



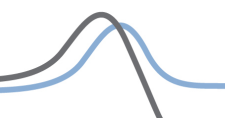
# BNCL01: Commercial Lighting Government Standards Evidence Base 2009: Key Inputs

Version 1.1

This Briefing Note and referenced information is a public consultation document and will be used to inform Government decisions. The information and analysis forms part of the Evidence Base created by Defra's Market Transformation Programme.

## 1 Introduction

- The aim of this Briefing Note is to provide details and reference sources of the underlying data in the model, along with the key assumptions used in the model.
- There are three main sections to this Briefing Note, corresponding to the main variables of the MTP modelling approach:
  - Ownership & stock
  - Sales
  - Usage
- Each section also includes an indication of the overall confidence in the dataset, to provide a sense of the robustness of the model.
- This GSN covers lamps, ballasts and luminaires used in the commercial sector.
- Commercial lighting covers all internal and external lighting fixed to a building for all commercial (i.e. non domestic) premises including offices, retail units, hotels, public services buildings, industrial units and warehouses.
- The MTP Commercial Lighting models split out lamps by use. While the Non-Domestic Lighting Annexe in the 'Product policy analysis and projections 2010' gives data for Commercial lighting at an aggregate level, this GSN splits out data for each category of use. Lamps are categorised as follows:
  - **'Ambient' lighting:** lighting to give a mood similar to domestic lighting for instance in restaurants, hotels, bars etc.  
*Lamps covered:* GLS filament, CFL, SSL (solid state lighting - LED or OLED) alternatives for this type of lighting.



- **'Office' lighting:** Linear fluorescent lighting for general illumination of offices and similar spaces.

*Lamps covered:* T12, T5, T8 Hal\_B2, T8 Hal\_B1, T8 Tri\_A, T8 Tri\_B1,<sup>1</sup> SSL alternatives to fluorescent lighting.

The four categories of T8 equate to various levels of efficiency of lamp (Halophosphate vs Tri-phosphor) and ballast (electronic A, or magnetic B1 or B2); it has been assumed that there are no halophosphate lamps with electronic A class ballasts and no tri-phosphor lamps with magnetic B2 ballasts. All T12 lamps are assumed to be Hal\_B2 until changed by the European Commission Energy related Products Directive regulation on Tertiary Lighting; all T5 lamps are assumed to be Tri\_A.

- **'Industrial' lighting:** High intensity discharge (HID) lighting for industrial, warehousing, retail shed and large scale leisure use.

*Lamps covered:* High-pressure sodium, low pressure sodium, high-pressure mercury, metal halide (excluding compact types), SSL alternatives to this type of lighting.

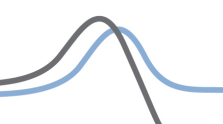
- **'Display' lighting:** Lamps for accent and display in retail, museums, galleries, offices.

*Lamps covered:* Tungsten halogen, compact metal halide, SSL alternatives to these lamps.

**The category titles are illustrative only and it is not implied, for example, that all fluorescent lighting is used in offices or that all high-intensity discharge lighting is used in industrial settings.**

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<sup>1</sup> All of these are difference sizes and categories of fluorescent tubes



## 2 Ownership & stock

### 2.1 Summary

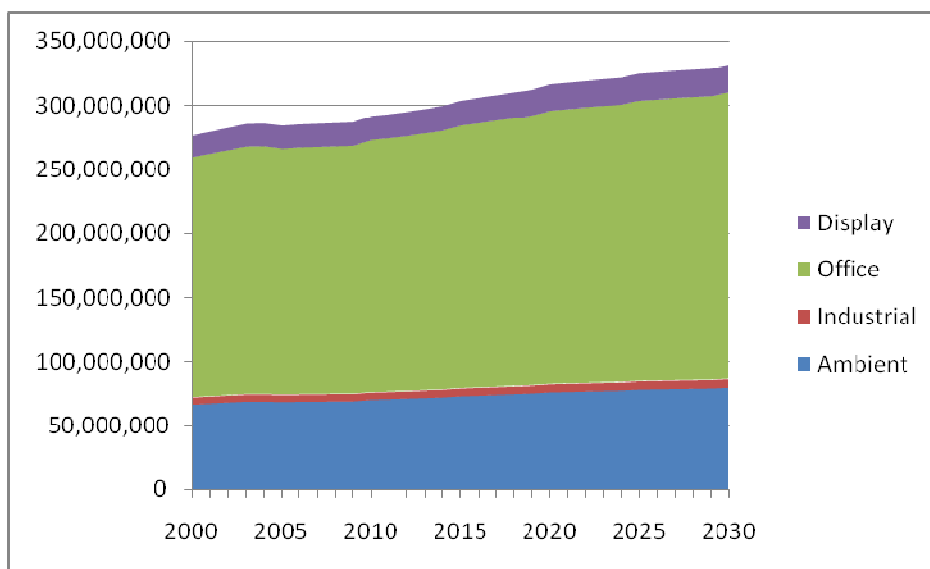
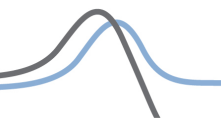


