ADVANCING NET ZERO

Asia Pacific Embodied Carbon Primer

WORLD GREEN BUILDING COUNCIL

WorldGBC

The World Green Building Council (WorldGBC) catalyses the uptake of sustainable buildings for everyone, everywhere.

Transforming the built environment across three strategic areas — climate action, health & wellbeing, and resources & circularity — we are a global action network comprised of around 70 Green Building Councils around the globe.

As members of the UN Global Compact, we work with businesses, NGOs and governments to drive the ambitions of the Paris Agreement and UN Global Goals for Sustainable Development. Through a systems change approach, our network is leading the building and construction industry towards a net zero carbon, healthy, equitable and resilient built environment.

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Disclaimer

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Executive summary

We are in a climate emergency. For Asia Pacific, the emergency is even more critical as it is one of the world's most vulnerable regions to climate change[1]. In 2018 alone, almost half of the world's 281 natural disaster events occurred in the region including 8 of the 10 deadliest, with an increasing number of these events being linked to environmental degradation and climate change[2].

This emergency calls for urgent action now.

The built environment sector has a vital role to play with buildings currently responsible for 39% of global energy-related carbon emissions[3]. As the world's population approaches 10 billion, the global building stock is expected to double in size around mid-century[4]. **To achieve net zero targets by mid-century and sustain predicted growth and urbanisation, we must decarbonise the whole lifecycle of our built assets — buildings and infrastructure.**

This means not only the emissions released during operation (energy to heat, cool and power buildings) but also during the manufacturing, transportation, construction, maintenance, repair and end of life phases known as **'embodied carbon'.** These emissions contribute around 11% of all global energy-related carbon emissions and 28% of building sector emissions[5]. The carbon emissions released before the building or infrastructure begins to be used, sometimes called upfront carbon, will be responsible for half of the entire carbon footprint of new construction between now and 2050, threatening to consume a large part of the world's remaining carbon budget. **As operational carbon is reduced, embodied carbon will continue to grow in importance as a proportion of total emissions.**

Knowing that embodied carbon is a critical challenge to tackle globally, we must shift the predominant focus across the region to whole life carbon, jointly addressing both operational and embodied carbon emissions. **By harnessing the effort that has been undertaken historically and channelling this into action on embodied carbon, a great opportunity awaits for Asia Pacific to create positive economic benefits, maintain business competitiveness and minimise the consequences of catastrophic climate change.**

Reaching net zero embodied carbon by 2050 will require immediate action, with far deeper cross-sector collaboration. Despite being a foundational issue in the region so far, there are leading examples across the value chain of action being taken. Building on this leadership and the work done by WorldGBC previously in Bringing Embodied Carbon Upfront, **this Primer provides actions that business, government and civil society can take today to raise awareness, set ambitions, drive demand and make substantial progress in reducing embodied carbon of projects, materials and products.**

1 CDP (2019) Asia Pacific's Ambition Gap
2 Guha-Sapir, D. (2019). EM-DAT: The Emergency Events Database
3 International Energy Agency, Global Status Report 2017
4 International Energy Agency, Global Status Report 2017
5 Architecture 2030, Why the Building Sector

Understanding embodied carbon

The importance of reducing embodied carbon

We are in a climate emergency. The landmark 2018 special report from the UN Intergovernmental Panel on Climate Change (IPCC 2018 report), Global Warming of 1.5ºC, presented a stark picture of the dramatically different world we will inhabit if global average temperatures rise above 1.5ºC. The consequences of climate breakdown will be long-lasting and, in some cases, irreversible. Asia Pacific will be disproportionately affected as it is one of the world's most vulnerable regions to climate change [6]. In 2018 alone, almost half of the world's 281 natural disaster events occurred in the region including 8 of the 10 deadliest with an increasing number of these events being linked to environmental degradation and climate change[7]. The annual economic impacts from disaster risk are predicted to be USD 675 billion[8]. This emergency calls for urgent action now. We must achieve net zero emissions by 2050.

The built environment sector has a vital role to play in responding to the climate emergency. With buildings currently responsible for 39% of global energy-related carbon emissions, decarbonising our sector is a critical measure to limit contribution to and lessen the impacts of climate breakdown. In some countries across Asia Pacific, buildings account for an even higher proportion of emissions. In Hong Kong, buildings account for over 90% of electricity and over 60% of carbon emissions[9] reinforcing decarbonisation of the built environment by 2050 as a critical solution. If we do not act to decarbonise our built environment, we increase the likelihood of physical and transitional risks that could result in stranded assets and higher insurance premiums.

