THE WHOLE STORY

FROM CRADLE TO GRAVE

IN ASSOCIATION WITH TATA STEEL BCSA
You could be forgiven for picking up this supplement and thinking: “I’ve got enough to worry about with the economy the way it is, I can’t deal with this sustainability stuff right now.” But the fact you’re reading this suggests that you, like me, believe that it’s not a binary choice between economy and environment, and that sustainable business – and indeed a sustainable built environment – will be central to our recovery, growth and future prosperity.

The topic of this supplement – whole lifecycle assessment – although it sounds like a bit of techie jargon, is really at the heart of this challenge. Of course, the energy used in operating our homes and buildings is a big issue, but sustainability is much broader and goes much deeper than this. Whole lifecycle assessment is an attempt to take into account the true cost and impact of the materials we use, from sourcing to end of life, or preferably re-use and renewal - so-called “cradle-to-cradle”.

This isn’t particularly new thinking – and resource efficiency is not a recent phenomenon. Arguably we’re only just recapturing a previous attitude to “waste not, want not” that had been the dominant paradigm for centuries. But the case for moving away from our current consumption-based economy towards a new, green economy that values the scarcity of natural resources has never been stronger. Rapid fluctuations in fossil fuel prices, changing climate and growing environmental pressures, markets still constrained by the global financial crisis and increasing demand for ever-depleting resources, are forcing us to look closely at the way we do things.

Businesses that flourish in the future will do so not because they have the best CSR programmes or green PR campaigns, but because they have made resource efficiency – the challenge of doing more with less - a core business strategy and are creating lasting value from more sustainable business practices. This supplement is full of examples of good practice, which must become the norm, not the exception, if we are to begin to meet the needs of billions of people trying to live off the interest of one planet rather than using up all of its capital in one or two generations.

Paul King, chief executive, UK Green Building Council

Waste not, want not
**WHY THE FUTURE MATTERS**

Enlightened clients are starting to ask difficult questions about whole-life impacts such as embodied carbon and recyclable components.

**WHEN IS EMBODIED CARBON NOT EMBODIED CARBON?**

Embodied carbon is the amount of CO₂ emitted during a product’s entire lifecycle, including raw material extraction, transport, manufacture, assembly, installation, maintenance, disassembly, or demolition and decomposition. However, people often use the term “embodied carbon” to refer to emissions during the earlier phases of a product’s life. Manufacturers can provide data on the carbon that has been embodied up to the point where the factory, so-called cradle-to-gate embodied carbon, is left. This is only significant if materials are used in buildings, with all of their materials and components sourced from around the world, and the fate of the rubble at the end of its life is conveniently ignored.

But it’s not embodied carbon emissions or resource depletion that are keeping the property directors awake at night. What concerns them is risk: is your portfolio worth what you think it is? “Anything that’s a risk to the future value of a property will concentrate on reduction,” says David Telford, who heads up Hurley Palmer Flatt’s sustainability division: “What chiefly concerns property fund managers is the point at which a building’s life is taken into account what happens to a material at the end of a building’s life. If something can be re-used or recycled, then much of the carbon spent in producing that product in the first place has been saved – which is taken into account in a cradle-to-grave assessment. If it’s, of course, easier to look only at what happens to a product up to the point it leaves the manufacturer, a so-called cradle-to-gate lifecycle assessment. The benefit of this is that these processes are defined and don’t change, whereas what happens once a product leaves the factory gate varies from project to project. However, the downside is that this approach can mislead consumers.”

The trouble with the cradle-to-gate metric is that you may draw the wrong conclusions if studying the embodied carbon of the initial construction phase only,” says James Fiske, head of the Economic Research Unit at Mott MacDonald. “We therefore strongly recommend that the industry adopts a cradle-to-grave approach to studying embodied carbon, linking this at the same time to the calculation of emissions over the life of a building.”

Measurement of carbon and cost should be linked, says Fiske, to save different construction lines measuring these items separately.

