CO_2 2.Low carbon

Setting carbon targets: an introduction to the proposed SCORS rating scheme

Will Arnold, Mike Cook, Duncan Cox, Orlando Gibbons and John Orr present SCORS – a proposed carbon rating scheme for structures – and encourage engineers to adopt carbon targets for their projects.

The Institution has recently published a guide on *How to calculate embodied carbon*[1]. The guide (free in PDF format) enables a structural engineer to estimate how much embodied carbon is present in their design, at any stage in the design process. For many, the publication of this method has raised the question of what a 'good' figure for that carbon footprint might be.

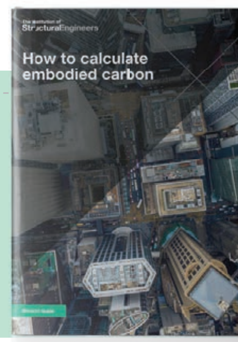
In this article, the authors propose the use of a Structural Carbon Rating Scheme (SCORS) that has been informed by project carbon data, and that can be used to compare high-carbon and low-carbon design decisions and options. We compare SCORS to targets set by the Royal Institute of British Architects (RIBA), the London Energy Transformation Initiative (LETI), and the Intergovernmental Panel on Climate Change (IPCC), and discuss how the reader might set their own targets.

The article highlights the need to adopt (and hold ourselves to) low targets that are periodically updated and that tend towards zero, starting immediately.

GET THE GUIDE

***How to calculate embodied carbon* is free to download at www.istructe.org/resources/guidance/how-to-calculate-embodied-carbon/.**

A hard copy version is also available to buy.



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SCORS

Figure 1 shows the SCORS rating 'sticker' suggested for use by structural engineers in communicating the implications of design decisions to those we work with and for.

The SCORS rating of an option, asset, or company's portfolio of work is based on the estimated A1–A5 emissions of the primary structure (superstructure plus substructure), calculated in accordance with *How to calculate embodied carbon*, which outlines calculation inclusions and exclusions, such as excluding the benefits of sequestration or offsetting. (See Figure 1.1 of the guide for an explanation of lifecycle modules.)

For early-stage calculations, embodied carbon factors should be based on typical values for the country in which the project will be built (including assumptions around cement replacement, steel recycled content, etc.), as provided in *How to calculate embodied carbon*. Once the supply chain is better understood, 'real' values based on product-specific environmental product declarations (EPDs) could be used instead.

The A1–A5 carbon footprint is then divided by the gross internal area (GIA) of the completed building (for refurbishment projects the full GIA is taken).

A final carbon count should be uploaded to the RICS Building Carbon Database[2] to drive progress around industry understanding of carbon. The engineer may also choose to make their carbon calculations freely available to all to maintain transparency across the profession – perhaps including a link to these calculations on the final 'sticker'.

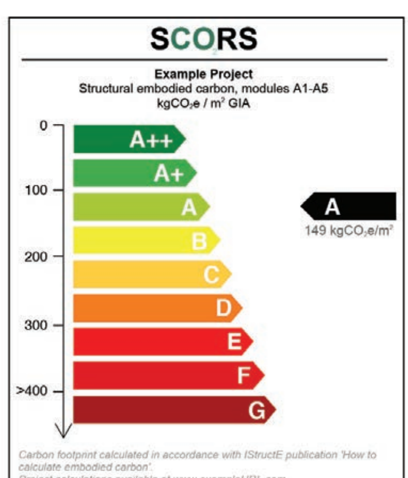


FIGURE 1: Proposed Structural Carbon Rating Scheme (SCORS) sticker

Using the scheme

It is proposed that structural engineers use SCORS to communicate the implications of design decisions. The benefit of using SCORS is that people assign a meaning to a green A+ rating, or a red F rating, facilitating conversations around embodied carbon with those who hold the most influence. It contextualises the carbon impact of a design, helping engineers, architects, clients and planners understand whether their design is high or low in embodied carbon compared with the typical range of industry practice.