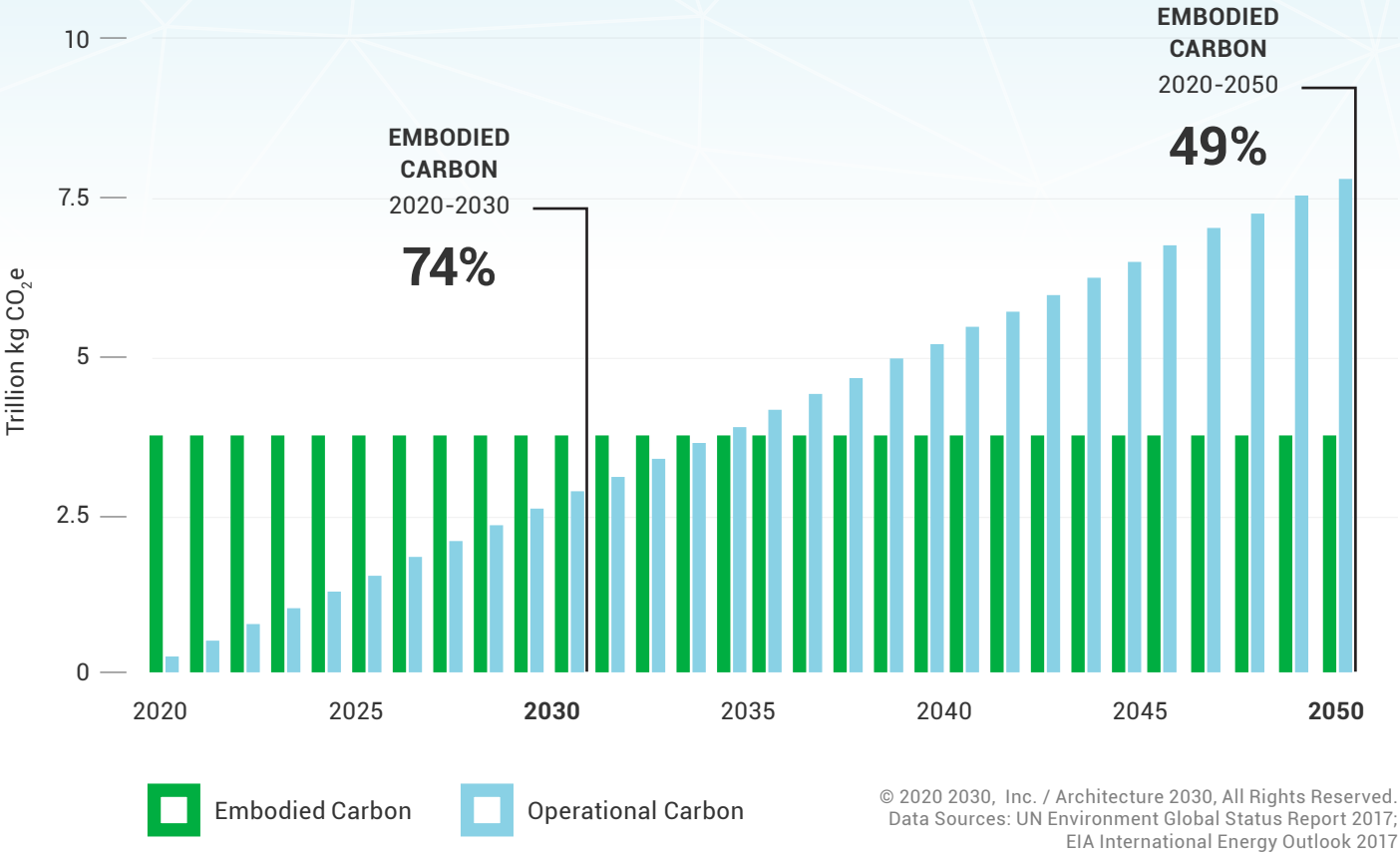
As the world's population approaches 10 billion, the global building stock is expected to double in size around mid-century[10]. To support the increase in building stock, large scale infrastructure investment and development will be needed as well. The Asia Pacific region is home to roughly 60% of the world's population including the world's most populous countries, China and India[11]. Around half, approximately 2 billion, live in urban areas that are projected to increase to 3.3 billion by 2050, directly contributing to large amounts of construction and development over the coming years. Without drastic changes to the way our sector operates, this growth will consume vast amounts of natural resources and energy contributing to an expected doubling of the total global consumption of raw materials by around the middle of the century[12], significantly increasing the sector's emissions and climate impact.

