

Compact fluorescent lightbulbs: an acceptability study

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ABSTRACT

Compact Fluorescent Lightbulbs (CFL's) use less energy than standard GLS lightbulbs, last longer, are widely available and cost less than ever before. They have also been issued free to households over a number of years through funding provided by the ECC. Despite this, a survey by Mintel¹ revealed that in 2005, just 13.3% of new bulbs purchased in the UK were CFL's.

By looking in detail at the effects of introducing CFL's into real homes, this study investigates some of the reasons that people don't use CFL's, as well as some of the reasons that they do.

1. INTRODUCTION

In 1998 an investigation was carried out by the Environmental Change Unit at Oxford University 'DELIGHT' (Palmer & Boardman)². This report looked at the potential for the uptake of CFL's throughout the European Union in the coming years and the potential energy savings which might be achieved. 9 years on from this report, my study provides a snapshot of the current use of CFL's in 9 homes in the UK and looks at the potential for increasing this use.

To study their performance in use, CFL's were introduced into 9 households in and around Cambridge, UK. In each case the ease with which the bulbs could be substituted for existing bulbs was noted, as was their capital cost. The effect on electricity consumption was then monitored, as were the householder's reactions to, comments and general experiences of using the CFL's.

2. OVERVIEW

2.1 Technical Background

UK Building Regulations define a 'low energy' light as one having an efficacy greater than 40l/w, and (although LED lighting is still developing), fluorescents are currently the only light source suitable for general domestic use able to achieve this standard. Additionally, CFL's can be used as a direct replacement for GLS bulbs, they are readily available with the same colour temperature (2700k) and have good (although not equal) colour rendering properties.

Hence with a typical stated efficacy of 50-60 l/w, CFL's

have the potential to reduce electricity consumption for lighting by up to 80% over existing GLS bulbs, without a significant reduction in lighting quality (and often without alteration to lighting infrastructure). Despite this there are significant technical differences between CFL's & GLS bulbs, and these should be carefully considered. Bulb life is 3-15 times longer than GLS bulbs (under test conditions), however warm-up times are in all cases worse. GLS bulbs reach full brightness almost instantly, whereas cold CFL's may take up to 30 seconds to reach 50% brightness, and over 5 minutes to reach their full power. Ambient Temperature also affects the performance of CFL's, and those operating at a typical indoor temperature of 20°C may only actually be performing at around 80% of their stated efficiency.

The Light Distribution characteristics of CFL's differ significantly from those of GLS bulbs, and this may affect light levels in a room, where CFL's are used with luminaires or shades designed for GLS bulbs. CFL's are often larger and may look different to GLS bulbs, and this may be significant in certain situations.

Finally, mercury is used in all CFL's and is extremely toxic to most life forms. Where CFL's are disposed of in landfill (no other facility is generally available in the UK) there is therefore an increased risk of environmental damage.

2.2 Current Use, Cost & Availability of CFL's

Uptake of CFL's has been slow in the UK domestic market, and although sales are rising, they are still modest compared to GLS types.

A recent report by the European Institute for Environment and Sustainability³ suggests that around 50% of UK households have at least 1 CFL. Interestingly it also estimates that the average number of CFL's in use is just 2 per household. The fact that such a large number of households have been exposed to CFL's as a technology, but that they are still only used in 10% of fittings, suggests that significant barriers exist to their use.

Performance differences between GLS bulbs and CFL's are covered earlier in this section, however, other important possible barriers to use include differences in Cost and Availability.

In 2001 a report by the University of Oxford 'Retail Therapy: increasing the sales of CFL's'⁴ looked at the availability of CFL's in 15 shops in the Oxford area. The report found reasonable availability of CFL's in

DIY shops and Department Stores, but very limited availability in Supermarkets. Costs for the bulbs were described as varying from £2.50 to £10.

