Report No: 2005/12

NATIONAL APPLIANCE AND EQUIPMENT ENERGY EFFICIENCY PROGRAM

Minimum Energy Performance Standards

COMPACT FLUORESCENT LAMPS

AN INITIATIVE OF THE MINISTERIAL COUNCIL ON ENERGY FORMING PART OF THE NATIONAL FRAMEWORK FOR ENERGY EFFICIENCY AND NEW ZEALAND ENERGY EFFICIENCY AND CONSERVATION STRATEGY

Minimum Energy Performance Standards - Compact Fluorescent Lamps

Compact Fluorescent Lamps (CFLs) are a single capped fluorescent lamp and work much like a standard fluorescent lamp. They consist of a short glass tube or globe filled with a gas that produces light when high voltage electricity from a ballast flows through it. The ballast may be either magnetic (in which case a starter is required) or electronic. When the ballast is permanently attached to the tube, it is known as a self-ballasted or integral CFL and is a direct replacement for standard incandescent lamps. Two-part CFLs have two or four pins on the bottom that plug into a socket on the ballast; thus the lamp can be replaced without replacing the ballast, which generally has a life expectancy five times longer than the lamps.

The international market for CFLs has expanded rapidly in recent years. It is now estimated that global sales of self-ballasted CFLs will reach 550 million units in 2005, responsible for 12 TWh of electricity consumption worldwide. Based on existing growth rates, these figures will nearly double by the year 2012.

Here in Australia the situation is similar, with sales of CFLs doubling since 1999 to over 13.5 million in 2004. At the same time the average imported cost of CFLs has dropped to around $1.80 per unit in 2004 from a high of $3.20 in 2000.

While the distribution of CFL sources has been evenly spread over a wide variety of countries up to 1995, since 1999 China has emerged as the major countries of origin supplying over 60% of the Australian market.

Self-ballasted CFLs provide a good energy efficiency solution for the replacement of general service incandescent lamps, particularly as CFLs become cheaper. However, moves by governments, utilities and energy efficiency agencies to encourage consumers to replace incandescent lamps with CFLs are hampered by issues of product quality. In particular it appears some consumer expectations are not met, particularly in respect to claims regarding lamp lifetimes. The danger is that once consumer confidence has been damaged, it will be extremely difficult to re-build, and this will have serious impacts on the potential to decrease energy consumption from the lighting sector.

Price alone appears no indicator of quality, therefore Australian consumers currently have no means to easily distinguish between the performances of competing products. Significantly, there is also reluctance on the part of those agencies in Australia which might actively encourage the use of CFLs to do so without the knowledge that they are supporting better performing products.

STAKEHOLDER COMMENT

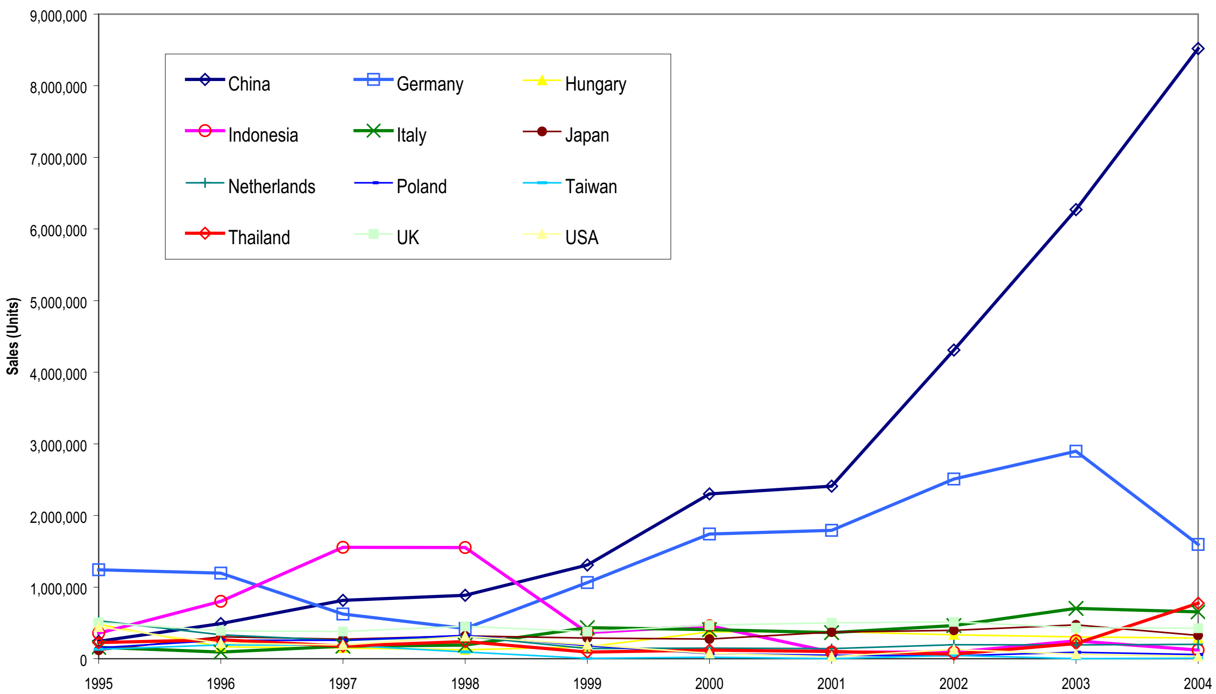
NAEEEC invites comments from any interested person or organisation on the measures proposed in this study. Comments should be directed to energy.rating@greenhouse.gov.au by 30 June 2005. Information sessions for industry participants can be arranged during the comment period if requested.

Electronic copies of profiles and full reports released for public discussion can be obtained from www.energyrating.gov.au

This issue has been addressed in several overseas countries through the implementation of endorsement programs specifying the performance standards for the key criteria determining quality products. There are currently at least 12 national or regional endorsement programs for CFLs around the world. In addition, MEPS programs prohibiting the sale of low efficiency CFLs have been implemented in China, Mexico, South Korea and Japan.

As a result, NAEEEC believes that Australia should adopt both MEPS and an endorsement label, which is supported by Lighting Council Australia in the ten year strategy for efficient lighting, “Greenlight Australia”. NAEEEC proposes to specify standards for a number of key performance criteria in addition to energy efficiency, focusing initially on self-ballasted CFLs.

Country of Origin for CFL Imports to Australia (ABS 2004/5)



INTERNATIONAL HARMONISATION

The Australian Government has a policy of matching world’s best practice, where feasible. For self-ballasted CFLs the most stringent MEPS and endorsement label energy performance levels are those used in China, although other programs have more stringent levels for other criteria.

China is also the source of the majority of CFLs sold in Australia, so harmonising with the Chinese programs would mean that lamps could be tested at source in China to determine their eligibility in Australia. This would reduce the testing requirements on Australian suppliers and the enforcement burden on Australian regulators. Therefore matching the Chinese performance levels is a logical choice for the Australian programs.

While this is the best option currently, international efforts to rationalise and harmonise test and performance standards may require some fine-tuning of the Australian proposals so that we align.

This process will be launched at a special session hosted by Australia at the Right Lights 6 Conference in Shanghai in May 2005. It is envisaged that if supported by sufficient countries, harmonisation will be achieved over the following three years. Full international harmonisation will substantially enhance the performance of CFLs everywhere, and support the initiatives undertaken in each individual country, including Australia. The timing is such that there is no need to delay proceeding with Australia's plans in order to ensure that we are part of this global initiative.

NAEEEC PLAN

NAEEEC proposes to introduce efficiency regulations for compact fluorescent lamps, with key components as follows:

1) MEPS and an endorsement label for self-ballasted CFLs based on the existing Australian test method "AS/NZS 60969 (2001): Self ballasted lamps for general lighting services – Performance requirements";

2) Performance levels will be aligned with China (see below), on the understanding that these may change during time taken to develop the Australian program;

3) Industry will be advised that the levels selected for the endorsement label are likely to be adopted as future MEPS levels 3-4 years after the implementation of the first MEPS;

4) The international harmonisation of test and performance standards will be pursued at the Right Light 6 conference in Shanghai in May 2005, and further if supported by sufficient numbers of other countries;

5) Market research will be undertaken on consumer expectations and experiences with respect to CFLs (the AGO has commissioned a study to be undertaken in March/April 2005);

6) Industry and other stakeholders will be consulted, including the US EPA, on whether the endorsement label used should be either Energy Star, TESAW or some other option such as ELI;

7) Consideration will be given to the introduction of MEPs and an endorsement label for pin-type CFLs within 3 years;

8) Detailed recommendations for specifications are shown below.

Summary of recommended specifications for self-ballasted CFLs

	MEPS Self-ballast		High Efficiency Self-ballast	
Efficiency level	**L/w**		**L/w**	
Rating (W)	Colour temperature: > 4400		Colour temperature: > 4400	
5 - 8	36		46	
9 - 14	44		54	
15 - 24	51		61	
25 - 60	57		67	
Rating (W)	Colour temperature: < 4400		Colour temperature: < 4400	
5 - 8	40		50	
9 - 14	48		58	
15 - 24	55		65	
25 - 60	60		70	
Sample:	*10: at least 8 must comply*		*10: at least 8 must comply*	
Test Methods	AS/NZS 60969 (2001)		AS/NZS 60969 (2001)	
Lumen Maintenance	After 2000h testing lumen maintenance (I_m) must be ≥ 80% $I_{(100)}$.		After 2000h testing lumen maintenance (I_m) must be ≥ 80% $I_{(100)}$.	
	Note: the test is conducted with lamps switched off for 15 minutes after every 2 hours 45 minutes on.		Note: the test is conducted with lamps switched off for 15 minutes after every 2 hours 45 minutes on.	
Sample:	*10: at least 8 must comply*		*10: at least 7 must comply*	
Rated Average Lifetime	> 6000 hours		≥ 10,000 hours	
CFL Lifetime Claims	CFL Rated Lifetime		Lifetime Claim	
	6,000 hours		4 years	
	8,000 hours		5 years	
	10,000 hours		7 years	
	12,000 hours		8 years	
	15,000 hours		10 years	
Lamp Position	No specific requirement		Declaration of orientation(s) which cause > 5% luminous flux output is required	
Power Factor	0.5		0.9	
Colour rendering	No specific requirement		> 4400: CRI ≥ 80 2700-4400: CRI ≥ 82 < 2700: CRI ≥ 84	
Mercury level	5mg per lamp	5mg per lamp	5mg per lamp	5mg per lamp
GLS Equivalence	CFL Luminous Flux Claim (lm)		Rated Wattage of Equivalent GLS Filament Lamp	
Where a claim is made that the rated luminous flux of the CFL is equivalent to, or exceeds that, of an equivalent GLS filament lamp, the lamp rating must comply with the following requirements	≥ 214		≤ 25 W	
	≥ 386		≤ 40 W	
	≥ 530		≤ 50 W	
	≥ 660		≤ 60 W	
	≥ 874		≤ 75 W	
	≥ 1100		≤ 90 W	
	≥ 1246		≤ 100 W	
	≥ 2009		≤ 150 W	

NAEEEC MEMBER ORGANISATIONS

The Commonwealth, New Zealand, and each state and territory are represented on NAEEEC and participate in its deliberations. Representatives are officials within government departments, agencies and statutory authorities or people appointed to represent those bodies. Representatives are usually a senior officer directly responsible for energy efficiency. The membership is currently under review and may expand to include other agencies working in these fields.

The Australian Greenhouse Office (AGO) is part of the Australian Government Department of the Environment and Heritage. The AGO is responsible for monitoring the National Greenhouse Strategy in cooperation with states and territories and with the input of local government, industry and the community. An AGO officer is the chair of NAEEEC and others provide support for its activities.

The NSW Department of Energy, Utilities and Sustainability provides policy advice to the NSW Government and operates a regulatory framework aimed at facilitating environmentally responsible appliance and equipment energy use.

The Office of the Chief Electrical Inspector is the Victorian technical regulator responsible for electrical safety and equipment efficiency. Its mission is to ensure the safety of electricity supply and use throughout the state and its corporate vision is to demonstrate national leadership in electrical safety matters and to improve the superior electrical safety record in Victoria. The office's strategic focus is to ensure a high level of compliance is sustained by industry with equipment efficiency labelling and associated regulations.

The Sustainable Energy Authority was established in 2000 by the Victorian Government to provide a focus for sustainable energy in Victoria. The authority's objective is to accelerate progress towards a sustainable energy future by bringing together the best available knowledge and expertise to stimulate innovation and provide Victorians with greater choice in how they can take action to significantly improve energy sustainability.

The Electrical Safety Office, Department of Industrial Relations, is the Queensland technical regulator responsible for electrical safety and appliance and equipment energy efficiency. The office ensures compliance with electrical safety and efficiency regulations throughout Queensland.

The Environmental Protection Agency, through its Sustainable Industries Division, is Queensland's lead agency in the promotion of energy efficiency, renewable power, and other initiatives that reduce greenhouse gas emissions throughout the state. Its key aim is to achieve increased investment in sustainable energy systems, technology and practice.

Energy Safety WA seeks to promote conditions that enable the Western Australian community's energy needs to be met safely, efficiently and economically.

The Western Australian Sustainable Energy Development Office promotes more efficient energy use and increased use of renewable energy to help reduce greenhouse gas emissions and increase jobs in related industries.

The Office of the Technical Regulator seeks to coordinate development and implementation of policies and regulatory responsibilities for the safe, efficient and responsible provision and use of energy for the benefit of the South Australian community.

The Tasmanian Government's interest is managed by the Department of Infrastructure, Energy and Resources' Office of Energy Planning and Conservation (OEPC). OPEC provides policy advice on energy related matters including energy efficiency.

Electricity Standards and Safety, Department of Infrastructure, Energy and Resources, is the technical regulator responsible for electrical safety throughout Tasmania. Regulatory responsibilities include electrical licensing, appliance approval and equipment energy efficiency.

The ACT Office of Sustainability was established in January 2002 to develop, facilitate and coordinate the implementation of policies and procedures related to sustainability. From the end of 2004, the Office has expanded to take on responsibility for energy and greenhouse policy, including energy efficiency issues. The ACT Planning and Land Authority is the ACT technical regulator responsible for electrical safety and equipment efficiency.

The Department of Employment, Education and Training is responsible for administering regulations in the Northern Territory on various aspects of safety, performance and licensing for goods and services including electrical appliances.

The Energy Efficiency and Conservation Authority (EECA) is the principal body responsible for delivering New Zealand's National Energy Efficiency and Conservation Strategy. EECA's function is to encourage, promote and support energy efficiency, energy conservation and the use of renewable energy sources.

The Ministry for Environment (MfE) is the lead department in New Zealand advising the Minister of Energy on the development of government policy advice on energy efficiency, conservation and the use of renewable sources of energy. It works with EECA and also monitors its performance under the Public Finance Act.

Final Draft Report

Compact Fluorescent Lamps

Assessment of Minimum Energy Performance and Labelling Options

by

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for

The National Appliance and Equipment Energy Efficiency Committee

March 2005

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Contents

1. Purpose

This paper examines whether Australian Governments should proceed with the use of MEPS and/or an endorsement label for compact fluorescent lamps (CFLs) in the Australian market, and if so, what criteria this label should be based upon.

In this report, a number of overseas endorsement programs for CFLs are examined and their scope and requirements are compared.

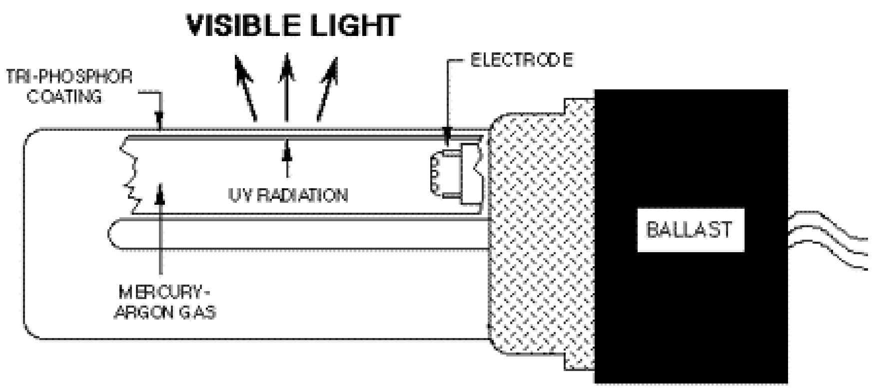
2. Background

CFLs have been available for over 20 years, and actively promoted as an energy saving device in residential and commercial applications. During this period they have experienced several changes in technology and design to make them more appealing and easy to use, particularly as a replacement for standard incandescent lamps in conventional light fittings. At the present time CFLs are available in a wider variety of styles, at a lower cost and in more outlets than ever before.

2.1. Product Description

CFLs are a single capped fluorescent lamp and work much like a standard fluorescent lamp. They consist of a short glass tube or globe filled with a gas that produces light when high voltage electricity from a ballast flows through it. The ballast may be either magnetic (in which case a starter is required) or electronic. When the ballast is permanently attached to the tube, it is known as a self-ballasted or integral CFL and is a direct replacement for standard incandescent lamps. Two-part CFLs have two or four pins on the bottom that plug into a socket on the ballast; thus the lamp can be replaced without replacing the ballast, which generally has a life expectancy five times longer than the lamps.

Figure 1: Components of compact fluorescent lamps



Components of a typical compact fluorescent lamp. A compact fluorescent lamp consists of a gas-filled glass tube with two electrodes mounted in an end cap. It contains a low-pressure mix of argon gas, mercury vapor, and liquid mercury, and is coated on the inside with three different phosphors. The electrodes provide a stream of electrons to the lamp and the ballast controls the current and voltage flowing into the assembly.

2.2. Ballasts

Magnetic ballasts have been around the longest, employing a wire-wound core to limit current drawn by the lamp. These ballasts typically consume an additional 15% to 25% of the lamp wattage, producing heat as a by-product. More energy-efficient magnetic ballasts have been developed recently using improved materials and manufacturing processes, but they tend to be slightly larger and more expensive than standard ballasts.

Most magnetic ballasts deliver current to the CFL at the same frequency supplied by the utility. The most recently developed ballasts are the smaller, lighter and more energy-efficient high-frequency electronic ballasts. These ballasts use transistors or thyristors to boost the input power to a frequency range of 25 to 40 kHz. High-frequency operation offers the advantages of improved overall efficiency, improved efficacy, reduced hum and increased lamp life. On the other hand, such ballasts are more likely to cause electromagnetic interference and are more susceptible to damage from supply voltage spikes and other transients. However many new electronic ballasts now come with built-in filtering and protection circuits to reduce or eliminate problems of this kind.

2.3. Colour

The first fluorescent lighting systems used a single phosphor coating inside the lamp and produced a cool white light. With the development of more efficient ’tri-phosphor‘ coatings came smaller ’compact fluorescent‘ lamps with light outputs rivaling those of incandescent lamps of similar size. The three phosphors produce light in the red, blue and green regions of the visible spectrum, giving white light when blended together. By changing the relative balance of these phosphors, manufacturers can produce CF lamps in a range of apparent colour temperatures from a cool 4100K (degrees Kelvin) to a warm 2700K. Incandescent lamps have a colour temperature of about 2900K.