To sustain this growth and urbanisation and achieve net zero targets by mid-century, we must decarbonise the whole lifecycle of our built assets — buildings and infrastructure. This means not only the emissions released during operation (energy to heat, cool and power buildings) but also during the manufacturing, transportation, construction, maintenance, repair and end of life phases. These emissions, commonly referred to as **'embodied carbon'**, have largely been overlooked historically but contribute around 11% of all global energy-related carbon emissions and 28% of building sector emissions[13]. At the asset level, carbon emissions released before the building or infrastructure begins to be used, sometimes called upfront carbon, will be responsible for half of the entire carbon footprint of new construction between now and 20508, threatening to consume a large part of the world's remaining carbon budget. **As operational carbon is reduced, embodied carbon will continue to grow in importance as a proportion of total emissions.**

6 CDP (2019) Asia Pacific's Ambition Gap
7 Guha-Sapir, D. (2019). EM-DAT: The Emergency Events Database
8 UNESCAP (2019) The Disaster Riskscape across Asia-Pacific: Pathways for Resilience, Inclusion and Empowerment
9 HK is 2050, Building Efficiency
10 International Energy Agency, Global Status Report 2017
11 UNFPA, Population Trends
12 UNEP, With resource use expected to double by 2050, better natural resource use essential for a pollution-free planet
13 Architecture 2030, Why the Building Sector

Total carbon emissions of global new construction from 2020-2050

Business as usual projection



Data Sources: UN Environment Global Status Report 2017; EIA International Energy Outlook 2017

Figure 1: The importance of reducing embodied carbon (Adapted from Architecture 2030 'New Buildings: Embodied Carbon')

While we must continue to focus on addressing operational carbon, we must rapidly increase efforts to tackle embodied carbon emissions at a global scale, too. We must take urgent action to tackle upfront carbon while designing with whole life carbon in mind. To show what needs to be done and by when, we set out a vision in our landmark call to action report of 2019 — Bringing Embodied Carbon Upfront:

By 2030, all new buildings, infrastructure and renovations will have at least 40% less **embodied carbon** with significant **upfront** carbon reduction, and all new buildings must be net zero **operational carbon.**

By 2050, new buildings, infrastructure and renovations will have net zero **embodied carbon,** and all buildings, including existing buildings, must be net zero **operational carbon.**

What is embodied carbon?

Before addressing embodied carbon, we must understand what it is and what aspects of a building or infrastructure's lifecycle are included[14]. WorldGBC defines embodied carbon as the:

"Carbon emissions associated with materials and construction processes throughout the whole lifecycle of a building or infrastructure."

As shown in **Figure 2,** this means that all emissions from material production and construction phases **(upfront carbon),** maintenance, repair and refurbishment **(use stage embodied carbon)** demolition, deconstruction and material processing/disposal **(end of life carbon)** are included[15].

