



Regulatory Impact Statement for Decision

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Proposed MEPS for incandescent lamps, compact fluorescent lamps and voltage converters

This Decision Regulatory Impact Statement was prepared by the Equipment Energy Efficiency Committee with the assistance of Syneca Consulting and Beletich Associates. The E3 Committee reports to the Ministerial Council on Energy (MCE), comprising the energy ministers of the Australian federal, state and territory governments, and the New Zealand government.

To ensure regulatory compliance and at the request of industry, a two stage enforcement process is recommended:

- An 'Australian only' import restriction (approved for implementation on General Lighting Service (GLS) incandescent bulbs from 1 February 2009); and
- An Australian point of sales MEPS on all non-complying incandescent and compact fluorescent lamps (CFLs) lamps, and extra low voltage converters (ELVCs) (proposed for implementation in Australia from no earlier than 1 November 2009).


For more information on the enforcement regime, please refer to the proposal section of the executive summary.

In September 2008, the New Zealand Government advised their intention to delay stakeholder consultation due to unresolved domestic issues, however confirmed their intention to continue with the proposed point of sale MEPS. As a result, a separate Australian Consultation RIS was progressed by the E3 Committee to continue with development of the proposed Australian importation restriction.

Following the consultation period, an Australian Decision RIS was prepared and a decision to implement the Australian import restriction was approved by the Minister for the Environment and his Ministerial colleagues in mid December 2008. Note that further import restrictions may be put in place in advance of the introduction of point of sale MEPS for future applicable products, as listed in table 3.3. The feasibility of such restrictions will be subject to a review.

On 16 December 2008, the New Zealand Minister for Energy and Resources announced that New Zealand would not longer participate in the point of sales MEPS for traditional or incandescent light bulbs. As a result of this announcement, there may be TTMRA implications under the current agreement. This issue has been discussed in more detail in Chapter 11. A statement has yet to be made in relation to MEPS in New Zealand for CFLs and ELVCs.

This RIS seeks decision on the proposal to regulate inefficient lighting products including incandescent, CFL and ELVCs, at the retail level in Australia from no earlier than 1 November 2009.



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22 May 2009

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Glossary

AGO	Australian Greenhouse Office
AS/NZS	Australian Standard/New Zealand Standard
BAU	business as usual
CaSServ	Conformance and Standards Services Pty Ltd
CfAF	Council for the Australian Federation
CFL	Compact Fluorescent Lamps
CoAG	Council of Australian Governments
CO ₂ -e	carbon dioxide equivalent
CCT	colour correlated temperature
CPRS	Carbon Pollution Reduction Scheme (formally known as the Emissions Trading Scheme)
CRI	colour rendering index
DEWHA	Department of the Environment, Water, Heritage and the Arts
DPMC	Department of the Prime Minister and Cabinet
EES	Energy Efficient Strategies Pty Ltd
ECEEE	European Council for an Energy Efficient Economy
ELVC	extra low voltage converter
ENA	Energy Networks Association
EPA	Environment Protection Authority (US)
EPHC	Environment Protection and Heritage Council
ERA	Energy Retailers Association
ERAC	Electrical Regulatory Authorities Council
EST	Energy Savings Trust (UK)
E2WG	Energy Efficiency Working Group
E3	Equipment Energy Efficiency Program
FTC	Federal Trade Commission (US)
GHG	greenhouse gas
GLh	gigalumen-hours (1,000,000,000 lumen-hours)
GLS	General Lighting Service lamps
GWA	George Wilkenfeld and Associates
GWh	gigawatt-hours
IEC	The International Electrotechnical Commission (global organisation that prepares and publishes international standards for electrical, electronic and related technologies)

IES	Illuminating Engineers Society
kHz	kilohertz
kWh	kilowatt-hours
LCA	Lighting Council of Australia
LCC	Life cycle cost
LED	light emitting diode
LRC	Lighting Research Centre
MCE	Ministerial Council on Energy
MEA	Mark Ellis & Associates
MEPS	minimum energy performance standard
MLh	Mega lumen-hours (1,000,000 lumen-hours)
MMA	McLennan Magasanik Associates Pty Ltd
MoU	Memorandum of Understanding
NAEEEC	National Appliance and Equipment Energy Efficiency Committee
NEMA	National Electrical Manufacturers Association (US)
NETT	National Emissions Trading Taskforce
NFEE	National Framework for Energy Efficiency
NGACs	NSW Greenhouse Abatement Certificates
NHMRC	National Health and Medical Research Council
NIEIR	National Institute of Economic and Industry Research
NMI	National Measurement Institute
OBPR	Office of Best Practice Regulation
PC	Productivity Commission
PNNL	Pacific Northwest National Laboratory
MJ	megajoules – 10^6 joules
Mt	megatonnes – 10^6 tonnes
NGS	National Greenhouse Strategy
REC	renewable energy certificate
RIS	Regulatory Impact Statement
SEAV	Sustainable Energy Authority Victoria (now Sustainability Victoria)
TJ	terajoules – 10^{12} joules
UNCCC	United Nations Framework Convention on Climate Change
UV	ultraviolet
VA	Volt-Amps
W	Watts
WSM	with specific measures
WoSM	without specific measures

Executive summary

This regulatory impact statement (RIS) details a proposal to introduce minimum energy performance standards (MEPS) for incandescent lamps, compact fluorescent lamps (CFLs) and the extra low voltage converters (ELVCs) used to provide power to low voltage halogen lighting systems.

The proposal is part of the work plan of the Equipment Energy Efficiency Program (known as E3), which is an element of Australia's response to climate change. The program is jointly managed and administrated by the Australian Commonwealth, state and territory governments and the New Zealand government.

MEPS enforcement will be undertaken in two stages:

1. A decision by the Minister for the Environment and his Ministerial colleagues was reached in December 2008 to introduce an Australian import restriction on incandescent lamps commencing on 1 February 2009; this will be followed by a
2. Ministerial Council on Energy decision (this proposal) to implement an Australian point of sales MEPS on all non-complying incandescent and CFL lamps, and ELVCs from no earlier than 01 November 2009.

See the proposal section below for more information on the two enforcement stages.

The problem

General lighting service (GLS) lamps are the common pear-shaped incandescent lamps with tungsten filaments. They are the most inefficient yet widely used lamp in the residential sector. They continue to sell remarkably well because, if their energy costs are ignored, they appear cheap. More efficient lamps such as CFLs and halogen types are facing a number of problems breaking into the market. Currently a CFL sells for up to five times more than a regular GLS lamp.

There are significant information failures and split incentive problems in the market for energy efficient lamps. Energy bills are aggregated and periodic and therefore do not provide immediate feedback on the effectiveness of individual energy saving investments. Consumers must therefore gather information and perform a reasonably sophisticated calculation to compare the life-cycle costs of tungsten filament lamps and CFLs. But many lack the skills. For others, the amounts saved are too small to justify the effort or they do not remain at the same address long enough to benefit fully from a long lived energy saving lamp. According to the 2006 census, 17% of people in private dwellings were at a different address 12 months earlier.

Both CFLs and lamp labelling have also had unfortunate histories. Early disappointments with aspects of the performance of CFLs – including problems with start up times, colour and durability – have created uncertainties in the minds of users. Lamp labelling has evolved in a way that identifies the lighting power of a lamp with its energy use, inhibiting awareness of energy efficiency lighting options.

It is estimated that, under business as usual (BAU) conditions, Australia's greenhouse emissions from lighting will increase by 150% from 1990 to 2010. Emissions will be approximately 32.4 Mt CO₂-e in 2010 or 5.4% of Australia's projected total of 603 Mt CO₂-e in 2010. By addressing market failures the proposed measures will reduce greenhouse emissions by 28.5 Mt CO₂-e over the period 2009 to 2020¹.

¹ See chapter 4.7.2 for more information.

Proposal

E3 initially proposed to phase out all incandescent lamps, albeit with long delays for certain types of lamp, to 2015. However this raised serious problems regarding the availability of replacement products, particularly for lighting systems that use dimmers, sensors, timers and other forms of electronic control. The proposal was revised to avoid potentially large costs of prematurely scrapping lighting assets.

The revised MEPS proposal will:

- remove the least efficient incandescent lamps from the market, including the familiar pear-shaped tungsten filament lamps, otherwise known as GLS (incandescent) lamps of less than 150 watts;
- set standards for the efficiency and quality of CFLs; and,
- remove the least efficient ELVCs from the market.

This will be implemented in two stages:

1. Introduction of an import prohibition on non-complying GLS lamps; and
2. Implementation of a point of sales MEPS.

A two stage enforcement regime has been proposed to ensure enhanced regulatory compliance and to meet the request of industry. This measure includes the use of an import restriction to stop non-compliant products from being imported into Australia. The import restriction was initially suggested by the lighting industry as a means of allowing depletion of stocks of GLS lamps prior to the point of sale restriction. Past history has proven that even where MEPS regulation has been implemented on individual products, these units were still being sold outside of major retail outlets, such as by smaller independent businesses. E3 hope to eliminate this problem by enforcing the two stage process.

The import prohibition on GLS lamps commenced on 1 February 2009. It was written into the *Customs (Prohibited Imports) Regulations 1956* as an amendment in mid December 2008. To disseminate this information, the Australian Customs Service (ACS) implemented a messaging service in late December 2008 to notify importers of incandescent lamps of the incoming imports restriction². Further, as part of the import restriction arrangements, the ACS have agreed to provide DEWHA with lighting import data which will assist in the preparation for the implementation of point of sales MEPS in November 2009.

Industry representatives including Lighting Council Australia (LCA) have been consulted throughout the development of this proposal and are strongly supportive. In June 2008, the Minister for the Environment announced that the proposed implementation of the Lighting Phase-out would be brought forward through the introduction of an import prohibition on GLS lamps which came into effect from February 2009. Given this, the E3 Committee are confident that importers will have had sufficient time to adjust supplier channels to ensure the proposed import restriction will be met accordingly.

Further, E3 propose to introduce the point of sales MEPS no earlier than 1 November 2009 for non-complying GLS lamps, extra low voltage (ELV) halogen lamps and CFLs of the non-reflector type, and November 2010 for ELVCs. The implementation of the MEPS for most other lamp types is proposed to occur in stages between 2010 and 2012. The relevant Australian standards set down the proposed dates for the staged implementation. It is proposed each year that this schedule will be reviewed by a committee consisting of supplier and Government representatives considering up-to-date market and product information. Timing of the phase-out will be adjusted where necessary to take into account

² www.customs.gov.au/webdata/resources/notices/acn0904.pdf

the availability of efficient alternatives. At this stage, it is considered feasible to apply the MEPS to all product types by October 2012, apart from pilot lamps of 25w and below.

It is important to note the proposed MEPS will not ban all incandescent lamps and will not mandate wholesale replacement with CFLs. Users will still be able to buy incandescent lamps of the tungsten halogen type. These are generally more efficient than the familiar tungsten filament lamps and, to comply with the proposed MEPS, will need to be the more efficient of the halogen products that are currently available.

The proposed regulations will increase demand for CFLs and E3 is acutely aware that inexperienced users could be disappointed with the quality of lighting provided by CFLs of low quality. The purpose of the proposed MEPS for CFLs is to ensure this does not happen. Inferior CFLs have been the bane of past attempts in many countries to expand the market for CFLs. Australia is participating in international efforts to harmonise the various CFL standards that have emerged internationally in response to quality issues.

In regard to quality issues, CFLs have improved steadily since the technology was commercialised 30 years ago. But CFLs of highly variable quality are still manufactured and sold internationally. The CFLs that are now marketed in Australia are already of superior quality and suppliers say their products already substantially comply with the proposed MEPS for CFLs. The MEPS for CFLs will raise the bar a little but, most importantly, will prevent a decline in product quality as large numbers of inexperienced users enter the market for the first time.

The least efficient of the magnetic type of ELVC will not comply with the MEPS that are proposed, and it is expected that most will be replaced with electronic converters. However, the more efficient type of magnetic converter will comply and will be available for use in situations where electronic converters are unsuitable.

The objective

The objective of the proposed MEPS is to contribute to cost-effective greenhouse gas abatement in Australia. Abatement measures that do not increase the life-cycle cost of appliances are considered to be cost-effective. This means that the value of energy savings is not less than the incremental purchase price of a more efficient appliance.

The measures also need to be efficiently designed to:

- minimise adverse impacts on suppliers and on product quality and function; and
- be clear and comprehensive, minimising potential for confusion or ambiguity for users and suppliers.

Impact assessment

The costs to the taxpayer and business compliance costs are modest compared to the value of energy savings and the contribution to greenhouse abatement. This is largely because the regulation employs administrative machinery that is well developed and familiar to industry, specifically, Australian standards and the product registration and reporting procedures have been developed by E3. The measures have been developed over a period of time and in consultation with industry.

The continued use of the more efficient types of incandescent lamps deals with a range of issues affecting the competitive supply of lamps and the availability of like-for-like replacements. E3 has taken advice from relevant agencies on a range of health, safety and environmental issues and is confident that there are no issues that would materially affect its positive assessment of the proposed measures. However, appropriate advice and assistance for people with Lupus-related photosensitivity is required however at this time further information is required before we can make recommendations on the most appropriate approach. This is further discussed in section 4.5.1.

E3 has examined a wide range of plausible combinations of lamp type, lamp size, duty hours of the lamp, and type of electricity tariff (residential, commercial and industrial). These assessments show that, in general, the proposed measures will deliver net financial savings. There are three exceptions:

- For technical reasons associated with the type of ELVC used with ELV halogen downlights, it is sometimes not possible to re-lamp with a more efficient lamp that draws less power. The new lamp would still be more efficient but, instead of using less energy, it simply generates more light. Most residential users can still save energy by dimming the lamp back to the preferred lighting level. However, a minority of residential users and a majority of commercial users do not employ this feature. They are obliged to take the improved performance as more light but still pay the incremental cost of the improved lamp.
- Lighting costs increase for combinations of small lamps (40 watts or less) or low duty (less than two hours per day) in non-residential applications. These are unlikely combinations, firstly because the smaller lamps are not generally used in commercial and industrial applications, and secondly because such lamps may be on for up to 8 hours per day.
- For technical reasons it is not always feasible to replace a conventional magnetic ELVC with the more efficient electronic type. In such situations the MEPS will require the use of an efficient magnetic ELVC that is significantly more expensive than both the conventional magnetic and electronic types. The energy savings generally don't provide adequate compensation and the cost of the lighting service increases. Suppliers say that the requirement for magnetic ELVCs is small, less than 5% of ELVC sales.

These small cost increases are outweighed by much larger cost reductions in the majority of lighting applications that are affected by the MEPS, to the point where there are weighted average cost reductions in all sectors – residential, commercial and industrial. Table 1 reports the estimated sectoral averages. Note the cost increases for ELV halogen downlights in commercial applications.

The relatively short operating life of incandescent lamps means that re-lamping and the associated cost reductions will happen relatively quickly, with most gains delivered within several years of implementation. The impact of MEPS for ELVCs will be delayed because the stock of ELVCs can only be renewed as lighting systems are refurbished and new buildings are constructed. The annual cost savings are also more modest, of the order of \$1.60/dwelling and \$25,000/million square metres of commercial floorspace.

TABLE 1 CHANGE IN LIGHTING COSTS: \$ PER YEAR

<i>Lamp type</i>	<i>Residential (per dwelling)</i>	<i>Commercial (per million square metres of floorspace)</i>	<i>Industrial (per million square metres of floorspace)</i>
Mains voltage non-reflector lamps	-\$25.86	-\$250,986	-\$14,407
Mains voltage reflector lamps	-\$3.73	-\$130,160	-\$37,780
Extra low voltage reflector lamps	-\$0.33	+\$1,312	-
Total	-\$30	-\$379,834	-\$52,187

Table 2 provides a summary statement of the nationwide impacts for the period to 2020. On this figuring, the proposed MEPS clearly satisfies the no regrets criterion, that is, delivering abatement at no financial cost to users. The proposals would deliver abatement

of 28.5 Mt CO₂-e and simultaneously provide savings of \$2,167 million. The cost of abatement is negative, -\$135/tonne CO₂-e.

Sensitivity analysis indicates that this positive assessment is not altered by any plausible changes to underlying parameters. Given the wide range of circumstances that have been examined, we are confident that there will be no adverse distributional consequences.

The estimates presented in table 2 allow for a significant contribution from the energy saving incentives created by an emissions trading scheme. Specifically, we calculated the impact of the proposed measures relative to a baseline scenario that assumes no change in *per capita* demand for lighting services or the mix of technologies used to provide those services, and assumed that 25% of the gains observed in 2020 would be achieved without specific lighting measures. That fraction would be delivered by the enhanced incentives to save energy under an emissions trading scheme. The total amount of lighting-related abatement, including the contribution from an emissions trading scheme, is 36.2 Mt CO₂-e.

These abatement contributions are a fraction of the total abatement that is planned for the period to 2020. In 2006, for example, the Australian Greenhouse Office (AGO) estimated that abatement measures will deliver about 1,330 Mt CO₂-e of abatement in the period 2008 to 2020. The proposed lighting measures would contribute about 2.1% of that total.

TABLE 2 SUMMARY STATEMENT OF NATIONWIDE IMPACTS: 2008 TO 2020

Electricity consumption(GWh)	-30,305
Greenhouse emissions (Mt CO ₂ -e)	-28.5
<u>Financial impacts - undiscounted dollar amounts (\$M)</u>	
cost to the taxpayer	+10.2
business compliance costs	+4.4
lamp operating costs (lamps & energy)	-3,883
<u>Financial impacts - present values (\$M), discount rate = 7.5%</u>	
cost to the taxpayer	+8.74
business compliance costs	+2.87
lamp operating costs (lamps & energy)	-2,177
<u>Investment analysis (\$M)</u>	
total costs	no capital costs*
total benefits	+2,165
net present value	+2,165

Note:

* Both lamps and energy are treated as operating costs of lighting services, which is consistent with normal practice in facilities management. It is analytically cumbersome to treat lamps as capital items, given their low unit cost and their short, variable lives. Hence, we have not calculated a benefit cost ratio.

The import restriction and associated arrangements are expected to cost \$500,000 in the first year of operation; however, significantly lower costs are expected to be incurred in outgoing years. Once the point of sales MEPS is in place, it may be possible to remove the import restriction and associated costs, while retaining ACS services to collect and distribute lighting import data. Collection of this information is aimed at improving the effectiveness of monitoring and compliance of the point of sale MEPS. This process is expected to result in a cost of \$100,000 in subsequent years. See chapter 4.1 for more information.

Policy alternatives

E3 considers that a combination of mandatory MEPS, labelling and a communications strategy is the most effective response, but also examined the following policy options:

- taxes on inefficient lamps;
- subsidies for efficient lamps;

- disendorsement labelling;
- comparative energy labelling; and
- information campaigns.

E3 considers that none of these options are sufficiently promising to warrant full development and assessment as feasible alternatives to the proposed MEPS.

Consultation

E3 first developed the MEPS proposals in consultation with suppliers, industry associations and lighting professional associations. E3 has since conducted two rounds of public consultation.

There were 25 responses to the technical report that was released in December 2007, describing the proposal in detail. This provided an opportunity to clarify the proposal and address a number of misunderstandings, particularly the mistaken idea that all incandescent lamps would be banned. But there were no substantive changes to the proposal.

There were also 25 responses to the consultation RIS that was published on 11 September 2008. Thirteen respondents expressed approval of the proposed measures and another seven raised issues but did not express a view one way or the other. Five respondents expressed disapproval. One disapproved the use of regulatory powers in this case as a matter of principle. Three others disapproved on health and environmental grounds. The fifth said that the proposed measures need to be reconsidered, starting with an intensive survey of residential lighting behaviour and using a systematic program design procedure.

E3 has altered neither the proposal nor its positive assessment of the proposal in response to these submissions. However, E3 has modified elements of the communications strategy and is continuing to research and monitor several issues, particularly the needs of people with Lupus-related photosensitivity. Chapter 11 of this RIS summarises the submissions and E3's response.

Recommendations

The E3 Committee recommend that the Ministerial Council on Energy (MCE) approve the proposed introduction of point of sale MEPS for incandescent lamps, CFLs and ELV converters in Australia. This proposal will be implemented no earlier than 1 November 2009. The point of sale MEPS will be supported by an appropriate communications strategy.

Further, E3 recommend that the MCE approve the request to invoke a TTMRA temporary exemption for CFLs and ELV halogen non-reflector lamps. More information on why an exemption is required in section 11.1.3.

E3 also recommend the reform of lamp labelling practices and arrangements; however this will require co-ordination with international reforms to avoid creating an unnecessary burden for industry. E3 are currently looking into a number of options aimed at influencing lamp labelling reform practices and is actively monitoring and/or contributing to several international forums including the Asia Quality Charter, the International Electro-technical Commission (IEC) and the European Standards committee.

Note that further import restrictions may be put in place in advance of the introduction of point of sale MEPS for future applicable products listed in table 3.3. This will subject to further review of the feasibility of such restrictions.

1. The Problem

This RIS assesses a proposal by the Equipment Energy Efficiency (E3) Committee to mandate MEPS for incandescent lamps, CFLs and for ELVCs used for extra low voltage halogen lighting systems, and to impose certain other standards and labelling measures in support of the main proposal.

All Australian jurisdictions have agreed to regulate products where the benefits exceed the costs.

1.1 Energy efficiency policy

Australia's greenhouse abatement and climate change policies have evolved consistently, since the release of the National Greenhouse Response Strategy in 1997. The paper received overall bi-partisan support, including for national energy efficiency measures. Appendix B records some of the more important stages in that development.

On 11 March 2008, Australia's ratification of the Kyoto Protocol was officially recognised by the United Nations Framework Convention on Climate Change (UNCCC). Under Kyoto, Australia is obliged to limit its greenhouse gas emissions in 2008-2012 to 108 per cent of 1990 emission levels. The Australian Government has also released a report demonstrating how Australia intends to measure the reductions in emissions required under Kyoto titled Australia's Initial Report under the Kyoto Protocol.

In October 2008, the Council of Australian Governments (COAG) agreed to develop the National Strategy for Energy Efficiency, to accelerate energy efficiency efforts across all governments and to help households and businesses prepare for the introduction of the incoming Carbon Pollution Reduction Scheme (CPRS). Streamlined roles and responsibilities for energy efficiency policies and programs will be agreed in early 2009. The strategy will be implemented by June 2009, ensuring that programs assisting households and businesses to reduce their energy costs are in place before the CPRS is introduced.

Most recently, the CPRS White Paper, released in December 2008 stated on page 110 (Vol 2) that:

“Energy efficiency is the final piece of the emissions reduction strategy. Energy use is the key driver of emissions growth in Australia. The Renewable Energy Target and CCS will reduce the emissions produced and released in generating energy, but there is also considerable scope to increase the efficiency of energy use. Using energy more efficiently can significantly reduce the cost of greenhouse gas abatement and ease the transition to a low-carbon economy”

and

“There are several impediments to the uptake of energy efficiency measures, including gaps in the information available to households and businesses to make informed decisions. By becoming more energy efficient, households can reduce the cost impacts of the Scheme. Prior to the commencement of the Scheme, the Government will deliver household energy efficiency initiatives building on existing programs to help households do their bit to tackle climate change and reduce energy bills”.

The MCE moves beyond “No Regrets” energy efficiency measures

In October 2006, the Ministerial Council on Energy (MCE, comprised of Australian federal, state and territory and New Zealand government energy ministers) agreed to new criteria for assessing new energy efficiency measures. The MCE replaced its previous “no regrets” test (that a measure have private benefits excluding environmental benefits which are greater than its costs) with the criteria that the MCE would consider ...*new energy efficiency measures which deliver net public benefits, including low cost greenhouse abatement measures that do not exceed the cost of alternate measures being undertaken across the economy.*

This means the MCE will consider regulatory measures that may have net up-front costs but have greater private economic and greenhouse benefits over the long term, recognising that prudent investment now may avoid more costly intervention later.

International Energy Agency (IEA) sees improving energy efficiency as top priority

Australian policy is in accord with international endeavours in this field.

The IEA estimates that under current policies, global emissions will increase 50% by 2030 and more than double by 2050. However, if we act now, this unsustainable and dangerous pattern can be curbed. IEA findings show that emissions could be returned to current levels by 2050 and even reduced thereafter, while an ever-growing demand for energy services, notably in developing countries, can be fully satisfied. Improving energy efficiency in the major consuming sectors – buildings and appliances, transport and industry – must be the top priority. While alleviating the threat of climate change this would also improve energy security and have benefits for economic growth. – Claude Mandil, Executive Director, IEA, Paris, February 2007.

Australia is at the forefront of international initiatives to improve the energy efficiency of globally traded products.

Equipment Energy Efficiency Program

In Australia, regulatory intervention in the market for energy-using products was first introduced with mandatory appliance energy labelling by the NSW and Victorian Governments in 1986. Between 1986 and 1999 most state and territory governments introduced legislation to make energy labelling mandatory, and agreed to co-ordinate labelling and minimum energy performance standards (MEPS) decision making through the MCE.

The proposed regulation is an element of the Equipment Energy Efficiency Program (E3). E3 embraces a wide range of measures aimed at increasing the energy efficiency of products used in the residential, commercial and manufacturing sectors. E3 is an initiative of the MCE comprising ministers responsible for energy from all jurisdictions, and is an element of Australia’s National Framework for Energy Efficiency (NFEE). It is organised as follows:

- Implementation of the program is the direct responsibility of the Equipment Energy Efficiency Committee, which comprises officials from Australian federal, state and territory government agencies and representatives from New Zealand. They are responsible for implementing product energy efficiency initiatives in the various jurisdictions.
- The E3 Committee reports through the Energy Efficiency Working Group (E2WG) to the MCE and is ultimately responsible to the MCE.
- The MCE has charged E2WG to manage the overall policy and budget of the national program.

- Members of the E3 Committee work to develop mutually acceptable labelling requirements and MEPS. New requirements are incorporated in Australian standards and developed within the consultative machinery of Standards Australia.
- The program relies on State and Territory legislation for legal effect in Australia, enforcing relevant Australian Standards for the specific product type.

The appliances and equipment that are included in the E3 program must satisfy criteria of feasible and cost effective intervention. These include potential for energy and greenhouse gas emissions savings, environmental impact of the fuel type, opportunity to influence purchase, the existence of market barriers, access to testing facilities, and considerations of administrative complexity. Policy measures are subject to a cost-benefit analysis and consideration of whether the measures are generally acceptable to the community.

E3 provides stakeholders with opportunities to comment on specific measures as they are developed by issuing reports (including fact sheets, technical reports, cost-benefit analyses and regulatory impact statements) and by holding meetings.

1.2 Product profile

Product technologies - lamps

The proposal affects two broad types of lamp technology – incandescent and fluorescent. Incandescence refers to the state of a body caused by approximately white heat and is produced in incandescent lamps by passing an electric current through a tungsten filament. Fluorescence is the property of emitting light on exposure to radiation. The tubes of fluorescent lamps are coated with a fluorescent substance that is bombarded with radiation when a current passes through the argon and mercury gas that fills the tube.

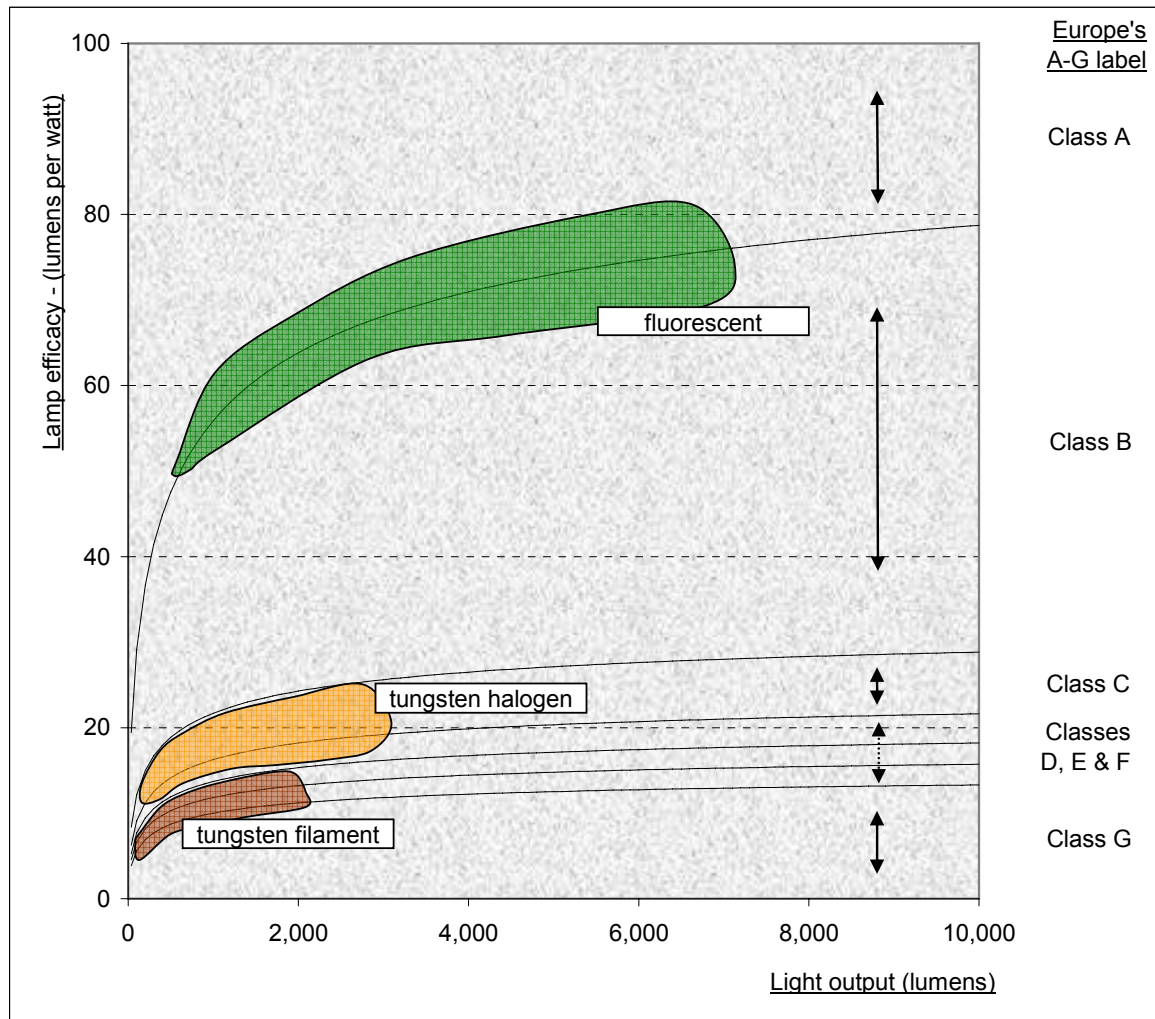
Two other technologies – high intensity discharge (HID) and solid state lighting (SSL) – are not directly affected by the measures³.

We use figure 1.1 to briefly describe the energy efficiency characteristics of the various lamp technologies. Note the following:

- Light output is measured along the horizontal axis in lumens, which is a measure of the amount of visually useful radiation that is emitted by a lamp. For example, a common 60 watt globe emits approximately 750 lumens.
- Lighting professionals use the term ‘efficacy’ for the ratio of the rate of light production (lumens) to the rate of energy input (watts). Efficacy is measured along the vertical axis in lumens/watt.
- In 1998 the European Union introduced a lamp labelling scheme with 7 classes, labelled A to G. The thresholds increase with lamp output because it is easier to efficiently produce large amounts of light and more difficult to efficiently produce small amounts of light. The incremental class thresholds are extremely non-linear, with relatively small differences between classes D and G in the lower regions but a larger gap between classes A and C in the upper regions – see figure 1.1.
- Incandescent lamps convert less than 10% of the radiation emitted by a white hot body into light, and inhabit the lower regions of figure 1.1. Suppliers seldom place incandescent lamps higher than class C.

³ HID lamps are used where high levels of light are required over large areas, such as for street-lighting and large public areas. SSL is a promising lighting technology lamps are not expected to be commercially viable before 2015.

FIGURE 1.1 EFFICACY OF RELEVANT LIGHTING TECHNOLOGIES



- There are several broad types of incandescent technology:
 - ‘Tungsten filament’ lamps are the cheapest and most widely used type of incandescent lamp and are predominately graded to class E or class F.
 - ‘Tungsten halogen’ lamps also have a tungsten filament. The difference is that they contain small quantities of a halogen gas as well as the inert gases (typically argon and nitrogen) that are contained in the conventional tungsten filament lamp. The halogen allows higher filament temperatures that increase efficacy and generate a whiter light, lifting tungsten halogen lamps into classes C and D. It also extends lamp life by setting up a “halogen cycle” that redeposits evaporated tungsten onto the hot surface of the filament.
 - A further refinement of tungsten halogen technology is to use coatings that reflect infra red radiation back into the bulb, further increasing temperature and efficacy.
- Both linear⁴ fluorescent lamps and CFLs of reasonable quality inhabit the upper regions of figure 1.1 – either the Grade A or upper Grade B parts of figure 1.1. This report is concerned mainly with the compact type since CFLs would be directly

⁴ Confusingly, the ‘linear’ description refers to all non-compact fluorescent lamps, including the circular type as well as those that are actually linear.

subject to MEPS. Linear fluorescent lamps will have a very minor role in replacing incandescent lamps and are already subject to MEPS.

- The data in figure 1.1 overstates efficacy in several ways.
 - It reports the initial efficacy of lamps, whereas efficacy declines over the life of most lamps.
 - It excludes the energy consumed by the external ballasts that maintain the correct voltage and current to fluorescent lamps. Some types of fluorescent lamps are self ballasted, including most CFLs.
 - It excludes the energy consumed by the ELVCs in low voltage lighting systems.
 - It excludes the reduction in efficacy when lamps on dimmer circuits are operated at less than full power.
 - It excludes the energy consumed internally by dimmers and sensors.

The energy used by dimmers and sensors is small enough to be entirely ignored. The reduction in efficacy over the life of lamps can also be ignored, since it is experienced as a reduction in light intensity, not a reduction in energy use. Our estimates of energy use and energy savings make appropriate allowances for the remaining factors.

Lighting technologies can be further disaggregated according to a number of lamp design and performance characteristics. For example, most lamps of interest are produced in reflector and non-reflector versions: the former have built-in reflector that shines the light in the desired direction. There are also differences in lamp life, light quality, lumen maintenance over the life of the lamp, and sensitivity of lamp life to switching.

Product technologies - ELVCs

Voltage converters for extra low voltage (ELV) electricity are used to reduce the voltage of mains electricity supply to a lower voltage, typically 12 volts, for operating ELV halogen lamps. (Hereafter, we refer to converters as ELV converters or ELVCs. They are also commonly called transformers. The lower voltage allows the use of a much smaller filament, creating a dot shaped point of light that can be easily focused and directed by a small light capsule.) ELVCs are supplied with screw terminals, flying leads or in some cases a mains plug. They are typically installed in a ceiling or wall cavity, close to the ELV lamp, since the transmission of power at low voltage requires thicker wires and incurs higher line losses.

ELVCs can either be magnetic or electronic type. Magnetic converters consist of a ferrous metal core wrapped with primary and secondary electrical windings. Electric current in the primary (mains) winding induces a magnetic flux in the core, which in turn induces a low voltage current in the secondary winding. The ratio of voltage reduction from the primary to secondary terminals is approximately proportional to the ratio of the number of coils in the primary and secondary windings. The output voltage of magnetic converters is typically not regulated but may incorporate varying forms of simple overload protection.

Electronic converters do the same job electronically, first converting mains frequency alternating current (50 or 60 Hz) into high frequency alternating current (typically 10-100kHz), and then passing it through a small magnetic transformer to reduce the output voltage to 12 volts of alternating current at 10-100 kHz. Units providing direct current output are also available and are used to reduce radio frequency interference and cable self-inductance over long circuits. Electronic converters are smaller and lighter than magnetic converters, and often include output voltage regulation with sophisticated protection circuitry and soft lamp starting characteristics.

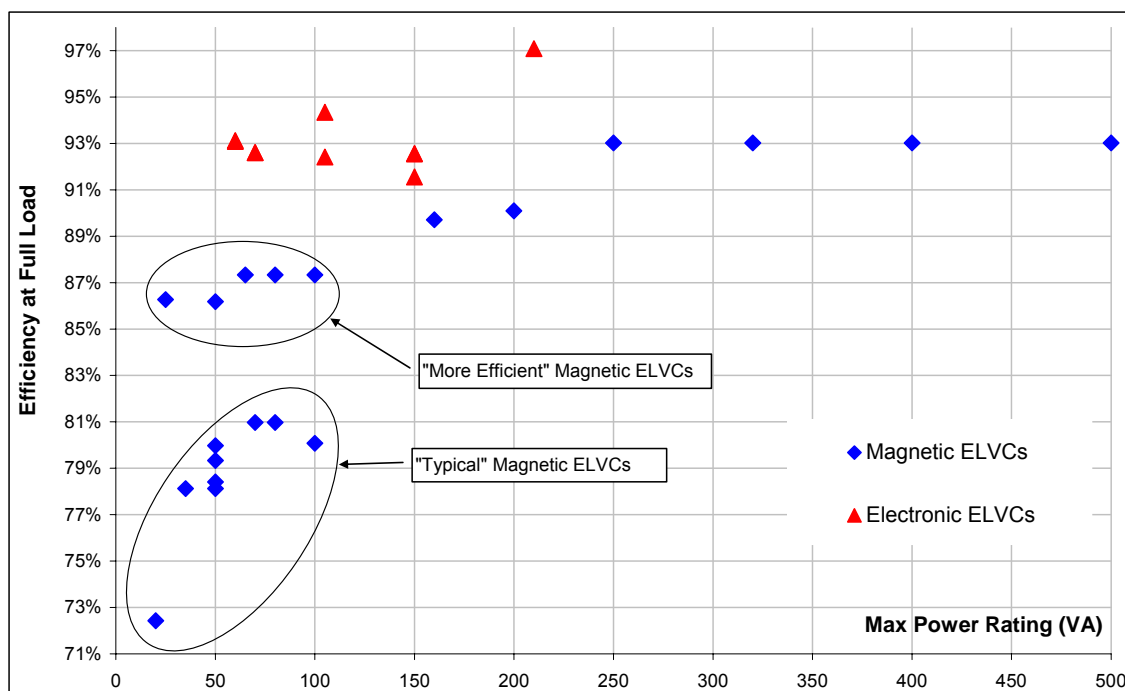
Some energy is lost as current is converted to low voltage and the efficiency of ELVCs is therefore reported as the ratio of output power to input power. More efficient ELVCs lose less energy in the conversion process, which means that they use less input electricity to

produce the same amount of output electricity. For example, an ELVC that consumes 10% of the input energy is said to be 90% efficient.

Electronic ELVCs are typically more efficient than magnetic units – see figure 1.2. This data indicates that the losses vary from 3% (efficiency = 97%) to about 27% (efficiency = 73%). We understand that there has been little change in the efficiency of either the magnetic or electronic types over the past 10 years, but the market share of the magnetic type has fallen.

It is apparent from figure 1.2 that most of the variation in efficiency occurs amongst magnetic converters with lower power ratings, in the range up to 100 VA. Note the group of ‘more efficient’ magnetic designs with rating less than 100 VA but efficiencies in excess of 85%. We understand that this group includes the ‘toroidal’ type of magnetic converters with windings around a donut-shaped core. This arrangement improves efficiency but winding these converters is a more involved process that adds to cost. We have conflicting advice on whether conventional magnetic designs can achieve the higher levels of efficiency.

FIGURE 1.2 FULL LOAD* EFFICIENCY OF ELV CONVERTERS



Source:

Manufacturer catalogues and laboratory testing in 2004. IEA has reported a similar range of efficiencies, saying that ...losses range from 5% to 25% at full load (IEA 2006: page 507)

Note:

Full load mode occurs when a converter is switched on, the maximum load is connected (that is, an appropriately sized lamp), and the lamp is undimmed. In this mode the converter loses power according to its full load loss rating. The losses at part load – that is, when dimmed – are not fully understood but it is known that the percentage losses can be higher under part loads (IEA 2006: page 507).

Product supply chain - lamps

All lamps are now imported, the last Australian factory having closed in April 2002. Therefore, the import data since that closure provides good estimates of the total number and mix of lamps purchased. Basic facts include:

- Average annual imports were 130 million for the period 2003-06.

- A breakdown of imports by exporting country indicates that China and Indonesia are the major suppliers in terms of the number of lamps, with a combined share of 60%. Two other Asian countries (Thailand and Taiwan) and three European countries (Germany, Italy and Hungary) have market shares of 4-8%.
- Asian countries, particularly China, have increased market share.
- Table 1.1 provides the breakdown of imports by lamp type. Incandescent lamps account for 73% of Australian imports (tungsten filament 58%, tungsten halogen 15%). Fluorescent lamps account for most of the remainder (linear fluorescent 14%, compact fluorescent 10%).

Several types of organisation are involved in the importation and distribution of lamps.

- *Multi-national companies*: There are several international brands – GE, Megaman, Osram and Philips – that are imported or distributed through subsidiaries or agents. These are listed in table 1.2. Multinationals own some factories but also contract with generic manufacturers for the supply of ‘commodity’ lamps.
- *Local importer/wholesalers*: Several companies have established local brands – Crompton, Nelson, Mirabella and Sylvania. They do not own factories but enter into partnerships or contractual arrangements with generic manufacturers.
- *Local importer/retailer*: Supermarkets and other large retailers have the capacity to enter directly into supply arrangements with manufacturers, and may have a house brand.

TABLE 1.1 LAMP IMPORTS BY TYPE OF LAMP: AUSTRALIA, 2003-06 (%)

Type of lamp	Non-reflector type	Reflector type	Total
Incandescent	56.5%	16.4%	73.0%
Tungsten filament	52.5%	5.9%	58.4%
Tungsten halogen	4.0%	10.5%	14.6%
Mains voltage	1.3%	2.1%	3.4%
Low voltage	2.7%	8.4%	11.2%
Fluorescent			23.8%
Linear			14.2%
Compact			9.6%
High intensity discharge			3.2%
TOTAL			100.0%

TABLE 1.2 TYPES OF LAMP IMPORTER

Brand	Company	Parent domicile
Subsidiaries of multi-national manufacturer/importer/wholesaler		
GE	GE Lighting Australia Ltd	United States
Osram	Osram Australia Pty Ltd	Germany
Philips	Philips Lighting Pty Ltd	Netherlands
Agents for multinational manufacturer/importer/wholesaler		
Megaman	Megaman Lighting Australia Pty Ltd	Hong Kong
Sylvania	Sylvania Lighting Australasia Pty Ltd	Local
Local importer/wholesalers		
Crompton	Crompton Pty Ltd	Local
Nelson	Nelson Industries	Local
Mirabella	Mirabella International Pty Ltd	Local
Local importer/retailers		
House brands	Coles, Woolworths, Mitre10	Local

- *Suppliers & installers*: Lamps are provided as part of lighting installations. The Australian Yellow pages list 790 wholesalers and manufacturers of lighting and lighting accessories, and 1,253 retailers of lighting and lighting accessories. A further 193 companies that appear to be lamp maintenance and replacement specialists.
- *Generalist retailers*: Households obtain most replacement lamps from supermarkets, homeware and hardware stores.

Product supply chain - ELVCs

Electronic converters are certainly imported to Australia, mainly from Asian countries, and it is expected that magnetic converters are also imported from the same sources. The more efficient types of magnetic converter are manufactured overseas and can be imported to Australia. Unfortunately, import data cannot be disaggregated to the level needed to identify quantities and sources of converter imports.

Regarding domestic production, we understand the situation as follows:

- TridonicAtco is the major Australian manufacturer of magnetic and electronic converters of the type that will be subject to the MEPS. It is a wholly owned subsidiary of its Austrian parent, TridonicAtco GmbH & Co KG. E3 has consulted with TridonicAtco who have advised that given the implementation of MEPS, their annual turnover and employment capacity will be reduced marginally and therefore presents only a small impact to the company. TridonicAtco understand that some products inevitably will not meet the standards. However, two of their other larger transformers will comply with the MEPS requirements and will ensure that the company remains competitive in the industry.
- Torema Australia Pty Ltd manufactures the more efficient type of magnetic converter, including for ELV halogen lamps. There other Australian manufactures but none, so far as we are aware, that manufacture the more efficient type of converter for lighting applications.

National standards and labelling measures

At present the only mandatory standards and labelling measures in Australia for lighting products are MEPS for linear fluorescent lamps and the respective ballast. However, the published *Greenlight Australia* strategy (NAEEEC 2004b) proposes a package of measures:

- *High priority MEPS*: for ELVCs, CFLs, public amenity lighting, luminaires, tungsten halogen lamps, high pressure sodium lamps, and ballasts for high intensity discharge lamps.
- *Future MEPS*: second round of MEPS for linear fluorescent lamps and ballasts, plus MEPS for traffic signals, emergency and exit lighting, photoelectric cells and tungsten filament lamps.
- *Energy labelling*: priorities not decided but consideration given to ELVCs, luminaires, CFLs and fluorescent ballasts
- *Market transformation initiatives*: high efficiency products database plus education and training for specifiers.

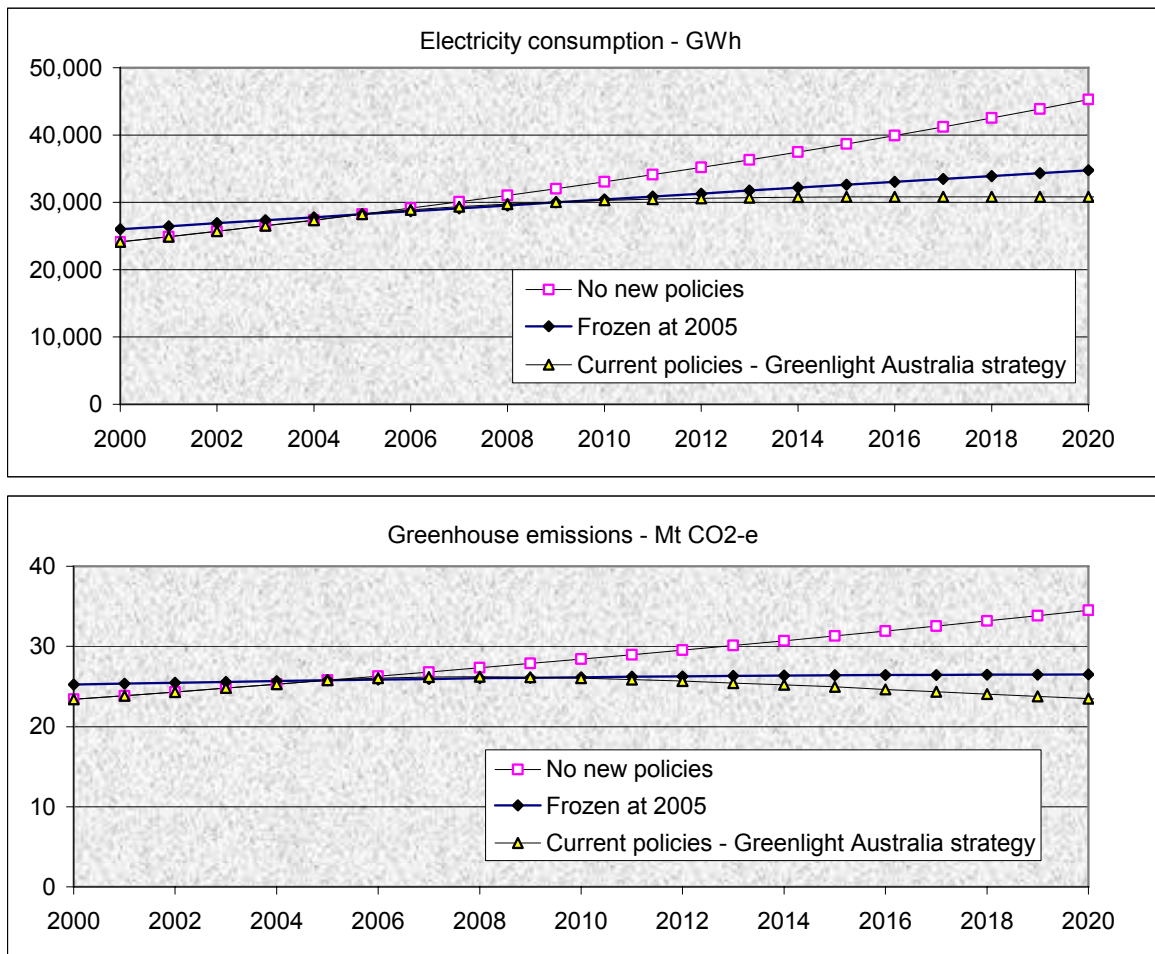
1.3 Projections of energy use and greenhouse emissions

Figure 1.3 shows the projections that were developed for the purposes of the *Greenlight Australia* strategy, but re-based to conform to the model of the lighting task that has been developed for this RIS.