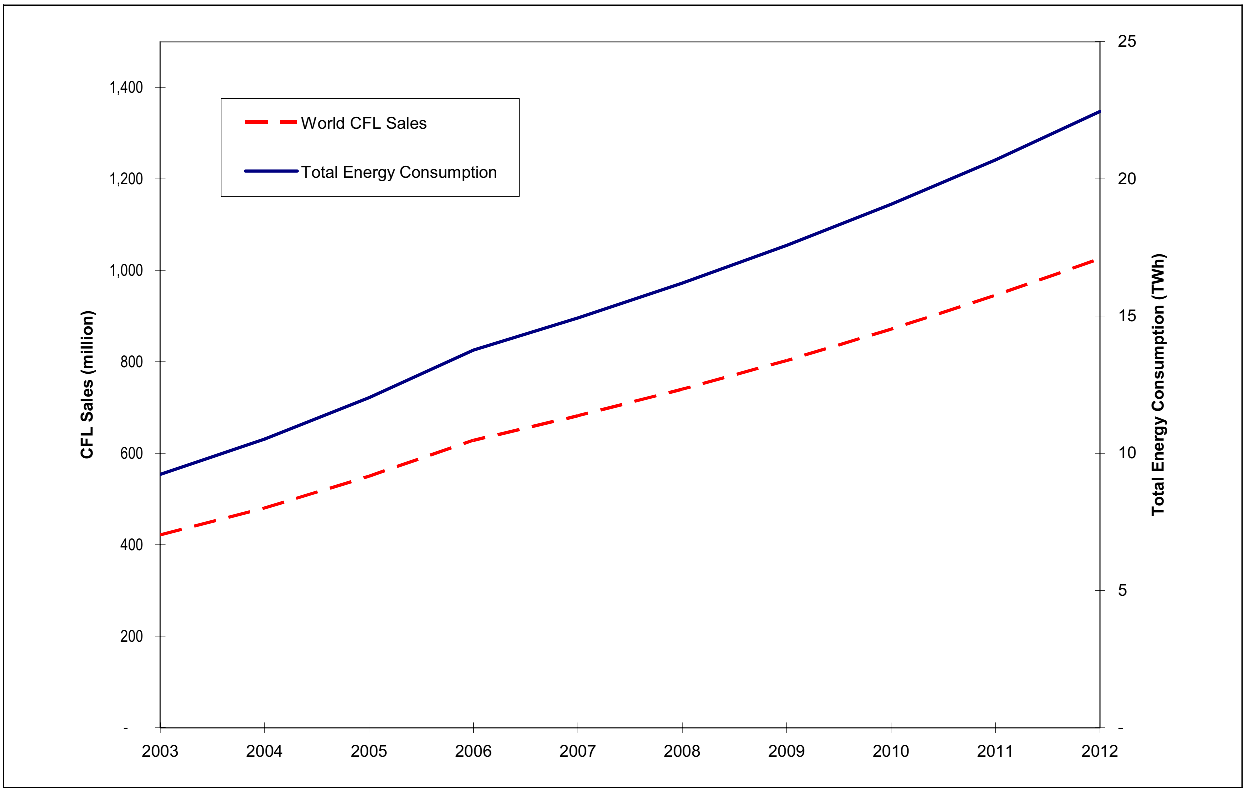
The Colour Rendering Index (CRI) of a lamp reflects how accurately the colour of an object can be determined under a given light source. Compact fluorescent lamps typically have a CRI of 82 (out of 100), which is considered excellent for fluorescent sources and good for artificial light in general. Incandescent lamps have a CRI of 97. Incandescent lamps provide excellent colour rendering because of the full spectrum of colour wavelengths present in the light they produce.

2.4. Market Issues

The international market for CFLs has expanded rapidly in recent years. For example, in the United States from 1998-2000, CFLs had a consistent 0.5% national market share. In California, this figure was 1%-1.6%. In 2001, the market share nationally grew to 2.2%, while in California the state market share became 8%.

It is now estimated that global sales of self-ballasted CFLs will reach 550 million units in 2005, responsible for 12 TWh of electricity consumption worldwide(MEA 2005). Based on existing growth rates, these figures will nearly double by the year 2012 (see Figure 2).

Figure 2: Estimated Global Sales of Self-Ballasted CFLS, and Total Energy Consumption (MEA 2005)



Over the last two to three years, the retail price of CFLs has dropped considerably, both overseas and in Australia, and the range of lamps available has also increased dramtically.

In the United States, despite a fall in lamp prices from $25/unit in 1998 to $5 in 2001, for the first time the total value of CFL sales in 2001 matched that of incandescent lamps (Calwell et al 2002).

An indication of the growth in product range is shown by the number of Energy Star partners. By the beginning of 2001, Energy Star partners included 17 manufacturers and covered 161 products. By the end of 2001, partners comprised 94 manufacturers covering 455 products (Calwell et al 2002), and the number of active partners has now increased to 147 (Karney 2004).

While less dramatic, branded CFLs in the UK have also experienced reductions in price, falling by half over the two years prior to 2001. As in the US, the value of CFL sales now equals that of standard GLS lamps (ECI 2001).

Here in Australia the situation is similar, with sales of CFLs doubling since 1999 to over 13.5 million in 2004 (see Figure 3). At the same time the average imported cost of CFLs has dropped to around $1.80 in 2004 from a high of $3.20 in 2000 (ABS 2004/5).

Figure 4 shows the country of origin for CFL imports from 1995 to 2004. While the distribution of CFL sources was evenly spread over a wide variety of countries in 1995, since 1999, China and Germany have emerged as the major countries of origin. Together they provide over 90% of all CFLs entering the Australian market in 2003 (ABS 2004/5).

Figure 3: Import Trends for CFLs into Australia (ABS 2004/5)

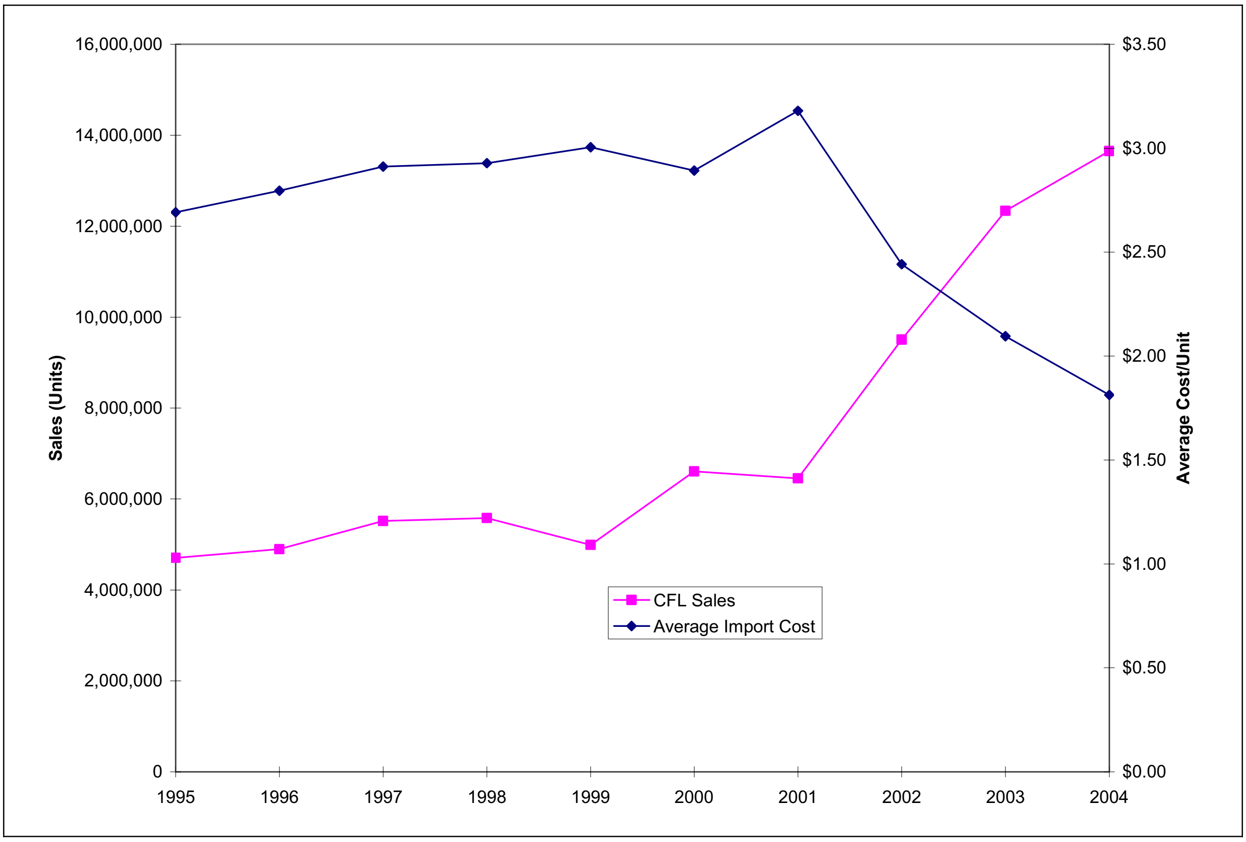
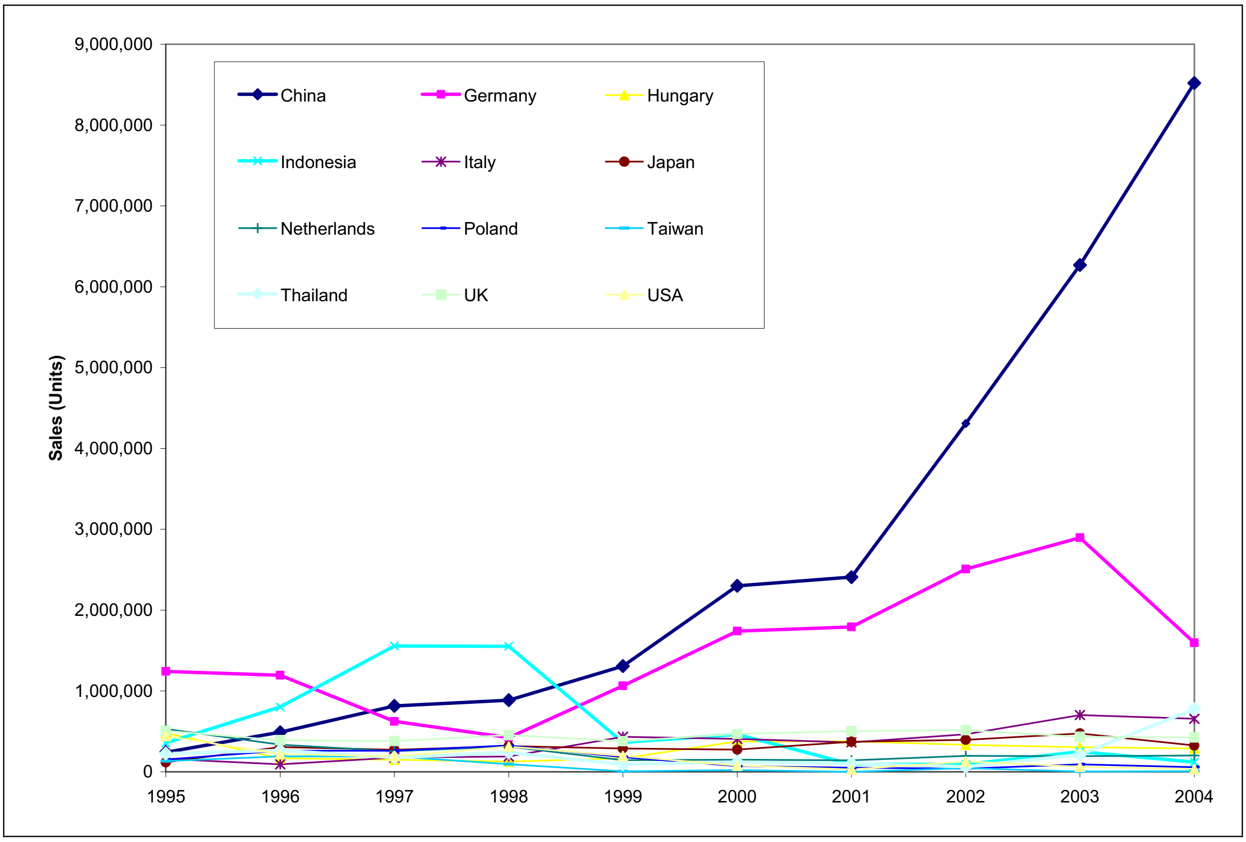


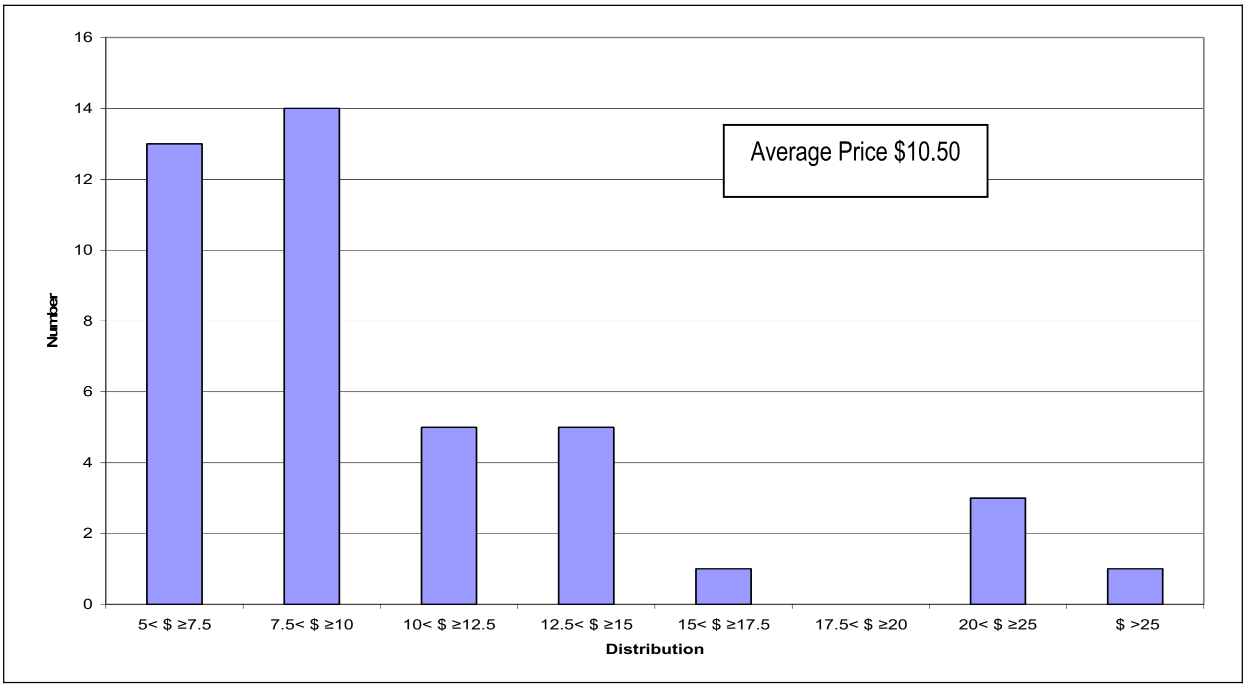
Figure 4: Country of Origin for CFL Imports (ABS 2004/5)



A recent survey of products available at Bunnings, the hardware chain, showed that there were 42 CFL models on sale, supplied by three manufacturers (MEA 2004). Of these 7 were pin-type.

Prices ranged from $6.20 to $29.94, with the average price being $10.50. The distribution of prices is shown in Figure 5, demonstrating that nearly 90% of models are below $15 each. This is nearly half the average price of a sample tested by *Choice Magazine* in 1999/2000, when the average was found to be $20.30 (Choice 2001).

Figure 5: Distribution of Retail Prices for CFLs in Australia – Bunnings 2003 (MEA 2004)



The increasing use of CFLs, and to some extent the intense price competition, has brought issues of product quality to the fore. Product performance has always been an issue, however the sheer numbers involved now make this appear of greater significance. There is also a suspicion that in an effort to reduce prices, there may be some slippage in performance levels.

Although it is hard to quantify, some consumers in many countries have expressed their dissatisfaction with CFLs, particularly with respect to the advertised service life and light output. In an effort to increase consumer confidence by identifying the better performing models, several countries have adopted energy endorsement labels.

3. Key Issues

It may be intuitive to assume that the presence of CFLs with a variety of performance characteristics and price points will, or may eventually lead to reduced consumer confidence in CFLs. However, the issue of whether an endorsement label for CFLs is warranted involves answering a number of questions in relation to consumer sentiment and the performance of CFLs. These are summarised as follows:

- Are there consumer expectations particularly associated with CFLs? If so what are these?
- Is there evidence of consumer dissatisfaction? Might there be dissatisfaction in the future?
- To what extent is there a basis for consumer complaints?
- Are there any further reasons for using an energy label?

These issues are discussed further in this section.

3.1. Consumer Expectations of CFL Performance

CFLs are marketed to consumers on the basis of their performance relative to ‘standard’ lamp types, such as GLS. Typically CFLs are promoted as having a lower energy consumption and longer life than their incandescent equivalents. Figures are often provided in marketing materials, including CFL packaging, to demonstrate the cost effectiveness of CFLs over the lifetime of the lamp, and to justify the extra capital investment. These calculations of the ‘payback’ time are predicated on assumptions regarding the lamp lifetime, and claims of equivalent light output compared to ‘standard’ lamp types.

Such has been the use of this type of information by the industry and other agencies seeking to promote CFL lamps, that it is likely that many consumers who purchase a CFL will have some expectation that CFLs last longer, and that their light output is similar to the wattage of GLS lamps identified on the packaging. Indeed, CFLs are quite often referred to as ‘long-life lamps’.

3.2. To what extent are consumers dissatisfied with the performance of CFLs?

While there is no known data collected on the numbers of disaffected consumers, the anecdotal evidence is there. The Australian Consumer Association, the AGO and other energy efficiency agencies in Australia have received complaints and queries relating to the premature failure of CFLs, and those in the industry cite many further instances.

This is by no means an Australian phenomenon, since endorsement labelling programs implemented in several overseas countries are designed to address exactly this issue. Correspondence with China and the UK indicate that their endorsement labelling programs were initiated as a direct result of consumer complaints. These programs are discussed in the following section.

However, despite this anecdotal evidence we have not been able to find any consumer surveys designed to determine the degree to which purchasers may be dissatisfied. However in a report on CFL promotions in the UK, the following comment is made:

> *"There is as yet no evidence (other than anecdotal) that shorter-lifetime CFLs have damaged the market. Evidence from New Perspectives (2000) showed both that people do not understand how long a CFL should be lasting, and that most felt that if a lamp lasted 2 years they would be satisfied. This may indicate that despite the concerns of the industry, shorter lifetime products will not have a negative effect on consumer perception."* (ECI 2001)

It should be noted that this conclusion is quite heroic, given that this was not tested by the survey, however it is probably true that consumer expectations on lifetimes reflect the capital cost of CFLs. In an environment of falling prices it may be that consumers do not expect them to last so long (New Perspectives 2003).

Before proceeding, it may be worth undertaking some surveys, perhaps by telephone, to test the extent of any dissatisfaction in Australia.

Of course, even if there was evidence that consumers were generally satisfied about the performance of their CFLs now, this would not guarantee that they would continue to be in the future. If prices continue to drop and result in lower performance standards, then consumer dissatisfaction might be expected to grow.

The key issue is therefore whether it is worth taking the risk, given that it is always harder to rebuild a reputation than to maintain it.

3.3. Is there any justification for consumer complaints?

We have assumed that the major consumer expectation is of increased lamp life, based on the life shown on the packaging. The 'average' lamp life contained in most standards is taken to be the length of time before 50% of a sample of lamps fail under test conditions, where the sample of lamps is greater than 20. The details of various standards and endorsement criteria are discussed further in later sections, however this is a typical definition.