In SCORS, no differentiation is made between structural type, number of storeys, client brief, presence of a basement, or whether the project is a new-build or refurbishment. Across all building structures, anywhere on the planet and in any configuration, an A rating means that the estimated A1–A5 carbon footprint of the primary superstructure plus substructure is in the range of 100–150kgCO_2e/m^2 GIA.

As well as allowing comparisons between different options of the same scheme or to a benchmark, it will allow structural engineers and our collaborators to understand the relative embodied carbon impacts of different types of buildings (e.g. comparing a 30-storey tower with three 10-storey buildings), with the intent of challenging the brief

TABLE 1: Targets in RIBA 2030 Climate Challenge[4]

	RIBA targets, modules A–C (excl. B6–7), whole building		A1–A5 as % of A–C[6]	Assumed structural carbon as % of whole-building carbon	A1–A5 structures 2030 target (and SCORS rating)
	2020 target	2030 target			
Domestic	600	300	74%	65%	144 (A)
Non-domestic	800	500	52%	60%	156 (B)
NB All figures are given in $kgCO_2e/m^2$ GIA					

TABLE 2: Targets in LETI Embodied Carbon Primer (ECP)[5]

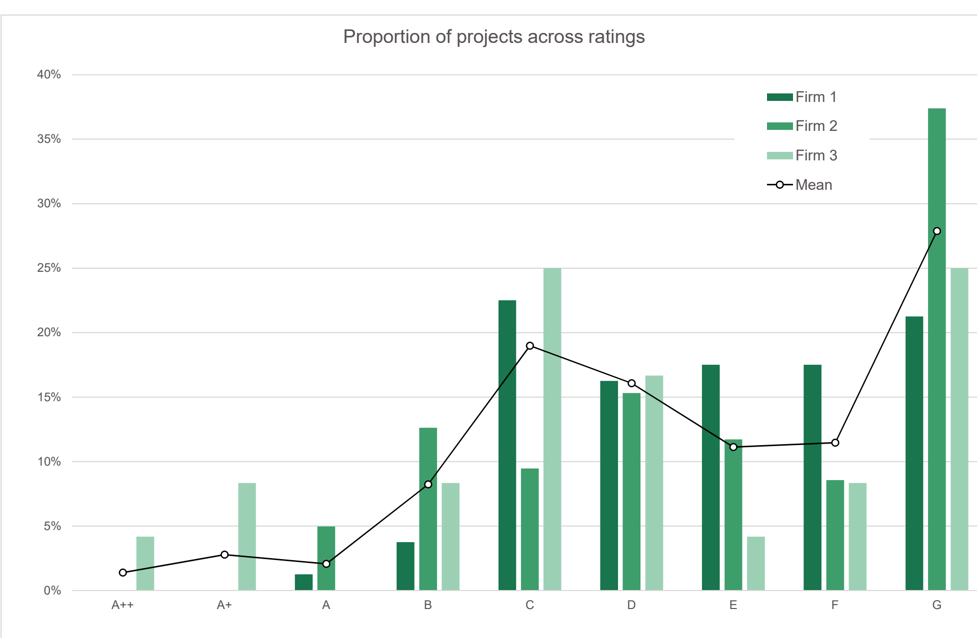
	LETI targets, modules A1–A5, whole building		Structural carbon as % of whole-building carbon (per LETI ECP)	A1–A5 structures 2030 target (and SCORS rating)
	2020 target	2030 target		
Residential	500	300	67%	201 (C)
Commercial	600	350	65%	228 (C)
Education	600	350	48%	168 (B)
NB All figures are given in $kgCO_2e/m^2$ GIA				

more often.

Note that SCORS focuses on A1–A5 (cradle–completion) emissions rather than A–C (lifecycle) emissions, the minimum scope of a structural embodied carbon assessment according to *How to calculate embodied carbon*. This is because these are the emissions that we have the most certainty and control over, as well as those which will certainly be released before our deadline to reach net zero of 2050.

Whole-building carbon reductions over the lifecycle remain the overall goal, with best practice being to consider A–C emissions, but reporting A1–A5 emissions enables the structural community to focus on emissions that will have the most impact today.