- No new policies: *Greenlight Australia* projected growth of 3.2% per year in the absence of any new lighting policies, implying growth of about 50% in the period from 2002 to 2015.
- Current policies: *Greenlight Australia* set targets to restrict further growth to 20% in lighting energy consumption over the period 2002 to 2015 and reduce the rate of growth to zero by 2015.

The remaining projection is based on the assumption that the lighting configuration observed in 2005 remains ‘frozen’, which means that lighting energy consumption grows in line with the building stock. Average annual growth in the period 2005 to 2020 is 1.4%.

FIGURE 1.3 SCENARIOS FOR LIGHTING ELECTRICITY CONSUMPTION AND GREENHOUSE GAS EMISSIONS



1.4 Impediments to energy efficiency in the market for lamps

This section explains why lamp users may not minimise the lifecycle cost of lighting services, due to imperfect information and split incentives. The following section (1.5) discusses whether these market failures would still be a policy concern in the presence of a CPRS.

Imperfect information

It is assumed that users prefer to reduce the cost of lighting services where possible and therefore have an incentive to acquire the information about the cost of alternative technologies, including energy costs. However, the assessment task is not trivial.

- The user must first identify the alternative lamps that are capable of performing a particular lighting task. This is a reasonably complex matter involving, at a minimum, the amount of light produced, the colour appearance of surfaces that are illuminated and the colour appearance of the light itself. These lighting qualities are quantified, respectively, as the lumens, the colour rendering index⁵ (CRI) and the colour correlated temperature⁶ (CCT) of the lamps.
- Further, the user needs to compare the price of the alternative lamps and make appropriate adjustments for differences in lamp life. This is a significant factor. For example, CFLs may be four to five times more expensive than tungsten filament lamps but last six to eight times longer. In terms of purchase cost per hour of operation, a CFL is often cheaper than a tungsten filament lamp.
- The user needs to calculate or otherwise identify the amount of energy consumed by the alternative lamps and, using their marginal electricity tariff, calculate the energy costs of the alternative lamps.
- The user needs to allow for any differences in the time profile of the costs of alternative lamps, which requires information about the duty hours of the lamp and the application of an appropriate discount rate.
- Finally, the user requires a good basis for either trusting the sources of such information or verifying the promised performance, and the ability to do the arithmetic.

The question is the extent to which households are able to ‘do the sums’ in this way. We have considered the following matters.

Imperfect feedback from energy bills

Lack of information is not critical where users have opportunities to learn quickly and cheaply from experience and experimentation. For example, users can get rapid feedback on their choice of coffee: each purchase is relatively cheap and feedback on the product, via tasting, is immediate.

In contrast, feedback on the energy performance of energy saving lamps is impeded by the fact that (a) users are not billed separately for the energy used by each appliance, (b) the energy bill is also periodic, at intervals of 2 or 3 months, and (c) the interpretation of energy bills is complicated by seasonal variation in energy consumption and the payment of varying marginal tariffs under block tariff arrangements. Electrical appliances are therefore at the more difficult end of the spectrum of purchasing decisions. They are best regarded as ‘credence goods’ or ‘experience goods’, as opposed to ‘search goods’⁷.

- The attributes of a search good can be fully determined prior to use, for example, a greeting card.
- The attributes of an experience good can be determined only with use, for example, motor vehicles and other durables that users value for their whole-of-life performance, including ongoing reliability and costs of operation and maintenance.
- The attributes of credence goods may never be discovered – for example, a medical procedure – or may be determined only after a very long delay.

⁵ Objects look ‘natural’ in the light of an incandescent lamp, as though illuminated by sunlight, but can look odd under fluorescent lighting, depending on the quality of the lamp. The CRI measures this quality on a scale of 1 to 100, with sunlight at 100 and most incandescent lamps close to 100. Recent generations of fluorescent technologies are in the range 70-95 and compact fluorescent lamps are in the range 82-85.

⁶ The correlated colour temperature (CCT) is reported in degrees Kelvin and relates to the chromaticity of a black body heated to that temperature. (IEA 2006: page 106)

⁷ This distinction originated with an article by Philip Nelson (Nelson 1970).

It seems highly significant that users do not have immediate feedback on the full costs of lighting services: electricity accounts for about 90% of the lifecycle costs of a 60 watt tungsten filament lamp⁸.

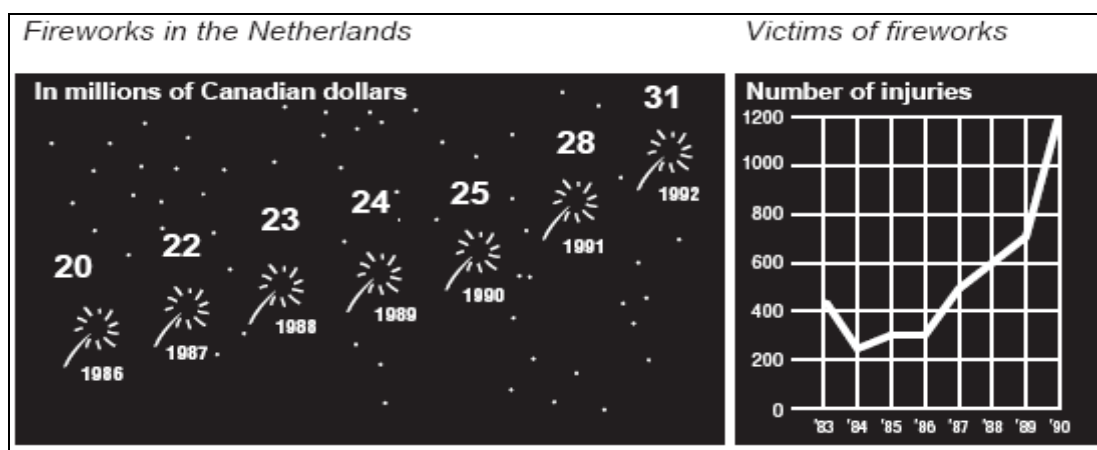
Sizeable minority without strong pre-purchase assessment skills

A proportion of the population appear to lack the literacy, numeracy and problem-solving skills that may be required to 'do the sums'. While E3 has not directly tested the skill set of the general population with regard to the ability to 'do the sums', results of the ABS survey of adult literacy and life skills (ABS Cat 4428.0) indicate that a significant minority would have difficulty. Specifically, on tests of literacy and numeracy, the ABS estimated that the following proportions of the adult population in private dwellings are at Level 1 or Level 2, where Level 1 is the lowest level of literacy and numeracy on a scale from Level 1 to Level 5.

- document literacy – 46.8%
- prose literacy – 46.4%
- numeracy – 52.5%

To understand what these numbers mean, it is necessary to review the Level 3 tasks: these are the 'next most difficult' tasks that could not be performed by survey respondents on Levels 1 and 2. Examples of the Level 3 tasks are provided in a report jointly published by Statistics Canada and the OECD – *Learning a Living: First Results of the Adult Literacy and Life Skills Survey*⁹ – and the interested reader should refer to that publication for a detailed explanation. For the purposes of this RIS, however, the following indicate the difficulty of Level 3 tasks.

- Document literacy: A document literacy task from the middle of Level 3 required the reader to look at the following charts involving fireworks from the Netherlands and to write a brief description of the relationship between sales and injuries based on the information shown.



- Prose literacy: One of the prose literacy tasks at the lower end of Level 3 refers to the following page from a bicycle's owner's manual and requires the respondent to determine how to ensure the seat of a bicycle is in the proper position. The respondent needs to identify, in writing that the seat is in the proper position when

⁸ A 60 watt tungsten filament lamp consumes 60 kWh over its life of 1,000 hours, with a value of about \$9 (= 60 * 15 cents/kWh). The lamp itself typically costs less than \$1.

⁹ http://www.oecd.org/LongAbstract/0,3425,en_2649_37455_34867439_1_1_1_37455.00.html

The International Adult Literacy Survey (IALS) was a large-scale co-operative effort by governments, national statistical agencies, research institutions and the Organisation for Economic Co-operation and Development (OECD). The development and management of the survey were co-ordinated by Statistics Canada and the Educational Testing Service of Princeton, New Jersey.

the sole of the rider's foot is on the pedal in its lowest position and the rider's knee is slightly bent.

PROPER FRAME FIT

RIDER MUST BE ABLE TO STRADDLE BICYCLE WITH AT LEAST 2 cm CLEARANCE ABOVE THE HORIZONTAL BAR WHEN STANDING.

NOTE: Measurement for a female should be determined using a men's model as a basis.

PROPER SIZE OF BICYCLE	
FRAME SIZE	LEG LENGTH OF RIDER
430mm	660mm-760mm
460mm	690mm-790mm
480mm	710mm-790mm
530mm	760mm-840mm
560mm	790mm-860mm
580mm	810mm-890mm
635mm	860mm-940mm

OWNER'S RESPONSIBILITY

1. **Bicycle Selection and Purchase:** Make sure this bicycle fits the intended rider. Bicycles come in a variety of sizes. Personal adjustment of seat and handlebars is necessary to assure maximum safety and comfort. Bicycles come with a wide variety of equipment and accessories . . . make sure the rider can operate them.
2. **Assembly:** Carefully follow all assembly instructions. Make sure that all nuts, bolts and screws are securely tightened.
3. **Fitting the Bicycle:** To ride safely and comfortably, the bicycle must fit the rider. Check the seat position, adjusting it up or down so that with the sole of rider's foot on the pedal in its lowest position the rider's knee is slightly bent. Note: Specific charts illustrated at left detail the proper method of determining the correct frame size.

The manufacturer is not responsible for failure, injury, or damage caused by improper completion of assembly or improper maintenance after shipment.

- Numeracy: One of the numeracy tasks at the lower end of Level 3 referred to the following graph and accompanying text on the levels of dioxin in breast milk. Respondents were not required to calculate the amount of change over each of the periods, just describe in their own words the change in the levels of dioxin (e.g., decreased, increased, stayed the same).

Is breast milk safe?

Since the 1970s, scientists have been worried about the amount of Dioxin, a toxin in fish caught in the Baltic sea. Dioxin tends to accumulate in breast milk and can harm newborn babies.

The diagram shows the amount of Dioxin in the breast milk of North European women, as found in studies done from 1975 to 1995.

Amount of Dioxin in Breast Milk

Year	Dioxin amount (in nanogram/gram fat)
1975	0.8
1985	0.6
1995	0.4

These Level 3 tasks seem commensurate with the task of absorbing general information about the qualities of energy saving and long life lamps, indicating that a significant minority of the population would not be confident about making such assessments. We also note that a numeracy task involving compound interest was assigned to Level 5.

The ABS survey also tested problem solving ability but, unfortunately, the source documentation (Statistics Canada *et al*: 2005) does not report the degree of problem solving that characterises Level 1 and Level 2. However, one of the scenarios used to assess problem solving was the planning of a family reunion, which involved the completion of a set of tasks that seems no more demanding than making an informed assessment of lamps. The specific tasks for the respondent were to:

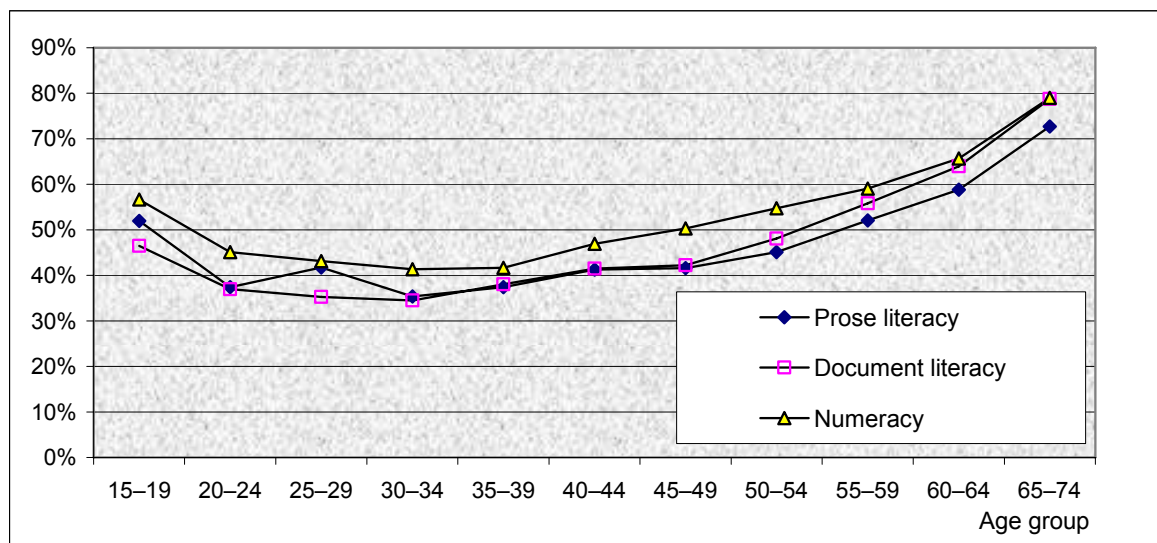
- set the date for the reunion allowing for the prior commitments of six relatives
- consider relatives' suggestions for a specific outing (a hike) and decide on a convenient location for the outing
- plan what needs to be done before booking your flight
- answer relative's questions about travelling by plane
- book your flight
- make sure your ticket is correct
- plan your own trip to the airport

The ABS found many could not complete all of these planning tasks – 34.9% of Australians were at Level 1 on problem solving and 70.1% were at Level 1 or Level 2, but now on a scale of Level 1 to Level 4.

Other general findings are that skill levels are positively related to education and labour force participation, and negatively related to age beyond 30 years. Figure 1.4 reports the latter finding.

Skill deficiencies relate to the concept of 'bounded rationality': decision makers with finite computational resources cannot make perfectly rational purchasing decisions. They use imperfect algorithms and heuristics instead, and learn by 'trial and error'. Several of the

FIGURE 1.4 PROPORTION OF AUSTRALIANS AT SKILL LEVELS 1 OR 2*, BY AGE



Source: ABS Cat 4882.0 *Adult skill and life skills survey*

Note:

* For each literacy domain, proficiency is measured on a scale ranging from 0 to 500 points. To facilitate analysis, these continuous scores have been grouped into 5 skill levels with Level 1 being the lowest measured level of literacy.

attributes of the lamp market – such as low unit cost, relatively infrequent purchases and unspectacular technology change – discourage buyers from thinking hard about their purchasing habits.

Small financial benefits

We calculate that the phasing out of tungsten incandescent lamps will save the average Australian household \$30-60 per year. Some people would regard such amounts as trivial and would not bother to make the required assessments, or would give so little attention to the matter that there are few opportunities to educate and inform. This is a reasonable explanation for the apparent lack of interest in labelling information, documented in chapter 8, dealing with the policy option of lamp labelling. The IEA puts this issue in terms of competing demands on the decision-making resources of individuals and considers that:

An analysis of this factor can favour measures that remove the work from the consumer by ensuring that efficient solutions are widely available in the market place through retailer and industry incentives or mandatory regulations. (IEA 2006: page 287)

Attitudes to small individual savings may change over time, as the price of emissions permits is factored into electricity prices and as people become more concerned to play their part in responding to the challenge of climate change.

History and evolution of lamp labelling

The practice of classifying lamps by wattage (40 watts, 60 watts, etc.), which is a measure of energy use rather than light output, is an anachronism based on familiarity with the operation and performance of tungsten filament lamps. Suppliers have responded to the need for users to understand that equivalent CFLs have lower wattage and longer life and may have different colour characteristics.

- *Same light but less energy:* Using text and images, it is common for CFL packaging to provide a direct comparison with a tungsten filament lamp that provides the same light. For example, a 14 watt CFL may be shown as equal to a 60 watt tungsten filament and saving 80% of the energy at the same time.
- *Operating life:* The CFLs operating life is often stated in hours and a graphic is used to show the CFL as equivalent to a number of tungsten filament lamps. For example, the graphic would show the CFL as equivalent to six pear shaped bulbs if the CFL has an operating life of 6,000 hours. Or long life may be indicated by stating that the lamp will last for a certain number of years, say, 3 years.
- *Colour appearance:* The issue of colour is typically reduced to a choice between ‘cool white’ and ‘warm white’, sometimes accompanied by an explanation that the cool look is a clear light that is appropriate to laundries and bathrooms and the warm look is cosy light that is appropriate to living areas and bedrooms.

Importantly, the user still has more work to fully understand the financial effects of using CFLs, in particular, to use their marginal energy tariff to calculate total energy costs and make adjustments for differences in the life of lamps.

In general, suppliers have not taken the further step of providing information about energy costs and savings on lamp packets – that is, doing the financial sums on behalf of users and providing them with dollar estimates. It is difficult to know exactly why suppliers do not employ these tactics; however the following points provide some indication.

- Information about operating expenses would need to be differentiated to a certain degree, at least for countries and regions with different currencies, energy costs and lighting requirements.
Further, packaging design and production costs associated with inventories and distribution management has been a constant issue with suppliers. In general, interchangeable products are valued highly by suppliers to global markets.
- Promised savings must then be further qualified, or discounted, to allow for inter-user variation in lamp configurations, duty hours and marginal electricity tariffs, and inter-regional variation in electricity tariffs. For example, there are non-trivial differences in commercial and residential duty hours and tariffs, and considerable potential for mixed messages and misunderstanding.
- The value of energy savings varies enormously with light output, for example, depending on whether the target is a 25 watt, 40 watt or 60 watt tungsten filament lamp. This may complicate the message to the point where users decide that the claims don't make sense and should be ignored.
- There is evidence that consumers generally pay little attention to packaging information, which therefore increases packaging costs unnecessarily. This is reviewed in chapter 3, in relation to our assessment of a 'labelling only' option for government intervention in the market for lamps.

Whatever the mix of reasons, it is apparent that suppliers have broadly formed a view that information about the dollar value of energy savings does not generally earn, in marketing terms, a place on lamp packaging. Users who want to fully understand the financial implications need to do their own financial calculations.

Reputation of CFLs and adverse selection

CFLs were first commercialised in the early 1980s and, until very recently, diffusion of the technology has been constrained by a number of quality issues. IEA has described the situation as follows.

The first CFLs had limited CCT ranges and tended to be available in only the higher CCT cooler-light values. Current generations are available in a wider range of CCT levels than incandescent lamps, including the same warm hues provided by incandescent lamps. CFLs using magnetic ballasts were prone to delayed starts and long warm-up times and could suffer from flicker. With the introduction of higher quality lamps using electronic ballasts these problems have been overcome and further production scaling up and cost reductions have now made CFL lamps a good alternative for standard incandescent lamps. As with other fluorescent lamps, the CRI of CFLs is not as high as for incandescent lamps. Typical values range from 82 to 86 which is good enough for most applications but may be a barrier in some situations. The highest quality CFLs now have CRIs up to 90. ... Another more serious obstacle that constrained residential sales until recently was their suitability for use in existing fixtures. Early CFLs were only available in a limited range of sizes and were not small enough to fit into many standard incandescent fixtures. In the last few years, however, numerous designs have now become available, allowing them to be used in almost any standard incandescent lamp fitting. In some markets CFLs are now also available in decorative forms such as flame shapes for candelabra fittings. (IEA 2006: pages 122-123)

Given this history of quality issues, it seems likely that take-up of CFLs has been affected by the problem of adverse selection. Adverse selection occurs where users cannot assess product quality prior to purchase and cannot systematically reward the better products with an appropriate price premium. Without that premium it is more profitable to produce products of poor quality ('lemons') and the bad products ultimately drive out better products. The market is consequently confined to the relatively few dedicated users who

acquire knowledge through a repeated process of trial and error. For the remainder, however, IEA (2006: pages 285-290) characterised ongoing user concerns as uncertainty about:

- avoiding use with incompatible dimmers or luminaires;
- how to choose a fluorescent lamp with appropriate light qualities;
- whether suppliers' claims about lamp life and light quality are truthful;
- whether reports of disappointing results are representative of general experience;
- how product performance has improved over time and whether the time is right to experiment again with technologies that have disappointed in the past.

IEA considers that the product history of CFLs has created doubts and reservations about CFLs that no longer have a strong basis in terms of the actual performance of the better quality CFLs that are now available. E3 agrees that, while CFLs of generally unacceptable quality are still manufactured and sold internationally, users are satisfied with the performance of CFLs that have entered the market in recent years. Consider that:

- IEA (2006: pages 122-123) documented a series of technological innovations, in particular, the ability of the latest CFLs to provide the warm coloured light that is associated with incandescent lamps, the use of electronic ballasts to reduce start up times and lamp flickering, and the production of smaller sized CFLs, required by some fittings.
- Many overseas governments responded to the problem of adverse selection by implementing quality standards. These were designed to build trust in CFLs and reward quality improvements. A recent review (Jeffcott *et al* 2006) identified nine existing CFL standards and another four in preparation¹⁰. Two certification standards have been progressively tightened as suppliers improved their products.
 - The UK Energy Savings Trust has certified CFLs since 2001 and, after a series of amendments, implemented Version 6 in February 2008 (EST 2007). Versions 4, 5 and 6 progressively included more types of CFL lamps and amended the requirements to impose maximum start and run-up times, longer operational life and minimum lumen maintenance over the operational life, maximum premature failure rates, improved colour appearance and maximum mercury content.
 - The US ENERGY STAR program has certified CFLs since August 1999 and has a similar history of progressively introducing higher standards. Version 3 was introduced in January 2004 (EPA 2003) and, according to the program's website, Version 4 will be implemented from December 2008.
- E3 now proposes that Australia follow the international lead, by introducing MEPS that define minimum standards for the efficiency, lighting quality and durability of CFLs. This proposal includes recognition of certain overseas certifications and, by definition, is designed to ensure that the Australian market is supplied with superior products that will generally be accepted as like-for-like replacements for incandescent lamps.
- It is apparent from E3's consultations that suppliers are comfortable with the minimum standards that are proposed for CFLs in the Australian market. Products that are certified by the UK Energy Trust are already well-represented in the Australian market.

¹⁰ The multiplicity of quality standards has itself become a problem. The regulation of CFLs is currently the focus of the *International CFL Harmonisation Initiative*, focusing on international harmonisation of CFL test and performance standards and aiming to reduce compliance and manufacturing costs and ultimately reduce the price of high quality CFLs. E3 is actively participating in that initiative.

- The quality of the lighting service provided by CFLs has reached the point where many countries are taking measures that they characterise as ‘phasing-out incandescent lamps’. A stock-take in February 2008¹¹ identified the following:
 - phase-out targets announced: Canada - 2012, Ireland – 2009, US – 2010 to 2012, UK – 2010
 - phase-out plans proposed: Europe – 2011 to 2015, with 60+ watts phased out in 2013, Ghana, Japan, Switzerland
 - accelerated CFL change-over programs in Argentina, Belgium, Egypt, France, Indonesia, Portugal, South Africa and Vietnam.

E3 recognises that there will still be concerns about replacing the familiar pear-shaped globe with CFLs and has modified the proposed measures to deal directly with such concerns. In particular, high efficiency incandescent lamps will still be available and broad classes of lamp will be exempted until product availability and performance improves to the point where lamps can be replaced on a like-for-like basis. Some exemptions may be retained until 2012 or later.

Chapter 3 provides a full account of the proposed measures and appendix A provides supplementary information, including fact sheets to address what E3 considers to be unfounded fears about the safety and convenience of lamp options.

Section 3.1.5 explains E3’s reasons for not proceeding with an original proposal to completely phase-out incandescent lamps, including identification and assessment of a range of product quality issues.

Split incentives

Split incentives occur where the purchaser is not the user or beneficiary and therefore the incentives facing the purchaser differ to the user. Although this presents only a minor problem in the case of lighting, it should nevertheless be addressed.

There are circumstances where appliance selections are delegated to people who do not pay the energy bills and may avoid the consequences of a poor decision, creating a problem of split incentives. In a recent report on ‘principal-agent’ problems in energy efficiency decisions, the International Energy Agency (IEA 2007) explained the problem as follows:

Split incentives occur when participants in an economic exchange have different goals or incentives. This can lead to less investments in energy efficiency than could be achieved if the participants had the same goals. A classical example in energy efficiency literature is the ‘landlord-tenant problem’, where the landlord provides the tenant with appliances, but the tenant is responsible for paying the energy bills. In this case, landlords and tenants face different goals: the landlord typically wants to minimise the capital cost of the appliance (with little regard to energy efficiency), and the tenant wants to maximise the energy efficiency of the appliance to save on energy costs. (IEA 2007: page 25)

The IEA report is an innovative attempt to quantify the split incentive problem in energy efficiency and includes a case study of residential lighting in the US (IEA 2007: chapter 9). IEA considers that split incentives have a negligible effect on residential lamping decisions, arguing that most residential tenants pay their own energy bills and therefore bear the consequences for their re-lamping decisions.

E3 do not find the IEA’s logic entirely convincing, certainly in the Australian context. The problem is that (a) CFLs have long operating lives of 6,000 to 10,000 hours and would often last for 5 years or more, and (b) Australians are highly mobile.

¹¹ Reported on the website of the Collaborative Labelling and Appliance Standards Program <http://www.clasponline.org/clasp.online.whatnew.php?no=517>, referenced on 4 September 2008.

According to the 2006 census, 17% of individuals were not at the same address as 12 months previously and a significant 43% of individuals had moved within a 5 year period¹². This suggests that in order to get full value from their investment in CFLs, many users would need to take their lamps with them when they move house. This may be economically rational behaviour, but could be somewhat tedious and time consuming, and may result in breakages and raise suspicions in the mind of the real estate agent, and is certainly inconsiderate towards subsequent residents. People without a taste for this level of rationality would leave lamps in the vacated premises.

It seems reasonable to classify this problem as one of split incentives, that is, involving the making of lamping decisions that will be inherited by subsequent residents of the dwelling. In addition to the many renters in this situation (28% of households from the 2006 census), similar disincentives affect owner-occupiers who intend to sell or rent the property within a year or two.

It may also be more difficult to negotiate energy saving measures in group households that share energy and re-lamping bills. At the 2006 census, 3% of people lived in group households.

Trends in the Australian market

The main trends in residential lamp usage are in respect of fluorescent lamps and ELV tungsten halogen lamps.

Fluorescent lamps

Regarding fluorescent lamps, table 1.3 reports ABS estimates that 30% of Australian households did not have either linear or compact fluorescent lights in 2005. Almost 40% of households used fluorescent lights as the main form of lighting in one or two rooms, and another 25% used them in three or four rooms. Only 7% of households used fluorescent lights as the main form of lighting in the whole house. A rough calculation¹³ suggests that the average dwelling has 2 rooms that are mainly lit with fluorescent lamps.

The trend is positive in Australia. Forty per cent of households reported no fluorescent lamps at the 2002 ABS survey and only 4% of households reported fluorescent lighting in the whole house. The average dwelling had about 1.5 rooms mainly lit with fluorescent lamps. Comparison with the 2002 and 1999 surveys suggests that there has been little change in the use of linear fluorescent lamps (about one room per house), which means that CFLs have delivered the apparent increases in penetration. That said, there is a suspicion that the question asked by the ABS, which is about fluorescent and 'energy saving' lights, elicits misleading responses from those who believe that extra low voltage tungsten halogen lamps are an efficient form of lighting. They are not.

TABLE 1.3 PENETRATION OF FLUORESCENT LIGHTS: % OF AUSTRALIAN HOUSEHOLDS, 2005

<i>Number of rooms mainly lit by fluorescent lamps</i>	<i>Detached house</i>	<i>Semi-detached, row, terrace or town house</i>	<i>Flat/unit/apartment</i>	<i>Other dwelling</i>	<i>Total households</i>
Households WITHOUT linear or compact fluorescent lights					
Sub-total	26.9%	37.0%	45.9%	26.6%	30.1%
Households WITH linear or compact fluorescent lights					

¹² Calculated from the 2006 Census Community Profile Series, available at <http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Census+data>

¹³ It was assumed that the average number of rooms in the 'four or more' group was 5, and the average number of rooms in the 'whole of house' group was 7.

One	20.0%	23.1%	22.0%	22.7%	20.5%
Two	18.0%	15.3%	15.9%	20.2%	17.5%
Three	12.6%	8.4%	6.3%	9.9%	11.4%
Four or more	15.3%	9.6%	4.4%	8.3%	13.5%
Whole house	7.2%	6.5%	5.5%	12.2%	7.0%
Sub-total	73.1%	63.0%	54.1%	73.4%	69.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Source: ABS 4602.0, 2005 edition (special tabulation because of errors in the published document)

The ABS surveys suggest two other generalisations for Australia. As shown in table 1.3, fluorescent lamps are most likely in detached dwellings and least likely in flats and apartments. They are also more likely in the northern jurisdictions, with Queensland and the Northern Territory returning average room counts of 2.3 rooms and 2.9 rooms, respectively, in 2002. Tasmania had the lowest count – 1.1 rooms on average. A likely explanation is that, historically, fluorescent lamps have provided a ‘cool white’ look that is more acceptable closer to the equator and incandescent lamps have provided a ‘warm’ look that is more acceptable closer to the poles (IEA 2006: page 106). Fluorescent lamps are now available in the ‘warm’ look.

The Australian Greenhouse Office commissioned research on user attitudes to CFLs at about the same time as the 2005 ABS survey (Artcraft 2005). Based on a combination of phone surveys and in-depth interviews¹⁴, Artcraft found that:

- About half of respondents had never purchased a CFL and about a quarter had not heard of CFLs, even after prompting.
- Most CFLs had been purchased fairly recently from supermarkets and discount stores. Only 5.7% were from lighting stores where there was some prospect of specialist advice.
- Users are sceptical about supplier claims regarding globe life and energy savings, but also don’t know how to interpret claims expressed in operating hours and don’t understand that claimed lives are averages and that a proportion of globes must fail at less than the average life.

The import data¹⁵ seems to indicate that there have been significant developments since the 2005 surveys. Australian imports of CFLs increased by 28% in 2006 and then doubled in 2007 – see figure 1.5. However, imports returned to more normal levels in the later months of 2007 and the early months of 2008. This strongly suggests that the 2007 surge in imports was a response to the announcement, in February 2007, that Australia would phase out inefficient incandescent lamps by 2010. The surge started two months after the announcement and lasted for about 6 months. Possibly, the announcement was interpreted as a strong positive endorsement of CFLs, reassuring users that CFLs are safe and reliable. Another contributing factor may have been a belated restocking after strong sales in 2006, in that case due to generous subsidies provided by the NSW Greenhouse Abatement Scheme. The rules have since been amended and the number of CFL ‘give-aways’ under that scheme has fallen significantly.

Overall, the import data indicates that CFLs have been gaining market share. However, the extent of government intervention is such that it difficult to determine how much has been the result of autonomous market forces, and the degree to which it would be sustained in the absence of government intervention.

ELV tungsten halogen lamps

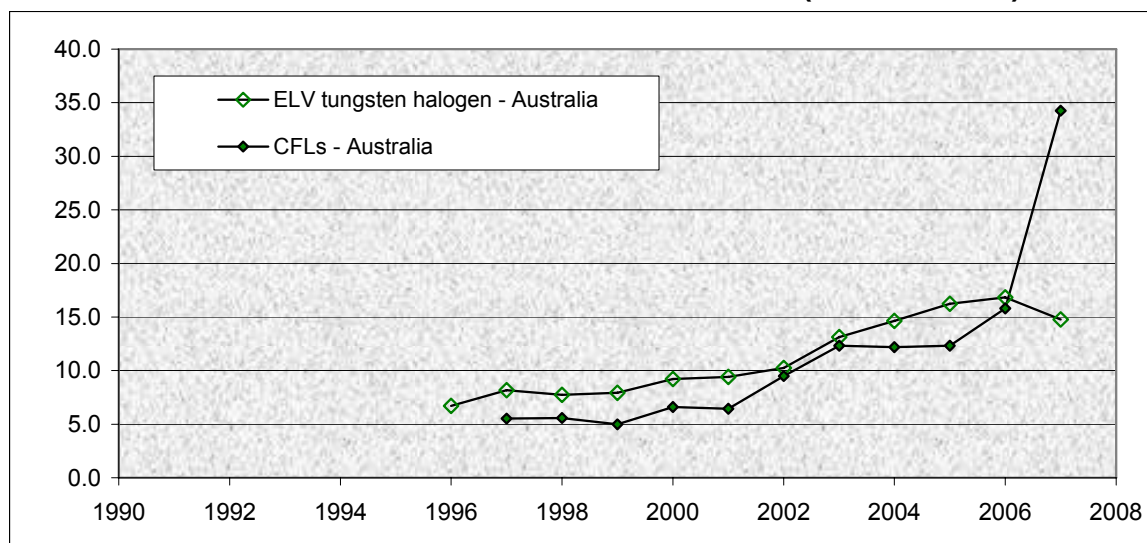
¹⁴ The study involved a series of three focus group discussions, fifteen in-depth interviews and telephone interviews with a representative sample of 600 people 18yrs+ in Sydney and Melbourne during mid to late April 2005.

¹⁵ Source: See figure 1.5 on page 33.

The import data tell us that there has been strong growth in the use of ELV tungsten halogen lamps – see figure 1.5. The trend rate of growth was 8.6%/year over the period 1996 to 2007). There are some indications that the rate of growth has moderated more recently.

- Imports have been flat over recent years.
- TridonicAtco told us that they manufacture 450,000 ELVCs per month at the peak of the market several years ago, using two production lines. Production has since fallen to about 80,000 per month, using one production line. Note that these figures exclude sales of electronic converters, which have increased their market share.

FIGURE 1.5 IMPORTS OF ELV TUNGSTEN HALOGEN LAMPS (MILLION LAMPS)



Source

ABS provides trade data at this level of detail by special tabulation. E3 is monitoring import trends through periodic requests for the latest data.

As noted earlier, low voltage means that the lamp can have a much smaller filament, creating a dot shaped point of light that can be easily focused and directed by a small light capsule. The resulting beam of light is narrow, making these lamps ideal for their original applications, which were to spotlight artworks and retail displays. However large numbers of these lamps are needed when used to illuminate larger areas, such as living areas and retail floorspace. On the evidence of display homes, twenty or more ELV tungsten halogen lamps may be used to illuminate living rooms.

ELV converters

The factors contributing to the continued use of magnetic converters have not been specifically researched. However, we speculate that:

- Buyers may be reassured by the familiar look and feel of magnetic converters. They are solid, chunky and weighty, and the smaller and lighter electronic types may appear inferior in comparison.
- While electronic converters can be adequately substituted for magnetic converters in at least 95% of cases (suppliers say 99%), magnetic converters should be used where durability is important and where the converter cannot be installed within two metres¹⁶ of the lamp. The stories resulting from inappropriate use of electronic converters may create doubts in the mind of the buyer.

¹⁶ We understand that the 2 meter rule is to protect against interference created by electromagnetic radiation that is emitted from the wires on the output side of the ELVC, carrying the low voltage current provided by

Conclusion on market failure

The figuring reported in chapters 4 and 5 indicates that the lighting service provided by incandescent lamps and ELVCs is unnecessarily expensive. For example:

- In the case of a lamp that is used one hour per day, conversion from tungsten filament to CFL would save 85 cents of electricity per year, cost an additional 20 cents per year in lamps, and reduce the re-lamping task by a factor of 6.
- Electronic converters are now generally cheaper than the less efficient magnetic type, which means their use can save on both the installation and running costs of ELV tungsten halogen lamps.

E3 considers that this unnecessary expense is caused by market failure, given the evidence of information failure and split incentives. The IEA came to the same conclusion in a recent review of policies for energy efficient lighting, introducing its discussion of barriers to energy efficient lighting with the following remarks.

Acknowledging cost-effective potential and realising all of it are quite different matters. Undoubtedly, some part of the potential will be realised through normal market forces, but an important share will be hampered by factors that make the market function less effectively; in turn, this presents a rationale for policy intervention. (IEA 2006: page 285)

1.5 Role of energy efficiency programs after CPRS is introduced

In 2007, the Australian Government formally announced its intention to introduce a Carbon Pollution Reduction Scheme (CPRS) (previously known as the Emissions Trading Scheme) by 2010. Economic literature suggests such a scheme can be used as an effective policy tool for internalising the costs associated with greenhouse gas emissions. However, even under a CPRS, there may still be a role for complementary policies.

Energy efficiency measures have been proven in some circumstances as a cost-effective method for households and businesses to reduce energy consumption while delivering greenhouse gas abatement. All other things being equal, the increase in costs of energy resulting from a CPRS should encourage households and businesses to improve the efficiency of their energy use. However, in some instances, market failures and/or other factors may act to mitigate some of the impacts of a CPRS, and therefore complementary energy efficiency measures may be appropriate.

For example, the presence of split incentives (such as between building owners and tenants) may lessen the effectiveness of a CPRS in delivering an 'optimal' investment in energy efficiency in tenanted dwellings.

In other instances, the transactions costs of investing in energy efficiency may outweigh the marginal benefits of such investments, even in a CPRS environment. For example, the potential energy savings to consumers may be small, relative to the time and effort required to calculate the associated life cycle costs when purchasing a product. In this circumstance, it is possible that a CPRS will not deliver an optimal investment in energy efficiency. A similar situation can arise if there is imperfect information, such as a lack of comparative energy consumption data on energy bills.

Taking into account the above factors, in some situations it is possible that the increase in electricity prices induced by a CPRS may result in a relatively small rise in demand for energy efficient products. Therefore it is possible that the carbon abatement costs induced by complementary energy efficiency measures may be lower than those induced solely

an electronic converter. Some sites don't have the ceiling or wall cavities that are needed to install converters close to lamps.

under a CPRS. In such cases, it may be beneficial to consider energy efficiency policies, including MEPS and energy labelling, in conjunction with a CPRS.

The CPRS will address the problem of excessive emissions; however in relation to lighting products, a CPRS will not:

- align the interests of a series of relatively temporary residents at an address, nor deal with the issue of split incentives;
- improve the literacy and numeracy skills of people who need to adjust their carbon budgets; or
- deliver the necessary information on an energy bill that informs the user whether investments in energy efficient lamps delivered the expected savings.

In short, the CPRS does not deal with the problems that people face in adjusting to the scheme and as such complementary measures are required.

2 Objectives of government action

2.1 Objective

The objective of government action is to contribute to cost-effective greenhouse abatement in Australia. The assessment of cost effectiveness includes consideration of both the direct financial impact and any effects on health, safety and the environment.

2.2 Assessment criteria

Abatement measures that do not increase the life-cycle cost of appliances are considered to be cost-effective. This means that the value of the energy savings to the user is not less than the incremental purchase price of a more efficient appliance and the ‘no regrets’ criterion is satisfied. The contribution to abatement is implicitly valued at zero.

The Ministerial Council on Energy (MCE) has determined that it will also consider greenhouse abatement measures that have a net financial cost to Australians, provided the net cost (per tonne of CO₂-e) is not higher than the cost of abatement achieved by other programs. This determination recognises that regulatory proposals can deliver a net benefit to the community despite an increase in financial costs, and implicitly puts a positive value on the contribution to abatement.

While MCE has not defined the maximum price that it is willing to pay for greenhouse abatement, Appendix E includes some supplementary figuring that assumes a value of \$10-20/tonne.

Several secondary assessment criteria have also been applied:

1. Does the option address market failures?
2. Does the option minimise negative impacts on product quality and function?
3. Does the option minimise negative impacts on manufacturers and suppliers?
For example, the measures need to be clear and comprehensive, minimising the potential for confusion or ambiguity for users and suppliers.

3 The policy options

This chapter explains the specific measures proposed for incandescent lamps and CFLs, including why E3 abandoned a more radical proposal to completely phase out incandescent lamps (section 3.1), and identifies other policy options that E3 has considered as an alternative to imposing MEPS (3.2).

3.1 Proposed regulation

3.1.1 Australian Import Restriction

The proposed import prohibition on GLS lamps commenced from 1 February 2009 and was written into the *Customs (Prohibited Imports) Regulations 1956* as an amendment in mid December 2008. To disseminate this information, the Australian Customs Service (ACS) implemented a messaging service in late December 2008, to notify importers of incandescent lamps of the incoming imports restriction. Further, as part of the import restriction arrangements, the ACS has agreed to provide DEWHA with lighting import data which will assist in the preparation of the point of sale MEPS implementation in November 2009.

The proposal also includes the placement of import prohibitions upon further inefficient lighting products in advance of the point of sales MEPS (see table 3.3), however the feasibility of those import prohibitions will be subject to further consultation with the Australian Customs Service.

3.1.2 Scope of the MEPS

MEPS are proposed for certain incandescent lamps and CFLs and for the ELVCs used with ELV lighting.

In layman's terms, the incandescent lamps that fall within scope of the regulation are defined mainly by the physical shape of the lamp and the type of 'cap', such as the conventional pear-shaped globe with a bayonet cap. These characteristics effectively limit the regulation to the types of lamp used predominantly in dwellings and to a lesser extent in commercial and industrial buildings. See appendix A for a list of the types of incandescent lamps that are commonly used in residential applications. However, suppliers should not rely on Appendix A to define the scope of the regulation. It simply illustrates the most common types of incandescent lamp that are in scope and other types that are not in scope.

The MEPS for CFLs apply only to CFLs with integrated ballast.

- AS/NZS 4934.1: *Incandescent lamps for general lighting purposes - Test methods - energy performance*
- AS/NZS 4934.2: *Incandescent lamps for general lighting purposes - minimum energy performance standards (MEPS) requirements*
- AS/NZS 4847.1: *Self-ballasted lamps for general lighting services - Test methods - energy performance*
- AS/NZS 4847.2: *Self-ballasted lamps for general lighting services - minimum energy performance standards (MEPS) requirements*
- AS/NZS 4879.1: *Performance of electrical lighting equipment - Transformers and electronic step-down converters for ELV lamps - Part 1: Test method-Energy performance.*

- AS/NZS 4879.1: Performance of electrical lighting equipment - Transformers and electronic step-down converters for ELV lamps - Part 2: Energy labelling and minimum energy performance standards requirements.

The measures will not affect the following activities with intensive or special lighting requirements:

- traffic management
- operating theatres
- stage productions
- photography and movie-making
- activities requiring enhanced spectrum lamps, such as speciality horticulture and aquaculture

3.1.3 Level of MEPS

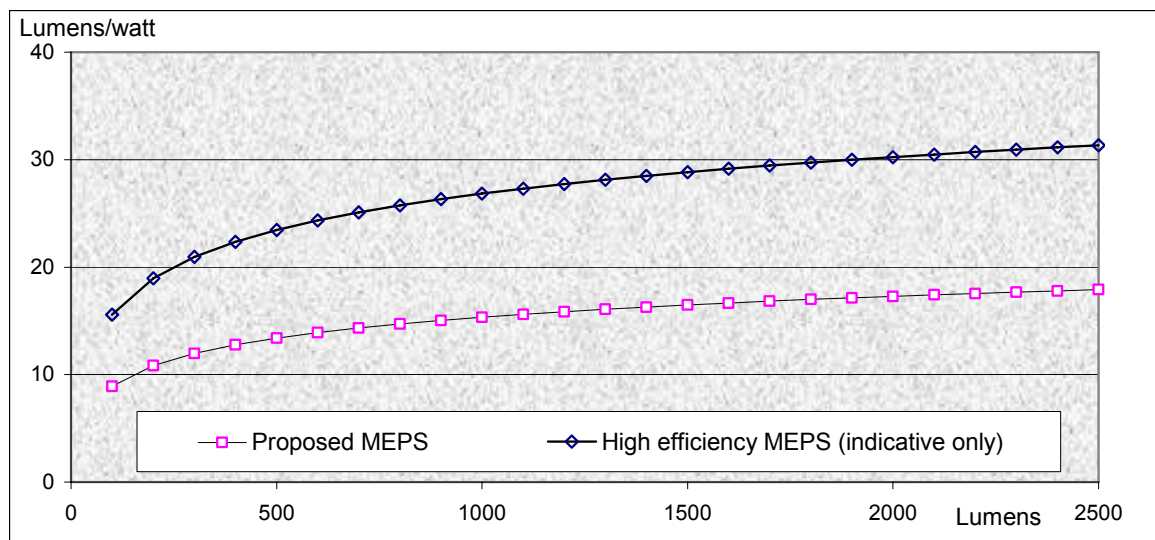
Incandescent lamps

The proposed MEPS is based around a minimum efficacy level of 15 lumens/watt for an incandescent lamp generating 900 lumens (900 lumens is the amount of light emitted by a 60 watt lamp that would just meet MEPS). However, there is a sliding scale that is defined mathematically. Figure 3.1 shows how the MEPS requirement increases with the lumen output of the lamp.

We understand that tungsten filament lamps cannot meet this standard and will be phased out. However, MEPS will not require the phasing out of incandescent lamps of the tungsten halogen type, since this technology can comply with the standard. Some compliant lamps are already available in the market.

It is also proposed that only lamps that significantly exceed the MEPS can be designated as 'high efficiency', possibly 75% more efficient. The current generation of tungsten halogen lamps would not qualify as high efficiency lamps.

FIGURE 3.1 PROPOSED MEPS – INCANDESCENT LAMPS



The MEPS for a reference lamp generating 900 lumens is at 15 lm/w. (900 lumens is approximately the amount of light emitted by the common 60 watt globe.) There is a sliding scale for other lamp sizes, with progressively lower MEPS for lamps providing less than 900 lumens and progressively higher MEPS for lamps providing more than 900 lumens. The requirements are defined by the following formula:

$$\text{Initial efficacy} \geq 2.8 * \ln(\text{initial lumens}) - 4.0$$

Compact fluorescent lamps

Table 3.1 defines the proposed requirements for CFLs. These are the local or default requirements that will apply if the CFL attribute is not certified to one of two overseas schemes, which are the certification schemes of the Efficient Lighting Initiative (ELI) or the UK Energy Savings Trust (EST). See appendix A for details of these schemes.

There are three broad groups of issues in addition to the energy efficiency specifications.

- There are light quality requirements, relating to the appearance of illuminated objects and the immediacy of the response to lighting controls.
- There are durability requirements, relating to the effective life and longer term performance of the lamp.
- There are also external impact requirements to ensure that CFLs do not impact adversely on the operation of electricity networks and the environment.

The light quality requirements and, to a lesser extent the durability requirements, address issues of concern to users in previous generations of CFL products. Other countries have regulated the lighting performance of CFLs, not just their energy efficiency, aiming to protect inexperienced customers from inferior products that unfairly damage the reputation of CFLs. They have developed a range of standards in the process and E3 has identified the ELI and EST certification schemes as compatible with the standards proposed for Australia.

TABLE 3.1 PROPOSED MEPS – COMPACT FLUORESCENT LAMPS

<i>Attribute</i>	<i>Local or 'default' requirements, if CFL attribute is not certified under the certification schemes of either the Efficient Lighting Initiative (ELI) or the UK Energy Savings Trust (EST)*</i>
Energy efficiency requirements - minimum efficacy in lm/w	
Bare lamp efficiency	$\frac{1}{\frac{0.24}{\sqrt{F}} + 0.0103}$ Where F = initial luminous flux in lumens
Covered lamp efficiency	$\frac{0.85}{\frac{0.24}{\sqrt{F}} + 0.0103}$ Where F = initial luminous flux in lumens
Reflector lamp efficiency	$\frac{0.6}{\frac{0.24}{\sqrt{F}} + 0.0103}$ Where F = initial luminous flux in lumens
Light quality requirements	
Colour appearance	IEC 60081 Graph D-16 for CCT 2700. Other temps to be approved but following same diagram***
Minimum CRI (colour rendering index)	80
Maximum starting time (seconds)	2.0
Maximum run-up time (min)	1.0
Durability requirements	
Minimum lumen maintenance	2,000 hrs = 0.88 / 5,000 hrs = 0.80 / 10,000 hrs = 0.75
Maximum premature lamp failure rate	10% at 30% of rated life

Minimum switching withstand	1,000 Cycles
Minimum lifetime (hours)	6,000

Requirements relating to external impacts

Minimum power factor	0.55 (0.9 for lamps claiming high PF)
Maximum mercury content (mg)	5**
Harmonics	AS/NZS 61000.3.2

Note:

* See appendix A for details of the alternative certification schemes. If the lamp is certified to ELI or EST, for which starting time, run-up time and mercury content may not be specified, then the lamp shall comply with the local criteria.