**CONSULTANTS AND DESIGNERS ARE STARTING TO MEASURE WHOLE-LIFE IMPACTS SUCH AS EMBODIED CARBON**

"It’s something that – instinctively – we all know is true. This focus on creating "low carbon" buildings in operation is a serious case of tunnel vision. The impacts of constructing that building, with all its materials and components sourced from around the world, and the fate of the rubble at the end of its life are conveniently ignored. But it’s not embodied carbon emissions or resource depletion that are keeping the property directors awake at night. What concerns them is risk: is your portfolio worth what you think it is? “Anything that’s a risk to the future value of a property will concentrate on reduction,” says David Telford, who heads up Hurley Palmer Flatt’s sustainability division: “What chiefly concerns property fund managers is the point at which a building’s life is taken into account what happens to a material at the end of a building’s life. If something can be re-used or recycled, then much of the carbon spent in producing that product in the first place has been saved – which is taken into account in a cradle-to-grave assessment. If it’s, of course, easier to look only at what happens to a product up to the point it leaves the manufacturer, a so-called cradle-to-gate lifecycle assessment. The benefit of this is that these processes are defined and don’t change, whereas what happens once a product leaves the factory gate varies from project to project. However, the downside is that this approach can mislead consumers.”

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**KRISTIAN STEELE is a senior consultant at Arup Materials.**

**Kristian Steele**

I was looking at the issues I would identify as important, I would look at the embodied impacts of your asset. But you also want your asset to be healthy and safe, be responsibly sourced and you should also strive to ensure it demonstrates good resource efficiency. These are all aspects which should be looked at on a lifecycle basis. We might say that if things last longer, they are better. But that does not mean they should not also demonstrate the qualities which would enable them to be recycled or, even better, for components or materials to be re-used.

Kristian Steele is a senior consultant at Arup Materials.
**The Market Will Lead Design for Dismantling and Re-use on High-Value Items**

There are a few trailblazers. In the Middle East, the developers of Masdar City are making serious attempts to consider the impacts of a building over its entire lifecycle, including re-use and recycling (see page 8). Foster + Partners have used their LCA-informed materials database to consider embodied and operational carbon, and found that the building's materials are a major contributor to its carbon footprint. Foster + Partners, for example, is adding LCA data into its materials database so that architects and interior designers can use the data to make informed decisions on material selection and product specification. Foster + Partners' work for example, is adding LCA data into its materials database so that architects and interior designers can use the data to make informed decisions on material selection and product specification.

Embodied Carbon (kgCO2e)

<table>
<thead>
<tr>
<th>Year</th>
<th>Value</th>
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<tbody>
<tr>
<td>1</td>
<td>80000</td>
</tr>
<tr>
<td>2</td>
<td>70000</td>
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<tr>
<td>3</td>
<td>60000</td>
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**Guy’s Hospital**

LCA allowed Arup to work out when the carbon spend would be paid back by the operational carbon improvements, a measure that was used in planning.

**Guy’s Hospital - Impact Reduction**

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<thead>
<tr>
<th>Phase</th>
<th>Impact Reduction</th>
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<tbody>
<tr>
<td>Frame</td>
<td>100000</td>
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<tr>
<td>Glazing</td>
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<tr>
<td>Cladding systems.</td>
<td>70000</td>
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**Guy’s Hospital - Carbon Payback**

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**Guy’s Hospital - Cleaning and Maintainance**

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The whole story: case study

CASE STUDY: MAODAR CITY

This pioneering Abu Dhabi eco-city offers a unique opportunity to develop ways to improve a building’s sustainability.

“THE ABILITY TO RECYCLE, DESIGN FOR DISMANTLING AND EMBODIED CARBON ARE IMPORTANT”

Telford based the tool on environmental, economic and social sustainability, the four pillars of Estidama. Abu Dhabi’s sustainable building framework. But the tool can be adapted to meet the values and requirements of any client. Like every building in Masdar, the information from the Sprinter Building will be fed into the city’s databases and tools to help inform future phases of development.

To help designers and specifiers, Masdar has set up a specialist portal called The Future Build, which is effectively a directory of “green” materials and products from the United Arab Emirates. Any product on the database must first be independently assessed to make sure that it lives up to its billing, with benefits listed that are relevant to Masdar’s 15 environmental criteria.

The plan is that professionals will begin to use the portal on other projects in Abu Dhabi and the United Arab Emirates – and ultimately that it will be useful to built environment professionals around the world.

The Sprinter Building being designed for multi-use in mind.

THE WHOLE STORY
THE WHOLE STORY

BEHIND THE FIGURES

Before you start comparing the impacts of different materials over their lifecycles, there are a few things you need to know ...

1. It’s not rocket science. If you want to compare the embodied impacts of different structural materials, just look up the impact figures per kg, multiply by the weight of the material they pertain to. That’s your answer. If only it were that simple.

2. Nobody is claiming that lifecycle assessment is an easy science. There are certainly a few knotty issues to tackle before designers and engineers can make informed comparisons between materials; ignore them, and you’re only looking at a partial picture.