↓FIGURE 2: Data from three firms compared for carbon footprint of their designs



Benchmarking SCORS against existing projects

The range and gradation of SCORS is informed by a review of embodied carbon estimates from 326 projects shared by Arup, Price & Myers and Thornton Tomasetti.

The data is a mixed set – slightly varying calculation methods, different (though appropriate) carbon factors, and a mixture of building typologies and locations. Data also had to be adjusted to cover lifecycle modules A1–A5, with 15% added to account for modules A4 and A5 where only A1–A3 had been investigated.

We recognise that there are limitations to interrogating such a small cross-section of the building industry, and welcome any data that firms would like to share to add to this study – please get in touch at climateemergency@istructe.org if you would like to contribute!

Despite the diversity of the calculations, the data allowed us to understand what a typical range of structural embodied carbon impacts looks like **(Figure 2)**. The average score was a high E, and a substantial number of projects were assigned a G due to the inclusion of many high-rise projects in the dataset. The highest reported figure was over $1000kgCO_2e/m^2$. Note that similar findings were shown in the Carbon Leadership Forum's (CLF) embodied carbon benchmark study[3].

What does 'good' look like?

Current UK industry targets

The next step was to work out what SCORS rating we should be targeting, now and in the future. In the UK, both RIBA[4] and LETI[5] have recently outlined targets for embodied carbon. Both set multidisciplinary whole-building targets (structure, facade, MEP and fit-out) – with RIBA looking at whole-life emissions (A–C, excluding B6–7) and LETI only A1–A5.

Their targets are shown in **Tables 1 and 2**, and we have calculated the structures-only A1–A5 target and SCORS rating to go with it. It should be noted that

Carbon Budget			
2018 IPCC Report allowance (from end-2017) =	580	$GtCO_2e$	
minus 42Gt/yr, budget remaining on 1-Oct-2020 =	**464**	**$GtCO_2e$**	
Structural Carbon Budget			
% of global emissions due to construction materials (A1-3 emissions) =	11	%	*(GABC lobal status report)*
% of emissions due to buildings =	55	%	*(55/45 split buildings/infrastructure)*
% of embodied carbon due to structure =	66	%	*(approx from LETI and RICS)*
Global Structural Carbon A1-A3 Budget =	18.5	$GtCO_2e$	
allowance for A4-A5 (transport and site emissions) =	+15%		
Global Structural Carbon Budget, A1-A5 =	**21.3**	**$GtCO_2e$**	

↗FIGURE 3: Calculation of embodied carbon budget for building structures to 2050

these are the first formal attempt by the UK building industry to set carbon targets and may be revised further as counting carbon becomes more commonplace and the achievability of targets better understood.

The RIBA and LETI targets would require building structures to achieve SCORS ratings between A and C by the year 2030.

Global science-based targets

Going beyond the UK, we then wanted to determine what embodied carbon figures our industry will need to achieve in order to limit global warming. The *IPCC Global Warming of 1.5°C* report[7] estimated that, as of the end of 2017, the atmosphere could absorb a further 580 gigatons of carbon ($GtCO_2e$) to maintain a 50% probability of limiting warming to 1.5ºC above pre-industrial levels*.

In the three years since 2017, the remaining capacity to absorb further CO_2 is estimated to have reduced to $464GtCO_2e$[8].

Figure 3 shows that in order to stay within 1.5°C of warming, we must limit building structures carbon emissions to $21GtCO_2e$ across the world (a rough sum, but indicating the order of magnitude). Once this 21Gt carbon budget is used up, we must operate at net zero going forwards. So what does this look like year on year between now and 2050?

Figure 4 shows one such pathway†, based on the 2017 Global Status Report estimate[9] of 5.3bn m² new construction each year. This example curve starts with an E rating (the average rating from our review of structural embodied carbon data) and then reduces by around 10% per year, tapering towards zero emissions by 2050.

The grey dashed lines indicate the range within which different parts of our industry might operate, with some achieving lower emissions, others higher. The curve shows 'design emissions' – with real (construction) emissions coming roughly two years later – and that typical designs must achieve an A rating by the year 2030.

