BNSTL04: Street & Traffic Lighting Government Standards Evidence Base 2009: Best Available Technology 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 Best Available Technology (BAT) Scenario is a hypothetical projection of what would happen if the best available technologies on the (current and future) market were bought or installed from now on.

- The best available technologies are defined as the most efficient, or lowest energy consuming technologies available on the market, or those which are close to market (where the development stage is completed, but it is not necessary available as a designed product).

- This GSBN covers lamps, ballasts and luminaires used for street & traffic lighting.

- Street lighting refers to all public street lighting and signage. Lamps used for street lighting are CFLs (for signage), High-Pressure Mercury, Metal Halide, High-Pressure Sodium (HPS) and Low-Pressure Sodium (LPS).

- Traffic lighting refers to traffic signals. General Lighting Service (GLS) and Light Emitting Diodes (LEDs) lamps are used for traffic signals. GLS lamps refer to tungsten halogen lamps.

2 Scenario Assumptions

See Section 4 for assumption sources.

Street Lighting Assumptions

1. All new installations on main and trunk roads are HPS 'plus' lamps
2. New installations on residential roads are ceramic metal halides
3. All high-pressure mercury lamps are replaced with HPS lamps
4. All LPS lamps are replaced with 'Eco' versions

- It is assumed that old lamps are renewed at a rate of 3% p.a. (based on stock figure in 2000).

- Under the BAT Scenario, stock of street lighting is therefore made up of the following:
    - 2009: 15.5% CFL; 0.5 % HP Mercury; 5.5 % Metal Halide; 45 % HPS; 33.5 % LPS
    - 2015: 15.5 % CFL; 0.03 % HP Mercury; 13 % Metal Halide; 47.5 % HPS; 24 % LPS
    - 2020: 15.5 % CFL; 19 % Metal Halide; 49 % HPS; 16.5 % LPS
    - 2025: 15.5 % CFL; 24.5 % Metal Halide; 50 % HPS; 10 % LPS
    - 2030: 15.5 % CFL; 29 % Metal Halide; 51.5 % HPS; 4 % LPS

- As street lighting already makes use of well developed, high-efficiency technologies, the use of LEDs is not assumed.

Traffic Lighting Assumptions

- All traffic signal heads are replaced with LED heads in 2009.

- Under the BAT Scenario, stock of traffic lighting is made up of the following:

    - 2009: 6% GLS; 94% LED
    - 2010 onwards: 100% LED

3 Scenario outputs

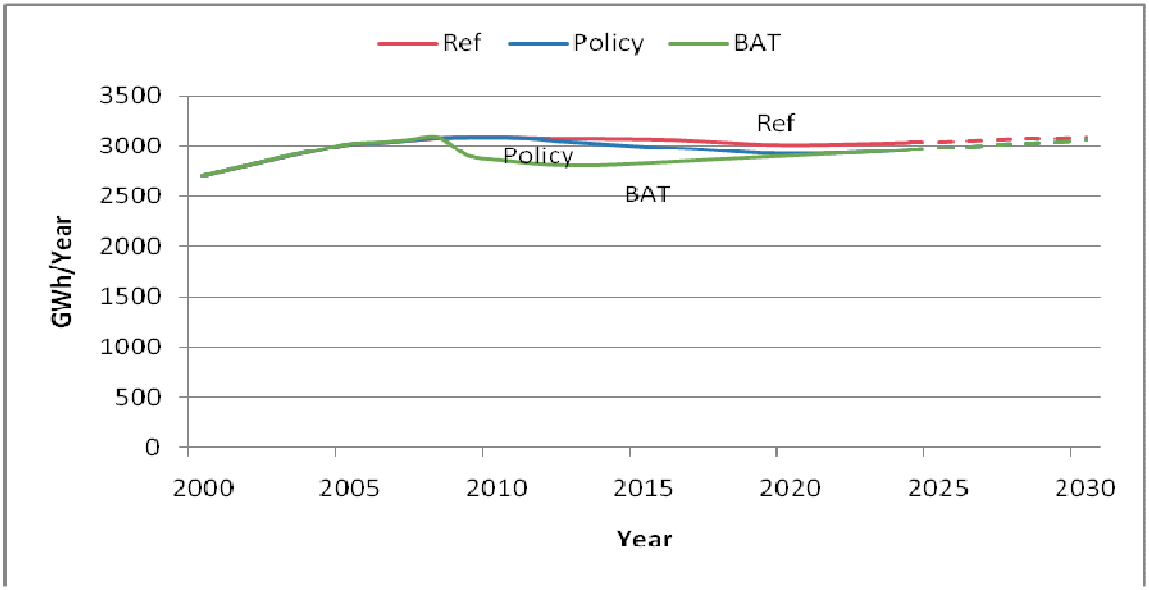

Figure 1: Street & Traffic lighting energy consumption, 3 scenarios

Table 1 Summary energy[1] and CO_2 data[2](Street Lighting)

Energy Consumption (GWh)	2009	2020	2030
CFL	60	60	70
High pressure mercury	20	0	0
Metal Halide	110	380	640
High pressure sodium	1840	2070	2240
Low pressure sodium	820	360	90
TOTAL	**2850**	**2870**	**3040**

[1] Energy consumption figures for the non-domestic sector in the 'Product policy analysis and projections 2010' document 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 the '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 CO2 factors, please see MTP Briefing Note BNXS01 Carbon Dioxide Emission Factors for UK Energy Use

Energy Savings (GWh)			
CFL	0	0	0
High pressure mercury	0	0	0
Metal Halide	0	0	0
High pressure sodium	0	0	0
Low pressure sodium	0	110	30
TOTAL	**0**	**110**	**30**
CO_2 Emissions ($MtCO_2$)			
CFL	0.02	0.03	0.03
High pressure mercury	0.01	0.00	0.00
Metal Halide	0.05	0.16	0.28
High pressure sodium	0.79	0.89	0.96
Low pressure sodium	0.35	0.15	0.04
TOTAL	**1.22**	**1.23**	**1.31**
CO_2 Emissions Savings ($MtCO_2$)			
CFL	0.00	0.00	0.00
High pressure mercury	0.00	0.00	0.00
Metal Halide	0.00	0.00	0.00
High pressure sodium	0.00	0.00	0.00
Low pressure sodium	0.02	0.05	0.01
TOTAL	**0.02**	**0.05**	**0.01**

Table 2 Summary energy and CO_2 data (Traffic Lighting)

Energy Consumption (GWh)	**2009**	**2020**	**2030**
GLS	20	0	0
LED	50	40	30
TOTAL	**70**	**40**	**30**
Energy Savings (GWh)			
GLS	0	0	0
LED	0	0	0
TOTAL	**0**	**0**	**0**
CO_2 Emissions ($MtCO_2$)			
GLS	0.01	0.00	0.00
LED	0.02	0.02	0.01
TOTAL	**0.03**	**0.02**	**0.01**
CO_2 Emissions Savings ($MtCO_2$)			
GLS	0.07	0.00	0.00
LED	-0.01	-0.00	0.00
TOTAL	**0.06**	**-0.00**	**0.00**

Note: The lack of energy saving in 2020 from traffic lighting is a result of all traffic signals being replaced by LEDs from 2010. These early replacements would be making use of lower efficiency LEDs than will be available in the future. As LED signals are expected to last a long time, the population in 2020 would be slightly less efficient than that of the Reference Scenario (where the move towards LEDs happens more slowly, and thus makes use of more efficient lamps in the future). However, the larger savings achieved from 2010 to 2019 would heavily outweigh the small later penalties.

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 dependant on wattage, so efficiency of lamps of lower than average wattage will be lower than the figures quoted, and for lamps of higher than average wattage, efficiency will be higher.