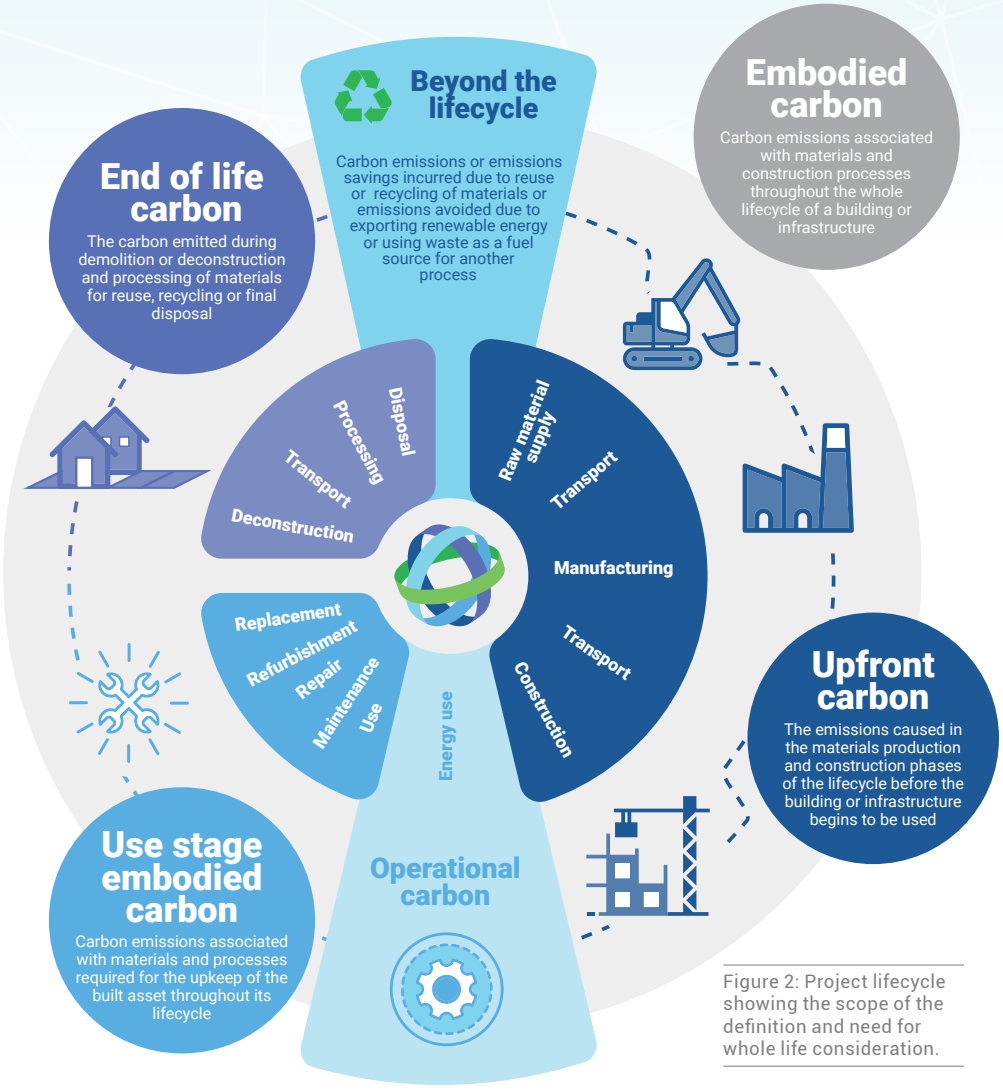


Figure 2: Project lifecycle showing the scope of the definition and need for whole life consideration.

Net zero embodied carbon should be pursued as part of a whole lifecycle approach to carbon reduction that includes net zero operational carbon.

Our definition of net zero embodied carbon in practice:

A net zero embodied carbon building (new or renovated) or infrastructure asset is highly resource efficient with upfront carbon minimised to the greatest extent possible and all remaining embodied carbon reduced or, as a last resort, offset in order to achieve net zero across the lifecycle.

14 For full breakdown of all definitions by scope and module against EN15978, please see the glossary of Bringing Embodied Carbon Upfront

15 Operational carbon emissions are not included in this definition. Together, operational carbon and embodied carbon equal the whole life carbon of a building

Common sources of embodied carbon

There are many sources of embodied carbon emissions across the lifecycle of a building or infrastructure project. **Figure 3** shows how upfront, use stage and end of life carbon account for different lifecycle stages as outlined in EN15978. The full impact from each source and the impact on lifecycle stages varies depending on local and project conditions but commonly are:

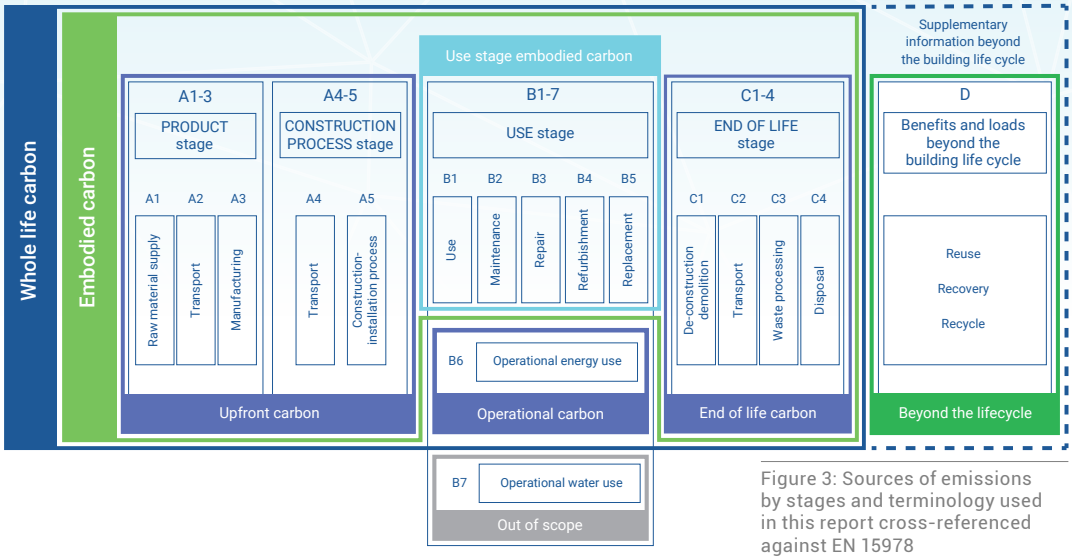


Figure 3: Sources of emissions by stages and terminology used in this report cross-referenced against EN 15978

Type and volume of structure installed

Elements such as foundations, frames and other forms of superstructure often represent the biggest contribution to embodied carbon[16], sometimes up to 80%[17] can be emitted during product manufacturing (A1-A3) and construction (A5) alone. The substantial contribution is due to:

- The large volume of materials used (e.g. footings of a building, concrete slabs)
- types of materials used with desirable load bearing properties being carbon intensive (e.g. concrete, steel, masonry)

Additionally, site selection can play a large role in how much embodied carbon the structure will contribute to a project. Sites that have soil conditions that require stabilisation or deep foundations will have a larger volume and therefore a higher embodied carbon contribution.