> **"TYPICAL DESIGNS MUST ACHIEVE AN A RATING BY THE YEAR 2030**

There are, of course, other curves that start at a different SCORS rating, or are based on different amounts of new floor area, but the curve always requires a dramatic reduction in emissions in the short term, and always ends at net zero by the time we get to the year 2050.

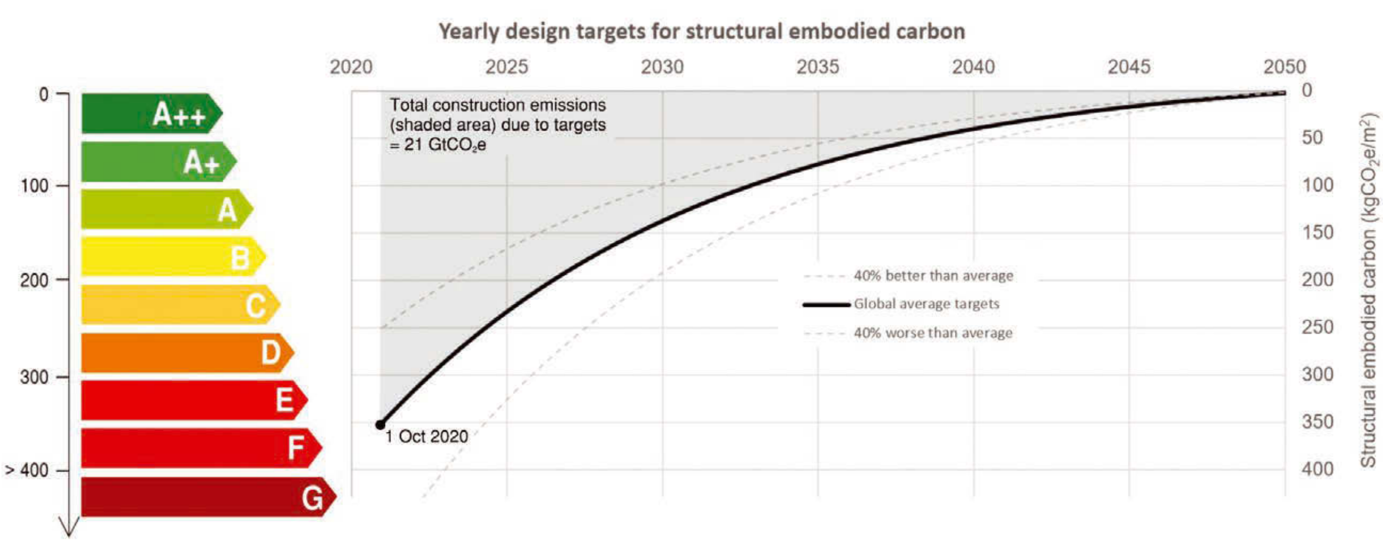
Setting targets

Setting your own targets

We know that setting the best targets doesn't come at the expense of client or employee demands. Clients are attracted to sustainable design, policy-makers are starting to demand it, and graduates want to work for firms that prioritise it. The 'better than average' engineer attracts the best work – in a market with an increasing focus on sustainability, why would you not want to be outperforming on carbon terms?

But until formal targets are adopted (e.g. by institutions or by legislation), individuals and firms must set their own targets if we are to see progress in this area. The authors advocate that all firms should set in-house science-based[10] SCORS targets for average structural A1–A5 emissions across all projects (taking advantage of refurbishment projects), and then target year-on-year reductions. This would form part of a company's compliance with their Structural Engineers' Declaration[11], notably item seven: whole-life carbon modelling and reduction as part of the basic scope of work.

Best practice on individual projects is



↘FIGURE 4: Spending the global carbon budget – carbon targets if you start at $350kgCO_2e/m^2$ and reduce emissions by 10% each year

* Note that Architecture 2030 in the USA uses the IPCC's more stringent '67% probability' carbon budget, which is around 40% lower. This would give a global buildings structural carbon budget of nearer $13GtCO_2e$. Architecture 2030 also advocates targeting net zero by the year 2040 rather than 2050.