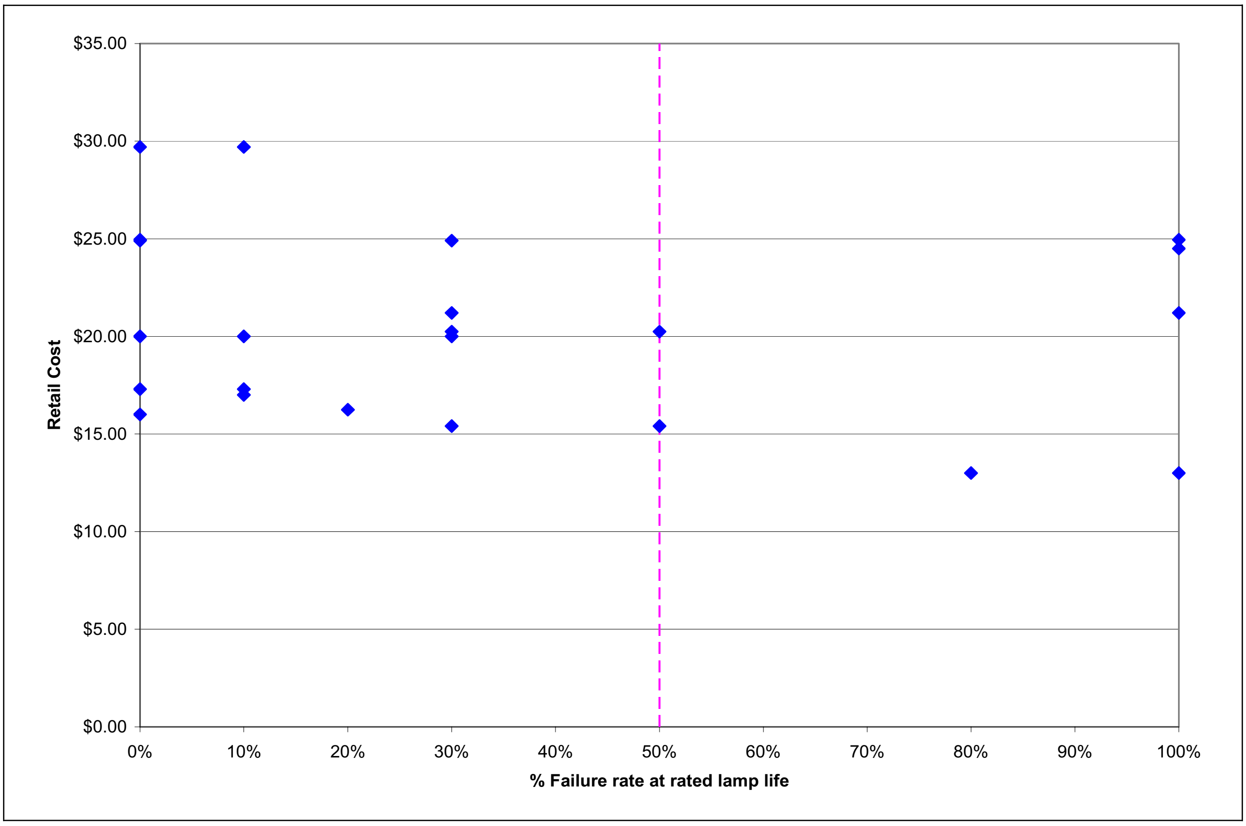
This in itself may surprise many consumers: that the lifetime quoted is only an average and that half of the lamps may fail by this time, and many may fail well before then while still being considered valid.

Even within this definition, surveys show that some lamps on the market do not fulfil this requirement. A set of tests on 23 commonly available CFL models (undertaken by *Choice Magazine* for the Australian Greenhouse Office in 1999/2000) found that 5 (22%) had more than a 50% failure rate at the quoted average life. In 4 of these models, all the sample products tested failed to meet the average life. An additional 2 had a 50% failure rate. These tests were undertaken on 10 samples per model (Choice 2001).

The results of the *Choice Magazine* tests are plotted in Figure 6. This shows the proportion of samples for each lamp type which failed at the rated lamp life (X-axis) against the cost of each lamp type. This indicates that:

- for lamps to the right of the dotted line, more than 50% of the sample failed before by the rated lamp life, and
- there is no correlation between longevity and the price of the product.

Figure 6: Distribution of CFL Lamp Failures at Rated Life vs Cost (Choice 2001)



The results of this test by *Choice Magazine* is very similar to those from a test undertaken by the UK Lighting Association on behalf of the Department for Environment Food and Rural Affairs (Defra). This found that 4 out of 12 models tested failed to achieve their claimed average life, for a sample of 20 products per model. (MTP 2000). In a further part of this survey, it was found that 5 out of 12 models were labeled with the incorrect (A-G) class, as required by EU labelling regulations.

Although these studies involve a small sample and occurred a few years ago, it appears likely that at least some lamps do not live up to the claims made.

3.4. Are there other reasons for using an endorsement label?

There are at least two further reasons why an endorsement label may also be warranted.

Given the concerns about the performance of some CFLs, there may be an increasing reticence amongst third parties to promote the use of CFLs. Currently there are a wide range of organisations which encourage the uptake of CFLs, including energy efficiency agencies, governments and NGOs, and these greatly enhance the marketing efforts by industry. In addition, State-based energy efficiency agencies and some utilities have initiated financial incentives for CFLs. If these third parties fear that the products they promote do not meet expectations, they are likely to withdraw support rather than risk their own credibility amongst customers.

In addition, there is a possibility that the market share of premium products becomes eroded by cheaper and shorter life products. For example there has recently been an influx of 3,000 hour products. If this trend continues then longer life CFLs may get withdrawn entirely from the market. This is of concern since there is no certainty that self-ballasted CFLs will get replaced with another CFL at the end of its life – hence energy savings can only be assured for the life of each lamp. We could therefore see consumers reverting to incandescent lamps after a relatively short period.

4. Existing Regulatory Position in Australia

CFL lamps are a 'prescribed' product in Australia and therefore are required to meet relevant safety standards. They do not however have to meet performance standards. The following section identifies relevant Australian and International standards applying to CFLs, highlighting the key elements of test methodologies and performance requirements. The voluntary lamp labelling program initiated by the AGO is also described.

4.1. Standards

The three primary standards relating to CFLs are:

- AS/NZS 60969 (2001): Self ballasted lamps for general lighting services – Performance requirements.
- AS/NZS 60901 (2003): Single capped fluorescent lamps – Performance specifications. This covers all single-capped fluorescent lamps with an external ballast (ie. pin-type).
- AS/NZS 4783.2 (2002): Performance of electrical lighting equipment – Part 2 : Energy labelling and minimum energy performance standards requirements. This standard defines a classification scheme and MEPS levels for ballasts for pin type CFLs.

4.2. AS/NZS 60969 (2001): Self ballasted lamps for general lighting services – Performance requirements.

This standard is identical to IEC 60969. The key requirements include:

- The luminous flux of a lamp shall be not less than 90% of the rated value.
- After 2000 hours of operation, the lumen maintenance of a lamp shall be not less than the value declared by the manufacturer.
- The life to 50% failures (average life) measured on 'n' lamps (where n ≥ 20) shall be not less than the rated life to 50% failures.
- Photometric tests are to be conducted in accordance with relevant recommendations of CIE.
- Electrical tests are to be undertaken in ambient temperature of 25°C +/- 1°C and RH 65% maximum.
- Lamp life and Lumen maintenance tests to be conducted in ambient temperatures of 15°C - 40°C. During the test, lamps shall be switched off 8 times in every 24 hours. The off period shall be between 10 and 15 mins.

  Other Relevant Standards:

  - AS/NZS 60968 (2001): Self-ballasted lamps for general lighting service, safety requirements.

4.3. AS/NZS 60901 (2003): Single capped fluorescent lamps – Performance specifications.

This is identical to IEC 60901. The key requirements include:

- The luminous flux of a lamp shall be not less than 90% of the rated value.
- The lumen maintenance of a lamp shall be not less than 90% of the rated luminous maintenance value.
- Photometric tests are to be conducted in accordance with relevant recommendations of CIE.
- Electrical tests are to be undertaken in ambient temperature of 25°C +/- 1°C, in a position specified on relevant lamp data sheet.
- Lumen maintenance test to be conducted in ambient temperatures of 15°C - 50°C. During the test, lamps shall be switched off for 15 minutes, after each 2hr 45min of operation.
- Lamps with an internal starter shall contain means to aid suppression of radio interference, the effect of which shall be equivalent to that of the RIS capacitor prescribed in IEC 60155.

  Reference Documents:

  - IEC 60061-1 Ed. 3.2 B (2002): Lamp caps and holders together with gauges for the control of interchangeability and safety – Part 1: Lamp caps.
  - AS/NZS 60155 (2000): Glow starters for fluorescent lamps.
  - AS/NZS 60598.1 (2001): Luminaires – General requirements and tests.
  - AS/NZS 60921 (2002): Ballast for tubular fluorescent lamps - Performance requirements (IEC 60921:1988, MOD).
  - IEC 60927 Ed. 2.0B (1996) and Ed 2.1 B (2000): Starting devices (other than glow starters) - Performance requirements.

- AS/NZS 60929 (2000): Auxiliaries for lamps - A.C. supplied electronic ballasts for tubular fluorescent lamps.

Other Relevant Standards include:

- IEC 61199 (1999): Single-capped fluorescent lamps – safety specifications.

4.4. AS/NZS 4783.2 (2002)

This standard is equivalent to the European Standard CENELEC EN 50294, and defines a classification scheme and MEPS levels for ballasts for pin type CFLs. The testing method is detailed in AS/NZS 4783.1 (2002) *Performance of electrical lighting equipment — Ballasts for fluorescent lamps. Part 1: Method of measurement to determine energy consumption and performance of ballast-lamp circuits*. The MEPS level (shown in Table 1) is defined as the maximum permitted corrected total input power of a ballast-lamp circuit specified in the standard.

Table 1: MEPS levels for pin-type CFL ballasts

Lamp type	Nominal lamp power (W)	MEPS
Compact 2 tube	40 55	46 63
Compact 4 tube: flat		none
Compact 4 tube: not flat		none
Compact 6 tube	32 42	39 49
Compact 2D (double D)	55	63

Reference Documents:

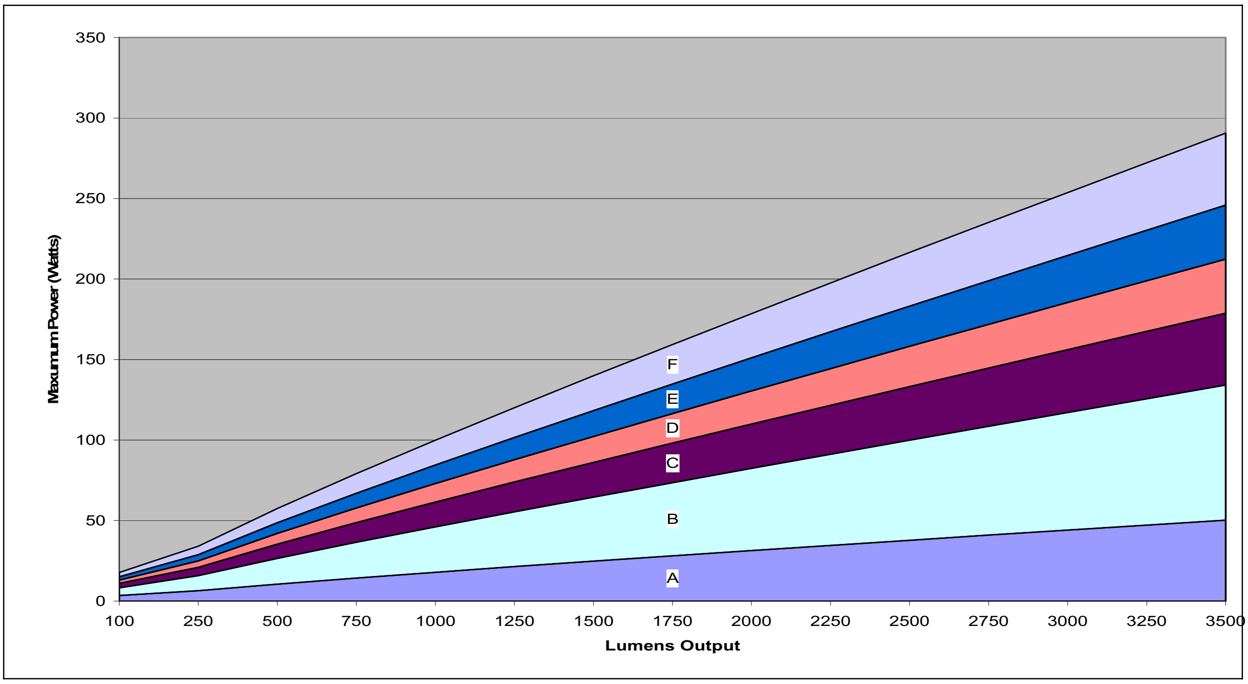
- AS/NZS 4783.1 (2002) Performance of electrical lighting equipment — Ballasts for fluorescent lamps. Part 1: Method of measurement to determine energy consumption and performance of ballast-lamp circuits.
- AS/NZS 60921 Ballasts for tubular fluorescent lamps — Performance requirements
- AS/NZS 60929 Auxiliaries for lamps—A.C. supplied electronic ballasts for tubular fluorescent lamps — Performance requirements
- AS/NZS 61231 International lamp coding system (ILCOS)

4.5. Labelling

The Australian Greenhouse Office has initiated a voluntary labelling program for domestic lamps sold in Australia[1]. The labelling requirements are identical to those established in 1998 by the European Union (98/11/EC) (see Appendix 1) and are contained within Appendix B of the Australian Standard 4782.2:2004. The label is a comparative energy label, ranking lamp performance in terms of energy efficiency on an 'A-G' scale (see Figure 7).

Figure 7: Bands for the European Energy Label ('A-G')

1 At this stage, use of the label is not mandatory, however state governments will consider a mandatory approach should the proportion of household lamps that carry the label not increase substantially.



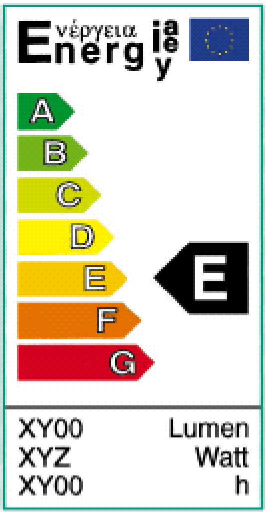
Note: the 'G' category includes all lamps falling in the area above the 'F' category.

In addition to energy performance, the label must carry information on the following attributes for each lamp:

- The luminous flux of the lamp in lumens.
- The input power (wattage) of the lamp.
- The average rated life of the lamp in hours. Where no other information on the life of the lamp is included on the packaging, this may be omitted.

Many domestic lamps currently sold in Australia already carry this label, shown in Figure 8 below.

Figure 8: Comparative Label: European 'A-G'



The primary aim of this label is to demonstrate to consumers the benefits of switching from incandescent bulbs (such as GLS) to CFL type bulbs. Since the 'A-G' rating label only ranks lamps according to their efficiency, the label effectively differentiates between different types of lamp technology. The following figure shows the approximate distribution of lamp technologies according to the 'A-G' label.

Figure 9: Distribution of Lamp Technologies by EU Label

A - tri-phosphor fluorescent lights (linear strips and pin-based CFLs) and integral electronic ballast CFLs
B - halo-phosphor fluorescent lights (linear strips and pin-based CFLs) and integral magnetic ballast CFLs
C - efficient halogen bulbs
D - other halogen bulbs
E/F - standard GLS bulbs
G - very poor incandescent bulbs

Table 2 shows the relevant European Label for a range of common lamps types produced for the domestic market in Australia by Sylvania (Sylvania 2003). This is typical of the range of products provided by major lamp manufacturers/importers, and indicates that all CFLs are rated as either 'A' or 'B', while incandescents are rated from 'D' to 'F'.

Table 2: European Label for the Sylvania Range of Lamps

Type	Name	Wattage	EU Label
Integral	Micro-Lynx F	7	B
	Mini-Lynx Economy	9, 11, 15, 18	A
	Mini-Lynx Ambience	7	A
		11, 15, 20	B
	Lynx Energy Saver	15, 20, 23	A
Pin-type	Lynx-S	7, 9, 11	A
		5	B
	Lynx-D	13	A
		10, 18, 26	B
	Lynx-TE Amalgam	18, 26, 32, 42	B
Incandescent	GLS Pearl	25, 40, 60, 75, 100	E
	GLS-T Brilliant Satin	25, 40, 60, 75, 100	F
	GLS Long Life	25, 40, 60, 75, 100	F
	GLS-Energy Saving	36, 54, 69, 93	D
	Candle Clear	25, 40, 60 W	E
	Globe Décor	60, 100 W	F

While the ‘A-G’ label provides consumers with a good indication of the comparative efficacy of different lamp technologies, it does not provide a good guide to the comparative performance of different lamps of the same technology. The major reason for this is that the range of efficiencies represented by each band is relatively large, and also that efficiency is only one performance measure valued by customers in relation to lamps in general and CFLs in particular. Other factors such as lamp life and lumen maintenance amongst others, affect consumer choice and are the basis for their expectations.

5. The Role of Minimum Energy Performance Standards (MEPS) & Labelling Programs

The following section briefly describes the role of MEPS and different types of labeling programs typically used to promote energy efficiency.

5.1. Minimum Energy Performance Standards (MEPS)

MEPS are mandatory standards applying to many products sold in Australia, set at a level to prohibit sale of the worst performing products in the marketplace. They currently apply to a range of residential appliances in Australia and are soon to be introduced for fluorescent lamps and commercial refrigerators, amongst other equipment.

MEPS are not designed to promote the best performing products, but can be combined with policy measures that do have this aim such as labels. However, the standard for commercial refrigerators also specifies a ‘high efficiency level’ which requires that only products which meet this performance level can use this term for marketing purposes. Although manufacturers are free to choose whether they sell a product within this category, the aim of this standard is to protect the investment of those who produce products which meet this superior level of performance.

5.2. Labelling

In general, labels attempt to provide consumers with information at the point of purchase. To be effective they rely upon consumers having a good understanding of what the label represents, and on the likelihood that consumer purchasing decisions will be altered by knowledge of the energy performance of the particular product. Energy labels are widely used in Australia (since 1987) and there is a high degree of consumer recognition of the energy star rating label used on whitegoods and other appliances.

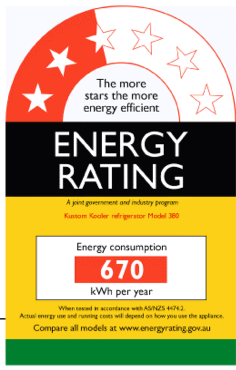
5.3. Endorsement Label

An energy endorsement label is used to signal to consumers that a product meets particular criteria (typically but not always related to performance). It provides an easily recognizable indicator so that consumers can identify ‘conforming’ products without having knowledge of detailed performance characteristics.

To work effectively, consumers must recognise the label and what it represents, at least at some rudimentary level. They must regard the qualities indicated by the endorsement label as valuable and credible. Government-backed endorsement labels are therefore generally more effective since consumers tend to regard governments as impartial authorities.

The most familiar energy endorsement label is ‘Energy Star’ – the logo developed by the US Environment Protection Agency (EPA). This is now used worldwide on a variety of electric and electronic consumer items. Like any endorsement label, Energy Star is primarily a marketing tool enabling manufacturers to easily promote the best products to their customers.

5.4. Comparative Label



A mandatory energy label is applied to a growing range of appliances in Australia. which uses a star rating scale to compare the performance of different models. The number of stars allocated to a model is calculated using a formula given in the relevant Australian Standard. The label also carries an estimate of the annual energy consumption of the appliance based on the tested energy consumption, and information about the typical use of the appliance in the home. The actual performance data and typical running costs for each model are also available in publications and on a website.

Comparative labels work best when models in the marketplace exhibit a spread of performances, thereby providing a range of ratings for consumers to choose from.

5.5. Warning Label

A 'warning label' is similar to an endorsement label except that its aim is to highlight poorly performing products. The intention is that manufacturers will avoid having to use the warning label by improving the performance of their products. Clearly, if a product qualifies for the label it must be a mandatory requirement that the label is fixed to the relevant product. To date, the warning label has not been used in Australia.

6. Overseas CFL MEPS Programs

MEPS programs prohibiting the sale of low efficiency CFLs have been implemented in China, Mexico and South Korea. China and South Korea have integrated MEPS with a labelling program for CFLs. Japan has also established weighted average efficiency targets for lighting appliances using CFLs in its Top Runner Program. This approach differs from MEPS in that it does not prevent products which do not meet the standard from being sold. Rather, it requires the average efficiency of products shipped by a manufacturer or importer in a target year to meet set efficiency levels.