** To be measured in accordance with AS/NZS 4782.3

*** IEC = International Electrotechnical Commission

The option of certification against the existing ELI and EST schemes would ensure that a good range of compliant product is available when the MEPS is first implemented and reduce regulatory barriers to the competitive supply of CFLs. Appendix A provides the details of these alternative certification arrangements. More information is available from their websites: www.efficientlighting.net and www.energysavingtrust.org.uk.

Extra low voltage converters

Table 3.2 defines the proposed MEPS for ELVCs. Figure 3.2 shows how these relate to the observed range of converter efficiencies. Formally, the MEPS vary with the rated power of the converter, measured in volt-amperes (VA). For our purposes, volt-amperes are equivalent to wattage (W). A stepped arrangement is proposed, with lower MEPS for ELVCs up to 200 VA. This ensures that the option of a magnetic converter is always available. Electronic converters are not suitable for applications where a more robust unit is required and where the converter cannot be located within two metres of the lamp.

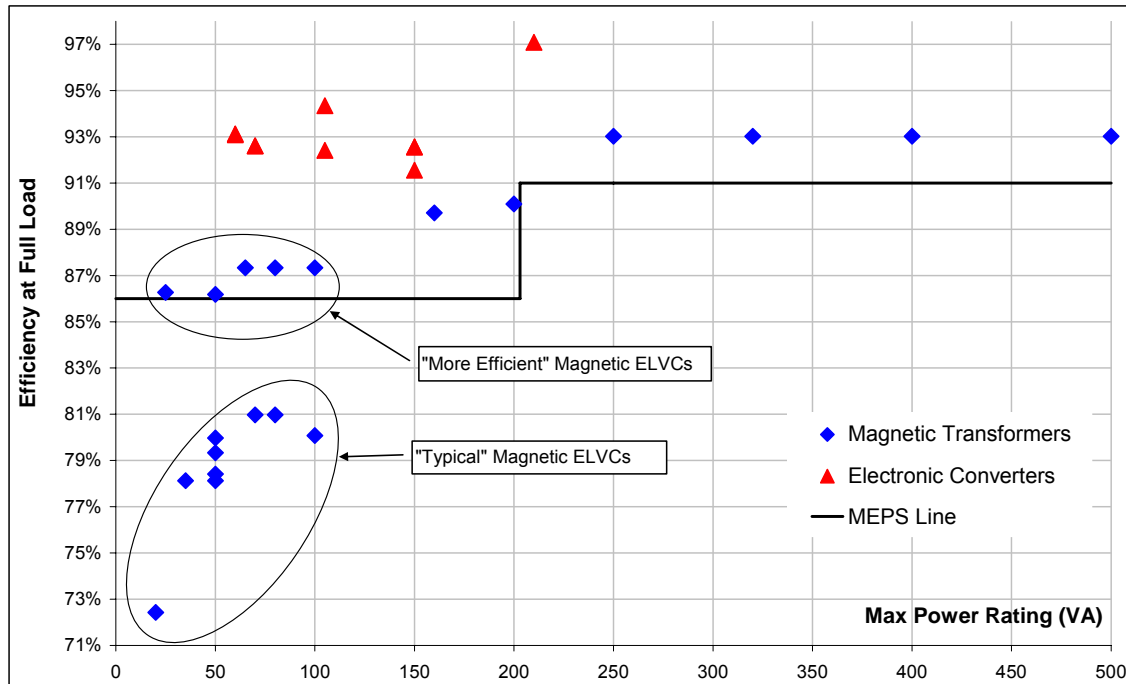
TABLE 3.2 PROPOSED MEPS – EXTRA LOW VOLTAGE CONVERTERS

Rated converter power (VA*)	MEPS level (% efficiency at full load)
≤ 200 VA	≥ 86%
> 200 VA	≥ 91%

Note:

* VA = volt-amperes, a measure of the converter capacity. For our purposes, it is equivalent to wattage.

FIGURE 3.2 EFFICIENCY OF ELVCs AND PROPOSED MEPS



3.1.4 Timing of MEPS

The MEPS apply to the sale of lamps and ELVCs. Implementation for a range of lamp types, including GLS lamps, will commence in November 2009, with implementation of the MEPS for most other lamp types proposed to occur in stages between 2010 and 2012. Table 3.3 provides a schedule of the staged application of MEPS. This schedule will be reviewed annually by a committee consisting of lighting industry and Government representatives, with the benefit of up-to-date market and product information. Timing of the phase-out will be adjusted where necessary to take into account the availability of efficient alternatives.

Table 3.3 also refers to related import restrictions that will be implemented 12 months earlier than the MEPS on sales, if that proves feasible. This arrangement would apply only to lamps, not ELVCs. The 2-stage process allows lamp stocks to be run down over 12 months. Hereafter, we refer to the date of application to sales (the later date) as the date of implementation.

E3 plans to implement a second round of MEPS from 2013, at 20 lumens/watt for a reference lamp of 900 lumens. Government representatives will work with the lighting industry to review the second round options in 2011, focusing on the feasibility of the 2013 timing and target. Again, a second round of MEPS will only be implemented as viable, efficient and affordable alternatives become available.

TABLE 3.3 SCHEDULE FOR MEPS IMPLEMENTATION

<i>Implementation date for MEPS at point of sale</i>	<i>Implementation date for import restriction* (Lamps only, Australia only)</i>	<i>Products required to comply</i>
	February 2009	- GLS**
November 2009	-	- GLS** - extra low voltage (ELV) halogen, non-reflector - CFL, non-reflector
October 2010, subject to annual review	October 2009, subject to annual review	- >40w candle, fancy round & decorative lamps - Mains voltage halogen non-reflector - ELV halogen reflector - ELVC***
October 2011	October 2010	- CFL, reflector
October 2012, subject to annual review	October 2011, subject to annual review	- Mains voltage reflector lamps, inc. halogen - >25w Candle fancy round & decorative lamps
To be determined dependent on availability of efficient replacement product		- Pilot lamps and other lamps 25w and below
Beyond 2015		- All incandescent lamps

Note:

* The feasibility of import restrictions is the subject of ongoing investigations.

** General lighting service (GLS) lamps are the familiar non-reflector incandescent globes that have been traditionally supplied to Australian markets with tungsten filaments and bayonet caps. Table A.1 in appendix A describes the main types of lamp.

*** ELVCs will not be subject to an import restriction 12 months earlier.

3.1.5 Communication strategy and labelling reform

All users will need to come to grips with new lighting technologies if conventional tungsten filament lamps are phased out. E3 proposes to assist users by conducting a communications campaign and reforming labelling practices.

The communications strategy has developed considerably since the release of the consultation RIS. It deals with the more immediate information needs of the community and the main elements are described here.

The lamp labelling options are the subject of ongoing discussions with suppliers and E3 does not propose comprehensive labelling measures for the current version of the MEPS. These are medium to longer term issues that, to a degree, need to be coordinated internationally. E3's current thinking on the broad issues is described here.

Communications campaign to address immediate issues

Most people will need to put some thought and effort into their lamp replacement decisions as the range of familiar products contracts over time. The NFREE Stage 2 Lighting Committee has developed a communications strategy to facilitate that process. A variety of communication channels are being considered, and may include information leaflets, a 1300 phone service, point of sale displays and the use of intermediaries like lighting designers, retailers and installers, who will be provided with appropriate training through existing training providers. The main work of communications will be to inform and advise consumers about their lighting options and how to make the transition to energy efficient lighting, and about health, safety and environmental issues.

The initial focus of the communication strategy will be point of sale (POS) materials in prominent retailers, including supermarkets, hardware and department stores. POS materials will inform consumers about what the phase-out means, what lamps are being phased out and what energy efficient alternatives are available. The materials include a lamp conversion chart that identifies the energy efficient equivalents of the incandescent lamps that are being phased out. In-store information will be linked to and supported by a web site with fact sheets and answers to frequently asked questions. Consumers and market intermediaries (lighting retailers, installers and designers) will be engaged through a series of public relations events and activities, media liaison, and articles in relevant trade magazines, journals and energy utility newsletters.

Health and environmental issues

Fact sheets have been prepared on a number of health and environmental issues that may cause concern for a minority of users. The current versions of the fact sheets are reproduced at appendix A and can also be found at:

<http://www.environment.gov.au/settlements/energyefficiency/lighting/index.html>

The fact sheets provide information on the following matters.

- *Photosensitivity Epilepsy*: CFLs are not more likely to be a risk to people with photosensitive epilepsy than other light bulbs.
- *Systemic Lupus Erythematosus*: Ultraviolet (UV) light from CFLs can be somewhat higher than incandescent light bulbs of equivalent (visible) light output, and may pose a problem for sensitive sufferers of Lupus if not ameliorated. The use of standard acrylic light covers or diffusers as set out in the fact sheet effectively eliminates any risk for most Lupus sufferers.
- *Meniere's disease*: CFLs 'flicker' at a rate well above that detectable by the human brain and so should not affect sufferers of Meniere's disease or migraine headaches.
- *Fluorescent Lamps, mercury and end-of-life management*: Scientific investigation indicates that it is unlikely that short-term exposure prior to, or during or after cleaning up a broken CFL could constitute a health risk. Less mercury is released into the environment from the use of CFLs than incandescent lamps.

Compatibility and safety

CFLs and tungsten halogen lamps are safe but, as with all electrical equipment, some care is required to ensure correct installation. Information will be provided, particularly on the website, explaining the lighting control systems that may not be compatible with CFLs and giving advice on safety and end-of-life issues. The following are key messages.

- CFLs operate satisfactorily on conventional 'switch' circuits but, unless specifically designed to do so, may not operate satisfactorily when controlled by an electronic dimmer, touch control, sensor, timer or other electronic controller. CFLs may not operate at all on such circuits, may flicker, and may experience a limited life. The use of non-compatible CFLs on such controllers may also damage the controller. Users should carefully read manufacturers' instructions, take expert advice before using CFLs in these circumstances, or otherwise reassure themselves that the CFL is designed for those circumstances.
- CFLs can be less tolerant of extreme conditions than incandescent lamps and may not perform adequately, particularly in terms of durability. These conditions include excessively low temperatures, high temperatures such as those created in some canister fittings used to house downlights, and moist conditions such as those encountered in bathrooms.
- Users who attempt a comprehensive changeover to CFLs may find that some lamp shapes and sizes are not readily available in the first instance. While the range of

CFLs available is expanding rapidly, E3 has recognised these market realities by providing exemptions for certain decorative and fancy shapes until the product range is more comprehensive. Therefore, users should not be concerned about continuing to use the available incandescent options where a suitable CFL replacement is not available.

- Whereas a tungsten filament lamp simply stops working when the filament finally burns out and breaks, CFLs, like other electronic appliances may fail in a number of different ways at the end of their life. The CFL may overheat in the process of trying to re-start itself and continues to do that until failure of its electronic components. A small proportion of CFLs may fail in ways that can be of concern to consumers, emitting smoke, soot, molten plastic and flame, or some combination of these for a short period of up to 20 seconds. All CFLs imported into Australia are required to meet Australian Standards (aligned with international standards) that specify safety parameters including the way in which the CFLs may fail when they reach the end of their life.
- CFLs are designed to fail safely even if somewhat dramatically on occasion, primarily by enclosing the electronic components in a fire retarding capsule.

Alternatives to CFLs

Communication materials will emphasise that the use of CFLs is not mandatory, that not all incandescent lamps will be banned, and that a broad range of halogen incandescent lamps will comply with the MEPS and will be available to those who, for whatever reason, cannot or prefer not to use CFLs. The communications campaign will explain about higher efficiency incandescent lamps, including that they use less energy, but do not save nearly as much energy when compared to a CFL.

Options for future reform of lamp labelling

As noted in section 1.4, suppliers have anticipated the needs of CFL buyers and provide packaging information in terms of equivalence with tungsten filament lamps, for example, that a 14 watt CFL provides the same light as a 60 watt tungsten filament lamp and lasts 6 times as long. While there is presentational variation between suppliers, the common element is that tungsten filament lamps are used as 'reference lamps'. Suppliers assume familiarity with such lamps. The lamp conversion chart that E3 will use in POS displays is based on the same idea. The DEWHA website now provides such a chart at the following address.

<http://www.environment.gov.au/settlements/energyefficiency/lighting/index.html#conversion>

The transitional advantages of this approach are (a) it deals with the most urgent needs, and (b) the information is provided with reference to familiar measures and technologies. However, several problems will become more and more pressing over time.

- The reference point is variable, since the light output from a tungsten filament lamp varies with the efficacy of the lamp.
- Comparative labelling with reference to tungsten filament lamps will become increasingly irrelevant as tungsten filament lamps recede into history.
- New conventions may emerge, using CFL and tungsten halogen wattages to indicate light output. Confusingly, they may coexist with the old convention.
- The diffusion and commercialisation of LEDs and other new lighting technologies will confuse the situation even further.

E3 considers that, sooner or later, users will need technologically neutral information that allows them to directly compare the light output from different lamps, rather than refer to a growing list of equivalence scales for energy input. Specifically, users will need to

understand light output in terms of lumens and recognise wattage as a measure of energy input that has a highly variable relationship with light output.

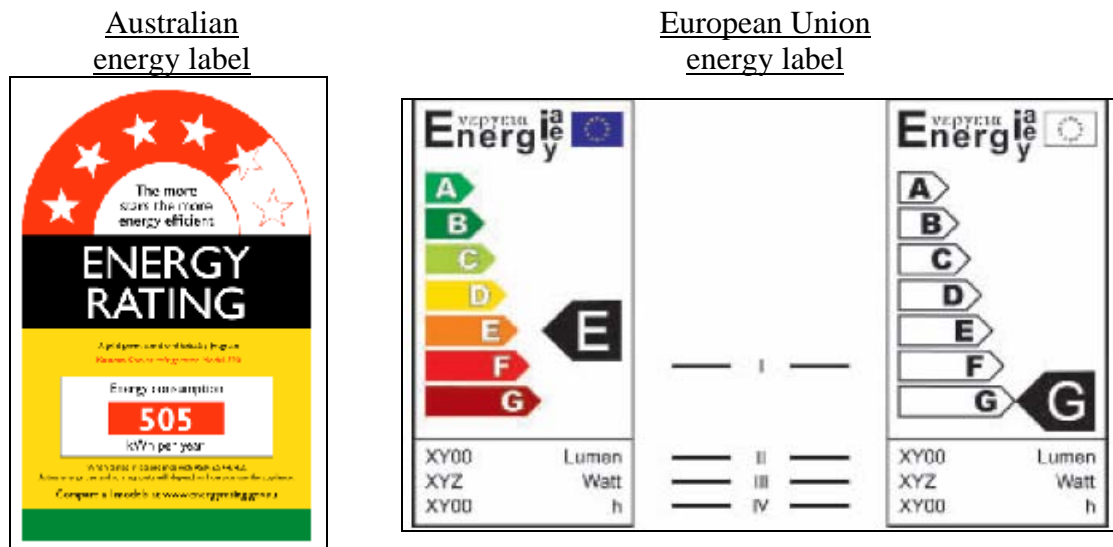
This learning process will be variously welcomed and resented in the short term but seems to be a necessary investment if lamp labelling is not to become confused and dysfunctional in the longer term. North American regulators have already adopted a technologically neutral approach and EU regulators propose to do the same. Common elements of the US, Canadian and (proposed) European schemes are that lamp packaging will include statements of light output in lumens, energy use in wattage, and lamp life in hours.

A related issue is whether energy efficiency should also be indicated by means of a comparative label. E3 has no preferred options at this stage. It would be preferable to adapt the energy rating system that is well-established in Australia, and which is now widely understood as ‘the more stars the better’. But, due to the costs associated with this label, suppliers have strongly resisted the implementation of a comparative label that is not identical to the European label, which grades lamps from G to A – see figure 3.3 below. E3 considers that adoption of the European label would be confusing and costly, and has not pursued this option.

The next best option to full comparative labelling is to follow the North American lead and require the following further statement.

To save energy costs, find the bulbs with the light output you need, then choose the one with the lowest watts.

FIGURE 3.3 ENERGY LABELS IN AUSTRALIA AND EUROPE



E3 is also consulting with suppliers on the need to mandate the provision of other information on lamp packaging, for example:

- whether the lamp is dimmable and the extent of compatibility with existing luminaires (the light fitting)
- colour characteristics and performance characteristics like starting time, warm-up time and lumen maintenance
- power factor and disposal methods

This more extensive information has been proposed for Europe, either on or with each package. But the following matters will need to be taken into account:

- There is relatively limited space on lamp packaging;

- Suppliers are motivated to provide information that reduces the incidence of customer dissatisfaction and product returns, for example, to warn that the product is not dimmable or is incompatible with certain luminaires;
- Some types of information are technically complex and may need to be presented in non-technical language, for example, colour characteristics reported as 'soft white' or 'cosy white' rather than CCT (colour correlation temperature);
- Variations in some performance characteristics would be reduced by the proposal to regulate the performance of CFLs, as outlined in table 3.1; and
- E3 can deal with these issues in its communications campaign.

Looking to the longer term, the labelling scheme should address the needs of a lighting market that may become more technologically active and diverse, including LEDs with lighting qualities that are quite different to those now available.

E3 has not included comprehensive labelling reform in the current proposal but intends to monitor international labelling developments and consider the inclusion of labelling reform at a later date, in consultation with industry. The next meeting of the lighting standards committee of Standards Australia is scheduled for May 2009 and provides an opportunity to consider the feasibility and usefulness of interim labelling reforms with a limited range of requirements, prior to more comprehensive labelling reforms at a later date. Responses to the consultation RIS included comments on labelling constraints and needs, and E3 will take these into account.

Restricted use of comparative 'energy savings' claims

The option of a 'high efficiency' MEPS for incandescent lamps has already been noted, indicatively at 75% above the proposed MEPS. This would ensure that complying incandescent lamps that remain in the market, which will be much less efficient than CFLs, are not marketed as 'energy savers'.

3.1.6 Why E3 revised its original proposal to ban incandescent lamps

E3 initially proposed to phase out all incandescent lamps, albeit with long delays for certain types of lamp, out to 2015. However, this raised serious problems regarding the availability of replacement products, particularly for lighting systems that use dimmers, sensors, timers and other forms of electronic control. The proposal was revised to avoid potentially large costs of prematurely scrapping lighting assets. This section identifies all of the issues raised by the initial proposal and reports E3's assessment of those issues.

We emphasise that the following discussion relates to the original proposal and should be read with that in mind. E3's revised proposal is to substantially neutralise these concerns by setting the MEPS at a level that allows the continued use of the more efficient types of incandescent lamps. E3 will also use labelling and communications measures to minimise the potential for inconvenience, frustration and poor product selection.

Inherent issues relating to the quality of surface illumination

1. *Colour appearance of the illuminated surface*: Objects look 'natural' in the light of an incandescent lamp but can look odd under fluorescent lighting, depending on the quality of the lamp. On a scale of 1 to 100, with sunlight at 100 and most incandescent lamps close to 100, recent generations of fluorescent technologies are in the range 70-95 and compact fluorescent lamps are in the range 82-85¹⁷. We understand that there is little evidence that people make fine distinctions based on this score and that there are no strong preferences over scores between 80 and 100 (IEA 2006: page 84). E3 proposes a minimum score of 80 for CFLs. This issue was rated as MINOR under the

¹⁷ The colour rendering index (CRI) is the metric used to measure this aspect of a lamp's performance. (IEA 2006: page 106)

original proposal and will be further reduced by the continued availability of incandescent lamps under the revised proposal.

2. *Lumen depreciation:* Both incandescent and fluorescent lamps suffer from lumen depreciation, which is a reduction in lighting power over the life of the lamp. The rate of depreciation is higher for fluorescent lamps, with losses in the range 10-20% at average lamp life. E3 proposes a maximum of 20% lumen depreciation for CFLs at 5,000 hours. The issue was rated as MINOR under the original proposal and will be further reduced by the continued availability of incandescent lamps under the revised proposal.
3. *Spotlighting and downlighting of the illuminated surface:* A light source is more easily directed if it has been reduced to a point of light, and that is the particular attraction of ELV tungsten halogen lamps. It is more difficult to collect and control the light from the relatively large tubes of fluorescent lamps. They are not generally used for spotlighting retail displays, artworks and other 'features' of that kind. Putting aside legacy issues, there seem to be three future options for more energy-efficiency spotlighting and downlighting. None is entirely convincing at this stage and, under the original proposal, there would have been MODERATE losses of lighting quality in these applications.
 - (a) Suppliers have developed a ELV tungsten halogen lamp that uses an infra-red coating (IRC) to capture what would otherwise be waste heat and reduce the amount of electricity needed to keep the lamp at operating temperature. Some have claimed efficacy of 25lumens/watt. This is less than one third of the efficacy of CFLs but about 67% higher than ELV tungsten halogen lamps without the infra-red coating.
 - (b) Suppliers have introduced CFL lamps of super compact design for downlighting, including products that directly replace ELV lamps. While likely to become a suitable replacement for most domestic downlights used for general lighting, they provide significantly less control over the 'spot'.
 - (c) Light emitting diode (LED) lamps will perform the task but it is uncertain when they will be available at reasonable cost. They operate on low voltage power and require an ELVC.

Concerns about the adequacy of these replacements are negated by the continued availability of ELV lamps under the revised proposal.

4. *Flicker:* Flickering is a problem associated with fluorescent lights on magnetic ballasts. These problems have been overcome by high frequency ballasts using electronics (IEA 2006: page 122). This issue is rated at NIL, even under the original proposal.
5. *Effectiveness under extreme conditions:* Fluorescent lamps are generally less effective under extremes of heat and cold. HID lamps would fill the gap under the original proposal: they have an efficacy comparable to fluorescent lamps. This issue was rated as MINOR under the original proposal and is negated by the continued availability of incandescent lamps under the revised proposal.
6. *Dimmers:* The legacy issues relating to dimmers are discussed at item 3(c) in this list. Putting those issues aside, and given sufficient time, suppliers are confident that dimmable CFLs will be available at reasonable cost. There is some work to be done on standards for dimmers and CFL to ensure that, in future, all dimmers are compatible with all dimmable CFLs. Dimmable CFLs have the compensating feature of maintaining their efficacy at less than full power, whereas the efficacy of incandescent lamps falls significantly as the power is reduced. This issue was rated as NIL under the original proposal, provided sufficient time for product development is allowed. The problem is eliminated by the continued availability of tungsten halogen lamps under the revised proposal.
7. *Start-up and warm-up times:* Whereas incandescent lamps provide 'service on demand', fluorescent lamps can take a noticeable amount of time to start and may not

reach full power for one or two minutes. E3 proposes a maximum start-up time of 2 seconds for CFLs and expects most CFLs to have a start-up time of no more than 1 second. The maximum warm-up time is 1 minute. High quality CFLs with electronic ballasts will perform adequately and these issues are rated as NIL, even under the original proposal.

Inherent issues relating to qualities of the lamp

1. *Colour appearance of the light:* People also have preferences for the colour appearance of the light from a lamp¹⁸, that is, what is seen when one looks directly at the light source or experiences glare from the light source. Lighting designers aim for the natural look of sunlight, which varies with latitude, season and time of day. Historically, fluorescent lamps have provided a 'cool white' look that is more acceptable closer to the equator and incandescent lamps have provided a warm look that is more acceptable closer to the poles (2006: page 106). This may be a factor in the higher penetration of fluorescent lamps in Queensland and the Northern Territory. More recently, fluorescent lamps have also become available in the 'warm' look. This issue was therefore rated as MINOR under the original proposal and is further reduced by the continued availability of incandescent lamps under the revised proposal.
2. *Lighting effects:* Chandeliers sparkle when illuminated by tungsten filament lamps but do not when replaced by a CFL. The same effect is exhibited when viewing diamonds. This is caused by the size of the light source which means future LED designs could give the same effect. This issue was rated as MINOR under the original proposal and is eliminated by the continued availability of incandescent lamps under the revised proposal.
3. *Reduced life when operated outdoors:* Fluorescent lamps are susceptible to humidity but linear fluorescent lamps have been used in street-lighting applications for many years and CFLs are being introduced to the same market. Lamps suitable for outdoor operation would be available under the original proposal but would require more careful selection. This issue was therefore rated as MINOR under the original proposal and is further reduced by the continued availability of incandescent lamps under the revised proposal.
4. *Appearance of lamps:* CFLs can look odd or ugly in comparison to the traditional globe, particularly in situations where a decorative lamp (fancy round or candle shape) is currently used. This is moderated somewhat by products that hide the tubes in a globe with the traditional appearance. This issue was rated as MINOR under the original proposal and is eliminated by the continued availability of incandescent lamps under the revised proposal.

Legacy issues relating to the compatibility of new lamps with old fittings and circuits

8. *Compatibility with existing luminaires and fittings:* Users have sometimes been unable to acquire CFLs that will fit into existing luminaires and fittings, mostly because the base of a CFL contains a ballast that makes the lamp somewhat bulkier. Suppliers now say that the range of CFL products has improved greatly, to the point where the products required for the vast majority of applications will be readily available in supermarkets. Any residual inconvenience and frustration would have been MINOR under the original proposal and is eliminated by the continued availability of incandescent lamps under the revised proposal.
9. *Compatibility with existing lighting control sensors:* A range of sensors are used to control lights, turning them off and on in response to time, motion, occupancy, daylight or touch. A wiring configuration that is commonly used in Australia is such that the sensor only receives a partial power supply, which means that power is available to the

¹⁸ The correlated colour temperature (CCT) is the metric used to measure this aspect of a lamp's performance. It is reported in degrees Kelvin and is related to the chromaticity of a black body heated to that temperature. (IEA 2006: page 106)

lamp when, notionally, the sensor has turned the lamp off. Some CFLs are known to have flashed intermittently under these circumstances and to fail quickly. Other CFLs appear to interfere with the operation of the sensor. It appears that not all CFLs suffer from these problems but further testing would be needed to understand the full range of adverse outcomes. The possible solution is to amend the CFL standard to ensure that CFLs are designed to protect themselves from the 'off current' and to otherwise operate harmoniously with sensors. Some legacy users may need to replace sensors or to partially rewire to provide full supply to sensors. This issue is rated as a MODERATE under the original proposal, but confined to a relatively small number of users and eliminated by the continued availability of incandescent lamps under the revised proposal.

10. *Compatibility with existing ELVCs and low voltage circuits*: The options for replacing ELV halogen downlights have improved somewhat. The situation is that:

- (a) LEDs will operate on existing ELVCs but it is uncertain when they will be available at reasonable cost.
- (b) Suppliers may develop an IRC lamp with a slightly higher voltage – 14 volts rather than 12 volts – in order to operate effectively on existing 50 watt ELVCs.
- (c) Compact CFLs that operate with existing ELVC are now coming into the market.

This issue presented a MODERATE difficulty under the original proposal but is eliminated by the continued availability of incandescent lamps under the revised proposal.

E3 considers that this long list is neutralised by setting the MEPS at a level that allows continued use of the more efficient types of incandescent lamp. This avoids the potentially large costs associated with the rewiring of lighting circuits and the premature replacement of lighting controls, luminaires (lamp housing) and other lamp holders and fittings, and the ELVCs used with ELV lamps.

The impact assessment for the revised measures deals separately with remaining concerns about adverse health, electrical safety and environmental impacts (section 4.5), and impacts on the operation of electricity networks (section 4.6).

3.2 Policy options

E3 aims to develop policy measures that will contribute to cost-effective greenhouse abatement in Australia, but with that contribution defined relative to a business-as-usual scenario. Importantly, the business-as-usual scenario now includes introduction of the CPRS and other policies that are not specific to a particular energy using product or sector of the economy. We therefore distinguish between two types of projections for the energy and emissions associated with a particular energy using product or sector of the economy.

- *WoSM scenarios* are scenarios for future energy use and emissions 'Without Specific Measures', but including the efficiency promoting effects of CPRS and other non-specific greenhouse policies.
- *WSM scenarios* are scenarios for future energy use and emissions 'With Specific Measures', including the effects of both non-specific and specific measures.

E3 seeks to (a) identify feasible specific measures that may deliver net benefits relative to the WoSM scenario, and (b) identify the option that provides the greatest net benefits. Note that the WoSM option is the default option. It becomes the preferred option if there are no specific policy options that cost-effectively improve on the WoSM scenario.

E3 has examined the following policy options that are specific to lighting tasks of the kind that dominate the residential sector.

- Option 1 MEPS, labelling and information measures that are specific to incandescent lamps, CFLs and ELVCs. This is the regulatory proposal that is described in section 3.1.
- Option 2 Taxes on less efficient types of lamps and ELVCs.
- Option 3 Subsidies for more efficient lamps and ELVCs
- Option 4 Disendorsement labelling of inefficient lamps and ELVCs.
- Option 5 Comparative energy labelling for lamps and ELVCs.
- Option 6 Information campaign promoting more efficient lamps and ELVCs.

Note that option 1 includes labelling and information measures, complementing MEPS. Options 5 and 6 are different in that they rely exclusively on information and labelling measures and would not implement MEPS.

The next six chapters – 4 to 9 – reports E3's assessment of these 6 options. However, E3 has not developed measures to implement options 2 to 6 and this document provides a detailed impact assessment for option 1 only. E3 considers that options 2 to 6 are not sufficiently promising, relative to option 1, to justify more detailed analysis than is provided for those options.

4 Option 1 – proposed MEPS, labelling and information measures

The measures are assumed to apply over the 12 year period from 2009 to 2020, but with cumulative impacts, as product exemptions are terminated and non-complying lamps are replaced. This chapter reports impacts at each stage in the process by which abatement is achieved.

4.1 Cost to the taxpayer

Table 4.1 provides estimates for the incremental cost of including incandescent lamps in the E3 Program, which is taxpayer funded. The E3 Committee and the Australian Customs Service (ACS) estimate that they will jointly spend almost \$4.0 million before June 2010 to develop and assess the proposals, implement the importation restriction and prepare to introduce MEPS at the point of sale. Expenditures will fall to around \$1.0 million per year for another 4 or 5 years, and then decrease to about \$200,000 per year. Total expenses to 2020 are \$10.2 million and have a present value of \$8.7 million.

TABLE 4.1 COST TO TAXPAYERS OF INCLUDING INCANDESCENT LAMPS IN THE E3 PROGRAM (\$A)

	<i>Cumulative total to 2009/10 (\$)</i>	<i>Annually, 2010-2014 (\$/year)</i>	<i>Annually, 2015-2020 (\$/year)</i>
Program administration – E3 Program	\$1,230,000	\$300,000	\$120,000
Program administration – ACS	\$500,000	\$100,000	\$0
Government/industry steering committee	\$10,000	\$10,000	\$10,000
Standards development	\$500,000	\$10,000	\$0
Product testing	\$500,000	\$200,000	\$50,000
Product and market analysis	\$100,000	\$50,000	\$0
Publications & communications	\$1,000,000	\$350,000	\$2,000
Impact assessment	\$100,000	\$10,000	\$10,000
Total	\$3,940,000	\$1,030,000	\$192,000

4.2 Business compliance costs

The Council of Australian Government (COAG) requires that impact statements provide estimates of the administrative and paperwork costs incurred by a business in meeting regulatory requirements, defined as follows:

- *Notification*: costs of reporting transactions before or after the event
- *Education*: maintaining awareness of regulations and regulatory changes
- *Permission*: applying for and obtaining permission
- *Purchases*: materials and equipment required for compliance
- *Record keeping*: keeping statutory documents up-to-date
- *Enforcement*: facilitation of audits and inspections
- *Publication and documentation*: displays and labels
- *Procedural*: required compliance activities such as fire drills and safety inspections

COAG's concern is to monitor the administrative and paperwork burden imposed by the particular form of regulatory transaction between government and business. These compliance costs are defined to exclude the costs of developing and testing new products, except for the cost of certification tests that are required for regulatory purposes. Also excluded are the costs to suppliers to working with government to develop regulations.

The compliance costs will be modest, for these reasons:

- The regulations are readily understood and all significant suppliers are involved in the development of the regulations.
- The regulations use the technical language of all commercial transactions in the manufacture and distribution of lighting products, which means that the regulatory requirements translate directly as product specifications.
- Standard international tests will be used to measure performance. These are same tests that govern commercial transactions and the delivery of product 'to specifications'. We understand that there will be minimal need for additional product testing.
- Suppliers will need to register their products and declare their performance, using the system for on-line registrations¹⁹ that has been developed for linear fluorescent lamps. This is a simple transcription of production information and we understand that experienced users can perform the task at the rate of 4 product groups per hour. We refer to groups of products because a single registration can be used for related products that have sufficiently similar performance characteristics.
- Compliance costs are reduced almost to zero where the practical effect of the MEPS is to ban certain lamps. The trivial remaining cost is to maintain awareness of the regulation.

The remaining compliance costs relate to possible labelling requirements, for example, a statement of light power (lumens), electrical power (watts), and efficacy (lumens/watt) or efficiency (for ELVCs). The cost estimates are indicative because, as discussed in section 3.1.4, E3 does has deferred consideration of new labelling requirements to a later stage in the process of reforming standards and labelling measures for household lamps. The cost allowance is modest because E3 will try to accommodate the concerns expressed by the suppliers of global brands, which are that special packaging, design and production runs for the Australian market would disrupt their practice of marketing uniform products in uniform packaging across all countries. E3 will examine options for an internationally coordinated approach that meets Australian needs with minimal disruption of global marketing arrangements. E3 notes that:

- Given global interest in the phasing out of incandescent lamps, it seems reasonable to assume that there will be increasing global demand for comparative information.
- There is already fragmentation of packaging arrangements between countries, with mandatory labelling requirements in Europe, Japan, Korea and US, and voluntary arrangements in US, Thailand and Brazil (IEA 2006: chapter 5 & page 430-31).

The Lighting Council Australia (LCA) has commented on the assessment reported in table 4.2, indicating that the compliance costs were not significant enough to warrant not proceeding with the proposal. The Council also noted that the industry, and several key lamp suppliers in particular, incurred significant costs in collaborating with E3 to develop the proposed measures.

¹⁹ This facility is available from E3's website - www.energyrating.gov.au

TABLE 4.2 BUSINESS COMPLIANCE COSTS

<i>Task</i>	<i>Global branded suppliers</i>	<i>Other branded suppliers</i>	<i>Other non- branded suppliers</i>	<i>Total</i>
<u>Maintain awareness of regulations</u>				
Av. annual hours per supplier	10	10	10	
Annual compliance cost	\$1,200	\$2,800	\$4,000	
Present value	\$9,282	\$21,659	\$30,941	\$61,882
<u>Initial registration</u>				
Av. hours per registration	0.25	0.38	0.5	
Once-only compliance cost	\$3,000	\$5,250	\$1,000	
Present value	\$3,000	\$5,250	\$1,000	\$9,250
<u>Annual registrations</u>				
Av. hours per registration	0.25	0.375	0.5	
Annual compliance cost	\$750	\$1,313	\$250	
Present value	\$5,801	\$10,153	\$1,934	\$17,888
<u>Record keeping</u>				
Av. annual hours/product group	0.25	0.375	0.5	
Annual compliance cost	\$3,000	\$5,250	\$1,000	
Present value	\$23,206	\$40,610	\$7,735	\$71,551
<u>Labelling</u>				
Av. annual cost per product group	\$500	\$500	\$500	
Annual compliance cost	\$150,000	\$175,000	\$25,000	
Present value	\$1,160,292	\$1,353,674	\$193,382	\$2,707,347
Total cost				
Present value				\$2,867,919
<u>Assumptions</u>				
Number of suppliers	3	7	10	20
Staff cost (\$/hour)	\$40	\$40	\$40	
Product groups per supplier	100	50	5	
New product groups per year	25	12.5	1.25	

4.3 Impacts on competition and trade

This section examines whether the proposed regulation may affect the quality of competition in the market for lamps.

4.3.1 Are like-for-like replacements generally available?

As discussed in section 3.1.5, E3 compiled a list of concerns about the availability of like-for-like replacements for incandescent lamps and determined that there were several significant issues that could only be resolved at substantial cost. E3 now propose MEPS that allow continued use of the more efficient incandescent lamps. The remaining issues are the following:

- *Loss of 'free heating'*: Lamps create heat that contributes to space heating tasks and some of this free heating is lost when more efficient lamps are used. Moderating factors are that:
 - Free heating is confined to the cooler parts of the year, whereas lighting services are required in all seasons.
 - More efficient lamps also reduce space cooling loads. These savings more than compensate for the loss of free heating in most commercial and industrial buildings, where the cooling task dominates. They also reduce the loss associated with free residential heating in tropical regions and other regions where the heating task is trivial or otherwise dominated by the cooling task.

- Tungsten halogen downlights operate at temperatures that require significant measures to reduce the fire risk. Heat is dissipated by cutting a hole in the ceiling insulation, reducing the amount of free heating that these lamps can contribute.
- Lamps are both inefficient and emissions-intensive in their role as space heaters. This is due to a number of factors including their location on walls and ceilings, the use of recessed fittings, the energy conversion technology, and the amount of electricity used. The free heating that is lost can be replaced by heating services that are better located and are either more energy efficient (heat pumps²⁰) or use fuels that are less emissions intensive (gas).
- Tungsten filament lamps are installed disproportionately in rooms that are used less intensively, such as bathrooms and bedrooms, and benefit less from free heating.

E3 has taken advice from a leading Australian expert on building energy efficiency, Dr Paul Bannister of Energex Australia Pty Ltd. He considers that the interaction between incandescent lamps and space conditioning systems can be safely ignored for the purposes of assessing the proposed MEPS.

- *Excess light:* Circumstances exist where users cannot take advantage of more efficient lamps by reducing lamp wattage and therefore consuming less electricity. Instead, the physical configuration of the lighting system is such that the replacement lamp uses the same amount of electricity and the increase in efficacy is delivered as more light. This problem is confined to ELV tungsten halogen lamps with certain types of ELVC and no dimmer, and is factored into the assessment of impacts on users (section 4.4).
- *Health, safety and environmental issues:* We deal separately with environmental health and safety issues in section 4.5.
- *Power quality:* The installation of large numbers of CFLs has implications for the operation of electricity networks. The issues are highly technical, associated with the harmonics and power factor of CFLs. We deal separately with these matters in section 4.6.

4.3.2 Does the regulation infringe international free trade obligations?

The proposal needs to be consistent with Australia's international obligations under the Technical Barriers to Trade (GTBT) Agreement, which is part of the General Agreement on Tariffs and Trade (GATT). Article 2 of the GTBT Agreement relates to the preparation, adoption and application of technical regulations by central governments and provides for matters such as the even-handed treatment of imports and domestically produced products, the avoidance of unnecessary obstacles to international trade, the development and use of international standards where possible, acceptance of the regulations of other countries where possible, and the adoption of performance-based regulation where possible.

Based on the following considerations, the proposed regulations are consistent with the GTBT Agreement.

- All lamps are imported, which means there are no concerns about the even-handed treatment of imports and domestically-manufactured goods.
- The proposed regulation is performance-based. It sets a threshold for minimum performance and does not constrain the manner in which the minimum level of performance is achieved. It follows that the regulation does not discriminate between suppliers, other than the energy efficiency of their products.
- Standard international tests are used to determine compliance.

²⁰ Lamps operate as resistive heaters, converting 100% of the electrical energy into radiation. Heat pumps have a coefficient of performance of approximately 3.0, which means that the each kWh of free heating provided by a lamp can be replaced by 0.33 kWh of electricity for a heat pump.

- E3 continues to monitor overseas lighting initiatives but Australia is the first country to start phasing out incandescent lamps and necessarily pioneers the regulatory approach. There is no comparable overseas requirement, either proposed or existing, that the Australian regulations can be aligned with.
- Where possible, the proposed performance standards for CFL are in terms of existing overseas and international standards.

4.3.3 Does the regulation otherwise reduce or distort competition?

Chapter 10 provides a statement of compliance with national competition policy.

Lamps

We are confident that the proposed measures will not reduce competition. We understand that there is a competitive supply of complying products from overseas factories, particularly in China. Australian suppliers can contract freely with manufactures to supply the Australian market.

However, the market will be temporarily distorted in favour of the lamps that are exempted during the transition period. Specifically, some users will replace their GLS lamps with candle and fancy round²¹ tungsten filament lamps. The most popular size, 60 watts, will be available in the candle and fancy round shapes for one year after November 2009. The smaller sizes, 40 watts and 25 watts, will be available for three and seven years respectively. They account for about 25% of tungsten filament sales. Candle and fancy round lamps may look a bit odd as replacements for GLS lamps in some situations, but otherwise there is no significant loss of lighting function.

Extra low voltage converters

To the extent that magnetic converters are replaced with electronic converters, we are confident that supply arrangement will remain competitive. The Australian manufacturer, TridonicAtco, plans to continue supplying electronic converters and there are competing imports from a range of Asian manufacturers.

We also understand that at least one company, Torema Pty. Ltd., will continue to manufacture the more efficient type of magnetic converter in Australia, and that there is also a competitive supply of imported products from Asia. There may be other Australian manufacturers that E3 has not identified.

4.3.4 Does the regulation impose excessive costs of search and learning?

There are 'hassle costs' associated with the measure. Users will need to come to grips with the new lighting technologies and develop new routines for describing and identifying the lamps that meet their needs. This will involve some learning from experience, including the purchase and return of lamps that don't quite do the job. However, much of this is an unavoidable investment in the labelling reforms that are needed to reform the practice of sizing lamps according to the input power of the lamp. As discussed in section 3.1.4, input power no longer provides useful information about light output.

E3 considers that it is the task of the communications campaign to ensure that there is a rapid and productive learning process as the community makes the required adjustments to its routines, reducing hassle costs to a minimum. Users will need to give the issues some attention for a period of time, but at a time when family and friends are also dealing with the same issues and the communications campaign is providing materials to inform those conversations.

²¹ See table A.1 in appendix A for lamp descriptions.

E3 considers that, with an appropriate communications campaign, the adjustment need not be more than a minor nuisance. Probably, many will value the opportunity to ‘do the right thing’ environmentally.

4.3.5 Does the regulation distort technology development?

It seems that suppliers have responded to regulatory signals by rapidly expanding the range of CFLs and HV tungsten halogen lamps on the market, to the point where there appear that there are no issues of product availability that cannot be accommodated by the proposed implementation schedule. A possible concern, however, is that this diverts innovative effort from more promising prospects for product development, such as LED lights and high efficiency incandescent lamps.

The alternative view is that standards and labelling measures send a strong signal that innovative effort will be rewarded. Standards and labelling measures can strongly promote the diffusion of new technologies once they become affordable and provide a range of like-for-like replacements for existing products. But the intervention needs to be technological neutral and periodic adjustments of the policy settings are necessary. MEPS can be revised upwards from time to time, and comparative product labels need to be recalibrated to reflect changes in the range of energy efficiencies on the market.

4.4 Direct financial impact on residential, commercial and industrial users

The assessment of financial impacts assumes that non-complying products will be replaced by existing lighting technologies, albeit with significant improvement, and is inherently conservative for that reason. Specifically, we ignore the prospects for light-emitting diode (LED) technology, which the IEA identified as the ‘great white hope’ for large energy savings in lighting (IEA 2006: chapter 7). IEA notes that the US Department of Energy and US manufacturers have set a target of 160 lumens/watt by 2015, which is 10 times more efficient than incandescent lamps and two and a half times more efficient than CFLs (IEA 2006: page 434). It is not known when LED lamps will be price competitive but suppliers say that costs are declining and quality is improving. We note that some Australian suppliers recently introduced LED lamps for downlight applications.

This means that the analysis for lamps is entirely in terms of three lighting technologies, tungsten filament, tungsten halogen and CFL.

4.4.1 Annualised life cycle cost

The life cycle cost (LCC) of a lighting service is the sum of five cost elements, (1) luminaires, (2) lighting controls, wiring and ELVCs, (3) lighting system maintenance, (4) lamps, and (5) electricity. LCC is usually expressed in present value terms, which is the amount of an up-front payment that would cover all future costs of a lighting service, including energy, but discounted to allow for the fact that present dollars are more valuable than future dollars. LCC can also be expressed as the annualised equivalent of the present value amount. This is the periodic payment that, if paid annually for the period of the lighting service, would have same present value as the up-front payment. We use the annualised cost method because it is a more convenient way to report the costs of an energy service that has a number of components with different asset lives, or to compare the costs of lighting services with different asset lives.

We report the cost impacts entirely in terms of the change in the annualised LCC. This means that cost reductions (net benefits) are reported as negative numbers, being reductions in the annualised LCC. Cost increases (net costs) are reported as positive numbers, being increases in the annualised LCC.

Our calculations are entirely in terms of changes in the cost of lamps and energy, which are operating costs. It is assumed that, at the MEPS levels now proposed, there will be no need to change or prematurely scrap existing luminaires, wiring or lighting controls, and that there will be no change in other costs of operation and maintenance.

A discount rate of 7.5% is used in the discounting and annualising calculations.

Effective life of lamps with very low duty hours

We have assumed that the effective life of all lamps, both complying and non-complying, are not interrupted by breakages and premature scrapping. This is obviously unrealistic in some situations. Consider that CFLs with an operating life of 6,000 hours but used for only 10 minutes per day must last for 100 years in order to deliver all the possible savings. However, we calculate that it makes little difference if all CFLs are assumed to fail after 10 years, limiting the asset life at 10 years. This is because (a) by definition, lamps on low duty contribute little to the re-lamping task, and (b) incremental lamp costs are small relative to the energy savings. Other moderating factors are that:

- On average, lamps that are used less intensively will be replaced later and sometimes very much later than those used more intensively, and will have the advantage of more advanced and cheaper alternatives as the market for CFLs and other energy-efficient lamps develops.
- A lamp may be used less intensively for a period of time but not indefinitely. For example, an unused bedroom may be re-occupied when the house is sold or new tenants move in. Surveys that take a snapshot of lamp use are misleading in that respect.
- Failed lamps are sometimes replaced with less-used lamps from elsewhere in the dwelling, and the less-used lamp is then replaced when convenient. This cycling process reduces variation in the asset life of lamps.

4.4.2 Premature scrapping of non-lamp assets

As discussed in section 3.1, the proposed measures are designed to ensure that like-for-like replacements will be available for all existing lamps that do not comply with the MEPS. Users will not need to prematurely scrap and replace their existing non-lamp assets such as switches, dimmers, sensors, wiring and luminaires. This will be achieved by exempting some categories of lamp from the regulation in the first instance and allowing the continued use of certain incandescent lamps. E3 will review exemptions in consultation with suppliers and terminate exemptions when suitable replacements are available.

As outlined in section 3.1.3 (table 3.3), E3 has proposed firm implementation dates for only GLS lamps (conventional pear-shaped tungsten filament lamps), LV non-reflector lamps, CFLs and ELVCs. With regard to LV reflector lamps specifically, the proposed MEPS will only eliminate the least efficient models.

4.4.3 Mains voltage (MV) non-reflector lamps

There are non-complying products of both the tungsten filament and tungsten halogen type in this category. The GLS type of tungsten filament accounts for 67% of the installed stock and will not be available after November 2009. Tungsten halogen lamps and the larger candle and fancy round types of tungsten filament lamps are scheduled for November 2010, and account for another 10% of the installed stock. Most of the remainder are scheduled for November 2012, leaving only the smallest (25 watt) candle and fancy round types off the schedule at this stage.

Calculation of energy savings

Suppliers are confident that complying tungsten halogen products will be available for the scheduled termination of the exemption, in November 2010. These will be 'enhanced technology' products that use infra red coatings to increase the operating temperature and

efficiency of the lamp. E3 has purchased two of the early products, which are claimed to be either borderline compliant or slightly above, but has yet to conduct independent tests. By comparison, non-complying 'current technology' products are listed in catalogues with a gap of 1-3 lumens/watt relative to the proposed MEPS. For modelling purposes we have assumed that these lamps need to improve by 2 lumens/watt, or 17% on average.

