Evaluation of a lighting market transformation program in Australia – Outcomes and Attributions

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Abstract

In 2009 Australia enacted mandatory efficacy standards which effectively eliminate incandescent lamps from the General Lighting Service (GLS) market. It was expected that the diverted demand would be met by Compact Fluorescent Lamps (CFLs), which use about 20% of the energy of an incandescent lamp of comparable light output, and by mains voltage halogens (MVHs), which use about 80% of the energy. The energy savings were expected to come from two mechanisms: substitution of MVH for GLS lamps, and substitution of CFLs for MVH.

As all lamps of these types are imported, the customs data on monthly imports give a fairly reliable track of the market. However, it is still necessary to test the counterfactual - how would the market have changed without the efficacy standards. There were also other large scale interventions over the same time period, notably giveaways of free CFLs.

This paper discusses the inter-related problems of estimating impacts from the available data, and attributing the impacts to separate programs targeting the same market actors. The conclusions have implications for whether there is any scope for further promotion of CFLs in Australia.

Phaseout of Inefficient Light Bulbs

The Commonwealth of Australia is a federation comprising six States and two Territories. For the past 20 years, many national energy efficiency policies and programs have been managed co-operatively between the energy agencies of the nine governments under a series of agreements, formerly the National Framework for Energy Efficiency and now the National Strategy on Energy Efficiency (COAG 2009). Most governments also maintain energy efficiency programs that are outside this national framework.

On 20 February 2007, the then Federal Environment Minister, Malcolm Turnbull, announced the Australian Government's intention to phase-out inefficient incandescent light bulbs by 2012. This was widely reported in both Australia and overseas as a 'ban', for example:

> "Australia will ban incandescent light bulbs to help cut greenhouse gas emissions, its government announced today" (*The Guardian*, 21 February 2007).

Subsequent press reporting reinforced this message. The phase-out measure was not in fact a ban, but a minimum efficacy level which tungsten filament (TF) lamps could not meet. The announcement made no mention of the fact that mains voltage halogen (MVH) lamps would be introduced as a substitute. MVH lamps were relatively rare at the time of the announcement and global suppliers did not start to manufacture them in large volumes until later – possibly in response to the phase-out measure itself, and similar measures adopted by the USA and other countries around the same time. It therefore left the impression (deliberately or not) that CFLs would become the only GLS option.

In this respect the Australian phase-out was similar to – and misinterpreted in the same way as – the incandescent lamp provisions in the United States Energy Independence and Security Act of 2007, which the then President Bush then signed into law in December 2007.

The Australian phase-out comprised three distinct elements:

- Minimum efficacy standards for GLS incandescent lamps up to 150W;[1]
- Efficacy and quality standards (including mercury content limits) for CFLs; and
- Minimum energy performance standards (MEPS) for the magnetic and electronic transformers which convert mains voltage to extra low voltage, to operate low voltage halogen (LVH) lamps. These devices are called extra low voltage converters (ELVCs).

The first stages of implementation were a ban on the imports of non-complying lamps from February 2009 and a ban on their sales from November 2009. As Australia no longer manufactures light bulbs, import restrictions under customs regulations were the most effective enforcement mechanism. The efficacy standards were extended to other non-reflector incandescent lamp types in October 2010. Reflector lamps will be covered from October 2012.

The phase-out was intended to reduce energy consumption from standard socket lamps in two ways:[2]

- By forcing TF lamps out of the market in favour of higher efficacy GLS lamps (whether MVH or CFL); and
- By moving the GLS lamp market from incandescent to CFL lamps.

Setting efficacy, service life and quality standards for CFLs was intended to contribute to the second outcome by addressing some of the problems that have made some buyers wary of CFLs in the past: perceptions of poor light quality and colour rendering, long warm-up times for some models, a reputation for failing sooner than the claimed service life and the high mercury content of some models, which represented a toxic material breakage and disposal problem.

The MEPS levels for ELVCs were intended to reduce lighting energy by limiting the energy losses from multi-lamp low voltage halogen installations, which have become increasingly popular in the past decade. This measure had no direct impact on TF/MVH/CFL choice.

1 GLS lamps include any lamp (TF, MVH or CFL) which provides a fairly uniform light output in all directions and can therefore be used in general lighting installations.