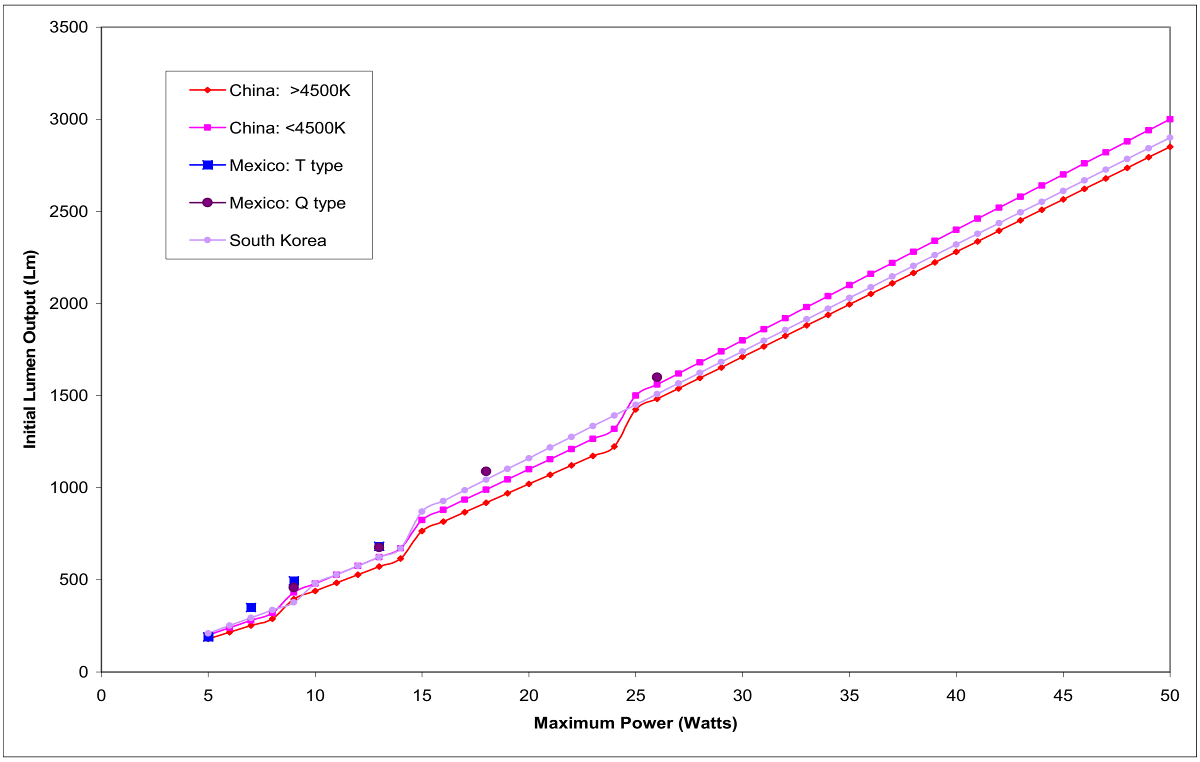
A summary of the scope of these programs is shown in Table 3. Details of the MEPS levels and testing methods for each program are given in Appendix 2.

Table 3: Summary of National MEPS Programs for CFLs

	China	South Korea	Japan	Mexico
Coverage - Self-ballasted	●	●	●	●
Coverage - Pin-type	●		●	
Efficacy	●	●	●	●
Lumen Maintenance				
Lifetime &/or Lifetime Guarantee	●			
Colour Rendering	●			

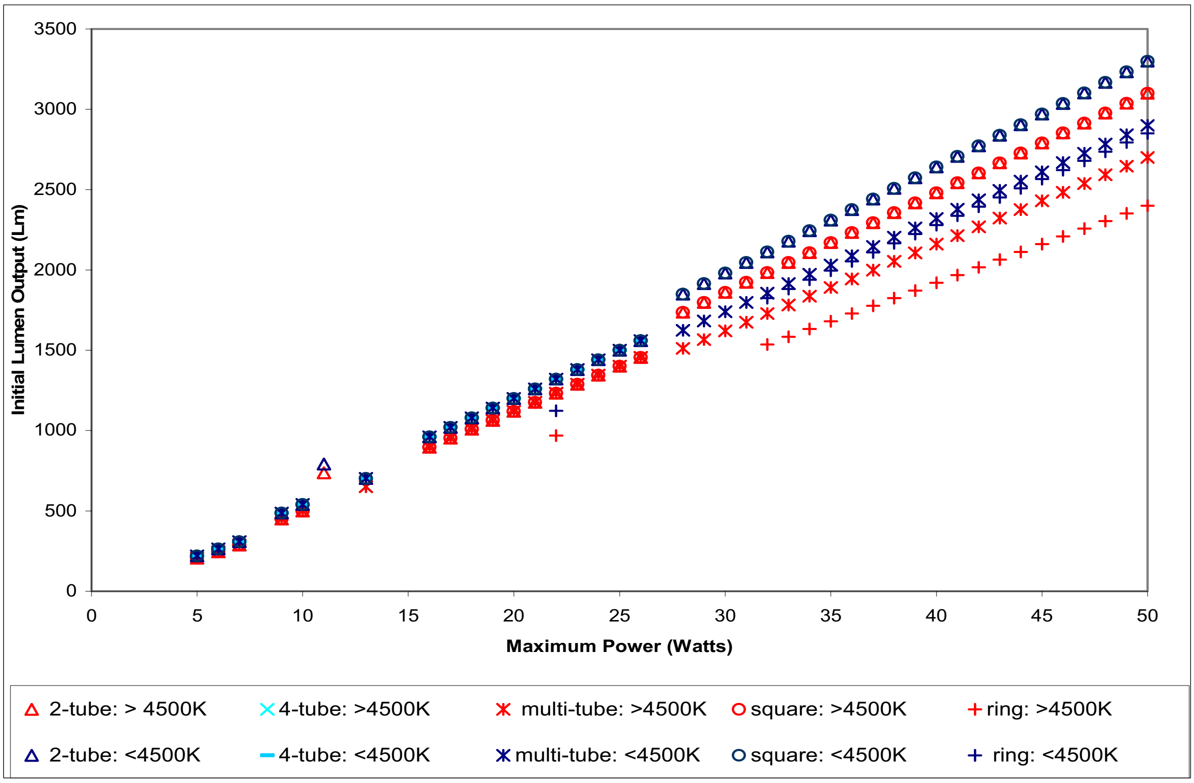
Each country specifies MEPS for efficiency in terms of Lumens per Watt for various types of CFLs at different wattages. Figure 10 compares the MEPS levels between China, Mexico and South Korea for self-ballasted CFLs. Figure 11 shows the Chinese MEPS levels for pin-type CFLs.

Figure 10: Comparison of MEPS for Self-Ballasted CFLs



Note: MEPS in Mexico for self ballasted types are not defined continuously and are therefore shown as defined points.

Figure 11: Chinese MEPS for Pin-Type CFLS



Note: MEPS in China for pin-type are not defined continuously and are therefore shown as defined points.

7. Overseas CFL Labelling Programs

Programs designed to differentiate between the performances of CFLs have been implemented in several countries around the world. Table 4 lists the CFL endorsement labeling programs, highlighting the scope of each. The following section and Appendix 3 provide greater detail on the certification criteria and requirements.

It should be noted that there are two basic models for endorsement labelling programs applied to CFLs. These are:

- Those which use the EU Labelling Directive (92/75/EEC) and Quality Charter for CFL Lamps as their basis, and conduct most of their tests to IEC 60969 or 60901; and
- Those which use Energy Star as their basis and test to IESNA – LM66-00, IESNA – LM65 & ANSI – C78.5.

Table 4: Summary of Overseas CFL Endorsement Programs

	UK Energy Saving Trust	European Quality Charter	US Energy Star	Hong Kong SAR	Chinese Taipei GreenMark	Environmental Choice Canada	China CECP	IFC/ELI	Procel (Brazil)	EGAT (Thailand)	South Korea	Philippines
Endorsement Label	●	●	●	●	●	●	●	●	●	●	●	●
Coverage - Self-ballasted	●	●	●	●	●	●	●	●	●	●	●	●
Coverage – Pin-type	●			●	●	●	●	●	●	●	●	
Efficacy	●	●	●	●	●	●	●	●	●	●	●	●
Lumen Maintenance	●	●	●	●			●	●	●	●		●
Lifetime &/or Lifetime Guarantee	●	●	●	●	●		●	●	●			●
GLS Equivalence	●	●	●					●				
Power Factor	●		●		●			●	●			
Luminous Flux Run-up	●	●	●					●				
Colour Rendering	●	●	●	●	●			●				
Statement of Mercury Content			●	●	●							

7.1. Efficiency

There is some variation in efficiency requirements, expressed as maximum power consumption per initial lumen output, although this is small. Figure 12 compares the thresholds for the Chinese label, Energy Star and the European labeling program. Note that the Chinese program has different thresholds dependent on the lamp colour temperature. Both the Chinese thresholds are more stringent than the others, although Energy Star and the European 'A' class are approximately equivalent.

Figure 12: Comparison of European Label, Energy Star and Chinese Evaluation thresholds for self-ballasting type

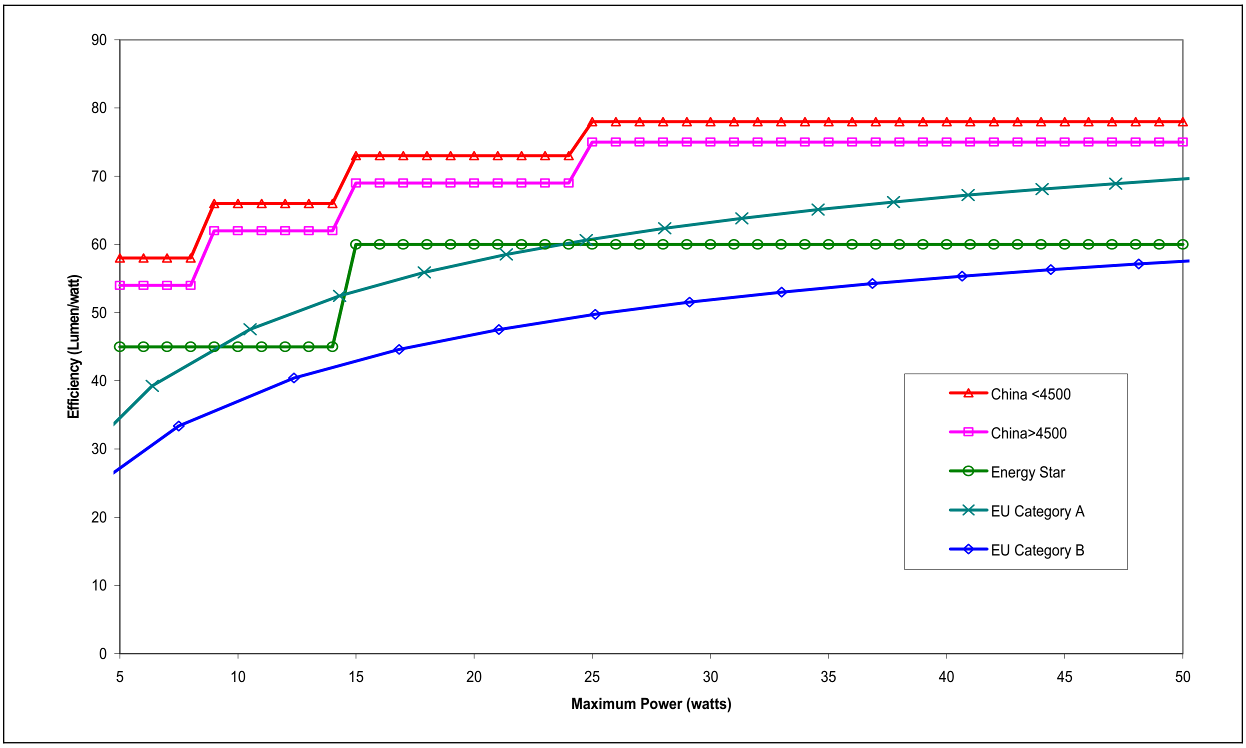
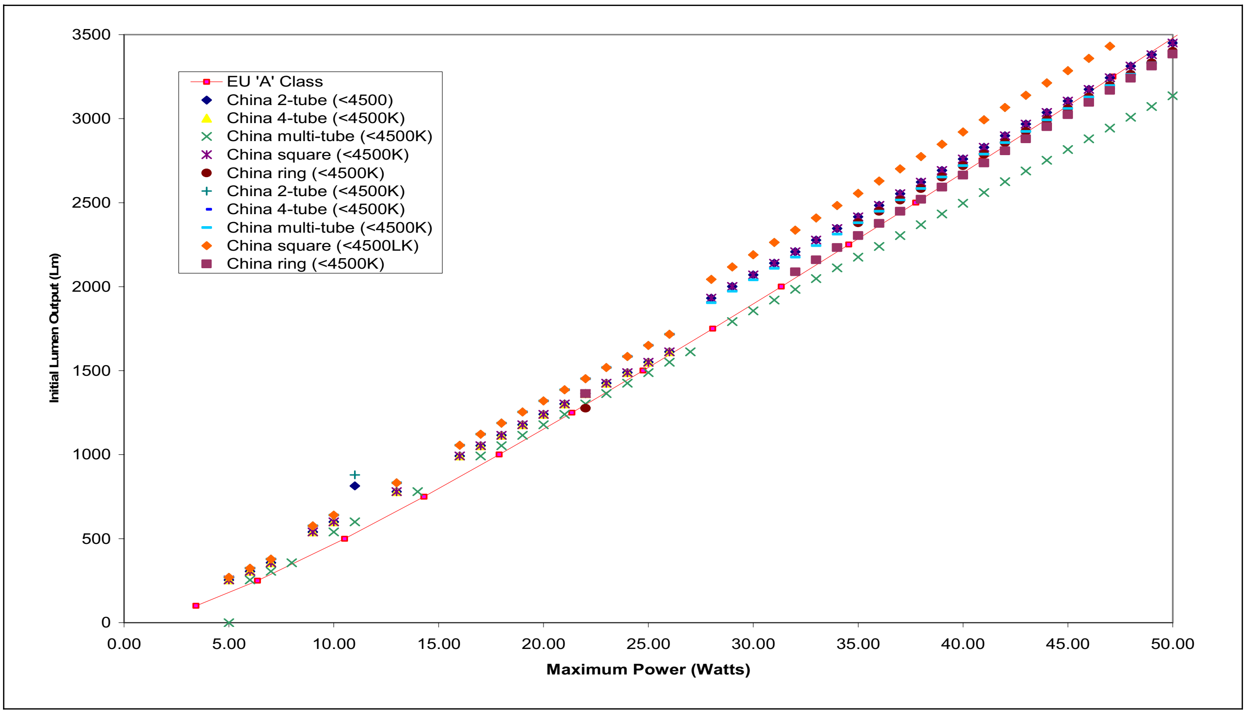


Figure 13 shows the Chinese Evaluation thresholds (see appendix 2A for definition) for pin-type type CFLs are comparable with EU 'A' class products.

Figure 13: Comparison of Chinese Evaluation thresholds for pin-type with EU 'A' class threshold



7.2. Lumen Maintenance

Although the requirements are generally similar, there are considerable differences in how the requirements are expressed, with measurements varying between 1,000 hours (Energy Star), 2,000 hours and 40% of rated lifetime.

7.3. Lifetime

Generally all programs use the average life of a sample (typically >20) to determine the lifetime. There are some differences in the test method with respect to the rapid cycle test and the position of the lamp during testing.

The minimum requirements for lamp life also vary between programs. The Energy Saving Trust program requires that not more than 10% of sample lamps fail the test at 2,000 hours, in addition to a maximum 50% failure rate at the average life.

The requirements of each labelling program with respect to these issues is shown in Table 5.

7.4. GLS Equivalence

Not all programs include requirements for the equivalence to be tested or checked, however amongst those that do, there is considerable consistency. Mostly this is presented as a table, however in the case of the Energy Saving Trust, their criteria are displayed graphically.

7.5. Power Factor

Generally power factors must be ≥ 0.5 although some require 0.9 as a minimum. Some require that lamps may only be labelled as having a high power factor if they are ≥ 0.9.

7.6. Luminous Flux Run-up

Most programs have a requirement for the time taken to reach a proportion of the final stabilised lamp output. For example:

- To 10% of light output ≤ 2 seconds
- To 60% of light output ≤ 60 seconds

However the precise requirements do vary slightly between programs.

7.7. Environmental Requirements

Some programs go beyond energy performance to include environmental criteria such as limits on mercury content and the use of recycled packaging materials.

7.8. Other Features

Almost all programs include similar requirements for the following attributes:

- Colour rendering
- Colour Temperature
- Electromagnetic inference – this tends to be specific to each country.

Table 5: Summary of International Energy Endorsement Labelling Programs

		UK Energy Saving Trust	US Energy Star	Hong Kong	Chinese Taipei GreenMark	China Greenlight	ICF/ELI	Procel (Brazil)	Philippines
Lifetime Test	Test Method	EN 60969	ANSI C78.5 – 1997 IESNA LM-40 – 2001 IESNA LM-65 – 2001	IEC 60969	Not known	IEC 60969	IEC 60969	NBR IEC 60901-1/97, NBR 14539-6/00	IEC 60969
	Ambient Conditions	10°C – 40°C		10°C – 40°C	Not known	10°C – 40°C	25°C. 65% RH	Not known	Not known
	Sample Size	> 20	10	> 20	Not known	> 20	≥ 10	10 plus 1 control	Not known
	Limits	≤ 50% sample fail by declared life ≤ 10% sample fail by 2,000 hours	≤ one sample failure at 40% of rated life	Average life ≥ 8,000 h	Average life ≥ 8,000 h	Average life ≥ 6000h	Average life ≥ 6000h	≤ 1 failure in 2000 hrs	Not known
Rapid Cycle Test	Cycle	8 times in every 24 h	once every 2 h	8 times in every 24 h	Not known	Not known	8 times in every 24 h	Test not used	Not known
	On	For ≥ 10 mins	5 mins	For ≥ 10 mins			For ≥ 10 mins		Not known
	Off	10-15 mins	5 mins	10-15 mins			10-15 mins		Not known
Lamp Position		Where orientation results in > 5% change in performance, this must be declared	50% sample with base down, 50% with base up	Not stated	Not known	Not known	Base up	Not known	Not known

8. Conclusions

8.1. The case for MEPS and/or an endorsement label

Although there is so far only anecdotal evidence that the reputation of CFLs has been damaged in Australia, there seems stronger evidence that this has been the case overseas, giving rise to the implementation of endorsement labels for higher quality products.

The prices of CFLs continue to fall in Australia, reducing the payback period and degree to which consumers might feel cheated by lamps which fail early. Since there appears to no obvious correlation between price and performance (particularly longevity), this leaves consumers with no means to easily distinguish between the performances of competing products.

In view of the difficulties in re-establishing credibility once damaged, there is justification in taking a precautionary approach, ie. acting in advance of strong evidence that consumer confidence in CFLs has been damaged.

In addition, there has been some reluctance on the part of those agencies who might actively encourage the use of CFLs to do so without the knowledge that they are supporting better performing products.

These arguments support the use of an endorsement label, designed to promote the better performing products in Australia. However, there is also justification for the introduction of MEPS for CFLs to remove the worst performing products from the market, and to ensure that these do not enter the market at some future date.

This is endorsed by Lighting Council Australia in the ten year strategy for efficient lighting, "Greenlight Australia" discussed below.

The use of both MEPS and a 'high efficiency' level signaled by an endorsement label has been used in Australia for other products with success. Typically, the high efficiency levels serve as an indication of likely future levels for MEPS, which are usually implemented 3-4 years after the current MEPS levels, as technology advances. One significant advantage for manufacturers is that this provides regulatory certainty over a period of 6-8 years, allowing them to plan ahead.

The above arguments apply primarily to self-ballasted CFLs, which account for the majority of CFLs sold in Australia. It is hoped that in due course the number of pin-type CFLs sold will also increase, when the range of luminaires grows, and for this reason it will be sensible to review the need for similar measures for these CFLs within the next 3 years.

8.2. Greenlight Australia

In December 2004, Australia's Ministerial Council on Energy approved Greenlight Australia, a strategy aimed to reduce lighting energy consumption by 20% by 2015, from its current level of around 25 TWh of electricity annually. Greenlight Australia has been developed jointly by Government and the Australian lighting industry with the objective of providing a clear indication of future policy. This provides industry with adequate time to prepare by highlighting areas for investment, thereby minimising any potentially detrimental economic impacts.

Figure 6 outlines the projects that will commence development in the period 2005/6 to 2007/8, which includes MEPS and an endorsement label for CFLs.