Figure 1: Commercial Lighting lamp stock

Table 1 Summary stock data

	Reference Scenario Stock ('000)				
	TOTAL	Ambient Lighting	Industrial Lighting	Office Lighting	Display Lighting
2007	285,676	68,894	5,620	193,078	18,084
2010	291,622	70,275	5,757	196,950	18,640
2020	316,143	76,113	6,273	213,314	20,442
2030	331,562	79,799	6,589	223,597	21,577



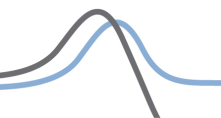
## 2.2 Data sources – ownership & stock

**Table 1 Ownership & stock data sources (Ambient Lighting)**

Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1960-1994	GLS, CFL	UK Electricity and Light Data	1998	BRE Non-domestic energy efficiency model	Survey results covered significant number of non-domestic installations in UK.	High confidence near 1994
1995-2008	GLS, CFL	BRE Non-domestic energy efficiency modelling team floor area predictions	2010	BRE Non-domestic energy efficiency model	Growth of stock based on floor area projections. Switch of stock from Ambient GLS replaced by CFLs based on estimated impacts of Building Regulations 2002 and 2006.	High near 1994; lower as projected forwards

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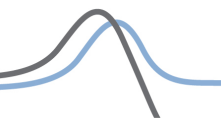
Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1960-2030	SSL (LED)	Technical expert opinion based on Multi-Year Program Plan FY'09-FY'15, Solid-State Lighting Research and Development (US Department Of Energy 2009)	2009	MTP Technical Expert	Based on when SSL may become best practice using efficacy projections from report quoted	Low

**Table 2 Ownership & stock data sources (Office Lighting)**

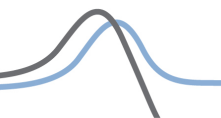
Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1960-1994	All except SSL	'Electricity & Light' data	1998	BRE Non-domestic energy efficiency model	Survey results covered significant number of non-domestic installations in UK.	High confidence near 1994

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Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1995-2008	T12 and T5	Based on confidential industry source lamp summary 2001-2007	2009	Confidential industry source and MTP Technical Expert	Good sales data for these lamps allows good estimate of stock growth or decline	High
1995-2008	All lamps	BRE Non-domestic energy efficiency modelling team floor area predictions	2010	BRE Non-domestic energy efficiency model	Growth of stock from best data available (floor area projections) in 2010 when MTP model updated following stakeholder feedback during consultation	Low – switch between T8 lamp classes based loosely on confidential industry lamp summary 2001-2007
2010-2030	SSL	Technical expert opinion based on Multi-Year Program Plan FY'09-FY'15, Solid-State Lighting Research and Development, US DOE 2009	2009	MTP Technical Expert	Based on when SSL may become generally used using efficacy projections from report quoted	Low

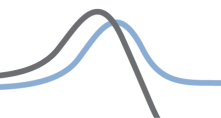


**Table 3 Ownership & stock data sources (Industrial Lighting)**

Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1960-1994	All except SSL	UK Electricity and Light Data	1998	BRE Non-domestic energy efficiency model	Survey results covered significant number of non-domestic installations in UK.	High confidence near 1994
1995 - 2008	All except SSL	BRE Non-domestic energy efficiency modelling team floor area predictions	2010	BRE Non-domestic energy efficiency model	Growth of stock based on floor area projections.	High near 1994; lower as projected forwards