2 ‘Standard socket’ lamps are those which can be inserted in common bayonet and Edison screw sockets, and so can be readily substituted for one another. TF, MVH and self-ballasted CFL lamps all fit in standard sockets and can be substituted, except that most CFLs will not operate satisfactorily on circuits controlled by dimmers. LVH lamps, linear and round fluorescent lamps are not standard socket lamps because they have special pin connectors.

Problems in Impact Evaluation

The multi-part nature of the measure, and shifts in the global lamp market around the time, make it difficult to evaluate the impacts. The sequence of key events is open to different interpretations, and it is possible to make various, and at times conflicting inferences regarding not just the behaviour of stakeholders (lamp importers, retailers, and buyers) but also the impact on each group of expectations about the behaviour of the others. For example, there are indications that some householders may have stockpiled old-style TFs in the period leading up to the import ban. Unfortunately, market research information that could have shed more light on these questions was not collected at the time. This was partly due to the rapidity and short notice with which the measure was announced by the Minister, and the understandable priority given to implementing it.

However, it is now possible to estimate the impacts of the measure in hindsight.

Evaluating the impact of the measure on the CFL market is complicated by the fact that the market was already moving toward CFLs before the measure was announced, and in 2007 CFLs already accounted for close to 50% of annual imports of GLS lamps (Figure 1).

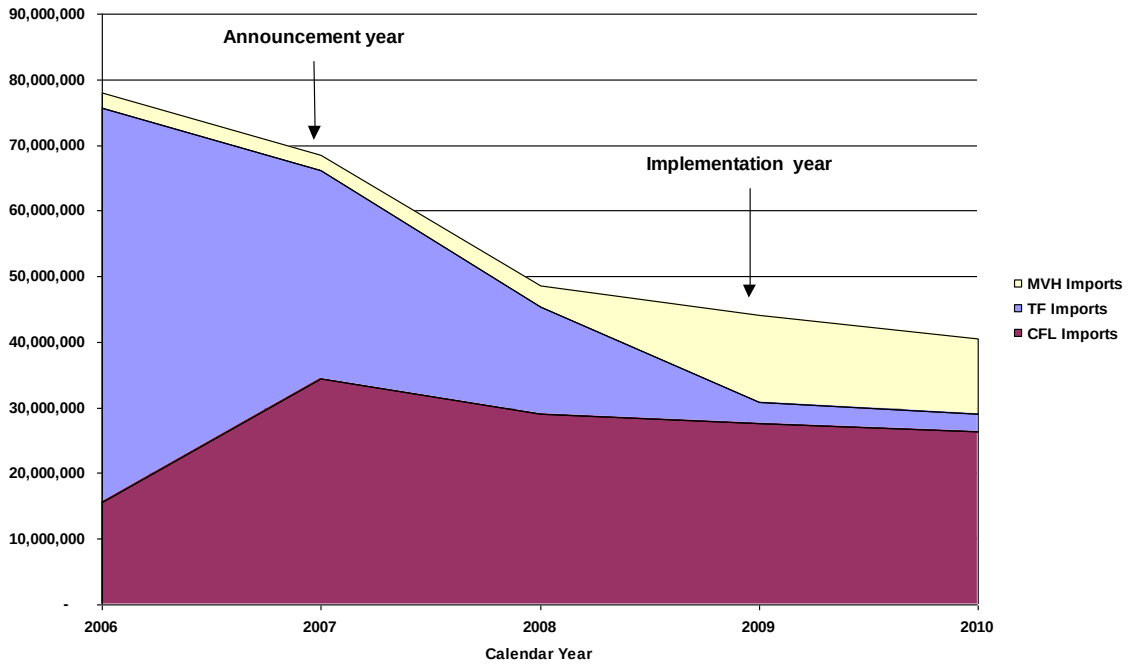

Figure 1. Annual Imports of standard socket GLS lamps, Australia 2006-2010.