Table 6: High Priorities 2005/6 to 2007/8

Project	Commence Project Development

	2005/6	2006/7	2007/8
Existing MEPS Projects			
Linear fluorescent lamps (phase 1)			
Linear fluorescent ballasts (phase 1)*			
New MEPS Projects			
Halogen transformers*	X		
New buildings (building code of Australia)	X		
CFLs*	X		
Public amenity lighting	X		
Luminaires*		X	
Halogen Lamps (including reflector lamps)		X	
HPS lamps			X
HID ballasts			X
New Non-MEPS Projects			
Energy Allstars high efficiency product database	X		
Education and training for specifiers	X	X	X

*These MEPS projects include some form of comparative or endorsement labelling.

8.3. Proposed Criteria and Performance Standards for CFLs in Australia

The existing test methods for CFLs in Australia are based on IEC procedures and are suitable for testing most of the criteria used to evaluate the performance of CFLs. An additional test method for the determination of mercury content has been developed in association with the regulatory standards for linear fluorescent lamps and is applicable to CFLs. This can be added as an appendix to the existing test methods.

As shown in previous sections, there are a range of criteria typically used to determine the performance of CFLs, some of which are common to most programs currently in existence. These are important considerations since issues such as the lamp lifetime, colour and start-up time tend to be those of greatest concern to consumers. The major performance criteria covered by most programs, and which should be included in the Australian program, are:

- Efficiency level
- Lumen maintenance
- Rated average lifetime
- CFL lifetime claims
- Power factor
- Colour rendering
- Mercury level
- GLS equivalence
- Start-up time

Each of these criteria would have one set of performance levels for MEPs and a second set for the endorsement label, with the latter typically being more stringent.

In terms of setting appropriate performance standards, the Australian Government has a policy of matching world's best practice, where feasible. For self-ballasted CFLs the most stringent MEPS and endorsement label energy performance levels are those used in China, although other programs have more stringent levels for other criteria.

China is also the source of the majority of CFLs sold in Australia, so harmonising with the Chinese programs would mean that lamps could be tested at source in China to determine their eligibility in Australia. This would reduce the testing requirements on Australian suppliers and the enforcement burden on Australian regulators. Therefore matching the Chinese performance levels is a logical choice for the Australian programs.

While this is the best option currently, international efforts to rationalise and harmonise test and performance standards should be monitored during the next one to two years (approximately the time taken to introduce standards) so that Australian proposals can be fine-tuned.

The push for international harmonisation will be launched at a special session hosted by Australia at the Right Lights 6 Conference in Shanghai in May 2005. It is envisaged that if supported by sufficient countries, harmonisation will be achieved over the following three years. A copy of the proposal to be discussed at this meeting is included in Appendix 4.

Full international harmonisation will substantially enhance the performance of CFLs everywhere, and support the initiatives undertaken in each individual country, including Australia. The timing is such that there is no need to delay proceeding with Australia's plans in order to ensure that we are part of this global initiative.

8.4. What type of endorsement label would be suitable?

Many of the existing major CFL endorsement labels use similar scope and criteria on which to base an Australian endorsement label. Not all programs currently include pin-type CFLs however, and since the use of these should be encouraged, it would seem sensible for them to be included at some stage. Whether wider environmental requirements, such as mercury content, should be included is a matter for debate and it is likely that further discussions with industry, consumer groups and other stakeholders will be useful in order to define the scope.

The Australian Greenhouse Office has a licensing arrangement with the US EPA covering the use of the Energy Star program in Australia, which currently covers home entertainment and office equipment. The Energy Star CFLs criteria are based on US test methods which are similar but not identical to the IEC test methods, which is one reason why no other country outside the United States has used this label. Discussion have been underway between Energy Star and a number of countries about setting CFL criteria suitable for a 230volt/50Hz system, and it appears that this might be possible.

Another endorsement label used in Australia is the Top Energy Saver Award (TESAW), which is currently used to promote domestic wet goods, refrigerators and freezers, and some air conditioners.

Both of these options appear to be suitable, however there is also discussion regarding the use of an international symbol, such at the ELI logo, at some stage in the future, pending decisions on further harmonisation. The use of a truly international label, tied to an international test method and set of criteria, would also be appropriate and should be encouraged by Australia.

A final decision on the form of endorsement label should be made following further discussions between the government and industry.

9. Recommendations

It is recommended that the NAEEEC undertakes the following actions:

1) Implements MEPS and an endorsement label for self-ballasted CFLs based on the existing Australian test method "AS/NZS 60969 (2001): Self ballasted lamps for general lighting services – Performance requirements";
2) Proceeds on the basis that the performance levels will be aligned with China (see below), on the understanding that these may change during time taken to develop the Australian program;
3) Indicates to industry that the levels selected for the endorsement label are likely to be adopted as future MEPS levels 3-4 years after the implementation of the first MEPS;
4) Pursues plans for the international harmonisation of test and performance standards at the Right Light 6 conference in Shanghai in May 2005, and further if supported by sufficient numbers of other countries;
5) Undertakes market research on consumer expectations and experiences with respect to CFLs (it is understood that the AGO has commissioned a study to be undertaken in March/April 2005);
6) Consults with industry and other stakeholders, including the US EPA, on whether the endorsement label used should be either Energy Star, TESAW or some other option such as ELI;
7) Considers introducing MEPs and an endorsement label for pin-type CFLs within 3 years;
8) Detailed recommendations for specifications are shown in Table 7.

Table 7: Summary of recommended specifications for self-ballasted CFLs

	MEPS	**High Efficiency**
	Self-ballast	**Self-ballast**
Efficiency level	**L/w**	**L/w**
Rating (W)	Colour temperature: > 4400	Colour temperature: > 4400
5 - 8	36	46
9 - 14	44	54
15 - 24	51	61
25 - 60	57	67
Rating (W)	Colour temperature: < 4400	Colour temperature: < 4400
5 - 8	40	50
9 - 14	48	58
15 - 24	55	65
25 - 60	60	70
Sample:	*10: at least 8 must comply*	*10: at least 8 must comply*
Test Methods	AS/NZS 60969 (2001)	AS/NZS 60969 (2001)
Lumen Maintenance	After 2000h testing lumen maintenance (l_m) must be ≥ 80% $l_{(100)}$.	After 2000h testing lumen maintenance (l_m) must be ≥ 80% $l_{(100)}$.
	Note: the test is conducted with lamps switched off for 15 minutes after every 2 hours 45 minutes on.	Note: the test is conducted with lamps switched off for 15 minutes after every 2 hours 45 minutes on.
Sample:	*10: at least 8 must comply*	*10: at least 8 must comply*
Rated Average Lifetime	≥ 6000 hours	≥ 10,000 hours
CFL Lifetime Claims	CFL Rated Lifetime	Lifetime Claim
	6,000 hours	4 years
	8,000 hours	5 years
	10,000 hours	7 years

	12,000 hours		8 years	
	15,000 hours		10 years	
Lamp Position	No specific requirement		Declaration of orientation(s) which cause > 5% luminous flux output is required	
Power Factor	0.5		0.9	
Colour rendering	No specific requirement		> 4400: CRI ≥ 80 2700-4400: CRI ≥ 82 < 2700: CRI ≥ 84	
Mercury level	5mg per lamp	5mg per lamp	5mg per lamp	5mg per lamp
GLS Equivalence	CFL Luminous Flux Claim (lm)		Rated Wattage of Equivalent GLS Filament Lamp	
Where a claim is made that the rated luminous flux of the CFL is equivalent to, or exceeds that, of an equivalent GLS filament lamp, the lamp rating must comply with the following requirements	≥ 214		≤ 25 W	
	≥ 386		≤ 40 W	
	≥ 530		≤ 50 W	
	≥ 660		≤ 60 W	
	≥ 874		≤ 75 W	
	≥ 1100		≤ 90 W	
	≥ 1246		≤ 100 W	
	≥ 2009		≤ 150 W	

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Kerney 2004	Presentation: "State of Energy Star CFL Program" April 27 2004. Richard Karney, US Department of Energy.
Lui Hong 2003	*MEPS, Certification and Improvements in Production Capacity for Starters! Where is China Greenlights Going Next?* Paper by Lui Hong, Han Wenke, Lu Wenbin, Adam Hinge, Stuart Jeffcott. Presentation China Green Lights at EEDAL Conference, Italy, 2003.
MEA 2004	Survey of Bunnings conducted for this research, December 2004
MEA 2005	Estimates based on world trade figures, provided by D. Fridley, LBNL, US. February 2005.
MTP 2000	Information on Website: http://www.mtprog.com/
New Perspectives 2003	pers.com. Robin Sadler, Director New Perspectives.

Appendix 1: COMMISSION DIRECTIVE 98/11/EC of 27 January 1998 implementing Council Directive 92/75/EEC with regard to energy labelling of household lamps

The energy efficiency class of a lamp shall be determined as follows:

Lamps shall be classified in class A if:

- Fluorescent lamps without integral ballast (those requiring a ballast and/or other control gear to connect them to the mains)

$$\mathbf{W \le 0{,}15\ \sqrt{\phi} + 0{,}0097\phi}$$

- Other lamps

$$\mathbf{W \le 0{,}24\ \sqrt{\phi} + 0{,}0103\phi}$$

where ϕ is the lumen output of the lamp

where W is the power input into the lamp in watts.

If a lamp is not classified in class A, a reference wattage W_R shall be calculated as follows:

$W_R = 0{,}88\ \sqrt{\phi} + 0{,}049\phi$, when $\phi > 34$ lumens

$0{,}2\ \sqrt{\phi}$, when $\phi \le 34$ lumens

where ϕ is the lumen output of the lamp.

An energy efficiency index E_I is then set as:

$$\mathbf{E_I = W / W_R}$$

where W is the power input into the lamp in watts.

The energy efficiency classes are then set in accordance with the following table:

Table 8: Definitions of Energy Efficiency Classes

Energy efficiency class	Energy efficiency index EI
B	$E_I < 60\ \%$
C	$60\% \le E_I \le 80\ \%$
D	$80\% \le E_I \le 95\ \%$
E	$95\% \le E_I \le 110\ \%$
F	$110\ \% \le E_I \le 130\ \%$
G	$E_I \ge 130\ \%$

Appendix 2: Details of CFL MEPS Programs

A. China Green Lights

The standard for integral CFLs (GB /T 19044—2003) and pin-type CFLs (GB 19415—2003) came into force in June 2003, and sets two thresholds:

- Minimum Efficiency Standards – The standard that all products must achieve to go on sale;
- Certification Standards – An optional efficiency level for premium products.

Certification labelling to enable the easy identification of premium (both quality and efficiency) products by consumers is relatively new within China. This is particularly true for lighting products for which no similar work has taken place before; a situation that has led to a serious souring of the market for CFLs as poor quality products have disappointed consumers who have then switched back to incandescent lamps.

Tables 9 and 10 show the MEPS and certification efficiency thresholds for integral and pin-type CFLs respectively.

Table 10: Energy Efficiency Thresholds for Self-Ballasted Fluorescent Lamps (CFLs)

Rating (W)	Initial Luminous Efficacy (lm/W)			
	Energy Efficiency Grades (Colour temperature: > 4400)		Energy Efficiency Grades (Colour temperature: < 4400)	
	Certification	Minimum	Certification	Minimum
5 - 8	46	36	50	40
9 - 14	54	44	58	48
15 - 24	61	51	65	55
25 - 60	67	57	70	60

Table 11: Energy Efficiency Thresholds for Pin-type Compact Fluorescent Lamps (CFLs)

Lamp Type	Rating (W)	Initial Luminous Efficacy (lm/W)			
		Energy Efficiency Grades (Colour temperature: > 4400)		Energy Efficiency Grades (Colour temperature: < 4400)	
		Certification	Minimum	Certification	Minimum
2-tube, 4-tube, muliti-tube and square	5 – 7	51	41	54	44
	9、10、13	60	50	64	54
	11 (two-tube)	74	67	80	72
	16 – 26	62	56	66	60
2-tube, square	≥28	69	62	73	66
multi-tube	≥28	64	54	68	58
ring	22	58	44	62	51
	≥32	68	48	72	57

Further requirements for certification include:

- Life time ≥ 6000h
- CRI: Colour temperature > 4400 – CRI ≥ 80

  2700-4400 – CRI ≥ 82

2700 – CRI ≥ 84

- Lumen maintenance: After 2000h testing (with 2 hours and 45 minutes on and 15 minutes off) lumen maintenance must be ≥ 80.

The testing requirements (GB/T 17263 and GB/T 2828) are almost equivalent to IEC standards.

There are currently about 20 manufacturers who have applied for certification for CFL; and 14 have received certification covering about 200 products. (Lui Hong 2003)

Although formal adoption of the new certification procedures is yet to occur, 20 manufacturers have already submitted over 300 products for certification.

B. Top Runner Program (Japan)

Japan does not have MEPS. Instead, Japanese manufacturers and importers are obliged under the Law Concerning the Rational Use of Energy (Law No.49 of 1979) to meet a weighted average target standard for all their products in a category by a specified year (target year). That is, the average efficiency of all products shipped by a manufacturer or importer in the target year must be above the set standard.

The standard is usually set using the most efficient product in the market as a benchmark to be reached by the target year. If a manufacturer wishes to sell products that do not meet the standard, they must also make products which have a much higher efficiency to adjust their weighted average to meet the target. This average target approach encourages energy efficient products without excluding products which do not meet the target value from the market, retains product diversity and provides flexibility to meet consumer demands.

Notification No. 191 of the Ministry of International Trade and Industry of 1999 set target levels for all fluorescent lighting appliances to be met by during the 2005 to 2006 financial year. Table 12 sets out the targets for lighting appliances which use CFLs. Manufacturers or importers who ship less than 30, 000 units are exempt from the target.

Table 12: Top Runner Program Energy Efficiency Requirements

Category	Standard Energy Consumption Efficiency (lm/W)
Lighting appliances that use type 96 compact single-capped fluorescent lamps	79
Lighting appliances that use type 36 and type 55 compact single-capped fluorescent lamps and type 32, type 42 and type 45, high frequency lighting only compact single-capped fluorescent lamps	86.5
Desktop lamps that use compact single-capped fluorescent lamps	62.5

Energy consumption efficiency is calculated from measurements of luminous flux and power consumption. Details for how these are measured are given in Table 12.

The calculations are as follows:

energy consumption efficiency (lm/W) = luminous flux (lm) / power consumption (W)

luminous flux (lm) = total luminous flux (lm) x optical power coefficient of ballast x temperature correction coefficient

optical power coefficient of ballast = optical power of ballast / optical power of reference ballast

Table 13: Top Runner Testing method

Measurement	Details
Total luminous flux (lumens)	Japanese Industrial Standard C7601 Initial Characteristics Tests
Optical power of ballast	Ambient temperature of 25±2°C For magnetic ballasts, Japanese Industrial Standard C8108 Lamp Current and Lamp Power Tests is used. For electronic ballasts, Japanese Industrial Standard C8117 Lamp Current and Optical Power Tests is used.
Temperature correction coefficient	Determined from tables in Notification No.191 of the Ministry of International Trade and Industry depending on the tube wall temperature
Tube wall temperature (°C)	Ambient temperature of 25±2°C Fluorescent lamp fixtures shall be installed as stipulated in C8106 of the Japanese Industrial Standard or in Normal Temperatures under C8115. A lamp specified in Annex 2 Reference Lamps of the Japanese Industrial Standard C8108 shall be fitted to fluorescent lamp fixtures and lit by the application of electricity of the rated frequency and rated voltage. This shall be continued until the lamp tube wall temperature becomes stabilized, thereby enabling measurement of the temperature of the lamp tube wall at its coldest point.
Power consumption (W)	Measured using Japanese Industrial Standard C8105 Input Tests under the following conditions: For magnetic ballasts, Japanese Industrial Standard C8108 Lamp Current and Lamp Power Tests is used. For electronic ballasts, Japanese Industrial Standard C8117 Lamp Current and Optical Power Tests is used.

C. MEPS in Mexico

In 1998, an Official Mexican Standard (Normas Oficiales Mexicanas or NOM) was implemented for CFLs under the Federal Law of Metering and Standards. It is compulsory for all CFLs up to 28W to meet the efficiency levels set out in Table 14 and for ballasts in modular systems to meet the efficiency levels in Table 15. The standard is in partial agreement with IEC 901-1987, amended in 1989 and 1992, however, the electricity supply in Mexico is 60Hz. The method of test is detailed in Table 16.

Table 14: Mexican Lamp Efficiency Limits

Type	Nominal Power (W)	Voltage (V)	Nominal Operating Current (mA)	Base	Bulb	Minimum Efficiency (lm/W)
T	5	38	180	G23	T-4	38
T	7	45	180	G23		50
T	9	59	180	G23		55
T	13	59	285	GX23		52.5
Q	9	59	180	G23-2	T-4	51
Q	13	59	285	G23-2		52
Q	18	100	220	G24d-2		60.5
Q	26	105	325	G24d-3		61.5

Table 15: Mexican Ballast Efficiency Limits

Nominal Lamp Operating Power (W)	Minimum Ballast Factor (%)	Minimum Ballast Efficiency Factor
7	92.5	9.00
9		7.80
13		5.10
18 (108 V_{OCV})		4.00
18 (198 V_{OCV})		3.30
26		2.50

Table 16: Mexican Testing method

Specification	Mexican Standard
Ballast efficiency	NMX-J-156-ANCE
Ballast pattern	NMX-J-197-ANCE
Method for measuring ballasts	NMX-J-198-ANCE
Lamp efficiency	NMX-J-295-ANCE

D. MEPS and Labelling Programs in South Korea

The mandatory labelling and MEPS program for CFLs came into force in 2000 under the Law on the Rationalized Use of Energy and is administered by the Korea Energy Management Corporation (KEMCO). Two thresholds are defined:

- MEPS – this standard defines the lowest rating of 5 on a comparative label and all products on sale must exceed the MEPS level in Table 17.
- Target Energy Performance Standards (TEPS) – this standard defines the top rating of 1 on a comparative label

The labelling program compares the performance of different products to the TEPS level and assigns a rating according to Table 18. The standard levels are revised every few years with the old TEPS level becoming the new MEPS level.

Table 17: South Korean MEPS and TEPS

Range	MEPS (lm/W)	TEPS (lm/W)
< 10W	42.0	48.3
≥ 10W and ≤ 15W	48.0	55.2
> 15W	58.0	66.7

Table 18: South Korean Rating Criteria

R	Grade
R ≤ 1.00	1
1.00 < R ≤ 1.06	2
1.06 < R ≤ 1.09	3
1.09 < R ≤ 1.12	4
1.12 < R ≤ 1.15	5

Where the grade index is given by:

R = target consumption efficiency (lm/W) / measured consumption efficiency (lm/W).

Appendix 3: Details of CFL Labelling Programs

3.A Summary of Energy Saving Trust Requirements (UK)

Since 2000, the Energy Saving Trust has maintained a web-based list of 'Recommended' CFLs, which are entitled to carry the energy efficiency logo. The CFL criteria has been updated subsequently and a summary of the key requirements are shown in Table 19 below.

The endorsement label covers both self-ballasted CFLs and pin-type models, divided into the following categories:

Group 1: Self Ballasted

a. Integral:
   - 'S' which meet Class A of EU Directive on energy labelling of lamps
   - 'L' which meet Class B of EU Directive on energy labelling of lamps, but 85% of minimum efficacy requirements

b. Two-part with electronic control gear, sold as a single entity:
   - 'T' meeting the requirements of Group 2 below

Group 2: Pin-Type

- Lamps requiring separate electronic ballasts, provided in a suitable luminaire or adaptor (as with 'T')

There are currently 104 eligible products on the UK market, equally divided between self-ballasted and pin-based CFLs (see Table 19).

