Science for Environment Policy
DG Environment News Alert Service
European Commission

17 June 2010

Low-carbon product design: look at the parts to improve the whole

Researchers have developed a method to identify the parts that contribute the most to a product's greenhouse gas (GHG) emissions and evaluate alternative design solutions. When applied to a LCD television, it showed that GHG emissions could be cut by 36 per cent by using alternative parts to those currently used.

In order for companies to assess the environmental impact of their products an accurate estimation of each product's GHG emissions over its entire life cycle is needed. This includes GHG emissions from raw materials, manufacture, product use and recycling.

During the design stage of a product, the necessary parts are identified in a bill of materials (BOM). This selects the most appropriate parts for the product depending on their qualities, features and cost. The study developed a design system based on the BOM but which also considered the GHG emissions of each part at each stage of its life cycle. This was known as the 'g-BOM', which could be a cost-effective and straightforward tool for designers wanting to develop a low-carbon product in a short time period. The system comprises several steps:

- Establish a GHG emission target for the product. This is tends to be in the form of two targets – one for the GHG emissions during the entire life cycle of the product, including manufacture, and one for the GHG emissions from the use of the product. The latter could be established from guidelines such as those set out in the EU's Ecodesign working plan[1].
- Establish the BOM. This includes information on the individual parts, such as name, size, colour and material composition.
- Form the g-BOM. This includes data on the GHG emissions of each part at each stage of its life cycle, from raw materials, through to manufacturing, distribution, use and end-of-life (i.e. waste and/or recycling).
- Identify problematic parts with high GHG emissions. These are the parts whose GHG emissions are more than 1 per cent of the product's total GHG emissions. These become targets for improvement.
- Select alternative parts to replace problematic parts according to four criteria: technical feasibility and exchangeability, customer requirements, cost and the potential to reduce GHG emissions.
- Evaluate the newly designed product's GHG emissions. Create a new g-BOM to estimate the GHG emissions of the product with alternative parts and compare it to the GHG emission target.

The system was applied to a 52 inch liquid crystal display (LCD) television with a GHG emission target of 1504 kg of CO_2 for its life cycle and 1225 kg of CO_2 for its use.

From the g-BOM the most problematic parts were identified and replaced with possible alternatives. For example, its cold cathode fluorescent lamp was responsible for 1174 kg of GHG emissions. However, when the number of lamps within the tube was reduced from 24 to 16 this figure dropped by nearly half to 643.5 kg of CO_2. When another part was reduced in thickness by 15 per cent its GHG emissions decreased from 27.34 kg CO_2 to 23.25 kg.

Using a number of alternatives, the total GHG emissions were reduced by 36 per cent from 1773 kg CO_2 to 1134 kg. This figure is well below the set target. The greatest reduction was in the "use" stage of the life cycle from 1493 kg CO_2 to 967.5 kg.

1. See: http://ec.europa.eu/enterprise/policies/sustainable-business/documents/eco-design/index_en.htm

Source: Song, J-S. & Lee, K-M. (2010). Development of a low-carbon product design system based on embedded GHG emissions. *Resources, Conservation and Recycling.* 54:547-556.

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Theme(s): Sustainable consumption and production