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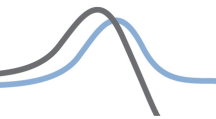
Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
2010-2030	SSL	Technical expert opinion based on Multi-Year Program Plan FY'09-FY'15, Solid-State Lighting Research and Development, US DOE 2009	2009	MTP Technical Expert	Based on when SSL may replace other lamps using efficacy projections from report quoted	Low

**Table 4 Ownership & stock data sources (Display Lighting)**

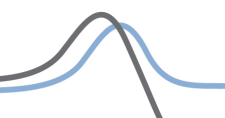
Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1960-1994	Tungsten Halogen	UK Electricity and Light Data	1998	BRE Non-domestic energy efficiency model	Survey results covered significant number of non-domestic installations in UK.	High near 1994; lower as projected forwards

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Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1995-2008	All lamps	BRE Non-domestic energy efficiency modelling team floor area predictions	2010	BRE Non-domestic energy efficiency model	Growth of stock based on floor area projections.	High near 1994; lower projected forwards
1960-1996	Compact Metal Halide	Expert opinion	1998	MTP Technical Expert	In absence of data on this new technology (in 1997), expert opinion was used	High
1997-2008	Compact Metal Halide	Technical expert opinion based on confidential industry lamp summary 2001-2007	2009	Confidential industry source	Growth of stock determined by sales from sales data from confidential industry source	High
2010-2030	SSL	Technical expert opinion based on Multi-Year Program Plan FY'09-FY'15, Solid-State Lighting Research and Development, US DOE 2009	2009	MTP Technical Expert	Based on when SSL may replace other lamps using efficacy projections from report quoted	Low



## 2.3 Methodology & key assumptions – ownership & stock

### 2.3.1 Historic data

**Table 5 Interpolation & background calculations – ownership & stock**

Year	Lamp Type	Methodology & assumptions
1960-1994	All except compact metal halide and SSL which were not on market	BRE data, 'UK Electricity and Light 'back projections used. Based on UK Digest of Energy Statistics (various years) and the assumption that lighting used 50% of non-domestic electricity (excluding industrial processes) from 1960 to 1980. Since no data were available on the breakdown of electricity consumption before 1994, a figure of 50%, slightly larger than the known 1994 figure, was chosen for 1960-1980 on the basis that ICT was growing in its share of electricity consumption from 1980 until 1994. Between 1980 and 1994 the proportion of electricity used for commercial lighting was assumed to decrease at a constant rate.
1994 - 2008	Ambient lamps Office lamps Industrial lamps Display lamps based on tungsten halogen population. All categories exclude SSL	Based on BRE NDEEM floor area projections converted into stock growth figures assuming constant lighting provision.
1996-2008	T5, T12 and other fluorescent lamps	Good sales data for T5 and T12 lamps used to estimate stock growth and stock decline, respectively. Confidential industry data on relative sales of halophosphate and tri-phosphor T8 lamps used to inform stock trends of T8 lamps. Stock mix of T8 estimated.
2002-2008	GLS,CFL	2% per annum reduction in sales of GLS post introduction of 2002 Non-Domestic Building Regulations increased to 5% per annum post 2006 Non-Domestic Building Regulations as it becomes harder to use GLS lamps in refurbishments. It is assumed that GLS lamps are replaced with CFLs.

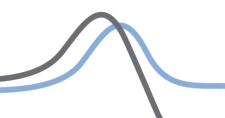
### 2.3.2 Future analysis

**Table 6 Extrapolation & background calculations – ownership & stock**

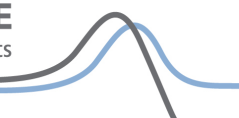
	Year	Lamp Type	Methodology & assumptions
Ambient lighting	2009 - 2012	GLS	Sales of GLS reduced in accordance with the voluntary phase out of GLS lamps by retailers. 100% of GLS lamps become CFLs. All GLS stock removed by end 2012.
	2009-2030	CFL	All GLS lamps become CFLs; no SSL lamps assumed in Reference Scenario.
	2009-2030	SSL	No stock assumed in Reference Scenario
	2009-2030`	Overall sector stock assumptions	Overall ambient lighting stock grows gradually over this period, from 70m lamps in 2009 to 80m lamps in 2030.