Table 19: Energy Saving Trust 'Recommended' CFLs

	2 part	2-pin	4- pin	Self ballasted
GE	1	1	4	15
Lumin				2
Megaman				2
Osram				15
Panasonic		3	3	5
Philips		12	13	8
Sylvania		8	8	4
Total	**1**	**24**	**28**	**51**

Table 20: Summary of EST Requirements for Recommended CFLs (Vs 3.2.2: November 2002)

Item	Requirement	Detail
Luminous efficacy	Class S lamps	Not less than EU Directive 98/11/EU requirements for class A energy label compliance (see Figure 14)
	Class L lamps	Not less than 85% of Class A energy label compliance (see Figure 14)
	Class T lamps	As above
Lumen maintenance	Class S lamps Class L lamps Class T lamps	Determined at 2,000 hours and declared median life not be less than minimum in Figure 14

		Figure 15
Photometric testing	Test voltage 240V	Appendix A, EN 60969
Luminous flux run-up	60% by 60 seconds 10% by 2 seconds	20ºC to 25ºC
Correlated colour temperature	2650K to 2800K	------------
General colour rendering index	$R_a \geq 80$	------------
Lamp orientation for proper operation	Luminous flux drop ≤ 5% for all operating positions	Declaration of orientation(s) which cause > 5% required
Life Test (normal cycle) Declared Median Life, Class S Declared Median Life, Class L	Supply voltage 240V, unless evidence is provided that 230V or 235V is equivalent. ≥ 12,000 hours ≥ 6,000 hours	EN 60969 - Appendix A, (n = 20) Termination of test not before actual 50% failure point of sample ------------- -------------
Declared Median Life, Class T	The lifetime of the ballast ≥ four times the rated life of the lamp component	
Electromagnetic Disturbance	Not exceed values in EN 55015	Immunity to electromagnetic disturbance to EN 61547
Power Factor	High Power Factor Others	≥ 0.9 ≥ 0.5

The requirements for Class T Pin-Type lamps are:

- lamps shall conform to En 60901
- The lumen flux shall not fall below the line in Figure 16.

To justify claims of initial luminous levels equivalent or similar to a standard tungsten filament lamp rating, the declared lumen output of the CFL lamp shall not lie below the relevant line in Figure 17 and Figure 18.

Figure 14: EST Efficacy Requirements for Recommended CFLs

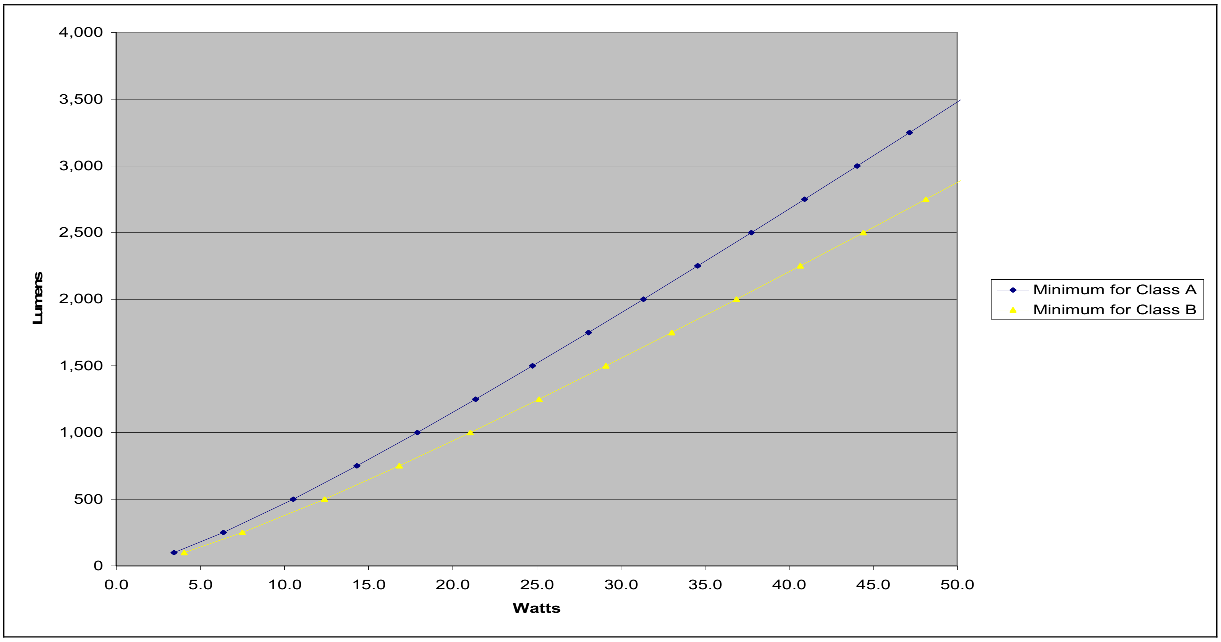
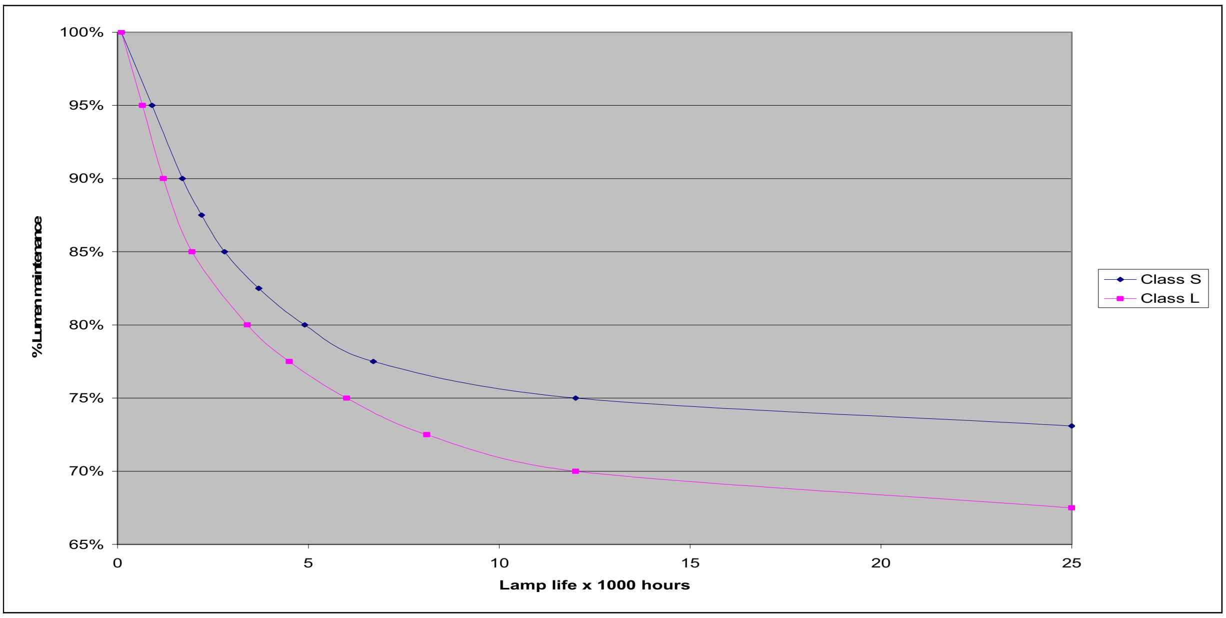
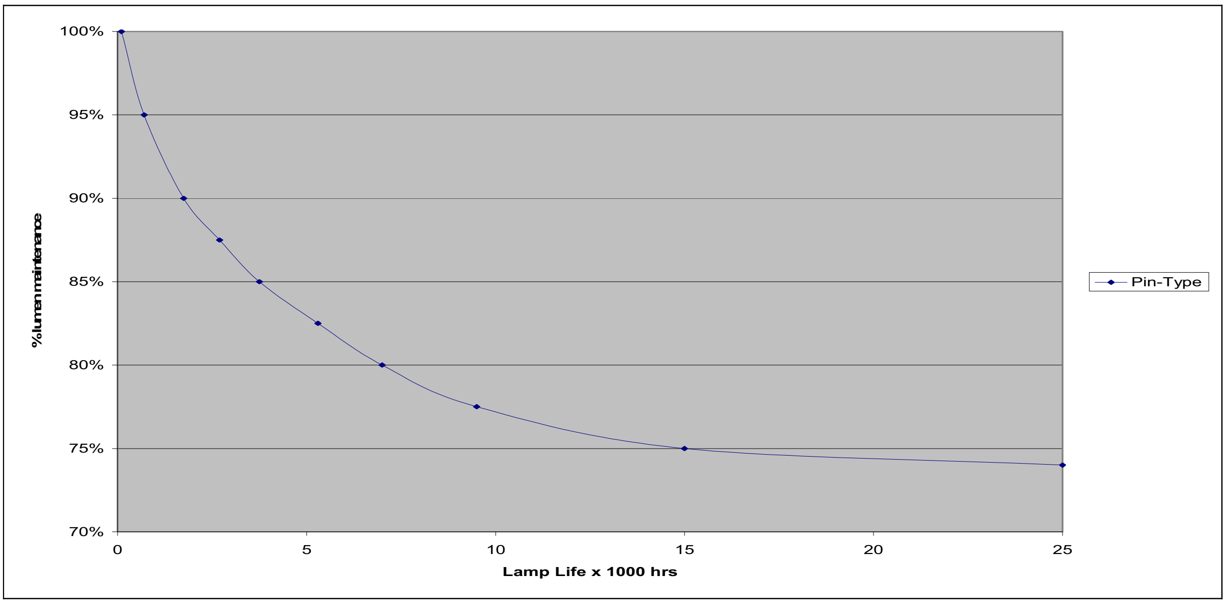


Figure 15: EST Lumen Maintenance Requirements for Recommended CFLs, Class S and L



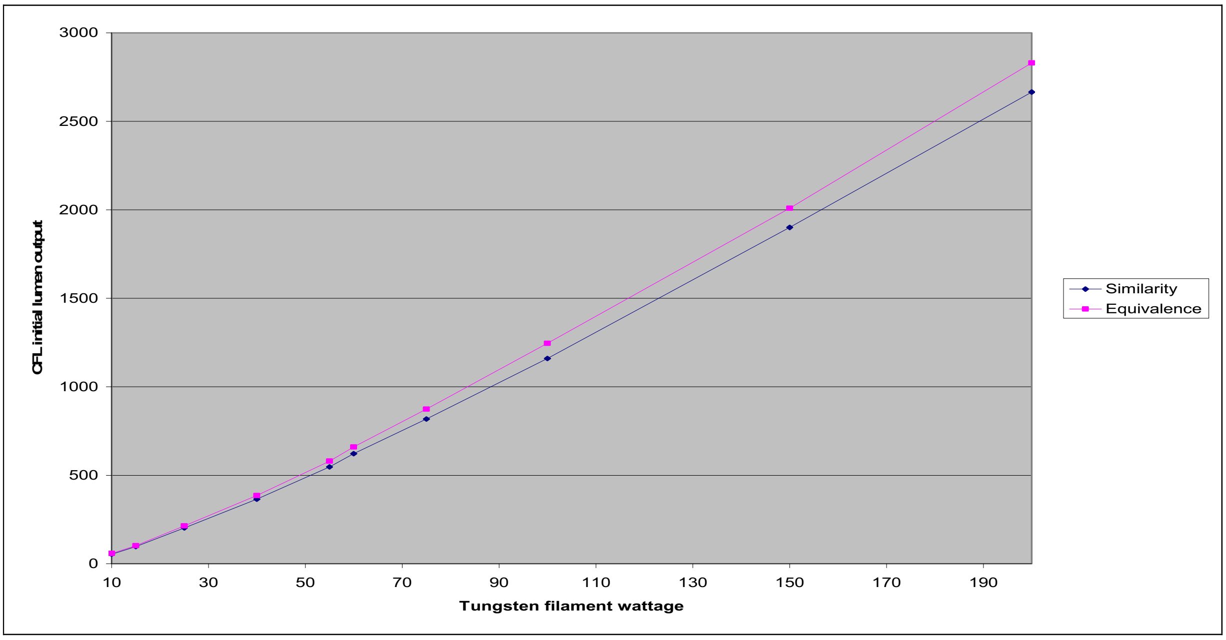
(Note: this figure is reproduced from hard copies and is approximate only)

Figure 16: EST Lumen Maintenance Requirements for Recommended CFLs, Pin-Type



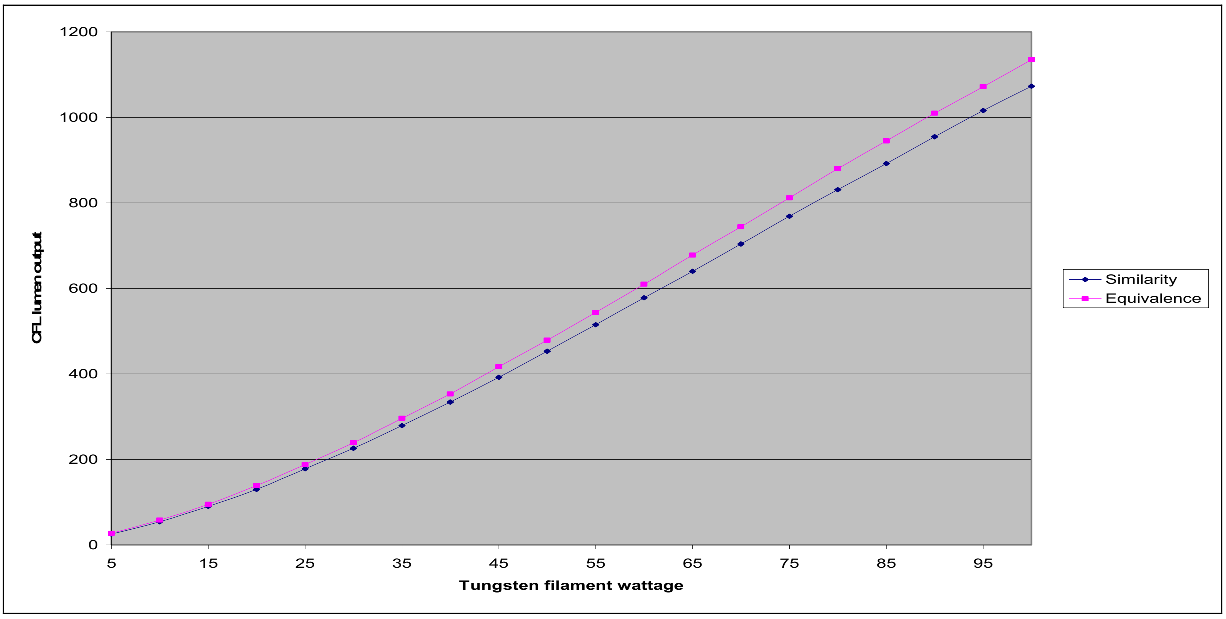
(Note: this figure is reproduced from hard copies and is approximate only)

Figure 17: EST 'Equivalence' Requirements for Recommended CFLs Compared to Clear GLS Tungsten Filament



(Note: this figure is reproduced from hard copies and is approximate only)

Figure 18: EST 'Equivalence' Requirements for Recommended CFLs, Compared to 'Soft' Coasted GLS Tungsten Filament



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3.B Summary of Energy Star Requirements

The Energy Star program for CFLs was launched in 1999 and there are now 1,044 products meeting current requirements in the US.

In an assessment of the Energy Star program for CFLs, Calwell et al (2002) suggest that the high growth rates achieved in the US 2001 (mentioned previously) were a combination of a number of factors, not least a sustained focus of a number of programs over a period of time, which had a cumulative impact on the technology and consumers. The authors point out that the technology has evolved very quickly over the past five years, providing many models of various shapes. While Energy Star labelling played a part in this, it was only one element of consumer education. It is noteworthy that the aim for Energy Star over the near future is to move away from consumer education and to focus more on refining product specifications.

The following table lists the major requirements for products that wish to qualify for the Energy Star endorsement label from 1.1.2004.

Table 21: Energy Star CFL Criteria (2004)

Minimum Efficacy	Lamp power < 15	45 Lumens/watt	Based on initial lumens
	Lamp power ≥ 15	60 Lumens/watt	Based on initial lumens
1,000-hour Lumen Maintenance	Average lumen output measurement of 10 lamps tested must be greater than 90.0% of initial (100-hour) lumen output @ 1,000 hours of rated life.		
Color Rendering (CRI)	Average of the 10 samples tested must be greater than 80.0		
Correlated Color Temperature (CCT)	2500 - 2699K:	Warm White	
	2700 – 3099K:	Soft White	
	3100 - 4199K:	White	
	4200 - 5000K:	Cool White	
	6500K (or greater):	Daylight	
Lumen Maintenance	Average of 10 samples tested must be greater than 80.0% of initial (100-hour) rating at 40% of model's rated life (Per ANSI C78.5, Clause 4.10)		
Power Factor	Average of 10 samples tested must be greater than 0.50		
Run-up Time	Average of 10 samples tested must be less than 3.0 minutes per ANSI C78.5, clause 3.11 and 4.8		
Starting Time	Time after switching on until full start (and remain lighted) shall be an average of < 1.00 second		
CFL/Incandescent Equivalency	A-Shaped Incandescent bulb (Watts)	Typical Luminous Flux (Lumens)†	† Lumens must be 100 hr, initial values
	40	Minimum of 450	
	60	Minimum of 800	
	75	Minimum of 1,100	
	100	Minimum of 1,600	
	150	Minimum of 2,600	
Electromagnetic Interference	Compliance with FCC 47 CFR including Part 2 (Equipment Authorization) and Part 18 (Technical Standards and Emission Limits) for consumer RF Lighting Equipment requirements for consumer limits		
Rapid Cycle Stress Test	Test Per ANSI C78.5 and IESNA LM-65 (clauses 2,3,5, and 6)		
	Exception: Cycle times must be 5 minutes on, 5 minutes off. Lamp will be cycled once for every two hours of rated lamp life. At least 5 out of the 6 sample lamps must meet or exceed the minimum number of cycles.		
Interim Life Test	@ 40% of rated life report on lamp life: < 2 sample failures		
Average Rated Lamp Life	> 6,000 hours as declared by the manufacturer on packaging and qualification form. Partner must complete lifetime test to stated rated lamp life on packaging (i.e. – if CFL is marketed as a 10,000 hour CFL, it must complete the life time test to 10,000 hours).		
Warranty	Product packaging must state "Warranty" or "Limited Warranty" ,		
	An "800" number, and mailing address, and web site (if applicable)s (or e-mail address) for consumer complaint resolution.		

For Residential Applications: Warrantor limited warranty statement must cover at least a minimum of 24 months (2 years) from date purchase based on 4 hours per day usage.

For Commercial Applications: Warranty or limited warranty statement must cover at least a minimum of 12 months (or 1 year) from date of purchase,

Mercury Statement

Package must state "Lamp Contains Mercury" and include Mercury symbol.

It is recommended (not required) that partners also provide a web site and an 800 number to direct consumers to access specific information on proper CFL disposal.

Required Disclaimer for CFL Guarantee / Lifetime Claims for Residential Use

For residential-use CFLs, partners must adhere to the chart below to reference how long the CFL will last (i.e. "guaranteed to last 4 years") and must include footnote to reference the 4 hours of use per day.

ENERGY STAR Qualified CFL Rated Lifetime	Residential Use – Number of Years Claimed (based on 4 hours/day)
6,000 hours	4 years
8,000 hours	5 years
10,000 hours	7 years
12,000 hours	8 years
15,000 hours	10 years

3.C Summary of Hong Kong Requirements

Suppliers of compact fluorescent lamps (CFLs) which meet specified efficacy levels (expressed in lumen/W) may register their products for the use of an endorsement label. The scheme covers electrically operated CFLs intended for general lighting purposes with a rated voltage of 220V, frequency of 50Hz and rated lamp wattage of up to 60W.

Two classes are covered:

- Integrated CFL (FB)s with built-in control gear (for which the lumen/W efficacy calculation includes the lamp control gear loss); and
- Non-integrated CFLs (FS) without built-in control gear (for which the lumen/W efficacy calculation excludes the lamp control gear loss).

The minimum allowable efficacies that CFLs of different wattage and type must meet to qualify for the endorsement label are summarised in the table below:

Table 22: Minimum Efficacy for CFL Endorsement Labels, Hong Kong

Integrated CFL (FB) with control gear		Non-integrated CFL (FS) without control gear	
Rated lamp wattage	Minimum allowable luminous efficacy (lumen/W)	Rated lamp wattage	Minimum allowable luminous efficacy (lumen/W)
$\leq$ 10W	45	$\leq$ 10W	50
11 - 20W	50	11 - 30W	65
21 - 30W	55		
$\geq$ 31W	60	$\geq$ 31W	75

Other performance requirements for labelled CFLs are:

- The rated average lamp life to be not less than 8,000h; and
- Lumen maintenance at 2,000 hrs to be not less than 78%.
- Colour Rendering Index of at least 80.
- Mercury content of the CFL shall not exceed 15 mg.