A limited survey by myself in Cambridge in 2007 (6 years later) revealed little change, with my local supermarket stocking just 2 types of CFL. Another Supermarket across town did however carry a much better selection, suggesting that availability in supermarkets may be improving. Neither of my closest local convenience stores stocked any CFL's though, and it was still necessary to go to a DIY superstore to access a large range of types (my local store stocks 36 different types of CFL's). The cost of bulbs also varied widely, from £1.12 for the cheapest 11W CFL, to £19.97 for a 23W R80 Spotlight. It was clear though that the most commonly used wattages & fittings were the cheapest, indicating that economies of scale may have a significant impact on prices.

2.3 Use of lighting in UK homes

The purpose of lighting can be defined as 'producing conditions to enable us to see what we are doing, and to create an ambience appropriate to the setting.' In the home basic considerations of health, safety and utility are combined with more subjective concepts of visual comfort, & these varying requirements of lighting of course result in varying lighting strategies.

Overhead pendant fittings provide for the basic lighting requirements in many rooms in UK homes, however wall lights, spotlights, chandeliers, striplights, downlighters, table lamps & standard lamps were all also in use in the homes in my study. Each home and person is different and lighting needs to respond to a myriad of factors such as room shape, room décor, personal taste, and the health of the occupant's eyes. When assessing the suitability of CFL's for use in the home, the desire to make use of varying & multiple fixed & portable light sources must therefore be adequately considered.

3. SURVEY METHOD

3.1 Selection of Properties

Limited resources and a desire to conduct a detailed investigation necessitated the use of a small sample for this study, and it is clearly not possible to extrapolate general trends for the UK from just 9 homes. It was expected however that the specific comments, attitudes and technical problems revealed by the study would be of wider interest.

3.2 Timescale

A monitoring period was selected from mid October to mid December. In 4 weeks of this period the homes were be lit as far as possible using GLS bulbs, in the

remaining 4 weeks these were substituted for CFL's. To compensate for variations in day length over the study period, the monitoring period was split into 4 periods of 2 weeks as shown below:

PERIOD 1	PERIOD 2	PERIOD 3	PERIOD 4
Weeks 1-2	Weeks 3-4	Weeks 5-6	Weeks 7-8
GLS Bulbs	CFL's	CFL's	GLS Bulbs

As the change of day length in Cambridge over the period is close to linear, the average day length for the 1st & 4th periods was taken to be similar to the average over the 2nd & 3rd periods.

3.3 Measuring Energy Use

For practical reasons it was not possible to measure electricity use specifically for lighting, therefore the total electricity consumption of the study households was measured using the supplier's electricity meter. It was expected that background electricity use from most non-lighting appliances would be relatively constant over periods of a week or more, allowing variations in lighting demand to show through.

3.4 Property Data Sheets & Occupant Surveys

Basic information was gathered for each property and a survey carried out of all light fittings and bulbs in general use in the house. A short questionnaire was also conducted to establish whether electricity was used for heating, hot water, or other appliances with a particularly heavy or intermittent demand. At the end of the study a detailed questionnaire was completed with each adult householder, to evaluate their perceptions of CFL's.

3.5 Bulb selection

Bulbs purchased for the study were in each case the cheapest available to suit the fittings encountered. Wattages were selected to match the light output of existing bulbs, based on the manufacturer's claims printed on the boxes.

4. SURVEY RESULTS

4.1 Introducing CFL's into Study Homes

Figs 4.11 & 4.12 show the number & type of light fittings in use in the study homes before the start of the study, and after the additional CFL's had been introduced. These figures show that it was possible to significantly decrease the installed lighting power in all of these homes, without altering the existing lighting infrastructure, using readily available types of CFL. It is also clear however that a significant number of fittings (around 25%) were not compatible with CFL's.

The majority of these were fittings designed for specifically for halogen bulbs, and the recent popularity of these bulbs can therefore be seen to be a significant barrier to using CFL's. Other common problems encountered were CFL's being too large for existing lightshades and CFL's being incompatible with existing dimmer switches or PIR controls. Additionally CFL's were also unavailable to suit B15 bayonet fittings on the day I visited the shops, and none were any available to replace a GLS nitelite'.