† The calculation on which Fig. 4 is based is very simplistic, a more accurate model needs to be developed. There are many variations that need to be accounted for, including different rates of decarbonisation between industries (the construction industry is expected to never quite reach zero emissions, being balanced by other carbon-negative industries) as well as different rates of floor area growth (5.3bn m² per year is a simplistic global average between now and 2060, whereas the figure increases throughout time, and is not evenly spread between continents).

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UNTIL FORMAL TARGETS ARE ADOPTED, INDIVIDUALS AND FIRMS MUST SET THEIR OWN

then to agree a target with the client and architect at an early stage, in order to 'lock in' that target. This could be done in conjunction with an industry-recognised carbon management standard, such as PAS 2080:2016[12], and should form part of a wider project strategy such as net-zero operational carbon.

Having set targets, firms should also be open and honest with their employees and competitors about how they're doing. To say 'we targeted a B rating this year but only achieved a C' may not sound positive, but it gets people talking, and prompts us to do better next year!

We also know that there will always be certain projects where we won't hit our targets (due to location, type of project, construction demands, etc.), so when setting a company-wide SCORS target, we need to aim higher than the 'acceptable' outcome that we ultimately expect to achieve. Perhaps we all need to aim for the '40% better' grey line in **Fig. 4**.

Roadmap to net zero

This article set out to promote the advantages of using a consistent carbon rating system such as SCORS, and to compare that against various targets set by industry and science. **Fig. 4** suggests that we will be targeting A ratings on all projects within 10 years, and we know that an A rating is achievable with the right brief – early engineer involvement, maximised reuse potential, not too tall, well-configured layouts, decent structural floor zones **(Figure 5)**.

A low-carbon future can also be sustained by these projects if we consider future reuse, reassembly, and ease of maintenance in our designs.

However, there will still be much work to do once an A rating becomes the norm, and it is an uncomfortable truth that there are parts of **Fig. 4** that we don't currently know how to get to.

At present, targeting A++ only seems realistic through low-impact reuse of existing structures, highlighting the need to prioritise reuse in countries where existing assets are plentiful. But how do we do this where this is no such building stock? How will we average an A++ rating for a new-build designed in the year 2040? How will we average figures even lower than that as we

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↗FIGURE 5: 1 Triton Square (Arup, top), Olive Road (Price & Myers, middle), and Santander Bootle Campus (Thornton Tomasetti, bottom) all achieve A ratings or better get closer to 2050? How will we ever achieve zero without the use of offsetting or sequestration?

Clearly, there are opportunities ahead for researchers and materials specialists to revolutionise this industry (a topic that the Institution's Climate Emergency Task Group (CETG) will be reporting on next) but we shouldn't let that distract us from the immediate need to make a dramatic impact of our own in the here and now.

Conclusions

This article has shown that a rating system like SCORS can contextualise both the carbon impact of our work and the progress that must be made in the coming decade. We are calling on industry bodies to adopt both this, and science-based targets, to better scrutinise the structural embodied carbon in our projects, and to accelerate progress in tracking and reducing carbon within the building industry.

We acknowledge that SCORS considers the structure in isolation from the rest of the building, whereas the bigger picture involves minimising the embodied carbon of the whole building. However, in order to do this, each discipline must understand its own carbon impact within that big picture, and this is what SCORS offers for structural engineers – a method of evaluating the impact of our piece of the puzzle.

Targets outlined by RIBA and LETI, along with those shown here by setting our own science-based targets, all highlight that there is significant work to do over the next decade to start to control our carbon emissions. Discovering at concept stage that a project is achieving a G rating needs to lead to the question: 'How do we do better?'

Firms need to make tracking carbon a standard part of their services – something that asset managers[13,14] and policy will soon demand of us anyway (e.g. the Greater London Authority[15] intends to make this a planning regulation soon). They should then share the results of their calculations using the RICS Building Carbon Database[2] so that our industry can better understand their impact and trajectory.

2030 is not very far away, and if we are to achieve ratings of A and better, we need a greater prioritisation of reuse in addition to everything we already know about lean and efficient design. We must not do any of this without considering the whole-life carbon impacts of our projects, but the certainty and imminence of today's carbon emissions must be considered in the context of a rapidly depleting carbon budget.

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