B	2,098	0.14	239	27	212	8.9
Proposal C	2,321	0.29	274	29	245	9.4
Proposal D	1,424	0.23	182	18	164	10.1

Note: This table uses discount rates of 5% (real) for New Zealand

New Zealand – MEPS: decrease incremental costs by 50%. Labelling: decrease LED price by 25%

Option	Energy Saved (cumulative GWh to 2030)	GHG Emissions Reduction (cumulative Mt to 2030)	Total (Gross) Benefit (NPV, $M)	Total Investment (NPV, $M)	Net Benefit (NPV, $M)	(Gross) Benefit to Cost Ratio
Proposal A	1,201	0.08	147	10	136	14.3
Proposal B	2,098	0.14	239	14	225	16.9
Proposal C	2,321	0.29	274	15	259	17.9
Proposal D	1,424	0.23	182	11	170	15.9

Note: This table uses discount rates of 5% (real) for New Zealand

Attachment A1: Electricity prices and GHG emissions

Table 13: Electricity prices (real 2016 $/kWh) for Australia and New Zealand

Region/year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Australia - Commercial (AUD)	0.175	0.177	0.177	0.179	0.182	0.184	0.195	0.197	0.199	0.201	0.204	0.207	0.208	0.211	0.213
Australia - Residential (AUD)	0.287	0.288	0.287	0.290	0.294	0.296	0.309	0.312	0.313	0.316	0.319	0.321	0.323	0.325	0.327
New Zealand - Commercial (NZD)	0.177	0.178	0.177	0.177	0.181	0.182	0.181	0.183	0.184	0.185	0.182	0.185	0.187	0.188	0.189
New Zealand - Residential (NZD)	0.267	0.271	0.271	0.280	0.280	0.280	0.280	0.280	0.279	0.279	0.279	0.279	0.279	0.282	0.283

Table 14: GHG emission factors for electricity (kg CO2-e/kWh) for Australia and New Zealand

Region/year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Australia	0.99	0.97	0.95	0.93	0.91	0.91	0.90	0.90	0.91	0.91	0.90	0.90	0.90	0.89	0.89
New Zealand	0.1413	0.1442	0.1471	0.1479	0.1210	0.1110	0.1117	0.1047	0.1035	0.0911	0.0922	0.0915	0.0940	0.0964	0.0883

Attachment B: Lamp technologies

Incandescent Lamps

The incandescent lamp was the most common lamp type for domestic lighting for many years. It produces light by heating a tungsten wire filament to a high temperature by running an electric current through it until it glows brightly. The tungsten filament incandescent lamp is a low efficacy light source and has a relatively short lamp life.

Figure 25: Examples of incandescent lamps

Omni-directional (non-reflector) incandescent lamp

Directional (reflector) incandescent lamp

Halogen Lamps

Halogen lamps have a tungsten filament suspended in a mixture of an inert gas (usually argon, krypton or xenon) together with a small amount of halogen gas (usually bromine or iodine). During lamp operation, the halogen gas combines with the tungsten molecules that have evaporated from the filament. The tungsten is deposited back onto the filament and the halogen released to start the cycle again. A halogen lamp can be operated at a higher temperature than a standard incandescent lamp, resulting in a higher lamp efficacy than tungsten filament lamps.

Figure 26: Examples of halogen lamps

Halogen GLS lamp (non-reflector MV)

Halogen capsule lamp (non-reflector MV or ELV)

Halogen MR16 reflector lamp (ELV)

Halogen GU10 reflector lamp (MV)

Fluorescent Lamps (Linear, Circular, Compact)

This family of lamps make light by first creating an electric discharge or arc within a glass tube filled with a low pressure mercury vapour. The arc stimulates the mercury atoms within the vapour, exciting electrons. The energised mercury vapour atoms emit ultraviolet radiation, which in turn excites the phosphor powder coating the glass tube and generates visible light. Fluorescent lighting has a high efficacy and long lifespan.

Fluorescent lamps require a ballast to operate and are available in a variety of shapes, including linear, circular and U-shaped (Figure 27).

Linear fluorescent lamps are identified primarily by their designated 'T' number that defines the tube diameter in eights of an inch. The most common linear fluorescent lamps in a commercial setting are T5 (16 mm) (the most efficient of linear lamps), T8 (26 mm) and T12 (38 mm). T8 lamps are available in a range of lengths, and have a higher efficacy and better colour rendering index than T12 lamps. T8 and T12 lamps can operate with either magnetic or electronic ballasts.

T5 lamps require an adapter kit to retrofit T8 lamp fittings, as they have a different pin-base connection and are 50mm shorter. A specifically designed T5 luminaire also makes the overall use of T5 lamps more efficient, as the luminaires are designed to reflect more light out of the fixture so fewer lamps are required to light an area.

Cold cathode fluorescent lamps, which apply a higher voltage rather than heating the electrode to generate an arc, are not covered by Minimum Energy Performance Standards.

Figure 27: Examples of Fluorescent Lamps

Integrated CFLs

Integrated CFLs (Figure 28) are single-capped lamps with a compact (e.g. folded or spiral) gas discharge tube, with integrated ballast circuitry for controlling the lamp.

CFLs are amongst the most efficient lamps available, employing a gas discharge technology together with a phosphor coating to produce visible light. An electronic ballast, required to operate the gas discharge at the correct current, is incorporated into the base of the lamp. CFLs in the typical lighting context are mains voltage and are a direct replacement for incandescent and halogen lamps (some 12 volt CFLs are available). They are available in both reflector and non-reflector formats. Examples are given in the photographs below.

Figure 28: Examples of CFLs

Spiral-shape omnidirectional CFL	Stick-shape omnidirectional CFL	Covered CFL	CFL reflector lamp

Non-integrated CFLs

Non-integrated CFLs predominantly have a tube diameter the same as a T5 lamp and generate light in the same manner as linear fluorescent lamps. However, they connect to the power supply with a base or socket system.

A ballast is required to operate the lamp at the correct current and can be integrated with the lamp or a separate piece of equipment. Non-integrated CFLs, sometimes referred to as a CFLn, pin-based or plug-in CFL, have the ballast installed in the luminaire, separate to the lamp.

Figure 29: Non-integrated CFLs (right and bottom of picture), electronic fluorescent lamp ballast (left top) and a magnetic fluorescent lamp ballast (left centre).

T8-T5 adapters

T5 linear fluorescent lamps can produce the same quantity of lumens using less power than a T8. This has led to a new energy-saving technological solution in the form of the T8 to T5 adapter, which is a plug-in fixture that allows replacement of fluorescent T8 lamps with the energy-efficient T5 lamp in the existing light fitting. Evaluation of these products in the Commercial Lighting Product Profile indicated that some models may not actually result in energy savings assumed, however advice from industry is that the adapters are fast disappearing from the market as building owners actively searching for energy savings are now choosing to refit with LED linear lamps or integrated luminaires.

Figure 30: A T8-T5 adapter. Images sourced from Enduralight (www.enduralight.com.au/products/t5-adaptors).

Light Emitting Diode Lamps

LEDs, or Solid State Lighting (SSL), use one or more semiconductor diodes (solid state chip) to emit non-coherent optical radiation (light) in the visible spectrum. This radiation can either be in the visible spectrum (i.e. the LED directly produces visible light), or the visible light can be produced indirectly, e.g. with the radiation exciting phosphor which in turns emits the visible light in a similar way to CFLs. LEDs are currently available to replace many types of lamps and continue to evolve rapidly to cover many different lighting applications. The performance of LED lamps is variable, although in the last 2-3 years significant improvements in performance have been observed. Figure 31 shows examples of LED lamps with integral power supply electronics.

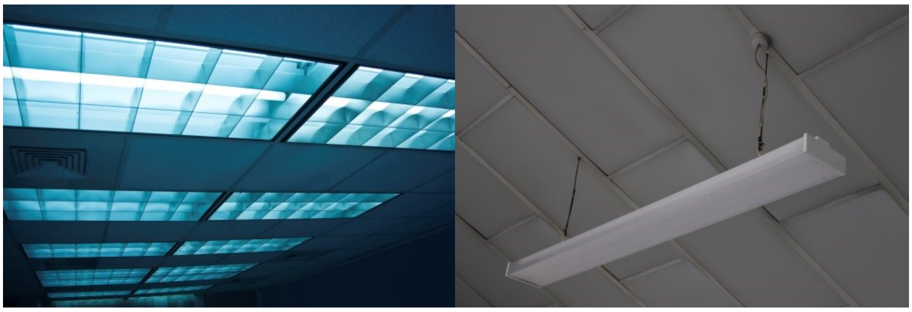
Figure 31: Examples of LED integral lamps (images courtesy Barryjoosen and Lee, E.G. via Wikimedia Commons)

Omnidirectional-replacement LED | LED MR16 | Directional LED lamp

Commercial Luminaires

A luminaire includes all the parts necessary for supporting, fixing and protecting lamps, but not the lamps themselves. Commercial luminaires are those luminaires marketed and intended to be used in a commercial or business environment. The basic commercial luminaires – troffers, battens and recessed canisters – are fixed installations that have the primary purpose of enabling people to perform visual tasks, but are also used for general lighting in corridors and foyers.