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	Year	Lamp Type	Methodology & assumptions
Office Lighting	2009-2030	T5	Sales level off as these lamps increase their market share of office lighting; sales kept constant from 2009 onwards in Reference Scenario
	2009 - 30	T12	Sales reduction trend continues until zero sales in 2026. It has been assumed that most of the T12 fittings left in 2015 are able to comply with the ErP Tertiary Lighting Regulation when fitted with a tri-phosphor lamp.
	2009 - 2030	Hal_B2	Sales set to zero in 2009 as a result of ErP Tertiary Lighting Measure; lamps switch to Tri_B1 or Tri_A categories in proportion 50:50 as they fail. No premature replacement of lamps assumed.
	2009 - 2030	Hal_B1	Sales set to zero in 2009 as a result of ErP Tertiary Lighting Measure; lamps switch to Tri_B1 or Tri_A categories in proportion 50:50 as they fail. No premature replacement of lamps assumed.
	2009-2030	Tri_B1	This category receives 50% of the lamps removed from the Halophosphate categories but it is assumed that the current trend to move from magnetic (B) ballasts to electronic (A) ballasts will continue and that sales in this category will reduce 10% per annum from 2017 as old magnetic fittings are replaced with electronic ones. Sales reach zero by 2026.
	2018 - 2030	SSL	A small growth of SSL office lighting has been assumed from 2018 in this scenario. This is the data at which SSL is expected to be significantly more efficient than fluorescent lighting and the cost premium is reduced to a more attractive level.
	2009-2030	T8_Tri_A	Any office fitting that is not any of the above is assumed to be T8_Tri_A.
	2009-2030`	Overall sector stock assumptions	Overall office lighting stock is assumed to increase by 15% over the period 2009-2030, from 194m to 224m lamps.
Industrial lighting	2009-2010	All industrial lighting	Historic stock trends continued
	2011 - 2017	High-pressure mercury	Sales reduce linearly year on year until removed from market altogether by ErP Tertiary Regulation in 2016.
	2011-2030	Metal halide	100% of HP Mercury lamps removed become metal halide. All new metal halide become 'ceramic' version from 2017.
	2011 - 2030	Low pressure sodium	Historic stock trends continued
	2011-2030	High-pressure sodium	Historic growth trend continues; all new lamps are 'plus' version post 2012.
	2009-2030	Overall sector stock assumptions	Industrial lighting stock is assumed to grow gradually over this period, rising from 5.6m to 6.6m lamps in stock.
Display lighting	2009 - 2030	Tungsten halogen	Stock maintained constant in Reference Scenario (reduced market share)
	2009-2030	Compact metal halide	Share of stock maintained constant in Reference Scenario (constant market share)
	2009-2030	SSL	Remaining display stock – equates to linear stock growth 2009 - 2030
	2009-2030	Overall sector stock assumptions	Display lighting stock is assumed to grow by 18% over this period, increasing from 18m lamps to 21.6m lamps.