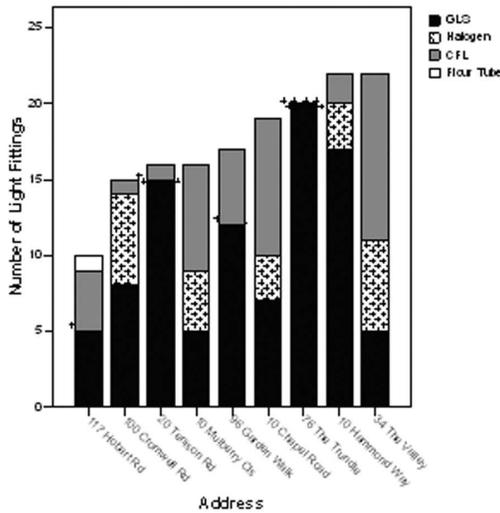


Figure 4.11 – Bulbs in use Before the Start of the Study

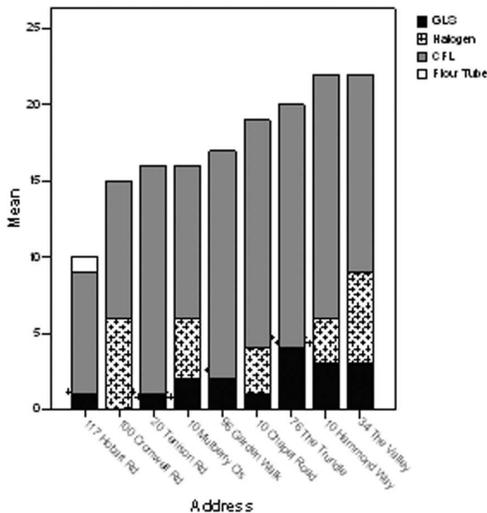


Figure 4.12 – Bulbs in Use Monitoring Periods 2 & 3

4.2 Purchase Cost of Bulbs

The total purchase cost of CFL's introduced into the study

homes varied from £12-£28 with the variation resulting from numbers and types of fittings suitable for replacement.

4.3 Electricity Consumption

Fig 5.11 shows total household electricity use over the study period (bars shown in grey are for periods with energy saving lighting installed) and although small relative to overall consumption, clear savings are nevertheless indicated for the 5 lowest energy users.

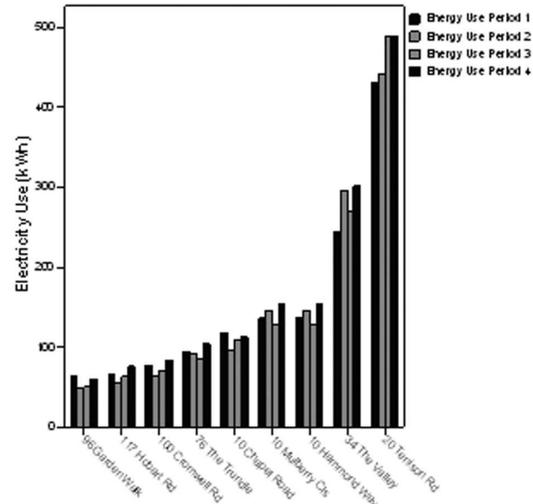


Figure 4.31 – Electricity Consumption Total by Monitoring Period

4.4 Occupant Feedback

All 20 adults living in the study homes were interviewed at the end of the monitoring period, to establish their attitudes to the Availability, Performance & Cost of CFL's, and also their attitudes towards Global Warming. Lack of availability of CFL's in local shops was an issue for some households, as was lack of availability generally of bulbs for more unusual fittings. Several people also commented that CFL's are not 'advertised'. Performance of CFL's was deemed 'acceptable' overall for 80% of people, however many also expressed negative comments about them & 55% of people asked thought that CFL's were dimmer than the bulbs they replaced. Everybody asked stated that CFL's took longer to reach full brightness than the bulbs they replaced, and a minority of householders said that they left CFL's on in certain rooms, due to the slower start up time. The capital cost of CFL's was an issue for many people and the cost of CFL's relative to normal bulbs did seem to be a barrier to their use. Additionally people did not seem to be as aware of the potential long term cost savings in terms of reduced energy use and increased life, as they did with the potential 'environmental' benefit.

