

Enlightenment Through Modelling and Monitoring: UK Domestic Lighting

JANE PALMER
Environmental Change Unit, UK

ABSTRACT

Domestic lighting electricity consumption figures are often based on rough estimates or on the 'residual' electricity after other end uses have been accounted for. There is a danger that this leads to inaccurate estimates of lighting consumption and so fails to highlight the importance of this sector in terms of potential energy savings.

As part of the DECADE (Domestic equipment and carbon dioxide emissions) project, the figures for UK domestic lighting electricity consumption have been revised to almost double previous estimates on the basis of a lighting stock model. These revisions were then confirmed through three studies which have actually monitored lighting consumption in the UK, thus illustrating the importance of such studies in determining accurate figures for this sector.

INTRODUCTION

Despite the fact that almost every household in Europe has electric lighting, surprisingly little is known about it. Estimates of annual lighting electricity consumption vary from 10 to 25 percent of residential electricity use in industrialised countries (Bartlett 1991).

Lighting consumption is inherently difficult to estimate and monitor. It is not simply a case of one appliance per household; it is more like twenty different appliances per household, each with a different usage pattern and power consumption. There also exists wide variation between different households which can be due to a range of interacting factors.

However, such problems are not insurmountable. A combination of modelling and monitoring studies has led to a doubling in domestic lighting consumption figures for the UK.

ESTIMATING LIGHTING CONSUMPTION

Figures for domestic lighting consumption in many European countries are usually estimated, based on rough calculations involving many assumptions. Where metering of household electricity consumption has been carried out, lighting consumption is usually assigned to the 'residual electricity': the electricity remaining after other end-uses have been metered. This is often because of the problems and costs involved in monitoring lighting separately. However, there is a risk that such methods give poor estimates of lighting electricity use.

In the UK, average household lighting consumption was previously estimated at 380 kWh per year, based on the Electricity Association's Domestic Sector Analysis (DSA). There were no measurements to confirm this figure.

MODELLING LIGHTING CONSUMPTION

UK domestic lighting was studied in detail as part of the DECADE (Domestic equipment and carbon dioxide emissions) project which has modelled historical UK electricity consumption for all domestic lights and appliances from 1970 and made projections through to 2020 (DECADE 1995).

This work represents the most detailed study of UK domestic lighting to date. It involved building up a lighting stock model on the basis of both ownership and sales data. One of the main problems encountered was the lack of such data. Even where sales data for light bulbs were available, there was the additional problem of identifying the split between residential and non-residential sales. Also, almost nothing is known about the lighting installed in peoples' houses. It is only in the last couple of years that light bulb ownership data have become available. There