Catalogue data indicates that none of the tungsten filament lamps now on the market comply with the proposed MEPS, and suppliers say that this technology cannot bridge the gap of about 3.5 lumens/watt and will be phased out.

We assume that non-complying lamps will be replaced with a 50:50 mix of complying tungsten halogen and CFL lamps. This is a critical variable, since CFLs are three times more efficient than tungsten halogens and deliver much more abatement. But we cannot yet be confident about how users will respond. Relevant considerations are that:

1. Existing CFLs cannot replace incandescent lamps on dimmers and other types of controls. However this problem affects less than 5% of replacements and the constraint will be further relaxed as new CFL designs come on the market.
2. The tungsten halogens are somewhat cheaper than the CFLs, at \$3 and \$4-5 respectively, providing them with a first-cost advantage.
3. Tungsten halogen lamps resembling the conventional pear-shaped GLS are available, but so are CFLs²².
4. Tungsten halogen lamps will be needed to replace tungsten filament lamps on dimmers and other control circuits, and may become more readily available as tungsten filaments are withdrawn from sale.
5. Consumer surveys consistently find that CFLs are generally recognised as energy saving lamps²³. A key program design issue for E3, which remains to be solved, is how to preserve that distinction and ensure that tungsten halogen lamps are not marketed as energy efficient, or otherwise assumed by users to be the equivalent of CFLs.

The above 50:50 assumption reflects an expectation in the market that CFLs will generally provide good like-for-like replacements for incandescent lamps. It should also be noted that subsequent experience suggests that this is a conservative, worst case scenario. Market acceptance in store today is such that CFLs now dominate the lighting shelf space in a number of major retail outlets and some (such as Woolworths) no longer stock tungsten filament lamps. The corresponding communications campaign is expected to improve the awareness of this proposal and the efficiency benefits of CFLs.

A sensitivity analysis has been conducted at table 4.11.

Incremental cost of more efficient lamps

GLS lamps generally sell for less than \$1/lamp and sometimes for less than 50 cents. We assume a price of 75 cents for all tungsten filament lamps, including all candle and fancy round types. CFLs sell for \$4-5/lamp and we assume a price of \$4.50/lamp.

Non-complying tungsten halogens are somewhat cheaper than CFLs, at \$3. E3 has only a small sample of the first complying products on the market – two lamps – and paid the going price for existing lamps, which is \$3/lamp. The 'enhanced technology' products seem to be priced for high volume sales and without a detectable price premium for increased efficiency. Nevertheless, we have assumed that a 10% increase in efficacy is associated with a 10% increase in the retail price, or 30 cents. This means that users will

²² The halogen capsule, or CFL coil, is fitted inside a conventionally shaped globe, which is fitted with the bayonet or screw cap required by conventional light fittings.

²³ For example, research commissioned by E3 in 2005 (Artcraft 2005) indicated that 75% of respondents understood that CFLs were energy saving lamps.

pay an extra 49 cents for complying tungsten halogens that provide a 16.5% increase in efficiency (= 1.65 * 30 cents).

We made conservative assumptions for the life of replacement lamps, putting both at the minimum that will be required by the proposed MEPS – 2,000 hours and 6,000 hours for tungsten halogens and CFLs respectively.

Financial impacts

Table 4.3 reports the resulting estimates of financial impacts in the residential sector, for various combinations of the initial lamp type, the replacement lamp type, lamp size and duty hours. Each panel relates to the replacement of non-complying tungsten filament and tungsten halogen lamps that produce the same amounts of light. Note that:

- The weighted averages across lamp types (final column) assume an initial configuration that is 98% tungsten filament and 2% tungsten halogen, and that both are replaced 50:50 by complying tungsten halogens and CFLs.
- We used conservative weightings for duty hours and wattages in the residential sector, with more than 80% of the lamps assumed to have duty hours of less than 2 hours per day and 30% of the lamps assumed to have wattages of less than 60 watts. The weighted averages for residential duty hours and wattage are 1.5 hours per day and 60 watts respectively for tungsten filaments, and 1.8 hours and 52 watts for tungsten halogens.
- The commercial and industrial sectors use more powerful lamps, more intensively. The 4-8 hour row in the 75 watt panel is indicative for the commercial and industrial sectors²⁴. While the lower electricity tariffs in the commercial and industrial sectors reduce the value of savings 10-70%, we estimate that there are cost reductions for all plausible combinations. It is only unlikely configurations of low wattage lamps (40 watts or less) or low duty hours (<4 hours), or both, that return cost increases. And it is only tungsten halogen replacements that return cost increases, not CFLs.

Overall, we estimate that:

- There are cost reductions for virtually all residential combinations and the gains vary positively with the duty hours and power of the lamp. The exceptions are low wattage lamps on low duty hours that are replaced with complying tungsten halogen lamps. See the top left-hand corner of the top panel in table 4.3.
- The reduction in operating costs is far greater for CFLs than for tungsten halogen.
- The average cost saving is sensitive to the mix of tungsten halogen and CFL lamps that are used to re-lamp. The residential average approaches 70 cents/lamp if tungsten halogens dominate, and \$4/lamp if CFLs dominate.
- Assuming a 50:50 mix, the average annual savings are \$2.38/lamp for residential users, \$9/lamp for commercial users and \$6/lamp for industrial users.

Impact of dimming

Dimming reduces the efficacy of lamps and the energy savings from more efficient lamps. We investigated this issue by assuming that, on average, these lamps are dimmed to 80% of maximum light output and that this is associated with a 10% reduction in efficacy²⁵. We found that annualised LCC is still reduced in all plausible configurations. The average

²⁴ The commercial and industrial sectors use larger lamps than the residential sector, and more intensively. For example, a US study (Navigant 2002) puts the average wattage and duty hours at 83 watts and 9.4 hours for the commercial sector, and 126 watts and 14.2 hours for the industrial sector, compared with 65 watts and 1.9 hours for the residential sector.

²⁵ This relationship between dimming and efficacy is suggested by Page (2007: figure 3). It should be noted that the relationship was derived for a more powerful type of tungsten halogen lamp (300 watt 'torchieres') than is the subject of the proposed regulation.

residential saving is \$2.07/lamp, compared with \$2.38/lamp at full power, ignoring the fact that dimmable lamps tend to be installed in high use areas such as living rooms.

TABLE 4.3 CHANGE IN ANNUALISED LCC: MV NON-REFLECTOR LAMPS, RESIDENTIAL (\$/LAMP)

Duty hours per day	Type of replacement lamp				Weighted average
	Tungsten halogen	CFL	Tungsten halogen	CFL	
<u>Lamp replaced:</u>	<u>25 watt tungsten filament</u>		<u>21 watt tungsten halogen</u>		
< 1 hour	+\$0.06	-\$0.41	-\$0.03	-\$0.50	-\$0.18
1-2 hours	-\$0.06	-\$1.64	-\$0.14	-\$1.72	-\$0.85
2-4 hours	-\$0.23	-\$3.45	-\$0.30	-\$3.53	-\$1.84
4-8 hours	-\$0.56	-\$7.04	-\$0.63	-\$7.11	-\$3.80
8-12 hours	-\$1.00	-\$11.83	-\$1.07	-\$11.90	-\$6.42
> 12 hours	-\$1.34	-\$15.42	-\$1.40	-\$15.48	-\$8.38
Residential average	-\$0.06	-\$1.64	-\$0.17	-\$2.09	-\$0.86
<u>Lamp replaced:</u>	<u>40 watt tungsten filament</u>		<u>34 watt tungsten halogen</u>		
< 1 hour	-\$0.04	-\$0.76	-\$0.09	-\$0.81	-\$0.40
1-2 hours	-\$0.35	-\$2.69	-\$0.32	-\$2.66	-\$1.52
2-4 hours	-\$0.81	-\$5.54	-\$0.66	-\$5.39	-\$3.17
4-8 hours	-\$1.73	-\$11.23	-\$1.34	-\$10.84	-\$6.47
8-12 hours	-\$2.95	-\$18.81	-\$2.25	-\$18.11	-\$10.86
> 12 hours	-\$3.86	-\$24.49	-\$2.93	-\$23.56	-\$14.16
Residential average	-\$0.35	-\$2.69	-\$0.39	-\$3.20	-\$1.53
<u>Lamp replaced:</u>	<u>60 watt tungsten filament</u>		<u>53 watt tungsten halogen</u>		
< 1 hour	-\$0.16	-\$1.23	-\$0.16	-\$1.23	-\$0.69
1-2 hours	-\$0.71	-\$4.09	-\$0.52	-\$3.90	-\$2.40
2-4 hours	-\$1.52	-\$8.35	-\$1.06	-\$7.88	-\$4.92
4-8 hours	-\$3.14	-\$16.84	-\$2.13	-\$15.83	-\$9.97
8-12 hours	-\$5.29	-\$28.16	-\$3.56	-\$26.43	-\$16.69
> 12 hours	-\$6.91	-\$36.64	-\$4.64	-\$34.37	-\$21.74
Residential average	-\$0.71	-\$4.09	-\$0.63	-\$4.70	-\$2.41
<u>Lamp replaced:</u>	<u>75 watt tungsten filament</u>		<u>66 watt tungsten halogen</u>		
< 1 hour	-\$0.24	-\$1.58	-\$0.21	-\$1.54	-\$0.91
1-2 hours	-\$0.96	-\$5.14	-\$0.66	-\$4.84	-\$3.04
2-4 hours	-\$2.02	-\$10.45	-\$1.33	-\$9.76	-\$6.22
4-8 hours	-\$4.13	-\$21.04	-\$2.68	-\$19.59	-\$12.56
8-12 hours	-\$6.95	-\$35.16	-\$4.47	-\$32.68	-\$21.01
> 12 hours	-\$9.07	-\$45.75	-\$5.82	-\$42.50	-\$27.35
Residential average	-\$0.96	-\$5.14	-\$0.79	-\$5.83	-\$3.06
<u>Lamp replaced</u>	<u>100 watt tungsten filament</u>		<u>89 watt tungsten halogen</u>		
< 1 hour	-\$0.38	-\$2.16	-\$0.28	-\$2.06	-\$1.27
1-2 hours	-\$1.35	-\$6.89	-\$0.87	-\$6.41	-\$4.11
2-4 hours	-\$2.81	-\$13.94	-\$1.76	-\$12.89	-\$8.36
4-8 hours	-\$5.72	-\$28.03	-\$3.53	-\$25.85	-\$16.83
8-12 hours	-\$9.59	-\$46.81	-\$5.90	-\$43.12	-\$28.13
> 12 hours	-\$12.50	-\$60.89	-\$7.68	-\$56.07	-\$36.61
Residential average	-\$1.35	-\$6.89	-\$1.05	-\$7.71	-\$4.13
<u>Lamp replaced:</u>	<u>all tungsten filament</u>		<u>all tungsten halogen</u>		
< 1 hour	-\$0.15	-\$1.20	-\$0.15	-\$1.20	-\$0.67
1-2 hours	-\$0.69	-\$4.08	-\$0.51	-\$3.89	-\$2.38
2-4 hours	-\$1.55	-\$8.58	-\$1.07	-\$8.10	-\$5.06
4-8 hours	-\$3.18	-\$17.21	-\$2.14	-\$16.17	-\$10.17

8-12 hours	-\$5.55	-\$29.57	-\$3.68	-\$27.70	-\$17.52
> 12 hours	-\$5.40	-\$31.16	-\$3.75	-\$29.51	-\$18.25
Residential average	-\$0.69	-\$4.06	-\$0.62	-\$4.67	-\$2.38

4.4.4 Extra low voltage (ELV) non-reflector lamps

These are tungsten halogen products that use an ELVC to step the electrical voltage down to 12 volts. Suppliers say that these products already comply with the proposed MEPS and E3 has confirmed that with a number of product tests. We are confident that this sub-market will not be affected.

4.4.5 MV reflector lamps

There are non-complying products of both the tungsten filament and tungsten halogen type in this category, contributing about 75:25 to the installed stock of non-complying lamps. There is a 3 year exemption, to November 2012.

Calculation of energy savings

Given time, suppliers consider that tungsten halogen lamps can be improved to the point where they comply with the proposed MEPS. E3 has tested a sample of six lamps and found that they would need to improve by 2 to 5 lumens/watt. We have assumed that tungsten halogen lamps will need to be improved by 3 lumens/watt, or 26% on average.

None of the tungsten filament lamps now on the market comply with the proposed MEPS. Tests commissioned by E3 indicate that the deficiency is 5 lumens/watt and that complying tungsten halogen lamps would be 54% more efficient on average. Suppliers say that this technology cannot bridge the gap.

We assume that non-complying lamps will be replaced with a 80:20 mix of complying tungsten halogen and CFL lamps. The CFL proportion has been set at only 20% because CFLs are not 'reflector friendly' and there is relatively small range of reflector CFLs now on the market. The problem is that the light emitting surface of a CFL is relatively large and the light cannot be easily marshalled and pointed in the desired direction. Again, the mix is critical because CFLs are three times more efficient than tungsten halogens and deliver much more abatement.

Otherwise, the general approach is the same as that for MV non-reflector lamps.

Incremental cost of more efficient lamps

MV reflector lamps sell for \$3-5/lamp with the tungsten filament lamps at the lower end and tungsten halogen at the upper end. We have assumed prices of \$3.50 and \$4.50 for non-complying tungsten filament and tungsten halogen lamps respectively.

The products that will eventually replace these are not generally available now. We made the following assumptions for the purposes of the RIS.

- For tungsten halogens, it is assumed that a 10% increase in efficacy is associated with a 10% increase in the retail price, or 45 cents. This means that the complying tungsten halogens will cost an extra \$1.16 cents for the 26% increase in efficiency (= 2.6 * 45 cents).
- Complying reflector CFLs are assumed to sell for \$6/lamp when the exemption is terminated. They cannot be much more expensive than that and still take a reasonable share of the market.

Again, we made conservative assumptions for life of the replacement lamps.

Financial impacts

Table 4.4 reports the resulting estimates of financial impacts in the residential sector. This is the same format as that used for the non reflector type (table 4.3), except that the lamps are somewhat more powerful. The weighted averages across lamp types (final column) assume an initial configuration that is 75% tungsten filament and 25% tungsten halogen, and that both are replaced 80:20 by complying tungsten halogens and CFLs.

Our stock modelling (appendix D, table D.3) indicates that the commercial and industrial sectors use more powerful lamps, more intensively. The 4-8 hour row in the 100 watt panel is indicative for these sectors. However, electricity tariffs are lower in the commercial and industrial sectors and, allowing for that difference, the savings are reduced by 50-75%. Nevertheless, we estimate that there are cost reductions for all plausible combinations. It is only low wattage lamps (35 watts) on industrial tariffs that return cost increases. And it is only tungsten halogen replacements that have net costs, not CFLs.

These estimates indicate that:

- There are cost reductions for all combinations and the gains vary positively with the duty hours and power of the lamp.
- The reduction in operating costs is far greater for CFLs than for tungsten halogen.
- The average cost saving is sensitive to the mix of tungsten halogen and CFL lamps that are used to re-lamp. The residential average approaches \$2/lamp if tungsten halogens dominate and \$5/lamp if CFLs dominate.
- Assuming an 80:20 mix, the average annual savings are \$2.57/lamp for residential users, \$9/lamp for commercial users and \$7/lamp for industrial users.

Impact of dimming

Dimming also reduces the efficacy of MV reflector lamps. As for the MV non-reflector lamps, however, we find that annualised LCC is still reduced in all plausible configurations. The average residential saving is \$2.21/lamp, compared with \$2.57/lamp at full power, ignoring the fact that dimmable lamps tend to be installed in high use areas such as living rooms.

4.4.6 ELV reflector lamps

ELV reflector lamps are all of the tungsten halogen type and are generally referred to as 'halogen downlights'. E3 tested a sample of 15 halogen downlights and found that:

- Of twelve 50 watt lamps in the sample, seven would not comply with the proposed MEPS. Efficacy ranged from 11.4 to 17.4 lumens/watt, compared with proposed MEPS of 14.4 lumens/watt. The average non-complying lamp is 1.5 lumens below the MEPS.
- All three of the 35 watt lamps in the sample complied with the proposed MEPS. Efficacy ranged from 14.1 to 17.2 lumens/watt, compared with proposed MEPS of 13.2 lumens/watt.

Suppliers say that 50 watt halogen downlights account for at least 90% of sales. We expect that a more comprehensive testing program would show that a significant proportion of other standard products – 20, 35, 72 and 100 watts – do not comply with the proposed MEPS. This is based on a comparison of test results with other technical data provided by suppliers, and extrapolation of the 50 watt comparison to the other standard wattages.

TABLE 4.4 CHANGE IN ANNUALISED LCC: MV REFLECTOR LAMPS, RESIDENTIAL (\$/LAMP)

Duty hours per day	Type of replacement lamp				Weighted average
	Tungsten halogen	CFL	Tungsten halogen	CFL	
<u>Lamp replaced:</u>	<u>35 watt tungsten filament</u>		<u>26 watt tungsten halogen</u>		
< 1 hour	-\$0.29	-\$1.02	-\$0.01	-\$0.74	-\$0.37
1-2 hours	-\$1.10	-\$3.39	-\$0.16	-\$2.46	-\$1.34
2-4 hours	-\$2.30	-\$6.90	-\$0.39	-\$4.99	-\$2.77
4-8 hours	-\$4.69	-\$13.90	-\$0.84	-\$10.05	-\$5.63
8-12 hours	-\$7.88	-\$23.23	-\$1.45	-\$16.79	-\$9.43
> 12 hours	-\$10.27	-\$30.22	-\$1.90	-\$21.85	-\$12.29
Residential average	-\$0.93	-\$2.89	-\$0.17	-\$2.53	-\$1.16
<u>Lamp replaced:</u>	<u>60 watt tungsten filament</u>		<u>50 watt tungsten halogen</u>		
< 1 hour	-\$0.57	-\$1.60	-\$0.19	-\$1.23	-\$0.69
1-2 hours	-\$1.90	-\$5.13	-\$0.68	-\$3.91	-\$2.26
2-4 hours	-\$3.88	-\$10.37	-\$1.42	-\$7.91	-\$4.60
4-8 hours	-\$7.85	-\$20.85	-\$2.88	-\$15.88	-\$9.28
8-12 hours	-\$13.14	-\$34.81	-\$4.83	-\$26.51	-\$15.52
> 12 hours	-\$17.10	-\$45.28	-\$6.29	-\$34.47	-\$20.19
Residential average	-\$1.62	-\$4.38	-\$0.71	-\$4.03	-\$1.98
<u>Lamp replaced:</u>	<u>80 watt tungsten filament</u>		<u>65 watt tungsten halogen</u>		
< 1 hour	-\$0.76	-\$2.07	-\$0.31	-\$1.61	-\$0.92
1-2 hours	-\$2.47	-\$6.53	-\$1.02	-\$5.07	-\$2.94
2-4 hours	-\$5.02	-\$13.17	-\$2.08	-\$10.23	-\$5.96
4-8 hours	-\$10.13	-\$26.44	-\$4.20	-\$20.52	-\$12.00
8-12 hours	-\$16.93	-\$44.14	-\$7.03	-\$34.24	-\$20.04
> 12 hours	-\$22.03	-\$57.40	-\$9.15	-\$44.53	-\$26.07
Residential average	-\$2.11	-\$5.58	-\$1.05	-\$5.23	-\$2.59
<u>Lamp replaced:</u>	<u>100 watt tungsten filament</u>		<u>85 watt tungsten halogen</u>		
< 1 hour	-\$0.95	-\$2.53	-\$0.41	-\$2.00	-\$1.14
1-2 hours	-\$3.01	-\$7.92	-\$1.33	-\$6.23	-\$3.60
2-4 hours	-\$6.10	-\$15.96	-\$2.69	-\$12.55	-\$7.27
4-8 hours	-\$12.28	-\$32.02	-\$5.42	-\$25.16	-\$14.62
8-12 hours	-\$20.52	-\$53.43	-\$9.06	-\$41.97	-\$24.41
> 12 hours	-\$26.70	-\$69.48	-\$11.79	-\$54.57	-\$31.75
Residential average	-\$2.57	-\$6.77	-\$1.37	-\$6.42	-\$3.17
<u>Lamp replaced:</u>	<u>120 watt tungsten filament</u>		<u>100 watt tungsten halogen</u>		
< 1 hour	-\$1.12	-\$2.99	-\$0.51	-\$2.39	-\$1.35
1-2 hours	-\$3.53	-\$9.31	-\$1.62	-\$7.39	-\$4.24
2-4 hours	-\$7.14	-\$18.73	-\$3.27	-\$14.86	-\$8.55
4-8 hours	-\$14.36	-\$37.56	-\$6.58	-\$29.78	-\$17.17
8-12 hours	-\$23.99	-\$62.67	-\$11.00	-\$49.68	-\$28.67
> 12 hours	-\$31.20	-\$81.50	-\$14.31	-\$64.60	-\$37.29
Residential average	-\$3.02	-\$7.96	-\$1.67	-\$7.61	-\$3.74
<u>Lamp replaced:</u>	<u>all tungsten filament</u>		<u>all tungsten halogen</u>		
< 1 hour	-\$0.74	-\$2.03	-\$0.29	-\$1.58	-\$0.89
1-2 hours	-\$2.45	-\$6.52	-\$1.00	-\$5.07	-\$2.92
2-4 hours	-\$5.11	-\$13.47	-\$2.11	-\$10.48	-\$6.08
4-8 hours	-\$10.22	-\$26.88	-\$4.23	-\$20.89	-\$12.14
8-12 hours	-\$17.34	-\$45.56	-\$7.21	-\$35.43	-\$20.60
> 12 hours	-\$18.91	-\$50.49	-\$7.18	-\$38.76	-\$22.47
Residential average	-\$2.09	-\$5.55	-\$1.04	-\$5.19	-\$2.57

ELVCs and standard downlight wattages

The impact assessment for halogen downlights is complicated by the ELVCs that are used to step the electrical supply down to 12 volts. The problem is that much of the installed stock of ELVCs operates correctly only for specific standard loads – 20, 35, 50, 72 and 100 watts – and should be matched with lamps that provide that specific load²⁶. This means that, until older ELVCs are replaced with newer types that operate effectively on different loads, a less efficient downlight must be replaced with a more efficient downlight that has the same wattage and provides the increased efficacy in the form of more light. Potentially, replacement lamps provide more light but use the same amount of electricity.

Given this constraint on lamp replacements, energy savings can only arise in specific ways. With reference to the dominant lamp size, 50 watts, there are three options for lamps that are not on dimmers.

1. The option of using a high efficacy 35 watt lamp is available²⁷ if (a) the lamp is connected to one of the newer types of ELVC that operate effectively with the lower load, or (b) there is new construction and refurbishment that provides the opportunity to install a ELVC for the 35 watt lamp. These users take advantage of the increased efficacy in the usual way, as a direct reduction in wattage and electricity consumption.
2. The option of using fewer but more efficient 50 watt lamps is also available to new construction and refurbishments, and where the user is content to partially re-lamp, leaving gaps in the existing lamp array. There are associated savings in the cost of labour and associated materials (wiring, transformers and luminaires) for new construction and refurbishments.
3. The remaining category is comprised of (a) those who cannot re-lamp at a lower wattage because they have the older type of ELVC and, (b) those who have an option of lower wattages or fewer lamps but, for reasons of ignorance or inertia, choose not to make the required changes. These users continue to purchase and install the same number of lamps of the same wattage and their new lamps simply put out more light, possibly 20-30% more. Some may use supplementary lighting that can be turned off instead.

The first two options are the same for lamps on dimmers as for lamps that are not on dimmers – 35 watt lamps or fewer 50 watt lamps. But the third option is different. It is reasonable to assume that users who cannot reduce wattage, or choose not to, would dim the new lamps back to the preferred level. There are energy savings in this case because efficacy declines as lamps are dimmed.

The limited information on the stock of halogen downlights does not allow us to confidently quantify the various types of users. Based on discussions with suppliers, however, we understand that (a) it is certain that relatively few users have the type of ELVC that will accommodate different loads, and (b) most residential users have their ELV reflector lamps on dimmers.

The constraint imposed by existing ELVCs means that it is necessary to distinguish between short and long term effects. In the short to medium term, we assume that there will be:

- a relatively small number of users with the type of ELVC that allows them to re-lamp at 35 watts;

²⁶ A different lamp may still work but its life is shorter. Historically, the loads were standardised to facilitate the matching of ELVCs and with lamps.

²⁷ E3 testing indicates that 35 watt lamps of sufficiently high efficacy are now available. That is, they would provide at least the same amount of light as some of the non-complying 50 watt lamps that are now on the market.

- many residential users who must re-lamp at 50 watts but save energy by dimming the lamp;
- a significant minority of users, particularly commercial users, who must re-lamp at 50 watts but do not have dimmers and can only save energy by reducing supplementary lighting.

New construction and lighting refurbishments will relax the constraints over the longer term, allowing preferred lighting levels to be provided at lower wattages or with fewer lamps. This can happen reasonably quickly in some residential and commercial applications with high rates of refurbishment. For taxation purposes, lighting systems are generally assumed to have asset lives of 15-20 years. However, these prospects may be overtaken by technological developments, in particular, LED or CFL downlights that compete with halogen downlights on price but are much more efficient.

Calculation of energy savings

Given the uncertainties about the longer term, we focused on likely gains over the short to medium term for the purposes of this RIS. We assumed that the energy savings can be assessed as follows.

- The 50 watt lamp is representative of all halogen downlights and has average duty hours of 2.25 hours.
- Non-complying lamps account for half of all lamp sales, which is the proportion indicated by the test sample.
- Non-complying lamps are replaced with existing halogen downlights that comply with the MEPS, not with CFLs. There are CFLs on the market that are designed for the same range of applications, but they cannot deliver the dot shaped point of light associated with halogen downlights, which can be easily focused and directed by a small light capsule. Existing CFLs also have limited dimming capability and are not always compatible with existing ELVCs and dimmers. On what we know now, it seems unreasonable to expect the proposed measures to contribute significantly to a shift from halogen downlights to CFL downlights.
- 90% of users without dimmers must re-lamp at 50 watts and can only save energy by reducing supplementary lighting. We put these savings at zero. The remaining 10% re-lamp at 35 watts and none take the option of reducing the number of 50 watt lamps.
- 90% of users with dimmers must re-lamp at 50 watts and save energy by dimming back to the preferred lighting level, which is assumed to be 80% of the light provided by an average 50 watt lamp at full power. The replacement lamp is dimmed further because it is more efficient and produced more light at full power. The remaining 10% re-lamp at 35 watts and none take the option of reducing the number of 50 watt lamps.
- We note the possibility that excess light from lamps that cannot be dimmed may impose non-trivial costs on some users, for example, if they prematurely scrap their existing lamp fittings or otherwise reconfigure their lights to restore the preferred level of lighting. However we assume that the increased light is not noticed or otherwise quite acceptable, since our eyes can adapt to a broad range of light intensities²⁸. We note that users can only learn by experience how much light a particular 50 watt lamp will provide, since existing labels contain only wattage information. This suggests that suppliers are unconcerned that 50 watt lamps provide varying amounts of light, ranging from 550 lumens to 850 lumens in E3's sample of twelve lamps. Arguably, suppliers would only be unconcerned if users are also unconcerned. For the purposes of this RIS, therefore, we assume that the users pay the increased cost of more efficient lamps but are otherwise unaffected.

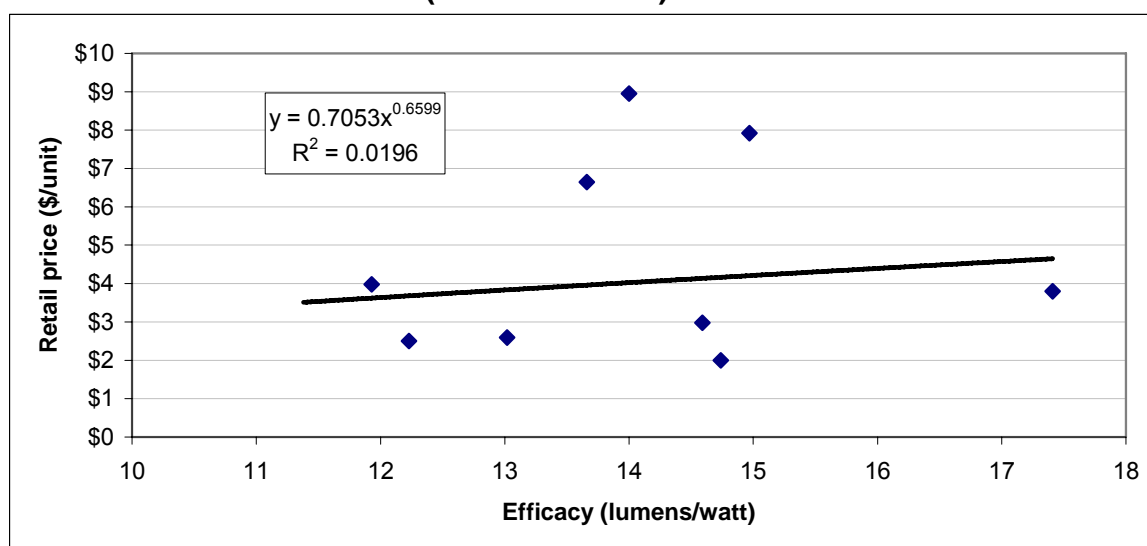
²⁸ *The eye functions over a vast range of light levels; once it has adapted to the prevailing conditions, visual performance is relatively insensitive to the amount of light.* (IEA 2006: page 69)

Incremental cost of more efficient lamps

The average retail price of the 50 watt lamps in the E3 sample was \$4.60, but with considerable variation and only weak evidence of a positive relationship with efficacy – see figure 4.1. We have assumed that a 10% increase in efficacy is associated with a 10% increase in the retail price, or 46 cents. (For what it's worth, the weak relationship reported in figure 4.1 indicates that a 10% increase in efficacy is associated with a 6.6 % increase in the retail price.)

This means that the users who re-lamp with 35 watt downlights incur an incremental cost of \$1.98 to obtain a 43% increase in efficacy ($= 4.3 * 46$ cents). Users who re-lamp with complying 50 watt downlights obtain a 15% increase in efficacy and are assumed to pay an extra 70 cents ($= 1.5 * 46$ cents).

FIGURE 4.1 PRICE AND EFFICACY OF 50 WATT ELV TUNGSTEN HALOGEN LAMPS, REFLECTOR TYPE (E3 TEST SAMPLE)



Financial impacts

Table 4.5 reports the resulting estimates of financial impacts in the residential sector. These indicate that:

- There are cost reductions for all users except for those who must take the increased efficacy as more light rather than savings on electricity bills.
- The cost reductions are much greater where the user re-lamps at 35 watts and otherwise modest. The cost savings are modest for what we understand to be the dominant group, comprising users who save energy by dimming a more efficient 50 watt lamp back to the preferred level. The weighted average across replacement types (last column) is close to the impact of this dominant group.
- Comparison of the savings from 35 watt replacements indicates that the savings on dimmed lamps are not significantly less than the savings on undimmed lamps. However, this outcome is sensitive to our assumption that, on average, these lamps are dimmed to 80% of their output at full power.
- The average annual saving is 25 cents/lamp-year in the residential sector, assuming that 90% of these lamps are on dimmers.

TABLE 4.5 CHANGE IN ANNUALISED LCC: ELV TUNGSTEN HALOGEN LAMPS, REFLECTOR TYPE, RESIDENTIAL (\$/LAMP)

Duty hours per day	Type of replacement for non-complying lamp		Weighted average
	Replaced with 35 watt lamp	Replaced with 50 watt lamp that is borderline compliant	
Lamps that cannot be dimmed			
< 1 hour	-\$0.25	+\$0.07	+\$0.04
1-2 hours	-\$0.92	+\$0.15	+\$0.04
2-4 hours	-\$1.92	+\$0.27	+\$0.05
4-8 hours	-\$3.91	+\$0.51	+\$0.07
8-12 hours	-\$6.56	+\$0.84	+\$0.10
> 12 hours	-\$8.55	+\$1.09	+\$0.12
Residential average	-\$1.42	+\$0.21	+\$0.05
Lamps on dimmers			
< 1 hour	-\$0.20	-\$0.02	-\$0.04
1-2 hours	-\$0.78	-\$0.11	-\$0.18
2-4 hours	-\$1.63	-\$0.25	-\$0.39
4-8 hours	-\$3.33	-\$0.53	-\$0.81
8-12 hours	-\$5.60	-\$0.91	-\$1.37
> 12 hours	-\$7.30	-\$1.18	-\$1.80
Residential average	-\$1.20	-\$0.18	-\$0.29
Weighted average of lamps with and without dimmers (90% with, 10% without)			
< 1 hour	-\$0.21	-\$0.01	-\$0.03
1-2 hours	-\$0.79	-\$0.09	-\$0.16
2-4 hours	-\$1.66	-\$0.20	-\$0.35
4-8 hours	-\$3.39	-\$0.43	-\$0.72
8-12 hours	-\$5.69	-\$0.73	-\$1.23
> 12 hours	-\$7.42	-\$0.96	-\$1.60
Residential average	-\$1.22	-\$0.14	-\$0.25

We assessed the non-residential impacts on the assumption that there is no significant use of halogen downlights in the industrial sector and that 90% of the halogen downlights in the commercial sector are not on dimmers. The significant differences between the commercial and residential sectors are therefore that the commercial sector (a) uses lamps more intensively, 8 hours per day, (b) pays lower tariffs, and (c) is less able to obtain savings by dimming and therefore more constrained to take increased efficacy as more light. We estimate that:

- There are significant reductions in the annualised LCC where commercial users re-lamp with 35 watt lamps, \$3.52/lamp for lamps at full power and \$2.93/lamp where the lamp is dimmed to 80% of full power. The weighted average is close to the former, at \$3.47/lamp reflecting our assumption that only 90% of halogen downlights in the commercial sector are not on dimmers.
- The annualised LCC increases by \$0.70/lamp where commercial users re-lamp at 50 watt lamps and cannot dim, and declines by \$0.38/lamp if the lamp is on a dimmer. The former dominates and the weighted increase in annualised LCC is \$0.63 /lamp.
- Our further assumption that only 10% of commercial lamps are dimmable means that there is a small increase in the annualised LCC of halogen downlights in the commercial sector, which we estimate at +\$0.25/lamp.

During the consultation period, stakeholder comments were requested to verify data used in the estimates above. However, no comments were received and as a result these estimates have not been revised.

4.4.7 Compact fluorescent lamps

Based on discussions with suppliers, the CFLs that are now supplied to the Australian market substantially comply with the proposed MEPS and there will not be a noticeable change in the energy efficiency, cost or performance of these products. But there is a risk that inferior CFLs will be introduced in response to the significant increase in sales that is expected when conventional tungsten filament lamps are no longer available.

Inexperienced users who purchase inferior CFLs can be extremely disappointed with their performance, particularly in respect of the colour and other qualities of the light provided, and operating life. The proposed measures are to ensure that (a) disappointments are kept to a minimum, (b) there is minimal temptation to re-lamp with tungsten halogen lamps that comply with the proposed MEPS but are much less efficient than CFLs, and (c) the reputations of CFLs, and energy efficiency interventions more generally, are preserved.

The E3 Committee understand that given the higher price associated with the purchase of CFLs compared to traditional incandescent lamps, some consumers may treat the purchase of CFLs similar to that of electrical appliances. That is, consumers may feel it necessary to keep receipts for long periods of time in case products are defective. However, as noted above E3 consider lifetime and product quality issues especially important and have designed the lighting standard to ensure that products imported and sold in Australia meet a specific level of quality assurance. Additionally, the E3 compliance program will be used to monitor the market and remove from sale, any lighting product that does not meet this requirement.

Many countries regulate the lighting performance of CFLs, not just their energy efficiency, aiming to protect inexperienced customers from inferior products that unfairly damage the reputation of CFLs.

We have not attempted to quantitatively assess the effects of not implementing the proposed measures or to otherwise assess the estimate the dollar value of the costs that would be incurred if the proposed measures are not implemented.

4.4.8 ELV converters

The proposed regulation would remove the least efficient magnetic ELVCs from the market, requiring users to replace them with either the more efficient type of magnetic converter or an electronic converter. The MEPS for ELVCs are scheduled for November 2010. That is a firm date, agreed with suppliers.

Calculation of energy savings

Catalogue data on the efficiency of ELVCs indicates that converters with more than 100 watts of output power will comply with the proposed MEPS – see figure 1.2. The assessment is therefore confined to ELVCs with less than 100 watts of output power. We assume that three levels of output power are representative – 35 watts, 50 watts and 80 watts. As indicated by figure 1.2, the non-complying ELVCs are all of the magnetic type. Suppliers confidently expect most users to adopt the electronic technology in response to the regulation.

The 50 watt ELVC now dominates the market. However, we assume that the associated MEPS for ELV non-reflector lamps will strongly promote 35 watt lamps in new construction and lighting refurbishments, which provide the main market for ELVCs. Logically, the reduction in wattage from 50 watts to 35 watts should be attributed to the

associated lighting MEPS and the main contribution of the MEPS for ELVCs is to raise the efficiency of 35 watt ELVCs. The relevant power savings are as follows:

- The regulation would reduce the input power of 35 watt and 50 watt ELVCs by 7.2 and 9.5 watts, respectively, if the replacement ELVC is of the electronic type.
- There are smaller reductions if the replacement ELVC is of the high efficiency magnetic type, of 4.2 watts and 5.8 watts respectively.
- The savings are further reduced if the associated lamps are on dimmers. We do not have good information about the effect of dimming on the efficiency of ELVCs and have assumed that the dimming reduces ELVC efficiency by 5%. Building on dimming assumptions for ELV lamps, the full set of assumptions is that:
 - halogen downlights are dimmed by 20%, to 80% of light output at full power;
 - this is associated with a 10% reduction in the efficacy of halogen downlights, which means that dimming reduces lamp wattage by only 10%; and
 - the 10% reduction in lamp wattage reduces ELVC efficiency by 5%.

The lesser market is for ELVCs with more than 50 watts of output power, and up to 100 watts. These are mainly used for ‘strings’ of 4 to 8 ELV lamps of the non-reflector type, with individual wattages of, mostly, 10-20 watts. A single transformer of 80 watts can provide power for, say, 4 X 20 watt lamps or 8 X 10 watt lamps. The relevant power savings are as follows:

- The regulation would reduce the input power of an 80 watt ELVCs by 12.7 and 6.8 watts, respectively, for replacement ELVCs of the electronic and high efficiency magnetic types.
- ELVC efficiency is reduced by 5% if the lamps are on dimmers, which is not usually the case in these applications.

We further assume that only 5% of the conversions are to the more efficient type of magnetic ELVC, which means that the remaining 95% deliver the larger gains associated with electronic ELVCs. This is conservative: suppliers say that only 1% of their sales are for more demanding installations for which electronic ELVCs are unsuitable.

The residential duty hours are set at 2.25 hours per day, consistent with the expectation that the associated lamps are often installed in living areas.

Incremental cost of more efficient ELVCs

Figure 4.2 reports the price data that was collected for 50 watt ELVCs when E3 first examined the potential for energy savings from ELVCs, in 2005. Conventional magnetic converters sold for the same price as electronic converters whereas the more efficient magnetic converters, with efficiencies of about 86%, sold at about double that price.

There were further discussions with a large Sydney wholesaler of electrical supplies in May 2006, who reported the trade prices of conventional magnetic and electronic converters at \$12 and \$7-11 respectively. We understand that, with recent rises in the price of steel and copper, the difference in trade prices has continued to move in favour of electronic converters. Suppliers consistently tell us that electronic converters are cheaper than the less efficient magnetic converters. We have assumed that conventional magnetic converters can be replaced with electronic converters at zero net cost for new installations, and regard that as a conservative assumption.

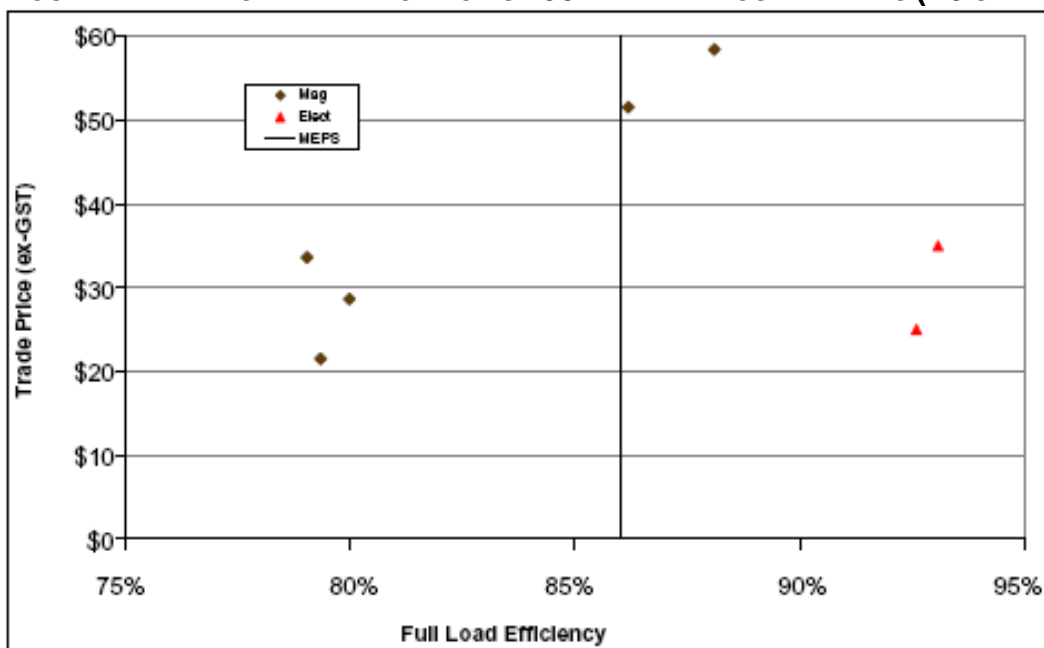
The only contrary piece of evidence has been prices observed in a large electrical retailer in Sydney, where most electronic models were priced around \$28 (but down to \$10) and conventional magnetic converters were about \$10 dollars cheaper, at \$18. Whatever the reason for the reverse relationship, we assume that electronic converters are generally priced to reflect production costs.

In contrast, suppliers agree that a significant price premium will be paid where conventional magnetic converters are replaced with the more efficient type of magnetic converter.

Using the 2005 data that is reported in figure 4.2, we have assumed that:

- The less efficient type of magnetic ELVC can be replaced with an electronic ELVC at no additional cost.

FIGURE 4.2 PRICE AND EFFICIENCY OF 50 WATT ELV CONVERTERS (E3 SAMPLE, 2005)



Source: MEA 2005: page 18

- For users who are obliged to use a magnetic ELVC, less efficient type of magnetic ELVC can be replaced with a high efficiency ELVC at the additional cost of \$25.

Financial impact

Table 4.6 reports the resulting estimates of financial impacts in the residential sector. These indicate that:

- Annualised LCC declines for all users who replace with an electronic converter. Average cost reductions are in the range \$1.00-\$1.50/converter
- Annualised LCC increases for those who are obliged to use the more efficient magnetic converters, in the range \$1.75-\$2.00/converter.
- Electronic converters dominate and, on average, annualised LCC falls by \$0.87/converter.

We assessed the non-residential impacts on the assumption that there is no significant use of halogen downlights in the industrial sector and that 90% of ELV lamps in the commercial are not on dimmers. Allowing for longer duty hours but lower tariffs in the commercial sector, there is a more modest increase in the annualised LCC for those obliged to use high efficiency magnetic ELVCs (\$1/converter) and larger reductions for those who can use the electronic type (\$3/converter). The weighted average reduction is \$2.89/converter.

TABLE 4.6 CHANGE IN ANNUALISED LCC: ELV CONVERTER, RESIDENTIAL (\$/CONVERTER)

Duty hours	Lamps not on dimmers, with ELVC replaced by ...			Lamps on dimmers, with ELVC replaced by ...		
	... high efficiency magnetic	... electronic	Weighted average	... high efficiency magnetic	... electronic	Weighted average
ELVC output = 35 watts						
< 1 hour	+\$2.51	-\$0.22	-\$0.08	+\$2.52	-\$0.21	-\$0.07
1-2 hours	+\$2.26	-\$0.65	-\$0.50	+\$2.28	-\$0.62	-\$0.47
2-4 hours	+\$1.89	-\$1.30	-\$1.14	+\$1.92	-\$1.23	-\$1.07
4-8 hours	+\$1.14	-\$2.59	-\$2.40	+\$1.21	-\$2.46	-\$2.28
8-12 hours	+\$0.14	-\$4.32	-\$4.09	+\$0.27	-\$4.11	-\$3.89
> 12 hours	-\$0.60	-\$5.61	-\$5.36	-\$0.45	-\$5.34	-\$5.10
Residential average	+\$2.07	-\$0.97	-\$0.82	+\$2.10	-\$0.92	-\$0.77
ELVC output = 50 watts						
< 1 hour	+\$2.46	-\$0.28	-\$0.15	+\$2.47	-\$0.27	-\$0.13
1-2 hours	+\$2.11	-\$0.85	-\$0.70	+\$2.14	-\$0.81	-\$0.66
2-4 hours	+\$1.59	-\$1.70	-\$1.54	+\$1.64	-\$1.62	-\$1.46
4-8 hours	+\$0.55	-\$3.41	-\$3.21	+\$0.65	-\$3.24	-\$3.05
8-12 hours	-\$0.84	-\$5.68	-\$5.44	-\$0.67	-\$5.41	-\$5.17
> 12 hours	-\$1.88	-\$7.39	-\$7.11	-\$1.66	-\$7.03	-\$6.76
Residential average	+\$1.85	-\$1.28	-\$1.12	+\$1.89	-\$1.22	-\$1.06
ELVC output = 80 watts						
< 1 hour	+\$2.43	-\$0.38	-\$0.24	+\$2.44	-\$0.36	-\$0.22
1-2 hours	+\$2.03	-\$1.14	-\$0.98	+\$2.05	-\$1.08	-\$0.93
2-4 hours	+\$1.42	-\$2.28	-\$2.10	+\$1.47	-\$2.17	-\$1.99
4-8 hours	+\$0.20	-\$4.56	-\$4.32	+\$0.32	-\$4.34	-\$4.11
8-12 hours	-\$1.43	-\$7.60	-\$7.29	-\$1.23	-\$7.23	-\$6.93
> 12 hours	-\$2.65	-\$9.88	-\$9.52	-\$2.39	-\$9.40	-\$9.05
Residential average	+\$1.72	-\$1.71	-\$1.54	+\$1.76	-\$1.63	-\$1.46
Weighted average across wattages & across lamps with and without dimmers						
	ELVC replaced by high efficiency magnetic		ELVC replaced by electronic		Weighted average	
< 1 hour	+\$2.50		-\$0.23		-\$0.09	
1-2 hours	+\$2.24		-\$0.68		-\$0.54	
2-4 hours	+\$1.85		-\$1.37		-\$1.21	
4-8 hours	+\$1.06		-\$2.74		-\$2.55	
8-12 hours	+\$0.02		-\$4.56		-\$4.33	
> 12 hours	-\$0.77		-\$5.93		-\$5.67	
Residential average	+\$2.05		-\$1.03		-\$0.87	

4.4.9 Summary of financial impacts

Table 4.7 summarises the figuring reported in this section. Note that the findings are not reported as averages per lamp, but as averages per dwelling or per million square metres of commercial or industrial floorspace. Appendix D describes the model of lamp stocks that has been used to aggregate savings on individual lamps to obtain the sectoral averages.

For lamps, the estimates indicate that there are net reductions in annualised LCC for all sectors, and for most types of lighting task. The exceptions are ELV reflector lamps in the commercial sector, for which the baseline assumption is that 90% of the lamps cannot be either dimmed or re-lamped at a lower wattage. The averages also hide some minor cost increases for unlikely configurations of small lamps that are replaced with tungsten halogen lamps rather than CFLs and are on low duty and non-residential tariffs.

