BNCL02: Commercial Lighting Government Standards Evidence Base 2009: Reference Scenario

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 Reference Scenario is a projection of what is likely to happen to energy consumption of each product if no new policies are implemented. All agreed and formally signed-off policies are included in the Reference Scenario.

- Energy-related Products (ErP) measures which been published in the Official Journal of the European Union are included in the Reference scenario.

- For cross-cutting policies such as CERT and Building Regulations, which are agreed but where the likely impact for specific products is unknown, assumptions are made about the impact per product, and detailed in the following sections.

- This GSBN 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 'Product policy analysis and projections 2010' gives data for Commercial lighting at an aggregate level, this GSBN 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, SSL alternatives for this type of 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 ErP measure on Tertiary Lighting; all T5 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), alternatives for this type of lighting.
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- **'Display' lighting**: Lamps for accent and display in retail, museums, galleries, offices.
  Lamps covered: Tungsten halogen, compact metal halide, SSL alternatives for this type of lighting.

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.

2 Scenario outputs

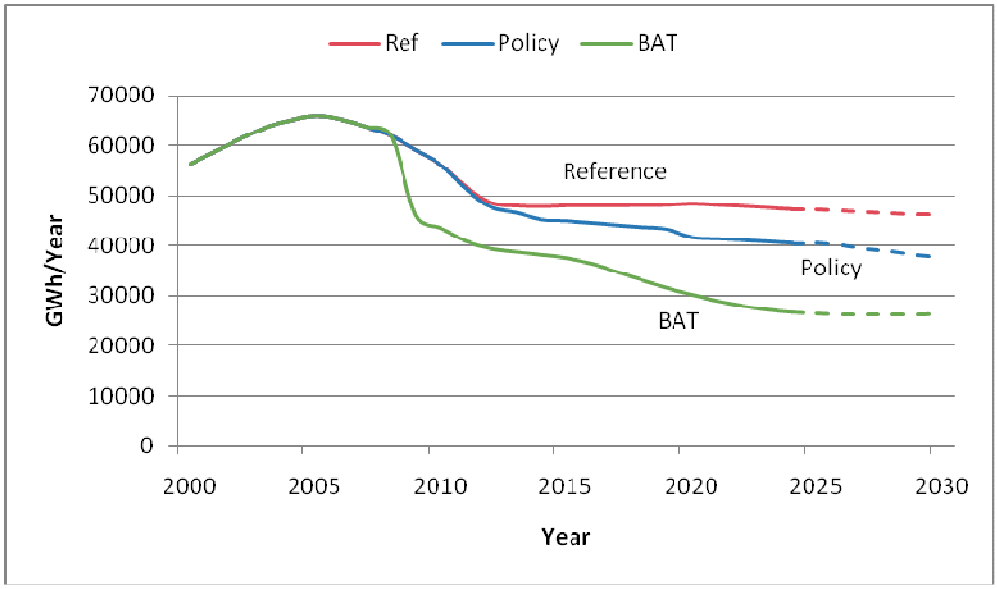

Figure 1: Commercial Lighting energy consumption, 3 scenarios

Table 1 Summary energy consumption[1] and CO_2 emissions[2] data

Energy Consumption (GWh)	2009	2020	2030
Ambient lighting	8,120	3,320	3,480
Office lighting	37,090	32,370	29,840
Industrial lighting	5,070	4,510	4,720
Display lighting	8,750	8,190	8,250
TOTAL	**59,010**	**48,390**	**46,290**
CO_2 Emissions ($MtCO_2$)			
Ambient lighting	2.85	1.19	1.24
Office lighting	13.02	11.57	10.67
Industrial lighting	1.78	1.61	1.69
Display lighting	3.07	2.93	2.95
TOTAL	**20.71**	**17.29**	**16.55**

[1] Energy consumption figures for the non-domestic sector in 'Product policy analysis and projections 2010' were scaled down to match DECC projections for overall energy demand (www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx).

MTP data represents the best currently available information based on a bottom-up modelling approach. MTP's data is the basis for detailed energy calculations in 'Product policy analysis and projections 2010'. However, DECC projections indicate that overall energy demand in the non-domestic sector is lower than projected by MTP's detailed models. MTP has assumed that the differences between the DECC overall projections and its detailed bottom-up projections are due to incomplete data on the following inputs for some of its non-domestic products:

- existing product stock;
- existing product efficiency;
- product usage.