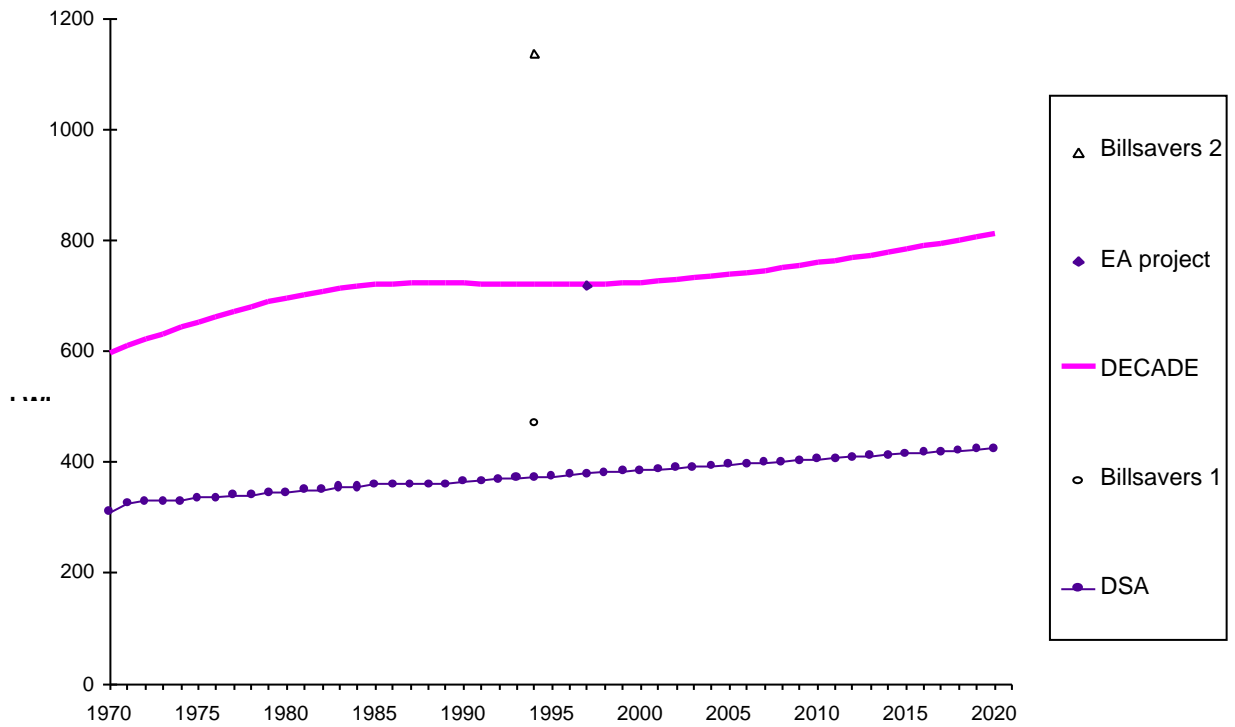


Figure 1 - Domestic lighting electricity consumption per household, UK 1970-2020

Table 1 - Domestic lighting electricity consumption figures

	Billsavers 1	Billsavers 2	Electricity Association	DECADE
Total lighting consumption (kWh/year/household)	<i>470</i>	<i>1138</i>	719	720
Fixed luminaire consumption (kWh/year/household)	385	933	588	-

Note: Figures in italics correspond to derived rather than measured figures. See text for details.

are other areas where data are lacking and so it was still necessary to make many assumptions, such as the lifetime of bulbs in situ, for inputs to the stock model. As a consequence of this, the resulting figures have a wide margin of error around them. However, the rationalisation of sales and ownership figures ensured confidence in the model output.

The DECADE figures for average household lighting electricity consumption are shown in Figure 1. Other outputs of the model include annual burning hours for all light bulbs and estimates of bulb sales.

As a result of the work done by DECADE, UK domestic lighting consumption per household has been revised to 720 kWh per year (DECADE forthcoming), almost double the DSA figures (Figure 1). This gives a total of 17 TWh for the whole of the UK and represents almost 17% of all domestic electricity. This revision also has an impact on other electricity end uses: some figures have to be decreased since all electricity consumption still has to add

up to the total on the electricity bill.

MONITORING LIGHTING CONSUMPTION

This major revision has now been confirmed through the results of three studies in the UK which have monitored lighting electricity consumption.

Two projects, based in Scotland and co-ordinated by LEEP (Lothian and Edinburgh Environmental Partnership), monitored electricity consumption in 100 low-income and 100 higher income households, Billsavers 1 (LEEP 1996) and Billsavers 2 respectively. The third project, run by the UK's Electricity Association (EA) – the major trade organisation of the electricity industry – metered lighting in a representative sample of 100 households spread throughout the UK.

The figures for mean annual household lighting electricity consumption in each of these projects are shown in Table 1.