Figure 32: Recessed troffers with louvres to direct light output (left) and a pendant batten with diffuser (right)



Auxiliary Equipment

The energy efficiency of a lighting system depends not only on the luminous efficacy of the lamp, but also on the efficiency of the auxiliary equipment. This equipment includes ballasts, starters, transformers, drivers and dimmers.

Ballasts

The ballast controls the amount of electrical current supplied to linear fluorescent, compact fluorescent and high intensity discharge (HID) lamps. Once started and the arc is established in the lamp, it progressively becomes a better conductor of electricity and increasingly more current is able to flow. The current becomes excessive within seconds (fluorescent lamps) to minutes (HID lamps) and could easily destroy the lamp. The ballast keeps this current rise under control so the lamp always receives the right current and voltage to function at its best. They consume a small amount of power in the process. Ballasts for linear fluorescent lamps are subject to MEPS in Australia and New Zealand.

Starters

The full function of the starter switch in switch start fluorescent lamp circuits is beyond the scope of this document. It is important to note they are only used to start the lamps and perform no function in the normal, light producing stage of operation. They can, however, affect how long the lamp will last.

Transformers/voltage converters

Transformers change the mains voltage (240V) to a lower voltage (typically 12V). The MR16 halogen lamps are all 12V and need to run from a transformer (also known as extra low voltage converters or ELVC). The wide range of transformers installed for halogen MR16 lighting systems in Australian homes means that it is also important to investigate whether retrofit LED lamps are compatible with installed transformers. Some suppliers will provide a list of transformers that their product has been tested with. Transformers for extra low voltage halogen lamps are subject to MEPS under the GEMS Act.

LED drivers

LEDs use direct current (DC) electrical power at low voltage. An LED driver is a power regulation unit with outputs designed to match the specific electrical characteristics of an LED or LED array.

Dimmers

Most domestic dimmers in use today will be one of two types – leading edge or trailing edge. They control the power delivered to the lamp by only switching on at a certain point in the mains voltage waveform. With iron core transformers, the best dimmer to use is the leading edge type. For electronic transformers it is best to apply the trailing edge dimmer.

Attachment C: Glossary of lighting terms

Ballast

A component of conventional control gear. It controls the current through the lamp, and is used with discharge lighting, including fluorescent and high intensity discharge lamps. The term is sometimes used loosely to mean control gear. Also called a choke.

Colour rendering

An indicator of how accurately colours can be distinguished under different light sources. The colour rendering index (CRI) compares the ability of different lights to render colours accurately with the measurement of 100 considered to be excellent. A value of 80 and above is good and appropriate for most situations where people are present. Where colour identification is important, a value of 90 or above should be used.

Colour temperature

Also known as colour appearance, the colour temperature is the colour of 'white' the light appears. It is measured in Kelvin (K), and ranges from 1800K (very warm, amber) to 8000K (cool). 6500K is daylight. There are many colours of 'white' available. For general use these are: warm white (2700–3300K), cool white (3300–5300K) and cool daylight (5300–6500K).

Control gear

A 'package' of electrical or electronic components including ballast, power factor correction capacitor and starter. High-frequency electronic control gear may include other components to allow dimming etc.

Diffuser

A translucent screen used to shield a light source and at the same time soften the light output and distribute it evenly.

Discharge lamp

A lamp which produces illumination via electric discharge through a gas, a metal vapour or a mixture of gases and vapours.

Efficacy (luminous efficacy)

The ratio of light emitted by a lamp to the power consumed by it, that is, lumens per Watt. When the control gear losses are included, it is expressed as lumens per circuit Watt. The higher the efficacy the more efficient the product.

Illuminance

The amount of light falling on an area, measured in lux. 1 lux is equal to one lumen per square metre. The higher the Lux, the more visible light on a surface area.

Intensity (Candela)

Intensity is the amount of light radiated in a given direction, measured as Candela (cd). The higher the Candelas the more intense the light.

Kelvin

A measure of colour temperature for lamps.

Light output ratio (LOR)

The ratio of the total amount of light output of a lamp and luminaire to that of just the bare lamp.

Luminaire

A light fitting and lamp including all components for fixing and protecting the lamps, as well as connecting them to the supply.

Lumen

Unit of luminous flux, used to describe the amount of light produced by a lamp. The higher the lumens, the more visible light emitted by the lamp.

Luminance (Candela/m^2)

Luminance indicates how bright an object will appear and is measured as candela (intensity) per m^2. The higher the luminance the brighter the object will appear.

Lux

An international unit of measurement of illuminance intensity of light.

Rated average lamp life

The number of hours after which half the number of lamps in a batch fail under test conditions.

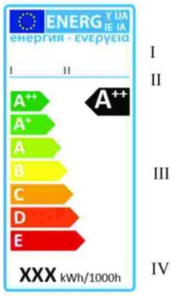
Commercial lighting

Generally refers to most lighting used for non-residential purposes including fluorescent lamps (excluding CFLs with an integrated ballast), fluorescent lamp ballasts, T8-T5 adapters, and basic commercial luminaires (troffers, battens and CFL cans).

Attachment D: Lamp Labelling Programs

Below is a summary of the types of lamp labelling programs currently in place in other economies.

Comparative labelling schemes provide a method to compare the relative performance of a lamp, however they can only compare against one attribute – energy. Examples of energy labels for lamps include the EU Energy label.



Concern with comparative labelling for lighting products was raised as part of feedback on the LED Product Profile in response to the option to introduce the Energy Rating Label or similar for lighting -"quality may then become overlooked as it is easy to make a poor quality of light with high efficacy, which I understand would have a high rating on your system." In addition to efficacy, other factors such as lifetime are considered important to highlight on light bulb packaging.

The EU regulation for directional lamps and luminaires requires display of energy efficiency class, comparative energy performance label, lumen, and estimated yearly power consumption (in kWh). In addition, beam angle is also required for directional lamps. EU Regulation for non-directional lamps specifies the display lumen output, lifetime, CCT, warm-up time and a warning if the lamps cannot be dimmed.

Energy efficiency is determined based on the power consumption (luminous flux, units: lumen) per Watt consumed. Energy efficiency classes A++ (high energy efficiency) to E (very low energy efficiency) are used on the labels for characterisation.

Short comings of the label include evidence from consumer organisations suggesting that the addition of '+' signs creates confusion, with going from an 'A+' to an 'A++' product being less appealing to consumers than going from a 'B' to an 'A'.

Alternatively **endorsement labelling** is a method that demonstrates that the product has passed some absolute level of performance. Generally only the high efficiency products (typically the top 25% of the market) are labelled and, while it would make it easier for consumers to identify these products, they would not be able to compare the performance and benefits amongst the lower efficiency products. Examples include the US ENERGY STAR. This endorsement label is only awarded to certain lamps that meet strict efficiency, quality and lifetime criteria. US research identified that national awareness of the label is high at 88 per cent, but only 36 per cent recalled the label on light bulbs when prompted.

New Zealand have adopted a similar approach, with the voluntary NZ ENERGY STAR programme including several lighting products.

The US Federal Trade Commission (FTC) **information label** introduced in 2012 is mandatory for LED, CFL, incandescent and halogen lamps. It requires manufacturers to give consumers key information in an easy-to-read format. Brightness (in lumens) and an estimated yearly energy cost are required on the front and light facts on the side or back (as listed below). The FTC rejected a star rating system as it was believed that it did not perform better than energy cost in helping consumers answer energy-related questions and that some consumers mistakenly viewed the stars as a measure of lamp quality.

Front display panel

1. Light output (brightness)
2. Energy Cost

Side or rear display - Light facts label content

1. Brightness/Light output (average initial lumens rounded to nearest 5). Lumen output must also be printed on the bulb
2. Estimated annual energy cost (based on average initial wattage, a usage rate of 3 hours per day and 11 cents per kWh)
3. Lifetime (expressed in years rounded to nearest tenth – based on 3 hours per day)
4. Correlated Colour Temperature (CCT) (as expressed as “light appearance”)
5. Wattage
6. ENERGY STAR logo (if desired by the manufacturer)
7. Voltage (if other than 120V)
8. Mercury (if present) (also required on the bulb)

***CRI was not included** as it was believed consumers would not benefit from a CRI disclosure after a minimum CRI of 80 came into effect in 2012.

***Lumens per Watt was not included** as US research indicated[138]:

1. The metric performed poorly in helping respondents answer energy use and efficiency questions.

2. Consumers were not yet familiar with the concept of lumens, the more complex lumens per watt disclosure likely would be ignored or cause confusion

3. Could lead to consumers choosing bulbs that are brighter than needed

[138] This consumer perception is expect to continue to evolve with the diversification of lighting products on the market and may have changed even since this research in 2012

Product example

Attachment E: LED lamp packaging in Australia

Purpose

To evaluate consistency in information being provided to consumers on LED packaging, the packaging attributes of 47 LED lamps from 20 manufacturers were examined. Of the lamps, 24 were directional and 23 non-directional. Packaging was also reviewed to determine the extent to which suppliers were already displaying proposed mandatory packaging requirements.

The 20 lamp manufacturers were: Akesi, Azoogi, Brilliant, Click, CLA, Crompton, Ecolamp, Ecolightup, E-Star, Ledare, Lucci LEDlux, LuceBella, Mirabella, Mort Bay, Osram, Philips, Toshiba, SAL, Sylvania and PHL.

LEDs were only included as data points where there was a noticeable difference in LED shape and/or packaging. Products with more than one lumen value were only included once.