The energy consumption figures in these GSBNs have **not** been scaled down, in order to enable constructive stakeholder comment on the MTP input data, and therefore differ from the ones presented in 'Product policy analysis and projections 2010'.

[2] For CO_2 factors, please see MTP Briefing Note BNXS01 Carbon dioxide emission Factors for UK energy use

3 Current policy & measures

Table 3 Current policies & measures, Reference Scenario

Policy name	Period in force	Description	Impact
Energy related Products (ErP) Directive on Tertiary Lighting	2009-2018	Agreed in 2008 and in force from March 2009. This measure effectively removes T8 halophosphate lamps from the market in March 2010; In March 2012 it removes T12 and T10 halophosphate lamps and T10 and T12 triphosphor lamps with efficacy <89 lm/W (i.e. less than 6 foot) and the least efficient high pressure sodium and metal halide lamps of low colour rendering. Luminaire requirements are established. In March 2015, high-pressure mercury lamps are removed from the market. In March 2017 the majority of metal halide lamps will have to reach efficacies equivalent to current ceramic versions and magnetic ballasts for fluorescent lamps will be removed from the market.	100% of T8 halophosphates are removed from the market. These are assumed to be replaced with T8 Triphosphor and T5 lamps. Remaining T10 and T12 fittings from 2012 will need to use tri-phosphor lamps with efficacy >89 lm/W. but they will, in general, produce more light rather than save energy. High Pressure mercury lamps are removed from the market from 2015. High pressure sodium lamps increase in efficiency from 2012. Metal halide lamps increase in efficiency from 2017
Enhanced Capital Allowance Scheme	2009-2014	The ECA scheme currently covers lighting controls, high efficiency lighting units and white LED units. Expected impacts to 2014 are based on the scheme's 5 year projections.	The scheme currently promotes the sales of tri-phosphor T5 and T8 lamps in efficient luminaires; CFLs for general and accent and display lighting; high-pressure sodium 'plus' lamps and metal halide lighting units for a number of external and industrial applications; and compact metal halide and LED lamps for accent and display purposes. The scheme is estimated to encourage around 10% of luminaire sales.

Policy name	Period in force	Description	Impact
Building Regulations; Part L (in England and Wales and equivalent in Scotland and Northern Ireland)	2006 - 2010	2006 Building Regulations for commercial premises specify that the minimum average initial efficacy is: General lighting in office areas – 45 luminaire lumens/W General lighting in spaces other than office areas – 50 lamp lumens/W Display lighting – 15 lamp lumens/W There are additional requirements relating to the use of lighting controls.	These regulations make it almost impossible to use tungsten filament (GLS) lamps in commercial lighting schemes, and are considered the primary cause of the decline of these lamps in the commercial sector from 2006. The requirements for lighting controls have been modelled within the MTP model as a reduction in the average wattage of the lamp types that are most likely to be the lamps used after refurbishment i.e. T8 Tri_A, T5, CFL, metal halide (for industrial and display lighting) and all solid-state lighting categories. This has been applied for the period 2002 - 2011.
Retailer Voluntary Initiative	2008-2011	Through the voluntary initiative, retailers committed to phase out GLS lamps by 2011. This will have a very small impact on commercial premises that buy their lamps in retail outlets (e.g. SMEs)	Zero sales of GLS lamps are assumed by 2012. Reduction in sales by 23% (2009), 30% (2010), 70% (2011), 100% (2012). These sales reduction assumptions are based on historical population of GLS in commercial premises by wattages
Policies contributing towards trends in the Reference scenario			
- Phase out of EU anti-dumping - Sustainable Procurement Action Plan/Government Buying Standards		The impact of these measures has not been quantified in the Reference Scenario, though it is understood that they are likely to contribute to the observed energy consumption pattern.	

