The role of sustainability rating systems in delivering infrastructure and building engineering's contribution to climate change mitigation and adaptation

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Abstract
Although overall drivers for climate change mitigation and adaptation are clear, it is often difficult for professionals working on infrastructure and buildings to assess what relevant action they should be taking in their designs and construction. In parallel, scientists working on construction or environment-related topics often need guidance on the key construction areas that need further investigation to assist with the challenges derived from the need for climate change mitigation and adaptation.

Over the last few years, rating systems have been developed for the environmental performance of buildings and infrastructure, and more recently their sustainability performance. Their development has included the formation of assessment questions and criteria that direct designers and constructors towards improved environmental and social performance. Alongside those rating systems, tools such as carbon calculators have also been refined to enable option comparisons.

This paper explores a selection of climate change-related issues assessed in or by such rating systems and tools, and how the nature of assessment questions, scoring systems and measurement tools can drive improved performance. Through that improved performance, design and construction teams can maximise their contribution to climate change mitigation and adaptation, and scientists identify the key areas for further examination.
Keywords: Infrastructure; Sustainability; Rating Systems; Climate change mitigation & adaptation.

1. Introduction

The issues outlined in the Abstract (not repeated here for space reasons) prompt a number of important questions:

- What sustainability rating systems for are available?
- What impacts or characteristics of infrastructure affect contributors to climate change? and What impacts of climate change may adversely impact infrastructure projects?
- How do assessments using sustainability rating systems help and influence these cross connections?
- How can scientists and technology developers contribute to these systems? and What can they draw from them to influence their future research?

2. Sustainability assessment and rating systems for civil infrastructure and building engineering

There are three main systems available across the world that assess and rate infrastructure, and two international – and very many local – systems that assess buildings:

a) For infrastructure:

- *CEEQUAL*, the first to start operations (in 2003), based in the UK but used extensively elsewhere;
- *Envision*, based and used in the USA and, currently, with a few trial assessments elsewhere; and
- *Infrastructure Sustainability* in Australia and New Zealand,

b) For buildings:

- *BREEAM*, started in the late 1980s by the UK Building Research Establishment and now very widely used around the world, with almost 2.3 million registered buildings;
- *LEED*, started in 1993, run by the US Green Building Council and now claimed to be the most widely-used system, in 165 countries;
- a very wide range (approx. 600) of other national or regional systems are available.

All of these systems are designed to be used for formal assessments of projects, but the manuals and the criteria against which assessments are made are, in most cases, available for download and can therefore be used informally to guide individual practitioners' designs and/or construction planning and management.

3. Characteristics of infrastructure affecting contributors to climate change and impacts of climate change on infrastructure projects

Each rating system contains a wide range of criteria against which performance of the asset is assessed. In terms of built assets contributing to global warming and therefore climate change, the primary connection is energy consumption, and associated carbon emissions, and the importance of this aspect is reflected in the inclusion for the first time in CEEQUAL of a section on Reducing whole-life carbon emissions in the soon-to-be-launched CEEQUAL Version 6.
In that context, we must be conscious that the connection to energy consumption is a much wider issue than just the direct operational energy consumption of an asset.

The embodied energy of built assets – such as the energy used in the materials supply chain, in transport, in construction plant – can be substantial. In addition, as energy consumption in built assets and operational processes becomes progressively more efficient, the embodied energy in the built asset becomes an ever larger proportion of whole-life energy consumption.

The embodied energy in waste from construction projects, as well as from the processes and activities that take place in built assets, is of course part of the total embodied energy of the asset. But it also can be a contributor to a much-worse greenhouse gas than carbon dioxide, namely methane, if the waste is left to decompose uncontrolled.

In terms of the resistance and resilience of the asset to the impacts on the asset from the actual and predicted effects of climate change, the rating systems include criteria related to such issues as rising sea levels, increased storm intensities and/or frequency, increased flood risk, extended dry periods and potential shrinking soils.

4. How do assessments using sustainability rating systems help and influence these cross connections

Most users of these systems are seeking a high score.

For building owners or developers, apart from the matter of feeling good about procuring a 'green building', there may be commercial incentives, because of lower energy bills or increased rents that can be charged for low-energy-consuming buildings. There may also be recruitment advantages, because employees are increasing interested in working in overtly 'good' buildings from an environmental or wider sustainability standpoint.

For infrastructure developers and owners, high scores demonstrate commitment to low-carbon and/or wider sustainability policies and targets, and may also derive from designs and techniques that not only have reduced carbon emissions associated with the asset, but the lower carbon impact may also have associated reductions in capital and/or operational costs.

So, whether these systems are being using for formal verified assessments or used informally by design and construction teams, they prompt positive action.

- The presence of an issue in the criteria prompts action to reduce adverse impacts and/or encourage positive actions that enhance the asset's benefits.
- The credits assigned to each criteria represent the system's owner's view of the importance of the topic behind each criteria.
- Progressively increasing credits against different levels of performance prompt teams to stretch beyond their previous performance norms.
- And, although this may not be in accord with the spirit of these systems, if a team is striving to reach a particular score and they are a few credits short, they will seek to stretch their performance even further in those areas where improved performance is least difficult to achieve.

Finally in this section, a few words of caution are needed here. In the development of the low-carbon agenda, especially in the UK, a low-carbon solution was/is often used as a proxy for a sustainable solution. Of course, the sustainability agenda is much broader in scope and coverage than the low-carbon agenda, covering such issues as environmental protection and enhancement, water consumption, wastewater treatment, and societal impacts and benefits.

It is possible that an ultra-low-carbon solution could have greater impacts on the wider sustainability aspects than a higher-carbon solution, and careful analysis and assessment of such projects should be undertaken to get the best overall solution, not sub-optimal skewed solution.

5. How can these systems influence future research, and how can scientists and technology developers contribute to system development?

The owners, promotors and/or operators of all of the rating systems mentioned here publish new versions from time to time, the triggers often being a combination of demand for revised or new criteria and the application of new scientific bases for assessment.

So scientists with an interest in improving the carbon performance and sustainability performance of built assets can engage with the operators of the systems to identify areas where they could expressly assist them, or can scour the systems for criteria and assessment methods that, in their view, could be improved. In addition, they could look for areas that they might expect to see included in such systems but which is not there, because no rigorous, science-based assessment methodology is available. This too can direct research efforts for new solutions.

One such area that is in need of science-based assessment techniques can currently be assessed only as a matter of judgement. The rating systems outlined here are almost exclusively directed at the performance of the asset, not its worthwhileness from a sustainability point of view. We can use our *judgement* to decide if a project is a good one from a sustainability point of view; *but we currently do not have science-based metrics to decide the point.*

Contributions from environmental scientists, social and political scientists, and/or technologists involved in virtual reality systems that could be used to compare the attributes of alternatives, may well be able to help solve this conundrum. Because in both areas – buildings and infrastructure – it is important not only to make an asset that performs well from a carbon and sustainability point of view, but also that we create the *right kind of projects*, ones that enhance human well-being alongside economic benefits, and environmental protection and enhancements.

Selected Bibliography of related websites

Built environment Sustainability Assessment & Rating Systems

- BREEAM at www.breeam.com
- CEEQUAL in the UK, www.ceequal.com
- Envision in the USA, https://sustainableinfrastructure.org/
- Infrastructure Sustainability, Australia, www.isca.org.au
- LEED at www.usgbc.org/leed.

UK National Infrastructure Commission, www.nic.org.uk/