The facts

In the table opposite, you will find background information and explanations to help people understand what they are reading when they look through tables of data such as Bath University’s Inventory of Carbon and Energy (ICE). And on pages 12 and 13 you will find illustrations that show what proportions of our main structural materials are currently re-used, recycled or sent to landfill.

If you need a quick briefing on what lifecycle assessment is all about, turn to page 16 for our Beginner’s Guide.

WHAT’S IN A LIFECYCLE?

How approaches and assumptions vary between the materials

<table>
<thead>
<tr>
<th>STEEL</th>
<th>TIMBER</th>
<th>CONCRETE</th>
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<tbody>
<tr>
<td><strong>CARBON FOOTPRINT ISSUES</strong></td>
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<tr>
<td>Quality of data</td>
<td>The general quality of data is good. Steelmakers have a high profile and have responded to pressure to make full and comprehensive studies of their impacts.</td>
<td>The quality of data is good, reflecting the effort of all the materials’ producers. It is not perfect; for example, many of the data refer to steel production in the UK. The choice of cradle-to-gate or cradle-to-grave approaches can produce quite different results.</td>
</tr>
<tr>
<td>Methods of analysis</td>
<td>The steel industry, along with most metals producers, favours the cradle-to-grave approach, which recognises the benefits of future recycling.</td>
<td>Timber manufacturers tend to use a cradle-to-grave approach, which strips the material down to virgin timber. Separation of the wood from the factory gate reduces the carbon if the by-product called blast furnace slag. Because it is classified as a by-product, LCA rules state that the manufacturer can take credit for this. Reinforcement burdens add 0.43kg CO₂e/kg of timber.</td>
</tr>
<tr>
<td>What are the values using these methods?</td>
<td>On the basis of a cradle-to-grave approach, the steel industry uses figures between 0.76kgCO₂/kg for structural sections and 2.85kgCO₂/kg for galvanised strip.</td>
<td>Timber inventory across the UK is managed by the DECC and the Forest Service. It is estimated that 80% of steel scrap is collected and captured infrastructure. Globally, it is estimated that 80% of steel scrap is captured in the UK. 94% is captured from construction demolition, and for heavy framing products, 99% is captured or re-used.</td>
</tr>
<tr>
<td>Other issues</td>
<td>Steel manufacturers from re-use producers take credit for recycling, the steel industry uses figures between 0.76kgCO₂/kg for structural sections and 2.85kgCO₂/kg of steel, depending on the product.</td>
<td>Re-use structural timber is in the form of beams, studs and studwork. Salvaged timber is sometimes re-milled and sold to consumers in the form of timber flooring, beams and decking. Little information is available on the percentage of timber re-used in this way.</td>
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<tr>
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<td>Recycling</td>
<td>Steel scrap has a high value and has an efficient collection and capture infrastructure. Globally, it is estimated that 80% of steel scrap is captured. In the UK, 94% is captured from construction demolition and, for heavy framing products, 99% is captured or re-used.</td>
<td>The BRE Green Guide estimates that 23% of timber from demolition sites is recycled. In 2008, TRADA estimated that approximately 50% of timber waste was used to make chipboard, suggesting 1% is recycled to its original or equivalent use.</td>
</tr>
<tr>
<td>Re-use</td>
<td>A study carried out in 2003 estimated that 13% of structural sections are re-used. This is thought to be high and the actual figure is probably between 5-10%. Sections re-use mainly occurs in the agricultural sector.</td>
<td>Most re-used structural timber is in the form of beams, studs and studwork. Salvaged timber is sometimes re-milled and sold to consumers in the form of timber flooring, beams and decking. Little information is available on the percentage of timber re-used in this way.</td>
</tr>
<tr>
<td>Landfill</td>
<td>The amount of steel that ends up in landfill from building demolition is a function of the ease of recovery. It is generally accepted that 2% of steel is lost permanently.</td>
<td>The BRE Green Guide estimates that 53% of timber from building demolition ends up in landfill, which may be due to the difficulty in separating timber with value from contaminated timber. A JOSIB publication puts the figure at 85%.</td>
</tr>
<tr>
<td>Downcycling</td>
<td>Steel scrap is manufactured into products with the same value as the original material. Downcycling does not take place.</td>
<td>A great deal of timber waste is recycled into products of lower value and utility. TRADA has estimated that over 1 million tonnes of wood waste goes into the manufacture of chipboard.</td>
</tr>
<tr>
<td>Incineration</td>
<td>Not applicable.</td>
<td>About 6% is incinerated at end of life. Energy recovery is restricted by lack of infrastructure.</td>
</tr>
</tbody>
</table>
END-OF-LIFE SCENARIOS
What happens to a building’s structural frame once it is demolished?