3.1 Policy timeline

- The following policy timeline identifies when policies modelled in the Reference Scenario come into effect.:

Policy name	Current specification in force	2009	2010	2011	2012	2013	2014	2015	2016-2020
Energy related Products (ErP) Directive on Tertiary Lighting	2009	Comes into force	Some lamp types removed from market		Further lamp types removed from market			Further lamp types removed from market	Further lamp type removed from market
ECA Scheme	2009								
Building Regulations (Part L)	2006								
Retailer Voluntary Initiative	2007								

3,2 Test Standards

Standard	Title
BS EN 60969:1993	Self-ballasted lamps for general lighting services – performance requirements
BS EN/IEC 60081:1998	Double-capped fluorescent lamps. Performance specifications
BS EN/IEC 60901:1996	Specification for single-capped fluorescent lamps. Performance specifications
BS EN 60064:1996	Tungsten filament lamps for domestic and similar general lighting purposes. Performance requirements
BS EN 60357:2003	Tungsten halogen lamps (non-vehicle) – performance specifications
BS 1853-2:1995	Specification for fluorescent lamps for general lighting service... not included in BS EN: 60081, 60901, or 61195

Standard	Title
Draft BS EN 60662:2009	High-pressure sodium vapour lamps. Performance specifications
IEC/PAS 62612:2009	Self-ballasted lamps for general lighting services. Performance requirements
BS EN 60921:2004	Ballasts for tubular fluorescent lamps – performance requirements
BS EN 60929:2006	AC-supplied electronic ballasts for tubular fluorescent lamps – performance requirements
BS EN/IEC 60923:2005	Auxiliaries for lamps. Ballast for discharge lamps (excluding fluorescent lamps) – performance requirements
BS EN12464:2002	Light and lighting. Lighting of work places. -1 Indoor work places. -2 outdoor work places
BS EN 1303201; BS EN 13032-2:2004	Lighting applications. Measurement & presentation of photometric data of lamps and luminaires. Part 1 Measurement, Part 2 Presentation of data
BS EN 15193:2007	Energy performance of buildings – Energy requirements for lighting

Performance specifications also exist for Low-pressure sodium vapour lamps (BS EN 60192:2001) and for High-pressure mercury vapour lamps (BS EN 60188:2001).

Other useful lighting standards that are not product specific are:

- BSEN 12665:2002 'Light and Lighting - basic terms and criteria for specifying lighting requirements'. This is a glossary of all lighting terms and includes equations for calculating common parameters.
- IECTS 61231:1999 'International lamp coding system (ILCOS)'.

4 Efficiency

4.1 Summary

- The base efficiency metric used in the Government standards is lamp luminous efficacy measured in lumens per watt. This is a measure of the amount of light emitted by the lamp (in lumens) for the amount of electrical power consumed (rated wattage in watts). The sales-weighted average efficacy of the total new lamp sales is presented.

- For simplicity the efficiency of the ballast (lamp control gear) is not accounted for in this metric although it has been fully accounted for in the model as a whole.

- The efficiency metrics quoted below correspond to values that are relevant to the average wattage of each lamp type. Lamp efficiency is dependent on wattage so efficiency of lamps of lower wattage than the mean wattage will be lower than the figures quoted and for lamps of higher wattage efficiency will be higher.

- In Tables 4-7 zero sales of some lamp types are expected in some years – these are shaded in the tables below.

Table 4 Ambient Lighting - Efficiency Metrics

	Average lumens/watt			
	Sales weighted average	**CFL**	**GLS**	**SSL**
2007	18.4	60.0	11.0	48
2010	25.0	60.0	11.0	101
2020	60.0	60.0	11.0	163
2030	60.0	60.0	11.0	163

Table 5 Office Lighting - Efficiency Metrics

	Average lumens/watt							
	Sales weighted average	**T5**	**T8_Halophosphate_B2**	**T8_Halophosphate_B1**	**T8_Triphosphor_A**	**T8_Triphosphor_B1**	**T12**	**SSL**
2007	89.6	104.0	82.7	81.4	95.5	95.1	76.7	48
2010	97.5	104.2	82.7	81.4	95.7	94.7	76.7	101
2020	101.6	104.3	82.7	81.4	95.7	94.7	89.0	163
2030	119.0	104.3	82.7	81.4	95.7	94.8	89.0	163