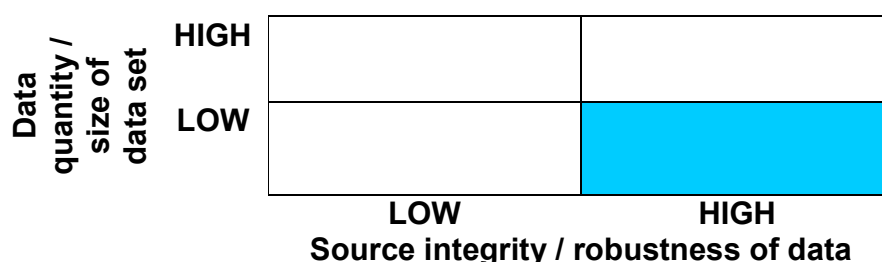


## 2.4 Data issues – ownership & stock

**Table 7 Data issues – ownership & stock**

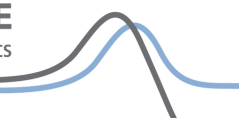
Issue/risk	Approach taken/rationale
The base survey (' UK Electricity & Light, 1998) data is now old, which means that projections made from it are uncertain	Confidential industry sales data has been used as far as possible to verify that the assumptions being made are reasonable.
The growth predictions from NDEEM floor areas will not necessarily reflect the actual changes within the UK economy on a year-by-year basis	Caution should be exercised on making predictions based on the reliability of a single year's figures; data should be viewed as an average picture of the sector stock size.
Model does not assume any switching of stock between the main use categories e.g. fluorescent (office) lighting being replaced with compact metal halide (display) lighting. This modelling approach may be too simplistic if the market shifts significantly	Although such transformations are possible there is insufficient evidence from the sales data available to suggest that we are badly over- or under-estimating the sales of particular lamp types.
Confidential industry sales data is not sufficiently detailed to be certain of the split between certain lamp types (e.g. T8). Also the data is known to be weak for assessing sales of high-intensity discharge lamps	The data has been cross-checked against other data sources such as AMA Research Lighting Report 2008, but similarly, that data is not sufficiently detailed to give high confidence in the full data set.
Confidential industry data does not collect solid-state lighting sales data at present	Early estimates of market penetration have been made by the MTP technical experts but these will need to be reviewed yearly. MTP has been involved in setting up a SSL users group to collect such data.
No sources of data for overall stock growth for each sector	Stock growth based on expert assumption taking into account the past growth

## 2.5 Confidence level – ownership & stock



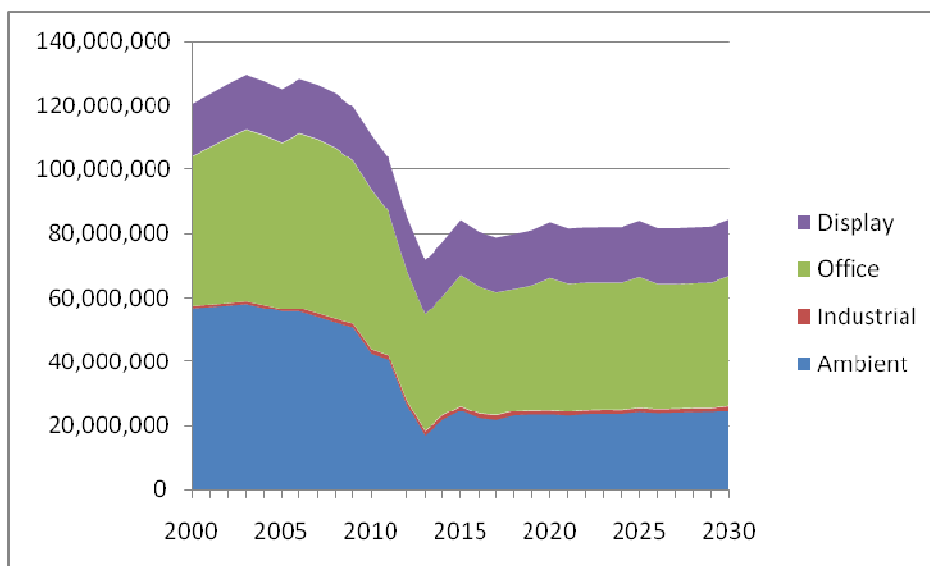
**Figure 2 Confidence indicator for ownership data**

- Stock growth now based on new data on floor area of non-domestic premises received in 2010 so robustness of the stock data is now stronger than previously.



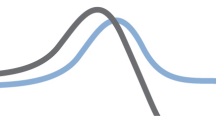
## 3 Sales

### 3.1 Summary



**Figure 3: Commercial Lighting lamp sales (output)**

- There is very little sales input data used in the commercial lighting models. In general, this model is a stock-based model, which calculates sales using the stock projection and the product lifetime. Real sales data is put in as a check only, to help evaluate the output sales calculated from the model. The sales shown in the Figure 3 illustrates the full generated (rather than input) sales data series. For more details of lamp sales data, see Commercial Lighting Government Standards Briefing Note – Key Outputs.