CONCRETE
The great majority of concrete from demolition sites is crushed and used as sub-base or fill. This is downcycling rather than recycling, as it is a secondary use which is not of the same value as the first.
Aggregates from demolition may be re-used in concrete production but its use is restricted both by rules governing maximum percentages allowed and also by supply, since the amount of aggregate that can be recovered for this purpose is limited. Where aggregates are re-used in concrete, new cement, the source of most of the CO2 emitted in concrete production, is still needed. The Concrete Centre is the source of the downcycling figure, with the other figures estimated using various sources.

TIMBER
Definitive information on what happens to timber waste following building demolition is difficult to find. Recent publications from TRADA indicate that up to 80% of timber waste in the UK goes to landfill. The information presented here is from the BRE Green Guide.
The downcycling figure is an estimate based on published information on how much timber is diverted from the waste stream for the manufacture of chipboard.
Problems with contamination in the waste stream in particular restrict opportunities to divert waste for re-use and recycling.

STEEL
Steel benefits from having a high intrinsic value supported by a well developed and efficient scrap collection infrastructure. It can be recycled at end of life to form products that are of the same, or higher, standard and quality as the original material and most steel components are large and easily captured.
Capture rates vary depending on the ease of extraction from the demolition site but are always above 90% and average 94% for all steel components. For sections, it is 99%
These rates can be found in Material Flow analysis of the UK steel construction sector, J. Ley, 2001.
FOR LIFE

Designers should think not only about getting a building up, but also when and how its elements will be retired, says Foster + Partners sustainability expert Chris Trott.

Chris Trott does not believe in designing buildings that last. Well, not unless you really need them to. “What I am not arguing for is a long life,” says the Foster + Partners partner and sustainability engineer. “But for a good long think about the life of a building and then actually planning for the life you choose to plan on.”

For most clients, this will require a paradigm shift in thinking, says Trott: “Clients need to be more analytical about where their values lie. Do they want a building that will last for 350 years? Or will they only need it for 20 years because things are moving quickly? You might shift two or three times in that timeframe. That after, that, the building down and recycle the site.”

For inspiration, Trott suggests that designers should look to the worlds of sport and entertainment. “If you follow Formula One, everywhere they go, they take their own pavilion building for their entertainment with them. They can disassemble a whole building. A lot can be learned from technology transfer from other sectors.”

For designers, this approach also requires from thinking. Trott guarantees that in the UK only a handful of buildings are being designed for decommissioning at the end of their life, in contrast with countries in central continental Europe and Scandinavia. “In Switzerland, designers have nine phases of service briefing, the ninth being deconstruction or decommissioning,” says Trott. “There is a requirement for there to be a plan on how buildings will be deconstructed and taken out of use.”

Green thinking and design in these countries has advanced faster than in the UK due to necessity, suggests Trott. “They have been energy resource poor, so energy tends to be a lot more expensive. That affects buildings’ costs and the costs of their materials, so they have had to think about issues in the green debate a lot earlier than us.” Trott thinks it would be sensible if the planning process in the UK took this approach too. “We live in a severely resource constrained world. We are running out of natural resources with the conventional once-through model.”

“Probably now one of our greatest resources is waste. We have to take the view that waste is a resource to be re-used – whether newspaper, a tin can or a piece of a building. We are probably now starting to approach the point where the majority of natural resources are already in the things we use. Eventually we will run out of natural resources with the conventional once-through model.”

“Foundations are pretty much there for life, as are the structural frame and structural floor systems,” says Trott. “Cladding systems might be replaced after 20 years. That is perfectly legitimate and should be thought about from the beginning so they can be demobilised and recycled. More would have been involved with an existing building where the cladding could not be taken off because it was a structural cladding system and the building would have fallen down. The building was a complete construction site in order to bring it back into use. What you need is an ongoing asset with income coming in as the work happens.”

Similarly, M&E systems should be easy to replace. “Quite a lot of things tend to go into modular plant rooms and risers. It’s entirely legitimate to expect these things to come out in the same way that they came in – with a little bit of thought,” he says.

In the new order of design for disassembly, connections and fasteners take on a new importance. “Don’t mix things up if possible,” advises Trott. “End where they do come together, think how they will come apart. Things that don’t work so well for dismantling are composites and things that need lots of glue.”

A few commodities – such as copper – are already valuable enough to warrant design that allows for easy extraction when a building is refurbished or dismantled. As more resources are depleted, this rule will apply even more widely.

