eldoLED

The TM65 Standard

White paper

A Driver Manufacturer's Perspective

Rob Bremmert, Quality Engineer and Patrick van der Meulen, Business Development Manager at eldoLED, break down CIBSE's TM65 initiative, and explain what it means for driver manufacturers.

The global building industry's response to national net-zero carbon targets will be a big factor in determining whether humanity avoids a catastrophic climate crisis in the coming decades.

Figures for the UK published by industry non-profit organization the UK Green Building Council (UKGBC) show that the built environment is responsible for more than 25% of total UK greenhouse gas (GHG) emissions. Annual emissions from the building sector have fallen by around 30% since the turn of the century, but this is largely attributable to the growth in renewables, mostly wind and solar, as a proportion of total electricity generation. In other words, it is not the result of any specific initiative for which the building sector can take credit, but is largely the result of government policy for the electricity industry.

Nevertheless, this means that operational emissions – to heat and light buildings and to power appliances – are on a downward trajectory. Harder to reduce are the embodied carbon emissions generated by the production of building materials and appliances, by the construction process itself, and by the disposal and decommissioning of equipment and structures. But without a massive reduction in embodied carbon emissions, the building sector has no chance of reaching net zero.

The first step in reducing the carbon built into new construction projects, refurbished, or re-equipped buildings, is to understand how much embodied GHG, measured in equivalent kilograms of carbon dioxide (kgCO2e), is in the various components of a building project: the cement, steel, brick or timber of the structure of course, but also the fixtures and fitments, including lighting equipment such as luminaires, lamps, wiring and control gear. This is why the TM65 initiative from the Chartered Institution of Building Services Engineers (CIBSE) has attracted the attention of environmentally aware individuals and organizations in the lighting industry, not only in the UK, but around the world: for the first time it gives lighting designers, lighting specifiers and architects a clear and transparent way to calculate the carbon embodied in new lighting equipment.

So what is the purpose of the TM65 standard? How is embodied carbon calculated according to TM65? And what is the experience of performing TM65 calculations for a manufacturer of lighting equipment?

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TM65 Explained

Let's start with a definition: the embodied carbon in a product is the GHG emissions associated with the extraction of the materials from which the product is assembled, its manufacturing process, repair, and treatment at the product's end of life, as well as any GHG produced in the shipping of the product. Where relevant, the effect of refrigerant leakage is also taken into account in calculating embodied carbon.

To illustrate the point, let's use the example of an LED driver, since this is eldoLED's area of expertise. The global warming potential embodied in an LED driver arises from the materials which it contains, such as copper, aluminium, brass and plastic. Energy is required to mine, process and refine the raw materials, to shape them, then to transport them to the factory where they are assembled into a new LED driver. At the end of a luminaire's life, the materials in the driver will be transported to a waste treatment site, where they will be either buried in landfill or – better – recycled.

Every part of this process uses energy, and so generates GHGs. The total GHG emissions attributable to a product can be declared in an environmental product declaration (EPD), a standard way of specifying the embodied carbon and other environmental impacts of a product. But, because of the complexity of building services products (including lighting equipment) and their supply chains, very few building services equipment manufacturers offer EPDs. This is why CIBSE devised TM65, a toolkit to enable consultants or designers to calculate the embodied carbon associated with mechanical, electrical and public health (MEP) systems in buildings when no EPD is available. Lighting professionals can use TM65 calculations to build a reliable estimate of the global warming potential of a lighting scheme early in the design phase. And with the information provided by TM65, the industry can make an informed choice to reduce the carbon embodied in the lighting equipment installed in new or refurbished buildings.

Weighing And Measuring: What It Takes To Perform A TM65 Calculation

The basic method of calculating a TM65 embodied carbon value has four stages (ignoring refrigerants. See Figure 1).

