

Save the Bulb!

kevan shaw
lighting design

One of the most used and best understood light-sources , the incandescent lamp, has become the target for politicians seeking to establish that they are actually doing something about the perceived causes of climate change. The movement to "ban the bulb" has been growing over many years since the compact fluorescent lamp became available with built in control gear in the late 1980s. Until the past couple of years this movement has been a darling cause of the "Green" fraternity, what has changed this is the publication of a book by European Energy Agency called " Light's Labour's Lost" that is a framework for legislation that specifically targets the incandescent lamp as a poor performing device in converting energy to light. This book also challenges any fuel based light source such as oil lamps or candles however no one has dared suggest banning these. . . yet!

The next part in the story is the dramatic statement of Legislation from the Australian Parliament in February 2007 effectively starting the process of, very rapidly, banning the import and sale of incandescent lamps. Once one government had done this without falling or losing significant support many others joined in including the USA who had a proposal drafted for Congress within weeks, the European Commission who issued a statement followed by the retrospective establishment of appropriate consultative structures. Individual countries in Europe have started their own processes, the UK Department of the Environment, Food and Rural affairs doing a dodgy deal with the Lighting Industry representatives to "withdraw from sale" incandescent lamps over the next few years starting on January 1, 2008, the announcement being conveniently timed to allow the Secretary of State to make his statement on the second last day of the Labour Party conference to prove he was actively doing something about climate change!

So why should we be worried about this? For the most part the proposals are based on replacing the rather large number of incandescent lamps sold, about 2.1 billion each year in Europe, predominantly with direct replacement ballast integrated Compact Fluorescent Lamps (CFLi). In various forms these have been in the market for about 20 years. In that time

there has been some development to make them more acceptable in general by reducing the size and improving the colour appearance however there remain many aspects of these lamps that make them unsuitable in many domestic applications and down right dangerous to the environment at the end of life.

Probably then greatest concern is what will happen to these lamps at the end of their life. Looking at the quantity that will be introduced to the market in a very short timeframe, assuming the manufacturer's stated operational life is correct, to replace 2.1 Billion incandescent lamps sold annually 350 million CFLs will be sold each year. This means that 350 million CFLs will reach end of life each year and will need to be disposed of. Each of these contains somewhere between 3mG and 5mG of Mercury in gaseous or liquid metal form. Despite any amount of effort persuading domestic users to recycle the vast majority of these lamps will end up in uncontrolled land-fill, disposed of with normal domestic waste. This is possibly the worst way of disposing of mercury. In land fill the microbes present digest mercury and excrete it as Methyl Mercury, a compound that is 20 times more toxic to higher vertebrates than metallic mercury. The Methyl Mercury is easily soluble and will leach out of the landfill into the watercourses and eventually the sea, where it gets into fish. It is not greatly poisonous to fish however they concentrate it in their fatty deposits, those ones that contain Omega-3 fatty acids, the ones that we are all supposed to be eating right now to improve our health and well being! From this it is reasonable to expect a significant increase in degenerative brain diseases in the not too distant future.

So what becomes of the CFLs that do get recycled? At present there is no significant path for recycling, the majority of lamp recycling companies will not take them, those that do charge pretty large sums per lamp we have been quoted between €0.75 and €1.50 per lamp! The main reason is that the lamps require manual separation, as each manufacturer and each size of lamp is put together differently. Once separated the glass element is broken, the mercury extracted however the glass remains contaminated with phosphors and cannot be recycled to glass so can only be used as a filler for concrete or road building materials. The gear component is shredded and heated to extract solder and other low melting point metals, the remains with ferrous metals extracted are sent

to land fill. At best there is less than 1 gram of recycleable material recovered from each lamp that typically weighs around 80 grams. To be fair the value of recycleable material in an incandescent lamps is so low as to be totally uneconomic to recover however the materials are biologically inert so do not cause any further pollution when stuck in landfill at any event the typical incandescent lamp is on 34grammes of somewhat denser materials.

There are some arguments suggesting that the mercury emitted by the increased requirement for generative capacity for Incandescent lamps is the same as that contained in a CFLi. Well I am very suspicious of the arithmetic. Taking the argument on face value the proposed arithmetic only works if, somehow, Incandescent lamps are only supplied by Coal Fired power stations, while this argument might be sustainable in Poland with nearly 100% coal fired generation it certainly does not apply in the UK with about 30% coal fired and even less in France with 80% nuclear generation! The other factor in terms of the emissions from power stations this is exclusively gaseous and very little will fall in areas where it is likely to be converted to the much more dangerous methyl Mercury. Oh, by the way, the emissions of radioactive isotopes from coal fired power stations greatly exceeds the emissions from nuclear power plants in Europe!