Overall Findings

LED lamp packaging in the Australian market is generally inconsistent across manufacturers and even within a manufacturer's own LED range.

The mixture of terminology used to describe light output creates unnecessary complexity for consumers.

The absence of 'efficacy' or similar to communicate the energy efficiency of the LED product means that consumers are required to derive this using Watts and Lumens, complicating the comparison process.

Inconsistency with 'equivalency claims' is also likely to cause confusion for consumers, with some products claiming equivalency to halogen, others incandescent and others an unspecified technology. In some cases, the LED lumen equivalency was inadequate as a suitable replacement lamp.

The range of lumen numbers on LED products further complicates the comparison process. The lack of consistent groupings, such as existed for incandescent lamps with wattage ranges, has the potential to create confusion and the need for consumers to try and understand if the variance in lumen numbers across products makes a noticeable difference to light output. For example consumers may be uncertain whether there is a noticeable difference in light output between an 800 lumen and 806 lumen lamp.

In terms of product markings, many products did not include lumens or colour temperature, making replacement challenging for a consumer.

Summary of key results

Luminous flux

- Luminous flux was displayed on 96% of products
- Overall inconsistency amongst manufacturer's own products in how lumens was displayed(font and location)
- Mixture of terminology in how luminous flux was described, e.g. brightness, lm, lumen, lumens, lumens output
- Wide range of lumens displayed, showing a lack of consistent groupings to simplify for consumers
- Luminous flux was generally in larger font than Watts:
    - In 49% of lamps, lumens were in larger font
    - In 34% of lamps, Watts were in larger font
    - In 17% of lamps, lumens and Watts were in the same size font

Efficacy

Efficacy was displayed on only 17% of lamps and on the back of packaging

Beam angle

- Beam angle was displayed on 70% of directional LED lamps

Lifetime

- Lifetime was found on only 62% of products

Colour temperature (CCT)

- A Kelvin value was displayed on 98% of packaging
- A colour description was displayed on 91% of packaging
- There was a wide range of colour descriptions used: warm, super warm, warm white, cool white, natural white and daylight.
- A range of graphic scales were also used to illustrate Kelvin value

Claims of equivalence

Equivalency was found on 57% of lamp packaging. Of these products:

- 41% were directional
- 59% were non-directional
- 41% provided equivalency with halogen
- 26% provide equivalency with incandescent lamps
- 33% provided equivalency with an unspecified technology

It was also noted that some lamps provided equivalency in Watts on the front of packaging but listed the equivalent technology on the back.

50% of omni-directional LEDs had lower lumen output than the minimum expected for the equivalent incandescent wattage (only omni-directional LEDs where equivalency was given with incandescent lamps were included as data points. Expected lumen values were taken from the IEA4ESSL wattage equivalence table).

Colour Rendering Index (CRI)

- CRI was displayed on 47% of all lamps
- In some cases displayed as an 'Ra' value or a colour rendering category, e.g. 1B

Dimmer compatibility

- 50% of products were listed as dimmable
    - 21% of products listed as dimmable provided information on compatible dimming models/manufacturers or system types, i.e. leading edge or trailing edge.
    - 38% of products listed as dimmable provided a web address. Web addresses were not analysed to determine if these websites listed compatible dimming system models

(LEDs may have included information on compatibility inside of packaging)

LED MR16 compatibility claims with electronic transformers

- Only 29% of MR16 LED packs had compatibility information for ELVC converters, with some products claiming general compatibility e.g. works with most electronic transformers or designed for electronic transformers.

(LEDs may have included information on compatibility inside of packaging)

Other attributes noted

- Supplier website link
    - 50% of packages included a website link
- Luminous intensity
    - 25% of directional LED lamps disclosed a candela value
- Mercury
    - Many products advised they didn't contain mercury. This was often advised using the symbol 'Hg' and the value '0'
- Regulatory Compliance Mark (RCM)
    - The RCM mark declares that the product has met electrical safety and electromagnetic compatibility requirements. Marking requirements are currently in transition and suppliers have until 1 March 2018 for products to be marked with the RCM
    - The RCM was displayed on 53% of product packaging.

Lamp marking

13 LED lamps (8 omni-directional and 5 directional) from nine manufacturers were reviewed for marking. Lamps included marking for the following attributes:

- Luminous flux was marked on 46% of lamps
- Wattage was marked on 100% of lamps
- CCT was marked on 100% of lamps (two products marked the colour description rather than the Kelvin number)
- Whether the lamp can/can't be dimmed was marked on 54% of lamps
- Beam angle was marked on 80% of directional lamps

In particular, luminous flux and colour temperature are important attributes to be marked on LED lamps to help consumers with the selection of replacement products.

Given the long life of LEDs, consumers may not remember the luminous flux of the lamp they are replacing or have the original packaging.

Colour temperature marking is also important, particularly for lamps used in track lighting.

Attachment F: Incandescent and halogen lamps

Table 15: Specified product classes covered by the GEMS (Incandescent Lamps for General Lighting Service) Determination

GEMS class	Lamp	Shapes	Caps	Nominal voltage	Nominal wattage	Exclusions
1	GLS tungsten filament	A50-A65, PS50-PS65, M50-M65, T50-T65 (as generally outlined in IEC 60630) or E50-E65	E14, E26, E27, B15 or B22d	≥220 V	<150 W	Coloured lamps, reflector lamps, crown-reflector lamps or lamps with a halogen gas fill
2	ELV halogen non-reflector (with tungsten halogen lamp burner)	Single-ended capsule, non-reflector	Bi-pin	5-14 V inclusive	All	Coloured lamps, reflector lamps or crown-reflector lamps
3	Candle tungsten filament	Candle or B (as generally outlined in IEC 60630) including twisted and bent-tip candle	E14, E26, E27, B15 or B22d	>220V	All	Coloured lamps, reflector lamps, crown-reflector lamps or lamps with a halogen gas fill
4	Fancy round tungsten filament	Round, P (as generally outlined in IEC 60630), G or globe	E14, E26, E27, B15 or B22d	>220 V	All	Coloured lamps, reflector lamps, crown-reflector lamps or lamps with a halogen gas fill
5	Decorative tungsten filament	Decorative shapes	E14, E26, E27, B15 or B22d	>220 V	All	Coloured lamps, reflector lamps, crown-reflector lamps, pilot lamps, lamps with a halogen gas fill or lamps that have the same shape as product classes 1 to 4
6	Mains voltage halogen non-reflector lamps (with tungsten halogen burner, non-reflector)	Single-ended	E14, E26, E27, B15 or B22d	>220V	All	Coloured lamps, reflector lamps or crown-reflector lamps
7	ELV halogen reflector lamps (with tungsten halogen burner, reflector)	MR 11-16	Bi-pin	5-24 V inclusive	All	Coloured lamps

- These lamps are not regulated in New Zealand.
- Lamps must meet MEPS requirements for initial efficacy, lifetime and lumen maintenance.
- Mains voltage halogen non-reflector lamps have a five percent exemption on initial efficacy requirements.
- The mean measured wattage of ELV halogen lamps cannot be more than 37 W.
- Marking requirements for light output, wattage and lamp lifetime are specified.

Attachment G: References

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Attachment H: Draft Minimum Energy Performance Standards for LED Lighting

Contents

Draft Minimum Energy Performance Standards for LED Lighting

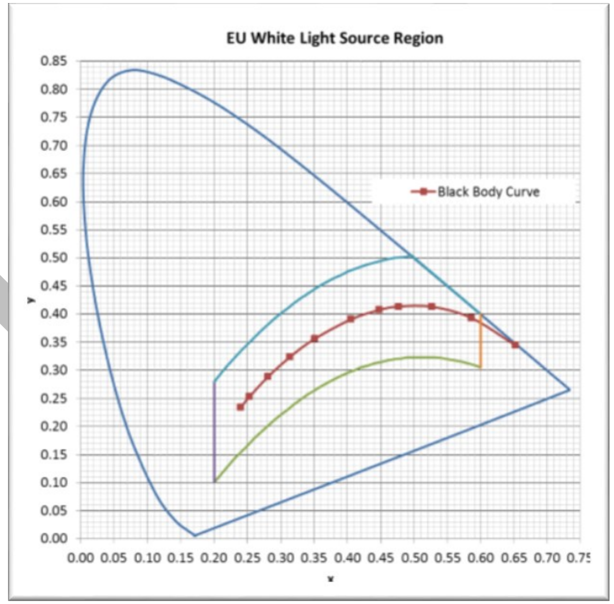
This draft MEPS has been developed as part of a range of options for addressing LED lighting efficiency and performance in Australia and New Zealand. Any application of a MEPS to LED lighting in Australia and New Zealand will be subject to approval by governments following consideration of a Regulation Impact Statement (after public consultation). The draft MEPS has been developed in consultation with a technical working group of stakeholders from lighting and control supply, government programs and test laboratories, and was issued for stakeholder comment in July 2016 as part of the development of these proposals. More information about the Equipment Energy Efficiency Program is available at: www.energyrating.gov.au/ with specific background on LED lighting available in the LED lighting Product Profile here: www.energyrating.gov.au/consultation/led-lighting-product-profile-consultation

Scope

This Draft Minimum Energy Performance Standards (MEPS) for LED Lighting products is proposed to apply to the sale and commercial use of the range of LED products specified below. The MEPS is intended to specify minimum performance levels for lighting efficacy and a number of other performance parameters important in ensuring LED lighting products provide an effective and efficient alternative to other less efficient lighting technologies (tables 1&2). Table 3 lists proposed package marking requirements. Where possible, the test requirements reference relevant international standards by the International Commission on Illumination(CIE), International Electrotechnical Commission (IEC), and regional standards such as the Illuminating Engineering Society of North America. The MEPS levels are largely derived from the International Energy Agency 4E Solid State Lighting Annex Product Quality and Performance Tiers (http://ssl.iea-4e.org/product-performance). Note that while product test data will be required for product registration, it is proposed that third party accredited testing will not be required. Where the use of module or LED package test data is allowed, this must be from an accredited (but not necessarily third party) laboratory.