The annual rate of growth in CFL imports between 1997 and 2005 was nearly 11% per annum. Between 2006 and 2008 nearly 28 million CFLs were distributed free under "white certificate" schemes in the states of New South Wales, Victoria and South Australia. These accounted for more than a third of the total number of CFLs supplied to the market over that period. About 62% of free CFLs were directly installed by auditors visiting homes and 38% were given away. It is assumed that half of giveaways were installed in the same year and half stockpiled by the recipients and installed in the following year. The combination of free CFLs directly installed, free CFLs installed from home stocks and purchased CFLs (assumed to be installed in the same year) indicates that annual CFL installation rates have been relatively steady since 2007 (Figure 2). The difference between the installation estimates and the market supply estimates is due to the assumed stockpiling delay.

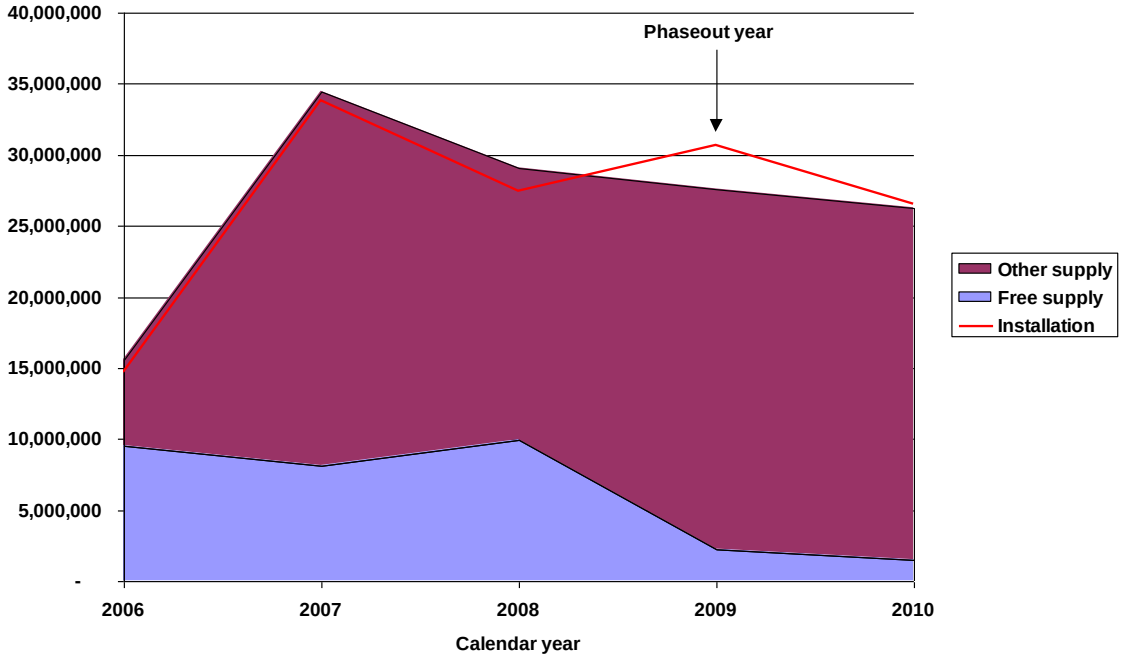

Figure 2. Free CFLs, total CFL imports and installations, 2006-2010

Although the CFL *share* of the GLS lamp market has risen since 2007, this is because CFL sales remained constant while the incandescent lamp sales and the total market declined, as can be seen clearly from Figure 1. A decline in total lamp demand would be expected as the CFL share of the installed stock rises, because their longer service life lowers the frequency of lamp replacements. As well as a decline in total market size, it was expected that MVHs would substitute for TFs. This trend is also confirmed by the import data (Figure 1).

The period of the analysis coincides with the global financial crisis beginning in 2007/08. This would not have had a significant impact on this particular measure. Australia was one of the few developed economies not to have a recession after 2008, and for most of the period it had the highest growth rate among OECD countries. While home-building rates slowed somewhat, little more than 1% of housing stock is added new even in high-growth years. The great majority of lamp sales are to existing homes, where replacement is non-discretionary: when a lamp fails, people replace it.

