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If the Stirling Prize was about sustainability, who would win?

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Ahead of next week's ceremony, Simon Sturgis takes a critical look at the carbon performance of the six finalists

How truly carbon efficient are the six 2015 Stirling Prize finalists?

Carbon emissions reduction is about both energy use and, crucially, resource efficiency. Reducing operational energy use is integral to the way we design buildings today, but resource efficiency, which covers both construction and life cycle (ie embodied) carbon emissions, is not. This is unfortunate as these latter emissions form the majority of emissions over most buildings' lives.

Most of the six finalists perform reasonably well in operational energy terms, achieving Breeam Excellent, although a couple were only awarded Very Good status, which should not be acceptable for a Stirling Prize finalist.

What are particularly important from a truly low-carbon viewpoint are the material and construction emissions and the related lifecycle emissions. A building may use carbon-expensive materials – for example, bricks at Niall McLaughlin's Darbishire Place or pre-cast panels at AHMM's Burntwood School – but if they last a century or more then that is a good carbon investment.

The key is to look at both the emissions from creating the building, and from the replacement cycles of the various systems and components. Both of these finalists will have modest maintenance regimes and the buildings can be upgraded over time on an incremental basis. Burtwood School's crisp, pre-cast facade will not stay pristine, but cleaning will not be difficult. Both buildings are simple and windows can be replaced individually or on a façade-by-façade basis or, in the case of Darbishire Place, on a unit-by-unit basis.

In stark contrast is Rogers Stirk Harbour & Partners' Neo Bankside. This impressively engineered residential scheme looks to be high in embodied carbon costs, but without the benefit of a well-considered future life cycle. The individual leases are well over 100 years, yet the seals on the glazing system are likely to last no more than 40 or 50 years. Replacement will be a very high-carbon activity at a time when global warming concerns will be even more acute than today. Will the glazed facades of each apartment be replaced by individual leaseholders incrementally or will all the blocks be refurbished together? This sort of lifecycle thinking, projecting well past practical completion, is crucial to managing a building's future carbon emissions performance. It does mean that at the point of design the architect needs to consider how their building can be dismantled and how the components can be beneficially recycled.

One of these comments can be leveled at MUMA's Whitworth at the University of Manchester. Using what are essentially short-life office cladding systems for public buildings creates unnecessary future carbon costs. However the Whitworth, to its great credit, is the only one of this year's finalists that comprehensively reuses and integrates with an existing building, the venerable Whitworth Museum. A lesson for today is that the carbon cost of the original Whitworth, expended in the 19th century, has proved a great carbon investment for more than 100 years and probably for at least another century.

Heneghan Peng's Stockwell Street Building for the University of Greenwich is the most comprehensively low carbon finalist. The design strategy of parallel blocks allowing both natural light and natural ventilation is an inherently low-energy approach. The architecture is also of a quality that suggests that it will be enjoyed by the wider community for many years to come. Quality architecture is inherently "low carbon" as it is appreciated and retained by the society in whose midst it sits. Poor architecture is demolished early which is a waste of resources. The Stockwell Street Building is also robustly built for the long term. The interiors are predominantly naturally finished and minimise decorative coatings (carpet, paint etc). The building is very flexibly designed which will allow infinite and easy internal adaption and change over its future life. The embodied carbon costs of construction may be high in some areas, but overall the building will have low lifecycle carbon costs. Recycled materials were included in the original design, and it has an inbuilt waste strategy. Finally, monitoring and reporting are integrated as part of the building's treatment as a living laboratory by the occupying architectural school.

Maggie's Lanarkshire by Reiach & Hall is the most modest carbon proposition. On the one hand the building is efficiently designed using simple, robust materials. On the other you could make similar points to the Whitworth about large areas of glazing. However, from a more holistic sustainability perspective, the social benefits to cancer sufferers of the expansive glass and the resulting light atmosphere must surely outweigh any small additional carbon cost.

In conclusion therefore the Stirling finalist with the broadest commitment to a low-carbon future must be Heneghan Peng's Stockwell Street Building. Not only is this building operationally efficient, but in "whole life" carbon terms it should also perform particularly well. It looks to have a good future on environmental, economic and social grounds. Paradoxically the most valuable of this year's finalists, Rogers Stirk Harbour & Partners' Neo Bankside, is probably the least likely to see out the 21st century. The cladding choices suggest a major façade refurbishment in 40 to 50 years, with consequent carbon and financial costs. Global warming will punish such large areas of glass with obvious energy and financial consequences.

This year's finalists show an interesting divergence, but with at least three performing well in "whole life" carbon terms. Last year's winner, Haworth Tompkins' Everyman Theatre, was a great example of how to do a comprehensively low-carbon public building. The Stockwell Street Building has many similarities although not to quite the same degree. I hope it wins this year.

Postscript: Simon Sturgis is an architect and managing director of Sturgis Carbon Profiling