TABLE 4.7 CHANGE IN ANNUALISED LCC: SECTORAL AVERAGES*

	<i>Residential (per dwelling)</i>	<i>Commercial (per million sqm of floorspace)</i>	<i>Industrial (per million sqm of floorspace)</i>
Lamps			
MV non-reflector	-\$25.86	-\$250,986	-\$14,407
MV reflector	-\$3.73	-\$130,160	-\$37,780
ELV reflector	-\$0.33	+\$1,312	-
Total	-\$30	-\$379,834	-\$52,187
ELV converters			
	-\$1.69	-\$26,541	-

Note:

* Appendix D described the model of lamp stocks that has been used to aggregate the savings on individual lamp types to the sectoral averages reported here.

There are also net savings for most plausible configurations of ELVCs, the exceptions being a minority of users (less than 5% and probably about 1%) who are obliged to use the more efficient type of magnetic converter.

Note that the timeframe for savings is quite different for lamps and ELVCs. Specifically, the estimates for halogen down lights assume that, given the legacy of 50 watt ELVCs, there will be relatively limited opportunities to re-lamp at 35 watts in the short to medium term. The longer term opportunities are better, but ignored because the outlook is clouded by the uncertain prospect of LED and CFL downlights that compete directly with halogen downlights on price and quality. In contrast, more efficient ELVCs can only contribute over the medium to longer term as they are applied to new construction and lighting refurbishments. A significant contribution from ELVCs is conditional on halogen downlights not being there substantially displaced by LED and CFL downlights.

4.5 Impacts on health, safety and the environment

E3 has examined possible adverse health, safety or environmental effects of the proposed measures. It has modified the communications strategy and arranged for certain exemptions to deal with the issues but considers that these matters do not materially alter its positive assessment of the measures.

This section explains the issues and how E3 has responded. They relate to the specific concerns of people with Lupus, the mercury content of CFLs, the electrical safety of CFLs and tungsten halogen lamps, and emissions associated with the production and distribution of CFLs.

4.5.1 Impact on people with Lupus-related photosensitivity

Lupus is an autoimmune disorder characterised by chronic inflammation of body tissues. People with Lupus produce antibodies that target their own healthy tissues and organs. The cause of Lupus is not clear but genetics, viruses, ultraviolet (UV) light, and medication all appear to play some role. Lupus can be exacerbated by exposure to sunlight, the UV light from lamps, and possibly in some cases also by violet or blue light in the visible spectrum.

The proposed measures create problems for people with Lupus-related photosensitivity. The general concerns for all people with the condition are that (a) CFLs emit more UV light than a GLS that provides the same lighting service, and (b) a tungsten halogen lamp can emit more UV light than a GLS if the halogen has the same wattage as the GLS but provides more light, rather than having a lower wattage and providing the same light. There is a further problem for a sub-group of people whose photosensitivity may extend to

violet and blue light in the visible spectrum: both CFLs and tungsten halogen lamps provide more violet and blue light than equivalent tungsten filament lamps.

E3's response

E3 formulated the following response after consulting with Lupus associations and taking advice from the Office of Health Protection (Department of Health and Ageing).

- E3 has provided a fact sheet that explains how most people with Lupus-related photosensitivity can obtain satisfactory lighting by (a) using acrylic light covers or diffusers to filter the UV light from tungsten halogen lamps and CFLs, (b) dimming tungsten halogen lamps, or (c) both.
- E3 is seeking further advice on the needs of people who may be sensitive to violet or blue light and are therefore not able to use CFLs or tungsten halogen lamps. One solution may be the use of special filters to filter out the blue light.
- E3 is also examining options to provide continued access to tungsten filament lamps, for example, using a system of medical certifications, import exemptions and special distribution arrangements.

E3 is aware of the cost and affordability issues that may arise, relating to the installed cost of light covers and diffusers, and possibly dimmers, and reduced energy savings when lamps are dimmed. However there is uncertainty about the costs at this stage. The difficulty is that photosensitivity is a variable condition and neither its distribution among people with Lupus nor their light management practices are known with reasonable certainty. Also, it is reasonable to assume that many people with Lupus-related photosensitivity have taken steps to manage their exposure to light and that a proportion of these arrangements will remain adequate. And some will stock up with tungsten filament lamps before the point of sale MEPS is implemented and thereby defer any additional expense, possibly for many years and until new lighting technologies provide better solutions.

For the purposes of this decision RIS, E3 has developed the indicative cost estimates that are reported in table 4.8, based on the following assumptions.

- There are approximately 7,000 people with Lupus-related photosensitivity. This is an estimate that an interested individual provided in a private submission to E3. Its origin is unknown and E3 has asked the Department of Health and Ageing to comment and, if necessary, provide an alternative estimate.
- A significant minority (20%) will employ an electrician to install two dimmers and four lamp covers/filters, at a cost of \$260. This is the 'worst case' in table 4.8.
- A large minority (40%) will self-install two lamp covers/filters at a cost of \$30.
- The remainder (40%) will accommodate the proposed measures without changing their existing arrangements for managing photosensitivity. This is the 'best case' reported in the table 4.8.

This figuring suggests an initial expense of about \$500,000 plus ongoing expenses of \$50,000-\$100,000/year, assuming the expense is incurred at intervals of 5-10 years as people move house and that costs are not significantly deferred by stockpiling of GLS lamps while they are still available. The ongoing annual expense is about \$10/person and there is a reasonable prospect that this will be at least negated by reductions in operating costs savings. These are expected to be \$30/year for the average household, as reported in table 4.7, but will be lower where the occupants frequently use dimmers.

Given the uncertainties at this stage, E3 put the net financial impact on people with Lupus at zero for the purposes of this RIS. This is indicative but expresses E3's view that, even with better information, there is no plausible figuring that would materially alter E3's positive assessment of the measures.

TABLE 4.8 INDICATIVE ESTIMATE OF LUPUS-RELATED ADJUSTMENT COSTS

		<i>Worst case</i>	<i>Intermediate case</i>	<i>Best case</i>	<i>All</i>
		Percentage weights			
		20%	40%	40%	100%
<u>Cost item</u>	<u>Unit price</u>	Individual impacts			
Lamp covers/diffusers/filters	\$15	4	2	0	1.6
Dimmers	\$25	2	0	0	0.4
Labour hours	\$75	2	0	0	0.4
TOTAL COST		\$260	\$30	\$0	\$64
		Aggregate impact			
Persons affected		1,400	2,800	2,800	7,000
TOTAL COST		\$364,000	\$84,000	0	\$448,000

Next steps

It seems likely that further investigation will show that the financial impacts are highly variable at the individual level, depending on the individual's specific condition and the types of measures already taken. Governments may determine that there is a need for financial compensation, particularly for people on low incomes, but it is not appropriate for E3 to express a view on that. E3 will refine its cost estimates and investigate the need for financial compensation or in-kind provision, and possible administrative arrangements. One possibility is to use existing state-based arrangements for meeting the special needs of people with disabilities.

E3 recognises that it may be necessary to provide selectively for continued access to the tungsten filament lamps that would otherwise be phased out, and will keep that option open.

E3 will resolve these issues by working with relevant health agencies and the Lupus associations in the various jurisdictions to better understand how people with Lupus currently manage their exposure to light, and the impact of the measures on the available options.

4.5.2 Mercury in CFLs

CFLs contain a small amount of mercury, which is a hazardous substance. People may be exposed to mercury when fluorescent lamps are broken, usually accidentally. The mercury in fluorescent lamps also poses a waste disposal issue.

The basic facts about mercury in CFLs are as follows:

- All fluorescent lamps contain a small amount of mercury, including the linear fluorescent lamps that have been used for more than 50 years in commercial, industrial and health buildings, and in 'public assembly' buildings like schools, theatres and halls.
- Fluorescent lamps can be designed to operate effectively with varying amounts of mercury, and international best practice is to limit the mercury content to the minimum.
- The mercury content of fluorescent lamps is regulated and regulators typically require 'best practice'. The AS/NZS 4782 series of standards defines the performance specifications for linear fluorescent lamp, including a maximum mercury content of 15 milligrams.

- The proposed measures would limit the amount in CFLs to 5 milligrams, as in Europe. Given the relatively small size of the Australian market, Australia does not have a realistic option of imposing a lower maximum at the present time but this limit will be kept under review and revised downwards when practicable.

In recent months, a number of large retail chains and manufacturers such as Ikea have established collection depots for broken or used CFLs, in an effort to promote their company as environmentally and sustainability friendly. It should also be noted, that some local councils and governments have established similar programs designed to collect CFLs for safe disposal and recycling.

Exposure to mercury from broken CFLs

As discussed in 3.1.4, E3 has prepared fact sheets on a number of health and environmental issues. The fact sheets were prepared in consultation with the Office of Health Protection within the Australian Government Department of Health and Ageing, and are reproduced in appendix A. In preparing the fact sheet on mercury, Professor Brian Priestly, Director, Australian Centre for Human Health Risk Assessment, Monash University was commissioned to conduct a review of the Maine Compact Fluorescent Lamp Study (February 2008) as E3 was aware of the level of interest in this study and its findings in relation to exposure and clean-up of mercury from broken CFLs. The Priestly review found that it is unlikely that short-term exposures prior to, during or after cleaning up broken CFL material could constitute a health risk. The review also identified the key elements of pragmatic advice to guide the clean-up of mercury containing material from broken CFLs, noting that the advice being developed by DEWHA is suitably cautionary and should not make such clean-up onerous or expensive. The E3 fact sheet for mercury in CFLs has been revised to take into account the outcomes of the review and can be found at Appendix A.

Additional cost of cleaning up and disposing of broken lamps

People should exercise some care when cleaning up a broken CFL and this may involve ventilating the room and wearing gloves. It seems impossible to know whether this is more or less work than cleaning up after breaking a tungsten filament lamp. There may be less work involved in cleaning up one tungsten filament but many more breakages. This is because tungsten filament lamps are replaced at least six times more frequently and have less value. People will probably take a bit more care in handling a CFL.

Disposal of CFLs

The issues that arise in the disposal of CFLs are that:

- Waste collectors and processors may be exposed to mercury as CFLs enter the waste stream, and that this exposure is likely to increase as more CFLs enter the waste stream.
- Mercury from lamps in landfills can be converted to methyl mercury. Methyl mercury is more toxic than elemental mercury and, when emitted to air, may be a risk to landfill workers
- If CFLs are processed in Alternative Waste Treatment facilities the mercury they contain may contaminate compost and render it unusable. .
- Mercury may also escape from landfills into the environment or into ground water as leachate.
- Mercury escaping from landfills in various forms can contribute to overall mercury pollution that can bioaccumulate in the environment and affect human health and animal health.

In June 2007 the Environment Protection and Heritage Council (EPHC) decided to investigate issues associated with the disposal of CFLs. Work is continuing with the Australian Council of Recyclers and other industry and government stakeholders, gathering information on the nature and extent of problems associated with the disposal of fluorescent lamps that contain mercury. EPHC has sought advice on whether waste CFLs should be listed as a priority waste for national action, and expects to consider this advice at the first EPHC meeting in 2009. Depending on EPHC's assessment of the need, some form of product stewardship scheme may be implemented. Such a scheme would aim to safely recover mercury from CFLs or otherwise dispose of CFLs more safely.

The present situation is that (a) E3 has no evidence that disposal issues will materially affect its assessment of the proposed measures, and (b) it is not appropriate for E3 to duplicate or otherwise anticipate the work of EPHC. Therefore, the practical issue for E3 is whether to recommend that the proposed measures be postponed until EPHC has finished its work and any additional costs are known, for example, costs associated with a national collection and recycling scheme. E3's decision is to recommend against postponement and notes that:

- By the end of its life, as much as 60% of the mercury in a waste CFL has been chemically 'locked up' in other parts of the lamp such as the phosphor powder and the glass;
- CFLs would contribute only an estimated 1-2% of the total mercury that enters landfill. Fluorescent tubes comprise the largest source of mercury in landfills;
- Health and environmental protection measures should be implemented in order of cost effectiveness, which means that other protective measures may have a better claim to additional resources than the management of waste CFLs;
- CFLs have a long life span (about five years) which provides time to develop options to deal with end of life lamps before significant numbers enter the waste stream; and
- All types of lamps are responsible for the emission of mercury in the combustion of fossil fuels. The contribution of a CFL (through lower energy consumption) to reduce emissions from power stations is actually greater than the amount of mercury in a CFL²⁹.

4.5.3 Electrical safety of halogen lamps, CFLs and dimmers

E3 is aware of several concerns about the electrical safety of lamps but considers that there are no safety issues that would materially affect its assessment of the proposal. This section explains the basis for this assessment.

The market and regulatory context is as follows:

- The fluorescent and incandescent lighting technologies that will replace non-complying lamps have been in use for many years.
- Australian Standards provide performance and safety specifications for tungsten filament lamps, MV tungsten halogen lamps and CFLs³⁰. These provide for inter-

²⁹ Parsons, David (2006)

³⁰ AS NZS 60432.1 - *Incandescent lamps - Safety specifications part 1: tungsten-filament lamps for domestic and similar general lighting purposes*
AS NZS 60432.2 - *Incandescent lamps - Safety specifications part 2: tungsten-halogen lamps for domestic and similar general lighting purposes*

changeability of lamps, protection against electric shock, maximum increase in the temperature of the lamp cap and resistance to torque. There are additional provisions for the safe failure of tungsten filament and MV tungsten halogen lamps at end of life, requiring that the lamp does not break, is not ejected from the cap and does not short circuit to the cap shell. For CFLs there are additional provisions requiring that insulation resistance and electric strength is retained in humid conditions, and for resistance to heat, flame and ignition.

- Standards for the safety, performance, and energy efficiency of lamps are the responsibility of Australian Standard committee EL41. (E3 is represented on the sub-committee that deals specifically with energy efficiency, EL41-08.)
- The US National Electrical Manufacturers Association (NEMA) has been recently reviewing North American electrical safety standards for CFLs in recognition of consumer concern regarding end of life failure modes. EL41 has resolved to consider the end of life failure safety standards for CFLs in line with outcomes of the NEMA review and to consider requiring suitable wording (for products or their packaging) dealing with CFL compatibility with dimmers, controllers and light fittings.
- The International Electrotechnical Commission (IEC) is a global organisation that provides international standards for electrical, electronic and related technologies. The IEC is re-drafting a safety standard for tungsten halogen lamps that requires protection against current surges that may damage circuits, dimmers and other controllers. These measures would protect against dangerous or damaging surges at end of life. The IEC are also considering drafting new standards to cover the compatibility of CFLs with dimmers, controllers and the like. Australian standards are developed to ensure they closely follow IEC standards.
- The state and territory governments have primary responsibility for electrical safety but coordinate their work through the Electric Regulatory Authority Council (ERAC). ERAC is made up of representatives of the regulatory authorities of New Zealand and the Australian states, territories and commonwealth, and is recognised in the electrical industry as an authoritative voice for electrical regulators.
- Each jurisdiction requires that CFLs comply with the relevant safety standard (AS NZS 60968). Compliance with the safety requirements for tungsten filament and tungsten halogen lamps (AS NZS 60432 series) is not mandatory now but will become mandatory as part of the proposed MEPS regime. Any changes to that standard, such as IEC's new measures for the end of life safety of MV tungsten filament lamps, would also become mandatory.

E3 approached EL41 and ERAC for advice on concerns that have been expressed about the electrical safety of lamps that will be used to replace non-complying incandescent lamps. It was made plain that the issues were (a) short operating life of CFLs and damage to CFLs, (b) damage to electronic controllers such as dimmers, (c) overheating of CFLs or controllers to the point of creating a fire hazard, and (d) the safety of MV tungsten halogen lamps.

Regarding the status of MV tungsten halogen lamps as an inherently safe alternative, EL41 advised that:

- As a replacement for GLS lamps, non-reflector halogen lamps should not lead to higher luminaire surface temperatures, as the lamps should be of lower wattage – for example, a 42 watt lamp replacing a 60 watt lamp.
- Concerns about the end of life safety of MV tungsten halogen lamps will be addressed by mandating any additional protections that are proposed by IEC.

Regarding CFLs, ERAC advised E3 that:

- CFLs are electronic devices and a basic principle for the safe operation of electronic devices is that they should not be used outside their normal operating range. However, it is known that most CFLs do not operate normally when installed on circuits with certain types of controls – such as dimmers, touch controls, sensors and electronic timers – or in the elevated temperatures that may occur in 3-in-1 bathroom heater lights and inside the recessed fittings used for downlights. Accordingly, users should be warned against using CFLs in these situations unless they obtain expert advice or otherwise reassure themselves that the CFL has been designed for that particular operating environment.
- Users should also know that a small minority of CFLs will fail in what appears to be an alarming fashion, emitting smoke, soot, flame or some combination of these.

E3 has accepted this advice and will formulate its communications strategy accordingly, aiming solely to provide users with objective information about CFLs. Refer to section 3.1.4 for an account of the communications strategy.

ERAC has not advised E3 that concerns about electrical safety are such that the proposal should be reconsidered or delayed until these matters are further investigated.

4.5.4 Greenhouse emissions during lamp production and distribution

We have not assessed differences in the ‘embodied emissions’ of the various types of lamps, for example, the possibility that emissions associated with the production and distribution of CFLs exceeds the emissions associated with the production and distribution of an equivalent number of tungsten filament lamps. Implicitly, it is assumed that the energy consumed during use dominates the environmental impacts of lighting services. We rely on a recent comparative study of the lifecycle environmental impacts of CFLs and incandescent lamps under Australian conditions (Parsons 2006), based on a complete inventory of the materials used in production. Parsons concluded that ... *the claimed environment benefit of compact fluorescent lamps over incandescent lamps is largely true and that it is true on almost any measure ...* (Parsons 2006: page 10). This includes a finding that CFLs reduce the use of fossil fuels by a factor of 5 even after allowing for energy used across the ‘cradle to grave’ lifecycle of these products.

4.6 Power quality and impacts on electricity networks

The installation of large numbers of CFLs has implications for the operation of electricity networks. The issues are highly technical, associated with the harmonics and power factor of CFLs.

E3 considers that these impacts would not materially affect its assessment of the proposal. This section explains the impacts and E3’s response to the issues that have been raised, based on advice from the Energy Networks Association (ENA) and the relevant committee of Standards Australia.

Harmonics caused by CFLs

CFLs and other types of electronic equipment create harmonic currents that distort the electricity supply in a way that may adversely affect the operation of other appliances and equipment that draw power from the network. Harmonic currents can also interfere with load control systems for off-peak hot water. ENA advised E3 that a suitable response would be to mandate the harmonic standard AS/NZS 61000.3.2 for CFLs, bringing Australia into line with mandatory CFL requirements in Europe.

E3 accepted that advice. CFLs will be the first electronic product with a mandatory harmonic requirement. ENA is also monitoring a range of the new products – such as home theatres, large TV screens and air conditioners – for their impact on electricity

networks, and may advocate mandatory harmonic requirements for all electronic equipment, as is now the case in Europe.

Power factor of CFLs

The power factor of an electrical appliance describes the relationship between the current that is supplied and the amount of real work that is performed. For example, the proposed MEPS for CFLs includes a minimum power factor of 0.55, which means that a CFL's ratio of real work to current cannot be less than 0.55. This relationship is sometimes misinterpreted in two ways.

- One misunderstanding is that CFLs will increase the current carried by electricity networks. However, as CFLs draw significantly less power than incandescent lamps, the combined effect of this and of their lower power factor is still to reduce the current by about 50% when compared to incandescent lamps.
- The second misunderstanding is that simple comparisons of the wattages of CFLs and incandescent lamps ignore the difference in power factors and greatly overstate the energy savings. This is incorrect for two reasons. First, the power factor affects only the distribution and transmission losses and these are second order effects compared with power that is drawn by the lamps. Second, the 'leading' power factor introduced by CFLs helps to compensate for the 'lagging' power factor typically experienced by electricity networks, due to the dominance of inductive loads such as electric motors.

Based on E3's discussions with ENA and the relevant committee of Standards Australia, the lower power factor introduced by CFLs is not a significant problem.

Quantification of network effects

ENA advised E3 that there is no known measured or modelled data that would allow the effects of CFL power factor and harmonics to be quantified accurately, due to the very complex nature of the issues involved. ENA has elected to keep a watching brief on this issue and E3 will continue the dialogue with ENA and ensure that these parameters are considered for other products covered by the program. E3 has encouraged electric network companies and the ENA to develop estimates of cost impacts associated with the power factor and harmonics of electronic equipment.

4.7 Nationwide impacts

4.7.1 How nationwide impacts were calculated

We estimated the nationwide impacts as the difference between a 'without specific measures' scenario and a 'with specific measures' scenario, referred to as the WoSM and WSM scenarios. Common to both scenarios are the assumptions that:

- New households form according to ABS population projections and there is commensurate growth of commercial and industrial floor-space. The increase from 2005 to 2020 is approximately 24%.
- There is no significant development of LED or other new technologies that would significantly reduce the cost of more efficient lamps.
- We ignore the growth in per-capita lighting demand that would normally be associated with increasing per-capita incomes. This is an uncertain effect and the assumption reduces our estimate of abatement.
- We ignore the rebound effect, that is, the tendency for users to respond to efficiency measures that reduce the cost of lighting services by consuming more lighting services. This is also an uncertain effect but the assumption increases our estimate of abatement.

- We ignore the apparent positive response to the announcement, on 20 February 2007, that incandescent lamps would be phased out. Import data indicate that, in response to the announcement, CFL sales increased significantly and displaced incandescent sales in the process. Plausibly, the announcement has given the community the confidence and incentive to trial CFLs, and will have the practical effect of accelerating the regulatory impact.

Baseline scenario

We developed the WoSM and WSM scenarios with reference to a baseline scenario – see figure 4.3. The baseline scenario assumes that lamp densities and types are frozen at the 2005 levels, which means that energy consumption grows in proportion to population. Appendix D describes the lamp stock model that we used to develop estimates of the lamp stock for 2005³¹.

With specific measures (WSM) scenario

We expect a large early response to the proposed measures but that it will take up to 10 years for the full impact to be realised. This is because intensively used lamps will fail first and, when replaced, will make the largest contributions to total energy savings³². But it will take several more years to replace lamps that are used less intensively.

This accounts for the shape of the WSM scenario shown in figure 4.3, with a large proportion of the gains achieved by 2015. Figure 4.4 provides some more detail about the time profile of transition. There are large gains in the first two or three years after implementation but a long tail before the process is substantially complete. The distribution is such that half of the gains from MV lamps, both reflectors and non-reflectors, are achieved within 18 months of implementation, and within 30 months for ELV reflector lamps.

The phasing out of non-complying ELVCs is a slower process. The distribution is such that it takes 10 years to achieve half of the gains and only 62% of the transition is complete by the end of 2020. Technological developments may have made this technology redundant by that time.

Without specific measures (WoSM) scenario

The WoSM scenario is concerned with what would happen in the absence of the specific measures, but with carbon pricing and other non-specific measures in place. This is uncertain, not least because the non-specific measures that will apply over the period to 2020 are uncertain. We make an arbitrary assumption that non-specific measures will deliver 25% of the abatement projected for 2020. Energy savings accumulate linearly to that point. This expresses the view that is put in section 1.5, which is that non-specific measures cannot address the sectoral problems that specific measures are designed to address.

³¹ The International Energy Agency has noted that the lack of comprehensive lighting end-use studies is a severe constraint on policy analysis (IEA 2006: pages 168-172). Following IEA's lead, we took a US model of the lighting task (Navigant 2002) and adjusted it in a manner calculated to make that model consistent with (a) the available Australian estimates of lighting energy consumption in both the residential and non-residential sectors, (b) ABS survey estimates of relating to the use of fluorescent lamps, and (c) lamp import data.

³² Consider that the replacement of tungsten filament lamps will contribute most of the of the energy savings and, even with low duty hours of only one hour per day, would be replaced within 3 years. The available data indicates that 75% of the residential lighting task (lamp hours) is from lamps that operate for at least one hour per day. Almost all commercial and industrial lighting tasks are also in this category.

FIGURE 4.3 PROJECTED ENERGY CONSUMPTION FOR LIGHTING, WITH AND WITHOUT SPECIFIC MEASURES: AUSTRALIA

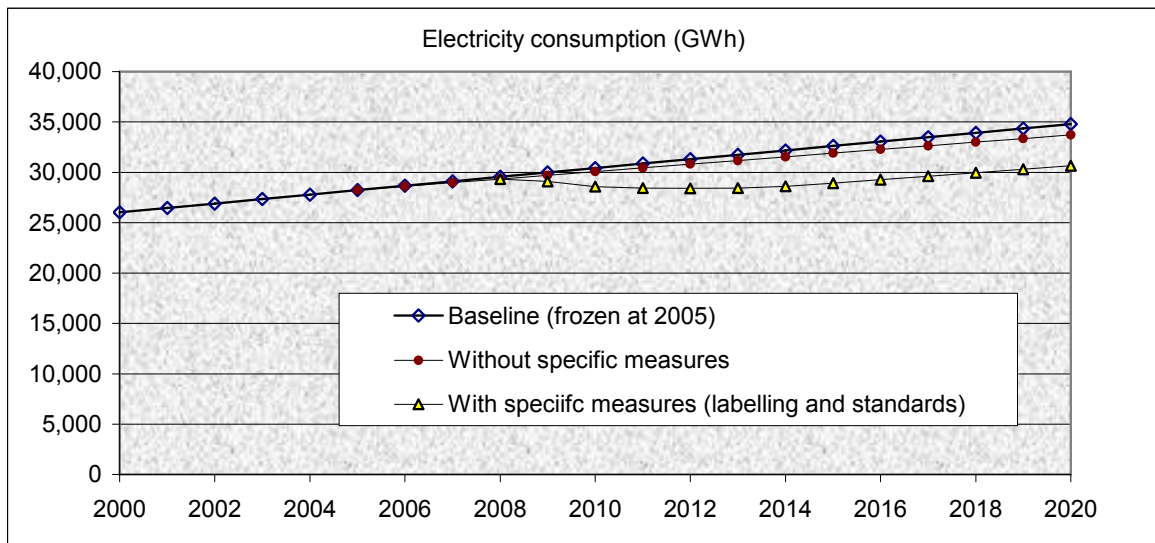
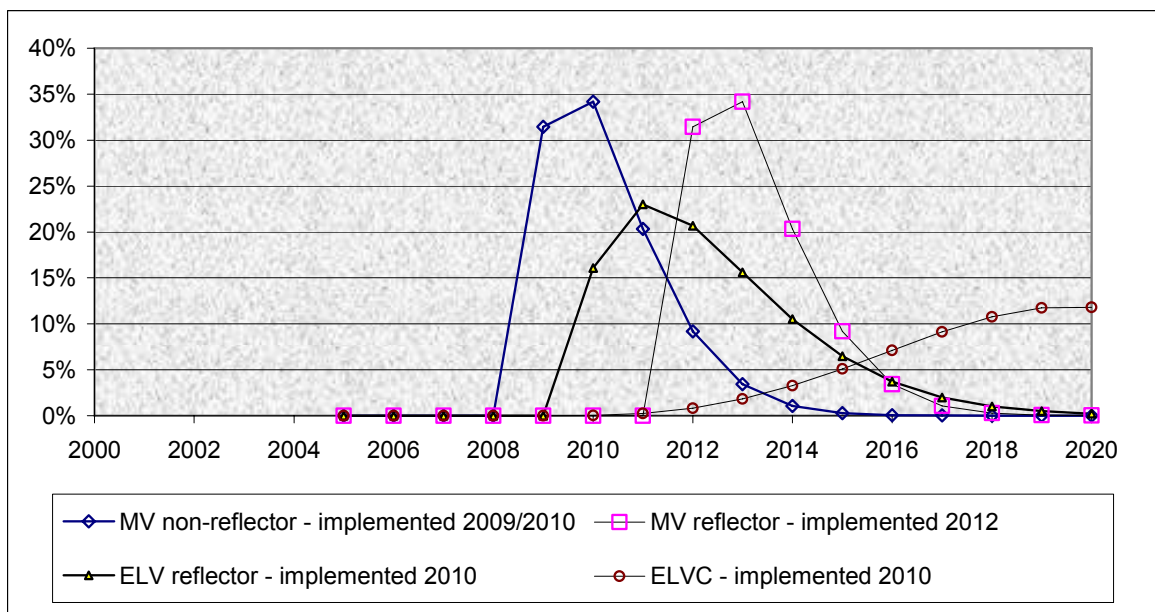


FIGURE 4.4 REPLACEMENT OF NON-COMPLYING LAMPS AND ELVCs: % OF NON-COMPLYING STOCK, BY YEAR



4.7.2 Greenhouse abatement

The WoSM estimate for lighting greenhouse emissions is 29.7 Mt CO₂-e/year in the first commitment period of the Kyoto Protocol (2008-12). This is 4.9% of Australia's total emissions, which are projected to reach 603 Mt CO₂-e/year in 2010. Note that the estimate is for all stationary lighting tasks, not just those performed by incandescent lamps.

Figure 4.5 presents our estimates of the impact of the measures, that is, the difference between the WoSM and WSM scenarios. The proposed measures reduce lighting greenhouse emissions by 7.3% over the period 2009 to 2020, contributing 28.5 Mt CO₂-e to greenhouse abatement. This is a fraction of the total abatement that is planned for the period to 2020. In 2006, for example, AGO estimated that abatement measures will deliver about 1,330 Mt CO₂-e of abatement in the period 2008 to 2020 (AGO 2006). The proposed lighting measures would contribute about 2.1% of that total.

4.7.3 Cost-effectiveness of abatement

Table 4.9 reports our estimates of the nationwide impacts for the period to 2020. Note that:

- The estimate of greenhouse abatement is that reported in section 4.7.2.
- The taxpayer costs and business compliance costs are as reported in sections 4.1 and 4.2.
- The change in aggregate lamp operating costs is obtained by applying the average sectoral estimates reported in table 4.7 to estimates of the total number of residential dwellings and the floorspace of commercial and industrial buildings.

On this figuring, the proposed MEPS satisfy the ‘no regrets’ criterion, that is, delivering abatement at no financial cost to users. The proposals would deliver abatement of 28.5 Mt CO₂-e and simultaneously provide savings of \$2,165 million. The cost of abatement is negative, -\$135/tonne CO₂-e³³.

FIGURE 4.5 PROJECTED GREENHOUSE EMISSIONS FOR LIGHTING, WITH AND WITHOUT SPECIFIC MEASURES: AUSTRALIA

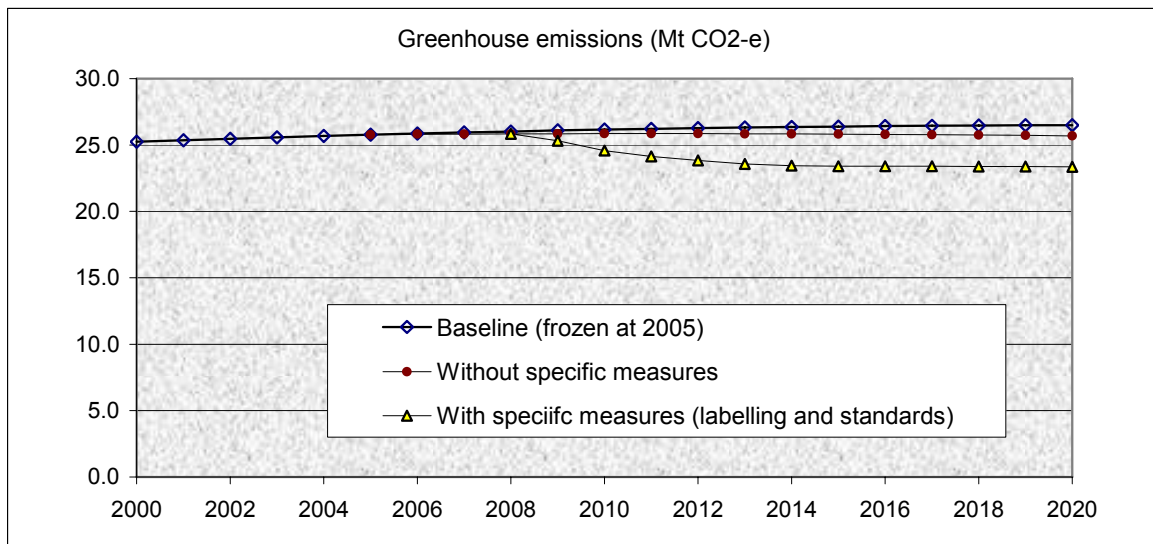


TABLE 4.9 SUMMARY STATEMENT OF NATIONWIDE IMPACTS: AUSTRALIA, 2008 TO 2020

Electricity consumption(GWh)	-30,305
Greenhouse emissions (Mt CO ₂ -e)	-28.5
<u>Financial impacts - undiscounted dollar amounts (\$M)</u>	
cost to the taxpayer	+10.2
business compliance costs	+4.4
lamp operating costs (lamps & energy)	-3,883
<u>Financial impacts - present values (\$M), discount rate = 7.5%</u>	
cost to the taxpayer	+8.74
business compliance costs	+2.87
lamp operating costs (lamps & energy)	-2,177
<u>Investment analysis (\$M)</u>	
total costs	no capital costs*
total benefits	+2,165
net present value	+2,165

Note

³³ This is the ratio of the net costs to abatement, but with the abatement also discounted to the present.

* Both lamps and energy are treated as operating costs of lighting services, which is consistent with normal practice in facilities management. It is analytically cumbersome to treat lamps as capital items, given their low unit cost and their relatively short and variable lives. Hence, we have not calculated a benefit cost ratio.

4.8 Sensitivity and distributional analysis

4.8.1 Sensitivity analysis of financial impacts on users

The analysis of financial impacts (section 4.4) indicates that there are net financial benefits for almost all plausible combinations of lamp type, lamp size and duty hours, and for most combinations of ELVC and duty hours. The exceptions are (a) halogen downlights that cannot be dimmed or re-lamped at a lower wattage, (b) unlikely combinations of small lamps on low duty and non-residential tariffs, and (c) situations where conventional magnetic converters cannot be replaced with electronic converters. However, the losses are small relative to the gains on other lamps and ELVCs.

Inter-jurisdictional variation in the price of electricity is a further significant variable. The estimates reported in table 4.10 indicate that, while this causes significant inter-jurisdictional variation the average sectoral outcomes, there is always a significant net reduction in annualised LCC. For example, the change in annualised LCC in the residential sector varies from -\$22/dwelling in Tasmania to -\$38/dwelling in South Australia.

4.8.2 Distributional analysis

We have examined a wide range of plausible combinations of lamp type, lamp size, duty hours of the lamp, and type of electricity tariff (residential, commercial and industrial) and consider that there are no circumstances giving rise to adverse distributional effects. Low income households are unlikely to have the unusual configuration of lamps that is required to generate significant net costs, that is, many non-dimmable halogen downlights and no offsetting savings from the replacement of tungsten filament lamps.

4.8.1 Sensitivity analysis of nationwide impacts

Table 4.11 presents a sensitivity analysis for the nationwide impacts, and represents our subjective sense of the uncertainties. The positive assessment is not altered by any plausible changes in underlying parameters.

The analysis indicates that the contribution to abatement is sensitive to the proportion of CFLs that are used to replace non-complying lamps, and also to the timing of implementation. The former may respond to policy interventions, particularly information and labelling measures, but the latter is determined by the size distribution of duty hours across the lighting stock. The latter indicates the possible significance of an ‘announcement effect’, that is, the effect of announcing the measures on individual incentives and confidence to start using CFLs.

The analysis is not sensitive to plausible variations in the incremental cost of more efficient lamps – see the final panel. This is because (a) the value of the energy used by lamps is large relative to the cost of lamps, and (b) more efficient lamps have longer lives than less efficient lamps, to the point where there is often little difference between the annualised cost of more and less efficient lamps, and more efficient lamps are sometimes cheaper on that basis.

TABLE 4.10 CHANGE IN ANNUALISED LCC: SECTORAL AVERAGES, BY JURISDICTION

	<i>Residential (per dwelling)</i>	<i>Commercial (per million sqm of floorspace)</i>	<i>Industrial (per million sqm of floorspace)</i>
NSW			
MV non-reflector	-\$28.90	-\$269,836	-\$14,407
MV reflector	-\$4.13	-\$138,431	-\$37,780
ELV reflector	-\$0.39	+\$1,002	-
Total	-\$33	-\$407,265	-\$52,187
Victoria			
MV non-reflector	-\$25.23	-\$247,093	-\$14,407
MV reflector	-\$3.64	-\$128,452	-\$37,780
ELV reflector	-\$0.32	+\$1,376	-
Total	-\$29	-\$374,168	-\$52,187
Queensland			
MV non-reflector	-\$21.56	-\$224,350	-\$14,407
MV reflector	-\$3.16	-\$118,473	-\$37,780
ELV reflector	-\$0.24	+\$1,751	-
Total	-\$25	-\$341,071	-\$52,187
South Australia			
MV non-reflector	-\$32.57	-\$292,579	-\$14,407
MV reflector	-\$4.61	-\$148,410	-\$37,780
ELV reflector	-\$0.47	+\$627	-
Total	-\$38	-\$440,362	-\$52,187
Western Australia			
MV non-reflector	-\$22.85	-\$232,310	-\$14,407
MV reflector	-\$3.33	-\$121,965	-\$37,780
ELV reflector	-\$0.26	+\$1,620	-
Total	-\$26	-\$352,655	-\$52,187
Tasmania			
MV non-reflector	-\$18.81	-\$207,292	-\$14,407
MV reflector	-\$2.80	-\$110,988	-\$37,780
ELV reflector	-\$0.18	+\$2,032	-
Total	-\$22	-\$316,249	-\$52,187
Northern Territory			
MV non-reflector	-\$24.13	-\$240,270	-\$14,407
MV reflector	-\$3.50	-\$125,458	-\$37,780
ELV reflector	-\$0.29	+\$1,489	-
Total	-\$28	-\$364,239	-\$52,187
Australian Capital Territory			
MV non-reflector	-\$20.28	-\$216,390	-\$14,407
MV reflector	-\$2.99	-\$114,980	-
ELV reflector	-\$0.21	+\$1,882	-\$52,187
Total	-\$23	-\$329,488	-\$14,407
ELV converters			
New South Wales	-\$1.89	-\$28,435	-
Victoria	-\$1.65	-\$26,149	-
Queensland	-\$1.41	-\$23,864	-
South Australia	-\$2.12	-\$30,720	-
Western Australia	-\$1.49	-\$24,664	-
Tasmania	-\$1.23	-\$22,150	-
Northern Territory	-\$1.58	-\$25,464	-
ACT	-\$1.33	-\$23,064	-

TABLE 4.11 SENSITIVITY ANALYSIS OF NATIONWIDE IMPACTS: AUSTRALIA, 2008 TO 2020

	<i>Electricity consumption (GWh)</i>	<i>Greenhouse emissions (Mt CO₂-e)</i>	<i>Operating cost of lamps (\$M)</i>	<i>Net present value (\$M)</i>
Baseline				
Baseline	-30,305	-28.5	-2,177	2,165
Rate of adjustment				
Faster adjustment – 50% phase-out achieved in 25% less time	-30,777	-28.9	-2,217	2,204
Slower adjustment – 50% phase-out achieved in 25% more time	-28,569	-26.8	-2,027	2,014
Timing of implementation				
Brought forward by 1 year	-33,660	-31.8	-2,516	2,503
Delayed by 1 year	-27,003	-25.2	-1,865	1,852
Proportion of CFLs used to re-lamp				
Reduced by half (to 25% and 10% for MV non-reflectors and MV reflectors respectively)	-23,201	-21.8	-1,497	1,484
Increased by half (to 75% and 30% for MV non-reflectors and MV reflectors respectively)	-37,409	-35.1	-2,856	2,843
Discount rate				
10%	-30,305	-28.5	-1,811	1,799
5%	-30,305	-28.5	-2,640	2,626
0%	-30,305	-28.5	-4,000	3,984
Incremental cost of more efficient lamps				
Doubled	-30,305	-28.5	-2,109	2,096
Reduced by half	-30,305	-28.5	-2,211	2,199
Other effects				
Rebound effect (less 10% of baseline)	-27,274.5	-25.65	-1,959.3	1,945.5
Net effect of BAU increases (plus 10% of baseline)	-33,335.5	-31.35	-2,394.7	2,381.5

5 Option 2 – tax on non-complying lamps

The aim of mandatory MEPS (option 1) is to prohibit the sale of non-complying lamps, thereby suppressing any expression of preferences for non-complying lamps, regardless of how strong those preferences may be. Such preferences may arise for a number of reasons. There may be no prospect of recouping the cost of more efficient but more expensive lamps, for example, because certain lamps are used infrequently or because the lamp wattage is fixed by the magnetic converter that has been installed on the circuit. There may be aesthetic or health reasons such as those arising from Lupus-related photosensitivity. Others may wish to avoid the hassle associated with learning how to select and manage alternative lamp technologies.

Governments may be concerned about the impact of prohibitive arrangements even where preferences are difficult to understand and run counter to government policy aims.

One way to allow private preferences to be at least partly expressed, but still substantially achieve the government's policy objectives, is to impose a tax on non-complying lamps but set it at a non-prohibitive level. It would be set at a level that discourages the use of non-complying lamps but still allows people to acquire and use them if their preference for non-complying lamps is sufficiently strong.

The practical question for E3 is whether it is feasible to design a tax that can be confidently recommended as superior to the proposed measures, or as sufficiently promising to justify deferring the proposed measures until the tax option is fully developed and assessed. Accordingly, the analytical approach adopted here is to explicitly compare option 2 (taxes) with option 1 (MEPS), focusing on the costs and benefits of option 2 relative to option 1.

Advantages and disadvantages of the option

The main advantage of a tax on non-complying lamps is that it allows users with a particular preference for an inefficient lamp to pay the required tax and retain their preferred lamp (i.e. purchasing the usual GLS lamp).

However, the main disadvantage of this option is that a specific tax on light bulbs provides an indirect means to reduce carbon emissions. For example, people using GLS bulbs in conjunction with 'green' energy would be subject to the tax despite the fact they do not contribute to increasing carbon emissions from energy use.

5.1 Uncertainty about the optimal tax

The rate of tax could be set at the level required to achieve any desired take-up of complying lamps. A tax of \$2.00-\$4.00/lamp would be enough to eliminate the price difference between tungsten filament lamps and CFLs. There would probably be a significant consumer response to a smaller tax, for example, reducing the price difference by half. But what is the optimal tax?

E3 has considered whether a tax might be set at an amount that induces users to mimic the outcomes that would be achieved if they made fully-informed and well-considered decisions to purchase lamps. That, is it possible to devise a tax that 'corrects' the market failures that are documented in section 1.4?

The problem with this design objective is that the optimal tax is different for different people. A tax that is just right for one group – that is, has the effect of closely mimicking fully-informed and well-considered lamp selections for that group – will be too strong for

those who are more diligent than that particular group and too weak to those who are less diligent. The former will over-react to the tax and the latter will under-react to the tax.

It follows that any tax is a compromise that cannot be customised to the needs of particular individuals. The optimal compromise strikes a good balance between the objectives of (a) providing an adequate price signal in the presence of market failures and (b) not transgressing on strongly held preferences.

A possible remedy for uncertainty about the appropriate tax is to manage the tax rate adaptively. It could be set arbitrarily in the first instance – say, to eliminate 50% of the cost difference between complying and non-complying lamps – and adjusted up or down in response to further examination of the lamp selections in response to the tax, including the effects of growing familiarity with lighting options and performance. It would be adjusted upwards if ongoing market analysis indicates that ignorance rather than strong preferences is the dominant reason for remaining purchases of non-complying lamps. It would be adjusted downwards if it is apparent that residual buyers have made considered decisions to continuing using non-complying lamps.

Option 1 does not provide for this learning process and in that respect is inferior to option 2. But what are the prospects that the learning process in option 2 would lead to a significantly different outcome? The following are relevant considerations.

- E3 has no objective evidence that non-complying lamps will be strongly preferred on a significant scale. As detailed in chapter 3, option 1 will be implemented in stages that are designed to ensure that efficient and affordable replacements are available on competitive terms and on a like-for-like basis, including complying incandescent lamps. As detailed in chapter 4, E3 has examined all plausible combinations of lamp type, lamp size, duty hours and tariffs, and finds that option 1 is overwhelming cost reducing. A high tax may be justified, including a prohibitive tax, if concerns about market failure dominate concerns about suppressed preferences.
- Sales of non-complying lamps under option 2 will be affected by negative feedback in the form of higher prices and reduced availability. Consider that prices of non-complying lamps are likely to rise as retailers recover overheads from smaller volumes. And availability will decline as inventory and shelf space is reallocated to better-selling items. Woolworths has announced that it will cease supplying non-complying lamps 12 months before the point of sales MEPS is implemented. The price and availability of complying lamps will be moving in the opposite direction at the same time, shifting the balance of both financial and hassle costs in favour of complying lamps. Plausibly, the effect of these negative feedbacks is that option 2 would eventually deliver a result that is not very different from that expected from option 1, since each customer that converts to complying lamps makes it more difficult for the remaining customers to obtain non-complying lamps on reasonable terms.

Overall, E3 considers that option 2 has merit in principle but, based on current knowledge, offers an uncertain prospect of what may be only relatively small gains relative to option 1.

5.2 Impact modelling

It follows from the above considerations that E3 can provide only indicative estimates of the impact of option 2. This figuring is presented in table 5.1 and is provided to help explain the information that is required to devise and assess a tax proposal. It is not a serious exercise in impact assessment of an actual proposal.

It is assumed for these purposes that the tax is applied only to tungsten filament lamps and that MEPS are retained for CFLs and tungsten halogen lamps. This is because the complying and non-complying versions of the latter differ mainly in respect of their energy efficiency and durability, and do not challenge consumer habits and preferences in the same way that CFLs may challenge someone who values the option of using tungsten filament lamps. Also, there are only small differences in the price of complying and non-complying products, which means that any significant tax will effectively prohibit the non-complying products. The effect of these assumptions is to focus attention on the loss of the tungsten filament option.

TABLE 5.1 INDICATIVE STATEMENT OF NATIONWIDE IMPACTS, COMPARING OPTION 2 WITH OPTION 1: 2008 TO 2020

	<i>Impact of Option 1</i>	<i>Difference</i>	<i>Impact of Option 2</i>
Energy use - GWh	-30,305	+2,121	-28,184
Greenhouse emissions (Mt CO ₂ -e)	-28.46	+1.99	-26.46
Undiscounted dollar amounts (\$M)			
cost to the taxpayer	10.24	+4.10	14.34
business compliance costs	4.44	+0.25	4.69
operating cost of lamps (lamps and energy)	-3,883	+272	-3,611
value of partial restoration of consumer choice		-386	-386
Present values (\$M), discount rate = 7.5%			
cost to the taxpayer	8.74	+2.82	11.56
business compliance costs	2.87	+0.16	3.03
operating cost of lamps (lamps and energy)	-2,177	+152	-2,024
value of partial restoration of consumer choice		-216	-216
Investment analysis (\$M), discount rate = 7.5%			
total costs	-	-	-
total benefits	2,165	+61	2,226
net present value	2,165	+61	2,226
benefit-cost ratio	na	na	na
Tax revenue			
undiscounted amount	0	+132	132
present value	0	+74	74

For the purposes of constructing table 5.1 it is assumed that:

- The tax on tungsten filament lamps is \$1.50/lamp, reducing the price difference between tungsten filament lamps and CFLs by about 50%.
- The response to the tax is such users retain tungsten filament lamps for 10% of the lighting task previously assigned to tungsten filament lamps. Allowing for the proportion of tungsten filament lamps in the lighting tasks affected by the measures, the energy and greenhouse savings are reduced by 7% relative to option 1.
- 50% of the people who choose to continue using tungsten filament lamps do so for reasons that may be regarded as fully-informed and well-considered, and positively value the option to continue using tungsten filament lamps. The other 50% have no such preferences and continue using tungsten filament lamps for reasons that may be classified as market failure.
- Sales of tungsten filament lamps are reduced to 8 million/year, compared with zero under option 1, generating tax revenue of \$12 million per year.

We are now in a position to work through the various impacts, comparing option 2 with option 1.

Cost to the taxpayer

There would be no significant reduction in the administrative costs that would be incurred to implement option 1, which are detailed in table 4.1. This is because it would still be necessary to develop standards, monitor compliance, conduct a communications program, and manage a staged rollout of new taxes as replacement products become available.