Conclusions on the Impact of the Measure

The data lead to the following conclusions:

- The standard socket lamp market was already moving towards CFLs by 2007, when the phase-out was announced. The annual rate of growth in CFL imports between 1997 and 2005, the year before the first large scale free CFL distribution started, was nearly 11% per annum;
- Annual CFL imports nearly tripled between 2005 and 2007 on the strength of free distributions, especially in New South Wales, which accounted for 85% of the 32 million CFLs distributed free in Australia between 2006 and 2010;
- The initial impact of the phase-out announcement in 2007 appears have been on two groups: some lamp importers seem to have immediately increased CFL imports in the expectation that CFLs would become the dominant GLS lamp choice, and some CFL-averse householders

seemed to react by stockpiling TFs. Neither group appeared to factor in the possibility that MVHs would become readily available;

- The phase-out probably did not impact on the behaviour of general lamp buyers until it took effect on imports in early 2009, and on sales in late 2009.

These overlapping effects make it necessary make a number of assumptions in order to estimate the impact of the phase-out on energy use. Figure 3 charts actual CFL imports against various assumptions of underlying growth in CFL sales, had the giveaways and the phase-out not been implemented.. The 10% trend line indicates what sales would have been had they resumed an annual growth rate of 10% after 2006, close to the pre-giveaway rate. Growth rates of 5%, 0% and -5% are also shown. A negative growth assumption would imply that the phase-out reversed what would otherwise have been a decline in CFL demand. There is no evidence to support such an assumption, but it is included for illustration.

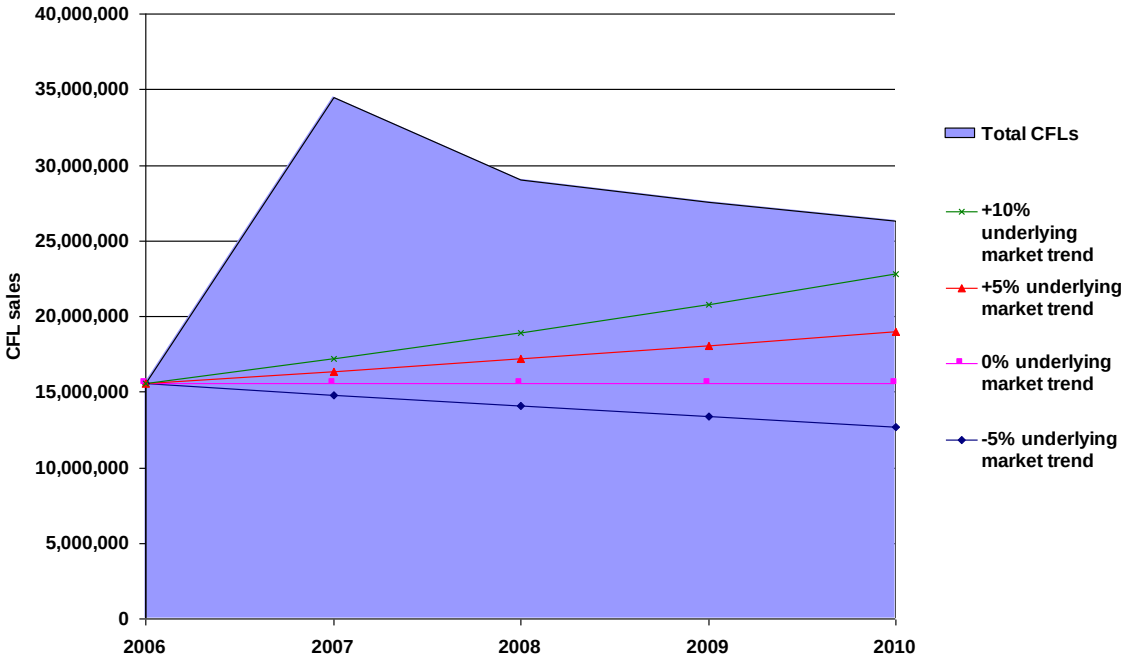

Figure 3. Actual CFL sales compared with range of underlying trends

The higher the underlying growth assumption, the lower the residual impact attributable to CFL giveaways and to the phase-out. It is considered that the most likely underlying CFL growth rate after 2008 would have been around 5%, because the large numbers of free CFLs distributed in 2006-2008 would have temporarily flooded the market and made a return to 10% annual growth rates difficult. If so, the phase-out would have had the effect of pushing CFL demand above the 5% line, but the effect would decline over time as CFL sales effectively saturated (and the signs that this is happening are discussed later). The shape of the graph area above the 5% line – a surge than a gradual reversion to trend – would be consistent with this hypothesis.