Table 6 Industrial Lighting - Efficiency Metrics

	Average lumens/watt					
	Sales weighted average	**High Pressure Mercury**	**High Pressure Sodium**	**Low Pressure Sodium**	**Metal Halide**	**SSL**
2007	87.2	54.6	100.0	154.8	82.6	48
2010	92.7	54.6	105.6	154.8	83.2	101
2020	106.3	54.6	122.5	154.8	95.4	163
2030	106.2	54.6	122.5	154.8	95.4	163

Table 7 Display Lighting - Efficiency Metrics

	Average lumens/watt			
	Sales weighted average	**Tungsten Halogen**	**Compact Metal Halide**	**SSL**
2007	24.1	17.0	87.0	48
2010	27.2	17.5	86.1	101
2020	31.3	17.5	85.8	163
2030	33.1	17.5	85.8	163

Table 8 Average efficiency metric for all Commercial Lighting based on distribution of sales

		% Sales across all Commercial Lighting					
	Average lumens/watt	≤17 lm/w	17 < lm/w ≤35	35 < lm/w ≤60	60 < lm/w ≤75	75 < lm/w ≤100	>100 lm/w:
2009	55.8	40%	0%	14%	0%	35%	11%
2010	58.7	28%	13%	11%	0%	34%	14%
2011	65.4	13%	14%	27%	0%	28%	18%
2012	73.1	0%	17%	31%	0%	25%	26%
2013	73.7	0%	20%	24%	0%	24%	31%
2014	73.2	0%	19%	28%	0%	24%	29%
2015	73.9	0%	17%	30%	0%	26%	27%
2016	74.0	0%	18%	28%	0%	26%	28%
2017	73.9	0%	19%	28%	0%	25%	29%
2018	73.8	0%	18%	29%	0%	24%	29%
2019	74.2	0%	18%	29%	0%	24%	29%
2020	75.4	0%	18%	28%	0%	26%	28%
2021	77.9	0%	18%	28%	0%	20%	33%
2022	77.6	0%	18%	29%	0%	20%	33%
2023	78.4	0%	18%	29%	0%	19%	34%
2024	79.4	0%	18%	29%	0%	18%	36%
2025	80.3	0%	17%	29%	0%	18%	36%
2026	80.3	0%	18%	29%	0%	15%	37%
2027	81.2	0%	18%	29%	0%	14%	39%
2028	81.7	0%	18%	30%	0%	13%	39%
2029	82.2	0%	18%	30%	0%	13%	40%
2030	83.5	0%	17%	29%	0%	12%	41%

Table 9 Average efficiency metric for Ambient Lighting based on distribution of sales

		% Sales across Ambient Commercial Lighting					
	Average lumens/watt	≤17 lm/w	17 < lm/w ≤35	35 < lm/w ≤60	60 < lm/w ≤75	75 < lm/w ≤100	>100 lm/w:
2009	27.6	66%	0%	34%	0%	0%	0%
2010	25.0	71%	0%	29%	0%	0%	0%
2011	44.3	32%	0%	68%	0%	0%	0%
2012	60.0	0%	0%	100%	0%	0%	0%
2013 - 2030	60.0	0%	0%	100%	0%	0%	0%

Table 10 Average efficiency metric for Office Lighting based on distribution of sales

		% Sales across Office Commercial Lighting					
	Average lumens/watt	≤17 lm/w	17 < lm/w ≤35	35 < lm/w ≤60	60 < lm/w ≤75	75 < lm/w ≤100	>100 lm/w:
2009	93.0	0%	0%	0%	0%	75%	25%
2010	97.5	0%	0%	0%	0%	70%	30%
2011	98.5	0%	0%	0%	0%	59%	41%
2012	100.0	0%	0%	0%	0%	46%	54%
2013	100.5	0%	0%	0%	0%	40%	60%
2014	100.4	0%	0%	0%	0%	42%	58%
2015	100.1	0%	0%	0%	0%	47%	53%
2016	100.2	0%	0%	0%	0%	45%	55%
2017	100.4	0%	0%	0%	0%	44%	56%
2018	100.9	0%	0%	0%	0%	43%	57%
2019	101.2	0%	0%	0%	0%	43%	57%
2020	101.6	0%	0%	0%	0%	45%	55%
2021	108.1	0%	0%	0%	0%	34%	66%
2022	107.6	0%	0%	0%	0%	35%	65%
2023	109.4	0%	0%	0%	0%	32%	68%
2024	111.1	0%	0%	0%	0%	29%	71%
2025	112.0	0%	0%	0%	0%	29%	71%
2026	113.7	0%	0%	0%	0%	25%	75%
2027	115.6	0%	0%	0%	0%	22%	78%
2028	116.7	0%	0%	0%	0%	20%	80%
2029	117.6	0%	0%	0%	0%	19%	81%
2030	119.0	0%	0%	0%	0%	19%	81%