Embodied carbon: Structural sensitivity study **CASE STUDY**

Buro Happold Engineering developed a Structural Sensitivity study to help structural engineers understand the impact of their design decisions on the embodied carbon of a hypothetical building. The study demonstrates the sensitivity of total embodied carbon to design parameters such as materials, loadings and foundations.

Key Characteristics

- The hypothetical building modelled was a generic 8000m^2 six-storey building with a 9m by 9m column grid designed for an imposed load of 4+1kN/m^2
- Three baseline schemes for the building were developed for concrete, steel and timber solutions using the most conventional approach for each of these materials
- Across the three baseline schemes, the impact on total embodied carbon from changing different design parameters including structural arrangement, loading, column grid, material specification, foundation type and structural system was studied
- For each baseline scheme a series of parameters were changed together in steps to look at the potential total variation in embodied carbon that could be achieved
- The study showed that the timber solution had the lowest baseline but changing design parameters did not create much further benefit. The concrete solution had the highest baseline but by changing a combination of design parameters significant reductions in total embodied carbon could be achieved. The same outcome was also demonstrated for steel design parameters against the baseline
- Through a final combination of options for each solution, similar levels of embodied carbon could be reached. This suggests that structural engineers should focus on ensuring lean design and sensible grids irrespective of the material used as an important way to drive down embodied carbon

16 UK Green Building Council (2017) Embodied Carbon: Developing a Client Brief
17 Urban Land Institute Greenprint (2019) Embodied Carbon in Building Materials for Real Estate
18 International Energy Agency (2018) Technology Roadmap: Low-Carbon Transition in the Cement Industry

Materials used and their associated carbon intensity from manufacturing processes

The upfront carbon from materials and products (A1 – A5) are a significant source of embodied carbon to consider. Globally, cement and steel are two of the most significant sources of material-related emissions in construction. Cement manufacture is responsible for 7% of global carbon emissions[18], with steel also contributing 7-9% of the global total (with half attributed to buildings)[19]. Both cement and steel are carbon intensive as they require very high temperatures during production (which is energy intensive and often supplied by fossil fuels) and also release carbon dioxide emissions as a chemical reaction during the manufacturing process. Similarly, glass and aluminium (generally) also require high temperatures for production and therefore are carbon intensive.

Processes by which these materials are constructed, maintained and finally removed and treated at the end of life

The application of a material across its lifecycle (A1-5, B1-5, C1-4) will have an important impact on the amount of embodied carbon that is emitted at the upfront, use stage and end of life carbon stages. For example, timber and other biomaterials like bamboo sequester carbon during growth meaning they absorb rather than emit carbon. The amount depends on the rapidness of growth and how it is replaced, with biomass retention or increase being of prime importance for the forest. When sustainably grown and harvested, timber and other biogenic material are an inherently low carbon material. However, if appropriate treatment of timber at end of life to mitigate any methane emissions associated with its decomposition or disposal[20] is not followed then this may not be the case, demonstrating that understanding the whole lifecycle impact over time is a critical aspect of decision making.

Interface Carbon Neutral Floors™ — **CASE STUDY**

Interface, Inc. is a worldwide commercial flooring company. As part of its Climate Take Back™ mission to reverse global warming, Interface sells flooring products that are carbon neutral across their full product life cycle and aims to be a carbon negative company by 2040.

Key Characteristics

- All Interface flooring products are carbon neutral across their full product life cycle, at no extra cost to customers. Interface achieved this by using manufacturing efficiencies, renewable energy, and recycled materials to reduce the carbon footprint of its carpet tile by 74% since 1996 and by investing in verified carbon offsets. For its luxury vinyl tile (LVT) and rubber flooring, Interface is following a similar pathway to reduce then offset, and those products are also carbon neutral
- In 2017, Interface unveiled the world's first carbon negative carpet tile prototype, Proof Positive, and introduced a carbon negative backing the next year. The company plans to launch its first carbon negative carpet tile in 2020
- Closely tied to Climate Take Back is the company's ReEntry programme, which enables Interface to collect used flooring from customers for recycling. Shifting towards recycled materials has helped Interface significantly reduce its Scope 3 emissions

Modes and distances by which materials are transported

While not being as significant a source of embodied carbon, the mode and distance that a material is transported can add additional emissions especially during upfront (A4) and end of life carbon stages (C2).