It starts with an analysis of the components of a product. The product's manufacturer will:

- Break down a product into its basic materials, such as various metals, plastics, rubber, and in the case of an LED driver, electronic components and the PCB
- Weigh each material separately, up to at least 95% of the total product weight
- Apply an embodied carbon coefficient to each material. The coefficients are provided in the TM65 specification. The sum of these gives subtotal 1 (see Figure 2)

In the second stage, subtotal 2 incorporates a repair allowance. During a product's life, it might be repaired. TM65 adds a step after the initial calculation to allow for the embodied carbon in parts that are typically replaced before a product reaches the end of its life. In the absence of specific information about replacement, it is assumed that 10% of the weight of a product will be replaced during its life (see Figure 2).

The third stage is to apply a 'scale up factor': this takes account of the carbon embodied in the processes of shipping, assembling, decommissioning and disposing of a product. The scale up factor is lower for simple products and higher for complex products: for an LED driver, the scale up factor is x1.4 and is applied to the total embodied carbon value for the manufactured and repaired product. (see subtotal 3 in Figure 2).

The fourth stage is to apply a buffer factor, set at x1.3. The buffer factor allows for the simplicity of the calculation method (eg. not requiring more elusive data such as multiple factory geographical locations and respective energy profiles). Applying a conservative margin to ensure that the GHG calculation does not substantially underestimate a product's global warming potential (see grand total in Figure 2). A lighting professional can then use this data to perform embodied carbon calculations for their project.
Now the user has calculated the total embodied carbon of a product. CIBSE strongly encourages users to fill out its TM65 reporting form and submit their results, so that it can build a database of products.

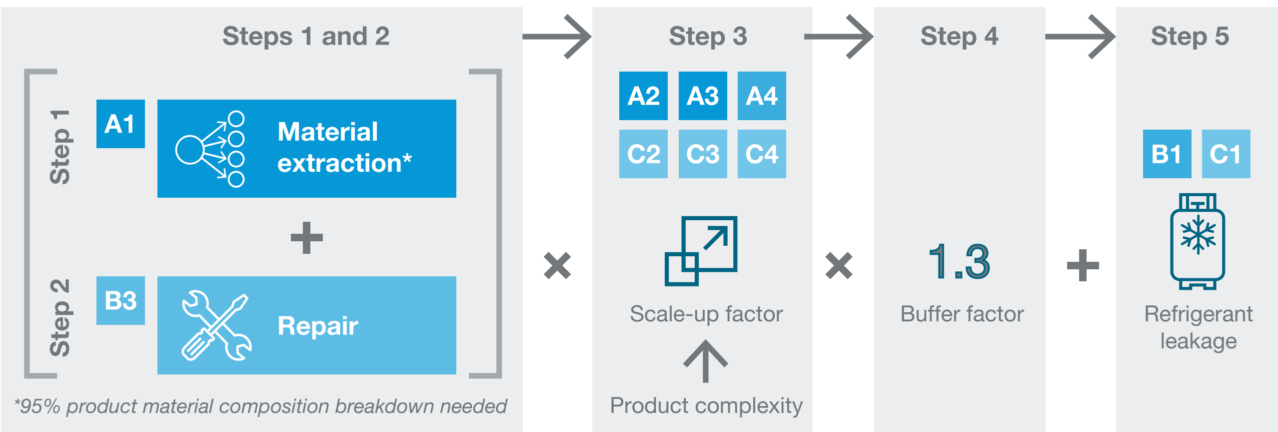

Fig. 1: the process of performing a TM65 basic level calculation

	SOLOdrive 561/A Total product weght (kg): 0,307	Embodied carbon coeffiecient (kg CO2e/kg)	Material % by weight	Embodied carbon	
Step 1	ABS (acrylonitrile butadiene styrene)	3,76			
	Aluminium	13,1			
	Brass	4,8			
	Ceramic	0,7			
	Copper	3,81	7,8%	0,09	
	Expanded polystrene	3,43			
	Glass	1,44			
	Insulation	1,86			
	Iron	2,03			
	Lithium	5,3			
	Plastics	3,31	17,8%	0,18	
	Polyamide	9,14			
	Polycarbonate	7,62			
	Polyethylene	2,54			
	Polyurethane foam	4,55			
	PVC (polyvinyl chloride)	3,1			
	PVC pipe	3,23			
	Rubber	2,85			
	Stainless steel	4,4			
	Steel (general or galvanised)	2,97	33,9%	0,31	
	Zinc	4,18			
	Cast iron	1,52			
	Silicon	13,8	0,7%	0,03	
	Electronic components	49	28,5%	4,28	
	Printed wiring boards, mixed, mounted	154	10,9%	5,14	
			99,6%	**10,04**	**Subtotal 1**
Step 2	If there is no specific information from the manufacturer on repair or replacement of components within the product lifetime, a standard assumption of a 10% increase in weight should be used. (10% from Subtotal 1)		10%	1,00	
				11,04	**Subtotal 2**
Step 3	Scale factor 1.4 for lighting control devices (subtotal 2 multiplied with 1.4)		1,4		
				15,45	**Subtotal 3**
Step 4	Buffer factor (subtotal 3 multipled with 1.3)		1,3		
	Embodied carbon result with scale-up and buffer factors			**20,09**	**kgCO2e**