The administrative cost of collecting the tax would be an additional cost to the taxpayer. They are generally 1-3% of the revenue collected (Gallagher 2005). We have assumed 2.5%, at the higher end of the range because the tax base is small.

The adaptive management of the tax may require ongoing market analysis. This would be an additional expense to the taxpayer, for example, to conduct consumer surveys, for which we allowed \$0.5 million.

These two items add \$4.1 million to taxpayer costs over the period to 2020, or \$2.8 million in present value terms – see table 5.1. We deal separately with the tax revenue, which is a transfer payment from one part of the community to another.

Business compliance costs

The tax revenue is also excluded from business compliance costs. However the associated administrative costs – incurred by suppliers to understand and calculate the tax liability and transact with the tax collection agency – are included in the compliance cost calculation. These would be quite modest, assuming that the tax is levied on the relatively few importers/wholesalers rather than on the relatively many retailers.

There would no significant savings on the compliance costs that would be incurred under option 1. A register of complying products may still be needed as a resource for compliance checking, discouraging attempts to avoid tax on non-complying products. Labelling may be given additional priority to help people to make the choices that option 2 would leave in their hands.

We allowed a modest amount for additional business compliance costs – \$0.25 million in the period to 2020, or \$0.16 million in present value terms.

Financial impact on users

The impact on the operating cost of lamps is reduced by 7%, in line with assumptions about the amount of the lighting task that tungsten filament lamps will continue to provide. Compared with option 1 this is a loss of \$272 million over the period to 2020, or \$152 million in present value terms.

However, half of these losses are to people who put an even higher value on retaining the right to use tungsten filament lamps. This accounts for the cost reduction of \$386 million that has been assigned to option 2, reversing half of the increase in operating costs and adding \$250 million for the consumer surplus³⁴ that is restored ($386 = 50\% * 272 + 250$). The equivalent amount in present value terms is \$216 million. The estimate is obviously contrived. It illustrates a possible difference between option 1 and option 2. It is not a calculation that can actually be made with the available data.

Investment analysis and transfer payment

Plausibly, the investment analysis may indicate that option 2 is superior to option 1, which is the contrived result in this case. The net present value of the government intervention increases by \$61 million to \$2,228 million.

³⁴ The consumer's surplus is the additional amount that consumers would be prepared to pay for a product, in addition to its actual price, rather than do without that product.

There is an associated transfer payment to the general community from people who continue to use tungsten filament lamps, via the taxation system. This is effectively a fee that is paid for continued access to tungsten filament lamps, totalling \$132 million in the period to 2020, or \$74 million in present value terms. After tax, the value of continued access to tungsten filament lamps is reduced to \$254 million in the period to 2020 (= 386-132), or \$142 million in present value terms (=216-74). The after-tax figuring is not shown in table 5.1/

Demanding nature of the information requirements

The critical part of this calculation relates to the composition of the group of people who continue to use tungsten filament lamps. Option 2 may be superior if a sufficiently large portion has sufficiently strong preferences for tungsten filament lamps. However, E3 has no evidence that this is the case or that it might be shown to be the case by introducing a non-prohibitive tax and then observing and analysing the market response.

5.3 E3's assessment of option 2, relative to option 1

Recently on 6 August 2008, the Commonwealth Treasurer noted that: *'the Government is particularly focused on building a tax system which is internationally competitive, streamlined, simplified and harmonised; and which encourages hard-work and rewards workforce participation by removing complex disincentives'*³⁵.

Taking this into account, the E3 Committee considers that there is no reasonable basis for recommending option 2 as superior to option 1, or as sufficiently promising to justify deferring option 1 until option 2 is fully developed and assessed.

E3 also notes that:

- A specific tax on light bulbs would be inconsistent with a broad-based approach to tax.
- Given Australia's intention to introduce a CPRS from 2010, any tax on light bulbs may need to be regularly reviewed and adjusted in light of permit allocations and the changing price of carbon emissions. This has the potential to increase business compliance costs and government administration costs.
- A tax on light bulbs provides an indirect means to reduce carbon emissions from the use of GLSs and therefore may have some distortionary effects. For example, anyone using a GLS bulb in conjunction with 'green energy' would pay the tax even though they were not adding to carbon emissions.
- Lastly, there are no overseas examples of taxes or similar arrangements being applied for energy efficiency objectives such as the phasing out of a particular technology.

³⁵ Treasurer of Australia - Media Release No: 093

<http://www.treasurer.gov.au/DisplayDocs.aspx?doc=pressreleases/2008/093.htm&pageID=&min=wms&Year=&DocType=0>

6 Option 3 – subsidies for complying lamps

Option 3 (subsidies) is a close relative of option 2 (taxes) and may be preferred to option 1 for the same reasons that option 2 may be preferred to option 1. That is, it is a way to allow private preferences to be expressed but still substantially achieve the government's policy objectives. Specifically, the use of non-complying lamps would still be allowed but users would forego a subsidy on complying lamps in order to do so. The only difference between options 2 and 3 is that option 2 reduces the price difference between complying and non-complying lamps through tax means, whereas option 3 achieves the same end by subsidising complying lamps.

Given E3's negative assessment of option 2, relative to option 1, the practical question for E3 is whether option 3 seems likely to remedy the deficiencies of option 2, to the point where E3 can confidently recommend deferring option 1 until option 3 is fully developed and assessed.

E3 considers that option 3 is inferior to option 2. This chapter explains why but assumes familiarity with chapter 5.

Advantages and disadvantages

The main advantage of a financial subsidy is that it allows users with a particular preference for an inefficient lamp to refuse the subsidy and retain their preferred lamp. Reasons for refusing the subsidy could include infrequent use, costs of changeover or aesthetic reasons.

However, a subsidy program also has the following disadvantages:

- It is desirable but administratively cumbersome and intrusive to limit payments to those who would not otherwise have purchased the efficient lamps. Inevitably, significant payments go to those who would have purchased efficient lamps without the subsidy;
- Subsidies are regressive, that is, made disproportionately to those who have bigger houses and more lights;
- Subsidies reduce the cost of lighting services and encourage people to install more unnecessary lamps;
- Subsidies would encourage unintended and possibly undesirable lamp substitutions, for example, the substitution of compact for linear fluorescent lamps, creating a demand to extend the subsidy to other energy-efficient technologies that are already well-established in residential, commercial and industrial applications;
- Regardless of the merits of a particular subsidy program it is easy for others to misrepresent its rationale and create demands for 'me too' policy measures that are less sound. It is prudent to confine subsidies to situations where recipients need to be compensated for some harm that has been done, or where the community needs to encourage activities that provide a benefit to the community. Paying people to do things that benefit themselves is not a good precedent; and
- There is a risk of tacit collusion between suppliers to not pass on the full value of the subsidy. Even the perception of such collusion would create demands for price monitoring and cost reviews, which are not necessarily effective or conclusive.

6.1 Uncertainty about the optimal subsidy

It would be possible to subsidise the purchase of complying lamps and set the rate of subsidy at the level required to achieve any desired take-up of such lamps. An amount of \$2.00-\$4.00/lamp would be enough to eliminate the price difference between tungsten filament lamps and CFLs. There would probably be a significant consumer response to a smaller subsidy, for example, reducing the price differential by half.

However, the optimal subsidy is not known, for the same reasons that the optimal tax is not known if the objective is to correct the market failures identified in section 1.4. Depending on the degree to which different users select lamps in a full-informed and well-considered way, different amounts of subsidy are needed to induce them to mimic the desired behaviour.

As with the tax option, the subsidy could set arbitrarily in the first instance and adjusted over time in the light of experience and ongoing analysis of the why remaining users of non-complying lamps continue to reject the subsidy. It would be adjusted upwards if ongoing market analysis indicates that ignorance rather than strong preferences is the dominant reason for remaining purchases of non-complying lamps. It would be adjusted downwards if it is apparent that residual buyers have made considered decisions to continuing using non-complying lamps.

Option 1 does not provide for this learning process and in that respect is inferior to option 3. But what are the prospects that the learning process in option 3 would lead to a significantly different outcome? As discussed in relation to option 2, there are good reasons to doubt that there would be significant differences. These relate to (a) the lack of evidence that non-complying lamps will be strongly preferred on a significant scale, and (b) the likelihood that there will be negative feedback effects that raise the price and reduce the availability of non-complying lamps.

6.2 Impact modelling

It follows from the above considerations that E3 can provide only indicative estimates of the impact of option 3. This figuring is presented in table 6.1 and is provided to help explain the information that is required to devise and assess a subsidy proposal. It is not a serious exercise in impact assessment of an actual proposal.

It is assumed that the subsidy is the economic equivalent of the tax that is discussed in chapter 5, resulting in the retention of the same proportion of tungsten filament lamps in both options 2 and 3. It is also assumed that the MEPS for tungsten halogen lamps and CFLs are retained, for the same reasons given in chapter 5. Accordingly, there are no differences between options 2 and 3 in respect of energy and greenhouse savings, reductions in lamp operating costs and the value to consumers of continued access to tungsten filament lamps.

The budgetary difference is that the subsidy of \$1.50/lamp would be paid on sales of about 20 million CFLs per year. The expense is \$30 million/year, funded by tax increases, whereas option 2 generates tax revenue of \$12 million per year.

For the purposes of impact assessment the differences between options 2 and 3 are as follows.

- There are additional costs to the taxpayer, arising because a larger sum has to be raised via taxation and then paid out in subsidies. We have conservatively assumed that the administration costs are 3% of the amount transferred.

- It is reasonable to expect an increase in business compliance costs. That is, compared with a tax-based transaction for smaller amounts (option 2), suppliers will incur higher costs to understand and calculate the subsidy entitlements and transact with the subsidising agency (option 3). We have allowed a modest further amount – \$0.25 million over the period to 2020.

TABLE 6.1 INDICATIVE STATEMENT OF NATIONWIDE IMPACTS, COMPARING OPTION 3 WITH OPTION 2: 2008 TO 2020

	<i>Impact of Option 2</i>	<i>Difference</i>	<i>Impact of Option 3</i>
Energy use - GWh	-28,184	0	-28,184
Greenhouse emissions (Mt CO ₂ -e)	-26.46	0	-26.46
Undiscounted dollar amounts (\$M)			
cost to the taxpayer	14.34	+7.20	21.54
business compliance costs	4.69	+0.25	4.94
operating cost of lamps (lamps and energy)	-3,611	0	-3,611
value of partial restoration of consumer choice	-386	0	-386
deadweight cost of taxation	0	+66	66
Present values (\$M), discount rate = 7.5%			
cost to the taxpayer	11.56	+3.36	14.92
business compliance costs	3.03	+0.16	3.19
operating cost of lamps (lamps and energy)	-2,024	0	-2,024
value of partial restoration of consumer choice	-216	0	-216
deadweight cost of taxation	0	+43	43
Investment analysis			
total costs (\$M)	-	-	-
total benefits (\$M)	2,226	-46	2,180
net present value (\$M)	2,226	-46	2,180
benefit-cost ratio	na	na	na
Subsidy payment (\$M)			
undiscounted amount			330
present value			185

- Table 6.1 includes a new item, the projected deadweight cost to the economy of the higher taxes that would be needed to finance the subsidy – \$66 million over the period to 2020, or \$43 million in present value terms. This is an estimate of the reduction in the value of production caused by the distorting effects of taxes on labour force participation and saving decisions. We have assumed that these costs accumulate at the rate of 20 cents of deadweight loss per dollar of additional taxation revenue. This is at the low end of the available estimates (Gross 2004: page 5). (This item is not in table 5.1 because the tax in that case is imposed precisely for its distorting effect and, assuming tax neutrality, the additional tax revenue allows tax reductions elsewhere.)
- Option 3 requires a larger transfer payment. There is a large degree of ‘churning’ involved, that is, tax paid by members of the community to subsidise their own purchases of complying lamps, but augmented to include subsidies that are paid for complying lamps that would have been purchased under BAU conditions. There would be net payments from users who continue to use non-complying lamps to users who convert to complying lamps, reducing the value of option 3 to the former. However, they would remain largely ignorant of the ‘fee’ that they pay for continued access to tungsten filament lamps.

A subsidy would also negate any concerns about the affordability of complying lamps for low income households. However, as discussed in section 4.8.2, we have examined all plausible combinations of lamp type, lamp size and duty hours and find there are no adverse distributional effects. Energy savings are also important for low income households.

6.3 E3's assessment of option 3, relative to option 2

Give the significant disadvantages of subsidies; E3 considers that option 3 is inferior to option 2. At best, it achieves the same outcomes as option 2 but at additional cost. E3 also notes that:

- Other countries have subsidised the purchase of CFLs but such measures have been used sparingly and for limited periods (IEA 2003: page 55). Similarly, subsidies in Australia have been used as a one-off financial incentive to encourage people to try CFLs and create a demonstration effect. Electricity retailers in NSW and the ACT can earn credits towards emissions and efficiency targets by installing CFLs, and similar arrangements were planned for Victoria, commencing January 2009.
- Governments cannot make credible long term commitments to maintain subsidy payments, and suppliers would factor the additional uncertainty about policy settings into their product development plans. MEPS will provide more certainty.
- The challenges of climate change will create significant new demands for financial compensation and incentives, including compensation for genuine hardship. The taxpayer's capacity and willingness to provide subsidies is a scarce resource and should be conserved.
- The development and assessment of a subsidy proposal would significantly delay implementation. E3 has not consulted with suppliers on this option.

7 Option 4 – disendorsement label

A disendorsement label warns users that the lamp does not meet a minimum standard of energy efficiency. A mandatory disendorsement labelling scheme would require suppliers to display such a label on non-complying lamps.

E3 considers that the disendorsement option would not be suitable alternative to the proposed measure and has not developed this option. E3 requested stakeholder comment on this decision, inviting stakeholders to argue a contrary point of view. There were no responses.

This chapter explains key aspects of E3's assessment of the disendorsement option.

7.1 Use of disendorsement labels to promote energy efficiency

E3 are aware of two labelling schemes that include disendorsement measures, both in the form of warning labels where products do not meet a minimum standard. Australia's water efficiency rating scheme requires products with less than zero stars to carry a warning that they do not meet the minimum standard. Similarly, Korea requires selected appliances to carry a warning label if they do not satisfy the standby power criteria.

7.2 Advantages and disadvantages

The main advantage of a disendorsement label is that it allows users with a particular preference for an inefficient lamp to ignore the negative information and retain their preferred lamp. Reasons for ignoring negative information could include infrequent use, costs of changeover or for aesthetic reasons. In contrast, MEPS reduce choice, denying particular product options regardless of individual circumstances and preferences.

Disendorsement labelling would also negate any concerns about the affordability of complying lamps for low income households. However, as discussed in section 4.8.2, we examined all plausible combinations of lamp type, lamp size and duty hours and find there are no adverse distributional effects. Energy savings are also important for low income households.

However disendorsement labelling is not a complete solution. It does not deal with split incentives and, although it warns the user that there is a problem with a product, it also requires them to gather more information and make further calculations to fully understand the associated costs and benefits. As discussed in section 1.4, the information and assessment requirements are reasonably demanding and beyond the problem-solving capacities of many people. Some would select an inefficient product when a fully-informed assessment favours the efficient product, while others would select the efficient product when a fully-informed assessment favours the inefficient product. We cannot anticipate the scale and mix of misjudgements.

On this last point, we note the findings derived from market research commissioned by the AGO (Artcraft 2003). Artcraft found that although a majority of users would respond to a disendorsement label, they differed about the degree of inefficiency that warrants a warning label. However, while most preferred stronger warning messages, some were then puzzled as to why strongly disendorsed products were not simply banned. This suggests considerable scope for variation in user interpretation of disendorsement labels.

The Productivity Commission interpreted the same research more favourably.

Many participants in that consumer research considered the tested warning labels to be extreme, and questioned why such appliances would be allowed to be sold (Artcraft 2003). This suggests that disendorsement labels would discourage most consumers from buying the least energy-efficient appliances, and so have a similar effect to a mandatory standard that removed those appliances from the market. However, a key difference is that disendorsement labels would not prevent a consumer from buying a less efficient appliance when that is the most cost-effective option for them, or they have a strong preference to buy such an appliance. Therefore, disendorsement labels are less likely to force individuals to forgo product features they value more highly than energy efficiency, remove products from the market that are more cost effective for some individuals, and to have regressive distributional impacts. (PC 2005: page 203)

The other main concern for E3 is that LCA has advised that its members would strongly resist disendorsement labelling, indicating they would not supply products with a warning label because it could damage their reputation and reduce the value of goodwill. LCA reiterated this concern in its response to the consultation RIS.

The reputation of suppliers has a significant impact on the efficient operation of markets, providing the informal equivalent of a bond or warranty for product quality. Users rely on brand names for reassurance about product quality that cannot be confidently assessed at the time of purchase, for example, that a durable product will provide reliable service over many years and maintenance costs will not be excessive. It follows that users with a preference for energy inefficient products cannot have both the performance and reduced cost characteristics that are associated with low energy efficiency plus the quality assurances that are associated with premium branded products. It is reasonable to be concerned that the effective exclusion of major brands from the supply of less efficient products will further reduce the quality of products in this market, particularly operating life and energy efficiency.

8 Option 5 – comparative energy labelling

As explained in section 3.1.4, E3 proposes to reform the energy labelling arrangements for lamps, including the provision of information that would allow users to identify lamps with the same light output and compare their energy consumption. The issue here is the effectiveness of ‘labelling only’ as an alternative to the proposed measures, that is, without MEPS.

E3 considers that the labelling option is inferior to the proposed measures and has not developed this option. Nor has E3 consulted with suppliers about the scope and design of such a program. E3 requested stakeholder comment on this decision, inviting stakeholders to argue a contrary point of view. Although labelling options and issues attracted considerable comment, none advocated further consideration of the labelling only option.

This chapter explains key aspects of E3’s assessment of the labelling option.

8.1 Use of labels to promote energy efficient lighting

IEA (2006 page 310) reports that some form of energy labelling for lamps is mandatory in Canada, China, EU, Japan, Korea, Norway, Switzerland and USA. A number of these countries now propose to introduce MEPS.

8.2 Advantages and disadvantages

The main advantage of a comparative label is that it allows users to make informed assessments of the relative costs and benefits of different lamps and select an inefficient lamp if, on balance, it is the preferred option. In contrast, MEPS reduce choice, denying particular product options regardless of individual circumstances and preferences.

Labelling is not a complete solution. Although it alerts the user to the energy consumption of different products, it also requires the user to gather more information and make further calculations to fully understand the pros and cons. As discussed in section 1.4, the information and assessment requirements are reasonably demanding and are beyond the problem-solving capacities of many people. Importantly, the user needs to confidently make calculations that justify payment of a significant price premium.

Comparative labelling does not deal with the problem of split incentives.

Evidence on the effectiveness of labelling

United States

Energy labelling of major household appliances has been mandatory in the US since 1979 and a modified form of labelling was extended to household lamps in 1994³⁶. Consumer surveys have found that 70% of Americans know about the appliance label but that only half can describe a pertinent aspect of the label (Opinion Dynamics 2000). The empirical evidence on the impact of this program has been reviewed recently (Banerjee *et al* 2003, Gillingham *et al* 2006), with the following results.

- There is little published analysis of labelling effectiveness in the US.

³⁶ As discussed in section 3.1.4, lamp packages must list light output (lumens), energy input (watts) and lamp life (hours), and make the statement “To save energy costs, find the bulbs with the light output that you need and, then choose the one with the lowest watts”.

- There is evidence that, in the presence of labelling, energy-saving innovation is more responsive to higher energy prices. This evidence is for two appliances with significant energy costs, air-conditioners and gas water heaters (Newell *et al* 1999).
- Various aspects of the program have been criticised, including that (a) the label is unattractive and the information is poorly organised, (b) it uses technical language, (c) it does not use a star rating or similar indicator of broad product categories, and (d) there is widespread non-compliance with the labelling requirements.

On the basis of extended work with focus groups regarding the purchase of CFLs that qualified for the ENERGY STAR label, the Lighting Research Centre (LRC 2003) found that users give little attention to lamp labelling information.

Though many of the participants noted that energy savings and environmental concerns are important factors in their purchases, they do not consider these effects when purchasing lamps for their homes. They believe that switching off lights will have a greater effect than choice of lamp. Most shoppers don't spend time comparing lamp products and studying the packaging details other than to look for the wattage and colour ... Although the package contains valuable information, consumers do not read the packaging or note the listed benefits. (LRC 2003: page 20)

Europe

In 1992, the European Union initiated energy labelling and steadily expanded its appliance coverage over the subsequent decade, including the labelling of household lamps from 1998. The European Commission is currently reviewing these arrangements and, as part of the process, commissioned an impact study that included a review of evidence on the impact of the existing energy labelling schemes and the collation of stakeholder feedback via interviews, meetings and an on-line facility (Europe Economics *et al* 2007). The main findings are:

- There is general agreement that labelling is a positive policy tool, including agreement by manufacturers and retailers.
- There has been a noticeable and well-documented improvement in the efficiency of whitegoods since labelling was first implemented in 1992. Additional categories were added to the rating scale (A+ and A++) as more efficient appliances emerged.
- There has been much less improvement in the efficiency of household lamps. Stakeholders said that the lamp label is less effective because the label is smaller and different to the appliance label, and energy-conscious users already know that the CFL is an energy saver. Whereas they need to examine the labels on fridges and washing machines, they immediately associate CFLs with saving energy and can ignore the lamp label.

A recent UK survey tested household understanding of a range of energy efficiency measures, including CFLs (Oxera 2006). The researchers found that respondents had a reasonably good grasp of the cost of CFLs but were less certain about their durability and the money saved. Purchasing decisions were mainly influenced by price, attitude to labelling and lamp life. 'Receipt of advice' was rated as a minor influence and 'cost savings' were rated as a very minor influence. Importantly, lamps in the UK have been subject to the EU energy labelling requirements since 1998.

Australia

Appliance labelling was introduced progressively through the 1980s and an early review (GWA 1991) reported contemporaneous developments in the energy efficiency of refrigerators and freezers, air conditioners, dishwashers, clothes washers, gas water heaters and gas heaters. GWA documents the following response to labelling:

- a surge in measures of average energy efficiency, including disproportionate response from suppliers that were more dependent on the Australian sales, particularly domestic manufacturers
- disproportionate retirement of the least efficient models and introduction of high efficiency models
- a series of marginal product improvements to qualify for the next level of star rating

In a later review (Wilkenfeld 1997), the same author estimated that labelling had reduced the energy consumption of labelled appliances by an average of 11%, with larger gains for dishwashers (16%) and for refrigerator and freezers (12%)³⁷.

It is also well-documented that a large majority of Australians recognise and understand the label, and to various degrees factor energy ratings into their purchase decisions. The most recent review commissioned by E3 found that:

... The energy rating label is almost universally recognised with 94% of consumers Australia wide being able to recall it unaided, rising to 96% when prompted.

...Seventy five per cent ... of consumers regard the energy rating label as important in the appliance purchasing process ... (Artcraft 2006: page 1).

There is no evidence suggesting that energy labelling of lamps would be any more effective in Australia than overseas. Some lamps are sold in Australia with the European label but there is no reason to expect that they have had an appreciable impact. The label design is unfamiliar to Australians and, as noted, appears to have had little effect even in Europe.

8.3 Can labelling be made more effective?

Regulators periodically review and modify labelling arrangements, asking basic questions about the information that should be included on the label and how it should be presented. This may include re-consideration of the choice between categorical and continuous labelling. Figure 3.4 illustrates the difference. Categorical labelling involves the assignment of appliances to energy efficiency categories that are ranked, for example, from one star to six stars in the Australian scheme. A continuous label reports a measure of energy use, such as annual energy use (kWh/year) or annual energy cost (\$/year), and locates that amount on a linear scale that ranges from the most efficient appliance of that kind to the least efficient appliance of that kind.

Labelling has recently been reviewed in the United States (US), Europe and Australia.

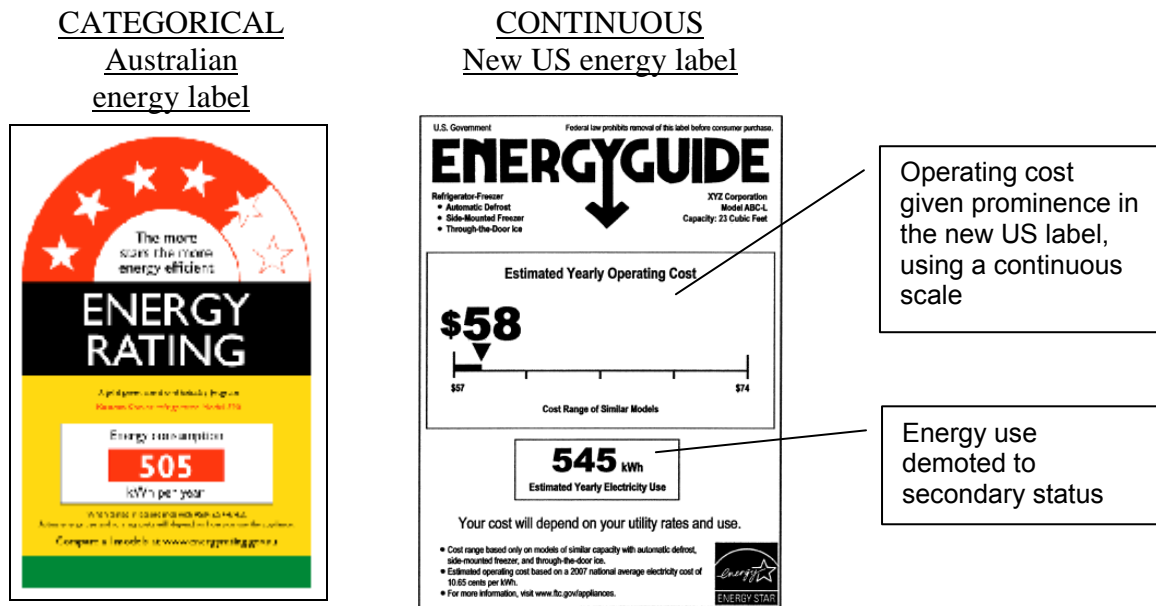
United States

The review conducted by the US Federal Trade Commission (FTC 2007) resulted in retention of the continuous labelling approach but a redesigned label that gives more prominence to energy cost and demotes information about energy use to secondary status – see figure 3.4. However, the FTC decided that it was not always feasible to provide information about energy cost, because of space limitations or where the variation in cost conditions is such that an average figure for energy cost is misleading. Energy labelling was therefore retained for some appliances, including household lamps.

Very recently, however, FTC reopened the issue of lamp labelling and will reconsider options for providing information about energy costs. Consultations were in progress at the time of writing and a decision is expected to be announced in 2009.

³⁷ Quoted by du Pont 1998: page 2-18.

FIGURE 8.1 EXAMPLES OF CATEGORICAL AND CONTINUOUS LABELLING



Europe

The work undertaken for the European Commission’s labelling review, which is also incomplete, included asking stakeholders whether the label should provide more or different information (Europe Economics *et al* 2007). The key findings were that³⁸:

- The process elicited suggestions that the European label include information about operating costs, greenhouse emissions and other aspects of environmental impact.
- These seems to have been no disagreement that information on operating costs is desirable by general agreement that there was no practical options for dealing with differences in fuels costs between countries and changes in fuel costs over time. While the initial stakeholder interviews elicited support from almost 50% of stakeholders, subsequent on-line submissions and the final consultation meeting effectively rejected the suggestion.
- There was also some initial support for information about emissions but, again, recognition that there are practical difficulties in dealing with variation in the emissions intensity of fuels. Again, subsequent on-line submissions and the final consultation meeting effectively rejected the suggestion.
- There was also some concern that additional information, by making the label more complex, would discourage use of the label.
- Of the broad types of reform that were considered, stakeholders assigned the lowest priority to the provision of additional information.

Australia

The option of giving prominence to energy cost was discussed and rejected in early debates about the design of the appliance label, about 20 years ago, and has not been given serious consideration since. It was considered that a prominent categorical rating (energy stars) would be effective and would avoid the complications associated with variation in marginal tariffs and appliance usage.

³⁸ The consultation documents are published at:
http://ec.europa.eu/energy/demand/legislation/domestic_en.htm

E3 is aware of the need for information about operating cost. Specifically, the most recent review reported that:

In response to a series of prompted questions, more than three in five people (62%) say that they would like to have access to a tool or calculator which would help them to compare the extent to which different types of appliances were contributing to their overall household energy bills, and around half would like to have access to a tool or calculator which would help you to compare the running costs (48%) and/or the amount of energy used (52%) and/or the greenhouse emissions (52%) of different appliance models. (Artcraft 2006: page 51)

These tools are currently provided on the E3 website for all labelled appliances³⁹. Users can obtain customised estimates of energy costs that are based on user-supplied settings for marginal tariffs and annual operating hours.

8.4 E3's assessment of the 'labelling only' option

E3 considers that, based on domestic and international experience with energy labelling, it cannot confidently recommend any configuration of lamp labelling that will adequately address the impediments to energy efficiency in lighting tasks, to the point where the proposed MEPS should be delayed or abandoned. This view is based on the following considerations:

- Mandatory labelling requirements need to have a measured, sober and informative tone, avoiding the loud or snappy 'dollar dazzler' approaches that are sometimes adopted in commercial marketing. As they see fit, suppliers can and do use normal commercial advertising practices to draw attention to favourable energy ratings.
- There is no evidence that lamp labelling in the US and Europe has been a useful policy tool.
- The provision of energy cost information on labels is desirable in principal but problematic in practice. It aims to provide users with ready-made cost comparisons but inevitably averages across users who face different marginal tariffs, and have different patterns of use. Users may be well advised to interpret the comparative energy cost as an indicator of relative efficiency rather than an estimate of actual dollar savings, which is the job that the star rating already does well.
- Much of what is 'known' about labelling is based on what people tell interviewers about their appliance purchasing behaviour and the information that they use or would like to have. This is not necessarily a reliable account of actual user behaviour and it is debatable whether we know enough about user behaviour to confidently reform labelling programs that are not obviously faulty.

In particular:

- We do not know the extent to which users can and would use energy cost information to calculate the lifecycle cost of appliances, rather than simply reinterpret the information as a categorical indicator of energy efficiency.
- We do know that categorical rating is the most widely used form of labelling and, compared with continuous rating, is less prone to misinterpretation and elicits stronger responses from users (Egan *et al* 2005). A salutary research finding is that a large minority of users (32%) interpreted the dollar value on the first US label as the value of energy savings rather than the energy cost, reversing the intended message (du Pont 1998: page 7-6). Further, du Pont documents a number of other idiosyncratic interpretations of labelling information, including by well-educated professionals.

³⁹ see <http://www.energyrating.gov.au/appsearch/default.asp>

- Users make errors when interpreting label information and the error rate increases during the transition to a new label. Based on the US experience, the old and new labels can co-exist for several years.
- All of the problems associated with cost labelling are exacerbated when applied to lamps. There is much less space on lamp packaging: they are largely distributed through grocery stores without in-store assistance to interpret labelling information; they are not major purchases of the kind that motivate inspection of labels; users don't need to look at the label to know that CFLs are energy savers.
- For the immediate future there are competing information priorities on lamp packaging, specifically, to familiarise users with lumens as a measure of lamp output, re-establish wattage as a measure of energy input, and emphasise the very large differences in operating life.
- The work needed to develop labelling options would significantly delay implementation of option 1. Relevant considerations are that:
 - It is confusing for users to have energy rating information presented in different formats on different appliances. Hence, giving prominence to energy costs is a decision that needs to be made at the program level, not on a product-by-product basis. E3 has reviewed labelling periodically, most recently in 2003 and 2006, and may further examine options for cost labelling at the next review.
 - Suppliers have strong views about labelling measures and, based on past experience, there is no prospect that energy labelling arrangements can be quickly reformed.
 - The global nature of the lighting industry has resulted in overwhelming resistance to specific labelling requirements in smaller markets such as Australia. Given that suppliers deliver similar labelling products internationally, it seems impractical to introduce a new labelling measure domestically at this time. Australia has been working closely with international players to develop an international or possible Asian region approach to labelling.
- There is every prospect that a 'labelling reform only' would be judged ineffective after a suitably lengthy trial, possibly five years, and the delayed implementation of MEPS would be strongly regretted.

9 Option 6 – information campaigns

As explained in section 3.1.4, E3 is preparing a communications strategy to complement the MEPS and labelling measures. The issue here is the effectiveness of ‘information only’ an alternative to the proposed measures, that is, without MEPS.

E3 considers that an information campaign would be inferior to the proposed measures and has not developed this option. Nor has E3 consulted with suppliers about the scope and design of such a program. E3 requested stakeholder comment on this decision, inviting stakeholders to argue a contrary point of view. Although information options and issues attracted considerable comment, none advocated further consideration of the ‘information only’ option.

This chapter explains key aspects of E3’s assessment of information campaigns.

9.1 Use of information campaigns to promote energy-efficient lighting

Information and awareness initiatives are the easiest and earliest policy responses to address energy related issues and have a history that dates back to the energy crises of the 1970s. Internationally, there are numerous programs, addressing a range of market barriers to the adoption of CFLs, for example:

- user awareness and knowledge of CFLs
- user fears and misperceptions about CFL performance,
- user scepticism about the amount and value of energy savings and the environmental benefits
- lack of awareness and misinformation amongst retailers, lighting department managers, builders and contractors
- lack of technical information and guidelines for designers and specifiers

IEA lists the following examples of straightforward information and awareness activities in its review of policies for energy-efficient lighting (IEA 2006: chapter 5).

- Japan – provision of *Energy Conservation Performance Catalogues* through retailers, including lists of energy-efficient lighting fixtures
- Japan – awards for the winners of design competitions, including for improved fluorescent lamps
- Canada – information on lighting efficiency through the *EnerGuide for Industry* website

The IEA list is far from exhaustive. In Australia, for example, DEWHA provides website resources that promote energy efficient lighting in the context of comprehensive guidance on how to achieve energy efficiency in homes and commercial buildings⁴⁰. It is reasonable to expect that these promotional activities are provided in a range of other countries that have seriously responded to the challenges of climate change.

The definition of ‘information measures’ can be expanded to include (a) product certification and endorsement schemes that aim to reassure users that unfamiliar products

⁴⁰ See <http://www.environment.gov.au/settlements/energyefficiency/buildings/> & <http://www.environment.gov.au/settlements/energyefficiency/index.html>

meet minimum standards of energy efficiency or quality, (b) product initiation schemes such as CFL give-aways and rebates, designed to encourage users to experiment with unfamiliar lighting products and 'acquire information' about their performance first hand, and (c) voluntary programs to establish awareness of energy-efficiency and initiate new practices.

As noted in chapter 5, subsidy-like arrangements are used in Australia as once-off inducements to encourage people to try CFLs. The proposed MEPS for CFLs will mandate certification.

9.2 Advantages and disadvantages

The main advantage of information-based measures is that they allow users with a particular preference for an inefficient lamp – because of infrequent use, cost of changeover or for aesthetic reasons – to consider the negative aspects of the lamp but still buy the lamp if, on balance, it is the preferred option. In contrast, MEPS reduce choice, denying particular product options regardless of individual circumstances and preferences.

Disendorsement labelling would also negate any concerns about the affordability of complying lamps for low income households. However, as discussed in section 4.8.2, we have examined all plausible combinations of lamp type, lamp size and duty hours and find there are no adverse distributional effects. Energy savings are also important for low income households.

The main disadvantages of information campaigns are the difficulty and uncertainty of achieving a lasting effect. Consider that:

- For good reasons, people ignore most of the information that is directed at them from numerous sources, leaving limited opportunities to get their attention. Exploitation of those limited opportunities requires marketing and communications expertise of a high order. It is generally necessary to co-opt organisations with marketing skills, such as energy and appliance retailers.
- Awareness and promotional activities only have a limited effect to establish new practices and norms, such as the adoption of industry guidelines or periodic auditing routines, or a habit of using endorsed products only. The awareness and promotional phase cannot be maintained indefinitely due to the large operational costs involved.

Evidence on the effectiveness of information campaigns

It is normal for information programs to claim a degree of success, but often only in terms of participation in the activity. It is difficult to find evidence of lasting effects. The following examples are from the IEA review (IEA 2006: chapter 5) and limited follow-up of those leads.

- Switzerland's *Top Ten* program is popular with suppliers and attracted 15% of Switzerland's population to its website in 2005. But there is no quantitative assessment of impacts.
- The claims made on behalf of the *Change a Light, Change the World* program are trivial, possibly contributing about 15,000 tonnes CO₂-e/year to abatement in the US.
- The *Green Lights* programs in the US, Europe and China have been judged a success. For example, it is credited with the phasing out of magnetic ballasts for fluorescent lamps in commercial buildings.
- Denmark's *A-club* has recruited 150 public housing associations and local governments that represent 250,000 households.

- The combination of promotional activity with either CFL give-aways or rebates is typically assessed as cost effective. However, these assessments relate only to the initial impact and provide no information about enduring impacts on lamp purchasing behaviour. It is reasonable to suspect that there is significant backsliding after such programs are terminated.

A recent report by the Pacific Northwest National Laboratory (PNNL 2006) provides a more detailed analysis of the US experience with promotional and awareness efforts to increase the market acceptance of CFLs, which began in the late 1980s. A key finding is that little has been achieved. Nationally, CFLs accounted for only 1.6% of the installed stock in 2002. There was considerable variation between states, depending on their exposure to high electricity prices and the promotional efforts of utilities. There are lessons for the 'promotion & rebate' programs that are currently employed in Australia. In essence, PNNL says that programs must work with organisational and market structures that already exist and will endure, and avoid using artificial structures and creations that will not endure (PNNL 2006: page iv-v). For example:

- Don't rely on CFL give-aways that bypass normal distribution channels or undermine retail sales.
- Avoid give-aways that obscure the retail price, leading to 'sticker shock' when the user returns for a repeat purchase.
- Require some action on the part of the user, if only to mail in a request card.
- Involve, educate and motivate the retailers, since it is their marketing behaviour that endures beyond the promotion and awareness phase.
- Invest in attractive point-of-sale displays that will endure beyond the promotion and awareness phase.

It is apparent that the task is difficult and, unfortunately, there is no evidence that even the best-designed programs have had more than limited success. PNNL says that the market share of CFLs stabilised at 5-8% in even the most successful US region, the Pacific Northwest.

9.3 E3's assessment of information campaigns

The broad lesson that we draw from this evidence is that information-based programs have enduring effects only when they succeed in grafting new practices and norms onto pre-existing structures. Larger organisations, including large commercial organisations, are attractive targets precisely because they are highly structured. They use rules and procedures to govern their operations and have some organisational machinery to monitor and enforce those rules. There is a sense in which they 'self-MEPS', that is, they have a capacity for formulating their own performance standards, such as specifying the use of electronic ballasts and endorsed light fittings and lamps.

We have found no evidence that activities promoting efficient lighting have lasting effects on decision-making units that don't have a significant degree of organisational structure, including households and smaller businesses. Denmark's *A-club* is not an exception to the rule. Consider that the *A-club* piggy-backs on pre-existing structures (public housing associations) that have an organisational capacity to maintain the procurement program.

Promotional and awareness activities may succeed where a small unit is contemplating a major expense and is giving more than usual attention to value for money, such as a home renovation or the design and purchase of a new house. Website resources may usefully inform such large and infrequent transactions but it seems unreasonable to assume that they would inform the day-to-day purchase of light bulbs.

These are generalisations and some proportion of households and businesses would be exceptions to the rule.

E3 considers that, based on domestic and international experience with information campaigns, it cannot confidently recommend any promotional or awareness activities that will adequately address the impediments to energy efficiency in lighting tasks, to the point where the proposed MEPS should be delayed or abandoned. The last 30 years of energy saving efforts have provided no evidence that a well-designed information campaign would deliver more than a fraction of the savings that can be achieved with MEPS.

10 Statement of compliance with national competition policy

The National Competition Policy Agreements set out specific requirements for all new legislation adopted by jurisdictions that are party to the agreements. Clause 5(1) of the Competition Principles Agreement sets out the basic principle that must be applied to both existing legislation, under the legislative review process, and to proposed legislation:

The guiding principle is that legislation (including Acts, Enactments, Ordinances or Regulations) should not restrict competition unless it can be demonstrated that:

- (a) *The benefits of the restriction to the community as a whole outweigh the costs; and*
- (b) *The objectives of the regulation can only be achieved by restricting competition.*

Clause 5(5) provides a specific obligation on parties to the agreement with regard to newly proposed legislation:

Each party will require proposals for new legislation that restricts competition to be accompanied by evidence that the restriction is consistent with the principle set out in sub-clause (1).⁴¹

Therefore, all RIS must include a part providing evidence that the proposed regulatory instrument is consistent with these National Competition Policy obligations.

No reduction in competition

We are confident that the proposed measures will not restrict competition. We understand that there is a competitive supply of complying products from overseas factories, particularly China. Australian suppliers can contract freely with manufacturers to supply the Australian market. No party has indicated to E3 that an existing supplier will withdraw from the market in response to the proposed measures.

Therefore, the proposed measures are considered to be fully compliant with the National Competition Policy.

Public benefit test satisfied

The public benefit test would be satisfied if there were a reduction in competition.

- (a) Our estimates of reductions in the lifetime cost of lighting, as reported in chapter 4, show that the benefits of such a restriction would outweigh the costs.
- (b) Our analysis of options, as reported in chapter 3, shows that there is no other feasible means of achieving the objectives.

⁴¹ *Competition Principles Agreement*, Clause 5. 1995. See: www.ncc.gov.au

11 Consultation

11.1 How consultation was organised

Industry consultation

The E3 Committee developed the proposal in consultation with lamp suppliers and retailers and with industry and professional associations. The Department of the Environment, Water, Heritage and the Arts' (DEWHA) and their technical consultant, Steve Beletich, carried out this consultation involving many meetings throughout 2007 and 2008 and many more informal contacts. The work has focused on the scope, timing and level of the MEPS, the implementation schedule, and the methods for determining lamp performance. The following organisations and groups have been involved:

- Lighting Council Australia
- Illuminating Engineers Society
- Standards Australia
- Lighting controls working group, Lighting Council Australia
- Lighting standards working group, Standards Australia
- Energy Networks Association (ENA)
- Lupus Associations
- Energy Retailers Association
- A range of relevant environment non government organisations
- Relevant government departments and agencies including Health and Ageing, Australian Customs Service, Australian Radiation Protection and Nuclear Safety Agency
- Electrical Regulatory Authorities Council
- Australian Customs

This work culminated in the public release for stakeholder consultation, in December 2007, of a technical report that sets out the proposal in detail (Beletich Associates 2007), as well as the recent publication of Australian lamp and ELVC standards. Submissions to the technical report were received from 25 organisations and individuals.

DEWHA has since consulted with major lighting product retailers and retailer associations and is working with them to develop a communications strategy.

Public consultation

The consultation RIS was published on 11 September 2008 and public submissions were accepted for the 4 week period to 10 October 2008. The RIS was uploaded onto the E3 Committee website (www.energyrating.gov.au) and advertisements were placed in two national newspapers, including The Australian and the Sydney Morning Herald. Industry and Government stakeholders were also sent an email advising of the release, which included a link the document.

Comments were invited on any relevant matter but the document also highlighted issues where specific comment was sought.

11.1.1 Summary of public comments and E3's responses

A total of 25 individuals and organisations responded to E3's request for comment on the proposed measures and the consultation RIS, including two organisations that made a joint submission. The breakdown by type of organisation is as follows.

- Private individuals - 8
- Businesses
 - lamp suppliers and retailers – 3
 - electricity networks – 2
 - waste management – 1
- Non-government organisations – 7
 - Alternative Technology Association (ATA, joint submission with TEC)
 - Energy Networks Association (ENA)
 - Lighting Council Australia (LCA)
 - Illuminating Engineers Society (IES)
 - Local Government and Shires Association of NSW (LGSA)
 - Planet Ark
 - Total Environment Centre (TEC, joint submission with ATA)
- Government agencies – 4
 - Australian Customs Service (ACS)
 - National Measurement Institute (NMI)
 - SA Department for Transport, Energy and Infrastructure (DTEI)
 - Sustainability Victoria

The following summary of the detailed comments deals first with the specific issues on which E3 requested comment and then with the other matters that were raised.

11.1.2 Responses to the specific questions asked by E3

Product profile

E3 asked whether lighting technologies and supply arrangements were accurately described in the consultation RIS. There were two comments on these matters.

- LCA corrected some of the company details provided in table 3.3.
- One respondent said that the RIS was based on a false assumption that the lighting efficiency of a lamp can be equated with the efficacy of the lamp, that is, the ratio of light output (lumens) to power input (watts). The performance of the lamp is determined by a range of other factors such as its directional characteristics and the properties of the luminaire in which it is housed.

E3's position is that lamp efficacy is the worldwide, universal measure of lamp efficiency, and that lamp directionality issues can be resolved by market forces (as currently occurs) without government intervention, which is seen as too prescriptive. Lamp directionality requirements and luminaire interaction are functions of intended lamp application, and MEPS programs are independent of application (i.e. we cannot mandate that certain lamps are used for certain applications). Any systems related issues should be addressed through the Building Codes of Australia.

Impediments to energy efficiency

E3 asked whether the consultation RIS provided a reasonable account of the barriers to the take-up of energy efficient lamps. Four respondents commented on this aspect of the consultation RIS.

- LCA expressed its broad agreement. LCA also took the opportunity to say that the existence of these impediments underlined the need for a communications program

to educate consumers about the unfamiliar lighting technologies that they will need to use, and for that program to begin without delay.

- Planet Ark expressed broad agreement.
- One individual seems to have misinterpreted the discussion of split incentives in section 1.4.
- Sustainability Victoria criticised this part of the RIS, saying that the impediments to energy efficiency had been assessed in an excessively narrow framework of information failures and split incentives, and ignored evidence that consumers took little interest in the cost of lighting services. The submission said that the concept of bounded rationality needs to be more prominent.

E3 has slightly redrafted section 1.4 for greater clarity in the discussion of split incentives. Otherwise, however, E3 considers that its treatment of impediments to energy efficiency is adequate for the purpose and there is little to be gained by revisiting these issues.

Role of MEPS and labelling after CPRS is introduced

The consultation RIS explains (a) that the proposed regulation is designed specifically for lighting technologies and is in addition to CPRS and other greenhouse abatement measures that will raise the price of energy and otherwise encourage the use of energy-using products, and (b) the circumstances where specific measures add value to general measures. E3 received two comments on that explanation.

- LCA said that it supported the MEPS proposal but that no other specific lighting measures should be introduced until the impact of the CPRS had been evaluated.
- Planet Ark said that the explanation was helpful and broadly agreed with this part of the RIS.
- Sustainability Victoria criticised this part of the RIS, saying that more attention should be given to the price inelasticity of consumer demand for electricity and the potential that this creates for energy saving policies to contribute to cost effective greenhouse abatement.

While there may be value in the argument put forward by Sustainability Victoria, E3 has made no changes to this part of the RIS. E3 considers that its treatment of the CPRS is adequate for the purpose and that there is little to be gained by revisiting these issues.

Proposed regulation

E3 asked whether the consultation RIS provided an adequate explanation of the proposed measures. LCA raised two matters.

- LCA asked that it be made clear that the measures do not apply to CFLs without integrated ballasts. Such CFLs are used in many retail applications and allow the CFL to be replaced without discarding the ballast. A paragraph to that effect has been added.
- E3 also acknowledges the LCA proposal regarding the timing of MEPS for reflector CFLs. The date for termination of this exemption (November 2011) is dependent on a satisfactory test procedure being developed. E3 continues to consult with industry on this methodology.

Reform of lamp labelling and roll-out of the communications strategy

There were five responses to E3's request for comments on options for labelling reform and the content of the communications program.