Another major issue relates to the figures for CO2 savings from the change to CFLi. If you look at the information on lamp boxes and sometimes on the bases of lamps there will be a figure in milliamps of the current used. Typically for a 12W CFLi this will be 110mA. When I went to school we were taught that Watts = Volts X Amps. If we do this calculation we find that this lamp uses 25.3 VA. This is where the discussion becomes a bit technical. With an incandescent lamp the voltage and current can be directly multiplied to give the power used. With non resistive loads, that is anything with electronics or a transformer things become more complicated. As we are using alternating current the type of load can determine whether the peak voltage is before or after the peak current. When the two peaks do not coincide then the load will appear to be greater to the generating machinery. This effect is called Power Factor , the incandescent, resistive load has a power factor of 1 this is the perfect load for rotative generators irrespective if they are driven by wind, a gas

turbine or steam turbine powered by coal or nuclear fuel. As power factor reduces more generative capacity is required and larger cables are necessary to move the electricity, engineers call this Harmonic Variation. So back to our lamp we need to provide the equivalent generative capacity for 25.3W to light up our 12W lamp! In the real world this has not so far been a problem as there are other loads, notably your television or Hi-Fi left on standby that will balance out the power factor, in the long term when the EC directives that prevent standby modes on TVs and we are all being forced to use CFLs the numbers may be different and our power costs will increase, for the moment all the calculations for CO2 savings by using CFLs based on the indicated wattage are overstated by a factor of 2.

The reasons given for the poor power factor by lamp manufacturers is that a higher power factor ballast would be more complex, larger, would compromise the life of the lamp and make them more expensive! Given the huge range of different form factors, anticipated life and prices for this product I find these explanations to be somewhat tenuous.

This is leading us on to the rather strange market that is developing for CFLs. In the UK the government requires that the energy supply companies provide funding from their profits of schemes to provide energy savings technologies. These are organised through QUANGOS like the Carbon Trust who determine what is acceptable. At present CFLs are seen as a suitable technology to fund and lamp manufacturers get some of their products approved which are then sold with substantial subsidies, recently these lamps have been given away free or swapped for Incandescent lamps at various DIY warehouses. Now this is pretty bad news however once the incandescent lamp ban is in place these lamps will no longer qualify for subsidy as there will be no alternative "inefficient" light-source in the market the price will then rise very dramatically. Even with subsidies there is a bewildering variety of different lamps and prices. At one point a local DIY store had a display of GE lamps all claiming to be the equivalent of a 60W Incandescent ranging in price from £0.99 to £4.98. The most expensive was a lamp with an envelope the same shape as an incandescent lamp, the next most expensive is a coiled tube type at £3.98. In the same store the same GE lamp was for sale in the store's own brand pack at 4 for £6. Clearly the market price for

lamps is not determined by the cost of the product but by retailer's and manufacturer's profit margins.

A question recently raised in a meeting with manufacturers; how are the lamp manufacturers going to supply CFLis at the rate necessary to effect the rapid changeover proposed by the legislation? They don't know! Much as they have serious commercial gains to be made the manufacturers do not have the capacity to replace the vast number of incandescent lamps in the year or two that will be available under the current programmes. Neither do they want to build the necessary amount of production capacity as this will not be necessary once the market has been "converted" to CFLi. As can be seen from the place of manufacture on most lamps the production capacity is in China. Despite much angst and complaints of poor quality from European lamp manufacturers they now seem happy to have their production in China but are still seeking to keep native Chinese lamp manufacturers out of the European market using "anti-dumping" legislation is this their attempt to maintain profit margins between buying from Chinese manufacturers and selling in Europe?

One final point that has seen much discussion and misinformation: very conveniently manufacturers have been confidently stating that the embodied energy, the energy inputs required to manufacture a product and create the required raw materials, for CFLi is 6 times that required for an incandescent lamp. Some have even provided figures for comparative CO2 emissions, where do these figures come from? That they can't or won't answer, neither can they or will they provide figures that provide meaningful comparisons. There is now some independent work being carried out by VITO, an environmental research organisation on behalf of the European Commission, below are comparisons for Incandescent GLS lamps and CFLi that merit some examination:

Energy used in manufacture:

GLS 1MJ = 0.28KwH

CFLI 12MJ = 3.33 KwH

Pollutants created in manufacture:

GLS 5g none hazardous
hazardous

CFLI 128g of which 78g

Well it is clear that the suggestion that it takes 6 times the energy used to manufacture an incandescent lamp to manufacture a CFLI as claimed by manufacturers is wrong by a factor of 2 but the amount of waste produced by the production of CFLIs is horrifying, about 1.5 times the weight of the finished lamp! As so much of the waste is hazardous no wonder the manufacturers prefer to do this in China rather than Europe. I think that the figures they have for the recycling of CFLIs are also rather optimistic given the research we have done.