## 3.2 Data sources - sales

**Table 8 Sales data sources (Ambient & Industrial Lighting)**

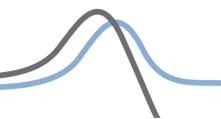
Year	Lamp Type	Reference	Author	Justification	Confidence in sources (High/Low)
1960-2008	All	No input data available NA	NA	No sales data available specific to the commercial sector. Confidential industry sales data is heavily convolved with domestic sales data.	NA

**Table 9 Sales data sources (Office Lighting)**

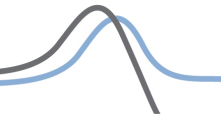
Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1996 -2007	T12, T5	Confidential Industry Lamp Summary 2001-2007  Confidential Industry lamp totals 1996-1998	1996-2007	Private communication from confidential industry source	Good sales data for these categories	High

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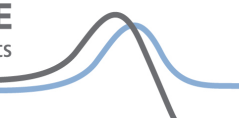


Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1996- 2007	T8 Triphosphate A	Confidential industry sales data used as a guide for sales to 2008. No true sales data available.  Confidential industry Lamp Summary 2001-2007  Confidential industry lamp totals 1996-1998  Note - data for this category is convolved with Tri_B category	NA	Private communication from confidential industry source	No true sales data available	NA
1960-2010	SSL and all T8 lamps (except Triphosphate A)	No input data available	NA	NA	NA	NA



**Table 10 Sales data sources (Display Lighting)**

Year	Lamp Type	Reference	Author	Justification	Confidence in sources (High/Low)	
1960-2008	Tungsten Halogen, SSL	No input data available	NA	No sales data available - – any available numbers are heavily convolved with the domestic sector	NA	
1997-2007	Compact Metal Halide	Confidential Industry Lamp Summary	2007	Confidential Industry Source	Good sales data available for this category	High



## 3.3 Methodology & key assumptions – sales

- The MTP model is a stock-based model, which calculates sales using a stock projection, the product lifetime and a stock churn calculation to account for products purchased in previous years gradually leaving stock. Real sales data is put in as a check only, to help evaluate the output sales from the model.
- Only confidential industry source data for T5 and T12 (office lighting) and compact metal halide (display lighting) was assumed to be sufficiently complete and free of integration with domestic or street lighting sales to be used in its entirety in this model.

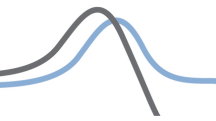
## 4 Usage

### 4.1 Summary

- Usage hours are given as stock weighted averages for the different usage groups.
- Usage from 2005 onwards is based on estimated hours from a British Standard (BS EN 15193:2007) combined with BRE floor area data for sector splits. The reduction in hours of use that had previously been applied in order to model the effects of lighting controls introduced by Building Regulations requirements has now been removed. The effect of new lighting controls has been added to average wattage calculations as a reduction in average wattage when lighting controls are used. This change is intended to model the effect of lighting controls dimming lighting rather than just switching off.

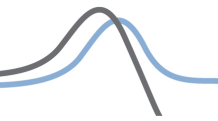
**Table 12 Summary usage data**

	Reference scenario usage (hours/year)				
	Weighted Average	Ambient Lighting	Industrial Lighting	Office Lighting	Display Lighting
2005-2030	3,652	3,607	4,000	3,579	4,490



**Table 13 Usage data sources (Ambient, Industrial & Office Lighting)**

Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1960-1994	All except SSL	UK Electricity and Light Data	1998	BRE Non-domestic energy efficiency model	Survey results covered significant number of non-domestic installations in UK.	High near 1994; lower as projected forwards
1960-1994	SSL	Technical expert opinion	2009	MTP Technical Expert	Based on usage of lamps replaced	Low
2005 -	All	MTP Technical expert calculations and assumptions	2010	MTP Technical Expert	Based on estimated hours of use from BS EN 15193:2007 and floor data predictions – two well respected and robust evidence sources	Medium



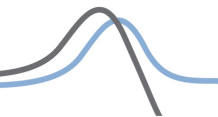
Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
2002 -	CFL Metal Halide T8TriA T5 SSL	Technical expert opinion	2010	MTP Technical Expert	Average wattage modified to take into account lighting controls, using data from: BS EN 15193:2007 and Building Regulations	Low