“With high value things, the market will lead, providing designers rise to the challenge,” says Trott. “It’s about recognising which elements people would recover value from, and not sinking that asset forever.”

That challenge is design today to meet requirements of the future. Otherwise clients will miss out now.

DESIGN PLAN

The structure and the cladding should be separate, as on Swiss Re, so that cladding can be refurbished every 20 years while still keeping most of the building operational, and therefore making money.

WE ARE LIVING IN A SEVERELY RESOURCE CONSTRAINED WORLD

“Clients need to be more analytical about the life of a building and then actually planning for the life you choose to plan on.”

“Designers need to be more analytical about where their values lie. Do they want a building that will last for 350 years? Or will they only need it for 20 years because things are moving quickly?”

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“If leases on offices get shorter for example, the available cycle-time for refurbishment will be shorter and the elements that need to be replaced or refurbished should aim to have lives which coincide with the lease lengths. If somebody is saying we are moving to a 15-year lease, then components should be reviewed in the same cycle and that would feed into the design process. Conversely, if you are working to a 25-year lease, what do you do with components that have to come out after 15 years?”

“Once this sort of brief has been set, it’s a case of designing your building so that the bits that need to be replaced can be easily dismantled and changed. And crucially, this should be possible while the building – or most of it – remains in operation.”

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WHAT IS LCA?

LCA (Life Cycle Assessment) is a method for assessing the environmental impacts of products and services throughout their entire life cycle, from cradle to grave. It involves analyzing the environmental burdens associated with a product or service, including raw material extraction, processing, manufacturing, transportation, use, and disposal.

WHERE DID IT COME FROM?

The concept of LCA can trace its origins back to the early 1960s, when researchers began to recognize the need for a comprehensive approach to assessing environmental impacts. In the 1970s, the concept began to gain momentum with the publication of several influential reports, including the Brundtland Commission’s “Our Common Future” in 1987.

WHAT ARE THE BENEFITS OF USING LCA?

LCA offers several key benefits, including:

1. **Improved environmental decision-making:** LCA provides a systematic way to evaluate the environmental impacts of different design and production options, allowing decision-makers to make informed choices.
2. **Enhanced product transparency:** LCA results can be used to communicate the environmental impacts of products to consumers, helping to build trust and foster sustainable consumption.
3. **Support for environmental policy development:** LCA can inform policy decisions by identifying areas where environmental improvements are possible and by highlighting the costs and benefits of different policy interventions.

WHAT’S CONSIDERED IN AN LCA?

An LCA typically considers several key perspectives, including:

- **Energy and raw materials:** The extraction, processing, and transportation of materials and energy used in the product.
- **Transport and manufacture:** The manufacturing and transportation of the product.
- **Operation and maintenance:** The use of the product.
- **Demolition and recycling:** The disposal and recycling of the product at the end of its life.


dr crraig jones is one of the authors of the inventory of carbon and Energy (ICE), which he have developed with Professor Geoffrey Hammond while at Bath University. He is now a senior associate at carbon reduction consultancy Sustain. Jones started working on ICE at the end of 2004, and within about nine months the first version of the database was ready. His University homepage made reference to the database and soon he started to receive a few emails. The steady stream of emails grew and now there is an automated distribution system. To date 12,000 people have downloaded the ICE. It still surprises Professor Hammond and myself how widely it has been picked up,” says Jones.

The challenges in building the database were the variability of results and the different methods used by different sectors to apply to all cases. “Cradle-to-gate calculations can even lead to nonsensical results. For example, materials that are responsible for taking in carbon – or sequestration – are given a negative emissions value. So in theory, the more of that material you use, the more environmentally friendly the building becomes.

Why are cradle-to-gate LCAs more common than cradle-to-grave LCAs?

The simple answer is that it is easier to consider impacts only as far as the factory gates. Many manufacturers provide cradle-to-gate LCIA information and databases such as Bath University’s Inventory of Carbon and Energy (ICE) (see box, above right) that contain data to the gate only.

**CRAIG JONES**

Cradle-to-gate figures give you an idea of what it takes to make a product. It very much depends on what happens to that product as to what its cradle-to-grave impact will be.

Dr Craig Jones is one of the authors of the Inventory of Carbon and Energy (ICE), which he developed with Professor Geoffrey Hammond while at Bath University. He is now a senior associate at carbon reduction consultancy Sustain. Jones started working on ICE at the end of 2004, and within about nine months the first version of the database was ready. His University homepage made reference to the database and soon he started to receive a few emails. The steady stream of emails grew and now there is an automated distribution system. To date 12,000 people have downloaded the ICE. “It still surprises Professor Hammond and myself how widely it has been picked up,” says Jones.