Table 11 Average efficiency metric for Industrial Lighting based on distribution of sales

		% Sales across Industrial Commercial Lighting					
	Average lumens/watt	≤17 lm/w	17 < lm/w ≤35	35 < lm/w ≤60	60 < lm/w ≤75	75 < lm/w ≤100	>100 lm/w:
2009	89.5	0%	0%	6%	0%	90%	4%
2010	92.7	0%	0%	4%	0%	84%	12%
2011	96.2	0%	0%	3%	0%	77%	21%
2012	100.8	0%	0%	2%	0%	61%	37%
2013	101.5	0%	0%	1%	0%	63%	36%
2014	102.3	0%	0%	1%	0%	63%	36%
2015	103.1	0%	0%	1%	0%	63%	36%
2016	104.6	0%	0%	0%	0%	65%	35%
2017	106.1	0%	0%	0%	0%	65%	35%
2018	106.1	0%	0%	0%	0%	65%	35%
2019	106.1	0%	0%	0%	0%	64%	36%
2020	106.3	0%	0%	0%	0%	64%	36%
2021	106.1	0%	0%	0%	0%	65%	35%
2022	106.0	0%	0%	0%	0%	65%	35%
2023	106.0	0%	0%	0%	0%	65%	35%
2024	106.0	0%	0%	0%	0%	65%	35%
2025	106.2	0%	0%	0%	0%	64%	36%
2026	106.0	0%	0%	0%	0%	65%	35%
2027	106.0	0%	0%	0%	0%	65%	35%
2028	106.0	0%	0%	0%	0%	65%	35%
2029	106.1	0%	0%	0%	0%	65%	35%
2030	106.2	0%	0%	0%	0%	64%	36%

Table 12 Average efficiency metric for Display Lighting based on distribution of sales

		% Sales across Display Commercial Lighting					
	Average lumens/watt	**≤17 lm/w**	**17 < lm/w ≤35**	**35 < lm/w ≤60**	**60 < lm/w ≤75**	**75 < lm/w ≤100**	**>100 lm/w:**
2009	25.7	87%	0%	0%	0%	13%	0%
2010	27.2	0%	86%	0%	0%	12%	2%
2011	26.2	0%	87%	0%	0%	12%	1%
2012	27.2	0%	87%	0%	0%	12%	1%
2013	27.8	0%	86%	0%	0%	12%	2%
2014	28.2	0%	86%	0%	0%	12%	2%
2015	29.4	0%	85%	0%	0%	12%	3%
2016	28.9	0%	86%	0%	0%	12%	2%
2017	29.2	0%	86%	0%	0%	12%	3%
2018	29.7	0%	85%	0%	0%	12%	3%
2019	30.2	0%	85%	0%	0%	12%	3%
2020	31.3	0%	84%	0%	0%	12%	4%
2021	30.2	0%	85%	0%	0%	12%	3%
2022	30.4	0%	85%	0%	0%	12%	3%
2023	30.8	0%	85%	0%	0%	12%	4%
2024	31.1	0%	85%	0%	0%	12%	4%
2025	32.2	0%	84%	0%	0%	11%	5%
2026	31.2	0%	84%	0%	0%	12%	4%
2027	31.3	0%	84%	0%	0%	12%	4%
2028	31.6	0%	84%	0%	0%	12%	4%
2029	31.9	0%	84%	0%	0%	12%	4%
2030	33.1	0%	83%	0%	0%	11%	5%