Table3 Street Lighting Efficiency Metrics

	Lumens/Watt					
	Average	**CFL**	**High Pressure Mercury**	**Metal Halide**	**High Pressure Sodium**	**Low Pressure Sodium**
2007	105.2	80.9	49.0	70.0	92.8	140.0
2010	115.1	80.9	49.0	77.7	93.2	140.0
2020	103.4	80.9	49.0	95.6	95.9	172.6
2030	93.6	80.9	49.0	95.6	97.9	172.6

Table 4 Average efficiency metric based on distribution of sales (Street Lighting)

	Percentage of sales in each classification					
	Average lumens/watt	≤60 lm/w	60 < lm/w ≤75	75 < lm/w ≤100	100 < lm/w ≤130	>130 lm/w:
2009	116.6	0.4%	2%	62%	2%	33%
2010	115.1	0.3%	2%	64%	2%	31%
2011	113.7	0.2%	2%	65%	3%	29%
2012	112.5	0.2%	2%	67%	3%	28%
2013	111.4	0.2%	2%	68%	4%	26%
2014	110.2	0.2%	2%	69%	4%	25%
2015	109.1	0.2%	2%	70%	5%	23%
2016	107.9	0.2%	2%	71%	5%	21%
2017	106.8	0.2%	2%	72%	6%	20%
2018	105.7	0.2%	2%	73%	6%	18%
2019	104.5	0.2%	2%	74%	7%	17%
2020	103.4	0.2%	2%	75%	7%	15%
2021	102.4	0.2%	2%	76%	8%	14%
2022	101.3	0.2%	2%	77%	8%	12%
2023	100.3	0.2%	2%	78%	8%	11%
2024	99.3	0.2%	2%	79%	9%	10%
2025	98.3	0.2%	2%	80%	9%	8%
2026	97.3	0.2%	2%	81%	10%	7%
2027	96.3	0.2%	2%	82%	10%	5%
2028	95.4	0.2%	2%	83%	11%	4%
2029	94.5	0.2%	2%	84%	11%	3%
2030	93.6	0.2%	2%	85%	11%	2%

Table 5 Traffic Lighting Efficiency Metrics

	Lumens/Watt		
	Average	GLS	LED
2007	18.5	18.1	48.0
2010	80.4	30.2	97.0
2020	162.0	NA	162.0
2030	162.0	NA	162.0

Table 6 Average efficiency metric based on distribution of sales (Traffic Lighting)

	Percentage of sales in each classification (Traffic Lighting)			
	Average lumens/watt	**≤50 lm/w**	**100 < lm/w ≤130**	**>130 lm/w:**
2009	80.4	0%	100%	0%
2010	97.0	0%	100%	0%
2011	105.5	0%	0%	100%
2012	114.0	0%	0%	100%
2013	122.0	0%	0%	100%
2014	130.0	0%	0%	100%
2015	138.0	0%	0%	100%
2016	146.0	0%	0%	100%
2017	154.0	0%	0%	100%
2018	162.0	0%	0%	100%
2019	162.0	0%	0%	100%
2020-2030	162.0	0%	0%	100%

4.2 Data sources – efficiency

Table 7 Efficiency data sources (Street Lighting)

Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
2009-2030	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. Lower confidence in exact product mix year on year.
2009-2030	All	ASLEC Survey, 2001	2001	Association of Street Lighting Electrical contractors	Survey results covered about one third of all street lighting installations in UK. Wattage of enhanced lamps such as HPS 'Plus' is 12% lower than standard version	High

Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
2009- 2030	HPS, LPS, Metal halide	Expert judgment	2009	MTP Technical Expert	BAT scenario assumes that all installations can use enhanced lamp types. In practice this may require a ballast change in addition to lamp change	High

Note: Historic data sources are included in BNSTL02 – Reference Scenario

Table 8 Efficiency data sources (Traffic Lighting)

Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)

Year	Lamp Type	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
2009	Halogen	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.
2009-2030	LED	Expert assumption and SSL DOE Roadmap projections of LED efficiency	2008	Navigant Consulting et al for USDOE	Efficiency assumption is best available estimate based on numerous experts in field. Equivalent wattage based on replacing current tungsten halogen lamps with LED from 2009	Low - this is a rapidly evolving technology and estimates of efficiency improvements change frequently