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**CRADLE-TO-GRAVE LCA HELPS TARGET THE PHASES WHERE MOST IMPROVEMENT COULD BE MADE**

What’s the difference between cradle-to-grave and cradle-to-gate LCAs?

Cradle-to-gate assessments cover the whole lifecycle from extraction to disposal and end of life. Cradle-to-gate assessments are a partial LCA, which stops at the factory gate, but the finished product has been transported anywhere.

What are the benefits of using cradle-to-gate LCAs?

Cradle-to-gate LCAs provide a comprehensive analysis of the resources used and the substances emitted through a product’s whole lifecycle. This allows decisions to be based on a true assessment of a product’s impact, and also means that manufacturers or users of a product can target the phases in a product’s lifecycle where the most significant improvements could be made.

Cradle-to-gate LCAs only provide a partial picture. Decisions made based on these alone ignore impacts during transport, construction, maintenance, disposal and recycling, and could mean materials or products with a worse overall impact on the environment are selected.

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**WHAT’S CONSIDERED IN AN LCA?**
**CLEAR FOOTPRINTS**

Only considering embodied impacts as far as end of construction can seriously distort the answers, as the Target Zero study shows.

**LCAs in construction.** We should also find out what’s going to happen at end of life, when a building is demolished or dismantled, because trying to live sustainably means trying to save resources for future generations. It’s about being forward-looking and not just considering what’s happening now.”

The Target Zero study took five actual buildings and used an LCA model to calculate the whole life cycle of cradle-to-grave embodied carbon of the main structure, looking at phases from materials extraction through to demolition and recycling. Engineers at Aecom then redesigned the buildings to consider the same structures with concrete, steel and where appropriate, timber frames, to compare the embodied carbon results.

Using lots of quantities produced by Cyril Sweett, Avery and his team then fed the information into an LCA model developed in-house by Tata Steel CLEAR (Construction Life-Cycle Environmental Assessment Resource). The buildings were split down into different elements: foundations, bearing structure, roof and so on. “You need to break it down to give meaningful results,” says Avery. “If you grouped them all together, you would not know where the most significant impacts were.”

Best practice for LCAs is to use current data for information such as wastage and recycling rates says Avery. “If you don’t use current data, you are really opening a can of worms: you can justify anything based on a future scenario. You have to take current manufacturing impacts and current end of life performance now and say: ‘This is what the current snapshot looks like’.”

Sourcing some of the data needed for the model took time. “We did quite a lot of work to try and define wastage rates on the construction site,” says Avery. “We then had to factor in additional material required to cover the wastage.” Whenever possible they used published data, much of it from WRAP.

The CLEAR model, which has been independently reviewed by Arup to ISO 14040 and 14044, takes into account recycling at end of life, which some tools don’t. The fact that 99% of scrap steel is melt-down and used again, gives a significant benefit of scrap steel. “For timber, it’s a complicated area and there’s no agreed method of dealing with it,” says Avery. “The conclusion we came to on Target Zero is that timber emissions are highly uncertain.”

Those are all issues which must be addressed. Unless we really don’t care about what happens beyond the next 20 years, our choice of materials should be informed by the impacts or benefits when a building is dismantled or demolished. One of the best ways to counter the effects of global population growth and resource consumption is to maximise the reuse and recycling of materials with minimalisation in function, says Avery. “You really should be taking into account what happens to the material at end of life, whether it’s beneficial to the planet or not.”

“If you ignore it, what you are saying is it does not really matter to the planet whether it will be re-used, recycled or landfilled.”

See page 23 for cradle-to-grave embodied carbon figures for the materials considered in the Target Zero study.
Steps towards sustainability

Brighton and Hove council now requires embodied carbon data for all new build housing applications. Sustainability officer Francesca Iliffe tells us why

Initially, the council will be using the information to build a database. Its online sustainability checklist, which was introduced in electronic form in 2008, allows the council to store a wide range of relevant information, and its latest version also includes a free tool for estimating operational carbon, which will allow for comparisons between cradle-to-gate embodied and in-use emissions.

The 2011 checklist contains 15 headings under which applicants must submit information, although not all are mandatory for every development. They range from CO₂ to water, food growing to parking, and the embodied carbon calculation coming under a heading of materials. "We can get really fantastic data about the sustainability of development as it comes through the planning system," Iliffe says. "All planning authorities have a duty to deliver sustainable development. But if you aren’t measuring it, how do you know if you are delivering it?"