- Labelling reform
 - LCA reiterated its opposition to mandatory labelling measures other than those adopted in Europe. LCA considers that it is unreasonable to impose special

- labelling requirements for the small Australian market, which accounts for 1-2% of global sales.
- LCA noted the proposal that only lamps that are at least 75% more efficient than the MEPS may be described as ‘high efficiency’, and expressed its concern that E3 has longer term plans to raise MEPS to this level.
- IES said that lamp packaging needs to state lamp efficacy and that this would facilitate compliance with the lighting provisions of Building Code of Australia and other relevant codes.
- DTEI said that more information needs to be provided on lamp packaging and possibly on the lamp itself, but building on concepts that already familiar to consumers, including Australia’s energy label and the wattage convention for identifying light output. Labelling is also needed because the proposed MEPS will not eliminate all incandescent lamps and those that remain will still be much less efficient than CFLs.
- One private respondent said that information about energy and financial savings was not important for CFLs but that all relevant technical information should be reported – including power, light characteristics and lamp dimensions – and that European labelling arrangements would be acceptable. Claims of equivalence to conventional lamps need to be verified and comprehensive standardised information should be provided on supplier websites.
- Planet Ark agreed that labelling needs to be improved.
- Communications strategy
 - LCA also urged E3 to implement its communications strategy without delay, in particular, those elements that are needed to educate consumers about replacement options as GLS become increasingly scarce and to discourage the inappropriate use of CFLs on dimmers and motion detectors.
 - IES offered to work with E3 to develop communications measures, for example, training for lighting and construction professionals, general knowledge dissemination and expansion of the IES website as a source of information.
 - DTEI said that the communications campaign would benefit from (a) clarification of the roles of E3 and the NFEE lighting committee, (b) market research on information needs, and (c) inclusion of information on environmental and personal benefits.

E3 does not propose a comprehensive labelling system for the current version of the MEPS. E3 intends to monitor international labelling developments, as discussed in the RIS, and will consider the inclusion of a labelling scheme at a later date in consultation with industry. Relevant comments on the consultation RIS will be taken into account. A meeting of the AS/NZS lighting standards committee in November 2008 provided an opportunity to discuss the value and feasibility of interim labelling measures with a limited range of requirements, prior comprehensive labelling reform at a later date.

E3 welcomes the support on the importance of a strong communications program. The communications strategy has developed significantly since release of the consultation RIS. Section 3.1.4 now provides more detailed information.

Alternatives to the proposed regulation

E3 asked stakeholders whether its alternative policy options should be more fully developed and assessed, and whether additional alternatives should be considered. There were four responses.

- LCA agreed with E3’s assessment of the alternative policy options.
- Sustainability Victoria said that the RIS had overstated the benefits of market-based policy options such as taxes and subsidies that preserve consumer choice, and also corrected a factual error regarding the operation of the Victorian Energy Efficiency Target.

- Planet Ark broadly agreed but suggested that compensation may be appropriate where the measures create financial hardship.
- In their joint submission, ATA and TEC disagreed with E3's conclusion that it was not feasible to set the MEPS significantly higher than is proposed. The submission discounted concerns about the cost and availability of lamps and the cost of prematurely scrapping lighting assets.

On the need of compensation, we have examined all plausible combinations of lamp type, lamp size and duty hours and find there are no adverse distributional effects – see section 4.7.2.

On the feasibility of more stringent MEPS, no new information has been provided and E3 stands by its assessment of the options.

The alternative policy options are now discussed in separate chapters, including more comprehensive impact assessments of tax and subsidy options, but otherwise E3 has made no substantive changes in response to these comments.

Business compliance costs

There were two responses to E3's request for comment on its estimates of business compliance costs.

- LCA said only that compliance costs were not significant enough to warrant not proceeding with the proposal. (LCA also noted that the lighting industry, and several key lamp suppliers in particular, incurred significant costs in working with E3 to develop the proposed measures.)
- Planet Ark noted that periodic changes to labelling provided low cost opportunities to introduce new labelling requirements.

Continued competition in supply of lighting products, including availability of like-for-like replacements

E3 said that it would be a concern if the proposed regulation weakened competition between products and suppliers or weakened incentives to innovate, and asked if there were any such issues. The following matters were raised.

- Competition between products and suppliers
 - Two individual respondents recounted previous unsatisfactory experiences with CFLs, one focusing on excessive claims for the life of CFLs and the other focussing on high search costs arising from inadequate labelling information and gaps in the range of CFLs that are available from various suppliers. Neither disapproved of the proposed measure. One expressing positive support and the other said that CFLs provided good value even when they do not last as long as suppliers promise.
 - Planet Ark said that the RIS downplayed the learning and search costs for some users, but that the measures would not reduce incentives to innovate.
 - One small overseas manufacturer of CFLs proposed a relaxation of the MEPS for CFLs, indicating that they would experience some difficulty in meeting the proposed quality standards, particularly in respect of light quality and harmonics. However, given the size of the manufacturer it is unlikely that this will create competition issues.
- Power quality: There were five submissions on the potentially adverse effect of CFL harmonics and power factors on the operation of electricity networks. These are highly technical issues and drew comments from two network operators, ENA, LCA and Sustainability Victoria.

On the issue of competition between products and suppliers, E3 considers that there is no credible threat to the competitive supply of complying CFLs and incentives to innovate.

The proposed quality standards for CFLs are commensurate with requirements in other countries and, while some overseas manufacturers may be less competitive, complying CFLs will be generally available on competitive terms to the Australian market. All major Australian suppliers have verified through Lighting Council Australia that their products will meet all requirements listed in the standard. This standard will encourage and promote better quality products into the country.

E3 also understands that, given the history of CFLs, some customers have genuine concerns about their performance. There will also be some learning by trial and error and a degree of frustration as users adapt their purchasing habits to the new technologies. E3 considers that these problems will be minimised by the combination of (a) quality standards for CFLs, (b) phased termination of exemptions until like-for-like replacements are available, (c) the proposed communications strategy and (d) more comprehensive stocking by suppliers. Users will discover gaps in the product range if they attempt to immediately replace all tungsten filament lamps with CFLs, but that will not be required and the communications strategy will remind users that they will need to continue using incandescent lamps in certain applications.

Regarding electricity networks, E3 has held discussions with the Energy Networks Association (ENA) and attended a recent meeting of the committee responsible for AS/NZS standards for power factor and harmonics. The conclusion of these meetings was that the lower power factor introduced by CFLs was not a significant problem, given that the (displacement) power factor introduced by CFLs was always 'leading', which helps to compensate for the 'lagging' power factor typically experienced by electricity networks, due to the dominance of inductive loads (i.e. electric motors).

On the face of it, the fact that CFLs have a lower power factor can be misinterpreted that CFLs will increase the currents experienced by electricity networks. However, as CFLs draw significantly less power than incandescent lamps, the effect of this and of their lower power factor is a net reduction in current of around 50% when compared to incandescent lamps.

One electricity network operator advocated the introduction of a mandatory high power factor requirement (minimum 0.9) for CFLs. E3 rejects this requirement as there is only one known CFL on the Australian market that would currently meet this requirement, which retails for around two to three times the price of an otherwise compliant CFL. Such a measure would take Australia out of step with Europe and Asia, with whom we share a great majority of CFL products. Discussions with the ENA concluded that this requirement would not solve the problem and that addressing the harmonic requirements of other electronic goods would be a more effective method of reducing harmonic impacts experienced by electricity networks, .

As indicated by submissions received in this area, the harmonic currents introduced by CFLs (and indeed by all electronic equipment) are of larger concern than their power factor, although the two are inter-related and often confused. In line with the ENA's request, E3 has elected to mandate the harmonic standard AS/NZS 61000.3.2 for CFLs, which would bring Australia in line with the mandatory CFL requirements in Europe. The ENA are also evaluating the benefit of widening the scope of mandatory harmonic requirements for all electronic equipment, as is currently the case in Europe. It should be noted that there is currently no clear regulatory vehicle for achieving this. CFLs will be the first electronic product to be subject to a mandatory harmonic requirement.

Direct financial impact on residential, commercial and industrial users

E3's assessment of the financial impacts attracted no negative comments other than the suggestions that (a) the calculations were somewhat complicated and could be better explained, and (b) the benefits would be significantly higher if prospective increases in the price of electricity were factored in.

LCA also passed on some information about the price of magnetic ELVCs that, if adopted, would further reduce estimates of the cost of the proposed measures.

We made no changes to this part of the RIS.

Impacts on health, safety and the environment

There were six responses to E3's request for comment in the health, safety and environmental issues.

- Three individual objected strongly to the proposal on health and environmental grounds. One stated simply that fluorescent lamps cause ill health and seems to refer to all fluorescent lamps, not just CFLs. Another said that the mercury related risks are unacceptable without a national scheme for collection and safe disposal of CFLs, not to landfill. The third is a very extensive submission detailing the adverse effects of fluorescent lighting on light sensitive individuals, particularly people suffering from Lupus.
- A waste management company put the environmental case for banning the disposal of fluorescent lamps to landfill and urged that the proposed measures be delayed until a national scheme for collection and safe disposal of CFLs had been assessed.
- Several non-government organisations – LGSA, Planet Ark, ATA and TEC – also said that the proposed measures should be accompanied by a national scheme for collection and safe disposal of CFLs.
- The submission from ATA and TEC said that there have been unacceptable delays in the EPHC's program of consultation and research on the disposal of mercury to landfill.

There were no responses to E3's request for comment on fire risks associated with the use of CFLs and halogen lamps. However, E3 has now received advice from ERAC and the relevant committee of Standards Australia. E3 accepted that advice and amended the relevant section of the RIS (3.2) accordingly.

On Lupus, E3 notes that there is considerable uncertainty about the number of Australians with Lupus but that it appears to be in the order of 2,000 to 20,000 persons. A sub-group is photosensitive and members of the sub-group need to manage their exposure to light, including artificial light. Since release of the consultation RIS E3 has further investigated whether tungsten halogen lamps and CFLs are suitable for use by people with Lupus-related photosensitivity. E3 subsequently revised the Lupus Fact Sheet (appendix A) to explain how people with Lupus-related photosensitivity can manage their condition by installing standard acrylic light covers or diffusers to filter out UV light and by using halogen lamps on their dimmer circuits.

The submission also provided E3 with more information about the concerns of people with Lupus-related photosensitivity that may extend to violet and blue light in the visible spectrum. They may find it more difficult to use successfully adapt to tungsten halogen lamps and CFLs, although yellow light filters seem to be an option. E3 is seeking further advice on this matter, including consideration of a possible need for continuing access to tungsten filament lamps that would otherwise be phased out. This may involve, for example, medical certification of need and special arrangements for the import and distribution of tungsten filament lamps.

The additional costs incurred by people with Lupus have been factored into a separate impact analysis that is now included in the RIS – see section 4.5.1. More work is needed to understand the cost effects and whether there are issues of affordability that need to be addressed by Government. This is partly in response to advice from Lupus Associations in a number of the jurisdictions that a significant portion of people with Lupus are on low or supported incomes as a result of their condition. E3 is examining alternative means of providing assistance, if needed. For example, the Government may subsidise or otherwise

support the selective import and distribution of tungsten filament lamps, or the purchase and installation of lamp covers, diffusers and filters.

The submission on Lupus also raised concerns about exposure to fluorescent lighting beyond the home and the impact of more extensive use of fluorescent lighting on people who are not yet aware that they have Lupus. E3 will examine this issue further but notes that fluorescent lighting is already used extensively in non-residential applications and a possible solution is to generally decrease the intensity of lighting and increase individualised control.

Nationwide impacts

There were four responses relating to E3's assessment of the nationwide impacts, raising two matters:

- Sustainability Victoria and one individual expressed doubt regarding the estimates of residential lamp stocks. The former provided some results of a Victorian residential survey and the latter provided anecdotal evidence.
- The two network companies said that, depending on certain power factor and harmonic characteristics of CFLs, the energy savings to users would be offset by some additional costs of network operation and power generation.

Regarding the stock estimates, E3 acknowledges that there is uncertainty about lamp stocks and trends. However, there are a number of data items to be reconciled – including the results of ABS household surveys, trade data on lamp imports, and the results of residential energy consumption surveys from the 1980s and 1990s. These sources tend to tell different stories and conservative assumptions have been used in the RIS, aiming for consistency with the trade. We have made no changes to this part of the RIS.

On the network issues, the ENA have stated that there is currently no known measured or modelled data that would allow the effects of CFL harmonics to be quantified accurately, due to the very complex nature of the issues involved. The ENA have elected to keep a watching brief on this issue. However, E3 would welcome any credible cost impact data from electricity companies or the ENA, which covers the power factor and harmonics affects of all electronic equipment. E3 will continue the dialogue with ENA and ensure these parameters are considered for other products covered by the program.

Sensitivity and distributional analysis

E3 asked whether its sensitivity and distributional analyses were adequate and credible. Planet Ark and one individual commented indirectly, saying that the measures imposed unacceptable costs on people who are least able to pay.

These concerns seem to ignore the energy savings, which are also important to people on low incomes. E3 has examined all plausible combinations of lamp type, lamp size and duty hours and finds there are no adverse distributional effects – see section 4.7.2.

11.1.3 Other matters

Issues of timing and implementation

LCA and one retailer urged the government to keep to the proposed schedule, particularly the scheduled ban on imports of GLS lamps from February 2009. They say that suppliers have organised their logistics for a February 2009 start, including cancellation of import orders and commitments to the supply of complying lamps.

There were comments on other aspects of the proposal.

- Sustainability Victoria and DETI questioned the one year exemption that is proposed for MV tungsten halogen non-reflector lamps.

- IES said that the MEPS for reflector lamps are too stringent and should be relaxed to 80% or 90% of the proposed value.
- NMI said that implementation of the proposed MEPS will require the urgent development of documentary standards and the associated measurement facilities to adequately monitor product quality. There are gaps in present arrangements, particularly in respect of dimmable CFLs and ELVCs.

Regarding the one year exemption for MV tungsten halogen non-reflector lamps, E3 negotiated this exemption with lamp suppliers to allow for further product development and ensure a competitive supply of complying products once the exemption has been lifted.

E3 also negotiated the MEPS for reflector lamps with lamp suppliers, including that there would be further developmental work to improve the accuracy of the test methods. At this stage no data has been provided that would support a relaxation in the proposed MEPS for reflector lamps. E3 can still defer these MEPS if required but, at present, it is considered that further product development will allow the MEPS to be implemented on schedule.

Regarding the need for new documentary standards and measurement facilities, there is currently no requirement for CFLs or ELVCs to be dimmable. E3 understands that the current efficiency test for ELVCs is adequate to implement MEPS as proposed and would consider introducing a voluntary dimmability test for these products and LEDs, if required. More stringent MEPS in the future may require improvements to the test method, particularly in relation to testing of very high frequency electronic ELVCs.

Inappropriate use of regulatory powers

As a matter of principle, one individual objected strongly to the use of regulatory powers in this context. This is an issue for the government and it is inappropriate for E3 to express a view one way or the other.

Trans Tasman Mutual Recognition Arrangement (TTMRA)

One submission asked whether the proposed measures raised any issues under TTMRA.

On 16 November 2008, the Zealand Minister for Energy and Resources released a media announcement declaring that New Zealand would no longer participate in the point of sale MEPS for traditional or incandescent bulbs. This media statement is available at: <http://www.beehive.govt.nz/release/light+bulb+ban+ended>

Given that the Australian Government has published a regulatory amendment to the Customs Imports Act (Prohibited List) for incandescent (GLS) bulbs⁴², no TTMRA issue is expected to arise for this product.

However, the NZ announcement may raise potential TTMRA implications for other products covered by this proposal including CFLs and ELV halogen non-reflector lamps for which retail restrictions are proposed for November 2009. Although E3 has been in contact with NZ Government and Lighting Association representatives who have indicated that they may regulate CFLs and other lighting products, uncertainty exists over when this will be implemented.

Given recent delays and setbacks, the E3 committee recommend that MEPS are introduced as planned in Australia. The situation regarding NZ plans for similar MEPS and whether or not this is effecting products coming into the Australian market should be monitored. If

⁴² See website for regulatory amendment:

[http://www.comlaw.gov.au/ComLaw/Legislation/LegislativeInstrument1.nsf/0/C58F4AC787A302FDCA257522007CB5C8/\\$file/0828604A081204EV.pdf](http://www.comlaw.gov.au/ComLaw/Legislation/LegislativeInstrument1.nsf/0/C58F4AC787A302FDCA257522007CB5C8/$file/0828604A081204EV.pdf)

non-MEPS compliant product is imported via NZ E3 regulators will seek a temporary exemption for CFLs and ELV halogen non-reflector lamps under the TTMRA.

It should also be noted that future exemptions for other incandescent products may be required at a later stage.

Corrections and alterations

There have been a number of minor changes to the RIS to incorporate new information that respondents have provided.

12 Conclusion and recommended option

12.1 Assessment

The primary assessment criteria are that the measures contribute to cost-effective greenhouse abatement. Table 12.1 reports our assessment against these criteria and various secondary criteria. Assessments of options 2 to 6 are often expressed relative to the proposed measures, which comprise option 1.

12.2 Conclusions

We conclude that the proposed measures will meet the assessment criteria and that E3 can finalise the measures with a high degree of confidence that the objectives will be achieved.

12.3 Recommendations

E3 recommends that the Ministerial Council on Energy (MCE) approve the proposed introduction of point of sale MEPS for incandescent lamps, CFLs and ELV converters for implementation no earlier than 1 November 2009. This will be supported by an appropriate communications strategy.

Further, E3 recommend that the MCE notes that it could be necessary to invoke a TTMRA temporary exemption for lighting products subject to MEPS including CFLs and ELV halogen non-reflector lamps at a later date. More information on why an exemption might be required appears in section 11.1.3.

E3 also recommend the reform of lamp labelling practices and arrangements; however this will require co-ordination with international reforms to avoid creating an unnecessary burden for industry. E3 are currently looking into a number of options aimed at influencing lamp labelling reform practices and is actively monitoring several international forums including the Asia Quality Charter, the International Electro-technical Commission (IEC) and the European Standards committee.

Note that further import restrictions may be put in place in advance of the introduction of point of sale MEPS for future applicable products listed in table 3.3. This will subject to further review of the feasibility of such restrictions.

TABLE 12.1 ASSESSMENT SUMMARY

<i>Option</i>	<i>Assessment</i>
Objective 1: Do the measures reduce greenhouse emissions?	
Option 1 - MEPS	The proposed measures would contribute 28.5Mt CO ₂ -e to greenhouse abatement over the period to 2020.
Option 2 – tax on non-complying lamps	A non-prohibitive tax would allow the continued use of lamps that do not comply with the proposed MEPS. The contribution to greenhouse abatement would be reduced, possibly by 5-10%, but it is not possible to estimate the difference with confidence.
Option 3 – subsidy for complying lamps	A subsidy would allow the continued use of lamps that would not comply with the proposed MEPS. The contribution to greenhouse abatement would be reduced, possibly by 5-10%, but it is not possible to estimate the difference with confidence.
Option 4 – disendorsement label for non-complying lamps	There is little experience with disendorsement labelling and none that attempts to deal with an issue of commensurate significance. It would probably be less effective than a tax (option 2).
Option 5 – comparative energy labelling	There is considerable evidence that comparative energy labelling would not be effective. E3 expects that the contribution to greenhouse abatement would be significantly reduced relative to option 1, certainly by more than 50%.
Option 6 – information campaigns	There is considerable evidence and opinion that information campaigns would not have an enduring effect. E3 expects that the contribution to greenhouse abatement would be significantly reduced relative to option 1, certainly by more than 50%.
Objective 2: Do the measures reduce the lifecycle cost of appliances?	
Option 1 - MEPS	The proposed measures would reduce the cost of lighting services by \$3.9 billion over the period to 2020, or \$2.2 billion in present value terms.
Option 2 – tax on non-complying lamps	A non-prohibitive tax has an uncertain effect on the cost of lighting services, relative to option 1. It will allow some to express a fully-informed and well-considered preference for non-complying lamps, which reduces lighting costs, but also allow the continued expression of market failures, which is cost increasing. It is not possible to reliably estimate the net effect.
Option 3 – subsidies for complying lamps	A subsidy has an uncertain effect on the cost of lighting services, relative to option 1. It will allow some to express a fully-informed and well-considered preference for non-complying lamps, which reduces lighting costs, but also allow the continued expression of market failures, which is cost increasing. It is not possible to reliably estimate the net effect.
Option 4 – disendorsement label for non-complying lamps	A disendorsement label has an uncertain effect on the cost of lighting services, relative to MEPS. It will allow some to express a fully-informed and well-considered preference for non-complying lamps, which reduces lighting costs, but also allow the continued expression of market failures, which is cost increasing. It will also reduce the quality of non-complying lamps, assuming that premium brands would not be associated with disendorsed products. It is not possible to reliably estimate the net effect.

<i>Option</i>	<i>Assessment</i>
Option 5 – comparative energy labelling	There is considerable evidence and opinion that comparative energy labelling would not be effective. E3 expects that the financial savings would be significantly reduced, certainly by more than 50%.
Option 6 – information campaigns	There is considerable evidence and opinion that information campaigns would not have an enduring effect. E3 expects that the financial savings would be significantly reduced, certainly by more than 50%.

Objective 3: Do the measures address market and regulatory failures?

Option 1 - MEPS	The measures address information failures and inertia in the market for lamps and ELVCs, associated with lack of user understanding of lighting as an energy cost, uncertainty about the performance of energy saving lamps, past disappointments with the performance of energy saving lamps, and weak incentives for builders and landlords to make lighting decisions in the best interests of end-users.
Option 2 – tax on non-complying lamps	It is possible that a non-prohibitive tax deals more effectively with market failures than option 1, because it does not completely suppress the expression of individual preferences. However, the optimal tax cannot be estimated with confidence and, for practical purposes, may have much the same effect as MEPS.
Option 3 – subsidies for complying lamps	It is possible that a subsidy deals more effectively with market failures than option 1, because it does not completely suppress the expression of individual preferences. However, the optimal subsidy cannot be estimated with confidence and, for practical purposes, may have much the same effect as MEPS.
Option 4 – disendorsement label for non-complying lamps	Disendorsement labelling has the advantage of allowing the continued expression of individual preferences, but it does not deal with the problem of split incentives and consumers it does not provide the consumer with full information about costs and benefits. Also, major suppliers would refuse to have their brands coupled with a disendorsement labelling and the quality of non-complying products may decline.
Option 5 – comparative energy labelling	There is no evidence that the comparative energy labelling of lamps deals effectively with market failures.
Option 6 – information campaigns	There is no evidence that information campaigns deal effectively with failures in the markets for household lamps.

Objective 4: Does the option minimise negative impacts on product quality and function?

Option 1 - MEPS	Option 1 includes a communications campaign that addressed a number of concerns about the negative impacts on product quality and function, either providing assurances that the concerns are unwarranted or explaining the practical steps for dealing with those concerns. The main outstanding issue is to organise appropriate advice and assistance for people with Lupus-related photosensitivity.
Option 2 – tax on non-complying lamps	A non-prohibitive tax would allow continued use of non-complying lamps by people who are concerned about the quality and functionality of complying lamps.
Option 3 – subsidies for complying lamps	A subsidy would allow continued use of non-complying lamps by people who are concerned about the quality and functionality of complying lamps.
Option 4 – disendorsement	Disendorsement labelling would allow continued use of non-complying

<i>Option</i>	<i>Assessment</i>
label for non-complying lamps	lamps by people who are concerned about the quality and functionality of complying lamps.
Option 5 – comparative energy labelling	Comparative energy labelling would allow continued use of non-complying lamps by people who are concerned about the quality and functionality of complying lamps.
Option 6 – information campaigns	Information campaigns allow continued use of non-complying lamps by people who are concerned about the quality and functionality of complying lamps.
Objective 5: Do the measures minimise adverse effects on suppliers?	
Option 1 - MEPS	The measures are been developed in close consultation with suppliers and E3 is not aware of any outstanding issues.
Option 2 – tax on non-complying lamps	E3 has not discussed this option with suppliers. However, it is expected that a non-prohibitive tax would impose modest additional compliance costs on suppliers.
Option 3 – subsidies for complying lamps	E3 has not discussed this option with suppliers. However, it is expected that a non-prohibitive tax would impose modest additional compliance costs on suppliers.
Option 4 – disendorsement label for non-complying lamps	Suppliers are opposed to disendorsement labelling, saying that they would withdraw form markets for non-complying products rather than have their brands associated with a disendorsement label.
Option 5 – comparative energy labelling	Suppliers are opposed to any labelling scheme that requires special labelling of globally traded goods for the small Australian market.
Option 6 – information campaigns	An information campaign would probably have least effect on suppliers.

13 Implementation and review

General administrative arrangements

The standards and labelling measures designed by E3 rely, for legal effect, on legislation in each of the Australian states and territories. The jurisdictions have also agreed to a set of administrative guidelines. While not legally binding, they aim to promote a uniform approach, consistent outcomes and to minimise compliance costs. The E3 Program released the latest guidelines in May 2005 (NAEEEC 2005). The key administrative arrangements are:

1. The technical details of MEPS are contained in Australian/New Zealand Standards that are incorporated by reference into the legislation of the various jurisdictions. Standards are the same for all jurisdictions. The format and content of Standards are also familiar to industry, as are the operations of Standards Australia and Standards New Zealand.
2. Changes to the technical detail in Standards are subject to transition periods that are negotiated between industry and government.
3. To minimise trade barriers, E3 has a policy of adopting international standards wherever appropriate.
4. Grandfathering arrangements are adopted where appropriate, allowing reasonable time for phasing out non-complying stock and changing labels.
5. All jurisdictions accept the registration of an appliance in another jurisdiction.
6. The regulatory agencies in each jurisdiction have targets for the timely processing of applications.
7. Proposed changes in administrative and operating practice are subject to consultation between the jurisdictions.

Product-specific compliance and enforcement activities

The E3 Program organises its compliance and enforcement activities as follows:

1. Compliance monitoring takes the form of a program of check testing by accredited laboratories.
2. Equipment is selected for check testing on the basis of risk factors rather than randomly. The risk factors are as follows:
 - history of success and failure in check tests;
 - age of models, with newer models given greater attention, reflecting the prospect of longer life in the market;
 - high volume sales;
 - claims of high efficiency;
 - complaints.
3. There are several sanctions. There is a 'shaming' option involving publication of failed brands or models in the AGO annual report. The second option is deregistration by the state authorities, subject to show cause procedures. Subsequent sale of deregistered appliances would be a criminal offence. Re-registration of models that are subject to MEPS is subject to new registration tests. The third option involves legal action.
4. Standard statistical criteria are applied to deal with normal variation in the performance of equipment selected for check testing.
5. Laboratories that produce misleading tests results may also be denied further registration business.

6. On 13 May 2008, the Minister for the Environment released a media statement which noted that the Australian Government will ‘review standards every three (3) years for all major appliances’. This review process will apply to all lighting products. A copy of the media release is available from:

<http://www.environment.gov.au/minister/garrett/2008/pubs/budmr20080513e.pdf>

General monitoring and benchmarking of impacts and effectiveness

In the past the E3 Program has periodically commissioned an omnibus evaluation of overall effectiveness. The last of these was published in June 2003 (NAEEEC 2003), titled *When you can measure it, you know something about it: Projected impacts 2000-2020*. The general aims of such an exercise are to document expected impacts, estimate costs and benefits, and compare outcomes with earlier projections. It commits the E3 Program to examination of the appliance register and store survey data, and comparative review of trends in appliance efficiency.

The program has since advised industry that the 2003 exercise was the last of the omnibus reviews and will be replaced by targeted reviews. The first of these will address air-conditioners and fridges. A review of arrangements for HWS has yet to be scheduled.

Annually, the E3 Program holds a consultation forum and invites stakeholders to raise concerns about its operation and impacts.

Less frequently, the E3 Program reviews program fundamentals. The most recent exercise of this kind was a major research-based review and scoping of future directions for a wide range of appliance efficiency labels.

The program also takes occasional opportunities to benchmark its activities with programs in other countries.

Regulatory review

Each Australian State and Territory has its own arrangements for review. The ‘subordinate legislation’ acts in several states provide for the automatic revoking of regulations after 10 years. These states are Victoria, SA, Queensland and Tasmania. NSW requires that all regulations contain sunset clauses. The remaining jurisdictions have no general requirement but may include sunset clauses on a case-by-case basis.

All jurisdictions have some Parliamentary machinery for the systematic review of regulations, such as a ‘Legislation Review Committee’. Arrangements for agency or inter-agency review are more variable. Only Victoria has a specific body charged with regulatory oversight, which is the Victorian Competition and Efficiency Commission. This work is undertaken by an inter-departmental committee in NT. Otherwise, however, the review process uses a parliamentary secretariat to raise issues and solicit public comment.

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APPENDIX A: SUPPLEMENTARY INFORMATION ON THE PROPOSED REGULATION

Table A1 Types of lamp commonly used in residential applications

Table A.2 Proposed CFL performance requirements, including acceptable overseas certification schemes

Fact sheets

CFLs HEALTH FACT SHEET 1 - Systemic Lupus Erythematosus










CFLs HEALTH FACT SHEET 2 - Photosensitive epilepsy

CFLs HEALTH FACT SHEET 3 - Ménière's disease






CFLs HEALTH FACT SHEET 4 – Migraines

Disposal of spent or broken compact fluorescent lamps (CFLs)

Table A1 Types of lamp commonly used in residential applications, including some that are not in the scope of the regulation*

<i>Lamp type</i>	<i>Example</i>	<i>Cap types</i>	<i>Typical wattage</i>	<i>Approximate price (\$A)</i>
GLS conventional, including frosted, clear and long-life		B22, E27	25 -100w	\$0.50-\$1.00
GLS coloured (NOT IN SCOPE)		B22, E27	25w	n. a.
GLS high wattage (NOT IN SCOPE)		B22, E27, E40 (500w+)	150 - 1000w	n. a.
Candle		B15, B22, E14, E27	25 - 60w	\$1.00-\$2.00
Fancy round		B15, B22, E14, E27	25 - 60w	\$1.00-\$2.00
Globe shaped		B22, E27	60 - 100w	\$1.00-\$2.00
Mains voltage halogen non-reflector lamps		E27	100 – 250w	\$3.00
Mains voltage halogen non-reflector lamps, double-ended (NOT IN SCOPE)		R7s, Fa4	60 – 1500w	n. a.
Extra low voltage halogen capsule lamps		G4, GY6, GY6.35	5 - 100w	\$4.00-\$10.00

<i>Lamp type</i>	<i>Example</i>	<i>Cap types</i>	<i>Typical wattage</i>	<i>Approximate price (\$A)</i>
Extra low voltage halogen reflector lamps		GZ/GU4, GX/GU5.3, G53, GZ/GU10, BA15D/19, B15D/24X17	15 - 100w	\$4.00-\$5.00
R & ER		B22, E14, E27	25 - 150w	\$3.00-\$4.00
PAR		E27	60 - 150w	\$5.00-\$9.00
Crown silvered		E14, E27	40 - 100w	\$2.00-\$3.00
Mains voltage halogen reflector lamps		E14, E26, E27, GU10, GZ10,	35 - 100w	\$4.00-\$7.00
PAR 38 coloured (NOT IN SCOPE)		E27	80w	n. a.
Infra-red heat lamps (NOT IN SCOPE)		B22, E27	250 - 375w	n. a.
Pilot lamp		B15, B22, E14, E27	15 – 40w	\$4.00-\$5.00

<i>Lamp type</i>	<i>Example</i>	<i>Cap types</i>	<i>Typical wattage</i>	<i>Approximate price (\$A)</i>
Oven lamp, temperature resistant		E14, E27	15 – 40w	\$4.00-\$5.00
Refrigerator lamp		E14	15w	\$4.00-\$5.00
Heavy duty and surge resistant				\$5.00-\$10.00
Anti-insect lamp (NOT IN SCOPE)		B22, E27	60-100w	n. a.
Double-ended tubular (NOT IN SCOPE)		S15s	30 - 60w	n. a.

Note

* Suppliers should refer to the relevant standards for the exact technical specifications of the lamps that are subject to the proposed regulations. The above list may exclude some types of incandescent lamps that are subject to the regulation.

Table A.2 Proposed CFL performance requirements, including acceptable overseas certification schemes

Attribute	Local	OR		OR	
		Efficient Lighting Initiative (ELI)		UK Energy Saving Trust (EST)	
				Version 5	Version 6
Efficiency requirements					
Minimum efficacy in lm/w - bare lamps	$\frac{1}{\frac{0.24}{\sqrt{F}} + 0.0103}$ Where F = initial luminous flux in lumens	<4500 K	≥5 to <9 W	50	$\frac{1}{\frac{0.24}{\sqrt{F}} + 0.0103}$ Where F = initial luminous flux in lumens
			≥9 to <15 W	55	
			≥15 to <25 W	60	
			≥25 to < 60 W	65	
		≥4500 K	≥5 to <9 W	46	
			≥9 to <15 W	52	
			≥15 to <25 W	57	
			≥25 to < 60 W	62	
Minimum efficacy in lm/w -covered lamps	$\frac{0.85}{\frac{0.24}{\sqrt{F}} + 0.0103}$ Where F = initial luminous flux in lumens	<4500 K	≥5 to <9 W	43	$\frac{0.85}{\frac{0.24}{\sqrt{F}} + 0.0103}$ Where F = initial luminous flux in lumens
			≥9 to <15 W	47	
			≥15 to <25 W	51	
			≥25 to < 60 W	55	
		≥4500 K	≥5 to <9 W	39	
			≥9 to <15 W	44	
			≥15 to <25 W	48	
			≥25 to < 60 W	53	
Minimum efficacy in lm/w - reflector lamps***	$\frac{0.6}{\frac{0.24}{\sqrt{F}} + 0.0103}$ Where F = initial luminous flux in lumens			Based on minimum 'centre beam candela efficacy'	

Attribute	Local	OR Efficient Lighting Initiative (ELI)	OR UK Energy Saving Trust (EST)	
			Version 5	Version 6
Light quality requirements				
Colour appearance	IEC 60081 Graph D-16 for CCT 2700. Other temps to be approved but following same diagram	5	CCT 2650-2800 K	IEC 60081 Graph D-16 for CCT 2700. Other temps to be approved but following same diagram
Minimum CRI	80	80	80	80
Maximum starting time (seconds)	2.0	1.5	*	2.0
Maximum run-up time (min)	1.0	*	*	1.0
Durability requirements				
Minimum lumen maintenance	2000 hrs = 0.88 5000 hrs = 0.80 10000 hrs = 0.75	0.8		2000 hrs = 0.88 5000 hrs = 0.80 10000 hrs = 0.75
Maximum premature lamp failure rate	10% at 30% of rated life			10% at 30% of rated life
Minimum switching withstand	1000 Cycles			
Minimum lifetime (hours)	6000	6000	6000	Not less than 10,000 hrs (not more than 15,000 hrs)
Requirements relating to external impacts				
Minimum power factor	0.55 (0.9 for lamps claiming high PF)	0.5		0.55 (0.9 for lamps claiming high PF)

Attribute	Local	OR Efficient Lighting Initiative (ELI)	OR UK Energy Saving Trust (EST)	
			Version 5	Version 6
Maximum mercury content (mg)	5**	*	*	5
Harmonics	AS/NZS 61000.3.2	AS/NZS 61000.3.2	IEC 61000.3.2	

* If the lamp manufacturer chooses to adhere to ELI or EST version 5, for which starting time, run-up time and mercury content may not be specified, then the lamp model shall comply with or exceed the local criteria for these three attributes (2.0 s, 1.0 min and 5 mg respectively).

** To be measured in accordance with AS/NZS 4782.3

*** Effective enforcement in 2010 for import and 2011 for retail.

CFLs HEALTH FACT SHEET 1 - Systemic Lupus Erythematosus

Are compact fluorescent lamps (CFLs) safe to use for people with light sensitivity conditions?

Some concern has been raised that compact fluorescent lamps (CFLs) can have adverse impacts on the health of individuals who are affected by ultra-violet (UV) light, specifically sufferers of Systemic Lupus Erythematosus (SLE) or Lupus.

The most common source of UV exposure is from sunlight. To put the amount of UV emitted from fluorescent lighting in context a 1993 study found that UV exposure from sitting under typical office fluorescent lights for eight continuous hours is equivalent to just over one minute of sun exposure (Lytle et al, 1993).

What is Systemic Lupus Erythematosus?

Lupus, in its many forms, is an autoimmune disorder characterised by chronic inflammation of body tissues. Patients with Lupus produce antibodies that target their own healthy tissues and organs. The cause of Lupus is not clear but genetics, viruses, UV light, and medication all appear to play some role. Lupus is up to eight times more common in women than men. Exacerbations or flare ups of Lupus can be induced by exposure to sunlight.

Possible impacts of compact fluorescent lamps (CFLs) on the health of Lupus sufferers?

All general use lamp types including the traditional incandescent light bulb emit low levels of UV light. UV light from CFLs can be somewhat higher than incandescent light bulbs of equivalent (visible) light output, and may pose a problem for sensitive sufferers of Lupus, if not ameliorated.

There are rare instances recorded of prolonged exposure to bare linear (tubular) fluorescent lamps provoking Lupus in hypersensitive individuals. The use of standard acrylic light covers or diffusers to filter light between the light source and the lupus sufferer eliminates the risk posed by UV light. Light covers are commonly used for aesthetics and to reduce glare, but have been shown to reduce UV light output by about 94 per cent.

What are the alternatives for individuals with severe light sensitivity?

Halogen Lighting

It is important to note that compact fluorescent lamps (CFLs) are not being mandated. More efficient forms of incandescent lighting will continue to be available, such as mains voltage halogen lamps. Mains voltage halogens have a very similar appearance to the traditional incandescent light bulb, can be used in all of the same fittings, and are readily available. The halogen gas they contain allows them to operate at a higher temperature, which results in higher efficiency levels. However, mains voltage halogens are not as energy efficient as CFL alternatives.

When changing from an inefficient incandescent lamp to a more efficient alternative make sure that you select a product with an equivalent light output (or brightness) to the lights you already have in your home. Unfortunately for individuals with severe light sensitivity this is not a simple conversion to a lamp of a similar wattage as energy efficient lamps use less energy to produce the same amount of light.

If you do select an efficient lamp (including a halogen lamp) that has more light output, it may also result in a small increase in UV exposure. For example, if you are currently using a certain wattage (e.g. 100W) incandescent lamp on a dimming circuit that is turned down low and you purchase a similar wattage (e.g. 100W) mains voltage halogen, there will be approximately a 20 per cent increase in light output (and UV emissions) as a result of the improved efficiency of this lamp type. In order to account for this increase in efficiency, you would therefore need to turn down the dimmer further than you had it previously. With this adjustment, a mains voltage halogen can provide exactly the same light output and light colour quality as achieved with the traditional incandescent lamp, but more efficiently.

As the phase-out of inefficient light bulbs progresses, the Australian Government will continue to consider health issues and examine options to address any significant concerns. This may include providing information about possible impacts on Lupus sufferers and or information about new and emerging lighting alternatives.

Globe conversion table

This globe conversion table is designed to assist you in your selection of a more energy efficient lighting alternative that best suits your lighting requirements.

(The fact sheet provides a link to a conversion table at the following address.)

<http://www.environment.gov.au/settlements/energyefficiency/lighting/index.html#conversion>

Further reading

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CFLs HEALTH FACT SHEET 2 - Photosensitive epilepsy

Can people who suffer from photosensitive epilepsy use compact fluorescent lamps (CFLs)?

Concerns have been raised that compact fluorescent lamps (CFLs) may have adverse impacts on the health of some people. One such concern is the effects of CFL 'flicker' on photosensitive epileptics.

What is photosensitive epilepsy?

Photosensitive epilepsy is the name given to epilepsy in which all, or almost all, seizures are provoked by flashing or flickering light, or some shapes or patterns. Both natural and artificial light may trigger seizures. Various types of seizure may be triggered by flickering light. Photosensitive epilepsy is rare and only 5 per cent of epileptics are diagnosed with this form of epilepsy.

Some known triggers for people with photosensitive epilepsy are:

- Watching television or playing video games
- Having a faulty lamp or television that flickers
- Strobe lights
- Driving at dawn or dusk with sun shining through a line of trees
- Sun flickering on water
- Looking out of the window from a fast moving vehicle
- Geometric patterns.

The frequency of flashing light most likely to trigger seizures varies from person to person. Generally it is between 8-30Hz or flashes per second. CFLs 'flicker' at a rate well above this sensitive range and do not pose a hazard to sufferers of photosensitive epilepsy.

Researchers have concluded that compact fluorescent lamps (CFLs) are no more likely to be a greater risk to people with photosensitive epilepsy than other lamps. For more information about photosensitive epilepsy see www.epilepsy.org.au/photosensitivity.asp). Further a recent study conducted by the Scientific Committee on Emerging and Newly Identified Health Risks, Light Sensitivity Report, September 2008 revealed that 'while photosensitivity of epileptics is scientifically proven, seizures induced by flicker can be accurately correlated to the frequency only for a small range (3Hz, 15-18 Hz). Therefore, there is no scientific data that fluorescent lamps, including compact fluorescent lamps (CFLs) induce seizures.'

CFL 'flicker'

As part of their normal operation fluorescent lamps flash on and off very rapidly - CFLs 'flicker' at a rate of more than 20,000 times per second, modern linear fluorescent tubes at more than 5,000 times per second, and older style linear fluorescents at 100 times per second. These rates of flickering are well above the level detectable by the human brain. Epilepsy Action (2007) suggests that fluorescent lights should normally not cause a problem for photosensitive epileptics, except when using faulty lamps, which may flicker

at a lower frequency - visible by the human eye. In addition, much higher risks are connected with television and video games.

Occasionally, fluorescent lamps may develop a fault which may cause them to have a noticeable flicker - these lamps should be replaced.

What are the alternatives for individuals with photosensitive epilepsy?

It is important to note that compact fluorescent lamps (CFLs) are not being mandated. More efficient forms of incandescent lighting will continue to be available, such as mains voltage halogen lamps. Mains voltage halogens have a very similar appearance to the traditional incandescent light bulb, can be used in all of the same fittings, and are readily available. The halogen gas they contain allows them to operate at a higher temperature, which results in higher efficiency levels. However, mains voltage halogens are not as energy efficient as CFL alternatives.

When changing from an inefficient incandescent lamp to a more efficient alternative make sure that you select a product with an equivalent light output (or brightness) to the lights you already have in your home.

Globe conversion table

The globe conversion table is designed to assist you in your selection of a more energy efficient lighting alternative that best suits your lighting requirements.

(The fact sheet provides a link to a conversion table at the following address.)

<http://www.environment.gov.au/settlements/energyefficiency/lighting/index.html#conversion>

As the phase-out of inefficient light bulbs progresses, the Australian Government will continue to consider health issues and examine options to address any significant concerns. This may include providing information about possible impacts on Photosensitive Epilepsy sufferers and or information about new and emerging lighting alternatives.

References:

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CFLs HEALTH FACT SHEET 3 - Ménière's disease

Can people who suffer from Ménière's disease use compact fluorescent lamps (CFLs)?

Concerns have been raised that compact fluorescent lamps (CFLs) may have adverse impacts on the health of some people. One such concern is the effects of CFL 'flicker' on Ménière's disease sufferers.

What is Ménière's disease?

Ménière's disease afflicts about 0.2 per cent of the population. It is a condition where excess fluid in the inner ear upsets the ear's balance and hearing mechanisms. This produces symptoms such as vertigo (dizziness), tinnitus (ringing in the ears) and hearing loss. The disorder usually affects only one ear and is a common cause of hearing loss.

There is no scientific evidence to suggest compact fluorescent lamps (CFLs) (or any fluorescent lights) can exacerbate or initiate symptoms of Ménière's disease. There are however, anecdotal reports that sufferers of Ménière's disease are more sensitive to flashing lights than others (because of their impaired balance systems), and so may be more susceptible to a phenomenon known as flicker vertigo.

Flicker vertigo

Flicker vertigo may arise from flicker rates in the range of 4-30Hz or 4 to 30 times per second. Symptoms range from vague and non-specific feelings of unease through to nausea, dizziness, migraines, unconsciousness, and even photosensitive epileptic seizures. Flicker vertigo can reportedly affect anyone, but some individuals may be more susceptible than others. Triggering events can be as simple as viewing fast moving objects (such as fan, helicopter blades or a tree line from a moving car) that intermittently obscures the sun, creating a flickering effect.

CFL 'flicker'

CFLs 'flicker' at a rate well above that detectable by the human brain and so should not affect Meniere's sufferers. As part of their normal operation fluorescent lamps flash on and off very rapidly - CFLs 'flicker' at a rate of more than 20,000 times per second, modern linear fluorescent tubes at more than 5,000 times per second, and older style linear fluorescents at 100 times per second. These rates of flickering are well above the 'sensitive range' for Flicker vertigo. Occasionally, fluorescent lamps develop a fault which may cause them to have a noticeable flicker - these lamps should be replaced.

What are the alternatives for individuals who experience flicker vertigo?

It is important to note that compact fluorescent lamps (CFLs) are not being mandated. More efficient forms of incandescent lighting will continue to be available, such as mains voltage halogen lamps. Mains voltage halogens have a very similar appearance to the traditional incandescent light bulb, can be used in all of the same fittings, and are readily

available. The halogen gas they contain allows them to operate at a higher temperature, which results in higher efficiency levels. However, mains voltage halogens are not as energy efficient as CFL alternatives.

As the phase-out of inefficient incandescent light bulbs progresses, the Australian Government will continue to consider health issues and examine options to address any significant concerns. This may include providing information about possible impacts on sufferers of flicker vertigo, and or information about new and emerging lighting alternatives.

CFLs HEALTH FACT SHEET 4 – Migraines

Can people who suffer from migraines use compact fluorescent lamps (CFLs)?

Concerns have been raised that compact fluorescent lamps (CFLs) may have adverse impacts on the health of some people. One such concern is the effects of CFL 'flicker' on migraine sufferers.

What are migraines?

Migraine is one of the most common diseases of the nervous system. In developed countries migraine affects about 10-15 per cent of people. Migraines can be triggered by many different things, including stress, exercise, certain foods, bright light, flickering light, loud noises, strong smells, lack of sleep or too much sleep. In women, attacks may be triggered by hormonal changes, for example during menstruation.

If light is suspected as the triggering event for migraines, ordinary headaches, or even eyestrain, the primary cause is likely to be glare, highly contrasting, or inappropriate light levels. These problems are a result of poor lighting design rather than a feature of fluorescent lamps and can occur with any lighting technology if used inappropriately. Light fittings that enclose lamps and distribute light evenly without compromising light output and efficiency can help avoid these problems.

The UK migraine action association (<http://www.migraine.org.uk>) recommends:

- Ensuring that lighting is adequate and well positioned
- Fluorescent lighting should be properly maintained to minimise flicker
- Fluorescent lamps should be fitted with the correct type of diffuser to imitate natural daylight as much as possible
- Avoid reflected glare from shiny/polished surfaces, plain white walls etc, opt for matt finishes and break up surfaces with pictures, posters or plants
- Fit adjustable blinds to windows.

CFL 'flicker'

While light sources with a detectable flicker can trigger migraines in susceptible individuals, CFLs 'flicker' at a rate well above that detectable by the human brain and so should not affect migraine sufferers. As part of their normal operation fluorescent lamps flash on and off very rapidly - CFLs 'flicker' at a rate of more than 20,000 times per second, modern linear fluorescent tubes at more than 5,000 times per second, and older style linear fluorescents at 100 times per second. Occasionally, fluorescent lamps may develop a fault which causes them to have a noticeable flicker- these lamps should be replaced.

What are the alternatives for individuals with migraines?

It is important to note that compact fluorescent lamps (CFLs) are not being mandated. More efficient forms of incandescent lighting will continue to be available, such as mains

voltage halogen lamps. Mains voltage halogens have a very similar appearance to the traditional incandescent light bulb, can be used in all of the same fittings, and are readily available. The halogen gas they contain allows them to operate at a higher temperature, which results in higher efficiency levels. However, mains voltage halogens are not as energy efficient as CFL alternatives.

When changing from an inefficient incandescent lamp to a more efficient alternative make sure that you select a product with an equivalent light output (or brightness) to the lights you already have in your home.

Globe conversion table

The globe conversion table is designed to assist you in your selection of a more energy efficient lighting alternative that best suits your lighting requirements.

(The fact sheet provides a link to a conversion table at the following address.)

<http://www.environment.gov.au/settlements/energyefficiency/lighting/index.html#conversion>

As the phase-out of inefficient light bulbs progresses, the Australian Government will continue to consider health issues and examine options to address any significant concerns. This may include providing information about possible impacts on migraine sufferers and or information about new and emerging lighting alternatives.