3.D Summary of Taiwanese GreenMark Program Requirements

The GreenMark Program is an endorsement label for CFLs. The overall energy efficacy of the production system, containing ballast and bulb (tube), shall meet the following conditions:

- For lamp wattage less than 10 watts, lamp efficacy must be greater than 50 lumens/watt;
- For lamp wattage between 10 and 20 watts (or equal to 20 watts), lamp efficacy must be greater than 55 lumens/watt;
- For lamp wattage between 20 and 30 watts (or equal to 30 watts), lamp efficacy must be greater than 60 lumens/watt; and
- For lamp wattage greater than 30 watts, lamp efficacy must be greater than 70 lumens/watt.
- The mercury content of each lamp bulb or tube must not exceed 10mg.
- Cadmium and arsenic must not be contained in the raw material.
- The lamp bulb (or tube) and the ballast shall be separable and replaceable. The total weight must not exceed 200g.
- Rate of flickering shall be less than 2%.
- The life span of the product shall be 8000 hours or over.
- Lamps must have a color rendering of not less than 80.
- Total harmonic distortion must be less than 33%.
- Power factor shall be greater than 90%.
- Raw material used for manufacturing of the product shall not contain radioisotopes.
- No volatile organic compound shall be used as a medium for the phosphors coating on the inner surface of the bulb (or tube).
- The packing material for the product shall not be a foaming material.
- Restraints on the product usage must be shown on the packaging material, e.g. "Do not use this lamp with an adjustable switch, nor in poorly ventilated lamp ornaments, nor for frequently switching places".
- The name and address of the Green Mark user shall be clearly shown on the product or the packaging material. For non-manufacturing Logo users, the manufacturer's name and address shall also be shown.
- The product or packaging material shall bear a label reading "Energy-saving."
- The packaging box used for the product is recommended to be made from recycled pulp with at least 80% recycled paper.

3.E Canadian Environmental Choice Program

The requirement for certification under the Environmental Choice Program is that all CFLs must have an energy efficiency of at least 3.6 cfm/watt.

3.F Efficient Lighting Initiative

The Efficient Lighting Initiative (ELI) is a $15 million program aimed at reducing greenhouse gas emissions by increasing the use of energy-efficient lighting technologies in seven countries: Argentina, the Czech Republic, Hungary, Latvia, Peru, the Philippines, and South Africa. ELI is funded by the Global Environment Facility (GEF) and implemented by the International Finance Corporation (IFC).

The ELI technical specification was revised in July 2002 and is summarised in Table

24. There are currently 78 CFL models which meet these criteria (see Table 23).

Table 23: CFLs Complying with ELI Criteria, by Manufacturers

Manufacturer	CFLs (all types)
Beauty Shadow	2
CE Lighting	4
Duralutz	3
GE	24
GFL	4
Indo Asian	1
Lumin8	1
Osram	18
Philips	18
Ultralite	3
Total	**78**

Table 24: ELI Criteria

Laboratory and Test Requirements	Performance Specifications
Laboratory Facility	Must be accredited according to ISO 17025, or equivalent standard. Accreditation document must be provided to ELI.
Testing Conditions	Performed at 25°C in an atmosphere with maximum relative humidity of 65%.
Position and Initial Burn-in	Measurements should be recorded from products in the VBU position, after an initial burn-in period of 100 hours at stabilized light output and current.
Test Data and Sample Size	Test data must be from the model for which qualification is sought. Values indicated on the application form shall be calculated as the average of the data from all the units tested. Measurements of electrical characteristics must be submitted for at least 10 units of the same CFL model. Measurements of photometric characteristics must be submitted for at least three units of the same CFL model.
Longevity of Test Results	Test results must be less than two years old, unless the manufacturer can document to ELI's satisfaction that older test results accurately portray the performance of the present model.

Efficiency Specifications
The CFL package must clearly state the performance of the following characteristics, as defined in IEC 60969: • Rated input power in watts; and • Light output in lumens
Efficiency shall be calculated from luminous flux and input power for the specific lamp and ballast combination in the CFL measured at 25 °C and 220 V. To qualify, CFLs of any tube configuration shall meet the following minimums.
If CFL has either an integral or a separate ballast • At input power of <15 W: ≥ 45 lm/W • At input power of ≥15 W and > 4000 CCT: ≥ 55 lm/W • At input power of ≥ 15 W and ≤ 4000 CCT: ≥ 60 lm/W
If CFL has a translucent cover • At input power of ≤ 14 W: ≥ 40 lm/W • At input power of 15 to 19 W: ≥ 48 lm/W

• At input power of 20 to 24 W: ≥ 50 lm/W At input power of : ≥ 25 W: ≥ 55 lm/W
If CFL has a reflector • At input power of <19 W: ≥ lm/W • At input power of ≥ 19 W: ≥ 40 lm/W

Operating Characteristics	**Performance Specifications**
Lamp Start	CFL must continuously illuminate within 1.5 seconds of being switched on at minimum rated starting temperature and maximum power. Prior to measurement CFL must be switched off for at least 30 minutes.
Starting Temperature	CFL package must declare the minimum starting temperature and any other conditions (such as installation in an enclosed luminaire) that would affect either reliable starting or the starting time.
Lifetime	CFLs must have a minimum rated lifetime of 6,000 hours as defined in IEC 60969. Lifetime shall be clearly indicated in hours on product packaging.
Safety	CFLs must meet all local safety requirements and the requirements of IEC 60968 for unitary CFLs and applicable parts of IEC 61199 and 60598 for modular CFLs.

Light Characteristics	**Performance Specifications**
Correlated Color Temperature	Correlated color temperature (CCT) of CFL must appear on product packaging (as defined in IEC 60969 and measured in accordance with IES LM-16-1984, “Colorimetry of Light Source” and the *1993 IESNA Lighting Handbook*).
Color Rendering	Color Rendering Index (CRI) of at least 80 for fluorescent lamps with a diameter less than 2.0 cm. CRI of at least 70 for all other lamps (as defined in IEC 60969, measured in accordance with CIE 29/2).
Lumen Maintenance	After 2000 hours of operation the luminous flux of CFLs must be ≥ 80% of initial levels (measured in accordance with IES LM-66-1991 or IEC 60969 for unitary CFLs, IEC 60901 for modular CFLs).
Stabilized Light Output	The time to 75% of stabilized light output after switch-on shall not exceed 100 seconds, or, the time to 80% of stabilized light output after switch-on shall not exceed 120 seconds (measured in accordance with IEC 60969).

Other	**Performance Specifications**	
Comparison of CFL to GLS on Label**	Lumen output noted on package must be the luminous flux as reported to ELI for the specific lamp and ballast combination in the package. Where the packaging or other literature claims that the rated luminous flux of the CFL is equivalent to, or exceeds that, of an equivalent GLS filament lamp the lamp rating must comply with the following requirements:	
	CFL Luminous Flux Claim (lm)	Rated Wattage of Equivalent GLS Filament Lamp
	≥ 214	≤ 25 W
	≥ 386	≤ 40 W
	≥ 530	≤ 50 W
	≥ 660	≤ 60 W
	≥ 874	≤ 75 W
	≥ 1100	≤ 90 W
	≥ 1246	≤ 100 W
	≥ 2009	≤ 150 W
	In addition, manufacturers must notify ELI if the CFL exhibits ≥ 10% light output degradation due to: • Operation outside of rated temperature range or, • Operation in other than VBU position or, • Any other factors	
Warranty	Purchaser may return the CFL to point of purchase with no explanation necessary within 12 months from the date of purchase for a full refund. Written warranty in at least one applicable local language must be included with CFL when purchased. Manufacturer shall provide a local address for customer contacts and complaints.	
Quality of Production	CFLs must be manufactured under a Quality Assurance System in accordance with ISO 9000-2000 or equivalent (equivalency to be determined by ELI).	

3.G European Eco Label

The European Eco-label is a voluntary scheme enabling European consumers to easily identify officially approved green products across the European Union, Norway, Liechtenstein and Iceland. It allows producers to show and communicate to their customers that their products respect the environment.

Environmental criteria are developed to cover everyday consumer goods and services (with the exception of food, drink and medicines). At present, the EU flower can be awarded to 21 product groups including CFLs.

The current CFL criteria were adopted on 1 Sept 2002 and are valid until 31 August 2005 and include the following requirements:

- Minimum lifetime: Single-ended 10,000 hours.
- Lumen maintenance:

  Single-ended (self-ballasted) ≥ 70% at 10,000 hours.

  Single-ended (pin based lamps) ≥ 80% at 9,000 hours.
- Switch on/off cycle > 20,000 for CFLs.
- Colour rendering (Ra) index > 80.

There is currently only one brand which complies, which is the Linea Self ballasted compact fluorescent lamp. This CFL is available in 5W, 7W, 9W, 11W.

3.H Danish Electricity Saving Trust [Karbo 2001]

In the autumn of 2000, the Danish Electricity Saving Trust conducted a campaign for CFLs with energy label A. The overall objective of the campaign was to further the consumers' purchase of compact fluorescent lamps (CFL A's) instead of incandescent lamps, so that the average stock of CFL A's could be augmented.

- Requirement as to light efficacy. The requirement is that the CFL must be class A in accordance to EU's energy labelling directive.
- Requirement as to luminous flux reduction. After 2000 hours of use, the luminous flux must constitute no less than 88% of the initial luminous flux.
- Requirement that the CFL A must be able to handle twice as many on/off's in a lighting test compared to the life expectancy in hours stated on the packaging. The lighting test is carried out with an on/off cycle of ½ min ON / 4½ min OFF, till there is no longer at least 50% that are live (cf. EU's Quality Charter for further details).
- Requirement that the colour reproduction index, R, must be at least 80.
- The colour temperature must be situated between 2,600 K and 3,000 K.

3.I EU Quality Charter

The EU Quality Charter was adopted on 19th July 1999 to help promote CFLs. It is not a requirement in any sense, but aims to set the benchmark for better performing CFLs. Since its introduction, elements of the Quality Charter have been adopted as requirements by labelling programs elsewhere, for example there are many similarities with the Energy Saving Trust criteria and the EU Charter.

It should be noted that the EU policy towards CFLs has several components and while the policy trend in Europe is to promote integral ballast CFLs in the short term, in the medium term the aim is to move towards pin-type CFLs. The reason for this is that pin-type CFLs are most efficient, have a longer life and are irreplaceable by incandescents.

As part of this longer term strategy, The Future Lamps Design Competition is aimed at overcoming the lack of dedicated luminaries for pin-based CFLs in the residential sector [Conti et al 2002).

Table 25: Quality Charter for CFL Lamps (19th July 1999)

SCOPE		
This Quality Charter applies to self ballasted, one and two part* CFL's with Edison screw or bayonet cap ** both lamp and adapter being supplied as a single entity at the point of sale*		
SAFETY		
Item	**Minimum Requirement**	**Measurement Method**
Lamps must be shown to be safe: when in use; when installed; and when they reach the end of their life.	Lamps must meet the safety requirements of EN 60968 (or EN 61199 and EN 60598) and comply with relevant CE Marking legislation.	For one part CFL's - EN 60968 For two part CFL's: - EN 61199 for the lamp - EN 60598 for the adapter (semi luminaire)
PERFORMANCE		
Item	**Minimum Requirement**	**Measurement Method**
Conformity of performance (relating to luminous flux and lamp life)	Module A as described in 93/465/EEC. Where there is no former knowledge of the involved lamp; Module Aa will be adopted.	A written conformity of performance statement from the manufacturer must be supplied. Relevant manufacturer's data is to be supplied if required. A written conformity of performance statement from an approved Notified Body* must be provided. If required, relevant test data must be provided by the Notified Body. ** Notified Bodies as defined in the Annex to 93/465/EEC. A list of Notified Bodies is published in the Official Journal of the European Communities and constantly updated.*
Efficacy	For lamps without external casing; Class A of the EU energy label. For lamps with external casing: - At least class B of the EU energy label - And luminous efficacy (lm/W) not less than following requirement (see Annex A): $\eta \geq \Phi \times 0.85/(0.24\sqrt{\Phi} + 0.0103\Phi)$ (ϕ luminous flux of lamp)	- 98/11/EC - EN 50285
Lumen maintenance	After 2000 hours the luminous flux should be not less than 88% of the initial luminous flux	- EN 60969 for one part CFL's - EN 60901 for two part CFL's
Stabilised light output	The time to 75% of stabilised light output, after switch-on from cold, at normal room temperature, shall be less than 60 seconds.	EN 60969
Fast switching life evaluation	The number of cycles in the rapid cycle test shall not be less than twice* the claimed lamp life in hours. • This target value has been derived from 10,000 hours CFL's for which a minimum of 20,000 cycles is generally used. • For CFL's which last less than 10,000 hours it is reasonable to accept also less than 20,000 cycles.	- Rapid cycle test: 0.5 min ON / 4.5 min OFF until 50% actual survivors - EN 60969 for lamp life

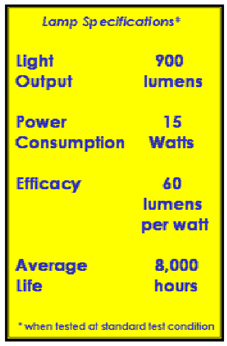
<table>
<tr><td></td><td colspan="2">*It is acknowledged that there is no physical relation between the number of cycles and the life in hours.</td><td></td></tr>
<tr><td>Life of the adapter in case of a two part CFL</td><td colspan="2">The life of the adapter in hours shall not be less than twice the life of the lamp in hours</td><td>- EN 60901 for lamp life
- EN 60929 for adapter life</td></tr>
<tr><td>Colour rendering</td><td colspan="2">CRI ≥ 80</td><td>CIE 29/2</td></tr>
<tr><td>Light distribution
(under consideration)</td><td colspan="2">For GLS replacement lamps the ratio of the intensity vertically downwards (Fv) to the mean horizontal intensity (Fh) shall not be less than u.c. (Fv/Fh > u.c.).
* CFL's with special shapes like globes/spots etc. are excluded.</td><td>- CIE standard for Photometric Measurement:
- Lamp cap on top
- Fv = partial luminous flux contained in the vertical 60^0 solid angle cone
- Fh = partial luminous flux contained in the horizontal 60^0 solid angle cone</td></tr>
<tr><td>Dimensions and weight</td><td colspan="2">The maxima for a GLS replacement lamp* shall not exceed:
Weight: 150 g.
Height: 160 mm
Width: 65 mm
* CFL's with shapes like globes/spots etc. are excluded.</td><td></td></tr>
<tr><td colspan="4">INFORMATION ON PACKAGE</td></tr>
<tr><td>Item</td><td colspan="2">Minimum Requirement</td><td>Measurement Method</td></tr>
<tr><td>Life</td><td colspan="2">Life of the lamp in hours must be shown on the individual package of each lamp</td><td>EN 60969</td></tr>
<tr><td>EU energy label</td><td colspan="2">The EU energy label must be shown on the individual package of each lamp.</td><td>98/11/EC</td></tr>
<tr><td>Comparison CFL / GLS</td><td colspan="2">Where the packaging or other literature claims that the rated luminous flux of the CFL is equivalent to, or exceeds that, of an equivalent GLS filament lamp, the lamp rating must comply with following requirements:</td><td rowspan="3">- EN 60969
- EN 60064
If there is no common GLS filament lamp wattage rating which fits this requirement:
- either the CFL is compared to an interpolated GLS filament lamp Wattage value;
- or if the rated luminous flux is ≤ 5% lower than the value in the left table for a commercially available GLS lamp, this lamp Wattage may be quoted along the following lines "…
lower but near to x Watt GLS"</td></tr>
<tr><td></td><td>CFL initial lumen claim (lm)</td><td>Ratted Wattage(s) of the GLS filament lamp for which equivalent is claimed (W)</td></tr>
<tr><td></td><td>≥ 214
≥ 386
≥ 660
≥ 874
≥ 1246
≥ 2009</td><td>≤ 25
≤ 40
≤ 60
≤ 75
≤100
≤ 150</td></tr>
<tr><td colspan="4">GUARANTEE & QUALITY</td></tr>
<tr><td>Item</td><td colspan="2">Minimum Requirement</td><td>Measurement Method</td></tr>
<tr><td>Guarantee to customer</td><td colspan="2">- Customers must be given a 1 year guarantee on lamp failure.
- For lamps supplied for operation with adaptors, there must be written assurance that replacement lamps will be available for a reasonable future period.</td><td>To ensure replacement lamps can be easily sourced, advice on how to obtain replacement lamps must be provided. Therefore a telephone number printed on the lamp, to advise the user on sourcing replacements is required.</td></tr>
<tr><td>Quality of production</td><td colspan="2">Lamps must be manufactured under a Quality Assurance System in accordance with EN ISO 9002 or equivalent.</td><td></td></tr>
</table>

3.J Summary of Philippine Labelling Requirements

The Philippine Appliance Energy Standards and Labelling Program will introduce mandatory labelling for self-ballasted CFLs in November 2005.

The test method will be IEC 60969 Edition 1.2:2001-03 "Self-ballasted lamp for general lighting services-Performance requirements" standard, with 230 volts input.

Under the labeling program manufacturers and importers will be required to attach a label the light output in lumens, power consumption in watts, the efficacy (lumens per watt) and the average life to all compact fluorescent lamps with rated power consumption of 65 watts and below.



3.K Summary of Thai Labelling Requirements

Thailand has two voluntary labelling programs. The Energy Efficiency No. 5 Label is implemented by the Electricity Generating Authority of Thailand (EGAT). The label is comparative and indicates the effiency, annual energy consumption and the energy saving estimates, with No.5 indicating the highest energy efficiency.

Testing is conducted under the Thailand Industrial Standard TIS 236-2533 (1990) with reference to IEC81:1984. A total of 121,900 CFL products from several manufacturers including Philips, GE, Unilux, National, Osram and Lampton, have adopted the label so far.

Table 26: Energy Efficiency No.5 Label Requirements

Item	Minimum Requirement		Measurement Method
Efficacy	Lamp Power (W)	Minimum Luminous Efficiency (lm/W)	• Based on initial lumens • Drought-free atmosphere, ambient temperature of 25±1°C
	< 10	45	
	11 - 15	50	
	16 - 20	55	
	> 21	60	
Initial Luminous Flux	No more than 4 out of 15 samples with less than 90% of rated luminous flux		• Measurements made after 100 hrs operation • Drought-free atmosphere, ambient temperature of 25±1°C
Lumen Maintenance	No more than 2 out on 10 samples with less than 80% lumens maintenance after 2000 hrs operation		• Drought-free atmosphere, ambient temperature of 25±1°C

The Green Labelling Scheme is an endorsement label administered by the Thailand Environment Institute. CFLs were added to the scheme in 1994. Table 27 shows the energy efficiency requirements for the scheme measured using the Thai Industrial Standard TISI 236.

Table 27: Energy Efficiency Requirements for Green Labelling Scheme

Lamp Type	Lamp Power (Watts)	Luminous Efficacy (lumens/Watt)	
		Daylight	Warm white/ cool white
Internal Ballasts	< 10 10-15 > 15	> 45 > 50 > 55	> 50 > 55 > 60
External Ballasts	< 7 7-9 > 9-13 > 13-18 > 18	> 40 > 50 > 55 > 60 > 62	

Other requirements for the scheme are:

- Certified to the Thai Industrial Standard TISI 236, Standard for Fluorescent Lamps, or International Standard or acceptable National Standard or if not certified the product must have passed the standardized tests of product quality.
- The product must have guaranteed service life of at least 10,000 lighting hours.
- For internal ballast compact fluorescent lamps, the power factor must not lower than 0.55
- The mercury content of the product shall not exceed than 10 milligram per lamp.
- The product packaging must be made of 100% recycled paper or corrugated carton which produced from 100 % recycled pulp.
- Foaming materials, laminates or plastic contained raw material must not be used in packaging.
- The following information shall be stated in manual accompany with the product on packaging ;
  - Warning and/or proper instruction to use accompany with another equipments such as Dimmer switches.
  - Appropriate procedures or conditions for storage of end used product and packaging by means of simplified message or figure.
  - The name and address of the label user shall be clearly stated on product or packaging. In case of the label user is not a manufacturer, the name and address of the manufacturer shall be stated instead as well.
- Take back and recycling policy shall be provided in environmentally sound manner and in practical way. It shall be clearly stated time frame to achieve the task since the product has been certified.