All Lamp Categories

As well as the specific scope below, this MEPS applies to lamps and luminaires capable of being tuned to within the specified white region in any of their modes of operation. This includes fixed white light sources as well as tuneable sources which are capable of being tuned to within the white region specified by the chromaticity coordinates (x and y) range:



- $0{,}2 < x < 0{,}6$; and
- $-2{,}3172\,x^2 + 2{,}3653\,x - 0{,}28 < y < -2{,}3172\,x^2 + 2{,}3653\,x - 0{,}1$.[139]

In the case of tuneable lamps and luminaires, compliance for photometric parameters will be based on testing at the lowest and highest CCTs achievable by the lamp plus the nominal CCT of 2700 K (non-directional and directional lamps and small luminaires), or 4000 K (linear LED lamps and large and planar luminaires, battens and troffers), if within the maximum and minimum CCTs. Also testing will be conducted at maximum light output (in case the lamps are also dimmable). Testing of tuneable products will be done with the product's CCT adjusted through operation with software provided with products as sold.

Non-directional LED lamps (table 1)

Lamps with LED light sources of all shapes with lamp caps B15, B22, E14, E27, E39, E40, GU10, G9 and ELV lamp bi-pin caps G4, that emit ≥ 100 lm.

Directional LED lamps (table 1)

Lamps with LED light sources of all shapes with lamp caps B15, B22, E14, E27, E39, E40, GU10, G9 and R7, and ELV lamp bipin caps GU5.3, GX5.3, G6.35, GX53, that emit ≥ 100 lm.

Linear LED lamps (table 1)

Linear LED lamps double-capped LED lamps including G5 and G13 caps, intended for replacing fluorescent lamps (as defined in IEC 60081) with the same caps (as defined in IEC 60081) or caps specific for double-capped linear LED lamps (related to IEC 60838-2-3) with a nominal length of 550 mm to 1500 mm.

Planar Luminaires, integrated battens & Troffers (table 2)

Integrated LED fixtures (including panel form) intended as an alternative to tubular fluorescent based general purpose

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139 Note: referenced from EU Regulation No244 (2009) and latest proposal for revised EU Regulation

- troffer/recessed luminaires (defined in AS/NZS 60598-2-2)
- batten/fixed general purpose luminaires, suspended or surface mount (defined in AS/NZS 60598-2-1)

Integrated LED Luminaires (small) (table 2)

Integrated LED luminaires with a luminous flux of ≥ 100 lm and < 2,500 lm. Note integrated includes a luminaire with remote control gear.

For decorative style integrated LED luminaires (see definition below) which have low volume sales of up to {a yet to be determined} annual units, or other limited production run luminaires which have low volume sales of up to 20 annual units a simplified registration may be submitted, including supply of manufacturer's datasheet, without demonstration of full compliance with MEPS. Import/production volumes to be provided annually for duration of registration. Where this upper sales limit is exceeded, the supplier may either withdraw the product from sale; or alternately both complete product testing and complete a full product registration (demonstrating compliance with MEPS). Note - where decorative luminaires are designed with lamp holders rather than an integrated light source, any supplied lamp will be subject to MEPS (in a standard registration process) rather than the entire luminaire.

Integrated LED Luminaires (large) (table 2)

Integrated LED luminaires with a luminous flux of ≥ 2,500 lm and < 50,000 lm. Note integrated includes a luminaire with remote control gear.

Includes integrated LED fixtures intended as an alternative to general purpose industrial style high bay, low bay and indoor area lighting luminaires

For decorative style integrated LED luminaires (see definition below) which have low volume sales of up to {a yet to be determined} annual units, or other limited production run luminaires which have low volume sales of up to 20 annual units, a simplified registration may be submitted, including supply of manufacturer's datasheet, without demonstration of full compliance with MEPS. Import/production volumes to be provided annually for duration of registration. Where this upper sales limit is exceeded, the supplier may either withdraw the product from sale; or alternately both complete product testing and complete a full product registration (demonstrating compliance with MEPS). Note - where decorative luminaires are designed with lamp holders rather than an integrated light source, any supplied lamp will be subject to MEPS (in a standard registration process) rather than the entire luminaire.

Scope Exclusions for LED Lamps and Integrated LED luminaires

Integrated LED luminaires (Small and Large) exclude:

- Planar Luminaires, integrated battens & Troffers (including those defined in AS/NZS 60598.2.1 and AS/NZS 60598.2.2:2002)[140]
- Theatrical luminaires as defined in AS/NZS 60598.2.17:2006

[140] As these are encompassed in the Planar Luminaires, integrated battens & Troffers category

- Lamps and luminaires compliant with cyanosis observation index and colour temperature requirements of AS/NZS 1680.2.5:1997 Interior lighting Part 2.5: Hospital and Medical tasks, with package marked 'For Medical Use Only'.
- Light source products that are battery operated in their fundamental operating state including
  - Portable luminaires for garden use: AS/NZS 60598.2.7:2005
  - Hand lamps as defined in AS/NZS 60598.2.8:2005
- Portable (non-fixed) luminaires (e.g. desk lamps, standard lamps, Portable general purpose luminaires as defined in AS/NZS 60598.2.4:2005, and portable luminaires for children defined in AS/NZS 60598-2-10)
- Rope lights and string lights (as defined in AS/NZS 60598.2.20:2002) or chain lights defined in IEC 60598-2-21
- Non-maintained emergency escape lighting luminaires and illuminated emergency exit signs (as defined in AS/NZS 60598.2.22)
- Outdoor luminaires with an ingress protection rating of IP65 and above
- Road and public space lighting luminaires (as defined in AS/NZS 1158).
- Wall luminaires with up/down lighting of beam angles less than 30 degrees and less than 500lm in either direction (ie up or down)
- Floor/step mounted luminaires with up lighting less than 200lm

Definition

Integrated LED Luminaire

Luminaire that:

- satisfies Type A or Type B LED luminaires specified in the scope of IEC 62722.2.1; or
- uses individual LED packages in place of a LED module
- and does not include IEC standardised lamp holders

Decorative style integrated LED luminaire

Integrated LED luminaires which are primarily designed for their lighted as well as their unlighted appearance and aesthetic contribution to the space. Such luminaires are typically intended for use where a decorative accent or an aesthetic appearance, not a specified amount of luminaire light output, is desired. The light output of decorative luminaires is typically not intended to independently illuminate a space or a task. (Based on NEMA Lighting Systems Division & American Lighting Association Joint Document: LSD 51-2009)

Note: a photometric quantification of this definition is under investigation for small (residential) decorative luminaires and large (non-residential) decorative luminaires.

Product Families for Registration

(1) Two or more models from a single product class may be registered in the same family of models, when the models:

(a) Are of a single brand;

(b) Rely on the one test report (or the test report of the least efficient family member where (e) applies) that sets out the results of testing conducted in accordance with the Determination;

(c) Have the same physical characteristics that are relevant to complying with the Determination, including, but not limited to, the following: overall size; optics, geometric form factor; and any other dimensions, components or component arrangements that may affect performance. However models within the same family may have different minor physical characteristics (that do not affect energy performance), for example:

- different lamp caps/ cap sizes
- shape of the outer glass or plastic lamp cover.
- mounting brackets and other casing or luminaire surround variations that do not change the size, shape and reflectivity of the light emitting components of the product.
- colour or other surface variations to casing areas other than changes to the reflectivity or diffusers of the light emitting components of the product
- an application may include either clear lamps or frosted/pearl, but not both;

(d) Have the same performance characteristics that are relevant to complying with minimum performance specifications set out in the Determination, including, but not limited to, the following:

(i) efficacy; and

(ii) wattage.

(e) Despite paragraph (d), models in the same family may have different luminous flux or efficacy where the difference arises as a result of different colour temperatures, colour rendering index, diffuser, or beam angles. In such cases:

(i) test results for registration purposes will only be required for the model with the lowest energy efficiency in the proposed family; and
(ii) all models in the family must have the same performance characteristics relevant to complying with the specified minimum performance requirements other than efficacy, colour temperature, colour rendering index, diffuser, and beam angle.

The rated luminous flux of all models must be within 10% of the test results submitted for family registration.

(2) For subsection (1), a model cannot be a member of a family if its inclusion in that family would lead to the family consisting of more than 25? lamp models or {to be determined} luminaire models.

(i) Within this limit, additional models may be later added to families at a reduced cost. Where additional models are updates of previous models with updated module or drivers, provided the physical characteristics are the same (as required by paragraph (c)) these models may consume less power (due to more efficient components) however the rated luminous flux must be within 10% of the test results submitted for family registration.