Disposal of spent or broken compact fluorescent lamps (CFLs)

What should I do if I break a compact fluorescent lamp (CFL) or other lamp that contains mercury?

All fluorescent lamps including compact fluorescent lamps (CFLs) contain very small amounts of elemental mercury. Government and industry continue to work together to minimise the mercury content. A new standard will be introduced for compact fluorescent lamps (CFLs) that includes a maximum mercury content aligned with the European Commission standard at 5 mg (one two-hundredth of a gram) per bulb. The ordinary fluorescent tubes in current use contain approximately 15 mg of mercury per tube, consistent with the Australian Standard; these have been used safely in most commercial and public buildings in Australia and around the world for over 40 years.

To put the amount of mercury contained in compact fluorescent lamps (CFLs) in context, 5 mg would fit on the tip of a ball point pen. The old mercury thermometers contain approximately 500 mg of mercury. With appropriate precautions regarding disposal in place, elemental mercury continues to be used safely in a variety of products including lamps, watch batteries, various medical instruments, and dental fillings.

Safe clean-up and disposal guidelines

Scientific investigations into the potential risks of mercury exposure from an accidentally broken CFL report that for the average person poisoning is very unlikely because of the very small amounts involved. However, following these simple and straightforward clean-up and disposal instructions will further minimise any potential risk.

Lighting companies generally recommend that if a CFL breaks you should observe the following:

1. Open nearby windows and doors to allow the room to ventilate for 15 minutes before cleaning up the broken lamp
2. Do not use a vacuum cleaner because this can spread the contents of the lamp and contaminate the cleaner
3. Use disposable rubber gloves rather than bare hands
4. Use a disposable brush to carefully sweep up the pieces
5. Use a paper towel, preferable moist, to wipe up any remaining glass fragments and phosphor powder
6. Wrap lamp remains in newspaper to conceal the glass and then place the parcel in a bag or sealable container
7. along with the cleaning equipment used (i.e. gloves, brush, damp paper)
8. Place in your outside rubbish bin – never in your recycling bin.

Alternatively for more information on the clean-up and disposal guidelines for broken compact fluorescent lamps (CFLs), please visit www.lighting.philips.com.au and www.gelighting.com for more details.

How should I dispose of compact fluorescent lamps (CFLs) at the end of their working life?

You should NOT place compact fluorescent lamps (CFLs) in your kerbside recycling collection because they can break during transport and contaminate recyclable items.

Waste disposal and handling is primarily a state and local government responsibility in Australia. While in general, the current accepted approach is disposal to landfill, several states have chemical waste collection programs and/or advise households to take their used lights to designated drop-off points for recycling. Detailed information about disposal and recycling, developed with the assistance of the states and territories is available at: www.environment.gov.au/settlements/waste/lamp-mercury.html

What are governments doing about compact fluorescent lamps (CFL) disposal?

The Environment Protection Heritage Council (EPHC), which includes state, territory, and Commonwealth environment ministers, is currently investigating the issues associated with the end-of-life management (disposal methods) of compact fluorescent lamps (CFLs). The EPHC has consulted with industry stakeholders, including the Australian Council of Recyclers, to gather information and to identify the nature and extent of any problems likely to be posed by landfill disposal of compact fluorescent lamps (CFLs). This work is ongoing, and any recommendations resulting from this investigation will be taken into account in the formulation of any national approach to this issue.

APPENDIX B: DEVELOPMENT OF AUSTRALIAN ENERGY EFFICIENCY POLICY

The Australian Government's initial response to concerns about the environmental, economic and social impacts of global warming was set out in the Prime Minister's statement of 20 November 1997, *Safeguarding the Future: Australia's Response to Climate Change*. The Prime Minister noted that the Government was seeking "...realistic, cost-effective reductions in key sectors where emissions are high or growing strongly, while also fairly spreading the burden of action across the economy." He also stated that the Government is "...prepared to ask industry to do more than they would otherwise be prepared to do, that is, go beyond a 'no regrets'⁴³, minimum cost approach where this is sensible in order to achieve effective and meaningful outcomes." This "no regrets" test was a key part of the guidelines adopted by the Council of Australian Governments (COAG) in 1997 that any initiative proposed by the MCE, including standards and labelling measures under the Equipment Energy Efficiency Program, must meet.

In 1998 the Australian Government released *The National Greenhouse Strategy* (NGS) that was endorsed by the Australian Government and state and territory governments and committed them to an effective national greenhouse response. Progress under the NGS was reported to the Council of Australian Governments (CoAG). Many key elements of the NGS were implemented successfully, but, over time, the Australian Government identified a range of emerging climate change priorities that required attention at the federal government level. Similarly, there was acknowledgment that state and territory jurisdictional boundaries necessitated state/territory level climate change action plans and these were developed.

In 2004, the Australian Government released a new climate change strategy as articulated through its Energy White Paper, *Securing Australia's Future*, and the 2004-05 Environment Portfolio Budget. Some elements of the earlier NGS were included in the new strategy. As a critical element of the Australian Government's climate change strategy, the new energy policy represented the refinement of strategic themes pursued in relation to energy under the NGS, including energy market reform, the development of low-emissions and renewable technologies, and improvements to end-use energy efficiency.

Since that time, CoAG has remained the primary forum for progressing Australian, state and territory government collaboration on climate change issues requiring inter-jurisdictional attention. Significant progress has been made under the CoAG climate change agenda since CoAG's agreement in June 2005 to establish a new Senior Officials Group to consider ways to further improve investment certainty for business, encourage renewable energy and enhance cooperation in areas such as technology development, energy efficiency and adaptation. This work culminated in the January 2006 CoAG climate change action plan. In addition, climate change issues requiring national coordination have been managed through a number of inter-governmental ministerial councils including the Ministerial Council on Energy.

The Australian Government's climate change strategy is the mechanism through which Australia will meet its international commitments as a party to the United Nations Framework Convention on Climate Change (UNFCCC). The Government has an overall target of limiting Australia's emissions in 2008-2012 to 108% of its 1990 emissions. This

⁴³ The Productivity Commission has defined "No regrets" policy options as measures that ... *have net benefits (or at least no net cost) in addition to addressing the enhanced greenhouse effect. A more intuitive interpretation of 'no regrets' measures could be that they are actions which would still be considered worthwhile even in the absence of concerns about the potential adverse impact of global warming.* (PC 1997: page vii). This may involve imposing additional business costs on suppliers if the resulting more efficient products deliver a net benefit to the wider community.

is a 30% reduction on the projected “business as usual” (BAU) outcomes in the absence of interventions.

Over 2006, the national policy debate over introducing a carbon price in Australia continued with the state and territory governments proposing an emission trading scheme, and the Australian Government holding a nuclear energy enquiry and announcing its own emissions trading inquiry by the *Task Group on Emissions Trading*.

In 2007, emissions trading became a major new plank in the Australian Government’s response to climate change. The then Government announced in that Australia will introduce a world-class domestic emissions trading system by 2012. The new Government, elected in December, has brought the implementation date forward to 2010. Emissions trading will be the primary mechanism for achieving the long term emissions reduction goal.

Emissions trading will complement existing Government actions to reduce greenhouse gases. These include:

- improving end-use energy efficiency;
- investing in the new low emissions technologies Australia and the world will need in the future, including renewable energy technologies and clean coal;
- supporting world-class scientific research to continue to build our understanding of climate change and its potential impacts, particularly on our region; and
- assisting regions and industries to adapt to the impacts of climate change.

An emissions trading scheme will build on the success of past and ongoing measures. These measures include the *2004 Energy White Paper*, *2004-05 Climate Change Strategy*, earlier measures such as *Measures for a Better Environment* and *Safeguarding the Future*, as well as new programs announced in 2006-07.

APPENDIX C: IEA REVIEW OF POLICIES FOR ENERGY EFFICIENT LIGHTING

This appendix draws on the recent IEA report that we referenced in chapter 1 (IEA 2006: chapter 5). It provides a review of lighting policies in OECD countries and in selected non-OECD countries.

C.1 POLICIES TO IMPROVE LIGHTING COMPONENT EFFICIENCY

Governments have applied MEPS and labelling requirements to a wide range of lighting components since the 1970s and especially since the mid-1990s. The components include not only lamps but also ballasts, ELVCs, luminaires⁴⁴, and specific applications like street lights and exit signs. IEA finds that there are still many gaps in the labelling and standards program and that more work is required to provide reasonable coverage.

Australia recently introduced MEPS for ballasts and linear fluorescent lamps and, in addition to the measures addressed in this RIS, there are plans to apply MEPS to lighting technologies that are used for industrial and outdoor applications. Legislative impediments to European MEPS are currently being addressed, paving the way for a more aggressive program of MEPS.

IEA says that the main problem with MEPS, as they have been used to date, is that they promote efficiency within product categories but do little to accelerate the phasing out of incandescent lamps, which promises the largest gains. IEA makes particular reference to the aggressive use of MEPS for individual products in Canada and the US, but where overall efficacy is still held back by extensive use of incandescent lamps (IEA 2006: page 334).

IEA says labelling programs are best regarded as complementing MEPS and other programs. There has been mandatory labelling of lamps in Europe since 1998 and it may be responsible for the higher penetration of CFLs there, but that is not clear. Both mandatory and voluntary labelling schemes have been used in the US since the early 1990s, with positive but not dramatic results.

It is interesting that fluorescent lamps have actually attracted more regulatory attention – both MEPS and labelling - than the much less efficient incandescent lamps. This is partly due to their importance in commercial settings and partly to preserve the quality of CFLs as viable replacements for incandescent lamps. The danger is that poorly-informed users cannot distinguish between good and bad CFLs and that an accumulation of bad experiences with poor products will destroy the reputation of CFLs generally. Economists refer to this as the ‘lemons’ problem. The regulation of CFLs is currently the focus of the *International CFL Harmonisation Initiative*, focusing on international harmonisation of CFL test and performance standards and aiming to reduce compliance and manufacturing costs and ultimately reducing the price of high quality CFLs.

C.2 BUILDING CODES AND BUILDING ENERGY PERFORMANCE CERTIFICATION

Building codes can regulate the maximum power of lighting systems that are installed in new and refurbished buildings, with the maximum defined as watts per square metre of floor space or watts per lumen (inverse of efficacy). Some codes require daylight and lighting controls such as dimmers, occupancy and motion sensors. Many US jurisdictions have adopted the lighting provisions of building codes over the last 20 years. Australia introduced building code measures for commercial buildings in 2006 and they are about to be rationalised and more widely adopted in Europe. Queensland recently introduced a requirement that 40% of the lamps in new houses are CFLs.

This form of regulation generally has the desirable property of setting a performance target and allowing suppliers to determine how best to meet that target, although the prescriptive

⁴⁴ A luminaire is the lamp housing that reflects and directs the light.

nature of the Queensland regulation is an exception. But its effectiveness is constrained by (a) the relatively slow turnover of the building stock, which can take decades, (b) reversion to inefficient products when lamps are replaced, and (c) the need for effective enforcement. Whereas enforcement of MEPS requires the monitoring of relatively few suppliers, enforcement of building codes requires the monitoring of many thousands of builders and building sites.

Many countries, particularly in Europe, are mandating the use of building energy certification (rating) schemes that are designed to provide building users (both new and existing buildings) with information about their energy efficiency. Lighting is one of the energy services included in such whole-of-building ratings and often one of the easiest to upgrade when owners seek a higher rating. Similar measures are under consideration in Australia.

C.3 MARKET TRANSFORMATION PROGRAMS

Market transformation programs usually comprise a mix of information and awareness activities, financial incentives and procurement initiatives, aiming to simultaneously 'create demand' and 'build capacity' for higher efficiency. Program organisers typically seek the cooperation of agents with significant 'clout', such as housing authorities and other property managers in the public sector, energy utilities and large commercial and industrial property interests. The incentive to participate is sharpest where there are there is an associated benefit in the management of loads on congested electricity networks. In residential applications there is more reliance on financial incentives, often outright gifts of CFLs. The aim is to familiarise households with good quality CFLs and increase acceptance.

IEA says that there is increasing use of financial incentive programs by the regulators of energy markets as they seek a better balance of demand reduction and supply augmentation responses to growing energy demands. The NSW Greenhouse Gas Reduction Scheme (GGAS) is an example, providing a financial incentive for electricity retailers to meet their emissions targets by installing CFLs in homes.

The problem with market transformation programs is to ensure that users do not revert to the older technologies as soon as the program is relaxed or the particular energy emergency passes.

C.4 IEA'S KEY FINDING - CURRENT POLICIES ARE INADEQUATE

IEA concludes that existing policy efforts ... *fall far short of delivering the majority of cost-effective saving potentials available through current technology and that a great deal more needs to be done* (IEA 2006: page 480). This is a major global issue: lighting accounts for 19% of electricity use and there is potential to reduce that by 40%. There is a need to define clear policy objectives. IEA identifies the phasing out of inefficient incandescent lamps as one such objective, amongst a raft of objectives covering procedures for determining lighting requirements, awareness of end-users and capacity of suppliers, upgrading of lighting technology, and objectives for emerging economies.

Regarding the replacement of incandescent lamps with CFLs, IEA considers that key factors are to reduce the price differential and preserve the quality of CFLs by eliminating inferior products. IEA noted that the time is approaching for MEPS that effectively ban tungsten filament lamps, given reductions in price, improvements in light quality, and much improved compatibility between CFLs and existing fixtures.

IEA (2006: pages 517-520) recommends adoption of mandatory energy performance requirements for lighting systems in all lighting end-uses⁴⁵. Performance-based regulation means that components that do the same job are subject to the same requirements.

⁴⁵ This is the first of 10 recommendations. The other nine relate to the importance of building codes and their enforcement, building energy performance certification, comprehensive labelling and information activities,

APPENDIX D: MODELLING OF LAMP STOCKS, ENERGY USE AND GREENHOUSE EMISSIONS

This account of the modelling approach is organised under is organised under 3 headings:

- Statement of the accounting framework
- Explanation of the baseline estimates, describing the state of play in 2005
- Explanation of the WPM estimates, as if imposed on the 2005 lighting task

The discussion is mainly in terms of the energy used for lighting. Greenhouse emissions are calculated by applying standard measures of greenhouse intensity to the estimates of energy use.

D.1 ACCOUNTING FRAMEWORK

The production of light is measured in lumens, which is a measure of the amount of visually useful radiation that is emitted by the lamp. The common 60 watt globe emits about 750 lumens, and a 500 watt ‘torchiera’⁴⁶ lamp emits about 9,500 lumens.

The amount of light that a lamp emits over a period of time is measured in lumen-hours. For example, a 60 watt globe that operates for 100 hours per year is said to provide 75,000 lumen-hours/year (= 750 * 100).

Given the amount of light produced, the amount of energy used by the lamp is determined by the energy efficiency of the lamp. This called the ‘efficacy’ of the lamp and is measured as the ratio of the lamp’s light output (lumens) to the lamp’s rate of energy input (wattage). For example, a 60 watt globe has an efficacy 12.5 lumens/watt (= 750/60) and will use 6 kWh of electricity over a year [= 75,000/(12.5 * 1,000)].

These relationships can be expressed as follows.

$$E_i = \frac{G_i}{e_i}$$

where

i denotes lamp *i*

G_i = annual light provided by lamp *i* (kLh : 10³ lumen – hours)

e_i = efficacy of lamp *i* (lumens per watt)

E_i = annual energy used by lamp *i* (kWh)

With the exception of lamps on dimmable circuits, lamps emit light at a fixed rate and use energy at a fixed rate. Given the lighting installation for a particular space, the amount of light provided to a particular space can then be governed by switching some or all of the lights off.

The following terminology is used for the total amount of light emitted by all lights.

selective market-transformation initiatives, removal of barriers to the efficient operation of energy service providers, R&D support and work with developing countries.

⁴⁶ The torchiera lamp is a standing lamp that shines powerful light up onto the ceiling and lights the space with the reflected glow.

$$G = \frac{\sum_{i=1}^N G_i}{1,000,000,000}$$

$$E = \sum_{i=1}^N \frac{G_i}{e_i}$$

where

N = total number of lamps

G = aggregate annual light provided by all lamps (GLh, 10^9 lumen – hours)

E = aggregate annual energy used by all lamps (GWh)

D.2 BASELINE ESTIMATES, 2005

The baseline estimate is that, in 2005, Australians consumed 1,366,182 GLh of light for stationary purposes, that is, excluding vehicle lights. There are four broad categories of stationary lighting task – residential, commercial, industrial and outdoor. The outdoor lighting task includes traffic lights, street lighting and other forms of public lighting, airfield lighting, billboards and parking lots).

Table D.1 shows the corresponding estimates of energy use and greenhouse emissions, and the per-capital equivalents.

These estimates have been obtained by adapting a US model of the lighting task and lighting energy use⁴⁷. This was a 4-stage process.

Table D.1 Baseline estimates of lighting output and electricity use, 2005

	Aggregate	Per capita
<i>Production of light</i>	<i>GLh</i>	<i>MLh</i>
Residential	90,142	4.5
Commercial	744,632	37.2
Industrial	297,698	14.9
Outdoor	233,710	11.7
Total	1,366,182	68.3
<i>Lighting electricity use</i>	<i>GWh</i>	<i>kWh</i>
Residential	5,146	257
Commercial	15,715	786
Industrial	4,636	232
Outdoor	2,736	137
Total	28,233	1,412
<i>Greenhouse emissions</i>	<i>Mt</i>	<i>kg</i>
Residential	4.70	235
Commercial	14.35	718
Industrial	4.23	212
Outdoor	2.50	125
Total	25.78	1,289

⁴⁷ This was the approach adopted by the International Energy Agency (IEA) for its recent report on the global lighting task and policies for energy efficient lighting (IEA 2006).

Stage 1 - model Australian lighting task on an 'equivalent US' basis

We first calculated the Australian lighting task on an 'equivalent US' basis, as follows:

1. We obtained the US 'sectoral matrices' for each of the 4 sectors – residential, commercial, industrial and outdoor. These matrices are estimates of per-building averages of the number of lamps, average daily operating hours, average wattage and average lamp efficacy, but broken down by lamp type. There are 35 lamp types, 7 incandescent, 16 fluorescent, 6 high intensity discharge types and 2 solid state types. (There are no outdoor buildings of course and the outdoor matrix contains the total for outdoor lamps.)
2. We obtained the US estimates of total buildings in each sector - 107 million residential, 4.7 million commercial, 0.23 million industrial and 1 outdoor 'building'.
3. Total US light production and lighting energy use can be calculated from items 1 and 2. These aggregates are 38,445,000 GLh/year of light and 765,000 GWh/year of electricity. The per-capita equivalents are 1,200 MLh/year and 2,400 kWh/year.
4. We reduced the 35 lamp categories to 11 categories, largely by combining the linear fluorescent categories onto one, and recalculated the sectoral matrices to ensure the new values for average hours, wattage and efficacy were appropriately weighted. We cross-checked by reproducing the US aggregates. The resulting categories are as follows:

INCANDESCENT

Tungsten filament - non-reflector
Tungsten filament - reflector
MV tungsten halogen - non-reflector
MV tungsten halogen - reflector
ELV tungsten halogen - non-reflector
ELV tungsten halogen - reflector

FLUORESCENT

Linear
CFL - non-reflector
CFL - reflector

OTHER

HID
SSL

5. AGO's technical advisor, Steve Beletich, advised on appropriate adjustments the US estimates of lamp efficacy, allowing for the fact that residential voltage is lower in the US (120 V compared with 240 V in Australia) and some lamps are more efficient at lower voltages. His advice was informed by a review of lamp efficacies for a sample of lamps on the Australian market, using both catalogue sources and the results of an on-going testing program commissioned by the AGO. This work is reported in a technical report to the AGO (Beletich and Associates, 2007).
6. It is then a relatively simple matter to calculate the Australian lighting task on an 'equivalent US' basis.
 - o The average US residential lighting task was married with ABS projection for the number of Australian households, but adjusted to take account of minor differences between the household and dwelling counts⁴⁸.
 - o The sectoral matrices for the commercial and industrial sectors were recalibrated to be expressed as amounts per million square meters of floor-

⁴⁸ There are somewhat more dwellings than households. Each census records about 10% more dwellings (unoccupied) than households.

space, rather than 'per building' as in the US model. This is because we have projections for Australia's stock of commercial and industrial floor-space, documented in a RIS published by the Australian Buildings Code Board (ABCB 2005). The average US commercial and industrial lighting tasks were then married with these projections.

- The Australian outdoor lighting task was set at one fifteenth of the corresponding US task, which is roughly in proportion to population.

However, it is apparent that the 'equivalent US' estimate is too high. Consider that:

- A series of energy end-use studies in the late 1980s and early 1990s estimated Australian residential lighting energy at 500-600 kWh/year⁴⁹. The corresponding US figure is 1,946 kWh and, even allowing for considerable growth since the end-use studies were conducted, seems too high.
- The US study estimates that there are 43 lamps in the average US dwelling, including 34 of the tungsten filament type. Intuitively, those figures are too high for the average Australian home of 3 or 4 bedrooms. There is supporting data. On average, CFL replacement programs are finding about 20 tungsten filament lamps in the average Australian home⁵⁰ and that is likely to be an overestimate because participation in such programs is more attractive to households with large lighting tasks and because it more difficult for operators to gain access to the smaller dwellings in apartment buildings. Also, most estimates for the more developed non-US economies are in the range 15-30 lamps per dwelling and average about 24 lamps per dwelling⁵¹.
- A 1999 study commissioned by the AGO (EMET 1999) provides estimates of the lighting energy used in the commercial building sector, with projections to 2010. Interpolation suggests a figure of about 640 kWh per capita in 2007, compared with a US figure of 1,230 kWh per capita.
- There may similar differences for the industrial and outdoor sectors. These are of less significance in the present context, since they account for small proportion of the lamps under consideration, for example, about 3% of the lamp-hours for lamps of the tungsten filament type.

While we know that that the 'equivalent US' estimate is too high, there is currently no objective data on which to base an Australian estimate. It is necessary to rely on a combination of expert judgment and scraps of evidence that can be gleaned from lamp suppliers and installers, and then to reconcile the tally across all sectors with the import data and with data from comparable countries.

Stage 2 – develop Australian 2005 residential model

Table D.2 presents the sectoral matrix for the Australian residential sector. For the average dwelling it gives an account of the number of the average number of lamps, hours of operation, efficacy and wattage. Light output and energy input are derived from these variables and are reported in the last two columns. The key matters of judgment were determined in stages, as follows:

1. It is assumed that there were 20 lamps in the average household. Of these, the average dwelling had 2.6 lamps on dimmer circuits and 17.4 lamps on switch circuits.
2. Of the 2.6 lamps on dimmer circuits, it is assumed that 94% were ELV halogen, 4% were tungsten filament and 2% were MV tungsten halogen.
3. Of the 17.4 lamps on switch circuits it is assumed that

⁴⁹ This data is reviewed in appendix G of the AGO commissioned baseline study of residential energy use (EES 1999).

⁵⁰ This estimate is based on informal advice from staff of the NSW Greenhouse Gas Reduction Scheme.

⁵¹ This observation is based on a review of the data in Bertoldi *et al* 2006.

- 2.4 were linear fluorescent and one is a CFL. These settings are suggested by ABS estimates (Cat 4602.0) of the average number of rooms that had fluorescent and energy saving lights, but with the further assumption that there were two such lamps per room.
 - There were 1.75 tungsten halogen lamps, .5 on mains voltage and 1.25 on low voltage.
 - The remaining lamps (12.25 per dwelling) are tungsten filament.
4. The proportion of reflector lamps was determined as follows: tungsten filament – 9%; MV tungsten halogen – 60; ELV tungsten halogen – 70%; CFL 5%.
 5. The average residential duty hours is 1.9 hours per day, with tungsten filament lamps on 1.5 hours and CFLs assumed to be on relatively high duty of 2.75 hours/day. Tungsten halogen lamps were put at intermediate duty, 1.85 hours/day for mains voltage lamps and 2.25 hours for ELV lamps.

It is assumed that the average household had 3 lamps that are out of scope, 2.4 linear fluorescent lamps and 0.6 tungsten filament lamps with 150 or more watts.

The key points of difference between the US and Australian models are the number of lamps and the average hours of operation. There are 53% fewer lamps in the Australian household – 20 in Australia compared with 43 in the US. The average hours of operation are 5% lower, at 1.9 hours per day in Australia compared with 2.0 hours per day in the US.

Lighting energy consumption is estimated at 684 kWh for the average Australian dwelling in 2005. This is somewhat higher than the estimates from the 15 years ago, which were in the region of 500-600 kWh per year.

Table D.2 Residential lighting matrix: average Australian dwelling, 2005

	<i>Number of lamps/ELVCs</i>	<i>Average lamp hours</i>	<i>Efficiency (lamps, lumens/w) (ELVCs, %)</i>	<i>Average wattage</i>	<i>Average light (kLh)</i>	<i>Average energy (kWh)</i>
SWITCH CIRCUITS (per dwelling)						
Tungsten filament - non-reflector	11.17	1.50	10.7	62.8	4,118.5	383.9
Tungsten filament - reflector	1.06	1.50	9.7	79.5	449.4	46.2
MV tungsten halogen - non-reflector	0.20	1.80	12.3	69.5	112.5	9.2
MV tungsten halogen - reflector	0.30	1.80	11.7	65.8	153.2	13.0
LV tungsten halogen - non-reflector	0.99	2.25	13.7	20.0	223.1	16.3
LV tungsten halogen - reflector	0.26	2.25	14.1	50.0	150.6	10.7
Linear	2.40	2.75	70.0	30.0	5,058.9	72.3
CFL - non-reflector	0.95	2.75	51.2	12.5	608.7	11.9
CFL - reflector	0.05	2.75	32.0	24.1	38.8	1.2
HID	-	-	-	-	-	-
SSL	-	-	-	-	-	-
ELVCs for reflector lamps	0.25	2.25	84.3%	93.7	-	3.0
ELVCs for non-reflector lamps	0.25	2.25	83.3%	62.5	-	2.1
All lamps	17.38	1.81	19.2	49.7	10,914	570
DIMMER CIRCUITS (per dwelling)						
Tungsten filament - non-reflector	0.06	2.25	9.4	56.7	24.7	2.6
Tungsten filament - reflector	0.06	2.25	8.7	70.6	28.2	3.2
MV tungsten halogen - non-reflector	0.02	2.25	10.5	58.8	11.3	1.1
MV tungsten halogen - reflector	0.03	2.25	10.5	58.7	17.0	1.6
LV tungsten halogen - non-reflector	0.11	2.25	12.3	17.8	19.8	1.6
LV tungsten halogen - reflector	2.34	2.25	11.8	42.4	963.9	81.4
Linear	-	-	-	-	-	-
CFL - non-reflector	-	-	-	-	-	-
CFL - reflector	-	-	-	-	-	-
HID	-	-	-	-	-	-
SSL	-	-	-	-	-	-
ELVCs for reflector lamps	0.03	2.25	79.8%	88.3	-	0.4
ELVCs for non-reflector lamps	2.25	2.25	78.7%	55.9	-	22.0
All lamps	2.62	2.25	9.3	53.0	1,065	114

	<i>Number of lamps/ELVCs</i>	<i>Average lamp hours</i>	<i>Efficiency (lamps, lumens/w) (ELVCs, %)</i>	<i>Average wattage</i>	<i>Average light (kLh)</i>	<i>Average energy (kWh)</i>
ALL CIRCUITS (per dwelling)						
Tungsten filament - non-reflector	11.22	1.5	10.7	62.8	4,143.2	386.5
Tungsten filament - reflector	1.12	1.54	9.7	78.9	477.5	49.5
MV tungsten halogen - non-reflector	0.22	1.85	12.1	68.2	123.8	10.3
MV tungsten halogen - reflector	0.34	1.85	11.6	64.9	170.2	14.7
LV tungsten halogen - non-reflector	1.10	2.25	13.6	19.8	242.9	17.9
LV tungsten halogen - reflector	2.60	2.25	12.1	43.1	1,114.5	92.1
Linear	2.40	2.75	70.0	30.0	5,058.9	72.3
CFL - non-reflector	0.95	2.75	51.2	12.5	608.7	11.9
CFL - reflector	0.05	2.75	32.0	24.1	38.8	1.2
HID					-	-
SSL					-	-
ELVCs for reflector lamps	0.28	2.25	83.9%	93.2	-	3.4
ELVCs for non-reflector lamps	2.50	2.25	79.2%	56.6	-	24.1
All lamps	20.0	1.9	17.5	50.2	11,978	684

Stage 3 – develop Australian non-residential models

Table D.3 presents the sectoral matrices for the three non-residential sectors – commercial, industrial and outdoor.

These settings have been obtained by applying adjustment factors to the US model, designed to reduce the sectoral estimates of lighting energy to plausible levels, particularly for the commercial sector. Most of the adjustment was achieved by reducing the average number of lamps per square meter of floor-space and the average hours of operation – to 80% of their US levels. These adjustments are arbitrary but we note that Australia is one of several countries with industry standards that recommend relatively low illuminance levels (IEA 2006: page 85). Recommended illuminance levels in the US tend to be ‘middle of the range’ compared with other countries.

We reduced the hours for tungsten filament lamps to 64% of the US level. One implausible feature of the US model is that the tungsten filament lamps have duty hours that are very similar to other types of lamps. Intuitively, it seems reasonable to expect that the relatively inefficient types of lamp (like tungsten filament) will tend to be restricted to tasks with lower duty hours.

We also adjusted the floor-space estimate and the average lamp wattages, reducing both to 90% of the US level.

The effect of these adjustments is to preserve the mix of non-residential lighting that has been estimated for the US but to restrict overall numbers and usage to more plausible levels. The Australian figure for the commercial sector is about 797 kWh per capita, which is comparable with the estimate of 640 kWh implied by the EMET study of 1999.

Table D.3 Non-residential lighting matrices: 2005

	<i>Number of lamps/ELVCs</i>	<i>Average lamp hours</i>	<i>Efficiency (lamps, lumens/w) (ELVCs, %)</i>	<i>Average wattage</i>	<i>Average light (kLh)</i>	<i>Average energy (kWh)</i>
COMMERCIAL (per million square meters of floor-space)						
Tungsten filament - non-reflector	32,882	6.7	10.9	77.7	67,913,201	6,221,545
Tungsten filament - reflector	11,705	6.2	10.2	93.6	25,362,560	2,482,511
MV tungsten halogen - non-reflector	1,414	7.6	12.4	91.3	4,437,868	357,914
MV tungsten halogen - reflector	1,696	6.2	11.8	70.0	3,176,980	269,042
LV tungsten halogen - non-reflector	3,128	8.2	13.7	20.0	2,581,590	188,148
LV tungsten halogen - reflector	14,259	8.2	14.1	50.0	30,223,073	2,144,303
Linear	154,809	7.7	70.0	40.2	1,220,396,565	17,434,237
CFL - non-reflector	16,934	6.8	53.2	15.0	33,705,025	633,395
CFL - reflector	546	6.6	26.6	14.4	503,247	18,926
HID	3,824	8.1	58.2	363.6	238,708,088	4,100,361
SSL	219	18.4	18.9	4.5	125,066	6,604
ELVCs for reflector lamps	792	8.2	83.9%	94.2	-	36,201
ELVCs for non-reflector lamps	13,711	8.2	82.8%	62.8	-	445,367
All lamps	241,415	7.5	47.4	52.3	1,627,133,264	34,338,553
INDUSTRIAL (per million square meters of floor-space)						
Tungsten filament - non-reflector	885	11.2	9.2	83.5	2,767,073	301,538
Tungsten filament - reflector	792	8.6	10.1	91.8	2,307,369	227,518
MV tungsten halogen - non-reflector	1,242	11.2	12.4	57.6	3,616,761	291,693
MV tungsten halogen - reflector	3,725	8.6	11.8	70.0	9,638,193	816,210
LV tungsten halogen - non-reflector	-	-	-	-	-	-
LV tungsten halogen - reflector	-	-	-	-	-	-
Linear	171,813	10.8	70.0	43.3	2,043,187,562	29,188,394
CFL - non-reflector	1,564	9.4	57.8	20.3	6,262,496	108,390
CFL - reflector	130	6.1	25.3	12.6	93,031	3,683
HID	8,733	11.1	58.2	382.5	789,264,704	13,557,437
SSL	39	18.7	18.9	4.5	22,770	1,202
ELVCs for reflector lamps	-	-	-	-	-	-
ELVCs for non-reflector lamps	-	-	-	-	-	-
All lamps	188,922	10.7	64.2	60.2	2,857,159,958	44,496,065

	<i>Number of lamps/ELVCs</i>	<i>Average lamp hours</i>	<i>Efficiency (lamps, lumens/w) (ELVCs, %)</i>	<i>Average wattage</i>	<i>Average light (kLh)</i>	<i>Average energy (kWh)</i>
OUTDOOR (all of Australia)						
Tungsten filament - non-reflector	758,341	5.1	11.6	102.5	1,691,254,160	145,261,791
Tungsten filament - reflector	98,917	4.6	10.5	100.0	174,196,578	16,637,002
MV tungsten halogen - non-reflector	129,374	5.1	13.6	80.0	262,510,361	19,341,876
MV tungsten halogen - reflector	194,060	4.6	13.1	100.0	427,485,198	32,639,416
LV tungsten halogen - non-reflector	-				-	-
LV tungsten halogen - reflector	-				-	-
Linear	126,267	8.6	60.8	134.9	3,265,798,036	53,732,068
CFL - non-reflector	6,313	8.6	57.8	20.3	23,304,198	403,345
CFL - reflector	-				-	-
HID	3,661,000	9.0	92.3	204.3	227,861,545,657	2,467,910,413
SSL	6,400	5.6	20.0	13.5	3,532,032	176,602
ELVCs for reflector lamps					-	-
ELVCs for non-reflector lamps					-	-
All lamps	4,980,672	8.07	85.4	186.6	233,709,626,220	2,736,105,512

Stage 4 – check for consistency with import and sales data

Given an account of the lamp stock, it is possible to estimate the annual re-lamping task and compare that with ABS estimates of annual lamp imports. The only additional data required are estimates of average lamp life. This exercise is reported in table D.4.

Inspect table D.4 to see that we have extracted estimates of total lamp hours from the stock model and, by dividing by typical lamp lives, have obtained estimates of the annual re-lamping task. These calculations suggests that there would need to be annual lamp imports of 138.9 million to maintain the estimated stock of incandescent and fluorescent lamps, including 93.5 million lamps of the tungsten filament type.

Lamp imports have averaged 135.5 million/year over the last several years, close to the re-lamping requirement of the stock model. The mix of lamps is also about right, except that there is noticeable deficit for tungsten-filament lamps of the non-reflector type, and an off-setting surplus in the imports of CFLs. This is because the mix of lamps is changing. Specifically, tungsten filament lamps are not being replaced at the rate that is needed to maintain their share of the lamp stock, and CFLs are being installed at a rate that will increase their share of the lamp stock.

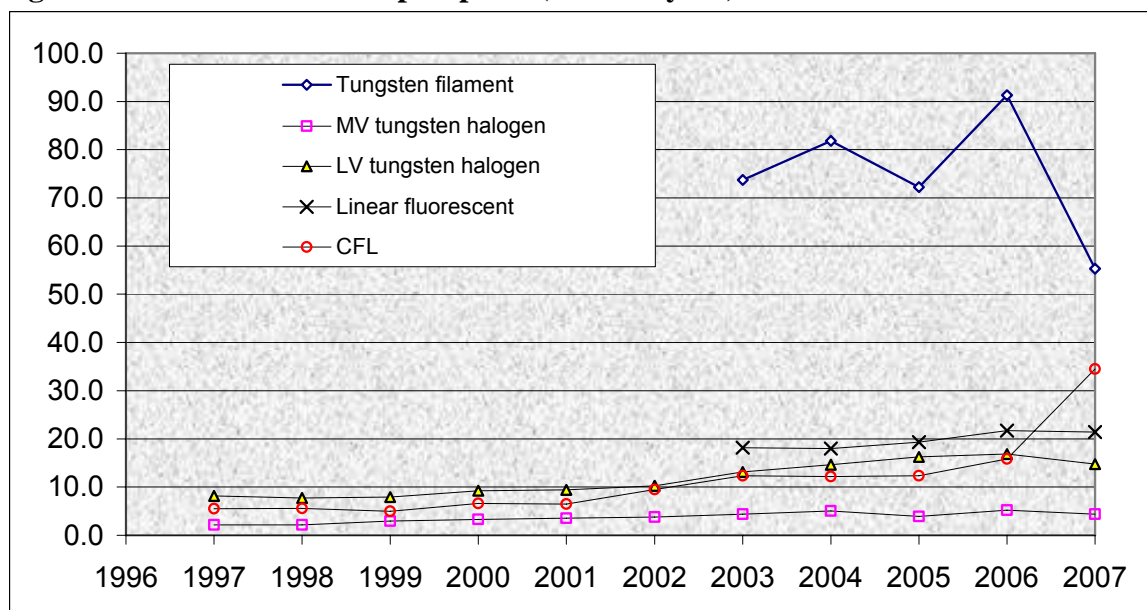
Figure D.1 shows trends in lamp imports over the last decade. (Note that the series for tungsten filament and linear fluorescent lamps is for the period 2003 to 2006. There was significant domestic production of these lamps prior to 2003 which means that the earlier import data is misleading.) There has been strong growth of the three minor technologies over this period, with average annual growth of 7.4% for both MV and ELV tungsten halogen lamps and 19.4% for CFLs. This suggests that there should be surplus imports for the tungsten halogens as well. However, close examination of chart D.1 shows tungsten halogen imports have flattened over recent years and that CFL imports have accelerated at the same time.

On this basis, we consider that our lighting stock model is consistent with the import data. It should be noted that we kept an eye on this reconciliation task and have modified the stock parameters in a manner calculated to eliminate obvious inconsistencies.

Table D.4 Comparison of re-lamping task with imports

	Annual lamp hours (millions)	Average lamp life (hrs)	Number of lamps (millions)		
			Annual re-lamping task	Annual lamp imports (Av. 2004 to 06)	Annual import deficit
Tungsten filament - non-reflector	84,810	1,000	84.81	74.14	-10.7
Tungsten filament - reflector	17,284	2,000	8.64	7.64	-1.0
MV tungsten halogen - non-reflector	3,478	2,000	1.74	1.89	0.1
MV tungsten halogen - reflector	5,217	2,000	2.61	2.84	0.2
ELV tungsten halogen - non-reflector	11,103	3,000	3.70	3.80	0.1
ELV tungsten halogen - reflector	35,703	3,000	11.90	12.10	0.2
Linear fluorescent	287,337	15,000	19.16	19.66	0.5
CFL	28,075	6,000	4.68	13.44	8.8
Total	473,008		137.24	135.51	-1.7

Source: AGO lamp stock model for re-lamping task. Import data from ABS

Figure D.1 Australian lamp imports (millions/year)

Source: ABS data consultancy, but with partial data for 2007 (to October 2007) converted to an annual figure on a *pro rata* basis.

D.3 'WITH SPECIFIC MEASURES' (WSM) ESTIMATES, 2005

Table D.4 reports estimates of how the 2005 lighting task would have been carried out if users had been required to comply with the proposed MEPS in 2005. The efficacy and re-lamping assumptions are those described in the sections of the RIS dealing with user impacts – see section 4.4. The figuring is hypothetical, since it ignores the fact that the implementation of MEPS will take time, but it provides a snapshot of the major impacts.

Table D.4 WSM estimates of lighting output and energy use, 2005

	Aggregate	Per capita	Change relative to baseline	
			Aggregate	%
<u>Lighting energy use</u>	<u>GWh</u>	<u>kWh</u>	<u>GWh</u>	
Residential	3,472	174	-1,674	-32.5%
Commercial	14,051	703	-1,663	-10.6%
Industrial	4,585	229	-52	-1.1%
Outdoor	2,692	135	-44	-1.6%
Total	24,800	1,240	-3,433	-12.2%
<u>Greenhouse emissions</u>	<u>Mt</u>	<u>kg</u>		
Residential	3.17	159	-1.53	-32.5%
Commercial	12.83	642	-1.52	-10.6%
Industrial	4.19	209	-0.05	-1.1%
Outdoor	2.46	123	-0.04	-1.6%
Total	22.65	1,132	-3.14	-12.2%

APPENDIX E: TRIAL STATEMENT OF ABATEMENT VALUATIONS THAT WILL BE INCLUDED IN FUTURE IMPACT ASSESSMENTS

The potential impact of an Australian emissions trading scheme (ETS) on the benefit-cost ratio is assessed in this appendix. Hence the RIS should take into account the increased benefits due to the avoided cost of carbon permits for electricity generators, which will result from the proposed MEPS reducing the consumption and generation of electricity at the margin. These valuations were trialled in an earlier RIS (EnergyConsult 2007) dealing with proposed MEPS for chillers. The same methodology is applied here, with the results reported in table E.1.

Table E.1 Abatement valuations for Australia

Discount rate	0%	5%	7.5%	10%
Carbon permit price = \$0/t CO₂-e				
Total Costs (\$M)	No capital costs			
Total Benefits (\$M)	3,988	2,630	2,167	1,802
Net Benefits (\$M)	3,988	2,630	2,167	1,802
Cumulative Mt CO ₂ -e Abatement (2008 -2020)	28.5			
Carbon permit price = \$10/t CO₂-e				
Value of greenhouse abatement (\$M)	284.6	187.8	154.9	128.8
Net Benefits (\$M) with greenhouse abatement included	4,272.1	2,817.5	2,322.1	1,931.1
Carbon permit price = \$20/t CO₂-e				
Value of greenhouse abatement (\$M)	569.1	375.6	309.7	257.7
Net Benefits (\$M) with greenhouse abatement included	4,556.7	3,005.4	2,476.9	2,060.0

APPENDIX F: BREAKDOWN OF IMPACTS BY JURISDICTION

Impacts have been allocated to jurisdictions in proportion to their population, but using each jurisdictions electricity tariffs to value the energy savings.

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
WoSM energy use (GWh)								
2000	8,559	6,393	5,073	2,110	2,593	659.2	216.9	421.6
2001	8,700	6,499	5,156	2,144	2,636	670.0	220.5	428.5
2002	8,845	6,607	5,242	2,180	2,680	681.2	224.1	435.7
2003	8,991	6,717	5,329	2,216	2,724	692.5	227.8	442.9
2004	9,138	6,827	5,416	2,252	2,769	703.8	231.6	450.1
2005	9,285	6,936	5,503	2,289	2,813	715.1	235.3	457.4
2006	9,382	7,013	5,624	2,303	2,864	719.7	238.6	462.6
2007	9,475	7,087	5,743	2,317	2,913	723.7	241.8	467.6
2008	9,570	7,163	5,865	2,330	2,963	727.8	245.5	472.7
2009	9,665	7,238	5,988	2,344	3,014	732.2	248.7	477.3
2010	9,758	7,314	6,112	2,357	3,064	736.2	251.9	482.3
2011	9,852	7,389	6,238	2,370	3,115	740.0	255.4	486.8
2012	9,944	7,463	6,365	2,382	3,166	743.5	258.5	491.3
2013	10,036	7,537	6,492	2,395	3,216	746.6	261.7	495.8
2014	10,127	7,611	6,620	2,406	3,267	749.7	264.8	500.3
2015	10,218	7,685	6,749	2,418	3,317	752.8	268.3	504.7
2016	10,309	7,758	6,880	2,429	3,368	755.6	271.4	509.2
2017	10,398	7,831	7,010	2,440	3,419	758.0	274.5	513.3
2018	10,487	7,904	7,141	2,450	3,469	759.8	277.7	517.5
2019	10,576	7,976	7,272	2,461	3,520	761.9	280.8	521.7
2020	10,664	8,048	7,403	2,471	3,570	763.8	283.9	525.8
WSM energy use (GWh)								
2000	8,559	6,393	5,073	2,110	2,593	659.2	216.9	421.6
2001	8,700	6,499	5,156	2,144	2,636	670.0	220.5	428.5
2002	8,845	6,607	5,242	2,180	2,680	681.2	224.1	435.7
2003	8,991	6,717	5,329	2,216	2,724	692.5	227.8	442.9
2004	9,138	6,827	5,416	2,252	2,769	703.8	231.6	450.1
2005	9,285	6,936	5,503	2,289	2,813	715.1	235.3	457.4
2006	9,382	7,013	5,624	2,303	2,864	719.7	238.6	462.6
2007	9,475	7,087	5,743	2,317	2,913	723.7	241.8	467.6
2008	9,570	7,163	5,865	2,330	2,963	727.8	245.5	472.7
2009	9,463	7,088	5,867	2,294	2,952	716.7	243.5	467.3
2010	9,275	6,952	5,816	2,240	2,915	699.4	239.5	458.4
2011	9,199	6,899	5,832	2,212	2,911	690.6	238.6	454.5
2012	9,168	6,880	5,877	2,195	2,921	684.9	238.5	452.9
2013	9,149	6,872	5,929	2,182	2,935	680.1	238.7	452.0
2014	9,185	6,904	6,015	2,181	2,966	679.5	240.3	453.8
2015	9,257	6,963	6,126	2,189	3,009	681.4	243.2	457.3
2016	9,346	7,034	6,248	2,201	3,057	684.4	246.2	461.6
2017	9,433	7,105	6,370	2,212	3,105	687.1	249.2	465.7
2018	9,521	7,176	6,493	2,223	3,152	689.2	252.2	469.8
2019	9,607	7,246	6,615	2,234	3,200	691.7	255.2	473.9
2020	9,693	7,316	6,738	2,245	3,247	693.9	258.2	478.0
Energy savings (GWh)								
2000-07	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0.0	0.0	0.0
2009	202	151	121	50	62	15.6	5.1	10.0
2010	483	361	296	117	150	36.7	12.4	23.9
2011	653	489	407	158	204	49.4	16.8	32.3
2012	777	582	488	187	244	58.6	20.1	38.4
2013	886	665	563	213	281	66.5	23.0	43.8
2014	941	707	604	225	300	70.3	24.5	46.5
2015	961	722	624	229	309	71.4	25.1	47.5

2016	963	724	632	229	311	71.2	25.2	47.6
2017	965	726	640	228	314	70.9	25.3	47.6
2018	967	728	648	227	317	70.6	25.5	47.7
2019	969	730	656	227	320	70.3	25.6	47.8
2020	971	732	665	226	322	69.9	25.7	47.9
Emissions abatement (kt CO₂-e)								
2000-07	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0.0	0.0	0.0
2009	199	165	113	55	55	12.0	5.3	9.8
2010	471	389	277	128	134	28.5	12.4	23.3
2011	629	531	378	174	170	38.5	16.7	31.1
2012	750	643	454	210	202	42.6	20.1	37.0
2013	838	721	507	230	231	48.7	23.4	41.4
2014	905	786	561	246	252	51.6	24.6	44.7
2015	883	757	569	232	261	52.8	26.1	43.6
2016	877	741	569	227	266	52.9	24.8	43.3
2017	852	720	572	225	256	53.0	24.5	42.1
2018	858	724	566	223	255	52.9	24.3	42.4
2019	853	704	567	227	258	52.8	24.7	42.1
2020	841	685	578	216	261	52.7	25.1	41.5
Change in annualised LCC (\$M)								
2000-07	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0.0	0.0	0.0
2009	-29	-19	-13	-8	-7	-1.5	-0.6	-1.0
2010	-68	-45	-33	-18	-17	-3.6	-1.5	-2.5
2011	-92	-61	-45	-25	-24	-4.8	-2.0	-3.4
2012	-109	-73	-54	-29	-28	-5.8	-2.4	-4.0
2013	-125	-84	-62	-33	-33	-6.6	-2.8	-4.6
2014	-133	-89	-67	-35	-35	-7.0	-3.0	-4.9
2015	-135	-91	-69	-36	-36	-7.1	-3.0	-5.0
2016	-136	-91	-70	-36	-36	-7.1	-3.1	-5.0
2017	-136	-91	-71	-35	-36	-7.1	-3.1	-5.0
2018	-136	-91	-72	-35	-37	-7.0	-3.1	-5.0
2019	-136	-91	-73	-35	-37	-7.0	-3.1	-5.0
2020	-135	-91	-73	-35	-37	-6.9	-3.1	-5.0