Lifecycle of a Lighting Installation

Kevan Shaw

Published in *Lighting India*, January 2010

Introduction

Given the current concerns over climate change we are being challenged with considering the environmental impact of our work as lighting designers. Almost all the legislation and thinking is going into the energy used during the operating life of the installation as this is seen to be the biggest potential generator of greenhouse gas emissions. This thinking is masking, and in some situations encouraging, a waste of resources and energy over the whole lifecycle of the installation, from the process of manufacturing, installing and using to disposing of lighting equipment.

The Lighting Lifecycle

The manufacture of lighting equipment consumes resources as well as energy. Winning the raw materials, or for that matter recycling scrap for re-use, has environmental impacts. Transporting part-finished and finished products consumes energy. So does the process of installing.

Over life in use there will be maintenance including replacement of lamps and some parts that fail in use. The lifetime will be very variable depending on the kind of building the equipment is installed in. In Europe and America shops might be refitted every 3 to 5 years; a museum may retain the same lighting scheme for 30 years or more. Typically offices are refitted every 15 years as leases expire. Obviously this is not the same situation in most of India where lighting equipment typically is used for much longer time periods.

At end of life more energy is used in demolition; then transport; materials separation; re-cycling of some material; and disposal of the rest, often to landfill, where they may re-enter the biosphere in harmful ways.

Lifecycle Assessment

How can we assess this process? There are tools, usually in the form of spread sheets, that will calculate various environmental impacts based on the materials in the product. For the purposes of this paper I will use the same tool as is being used by the people working on European energy using products legislation. This spreadsheet was originally designed for the assessment of household goods so there may be some issues relating to scalability when looking at lighting. The spreadsheet was also designed to look at energy in use although we will be ignoring this for now. The bottom line is that we are looking at comparisons between different lighting products rather than expecting an absolute quantitative result from this exercise.

Let us take a look at a decision we made on a recent project. This was a refurbishment of an office building with exterior path lighting provided by Bega bollards. These had been in situ for around 17 years and were suffering from dirt build-up, some corrosion and flaking finishes. They were fitted with 80W mercury lamps, probably the original ones installed when new. We thought it was worth investigating the potential for re-use of the fittings, replacing the existing lamps and gear with suitable metal halide lamps and electronic gear; stripping and re-finishing the fittings; and cleaning reflectors and lenses to as-new condition.

We felt that this would be a distinct environmental benefit however we did not, at that stage, calculate an environmental impact for this. For this paper I have done so. Table 1 is a summary of the impacts of one bollard.

Table 1: EcoReport results for manufacture and recycle of one bollard

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	g			**0**			0	0	**0**	**0**
2	TecPlastics	g			**0**			0	0	**0**	**0**
3	Ferro	g			**255**			13	242	**255**	**0**
4	Non-ferro	g			**20075**			1004	19071	**20075**	**0**
5	Coating	g			**125**			6	119	**125**	**0**
6	Electronics	g			**0**			0	0	**0**	**0**
7	Misc.	g			**100**			5	95	**100**	**0**
	Total weight	g			**20555**			1028	19527	**20555**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	1174	136	**1310**	**496**	**13**	70	5	**65**	**1884**
9	of which, electricity (in primary MJ)	MJ	10	82	**92**	**1**	**1**	0	0	**0**	**94**
10	Water (process)	ltr	7	1	**9**	**0**	**0**	0	0	**0**	**9**
11	Water (cooling)	ltr	48	38	**87**	**0**	**1**	0	0	**0**	**88**
12	Waste, non-haz./ landfill	g	15756	438	**16194**	**233**	**162**	1260	0	**1260**	**17849**
13	Waste, hazardous/ incinerated	g	3	0	**3**	**5**	**0**	0	0	**0**	**7**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	75	8	**82**	**31**	**1**	5	0	**5**	**119**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	330	33	**363**	**92**	**4**	10	0	**10**	**468**
17	Volatile Organic Compounds (VOC)	g	2	0	**2**	**8**	**0**	0	0	**0**	**10**
18	Persistent Organic Pollutants (POP)	ng i-Teq	676	1	**677**	**1**	**7**	9	0	**9**	**693**
19	Heavy Metals	mg Ni eq.	26	2	**28**	**12**	**0**	21	0	**21**	**61**
	PAHs	mg Ni eq.	361	0	**361**	**20**	**4**	0	0	**0**	**385**
20	Particulate Matter (PM, dust)	g	85	5	**90**	**1367**	**1**	91	0	**91**	**1550**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	138	0	**138**	**0**	**1**	6	0	**6**	**145**
22	Eutrophication	g PO4	1	0	**1**	**0**	**0**	0	0	**0**	**2**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

According to this model we have saved gross 1,884 Mj of energy and CO_2 equivalent emissions of 119kg for each bollard re-used, along with sundry other noxious emissions generated in the manufacturing of the product and winning of the necessary materials. For the total of 80 bollards we saved gross 9,520kg of CO_2 equivalent emissions.