Performance requirements
Table 1 – Lamps

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
	Energy Efficiency & Photometric						
1	Efficacy	≥ 65 lm/W ≥ 85 lm/W (2020) ≥ 100 lm/W (2023)		≥ 100 lm/W ≥ 110 lm/W (2020) ≥ 120 lm/W (2023)	10	Average ≥ value specified	CIE S025 LM79 accepted until July 2019 EN 13032-4:2015

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
2	Replacement Lamp Equivalence	ONLY IF CLAIMING (1) Minimum Lumen output required when claiming equivalence to a specified GLS Tungsten Filament lamp[141] 10W = 100 lm 15W = 150 lm 25W = 250 lm 30W = 350 lm 40W = 500 lm 60W = 800 lm 75W = 1000 lm 100W = 1500 lm 125W =2000 lm 150W = 2500 lm 175W = 3000 lm	ONLY IF CLAIMING (1) Minimum lumen output (as a percentage of GLS lamp equivalences of same wattage) required for claimed equivalent wattage reflector filament lamps of stated lamp shapes[142] MR11: 80% MR16: 80% AR-111: 70% R: 45% PAR: 60%	ONLY IF CLAIMING (1) Minimum lumen output required for claimed equivalence to linear fluorescent lamp. Bare lamp[143] L ≤ 600mm: 800 lm *600 < L ≤ 900mm: 1200 lm 900 < L ≤ 1200mm:1600 lm *1200 < L ≤ 1500mm:2000 lm	10 3 (Linear LED)	Average Luminous flux ≥ the specified minimum light output (lm) of the claimed Equivalent wattage	CIE S025 LM79 accepted until July 2019 EN 13032-4:2015

141 All lumen values (except >125W) align with IEC62612 amd 1:2015 section 9.1 preferred rated luminous flux values

142 Based on IEA 4 E SSL averaged values for directional lamps

143 Based on Design Lights Consortium DLC requirements with * extension

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
		200W = 3500 lm (2) Dimensions of the lamp must comply with equivalent lamp's requirements in the relevant IEC lamp performance specification Standard	R7 (forward lumens) 55% (use linear interpolation between GLS wattage values listed) (2) Dimensions of the lamp must comply with equivalent lamp's requirements in the relevant IEC lamp performance specification Standard	[Based on Design Lights Consortium DLC requirements with * extension] (2) Dimensions of the lamp must comply with equivalent lamp's requirements in the relevant IEC lamp performance specification Standard			
3	Centre beam luminous intensity	N/A	For MR or PAR lamps with a beam angle <65°, centre beam intensity should meet equivalent levels using the online tool: http://www.energystar.gov/ia/products/lighting/iledl/IntLampCenterBeamTool.zip	N/A	10	For MR or PAR lamps: Average ≥ equivalent level	CIE S025 LM79 accepted until July 2019

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
			For others lamps: ONLY IF CLAIMING Centre beam luminous intensity ≥ declared value			For other lamps: Average ≥ declared value	EN 13032-4:2015
4	Light distribution	ONLY IF CLAIMING to be an 'omnidirectional' lamp or replacement for a General Lighting Service (GLS) lamp. Omnidirectional equivalence No less than 5% of total flux (zonal lumens) shall be emitted in the 130° to 180° zone. No less than 35% of total flux (zonal lumens) shall be	Beam angle is ± 25% of declared beam angle and 50% of flux shall be in declared beam angle	Beam angle is ± 25% of declared beam angle and 50% of flux shall be in declared beam angle	10 3 (Linear LED)	No less than 8 lamps (or 3 for linear LED lamps) meet the specified requirements	CIE S025 LM79 accepted until July 2019 EN 13032-4:2015

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
		emitted in the 90° to 180° zone.					
	Energy conservation						
6	Standby Power (For lamps with Standby mode only)	$P_{STANDBY}/P_{ON} \leq 5\%$ Capped at: < 0.5W < 0.3W (2023)			5 3 (Linear LED)	Average ≥ value specified To be tested as supplied for sale (additional functionality may be supplied not activated). See also smart lamp criteria.	AS/NZS IEC 62301 (or IEA 4E SSL Task 7 2016 publication http://ssl.iea-4e.org/news/stand-by-of-smart-lamps)
7	Smart Lighting:	Device to provide energy consumption reporting that is accessible by owner.			1	Require device to provide	

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
	on-demand power consumption feature (smart lamps only)	To be considered further following the outcomes of investigations by the IEA 4E SSL and G20 working groups.				energy consumption reporting that is accessible by owner	Energy Star Lamps v2 Section 12.9
	Colour						
8	Colour Rendering	Ra ≥ 80			10	Average ≥ value specified	CIE S025 (refers to CIE 13.3) LM79 accepted until July 2019 EN 13032-4:2015

<table>
<tr><th rowspan="2">Ref</th><th rowspan="2">Attribute</th><th colspan="3">Requirement</th><th rowspan="2">Sample size</th><th rowspan="2">Compliance criteria</th><th rowspan="2">Test method</th></tr>
<tr><th>Non-directional lamps</th><th>Directional lamps</th><th>Linear LED (tube)</th></tr>
<tr><td></td><td></td><td colspan="3"></td><td></td><td></td><td></td></tr>
<tr><td>9</td><td>Colour Appearance</td><td colspan="3">Lamp must have one of the following nominal CCTs consistent with the 7-step chromaticity quadrangles and Duv tolerances below.[144]
<table>
<tr><th>Nominal CCT (K)</th><th>Target CCT and Tolerance (K)</th><th>Target Duv</th><th>Duv Tolerance Range</th></tr>
<tr><td>2200</td><td>2238 ± 102</td><td>0.0000</td><td rowspan="10">T_x: CCT of the source
For T_x < 2870K
0.000 ± 0.0060
For $T_x \geq$ 2870K
$D_{uv}(T_x) \pm 0.0060$
where
$D_{uv}(T_x) = 57700 \times (1/T_x)^2 - 44.6 \times (1/T_x) + 0.00854$</td></tr>
<tr><td>2500</td><td>2460 ± 120</td><td>0.0000</td></tr>
<tr><td>2700</td><td>2725 ± 145</td><td>0.0000</td></tr>
<tr><td>3000</td><td>3045 ± 175</td><td>0.0001</td></tr>
<tr><td>3500</td><td>3465 ± 245</td><td>0.0005</td></tr>
<tr><td>4000</td><td>3985 ± 275</td><td>0.0010</td></tr>
<tr><td>4500</td><td>4503 ± 243</td><td>0.0015</td></tr>
<tr><td>5000</td><td>5029 ± 283</td><td>0.0020</td></tr>
<tr><td>5700</td><td>5667 ± 355</td><td>0.0025</td></tr>
<tr><td>6500</td><td>6532 ± 510</td><td>0.0031</td></tr>
</table>
</td><td>10</td><td>All samples shall have Chromaticity values that fall into the rated nominal CCT quadrangle</td><td>CIE S025 (refers to CIE S015)

LM79 accepted until July 2019

EN 13032-4:2015</td></tr>
</table>

144 As per ANSI C78.377: 2015 Specifications for the Chromaticity of Solid State Lighting Products

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
10	Colour maintenance	The shift in chromaticity co-ordinates after 6000 hours of operation, Δ u',v' (6000 hours), ≤ 0.007 LED Module or LED package test data (from an accredited lab) may be used, combined with ISTMT junction temperature test of lamp to be registered.			3	All samples satisfy conditions of the test method. Compliance testing may be an ISTMT junction temperature test and relevant module/package test report or a full product test.	ISTMT ((IEC 60598.1 Section 12.4.1 or UL 1598 Clause 14) & IESNA LM80 (test includes lens and phosphors) or IESNA LM84 [145]
	Life						
12	Endurance	Must survive one switching cycle for every 2 hours of rated life			10	Satisfy conditions of	

[145] Note these test methods relate to luminaires. A test "housing" (ie representative luminaire) for lamps may be required. Consider allowing use of thermal imaging camera.

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
		Must survive temperature cycling test for 1,000 hours Must survive accelerated operational life test for 1,000 hours				the test method.	IEC 62612: 2013 Section 11.3.2-4
13	Lumen maintenance	Lumen maintenance @ 6000 hrs $L_{x,6k} \geq 86.7\%$ (based on $L_{70}B_{50} \geq 15{,}000h$) LED Module or LED package test data (from an accredited lab) may be used, combined with ISTMT junction temperature test of lamp to be registered.		Lumen maintenance @ 6,000h $L_{x,6k} \geq 91.8\%$ (based on $L_{70}B_{50} \geq 25{,}000h$)	10	Average $L_{x,6k} \geq$ value specified Compliance testing may be an ISTMT junction temperature test relating to module/package test report or a full product test.	IESNA LM80/TM21 & ISTMT (IEC 60598.1 Section 12.4.1 or UL 1598 Clause 14) or IESNA LM84/TM28 [146]

[146] Note these test methods relate to luminaires. A test "housing" (ie representative luminaire) for lamps may be required. Consider allowing use of thermal imaging camera.