In each of the four scenarios it is possible to project lamp energy use without and with the phase-out. However, it was necessary to standardise the projections so that the total number of purchased lamp-hours matched, using standard service lives of 8,000 hrs for CFLs, 1,000 hrs for TFs and 2,000 hrs for MVHs. If the number of lamp sales were held constant and simply allocated to different lamp types,

then a higher CFL market share would imply an increase in total average lamp operating hours. By holding lamp-hours constant instead, it is assumed that the benefits of higher CFL efficacy are taken as lower energy use rather than increased consumption of lighting.

If it is assumed that the underlying growth rate in CFL sales without the phase-out would have been 5%, then the effect of the phase-out is a saving of about 850 GWh per year in 2010, rising to about 980 MWh in 2030 (Figure 4). This includes the impact of higher CFL sales than otherwise, the impact of substituting MVH for TF lamps in the remainder of the GLS market, and the impact of MEPS for ELVCs. These impact estimates were somewhat lower than the projections made by the present author around the time of implementation of the phase-out (E3 2009). The main difference is that the previous projections did not account for the shift in the lamp market to CFLs which was already taking place, or the number of free CFL giveaways occurring around that time.

The energy saving estimates in Figure 4 do not take into account possible efficacy increases due to improvements in CFL quality that may result from the phase-out, because any such benefits are likely to be taken as increases in light output.

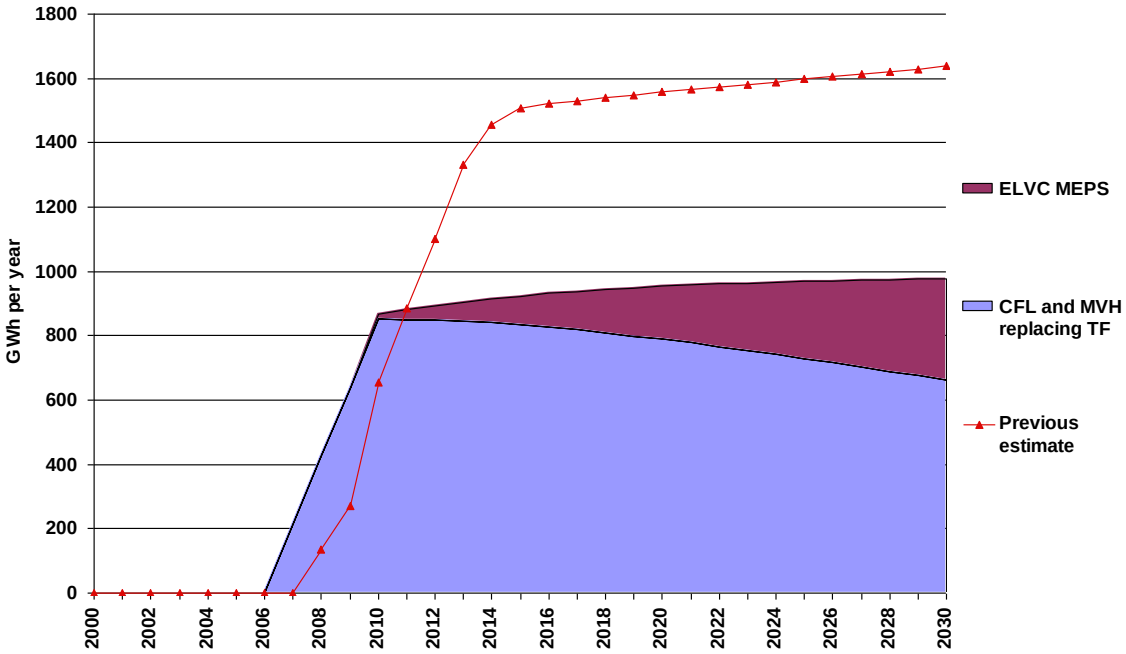

Figure 4. Comparison of lighting phase-out impact with previous estimates (residential lighting only)

Is the CFL Market now saturated?