4.2 Data sources – efficiency

Table 13 Efficiency data sources

Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1960-2008	All	Various manufacturers catalogues	Various years	Various. e.g. Philips, SLI-Sylvania (Thorn), GE, Osram	Lumen and rated wattage values are published for each lamp type. These are used to produce efficiency data from stock and average wattage data.	High confidence in efficiency data. Less confidence in exact product mix year on year.
1960-2008	All except SSL	UK Electricity and Light Data	1999	BRE Non-domestic energy efficiency model NDEEM	Lamp wattage spread given in survey. Survey results covered significant number of non-domestic installations in UK.	High (except T12, T8 lamps, Compact Metal Halide which is low)
1960-2008	SSL	Technical expert opinion	2009	MTP Technical Expert	No significant stock and sales of SSL prior to 2009 in this scenario	Low – market data for UK is currently poor

4.3 Methodology & key assumptions – efficiency

4.3.1 Historic data

Table 14 Interpolation & background calculations – efficiency

Year	Methodology & assumptions
1960 - 2008	Efficiency metrics are taken from a combination of manufacturers' catalogue figures (lumen output for particular rated lamp wattage) and the average wattage of the lamp type taken from the BRE NDEEM model. The efficacy of the average wattage lamp is interpolated from the two nearest rated wattage lamps of the same type.

4.3.2 Future analysis

Table 15 Extrapolation & background calculations – efficiency

Year	Methodology & assumptions
2009-2030	As policies in the reference scenario impact the minimum standard for particular lamp types: E.g. High-pressure sodium lamps used in Industrial lighting, becoming 'plus' types from 2012, the efficiency of the lamp type is increased from the 'standard' level to the 'plus' level (12% more efficient). Similarly Metal Halides used in Industrial lighting from 2017 are assumed to be changed to the more efficient ceramic types. All other changes result in one lamp type being used instead of another e.g. in office lighting, Hal_B1 are replaced by Tri_B1; or GLS lamps used for ambient lighting are replaced by CFLs. In these cases the sales weighting of the different lamp types alters the overall efficiency of the population.

4.4 Data issues – efficiency

Table 16 Data issues – efficiency

Issue/risk	Approach taken/rationale
Some high-intensity discharge lamps used for industrial lighting may have been higher efficacy versions prior to ErP intervention, but the benefit has not been modelled	MTP has no information on the relative sales of standard and 'enhanced' versions of the lamps and has no evidence on which to base any split.
The actual efficacy figures used in section 4.1 depend on the average wattage of each lamp type remaining unchanged from the 1999 product mix.	MTP has no more recent information on the average wattage of the various lamp types sold on which to model any change in this assumption. The model assumes constant lighting provision (equal lumen output from old and new installation)

4.5 Confidence level – efficiency

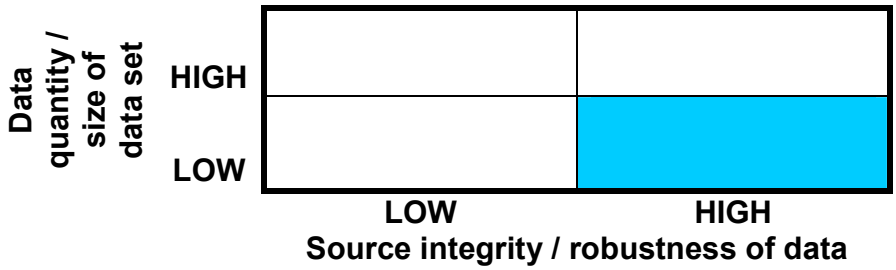

Figure 2 Confidence indicator for efficiency data

- The data are based on one survey conducted in the 1990s and observed trends since that time. Although the original source was based on a good sample of non-domestic premises and a respected source, the age of the survey reduces the confidence in these figures.

5 Other issues

- There are recognised health impacts that can result from the use of CFLs for people with pre-existing light-sensitive disorders, estimated as affecting an absolute maximum of 0.05% of the population, and those with some specific visual impairments. These have been taken into account when future sales/stock of each lamp type used was estimated. Alternative light sources (e.g. efficient halogens and UV filtered fluorescent tubes) remain available.

- Market data on the sales of solid-state lighting in the UK is poor. The reference scenario may be underestimating the penetration of non-domestic markets by this lighting type.

Related MTP information

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

- 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 description of how Building Regulations 2006 is modelled
- Test standards section added
- 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** 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**