**Table 14 Usage data sources (Display Lighting)**

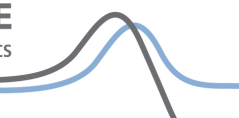
Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1960-1994	Tungsten Halogen	'UK Electricity and Light'	1998	BRE Non-domestic energy efficiency model	Survey results covered significant number of non-domestic installations in UK.	High near 1994; lower as projected forwards
1960-1994	Compact Metal Halide	'UK Electricity and Light'	1998	BRE Non-domestic energy efficiency model	Based on usage of lamps replaced and requirements of Building Regulations	Low – hours reduction based on expert opinion only

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Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1960-1994	SSL	Technical expert opinion	2009	Hilary Graves	Based on usage of lamps replaced and requirements of Building Regulations	Low – high use lamps may be replaced first; this is not accounted for in model
1995 -	ALL	Technical expert opinion	2010	MTP Technical Expert	Based on estimated hours of use from BS EN 15193:2007 and floor data predictions	Low
2002 -	Halogen SSL	Technical expert opinion	2010	MTP Technical Expert	Average wattage modified to take into account lighting controls, using data from: BS EN 15193:2007 and Building Regulations	Low



## 4.2 Methodology & key assumptions – usage

### 4.2.1 Historic data

**Table 15 Interpolation & background calculations – usage data**

Year	Methodology & assumptions
1960 - 2005	NDEEM survey usage figures for overall energy consumption retained from 1960 – 1994, then interpolated to 2005 derived from BS EN 15193:2007 and floor area predictions. These values then retained into the future
2006-2011	Impact of Building Regulations 2006 lighting controls requirements modelled with BS EN 15193:2007 data as a staged reduction in average wattage for the most modern lamp types (CFL, T5, T8, TriA, SSL, metal halide)

### 4.2.2 Future analysis

**Table 16 Extrapolation & background calculations – usage data**

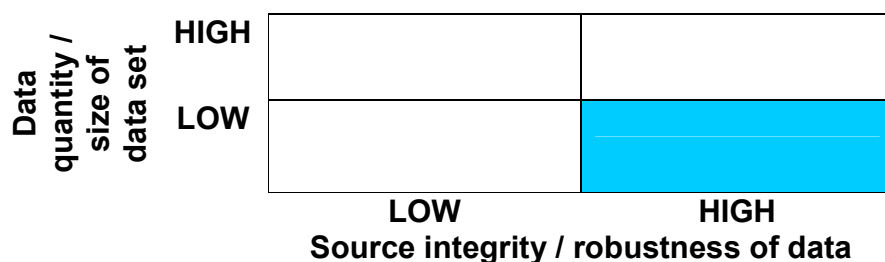
Year	Methodology & assumptions
2005 -2030	In absence of further evidence, usage hours are assumed to be constant for all lamps over this period.

## 4.3 Data issues – usage

**Table 17 Data issues – usage**

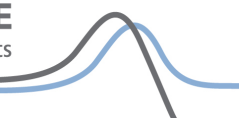
Issue/risk	Approach taken/rationale
Revised usage data is based on only two sources.	These two sources are deemed to be best available and reliable.

## 4.4 Confidence level – usage



**Figure 4 Confidence indicator for usage data**

- Usage is now based on two reliable sources; the European Standard BS EN 15193:2007 and the new data received from the BRE NDEEM team on floor area splits by product type.



## Related MTP information

- BNCL02: Commercial Lighting Government Standards Evidence Base 2009: Reference Scenario
- BNCL03: Commercial Lighting Government Standards Evidence Base 2009: Policy Scenario
- BNCL04: Commercial Lighting Government Standards Evidence Base 2009: Best Available Technology Scenario
- BNCL KO01: Commercial Lighting Government Standards Evidence Base 2009: Key Outputs

## Changes from Version 1.0

- Text and data tables updated since Commercial Lighting was re-modelled in early 2010, following stakeholder feedback on the 'Saving Energy Through Better Products and Appliances' document. As a result of this feedback, higher usage hours and lower stock data for all sectors have been used as inputs in the models.
- Minor changes to GSBN template

## Consultation and further information

Stakeholders are encouraged to review this document and provide suggestions that may improve the quality of information provided, email [info@mtprog.com](mailto:info@mtprog.com) quoting the document reference, or call the MTP enquiry line on +44 (0) 845 600 8951.

For further information on related issues visit <http://efficient-products.defra.gov.uk>