The extent of the market shift to CFLs raises the question of how much potential there may be for additional measures to further increase their use in Australia. Adjustment for service life indicates that CFLs already supplied about 88% of the lamp-hours embodied in standard-socket GLS lamps imports in 2007, and this share has been maintained since (Figure 5). CFL sales have stabilised at the equivalent of 3 to 4 lamps per Australian household per year (recognising that many CFLs are used outside the household sector).

The 'CFL saturation point,' or the maximum the number of CFLs which households can accommodate, is not the absolute number of standard socket lamps but the number which:

- are used for enough hours on average to make a CFL cost-effective; and

- where any differences in the size, quality and performance of a CFL compared with a MVH lamp (in terms of colour rendering, flicker, warm-up time or dimmability) are acceptable.

The results of a survey of Victorian households in 2007 allow estimates to be made of the proportion of standard socket GLS lamps already occupied by CFLs, room by room (Table 1). Even before any impact of the phase-out measure or free CFL installation programs in Victoria, CFLs had reached 39% of their potential market in kitchens, and 25-29% in other living areas. The share of standard socket bedroom lighting was in the range 19-23%. This would be expected because average daily use hours per lamp is much lower in bedrooms, so weakening the economic case for CFLs, and a warmer and softer light quality is generally preferred.

The average number of CFLs installed per visit by home energy auditors in Victoria in 2008 and 2009 was 4.8. Presumably this was the number of high-use standard sockets which merited relamping, beyond those which already had CFLs.

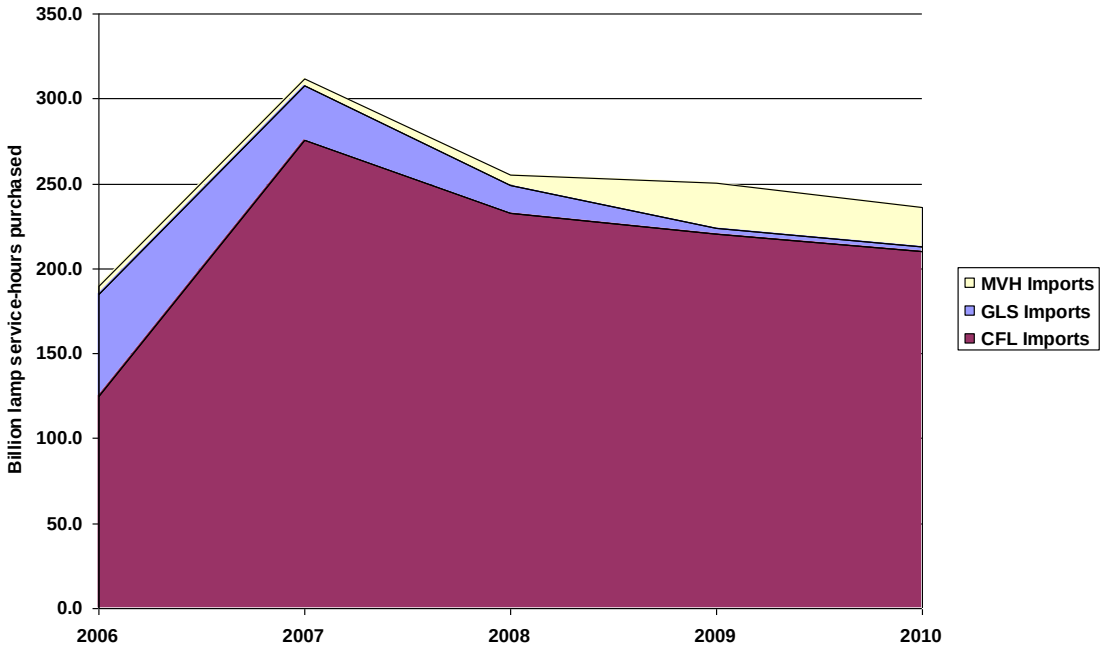

Figure 5. Lamp-hours embodied in standard socket lamp imports, 2006-2010

Table 1. Share of households indicating main lighting type by living rooms, Victoria 2007