Construction processes and associated emissions from equipment used on-site

Equipment used during construction (A5), such as excavators and cranes all require a form of energy to operate. When this equipment is powered by fossil fuel sources such as petrol or diesel, they are a source of embodied carbon for the developer. The method of construction can also impact how much embodied carbon a project has. Pre-fabrication requires less machinery and equipment on-site with lower construction times thereby reducing the upfront carbon of the project. Embracing disruptive technologies in construction like additive manufacturing (e.g. 3D printing) could result in energy savings of up to 21% in the sector by 2050[21], as well as reduce waste and reliance on traditional transportation methods.

19 Stockholm Environment Institute (2018): Low-emission steel production – decarbonising heavy industry
20 Sending timber to landfill is banned or restricted in many countries and methane capture technologies are being implemented.
21 Verhoef et al, 2018, The effect of additive manufacturing on global energy demand: An assessment using a bottom-up approach
22 For a full description of each principle, please see page 21 of Bringing Embodied Carbon Upfront

Gammon: Avoiding generators with battery energy storage

CASE STUDY

Headquartered in Hong Kong, Gammon has a reputation for delivering high-quality projects throughout China and Southeast Asia. They are committed to delivering client satisfaction while having minimal impacts on and creating positive change for, society and the environment. As part of this commitment, Gammon sees site electrification as a key solution for the decarbonisation of the construction sector. Gammon helped Hong Kong start-up, Ampd Energy, to develop a battery energy storage system called the Enertainer for their construction sites.

Key Characteristics

- The Enertainer, runs off a small mains power connection (say 15 amperes) charge and is ideally suited to deliver power for equipment which has high peak demands (up to 800 amperes) such as tower cranes, hoists, welders, bar benders and desanders
- The Enertainer delivers power only when needed as opposed to diesel generators which tend to run at sub-optimal efficiency. It has significantly reduced direct air quality impacts compared to diesel combustion and takes advantage of the carbon reductions provided by the electricity suppliers in Hong Kong. With these efficiencies the Enertainer currently provides up to 80-85% carbon reductions against traditional diesel approaches and one Enertainer can replace two (or more) generators
- The Enertainer is significantly quieter than comparable generators, has less down time, is virtually maintenance-free with less risks associated with diesel use and is digitally enabled allowing further insights into equipment operational efficiencies

How to reduce embodied carbon

Start early: Maximise reduction from the outset

While opportunities for reducing or eliminating embodied carbon will vary between projects and at the local level, in general, the greatest savings can usually be realised at the earliest stages of a project as shown in **Figure 4.** By putting embodied carbon on the agenda from the outset of project planning, there will be a higher level of influence to reduce embodied carbon, and will enable certainty on quantifying and achieving desired outcomes as the project progresses and more robust data is verified.