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
14	Rated Life Declaration (relates to packaging requirement)	Packaging declaration of a minimum lifetime of 15,000 hours		Packaging declaration of a minimum lifetime of 25,000 hours	N/A	Declaration Only	N/A
15	Minimum Rated Life, F_{50}	< 50% at 15,000 hours Not to be applied until a practical test method becomes available		< 50% at 25,000 hours Not to be applied until a practical test method becomes available	To be determined	Average ≤ value specified	To be determined
	Electrical						
17	Power Factor			PF > 0.90	10		

<table>
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<tr><th>Non-directional lamps</th><th>Directional lamps</th><th>Linear LED (tube)</th></tr>
<tr><td></td><td></td><td colspan="2">< 25W: PF > 0.50
≥ 25W: PF > 0.90</td><td></td><td>3 (Linear LED)</td><td>Average power factor ≥ value specified</td><td>IEC 61000-3-2 (2014)

Test data may be sourced from control gear manufacturer if available</td></tr>
<tr><td>18</td><td>Harmonics</td><td colspan="3">For products 5W < P ≤ 25W: {text here is pending final approval of amendment to 61000-3-2}

One of the following three requirements:

1. the harmonic currents shall not exceed the power-related limits of Table 3, column 2,

Table 3 – Limits for Class D equipment
<table>
<tr><th>Harmonic order
n</th><th>Maximum permissible harmonic current per watt
mA/W</th><th>Maximum permissible harmonic current
A</th></tr>
<tr><td>3</td><td>3,4</td><td>2,30</td></tr>
<tr><td>5</td><td>1,9</td><td>1,14</td></tr>
<tr><td>7</td><td>1,0</td><td>0,77</td></tr>
<tr><td>9</td><td>0,5</td><td>0,40</td></tr>
<tr><td>11</td><td>0,35</td><td>0,33</td></tr>
<tr><td>13 ≤ n ≤ 39
(odd harmonics only)</td><td>$\frac{3,85}{n}$</td><td>See Table 1</td></tr>
</table>
or:</td><td>1</td><td>Comply with the requirements of IEC61000-3-2</td><td>IEC 61000-4-7

Test data may be sourced from control gear manufacturer if available</td></tr>
</table>

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
		2. the third harmonic current, expressed as a percentage of the fundamental current, shall not exceed 86 % and the fifth harmonic current shall not exceed 61 %. Also, the waveform of the input current shall be such that it reaches the 5 % current threshold before or at 60º, has its peak value before or at 65º and does not fall below the 5 % current threshold before 90º, referenced to any zero crossing of the fundamental supply voltage. The current threshold is 5 % of the highest absolute peak value that occurs in the measurement window, and the phase angle measurements are made on the cycle that includes this absolute peak value (see Figure 2). Components of current with frequencies above 9 kHz shall not influence this evaluation. or: 3. the THD shall not exceed 70%. The third order harmonic, expressed as a percentage of the fundamental current, shall not exceed 35%, the fifth order shall not exceed 25%, the seventh order shall not exceed 30%, the ninth and eleventh order shall not exceed 20% and the second order shall not exceed 5%. If the lighting equipment includes means for control (e.g. dimming, colour), or is specified to drive multiple loads, then the measurement is made only at the control setting and the load of lamps that gives the maximum active input power. NOTE The preceding requirement is based on the assumption that, for lighting equipment using control other than phase control, the THC decreases when the input power is reduced. For lighting equipment containing a control module with an active input power ≤ 2 W, the contribution of the control module to the harmonic current of the lighting equipment is disregarded e.g. by testing the equipment with control module fed by a separate mains supply.					

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
		For products >25W[147]: (see below)					

For products >25W[147]:

Harmonic Order n	Maximum permissible harmonic current expressed as a percentage of the input current at the fundamental frequency (%)
2	2
3	30 - *CPF* *
5	10
7	7
9	5
11 ≤ n ≤ 39 (odd harmonics only)	3
* *CPF* is the circuit power factor	

{text below is pending final approval of amendment to 61000-3-2}

For the other types of lighting equipment that includes means for control (e.g. dimming, colour), the following conditions apply:

1. the harmonic current values for the maximum active input power condition derived from the percentage limits given in Table 2 shall not be exceeded;
2. at control settings leading to an active input power less than the maximum input power condition, the harmonic currents shall not exceed the limits based on the maximum active input power of:
    - below 50W: no limits below 5 W;
    - 50 W - 250 W: no limits below 10% of maximum active input power;
    - above 250 W: no limits below 25 W.

[147] IEC 61000-3-2, Table 2, Limits for Class C equipment

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
	Operation						
19	Dimmer compatibility	Lamp dims smoothly to 30% of light output with no observable flicker and no audible noise. When dimmer is set to 100%, light output ≥ 90% of lamp without dimmer. For dimmable products, the lamp manufacturer shall: (d) declare the conditions under which the lamp will dim (e) provide a webpage address that lists compatible dimmer makes and models including (for ELV lamps) compatible makes and models of ELVCs available in the local market; and (f) for each compatible dimmer, the number of lamps that can be dimmed and the range of luminous flux levels a given dimmer-lamp combination can achieve. Note. Condition applies to Lamp		N/A	3 lamps 2 dimmers (1 ELVC model if required)	All lamp/dimmer/ (ELVC, if required) combinations where compatibility claimed satisfy conditions of the test method.	To be developed [148] To include tests for inrush current, maximum cycle current, 30% dim and flicker (IEEE 1789 or other). Suppliers do not need to

[148] IEC Joint Working Committee TC 34 & 23B on the interoperability of dimmers and LED products 34/305/DTR may provide reference Also IEC TC document 34C/1187/DC on in-rush current may provide reference

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
							submit tests for registration. Compliance may test.
20	ELV converter compatibility (For ELV Lamps only)	In combination with ELV converter shall operate in a stable manner without observable flicker, light fluctuation or audible noise Also the manufacturer shall: (c) declare which ELV conditions (e.g. minimum/maximum number of lamps connected to ELVC) under which the lamp will operate (d) provide a webpage address that lists compatible ELV converter makes and models including ELVCs available in the local market.		N/A	3 lamps 3 ELVCs	All lamp/ELVC combinations where compatibility claimed satisfy conditions of the test method.	To be developed To include tests for flicker (IEEE 1789 or other) and audible noise. Suppliers do not need to submit tests

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Non-directional lamps	Directional lamps	Linear LED (tube)			
							for registration. Compliance may test.
	Health						
21	Photo-biological Safety	For ELV Lamps only (other lamps subject to similar safety regulation) Blue Light & UV hazards shall be either RG0 or RG1 unlimited[149] (This is based on advice that Australian electrical safety regulators will regulate Photo-biological Safety for all but ELV lamps - awaiting advice on New Zealand)			1	Satisfy conditions of the test method.	IEC 62471 / CIE S009
22	Dominant light modulation	Maximum flicker modulation (based on the flicker frequency)[151]			1	Satisfy conditions of	IEEE 1789 or other if specified in

[149] Based on IEC 62471/CIE S009. Guidance is provided in IEC/TR 62778:2014: Application of IEC 62471 for the assessment of blue light hazard to light sources and luminaires

[151] Based on IEEE 1789:2015, Confirmed that Australian electrical safety regulators will not be covering flicker

<table>
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<tr><th>Non-directional lamps</th><th>Directional lamps</th><th>Linear LED (tube)</th></tr>
<tr><td></td><td>frequency (f) Modulation percent at this frequency (Mod%)[150]

(includes Flicker effects)</td><td colspan="2"><table><tr><th>Dominant modulation frequency (f)</th><th>Modulation percent at f</th></tr><tr><td>f ≤ 90Hz</td><td>FM ≤ (0.025 × f)</td></tr><tr><td>90Hz ≤ f ≤ 1250Hz</td><td>FM ≤ (0.08 × f)</td></tr><tr><td>f > 1250Hz</td><td>No Mod% requirement</td></tr></table></td><td></td><td></td><td>the test method.</td><td>Determination.</td></tr>
<tr><td>23</td><td>Maximum high angle Luminance</td><td colspan="2">N/A</td><td>When the gamma (ɣ) angle exceeds 60 degrees, the light source luminance is no more than 10,000 candela/m² in C_0, C_{45} and C_{90} planes</td><td>3</td><td>All lamps satisfy requirements</td><td>CIE S025

LM79 accepted until July 2019

EN 13032-4:2015</td></tr>
</table>

[150] The requirements are based on IEEE 1789-2015. The priority here is on restricting the visible modulation of light (including flicker) at frequencies ≤ 90 Hz, as more research is required on the effects of light modulation frequencies beyond 90 Hz (i.e. non-visible effects). NOTE1: In some particular instances, there is a strong sub-harmonic or inter-harmonic frequency in the luminance modulation waveform. In this case, the dominant light modulation frequency may not be clearly defined. The requirements should then be met for both the Fourier fundamental frequency and the sub/inter harmonic frequency. NOTE2: Due to the lack of a standard for the photometric measurement of modulated light , the SSL Annex are continuing to work on this issue, consult with stakeholders including CIE TC 1-83 (authors of CIE TN 006:2016), and will issue an update when new guidance becomes available.