Fig. 2: TM65 calculation of the embodied carbon of a 50W SOLOdrive 561/A driver

The TM65 Process:
An LED Driver Manufacturer's Perspective

CIBSE's intention is that the industry will take the initiative to provide TM65 calculations for MEP products, and publish the figures to the CIBSE database. eldoLED has already started this process: it has performed TM65 calculations for four of its most popular products, with more planned. As we will see, though, the TM65 process has prompted some new thinking about ways to reduce the global warming potential of the company's products. This new thinking was accelerated by a request from an eldoLED customer, Stoane Lighting, who provided fixtures for Our Time on Earth, an exhibition at the Barbican with lighting design by Speirs Major, covered in arc #128.

On eldoLED's part, the TM65 process involved stripping a driver back to its raw materials (see Figure 3), classifying each material type, weighing each, applying the embodied carbon coefficient, and then summing the results. A report page for the 50W SOLOdrive 561/A driver is shown in Figure 2.

Fig. 3: an eldoLED 50W SOLOdrive 561/A driver and its basic elements, from the copper, metal and plastic to component parts

Compiling the product data was straightforward. Now eldoLED has a plan to perform TM65 calculations for any of its driver products on request from customers, and for all of its most popular models.

The most interesting insight to emerge from the TM65 process was the overwhelmingly large contribution to embodied emissions contributed by the PCB and the electronic components, as shown by Figure 2. This is prompting eldoLED to rethink its approach to reducing the environmental impact of its products.

We now understand that any reduction in the size and weight of the PCB has a disproportionately beneficial effect on the embodied carbon of a driver product. This is a big challenge for the design engineers at eldoLED. Miniaturization of electronics systems is not straightforward. For instance, the closer that components are placed on the board, the harder it is to keep them within their maximum temperature limits. The techniques for board size reduction are well understood at eldoLED, and we think we can make some substantial reductions in the embodied carbon in our products over time by reducing the size of the PCB layout.

For a driver manufacturer, power conversion efficiency also has a huge impact on sustainability: the more efficient the driver, the less power is wasted, directly reducing operational CO2 emissions. Increasing efficiency is another long-term project for eldoLED, which is working with customers to balance performance, cost and efficiency.

Alongside these initiatives, eldoLED is in the early stages of investigating the scope to bring driver production closer to the point of end use, and to facilitate re-use and recycling of drivers after their first use. These initiatives are consistent with the principles of a circular economy, and of localization, both of which have an important role to play in industry's work to reach net zero.

MEP Products In The Spotlight

CIBSE's work in devising the TM65 method, provides a consistent and clear way for the lighting industry to calculate the embodied carbon in the products it relies upon, a valuable tool for the industry to use in reducing its embodied carbon footprint towards zero. Equally important, it is providing information to manufacturers like eldoLED, helping them to understand the sources of embodied carbon in their products, and to use novel design approaches to reduce a product's carbon footprint.

Europe, Rest of World

eldoLED B.V.
Science Park Eindhoven 5125
5692 ED Son
The Netherlands

E: sales@eldoled.com
W: www.eldoled.com

North America

eldoLED America
One Lithonia Way
Conyers, GA 30012
USA

E: nasales@eldoled.com
W: www.eldoled.com