3.L Summary of Sello FIDE Requirements (Mexico)

The Fideicomiso para el Ahorro de Energía Eléctrica (FIDE) administers a voluntary endorsement label for CFLs. Participating manufacturers include General Electric, SLi, Osram, Philips, Sanelec and MaxLite.

3.M Summary of Procel Requirements (Brazil)

In 1994, Brazil's National Program for Electrical Energy Conservation (Procel) introduced a voluntary endorsement label to indicate the most energy efficiency models (called SEAL) in conjunction with the Energy Conservation Label (ECL) which provides consumer information. The programs cover pin-type self-ballasting and circular CFLs, with magnetic or electronic ballasts, and with covers or reflectors. The combined requirements for both labelling programs are given in Table 28.

Table 28: Procel Requirements

Item	Requirements				Measurement Method
Operating voltage	127 or 220 V				
Test data source	• Testing undertaken by authorised testing laboratories. • Sample size of 10 for testing, plus 1 control selected by manufacturers.				
Energy efficiency (Initial efficacy)	**Lamp type**	**Rated Input Power**	**ECL**	**SEAL**	IEC 60901-1/97, NBR 14539-6/00
	Bare-tube	< 15 W	≥ 40 lm/W	≥ 45 lm/W	
		≥ 15 W	≥ 40 lm/W	≥ 60 lm/W	
	With translucent cover	< 15 W	≥ 40 lm/W	≥ 40 lm/W	
		15 -18 W	≥ 40 lm/W	≥ 48 lm/W	
		19 - 24 W	≥ 40 lm/W	≥ 50 lm/W	
		≥ 25 W	≥ 40 lm/W	≥ 55 lm/W	
	With reflector	"Lamps with reflectors should be tested without the same for the purposes of this table"			
Lumen maintenance	ECL: 2000-hour rating ≥ 80% of initial output (100 hrs) SEAL: 2000-hour rating ≥ 85% of initial output (100 hrs				IEC 60901-1/97, NBR 14539-6/00
Rated life	maximum 1 failure in 10 bulbs in 2000 hours				NBR IEC 60901-1/97, NBR 14539-6/00
Power factor	PF ≥ 0.5 CFL < 30 W (voluntary): High power factor ≥ 0.92 CFL ≥ 30 W (mandatory): High power factor ≥ 0.92				
Harmonic distortion	CFL < 30 W (voluntary): Total harmonic dist. ≤ 33% CFL ≥ 30 W (mandatory): Total harmonic dist. ≤ 33%				NBR 14539-2000; CISPR 15/96
CFL vs. GSL Illuminance Equivalency	**Rated wattage of filament lamp equivalent (W)**	**Luminous flow for 127 V (lm)**	**Luminous flow for 220 V (lm)**		

	15	104	110	
	25	214	220	
	40	480	415	
	60	804	715	
	75	1018	890	
	100	1507	1350	
	150	2330	2180	
	200	3274	3090	
Cold temperature reporting and labelling	< 3300K : Warm 3300 to 5000K : Neutral >5000K: Cold			

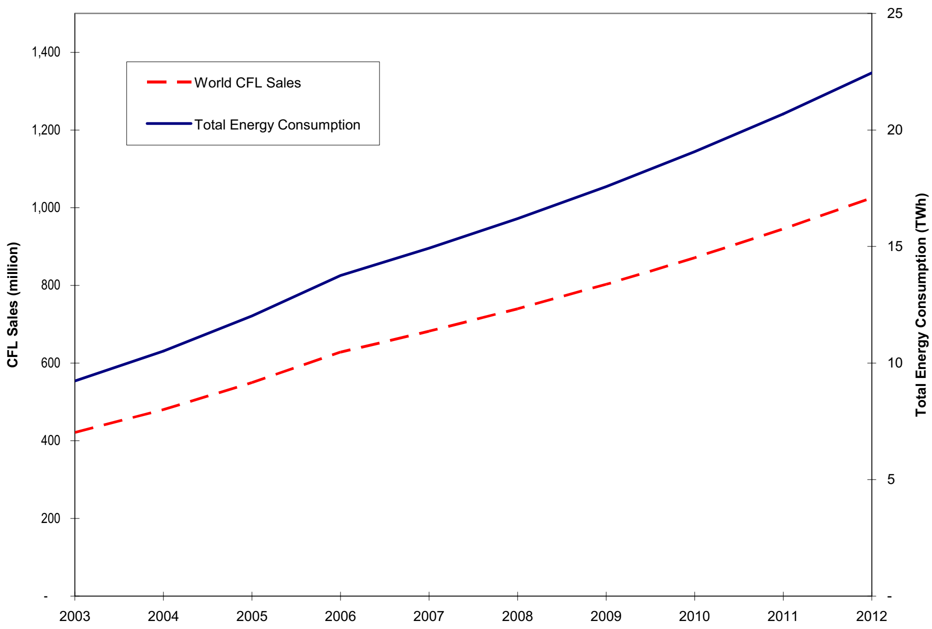
Appendix 4: International Harmonisation of CFL energy efficiency standards

Authors: Mark Ellis, MEA, Australia. David Fridley, LBNL, United States. Shane Holt, Australia Peter du Pont

11. Introduction:

CFLs are now a highly significant globally traded commodity, and in many countries the sales value of CFLs now exceeds that of equivalent incandescent lamps. As demonstrated in Figure 19, the volume of production, the energy implications and the volume of international trade make this product type a high priority for concerted and coordinated international action.

Figure 19: Estimated Global Sales of Self-Ballasted CFLS, and Total Energy Consumption



(Source: authors estimates)

CFLs have been available for over 20 years, and actively promoted as an energy saving device in residential and commercial applications. At the present time CFLs are available in a wider variety of styles, at a lower cost and in more outlets than ever before. The increasing use of CFLs, and the intense price competition, has brought issues of product quality to the fore. Product performance has always been an issue; however the sheer numbers involved now make this appear of greater significance.

Consumers in many countries have expressed their dissatisfaction with CFLs, particularly with respect to the advertised service life and light output. In an effort to increase consumer confidence by identifying the better performing models, several countries have adopted energy endorsement labels and/or minimum energy performance requirements. These have proved successful; however the growth in international trade of CFLs and the increasing number of national programs have highlighted the variation in requirements of these different programs.

The purpose of this paper is to explore the potential for more effective global implementation through harmonization over the next 2-3 years, and the possibility of reducing costs to regulators and manufacturers. It is important to note that what is being considered is the harmonisation of both test procedures, and performance standards – the levels specified for compliance.

This fits not only the World Trade Organisation agenda, but also that of regional groups such as Asia Pacific Economic Cooperation (APEC), which are seeking to enhance trade through the advancement of common standards. Trade enhancement includes not only potentially larger volumes but also lower costs of entry and on-going compliance costs.

Note that in this paper, the following terms are used:

Criteria:	The range of issues examined with respect to the performance of CFLs.
Test procedure:	The methodology for testing a lamp to measure efficiency and other performance criteria, such as those contained within a performance standard.
Performance standards:	The performance levels specified by a program with respect to each of the criteria covered.

12. Summary of Existing programs

National CFL programs have been identified in the following two tables, together with the list of major criteria which are covered by each program. Table 29 refers to known minimum energy performance standards, and Table 30 relates to endorsement labeling programs.

Table 29: Summary of National MEPS Programs for CFLs

	China	South Korea	Japan	Mexico
Coverage - Self-ballasted	●	●	●	●
Coverage - Pin-type	●		●	
Efficacy	●	●	●	●
Lumen Maintenance				
Lifetime &/or Lifetime Guarantee	●			
GLS Equivalence				
Power Factor				
Luminous Flux Run-up				
Colour Rendering	●			
Statement of Mercury Content				

Table 30: Summary of National CFL Endorsement Programs

	UK Energy Saving Trust	US Energy Star	Hong Kong SAR	Taiwanese GreenMark	Environmental Choice Canada	China CECP	IFC/ELI	Procel (Brazil)	EGAT (Thailand)	South Korea	Philippines
Endorsement Label	●	●	●	●	●	●	●	●	●	●	●
Coverage - Self-ballasted	●	●	●	●	●	●	●	●	●	●	●
Coverage – Pin-type	●		●	●	●	●	●	●	●	●	
Efficacy	●	●	●	●	●	●	●	●	●	●	●
Lumen Maintenance	●	●	●			●	●	●	●		●
Lifetime &/or Lifetime Guarantee	●	●	●	●		●	●	●			●
GLS Equivalence	●	●					●				
Power Factor	●	●		●			●	●			
Luminous Flux Run-up	●	●					●				
Colour Rendering	●	●	●	●			●				
Statement of Mercury Content		●	●	●							

13. Major Issues

This section highlights some of the major issues with respect to the international harmonisation of test procedures and performance standards for CFLs.

13.1. Test procedures

There are currently several test procedures for CFLs used by the many countries identified in Tables 1 and 2, and these vary in terms of scope and methodology. This has the potential to lead to non-comparable results and to limit international trading opportunities.

It is axiomatic that all lamps should be tested according to the same test standard incorporating all necessary criteria to accurately measure performance. Potentially this could mean that lamps are tested for conformity only once, at the point of manufacture – this will depend upon decisions regarding mutual recognition (see below) – with those results accepted in the country of use.

The International Electrotechnical Commission publish two internationally used standards(often reproduced in technically identical national standards):

- IEC 60969 Self ballasted lamps for general lighting services – Performance requirements.
- IEC 60901 Single capped fluorescent lamps – Performance specifications

Although these are called 'performance standards', these standards include test methods for a range of criteria commonly specified with an endorsement labeling program. One option is for the IEC test methods, or technically identical national standards, to be used in assessing compliance with harmonized performance criteria.

It should be noted that one potential outcome of full harmonisation of test procedures could be the development of a new range of CFLs capable of operating efficiently at any input voltage.

13.2. Mutual Recognition of test results

The extent to which each country recognises the results of tests undertaken elsewhere is an important issue. For suppliers there are considerable benefits if the number of tests can be limited. However, national energy efficiency agencies and regulators need confidence that the results are sufficiently accurate to accept without further verification in order to discharge their national enforcement responsibilities.

There will be a role initially for "round-robin" testing of CFLs amongst accredited laboratories across a number of countries. This type of developmental testing provides data that leads to practical improvements in the performance standards, enhancing the repeatability and reproducibility of results.

13.3. Self-ballasted vs Pin-type

Self-ballasted lamps comprise the majority of CFL sales internationally, and are included in the scope of all current national energy efficiency programs covering CFLs. While pin-type CFLs are less common, they may be strategically important as basis of some longer-term strategies to stimulate the development of dedicated luminaries.

For practical reasons, it is recommended that groups committed to harmonization initially focus on self-ballasted CFLs. Governments should also commit to incorporate pin-type CFLs within the international program sometime in the future, after a similar standard development process and advice to manufacturers.

13.4. Selection of key criteria

Although the range of criteria covered by existing national programs does vary, many are common to most programs. It is likely therefore that agreement can be reached on a core set of criteria by technical experts relatively easily.

Some criteria are necessarily specific to individual countries, such as electromagnetic disturbance, and some safety requirements, and these may continue to be additional conditions which must be met in individual countries over and above the international requirements.

It is therefore feasible for technical experts agree a set of criteria, harmonised internationally, incorporating scope for additional requirements applicable to certain specified regions.

A suggested list of the core performance criteria for the international standard are:

- Efficiency level
- Lumen Maintenance
- Rated Average Lifetime
- CFL Lifetime Claims
- Power Factor
- Colour rendering
- Mercury level
- GLS Equivalence
- Start-up time

A test procedure for each of these criteria is necessary in any internationally-harmonised test procedure. These should be a mandatory requirement for testing, even if some criteria are not specified within national standards program by some countries.

13.5. Accommodating difference levels of performance standards

More than one set of performance standards will be required, since countries wishing to implement minimum energy performance regulations will usually wish to adopt levels which are less stringent than those countries that desire to use only an endorsement label system, (designed to promote the best-available-technology products). Such a tiered performance system also enhances the capability of nations wanting to use a mix of both minimum performance standards and higher efficiency requirements for product endorsement.

It is feasible to accommodate multiple performance criteria should countries require a greater range in stringency levels, for example to denote existing and future standards. It should be noted that this proposal is not intended to lessen the ability of countries to decide the performance levels for minimum performance standards or endorsement labels which they consider appropriate, but to agree where technology steps exists thereby limiting unintended trading difficulties for suppliers and to encourage other countries to adopt measures for CFLs.

Further improvements in technology over time may warrant a higher stringency level than currently envisaged, and the system will incorporate the capacity to improve and display compliance with that improvement over time.

Consideration may need to given to whether different performance standards are required for lamps designed to operate at different voltage/frequency combinations; or whether one set of standards can apply universally.

13.6. Marking

A further consideration is whether there should be some marking of CFLs to indicate that they have been tested according to the agreed standard and meet a certain standards in respect to the performance criteria. If manufacturers test lamps according to agreed harmonised test procedure, then the results could be marked on the lamp (and packaging) prior to shipment. This improves the position of national regulators and competitors undertaking enforcement activities, since the declared performance of the lamp will be displayed on every unit. This may replace the need in some cases for importers to produce further test reports in the first instance – although when a product is suspected of non-compliance, such evidence may be required.

Table 31 shows how such a system could work, using roman numerals to indicate compliance with different performance standards. In this example, **I** is the lowest level of stringency, such as required by a minimum performance standard. Level **II** is a more stringent MEPS level, perhaps introduced at a later stage. Level **III** represents the level of criteria for an endorsement label, while level **VI** is reserved for a future, higher, specification once the majority of products have achieved compliance with level **III**. Further levels could be included as necessary.

Table 31: Illustration of Marking System for self-ballasted CFLs

Mark (example)	Description	Stringency
I	Minimum energy performance standard (initial)	↓
II	Minimum energy performance standard (future)	
III	Endorsement label (initial)	
IV	Endorsement label (future)	

It should be noted that this mark is not intended to be, and should not be confused with, any national consumer energy efficiency label, such as an endorsement or comparative label. The mark would compliment the enforcement of national endorsement, and could be made mandatory for lamps the subject of financial incentive programs. Care will need to be taken to select a mark that is not potentially confused with other compliance indicators.

A similar system has been agreed with respect to External Power Supplies, brokered by the National Resources Defense Council (NRDC) between the following participating agencies: Australian Greenhouse Office (AGO), California Energy Commission (CEC), China Certification Center for Energy Conservation Products (CECP) and ENERGY STAR - United States Environmental Protection Agency (USEPA).

14. The Way Forward

14.1. The opportunity

Informal discussions with energy efficiency agencies in a number of countries have indicated that concerted international action is possible on the issue of harmonisation for CFL test procedures and performance standards. The Workshop at Right Lights 6 provides an excellent opportunity to discuss these issues openly and to canvass in-principle support from key organisations/countries to pursue a greater level of cooperation in the future. This event can mark the agreement of parties to commence an international project to harmonise testing and performance standards for CFLs.

14.2. Management of the project

Following this in-principle agreement, there will be a need for further liaison between countries, facilitating the drafting of proposals and other coordinating functions. The Collaborative Labeling and Appliance Standards Program (CLASP) and the Renewable Energy and Energy Efficiency Partnership (REEEP) have expressed interest in providing this coordinating capacity, ensuring international ownership of the project and maintaining the momentum created at the Right Light 6 conference. Both of these organisations are independent of vested interests, with a mandate to assist all interested parties involved in codes and standards development, and both can bring considerable international support to the program.

Each participating country will need to commit to working cooperatively within this international endeavour. On a practical basis, country partners should nominate as a point of contact, the government official, technical expert, testing experts and local industry representatives who may participate on this project.

14.3. Timing

Although it is recognised that some countries may be in a position to move faster than others, setting deadlines will help to focus attention to our agreed tasks. Given the focus by many nations on test methodologies, it should be possible for a common procedure to be proposed by an expert group within 12 months and verified through an international round robin in 2006. Such a test procedure should become an IEC standard no later than 2008. Given the existence of both minimum performance standards and endorsement levels, it should be possible to agree a set of international performance levels for existing technologies and to incorporate anticipated future performance levels within an international framework document in 2006 with the implementation of such a scheme remaining a decision for individual nations.

14.4. Status of agreement

It is envisaged that participation in this effort will initially be guided by a non-binding agreement to explore the issues of harmonisation further, as shown in Annex 1.

Within the next year work on testing, specification and mutual recognition issues could proceed in parallel subject to a Memorandum of Understanding (MoU), for presentation and discussion at a workshop in 2006.

In future, consideration could be given to more formal type of agreement, such a Mutual Recognition Arrangement for the achievement of full harmonisation. It is suggested that this does not need immediate attention; however some participants may have strong views which should be recognised at an early stage.

14.5. Workshop outcomes

Participants should agree to three interrelated outcomes:

1. A list of national contacts should also be established at the workshop for international publication
2. Settling a number of practical issues to allow the technical experts to proceed to develop the desired test and performance standards:
    a. Whether to develop unified performance standards for all permutations voltage/frequency of supply or agree to develop two sets of performance standards for the two main supply platforms
    b. When to proceed with a round robin testing program to build confidence in the proposed test methodologies
    c. Whether to make mandatory the efficiency marking on product to declare compliance to the corresponding performance standard
    d. What type of agreement should be used to link participants to the project
    e. An indicative budget for common elements of the project and the means for funding those elements
3. Issue a communiqué within a reasonable period of this conference, which:
    a. Identifies the countries and international organizations which have given in-principle support to the pursuit of international harmonisation for CFL standards.
    b. Identifies the organisation which will coordinate the project in the future, CLASP, REEEP or the agreed organisation.
    c. Announces the timeframe for harmonisation, eg. 2 years for the publication of the methodology by at least one nation and 4 years by the IEC and the endeavour to establish common steps in performance requirements.
    d. Limits the immediate focus to self-ballasted type CFLs.
    e. Commits to the key elements discussed in this paper:
        i. Testing standards
        ii. Performance standards
        iii. Marking protocol
        iv. Investigation of mutual recognition
    f. The proposed wording of a communiqué is shown in Annex 1.

For further information

Please contact the following to provide comments or to discuss further:

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Annex 1: Proposed Items for Agreement

The following paragraphs have been drafted as the basis of an agreement to be endorsed by parties at the Right Light 6 conference. They allow any parties to provide ‘in-principle’ support only for the further develop of harmonisation plans, and are non-binding. While it is acknowledged that most national organisations will need to initiate the required processes to gain ratification and further commitment, these statements do nevertheless represent the first important step on the road of harmonisation.

1. We, the undersigned, express our in-principle support for the development of a harmonised test procedure for self-ballasted compact fluorescent lamps, with the aim of agreeing a final test procedure during 2006 and to submit this test procedure to the IEC for publication as an international standard.
2. We express our in-principle support for the development of an agreed set of performance standards for self-ballasted compact fluorescent lamps, with the aim of reaching agreement during 2006. These performance standards will reflect varying degrees of stringency to match individual national requirements for mandatory and voluntary implementation, for example to be used as minimum performance standards or to indicate best available technology. Individual countries would determine if and when these performance standards are to operate in that jurisdiction.
3. We express our in-principle support for a mandatory marking system for self-ballasted compact fluorescent lamps designed to demonstrate (a) compliance with the testing regime, and (b) the performance level achieved by the lamp under test. The intention is that this system would be incorporated within the testing method standard and implemented by individual nations on a timetable set by each country. We agree that this marking system is not intended to be, nor will it attempt to supplant, energy efficiency labels that inform consumers about this product type.
4. We agree in-principle that each jurisdiction shall bearing their own costs for their own activities and will agree to fund common development tasks from a fund established to operate from 2005-2008, subject to further budgetary information becoming available. This fund will sponsor coordination activities and the participation in standards development activities such as the round robin testing of product.
5. We express our in-principle support for these activities to be coordinated by the Collaborative Labeling and Appliance Standards Program (CLASP) and the Renewable Energy and Energy Efficiency Program (REEEP).