Brighton and Hove council has always been ambitious about its sustainable development goals. Its adopted local plan says: "Planning permissions will be granted for proposals which demonstrate a high standard of efficiency in the use of energy, water and materials."

In 2008 it introduced a supplementary planning document on sustainable building design, which called for zero carbon emissions in use, a standard that was revised as a ‘recession busting measure’. As well as helping to inform some of the council’s future decisions about sustainability, Iliffe hopes that the tool will help educate local architects, planning agents and consultants about embodied carbon. "Architects and planning agents can try different options then see what will reduce their embodied carbon footprint."

The requirement to calculate embodied energy is limited to new build residential – conversions and commercial buildings would require a more complex tool – so Brighton and Hove’s picture will be incomplete. The other limitation is that the tool measures only the carbon emitted to make a product, not that produced during transportation, installation, maintenance or dismantling. "We looked at cradle-to-grave but that was an extra level of complexity," Iliffe says, who adds that Phlorum’s tool, from which Brighton and Hove’s version was developed, does have this ability. To date there have been 16 planning applications that have included the embodied carbon data, but many more people have been online to try the tool out.

It is too early to say what impact – if any – the embodied carbon measurement tool will have. Outside interest so far has come from academic institutions, rather than other local authorities. "Will other local authorities follow suit? Perhaps not immediately. But embodied impacts are moving up the local government agenda and when more mainstream political policy does turn to embodied carbon, Brighton and Hove will be ahead of the game."

AN ARCHITECT’S VIEW

Mark Pellant is a partner in Hooff Architecture. He has experience of building houses with low embodied carbon. His house and studio at Lloyds Road in Hove (pictured) was completed last year and includes all he deemed a traditional brick and block house.

Pellant’s support for Brighton and Hove’s move to record the embodied energy of new buildings at the planning stage is due, but questions whether if we will have any impact on the materials architects choose.

“You have to have the will and desire to reduce the embodied energy or the environmental impact or to improve the environment for the occupants,” he says. "The checklist is a good idea, but how do you encourage the use of these materials? I think we should be looking for the cheapest option." Clients are not asking for low embodied carbon materials, says Pellant. But some are looking for natural materials for health reasons, to avoid offgassing, and these tend to have low embodied carbon, he says.

FROM JULY THIS YEAR, ANY PLANNING APPLICATIONS FOR NEW BUILDING PROPOSALS IN BRIGHTON AND HOVE MUST INCORPORATE EMBODIED CARBON INFORMATION AS PART OF THE APPLICATION PROCESS. THIS HAS BECOME A KEY ASPECT OF THE LOCAL GOVERNMENT AGENDA AND WILL BE DEVELOPED INTO A COMPREHENSIVE TOOL. YOU ARE INVITED TO READ THE REPORT BY FRANCESCA ILIFFE, THE SUSTAINABILITY OFFICER AT BRIGHTON AND HOVE COUNCIL, WHICH EXPLAINS THE IMPLICATIONS OF THIS POLICY.

Mark Pellant’s house and studio in Hove has about half the embodied carbon of a traditional brick and block house. His picture was developed at the planning stage. He says: "If you aren’t measuring it, how do you know if you are delivering it?"

Brighton and Hove council worked with local environmental consultant Phlorum to produce a simple tool that estimates the embodied carbon of the materials and products being used, up to the end of the manufacturing phase, using a few basic pieces of information about the house. The tool is free to use and has been designed to take no more than 10 minutes to fill out.

“We worked with Phlorum to really simplify this. We did not want it to be onerous,” says Iliffe. "To do a full lifecycle assessment for the building and get really accurate data would more than likely involve using consultants. This tool is based on accurate data, but provides an estimate."

At the moment, Brighton and Hove’s only requirement for applicants to submit their partial embodied carbon figures: there are no targets set and no suggestion yet that planning decisions will be based on the results. Although the tool considers only cradle-to-gate carbon, Iliffe hopes that introducing it will be a step towards considering whole-life impacts: "It is certainly our aspiration at Brighton and Hove that there be a cradle-to-grave approach and that these issues be considered as early as possible by local architects and developers. Our intention with the tool is to signal that the council sees embodied carbon as a significant impact of development and to initiate a basic measurement of what comes through the planning system."

"We are aware that there will be inaccuracies but this tool will provide more information than we have ever had before and is a first attempt at quantifying carbon impacts in a way we have not tried before."