In the rest of Europe this might be considered quite a small contribution to saving the planet as the energy used throughout the operating life of the bollard will generate 965,983kg of CO_2 (based on EcoReport figures). However I am not at all satisfied that this comparison is appropriate if we accept that we have an absolute limit on use of natural resources such as the materials used for manufacture, but that we have a potentially limitless resource for non fossil fuel power generation. In Scandinavia we have hydro electric, the French have nuclear, the Southern States of America and desert regions of North Africa and Arabia have direct solar, most of Europe has photovoltaic and wind generation. Also there are many advances in micro generation using photo voltaic and combined heat and power systems.

If we start to look at materials as a significant element in our environmental impact as lighting designers we need to start thinking a lot more carefully about the equipment we are specifying and we also need to be much more thoughtful about the likely life of our design. We start to develop a list of new questions to add to those we already have to answer in the design process.

Likely Life of the Installation

In the UK, office installations are now on a 15 year cycle of tenancy and subsequent refurbishment. This can obviously stretch as tenants renew leases but there are many older tenancies expiring annually. How should this inform our design? Assuming the lights are switched off at night we are typically looking at around 2,000 hours of use a year totalling 30,000 hours over 15 years. Does it make sense to specify a light source or lamp that will exceed 30,000 hours? Current good quality T5 lamps have an operating life of 16,000 hours so would only require re-lamping once during the life of the installation. Thinking of light fittings what should we consider? Well if it is only expected to have a life of 15 years, re-cyclability or re-usability should be prime considerations. We should also be looking for fittings that minimise the use of raw materials and use a high proportion of recycled material in their manufacture.

The retail refurbishment cycle is even shorter. Depending on the product offer, the most fashion conscious retailers will have the shortest cycle. Typically these stores are likely to re-fit within 5 years. Less fashion conscious retailers will typically refit when there is a compelling reason, such as wear and tear, change in marketing direction, or change in product range for example. In these situations life strategies can be tailored to suite, maybe a background lighting installation that would be expected to serve through several re-fits and specific decorative and display fittings intended for one refit cycle only. Lamp types and fittings should be selected according to the expected life. Sometimes it is difficult to focus the client on longer term solutions when they are excited about a refurbishment and inevitably looking for a least cost solution.

Equipment Specification

In the case of our bollards this was the only part of the project that reasonably permitted re-use of existing equipment. The decision was based on the quality of the original fittings, giving an expectation that there was a longer life achievable for the majority of the fitting and there was a simple way to improve the light output and energy efficiency of the fittings.

I am happy to say that these fittings had been specified by an independent lighting designer when the project was newly built.

We can emulate this by ensuring the budget for lighting is apportioned appropriately, spending proportionately more on fittings that are likely to have a long life and be suitable for several refurbishment cycles, and spending less on fittings that are more likely to be changed. Sad to say these are likely to be ceiling mounted general area lighting, where it has been known for the fittings to be disposed of by the first tenant. Again ensuring a high efficiency, good performing fitting that is good looking is less likely to suffer this fate than a cheap fitting of basic appearance.

We touched on selecting fittings according to the expected life in use. We also need to ensure that they are designed with appropriate materials that are selected to minimise environmental impact. Interrogating light fitting manufacturers on sources of materials will now become a regular part of our research. The more questions that are asked the sooner that fitting manufacturers will start to pay attention to their material sources!

Aluminium is highly recyclable and the raw material, bauxite, is one of the world's most common minerals. Steel is also recyclable so it is interesting to ask what proportion of the steel used is recycled. Plastics of all varieties are less recyclable and tend to be made from oil, one of the more limited resources. It is possible to find plastic materials that are made from recycled plastics, again ask the manufacturers.

We are in the midst of a period of change in the lighting market. All the focus has been on savings of energy in use. Much as the approach to this has been, and remains, deeply flawed it has a limit of reach that is close to being met. The issue of the environmental costs of endless manufacture and recycling of lighting equipment will surface sooner rather than later.

Kevan Shaw 20.01.2010

Kevan Shaw is an independent architectural lighting designer who has been practicing for over 30 years. He is currently the Director of Sustainability for the Professional Lighting Designer's Association; as such he is engaged with the European energy using products legislative process, speaks frequently on lighting sustainability and is running a series of workshops to develop a statement on lighting sustainability for PLDA. His practice, KSLD, is active in many regions of the world and undertakes a wide variety of lighting design projects including major museums, office towers and hospitals.