Table 2 – Integrated LED luminaires[152]

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
	Energy Efficiency & Photometric						
1	Efficacy	<u>Directional</u> ≥ 65 lm/W ≥ 85 lm/W (2020) ≥100 lm/W (2023) <u>Non-directional</u> ≥ 65 lm/W (2019) ≥ 85 lm/W (2021) ≥100 lm/W (2023)	≥ 110 lm/W (2020) ≥ 120 lm/W (2023)	≥ 90 lm/W (2019) ≥ 110 lm/W (2021) ≥ 120 lm/W (2023)	4 (Small) 2 (Large & P/B/T)	Average ≥ value specified	CIE S025 LM79 accepted until July 2019 EN 13032-4:2015
2	Replacement Lamp Equivalence	ONLY IF CLAIMING. Where claiming replacement equivalence to a specific lamp based fixture the luminaire must meet minimum lumen output provided for lamps in table 1. (eg for halogen downlights replacements, use	None provided	ONLY IF CLAIMING. Luminaire lumens (per lamp) for claimed number of tubular fluorescent lamp equivalents must meet minimum lumen output provided in the lamp table 1.	3 (Small) 1 (P/B/T)	Average Luminous flux ≥ Claimed Equivalent wattage specified minimum light output (lm)	CIE S025 LM79 accepted until July 2019 EN 13032-4:2015

[152] Note that for maintained emergency lighting luminaires compliance with the performance requirements shall be met when the emergency components are disconnected.

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
		equivalence of MR16 directional lamp)					
3	Centre beam luminous intensity	ONLY IF CLAIMING. For luminaires claiming equivalence to MR or PAR lamps with a beam angle <65°, centre beam intensity should meet equivalent levels using the online tool: http://www.energystar.gov/ia/products/lighting/iledl/IntLampCenterBeamTool.zip ONLY IF CLAIMING Centre beam luminous intensity ≥ declared value	ONLY IF CLAIMING Centre beam luminous intensity ≥ declared value	N/A	3 (Small) 1 (Large)	For MR or PAR lamp claimed equivalence: Average ≥ of equivalent level For other lamps: Average ≥ of declared value	CIE S025 LM79 accepted until July 2019 EN 13032-4:2015

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
4	Light distribution	ONLY for Directional luminaires: Beam angle is ± 25% of declared beam angle and 50% of flux shall be in declared beam angle	None provided		3	All samples meet the specified requirements	CIE S025 LM79 accepted until July 2019 EN 13032-4:2015
	Energy conservation						
5	Standby Power (For luminaires with Standby mode only)	$P_{STANDBY}/P_{ON}$ ≤ 5% capped at: < 0.5W < 0.3W (2023)	< 0.1.1W < 0.0.5W (2023) Note: Where only 1 standby product/parameter is applicable, e.g. DALI, then test data from control gear/module may be used. Where a luminaire incorporates more than standby		3 (Small) 1 (Large & P/B/T)	All samples ≤ value specified To be tested as supplied for sale (additional functionality may be supplied not	AS/NZS IEC 62301 (or IEA 4E SSL Task 7 2016 publication)

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
			product/parameter, e.g. DALI and sensor, luminaire is to be measured.			activated). See also smart lamp criteria.	
7	Smart Lighting – controlled variations in power consumption (smart luminaires only)	To be considered following the outcomes of investigations by the IEA 4E SSL and G20 working groups			1	Require device to provide energy consumption reporting that is accessible by owner	Energy Star Lamps v2 Section 12.9
	Colour						
8	Colour Rendering	Ra ≥80			3 (Small) 1 (Large & P/B/T)	Average ≥ value specified	CIE S025 (refers to CIE 13.3)
9							

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0.000 ± 0.0060
For $T_x \geq$ 2870K
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where
$D_{uv}(T_x) = 57700 \times (1/T_x)^2 - 44.6 \times (1/T_x) + 0.00854$</td></tr>
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<tr><td>6500</td><td>6532 ± 510</td><td>0.0031</td></tr>
</table></td><td>3 (Small)

1 (Large & P/B/T)</td><td>All samples shall have chromaticity values that fall into the rated nominal CCT quadrangle</td><td>CIE S025 (refers to CIE S015)</td></tr>
<tr><td>10</td><td>Colour maintenance</td><td colspan="3">The shift in chromaticity co-ordinates after 6000 hours of operation, Δ u',v' (6000 hours),

≤ 0.007</td><td>3</td><td>All samples satisfy conditions of the test method.</td><td>ISTMT (IEC 60598.1 Section 12.4.1 or UL 1598 Clause 14) & IESNA LM80</td></tr>
</table>

[153] As per ANSI C78.377: 2015 Specifications for the Chromaticity of Solid State Lighting Products

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
		Module or LED package test data (from an accredited lab) may be used, combined with ISTMT junction temperature test of lamp to be registered.				Compliance testing may be a ISTMT junction temperature test and relevant module/package test report or a full product test.	(acceptable where module tested includes lens and phosphors) or IESNA LM84 [154]
	Life						
12	Endurance	Must survive one switching cycle for every 1 hours of rated life[155] Must survive temperature cycling test for 1,000 hours Must survive accelerated operational life test for 1,000 hours			3 (Small) 1 (Large & P/B/T)	Satisfy conditions of the test method.	IEC 62722.2.1: 2011 Section 10.3.2-4 Test data from module and driver accepted

154 Note testing of small luminaires may require consideration of insulation requirement. Consider allowing use of thermal imaging camera

155 Note: twice requirement of IEC 62722.2.1

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
							(IEC 62717 Section 10.3)
13	Lumen maintenance	Lumen maintenance @ 6,000h $L_{x,6k} \geq$ 93.1% (based on $L_{70}B_{50} \geq$ 30,000h) Module or LED package test data (from an accredited lab) may be used, combined with ISTMT junction temperature test of lamp to be registered.	Lumen maintenance @ 6,000h ($L_{x,6k}$) ≥ 95.4% of initial (based on $L_{70}B_{50} \geq$ 45,000h) Module or LED package test data (from an accredited lab) may be used, combined with ISTMT junction temperature test of lamp to be registered.		3	Average $L_{x,6k} \geq$ value specified Compliance testing may be a ISTMT junction temperature test and relevant module/package test report or a full product test.	IESNA LM80/TM21 & ISTMT (IEC 60598.1 Section 12.4.1 or UL 1598 Clause 14) or IESNA LM84/TM28 Consider allowing use of thermal imaging camera [156]
14	Rated Life Declaration	Packaging declaration of a minimum of 30,000 hours	Packaging declaration of a minimum of 45,000 hours		N/A	Declaration Only	N/A

[156] Note testing of small luminaires may require consideration of insulation requirement.

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
	(relates to packaging requirement)						
15	Minimum Rated Life, F_{50}	< 50% at 30,000 hours Not to be applied until a practical test method becomes available	< 50% at 45,000 hours Not to be applied until a practical test method becomes available		To be determin ed	Average ≤ value specified	To be determined
	Electrical						
17	Power Factor		> 0.90		1 (Small) 1 (Large & P/B/T)	Average power factor ≥ value specified	IEC 61000-3-2 (2014) Test data may be sourced from control gear manufacturer

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For products 5W < P ≤ 25W: {text here is pending final approval of amendment to 61000-3-2}
One of the following three requirements:
1. the harmonic currents shall not exceed the power-related limits of Table 3, column 2,
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or:
2. the third harmonic current, expressed as a percentage of the fundamental current, shall not exceed 86 % and the fifth harmonic current shall not exceed 61 %. Also, the waveform of the input current shall be such that it reaches the 5 % current threshold before or at 60º, has its peak value before or at 65º and does not fall below the 5 % current threshold before 90º, referenced to any zero crossing of the fundamental supply voltage. The current threshold is 5 % of the highest absolute peak value that occurs in the measurement window, and the phase angle measurements are made on the cycle that includes this absolute peak value (see Figure 2). Components of current with frequencies above 9 kHz shall not influence this evaluation. or:
</td><td>1</td><td>Comply with the requirements of IEC61000-3-2</td><td>IEC 61000-4-7

Test data may be sourced from control gear manufacturer</td></tr>
</table>

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
		3. the THD shall not exceed 70%. The third order harmonic, expressed as a percentage of the fundamental current, shall not exceed 35%, the fifth order shall not exceed 25%, the seventh order shall not exceed 30%, the ninth and eleventh order shall not exceed 20% and the second order shall not exceed 5%. If the lighting equipment includes means for control (e.g. dimming, colour), or is specified to drive multiple loads, then the measurement is made only at the control setting and the load of lamps that gives the maximum active input power. NOTE The preceding requirement is based on the assumption that, for lighting equipment using control other than phase control, the THC decreases when the input power is reduced. For lighting equipment containing a control module with an active input power ≤ 2 W, the contribution of the control module to the harmonic current of the lighting equipment is disregarded e.g. by testing the equipment with control module fed by a separate mains supply. For products >25W[157]:					

[157] IEC 61000-3-2, Table 2, Limits for Class C equipment

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			

Harmonic Order n	Maximum permissible harmonic current expressed as a percentage of the input current at the fundamental frequency (%)
2	2
3	30 - *CPF* *
5	10
7	7
9	5
$11 \le n \le 39$ (odd harmonics only)	3
* *CPF* is the circuit power factor	

{text below is pending final approval of amendment to 61000-3-2}

For the other types of lighting equipment that includes means for control (e.g. dimming, colour), the following conditions apply:

1. the harmonic current values for the maximum active input power condition derived from the percentage limits given in Table 2 shall not be exceeded;
2. at control settings leading to an active input power less than the maximum input power condition, the harmonic currents shall not exceed the limits based on the maximum active input power of:
    - below 50W: no limits below 5 W;
    - 50 W - 250 W: no limits below 10% of maximum active input power;
    - above 250 W: no limits below 25 W.