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We're on the cusp of a major change

The steel sector is committed to helping the construction industry assess the environmental performance of materials in an accurate and meaningful way. Alan Todd, director of market development at the British Constructonal Steelwork Association (BCSA), explains why and project teams at the leading edge of our industry – it’s the way that the sustainability of our built environment will be measured in the future. But before we reach the point where it is our standard system of evaluation, there are some obstacles that we will need to work on together to overcome.

Primary, the information about what happens to major construction materials at the end of their use will have to be made more widely available. Without this, the journey to proper whole lifecycle cradle-to-grave assessments becoming the standard across the industry will be very challenging. The limited information that is needed for a cradle-to-gate assessment is more readily available, so this type of assessment is currently easier to carry out. There is danger that this approach will be accepted by some practitioners as “good enough”. Should this become an attitude that prevails, the construction industry’s considerable efforts to reduce its environmental impact will be less effective.

The question for organisations and individuals who truly believe in the sustainability agenda, is what can we do to facilitate the process of change? The BCSA and Tata Steel are committed to making data available that will facilitate cradle-to-grave assessments of steel solutions but practitioners must have access to comparable data for all the major construction materials. This supplement provides cradle-to-grave emission figures for steel and other materials, along with the assumptions that we believe are reasonable for their end-of-life treatment.

Well-evolved views and input from other organisations – please contact John Dowling (BCSA sustainability manager) at cradletograve@steelconstruction.org.uk if you are interested in getting involved and playing your part in this important journey towards cradle-to-grave whole lifecycle assessment. We’re on the cusp of a major change and this is an opportunity to help shape that change.

"ASSESSMENTS LIMITED TO JUST SOME PARTS OF A MATERIAL'S LIFECYCLE CAN ONLY GIVE PART OF THE PICTURE"

Over the past decade, the drive to reduce the environmental impact of construction has resulted in some of the most exciting innovations and dramatic changes that our industry has ever seen. And as all parts of the industry’s supply chains work increasingly towards targets and requirements set by construction clients and by the government, the means of measuring and assessing environmental performance is developing and improving too.

There is little doubt that lifecycle assessment (LCA) is the most sophisticated, useful environmental measure of assessment approach developed to date. LCA is not a new concept for construction, but it is becoming increasingly refined to make the results as useful and accurate as possible. Standards that are being developed, such as GEN/TC950 in the UK and Europe, show the importance of carrying out an LCA assessment correctly.

By studying the environmental aspects and potential impacts from raw material extraction to manufacture, use and disposal, a whole LCA provides data for each point in a material’s life. It is the most complete way to assess environmental impact, and enables true comparisons to be made between the environmental impacts of materials and building approaches. However there is currently some areas of confusion and uncertainty associated with the whole LCA approach: the term “LCA” is applied at times to cradle-to-gate assessments, which do not include data for a material’s use or at the end of life. Assessments that are limited to just some of the elements of a material’s lifecycle can only give part of the picture, and pose a risk that important sustainability decisions may be made with the best intentions but without the longer-term environmental impacts – which can be both positive and negative – being taken into account.

Both cradle-to-gate and whole-life cradle-to-grave assessments rely on a number of assumptions in their underlying methodology. However, as the cradle-to-gate approach is, by definition, founded on the correct principle of considering the whole lifecycle, it should surely be treated as a more accurate assessment than any approach that excludes key parts of a material’s lifecycle. Whole LCA are beginning to feature more and more in the media as well as in the requirements of clients.

Cradle-to-grave embodied carbon of materials

Below is a table showing the full lifecycle (cradle-to-grave) embodied carbon of some common construction materials. These values were generated for the Target Zero low carbon building study (see pages 18-19) using recognised information sources. They are presented as an appendix within the Target Zero guidance documents. See www.targetzero.info

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>DATA SOURCE</th>
<th>SOURCE</th>
<th>TOTAL LIFECYCLE CO2 EMISSIONS (tCO2e)</th>
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<td>MPA of the UK steel construction sector 1</td>
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<td>GaBi LCI database 2006 - Pe International</td>
<td>Department for Communities and Local Government</td>
<td>0.020</td>
</tr>
</tbody>
</table>

1 Material flow analysis of the UK steel construction sector, July 2005
2 Survey of Arisings and Use of Alternatives to current materials in the UK construction sector, J. ley, 2001
3 tRADA technology wood information sheet 2/3
5 Data includes CO2 uptake or CO2 emissions from biomass.
“The future is not completely beyond our control. It is the work of our own hands.”

Robert F Kennedy (1925-1968)