So far we have looked only at technical and economic arguments. A comparison of the qualities of light produced by incandescent and CFLi lamps is very clear to the user when compared directly it is, however, not so easy to quantify these or attach a particular environmental significance. We have all seen many misapplications of the CFLi ranging from lamps sticking out of downlights designed for incandescent lamps, cold colour appearance in a domestic setting or hotel room, gloomy light in a corridor where the CFLi takes a long time to achieve full brightness from switch on, crystal chandeliers dulled by the use of CFLI "candle " bulbs the list is extensive and growing. CFLI technology cannot achieve the qualities of warmth and sparkle with near perfect colour rendition that is the light from the incandescent lamp so from this aspect any claim that they are an equal replacement is just wrong.

With all this depressing information is there an alternative light source that will achieve energy savings without compromising quality of light and with reduced risk to the environment? Thankfully there are now products in the market that are as far as I am concerned appropriate replacements. The first to hit the mass market are Osram Classic A energy saver lamps. These use a mains tungsten halogen lamp within a conventional Incandescent lamp envelope. They offer a direct energy saving of 30% over the traditional lamp, provide all the qualities of colour appearance, rendering and sparkle, are a resistive load therefore do not present problems with the power generation network and are fully compatible with existing dimmers and light fittings. They also have a life of 2000 hours double that of the traditional incandescent lamp. Philips are working on products using low voltage TH capsules in a incandescent envelope however these also require electronics that will increase the cost, and create problems with waste disposal and recycling. GE in the USA

are working on lamps using ceramic rather than tungsten filaments, these are promising efficiencies equal to or better than that currently achieved by CFLs.

Really the proposed bans are untimely to say the least and potentially will create serious long-term irreversible problems in the environment though forcing the mass use of CFLs. As there are technologies either just entering the market or that may do in the next few years a moratorium would be a sensible thing at this time, allowing the lamp manufacturers to develop a range of alternative lamp types to replace the many functions that are achieved by the simple incandescent lamp, alternatively just leave them alone and let the market develop products that will be more appealing to the consumer.

Base-Case CFLi

0 BIO

Life Cycle phases -->	PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
Resources Use and Emissions	Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	

Materials

unit

Bulk Plastics	g			0			0	0	0	0
TecPlastics	g			0			0	0	0	0
Ferro	g			0			0	0	0	0
Non-ferro	g			1			0	1	1	0
Coating	g			0			0	0	0	0
Electronics	g			18			14	5	18	0
Misc.	g			31			2	30	31	0
Total weight	g			51			15	35	51	0

Other Resources & Waste

debet | see note!
credit

Total Energy (GER)	MJ	10	2	12	53	1125	1	1	0	1190
of which, electricity (in primary MJ)	MJ	6	0	7	0	1125	0	1	-1	1131
Water (process)	ltr	8	0	8	0	75	0	0	0	82
Water (cooling)	ltr	2	1	3	0	2999	0	0	0	3001
Waste, non-haz./ landfill	g	48	2	50	52	1304	4	2	3	1409
Waste, hazardous/ incinerated	g	78	0	78	1	27	5	1	4	109

Base-Case GLS-C

0

0 BIO

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			0			0	0	0	0
4 Non-ferro	g			1			1	0	1	0
5 Coating	g			0			0	0	0	0
6 Electronics	g			0			0	0	0	0
7 Misc.	g			21			21	0	21	0
Total weight	g			22			22	0	22	0

Other Resources & Waste

debet | see note!
credit

8 Total Energy (GER)	MJ	1	0	1	52	567	2	0	2	621
9 of which, electricity (in primary MJ)	MJ	0	0	0	0	567	0	0	0	567
10 Water (process)	ltr	0	0	0	0	38	0	0	0	38
11 Water (cooling)	ltr	0	0	0	0	1512	0	0	0	1512
12 Waste, non-haz./ landfill	g	5	0	5	52	657	27	0	27	742
13 Waste, hazardous/ incinerated	g	0	0	0	1	13	0	0	0	14