Carbon reduction potential

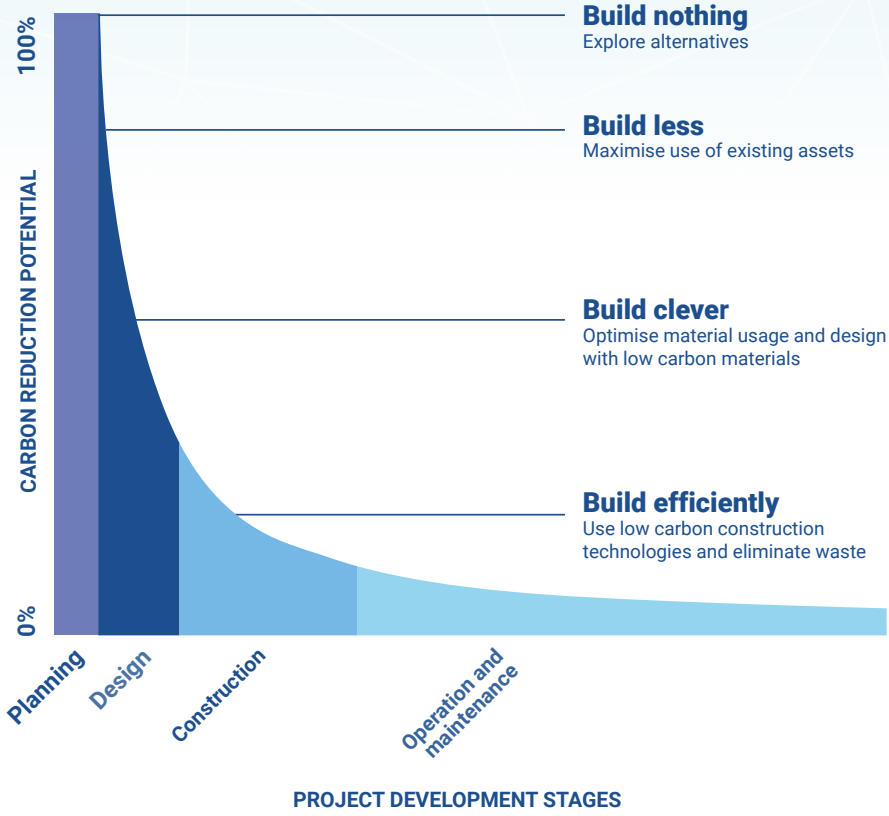


Figure 4: Opportunities to reduce embodied carbon across project development stages (Source: HM Treasury: Infrastructure Carbon Review, 2013, adapted for Bringing Embodied Carbon Upfront, WorldGBC, 2019)

Follow the steps: Key principles to apply

Adapting the ideas of **Figure 4,** some universal principles[22] can be applied by all stakeholders, regardless of their position in the value chain, the nature of their project or product, and the region they operate in as shown in **Figure 5.**

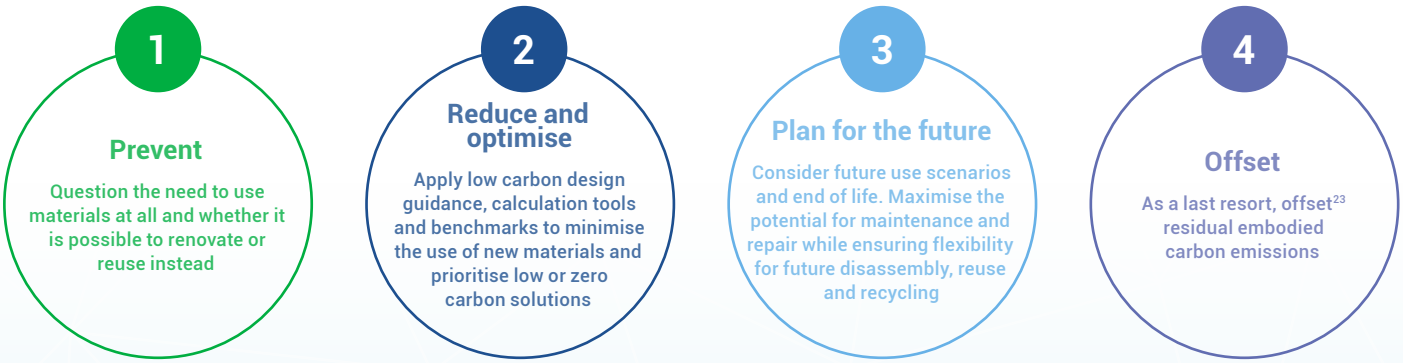


Figure 5: Schematic design for key principles

23 For hard to abate sectors, consult sector decarbonisation roadmaps for appropriate carbon mitigation technologies and processes. Approved offset schemes to be determined by local GBC or relevant industry body.

Lifecycle Assessment (LCA) process for designers

1. Goal and scope definition
2. Lifecycle inventory analysis
3. Lifecycle impact assessment
4. Interpretation & decision-making

Environmental Product Declaration (EPD) process for manufacturers

1. Determine product category rules (PCR)
2. Conduct the LCA
3. Compile EPD
4. Verification against PCR
5. Register or publish

Figure 6: What assessment method is right for you

Crunch the numbers: Assessment methods, low carbon design tools and data

The appropriate method for assessing embodied carbon will vary depending on the type of actor and what is being assessed. An example of this is shown in **Figure 6** above. There are three common methods that are undertaken for projects and products which are Lifecycle Assessment, Environmental Product Declarations, and prescriptive-based tools. These are discussed over the following pages.

Lifecycle Assessment (LCA): LCA is the globally accepted method for evaluating and communicating a wide range of environmental impacts across the whole lifecycle of a material, a product or a whole building/infrastructure asset. A life cycle approach during project planning helps key stakeholders (e.g. designers) to make decisions that favour solutions optimised in terms of various environmental issues, locations and times of environmental impacts[24]. For manufacturers, the same approach helps to establish decisions relating to manufacturing, transportation and end of life treatment. International standards[25] like EN15978 and ISO14040 ensure consistency and comparability of outcomes.

A range of simplified tools are now available to calculate the LCA of a project. These tools vary in price, scope and application with some being freely available and some specifically developed to focus on early design-stage assessments or certain stages of the lifecycle only. Availability and use of tools vary by region, country and project but some common ones are shown in **Table 1** over page.

