Editorial

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This issue highlights the use of energy in goods and services, and the problems in evaluating the impact of engineering decisions on climate change.

Two important causes of difficulty are uncertainty and the poor application of the economic methodology for calculating the social cost of the emission of greenhouse gases.

Organisations and engineers have to assess many factors in product design and operation; safety, cost, timing and sustainability are just a few. Such factors are captured in prices of outputs, such as overheads due to meeting quality standards and regulations. In contrast, this is not yet the case for greenhouse gases, which should have their embodied emissions assessed. That assessment requires judgements on the relative merits of alternative costing methodologies to calculate the CO_{2e} of the embodied emissions.

The papers in this issue address practical and ethical issues in making the underlying measurements and judgements. Further background to these discussions is provided in the briefing (Rennie, 2011) and some possible future context of product decisions in the first reviewed book (Roddy, 2011; Skea *et al.*, 2011).

The paper 'Carbon footprint and risk assessments' (Thorniley-Walker, 2011) presents a challenging perspective by linking climate change and risk assessments in design. It argues that strict application of the Engineering Council's *Guidance on Sustainability* would include a precautionary approach to risks arising from climate change, linking this with the duty to reduce dangers to an acceptable level under the Construction (Design and Management) Regulations. It recommends impact above base line emissions at a global long-term marginal level.

We have published this paper because of the different point of view regarding the designer's role in the embodied CO_{2e} content of built objects. While it is possible to be critical of this paper (for example on the implications drawn from the survey responses, the controls already offered by pricing emissions and by regulations and standards) it is published because of the considered train of the thought, which may be one that other engineers have considered, but which needs further consideration.

Cross-learning is important, and this is supported by a paper on lessons from life-cycle analysis for bioenergy (Vad *et al.*, 2011)

which gives good advice on allocation of greenhouse gas (GHG) emissions and adds to the discussion regarding the UK's carbon code level 6 which was described in an earlier issue (Holden and Twinn, 2011). Regulations that do not consider the whole life cycle seem particularly inconsistent with analysis of sustainability and of GHG emissions in capital goods and some other indirect emissions. Energy consumption in use is equated to bad design, but that fails to consider the source of the energy or the sustainability of the goods and services produced or consumed, be it triple glazing or nuclear power plants.

More thought on the scope 3 emissions is provided by the GHG Protocol in the briefing (Rennie, 2011) and with respect to sourcing and end use of timber (Weight 2011) and reconstruction issues, in the consideration of options for a bridge (Zhang *et al.*, 2011). Weight concludes on the major importance of material sourcing. Zhang shows how different designs can have similar outcomes, but with very different key sensitivities – in one case due to embodied emissions in a material choice and in another due to the assumed traffic diversion. Articulating the issues and difference between energy and emissions and reflecting aspects elsewhere in this issue, the paper on re-use of materials in buildings (Densley Tingley and Davison, 2011) discusses ways to think about and reward reductions in scope 3 emissions.

The energy associated with consumption is interesting for reasons of cost and efficiency, but is not important for sustainability or climate change. It is the GHG emissions, measured in tonnes of carbon dioxide equivalent, arising from consumption that is critical in the coming decades. Furthermore, it is not a matter of high embodied emissions in a small component of a wind turbine for example, but the attributed emissions for the final consumption that is important. Having a measure in CO_{2e} tonnes of the life cycle gives organisations and designers information over choice of alternatives. Partial life-cycle assessments are useful for business-to-business information, and for option evaluation, but many current methods give misleading conclusions due mostly to poor boundary definitions.

Monetising tonnes of CO_{2e} for economic comparison can allow a clearer business case but can lead to complications such as double counting where emissions pricing affects some inputs to the total CO_{2e} and not to others. This is most evident

where traded goods have embodied CO_{2e} and where some inputs are given free emissions allowances. However, internalising the costs of GHG emissions gives practical benefits, such as allowing time effects to be accounted for, as well as better representing the overall cost of GHG emissions in consumption.

It also could be argued that not including embodied GHG emissions costs distorts trade and a regime of uneven regulation worldwide can result in political tension, for example from local producers, as well as being the cause of ad hoc relocation of production, inefficient subsidies, unnecessary employment problems, and mis-measuring of national GHG emissions, all without improvement in global emissions.

Further discussion and guidance is needed on the subject of good engineering practice in considering assessment of the embodied carbon dioxide equivalent of greenhouse gases in design and construction, and we welcome further papers on this subject.

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