Only consumption data for the fixed luminaires (usually

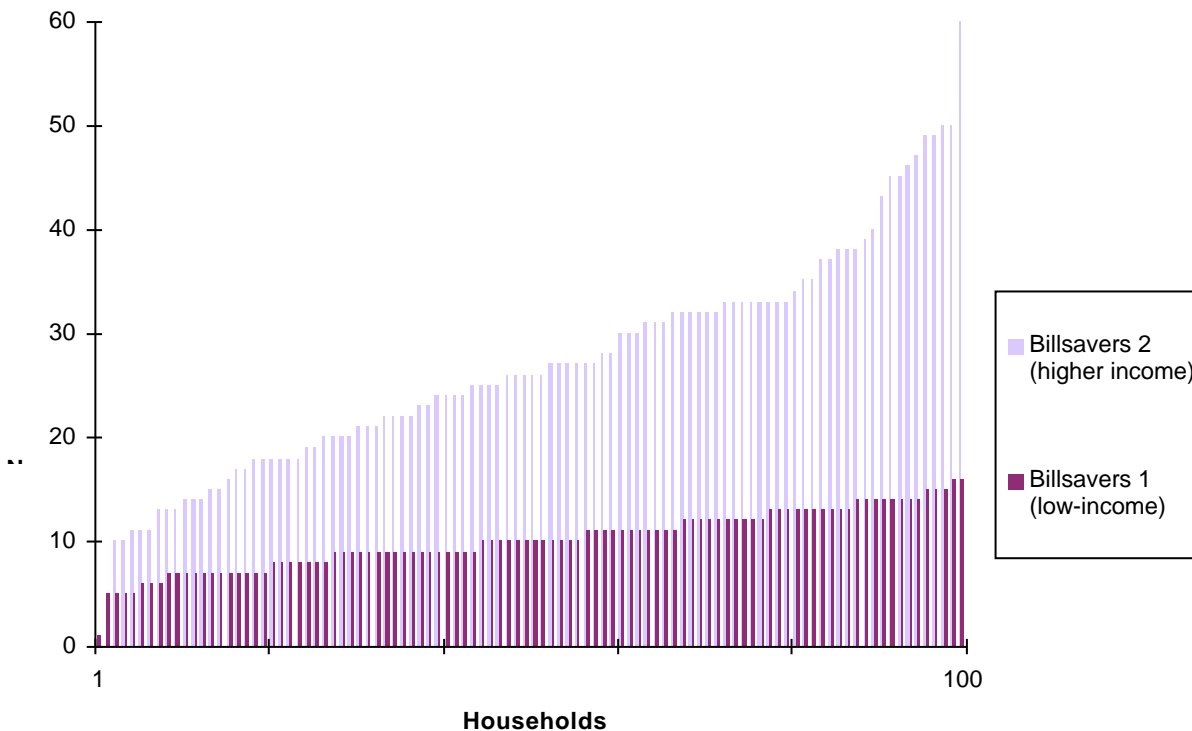


Figure 2 - Comparison of light bulb ownership in Billsavers low-income and higher income households

located on the ceiling or wall and operated by a wall mounted switch connected to a separate light circuit) were available for the Billsavers projects. However, the EA project monitored both fixed luminaires and the majority of portable luminaires (luminaires with a switch, either on the luminaire itself or on the cable, and which plug into a wall socket). Hence, the ratio of consumption for the different luminaires derived from the EA data was used to adjust the Billsavers figures to give total lighting consumption.

The Billsavers data demonstrate the differences which exist between income groups: lighting consumption in the Billsavers 2 sample is over twice that of the Billsavers 1. This is partly because the Billsavers 2 sample consists of households with a large number of rooms and an average of 32 light bulbs, whereas the Billsavers 1 households are much smaller and have an average of 10 bulbs (Figure 2). It is also possible that the lower consumption is because some of the low-income households are not actually able to afford an adequate level of lighting.

The average household lies somewhere between the two Billsavers samples, as illustrated by the EA figures. It is likely that the EA data slightly underestimate lighting consumption since only the majority of portable luminaires were metered. Whilst the sample is nationally representative, it is still only a small sample and there will be fairly wide margins of error associated with these figures. However, the EA and DECADE figures match very closely, thus confirming the upwards revision and increasing confidence in the strength of the DECADE lighting stock model.

CONCLUSIONS

Historical estimates for UK domestic lighting consump-

tion have been found to be inaccurate as a result of detailed modelling and monitoring studies. While doubling the figures for lighting consumption does not mean an actual increase in total domestic electricity use, it shifts the focus onto lighting as an important area in terms of energy savings and policy.

It is likely that, given the lack of data and knowledge on lighting, the situation may be similar for other countries. A combination of modelling and monitoring can improve the reliability of estimates for lighting electricity consumption and hence estimates of potential energy savings.

ACKNOWLEDGEMENTS

This work was funded by the UK Department of the Environment, Transport and the Regions and the European Commission SAVE programme. I would also like to thank the Electricity Association and LEEP for providing the data and the DECADE team for their help and comments. ●

REFERENCES

- Bartlett, S. 1991. "Shedding light in residential consumers." *Proceedings of Right Light 1*. pp 221-237. Stockholm, Sweden.
- DECADE. 1995. *DECADE - Domestic equipment and carbon dioxide emissions, Second Year Report 1995*. Environmental Change Unit, University of Oxford, UK.
- LEEP. 1996. 'Securing the Savings: a report on the first two years of the Billsavers project'. Lothian and Edinburgh Environmental Partnership, Edinburgh, UK.