	Kitchen	Lounge	Dining	Family
Incandescent globe (a)	20%	52%	51%	41%
Incandescent downlight	10%	7%	6%	10%
Incandescent reflector lamp	3%	3%	3%	5%
Linear fluorescent lamp	31%	3%	6%	5%
Circular fluorescent lamp	8%	2%	4%	2%
CFL (a)	13%	21%	17%	17%
Low voltage halogen	15%	11%	13%	18%
Total	100%	99%	100%	98%
Share of Total that is GLS/SSL	33%	73%	68%	58%
Share of GLS/SSL that is CFL	39%	29%	25%	29%

Source: Roy Morgan Research 2008 (a) GLS/SSL type. Other type are directional or have special pins

The most recent data on lamp types in households are from a walk-through audit of 150 homes conducted in 2010, shortly after the phase-out took effect. This found an average of 14.4 CFLs per house (Table 2), or 45% of the number of potential standard sockets available. Interestingly, about 19% of standard sockets already contained MVH lamps, suggesting that they had been relamped relatively recently, because MVHs only became available in quantity in 2009. This group of householders was obviously aware of CFLs and accepted them to the point where they were the most common type of standard socket GLS lamp, yet still continued to purchase incandescent MVH lamps for a significant number of replacements. This strongly suggests effective market saturation of CFLs.

Table 2. Number of lamps by household, walk through survey

		Average per household	Share of standard socket lamps
Standard socket lamps	GLS Tungsten Filament	10.5	33%
	Mains voltage halogen	6.1	19%
	CFL	14.4	45%
	LED	0.7	2%
	Total standard socket	31.7	100%
Special fitting lamps	Low voltage halogen	10.0	NA
	Linear Fluoro	4.2	NA
	Total special fitting	14.2	NA
Total (excludes heat lamps)		45.9	NA

Energy Efficient Strategies, 2012. Household located in Victoria, NSW and Queensland

Conclusions

There was a major shift in the general lighting service (GLS) lamp market in Australia between 2006 and 2010. The market share of CFLs increased significantly, as did the share of mains voltage halogen (MVH) lamps. The market share of old-style tungsten filament lamps, on the other hand, fell from 77% of lamp imports in 2006 to 7% in 2010. The overall market size also fell, as the average service life of lamps increased.

There were at least three major factors at work over the period:

- a gradual long-term trend to CFLs due to growing customer familiarity, increasing quality and falling relative prices;
- Large scale free giveaways and installations of CFLs in the period 2006 to 2008; and
- A national policy to phase-out inefficient GLS lamps, first announced in early 2007 and taking effect during 2009.

These factors interacted in a number of ways. It is possible that the phase-out may have accelerated the pre-existing trend towards CFLs by enhancing customer confidence in their quality and performance. It is also possible that the free giveaways could have masked the early effects of the phase-out by creating household stocks of CFLs and depressing overall market demand. Conversely, the introduction of MVHs, prominently marked on their packaging with messages such as ‘Energy saver: 30% less energy’, may have prompted many buyers to stay with incandescent lamps rather than switch to CFLs.

Whatever the share of the market shift to CFLs that may be attributed to each of these factors, it appears that the demand for CFLs may be close to effective saturation, and further efforts to promote their use will be increasingly expensive in relation to the potential for further energy savings. Effective

saturation does not mean that every available lamp socket is occupied by a CFL, but that most buyers are aware of CFLs, already have several CFLs and are in a position to make an informed judgement about whether CFLs suit the requirements of each particular lighting application in terms of cost-effectiveness and quality of light.

Consequently, it may now be time to focus policy initiatives on supporting the next generation of high-efficiency lamps – LEDs – and on increasing the energy efficiency of forms of household lighting other than GLS. In Australia, this means addressing the large number of low voltage halogen lamps in use in the household sector.

Acknowledgements

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References

COAG 2010 "National Strategy on Energy Efficiency (updated July 2010)", Council of Australian Governments, July 2010

E3 2009 "Prevention is Cheaper than Cure - Avoiding Carbon Emissions through Energy Efficiency; Projected Impacts of the Equipment Energy Efficiency Program to 2020" Equipment Energy Efficiency Program. January 2009

Roy Morgan Research 2008. "Victorian Utility Consumption Household Survey", Roy Morgan Research for Department of Human Services, April 2008