Note: Historic data sources are included in BNSTL02 – Reference Scenario

4.3 Methodology & key assumptions – efficiency

4.3.1 Future analysis

Table 9 Extrapolation & background calculations – efficiency

Year	Lamp Type	Methodology & assumptions
2009-2030	All types	Relative percentage sales of the main street lamp types remain the same as the Reference and Policy Scenarios which the exception of high-pressure mercury lamps, which are removed from the market in 2009. No increase in the rate of replacement of lighting columns has been assumed.
2009-2030	Discharge lamps	Efficiency of LPS, HP Mercury and old stock HPS 'standard' versions assumed to be the same as that seen in Aslec survey 2001. The 'plus' version of HPS is 12% lower wattage; 'Eco version' of LPS is 27% lower wattage; HPS lamps replacing HP mercury are 78% more efficient.
2009-2030	High and low pressure sodium	Expert judgment that same average wattage can be applied to new high-pressure sodium schemes replacing low pressure sodium is based on the fact that although HPS lamps are approximately 30% less efficient, the luminaires that use them can be more optically efficient than LPS luminaires, allowing no increase in wattage for 'standard' version. 'Plus' version is 12% lower wattage.
2009-2030	Metal halide	Expert judgment on metal halide lamps in new installations on residential roads. Average lumen output of LPS lamp is 5280 Lm. PD CEN/TR 13201-1:2004 allows approximately 33% reduction in lumen with white light or ~3500 Lm. 45W 'cosmo white' gives 4300 lumen and is lowest wattage 'white' light available so wattage of this lamp used for 'ceramic' version. The 'standard' metal halide version is assumed to be 12% higher wattage.

4.4 Data issues – efficiency

Table 10 Data issues – efficiency

Issue/risk	Approach taken/rationale
Some lamps may have been higher efficacy versions (such as the HPS Plus' lamp) prior to 2009 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..
Evidence for the number of metal halide installations is small.	Growth of this new category is based on a very small survey of local authorities so there is low confidence in the data.

4.5 Confidence level – efficiency

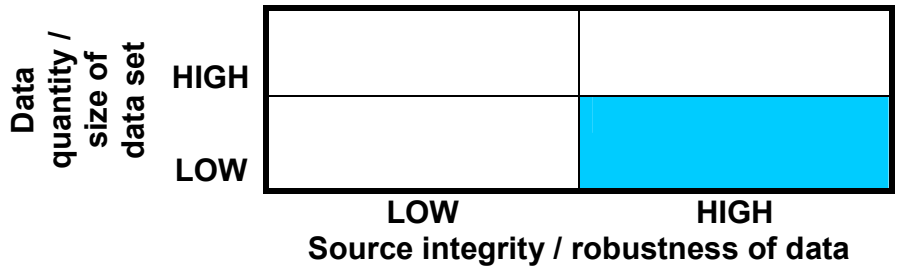

Figure 2 Confidence indicator for efficiency data

- Impacts in the BAT Scenario are based on a stock mix that has not been fully surveyed since 2001.

5 Other issues

- Some historic lighting schemes may have been giving lighting levels significantly below those recommended in PD CEN/TR 13201-1:2004. Such schemes may require a higher average wattage than used previously but it has been assumed that such schemes will be balanced out by schemes in which efficiency savings can be made through better design.

Related MTP information

- Briefing Note BNCL12: Light-emitting Diodes - Innovation Briefing Note
- BNSTL01: Street & Traffic Lighting Government Standards Evidence Base 2009: Key Inputs
- BNSTL02: Street & Traffic Lighting Government Standards Evidence Base 2009: Reference Scenario
- BNSTL03: Street & Traffic Lighting Government Standards Evidence Base 2009: Policy Scenario
- BNSTL KO01: Street & Traffic Lighting Government Standards Evidence Base 2009: Key Outputs

Changes from Version 1.0

- Reformatting of data in Tables 1 and 2
- Clarification of the term GLS referring to tungsten halogen lamps
- Reference to 2009 consultation document replaced with final document 'Product policy analysis and projections 2010'.
- 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**