Ref	Attribute	Small	Large	Planar, Battens & Troffers (P/B/T)	Sample size	Compliance criteria	Test method
	Operation						
19							

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
	Dimmer compatibility	Luminaire Dims smoothly to 30% of light output with no observable flicker and no audible noise. When dimmer is set to 100%, light output ≥ 90% of luminaire without dimmer. For dimmable products, the manufacturer shall: (a) declare the conditions under which the luminaire will dim (b) provide a webpage address that lists compatible dimmer makes and models; and (c) for each compatible dimmer, the number of luminaires that can be dimmed and the range of luminous flux levels a given dimmer-luminaire combination can achieve.	N/A		1 luminaire 1 dimmer	Satisfy conditions of the test method.	To be developed [158] To include tests for inrush current, maximum cycle current, 30% dim and flicker (IEEE 1789 or other). Suppliers do not need to submit tests for registration. Compliance may test.

[158] IEC Joint Working Committee TC 34 & 23B on the interoperability of dimmers and LED products 34/305/DTR may provide reference Also IEC TC document 34C/1187/DC on in-rush current may provide reference

<table>
<tr><th>Ref</th><th>Attribute</th><th colspan="3">Requirement</th><th>Sample size</th><th>Compliance criteria</th><th>Test method</th></tr>
<tr><th></th><th></th><th>Small</th><th>Large</th><th>Planar, Battens & Troffers (P/B/T)</th><th></th><th></th><th></th></tr>
<tr><td></td><td colspan="7">Health</td></tr>
<tr><td>20</td><td>~~Photo biological Safety~~</td><td colspan="3">(To be deleted subject to confirmation that New Zealand Electrical Safety regulations cover)

~~Blue Light & UV hazards shall be either RG0 or RG1 unlimited~~[159]</td><td>~~1~~</td><td>~~Satisfy conditions of the test method.~~</td><td>~~IEC 62471 / CIE S009~~</td></tr>
<tr><td>21</td><td>Dominant light modulation frequency (f) Modulation percent at this frequency (Mod%)[160]

(includes Flicker effects)</td><td colspan="3">Maximum flicker modulation (based on the flicker frequency)[161]
<table><tr><th>Dominant modulation frequency (f)</th><th>Modulation percent at f</th></tr><tr><td>f ≤ 90Hz</td><td>FM ≤ (0.025 × f)</td></tr><tr><td>90Hz ≤ f ≤ 1250Hz</td><td>FM ≤ (0.08 × f)</td></tr><tr><td>f > 1250Hz</td><td>No Mod% requirement</td></tr></table></td><td>1</td><td>Satisfy conditions of the test method.</td><td>IEEE 1789 (or other specified in Determination)</td></tr>
</table>

~~159 Based on IEC 62471/CIE S009. Guidance is provided in IEC/TR 62778:2014 : Application of IEC 62471 for the assessment of blue light hazard to light sources and luminaires~~

160 The requirements are based on IEEE 1789-2015. The priority here is on restricting the visible modulation of light (including flicker) at frequencies ≤ 90 Hz, as more research is required on the effects of light modulation frequencies beyond 90 Hz (i.e. non-visible effects). NOTE1: In some particular instances, there is a strong sub-harmonic or inter-harmonic frequency in the luminance modulation waveform. In this case, the dominant light modulation frequency may not be clearly defined. The requirements should then be met for both the Fourier fundamental frequency and the sub/inter harmonic frequency. NOTE2: Due to the lack of a standard for the photometric measurement of modulated light , the SSL Annex are continuing to work on this issue, consult with stakeholders including CIE TC 1-83 (authors of CIE TN 006:2016), and will issue an update when new guidance becomes available.

161 Based on IEEE 1789:2015

Ref	Attribute	Requirement			Sample size	Compliance criteria	Test method
		Small	Large	Planar, Battens & Troffers (P/B/T)			
22	Maximum high angle Luminance	When the gamma (ɣ) angle exceeds 60 degrees, the light source luminance is no more than 10,000 candela/m² in C_0, C_{45} and C_{90} planes			3	All lamps satisfy requirements	CIE S025 LM79 accepted until July 2019 EN 13032-4:2015

Table 3: Proposed product package marking requirements[162]

Ref	Attribute	Product	Package	Spec Sheet /website	Marked Value Criterion
1	Lumens	X	X	X	<u>Non-directional LED lamps:</u> The rated luminous flux should ~~preferably~~[163] be one of the following values: 100 lm, 150 lm, 250 lm, 350 lm, 500 lm, 800 lm, 1000 lm, 1500 lm, 2000 lm, 3000 lm.[164] The initial luminous flux of each individual LED lamp in the measured sample shall not be less than the rated luminous flux by more than 10 %, and not be more than the rated luminous flux by more than ~~10% unless, if the rated value is one of the preferred values listed above, then~~ [165]20%. The average initial luminous flux of the LED lamps in the measured sample shall not be less than the rated luminous flux by more than 7.5 %. <u>Directional lamps:</u> The initial luminous flux of each individual LED lamp/luminaire in the measured sample shall not be less than the rated luminous flux by more than 10 % and not be more than the rated luminous flux by more than 10%. The average initial luminous flux of the LED lamps in the measured sample shall not be less than the rated luminous flux by more than 7.5 %. <u>Luminaires:</u>

[162] Note that the allowed variations between tested and rated values specified below do not apply to compliance with minimum performance requirements.
[163] Stakeholder input sought on whether these values should be mandatory or only encouraged. If only encouraged, the strike-through text would be retained.
[164] Note these lumen values (except for the 150W which doesn't exist) align with the IEC62612 amd 1:2015 section 9.1 preferred rated luminous flux values
[165] The strike-through text here would be included if the preferred luminous flux values were not mandatory.

Ref	Attribute	Product	Package	Spec Sheet /website	Marked Value Criterion
					The initial luminous flux of each individual LED luminaire sample shall not be less than the rated luminous flux by more than 10 % and not be more than the rated luminous flux by more than 10%.
2	Efficacy (lumens per Watt)		X	X	The initial efficacy of each individual LED lamp or luminaire in the measured sample shall be no less than the rated efficacy by more than 10 %. The average efficacy of the LED lamps in the measured sample shall be no less than the rated efficacy by more than 7.5 %.
3	Watts (must be in a smaller font than efficacy on package)	X	X	X	The initial power consumed by each individual LED lamp in the measured sample shall not exceed the rated power by more than 5 %.
4	Replacement Lamp Equivalence (directional and non-directional lamps)		X	X	Statement of equivalence to a filament lamp. Minimum lumen output required when claiming as specified in Table 1 above.
5	Rated Lifetime		X	X	Must be equal or above the specified minimum rated life
6	Correlated colour temperature	X	X	X	
	CRI			X	Must be equal or above the specified CRI
7	Beam Angle (for directional lamps & small luminaires)	X	X	X	
8	Dimmable	X	X	X	
9	Dimmer compatibility information and weblink		X	X	

Ref	Attribute	Product	Package	Spec Sheet /website	Marked Value Criterion
10	ELVC converter compatibility information and weblink		X	X	
11	Ballast compatibility information and weblink (for Linear LED lamps)	X	X	X	
12	Website link for disposal information		X	X	
13	Standby energy use		X	X	
	Photo biological Safety	X	X	X	Blue light and UV risk categories. Product marking only required if above RG0.
14	Product identification number as used for product registration		X	X	

- **Table 4: Proposed test conditions**

Ref	Attribute	Test method
1	Efficacy	CIE S025 or LM79 accepted until July 2019 or EN 13032-4:2015

Ref	Attribute	Test method
2	Replacement Lamp Equivalence	CIE S025 or LM79 accepted until July 2019 or EN 13032-4:2015
3	Standby Power (smart lamps only)	AS/NZS IEC 62301 (or IEA 4E SSL Task 7 2016 publication)
4	Smart Lighting – controlled variations in power consumption (smart lamps only)	Energy Star Lamps v2 Section 12.9
5	Colour Appearance	CIE S025 or LM79 accepted until July 2019 or EN 13032-4:2015

Ref	Attribute	Test method
		(All refer to CIE S015)
6	Colour Rendering	CIE S025 or LM79 accepted until July 2019 or EN 13032-4:2015 (All refer to CIE 13.3)
7	Lumen maintenance	IESNA LM80/TM21 & ISTMT (IEC 60598.1 Section 12.4.1 or UL 1598 Clause 14) Or IESNA LM84/TM28
9	Power Factor	IEC 61000-3-2 (2014)
10	Harmonics	IEC 61000-4-7
11	Dimmer compatibility	To be developed

Ref	Attribute	Test method
12	ELV converter compatibility	To be developed
13	Photo biological Safety	IEC 62471/CIE S009
14	Endurance Lamps Modules/packages Luminaires	IEC 62612: 2013 or IEC 62717: 2014 or IEC 62722.2.1: 2011
15	Flicker	IEEE 1789
16	Centre beam luminous intensity (directional lamps only)	CIE S025 or LM79 accepted until July 2019 or EN 13032-4:2015

Ref	Attribute	Test method
17	Beam Angle	CIE S025 or LM79 accepted until July 2019 or EN 13032-4:2015
18	Colour maintenance	ISTMT (IEC 60598.1 Section 12.4.1 or UL 1598 Clause 14) & IESNA LM80 (acceptable where module tested includes lens and phosphors) Or IESNA LM84

Lighting Consultation Regulation Impact Statement

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