Of the people surveyed 90% were concerned about the threat of Global Warming and 85% believed that reducing electricity use could reduce the rate of Global Warming. Overall satisfaction with the bulbs was high, with 100% of people stating that they would continue to use at least some of the CFL's provided, and 75% saying that they would buy CFL's in the future. However 45% said that they would not continue with the bulbs in certain rooms, and in every case this was due to performance related complaints i.e. slow start up times, lower light levels and incompatibility with existing light fittings.

5. CONCLUSIONS

In general I was able to significantly reduce the installed lighting power in study homes, using integrated CFL's. Furthermore, my research suggested that the CFL's were mostly acceptable to the householders, and that they could produce a measurable reduction in electricity use. Existing infrastructure in terms of Halogen fittings, unusual GLS fittings, lampshades and dimmer switches, was however a significant barrier to use of CFL's, and significantly these fittings and controls typically occurred in areas of the home with high lighting use (particularly in the Lounge & Kitchen).

The DELight study (Palmer & Boardman) identified the production and promotion of dedicated fittings for CFL's as a major potential route to their long term increased use, however a spot check at my local DIY store revealed that of 200+ light fittings on display just one was actually shown fitted with a CFL. UK households replace on average 1 light fitting per year⁵, however there was no evidence from my study that new fittings are being selected with CFL's in mind. This failure to provide fittings for CFL's which match consumers expectations is in stark contrast to the large range of fittings available for less efficient halogen lighting.

The long term cost savings associated with CFL's seemed to be of only limited interest to most people in my study. Neither did performance seem to be an overriding consideration, except for particular bulb types. (many people considered that the CFL's provided were generally dimmer, as well as taking longer to reach full brightness, and yet 100% of people stated that they would continue using at least some of the CFL's in their homes). In fact, in discussion the people in my study more commonly weighed the environmental benefits of the bulbs against their higher capital cost. It may be therefore that although many people in the study could certainly have 'afforded' to buy additional CFL's, the fact that their motivation was 'altruistic' limited the amount of money that they were willing to spend. If this is the case then it is likely that that this attitude would be

even more pronounced in low income groups.

Perhaps the notion that using CFL's is 'the right thing to do' results in a situation where people 'put up' with more expensive bulbs with lower performance, in an effort to do what they believe is correct for wider society. Significantly promotion of CFL's is also often carried out in similarly negative terms, with CFL's being described as 'energy saving', whereas they could equally be described as 'brighter'. The introduction of energy labelling may encourage people to buy CFL's, but CFL's surely still need to be seen as a good product in their own right. After all somebody buying an A-rated washing machine may well expect it to be more expensive than an F-rated machine, but they will probably not expect it to wash their clothes any less well.

Aside from producing quality dedicated fittings, another good starting point for this change of emphasis might be to further investigate manufacturer's wattage recommendations for replacing GLS bulbs with CFL's. 55% of people in my study found CFL's to be dimmer than GLS bulbs when replaced in the recommended wattage, with the vast majority of the remainder being 'unsure'. Older CFL's suffered a number of failings in terms of inappropriate colour temperature, inefficient humming ballasts and premature failure, and it is surely counter-productive to now perpetuate the poor image of CFL's by overestimating their light output?

In summary therefore, I have found a general willingness amongst people to convert to CFL's, where their existing light fittings allowed it, where the bulbs were provided for free and where assistance was provided in selecting and fitting the correct bulbs. The existence of CFL's already in many homes also provides some evidence of longer term acceptability and also a willingness to purchase CFL's, at least in small numbers.

There is no evidence however that people are willing to go to any large amount of effort or expenditure to change to CFL bulbs. The small scale of this study does not allow any definite assertions to be made, however the findings do indicate that people consider CFL's poor value for money in terms of their capital cost. Prices will no doubt continue to fall, however the price of GLS bulbs has also fallen and this was pointed out to me by more than one person.

Value for money could therefore perhaps be increased more effectively in this case by increasing the perceived quality of the product. Currently CFL's may simply be seen as good for the environment, but expensive and with suspect performance. With correct specification however and the use of purpose designed fittings, perhaps this perception could be altered to powerful, cheap to run, and good for the environment?

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