24 DGNB, ENV 1.1 Building Lifecycle Assessment

25 While not a standard, Royal Institution of Chartered Surveyors (RICS) Professional Statement: Whole life carbon assessment for the built environment has been well received for its guidance on interpretation and implementation of the methodology in EN 15978

			Focus on whole lifecycle					Focus on upfront carbon			
Tool			Athena Impact Estimator for Buildings	eTOOL LCA	The Footprint Calculator	One Click LCA	Tally	One Click LCA Planetary	Embodied Carbon Calculator for Construction (EC3)	CIC Carbon Assessment Tool	Infrastructure Sustainability Materials calculator
Coverage			North America	Global	Australia	Global	North America	Global	Global	Hong Kong	Australia and New Zealand[26]
Cost			Free	Paid	Paid	Paid	Paid	Free	Free	Free	NA[27]
Lifecycle stages covered	Upfront Carbon	A1	✓	✓	✓	✓	✓	✓	✓	✓	✓
		A2	✓	✓	✓	✓	✓	✓	✓	✓	✓
		A3	✓	✓	✓	✓	✓	✓	✓	✓	✓
		A4	✓	✓	✓	✓	✓			✓	✓
		A5	✓	✓	✓	✓	✓			✓	
	Use stage embodied carbon	B1		✓	✓	✓					
		B2	Partial	✓	✓	✓	✓				
		B3		✓	✓	✓	✓				
		B4	✓	✓	✓	✓	✓				
		B5		✓	✓	✓	✓				
	Operational carbon	B6	✓	✓	✓	✓	✓				
	End of life carbon	C1	✓	✓		✓					
		C2	✓	✓	✓	✓	✓				
		C3		✓	✓	✓	✓				
		C4	✓	✓	✓	✓	✓				
	Beyond the lifecycle	D	✓	✓	✓	✓	✓				

Table 1: Simplified comparison of common LCA tools

26 There are two different versions of the calculator available for each nation
27 This calculator is used for submissions under the Mat-1 credit: Materials Life Cycle Impact Measurement and Reduction in the Materials Category of the Infrastructure Sustainability (IS) rating scheme, developed and administered by the Infrastructure Sustainability Council Australia (ISCA)

Construction Industry Council 'CIC Carbon Assessment Tool' – Hong Kong

CASE STUDY

The Construction Industry Council (CIC) is a statutory body that provides a communication platform between the Hong Kong Special Administrative Region (HKSAR) Government and the construction sector in Hong Kong. With a strong network of stakeholders across both sectors, the CIC strives to lead the way in carbon reduction and play a vital role in establishing a local carbon database as well as an industry benchmark. The CIC Carbon Assessment Tool (CAT), which was launched in September 2019, is an online tool for Hong Kong construction industry practitioners that evaluates carbon performance of construction projects using a standardised assessment method. It was developed with the assistance of over 2200+ stakeholders across the construction industry.

Key Characteristics

- CAT is expected to raise awareness of embodied carbon and carbon emissions of on-site construction processes, and drive change through implementation on projects and ultimately result in embodied carbon reductions
- To date, the project has been successfully integrated with international green building assessment schemes (e.g. BEAM Plus), achieved buy-in from public and private sectors, and increased industry capability
- Utilises a localised carbon database based on research conducted to determine accurate emissions factors for supply chains, mix design and raw materials source locations
- Project scope includes the structural elements of a development, both building and infrastructure, which are evaluated from stage A1-A5 of the LCA
- Facilitates the analysis of a construction project's carbon performance and establishes a carbon reduction target

Environmental Product Declarations (EPDs): The results of a LCA for a product or material (and sometimes a whole project component) are communicated in the form of EPDs. EPDs are often used by manufacturers to certify the carbon and environmental impact of their products. They are an important data source for conducting LCAs of projects as specifiers, such as architects or engineers, who use them to compare the performance of different materials or products. International standards like ISO14044 and EN15804 set high levels of transparency, quality and credibility for EPDs. As more EPDs come onto the market, databases are starting to form through LCA software or otherwise, which makes reviewing and comparing EPDs quick and easy, and enables the choice of lower carbon alternative materials.

Prescriptive-based tools: These tools contain information on the typical attributes of a range of construction materials (e.g. recycled content, renewable energy supply, low/zero carbon manufacturing processes). The GreenBook™ is one such tool and is an online resource solely devoted to upfront carbon. This information is often used to develop design specifications for low carbon and carbon positive materials. For policymakers, green public procurement has been shown to be a very effective prescriptive-based tool[28]. When public entities leverage their large-scale purchasing power by buying sustainable goods for their projects (e.g. buildings and infrastructure), they help drive markets in a direction that can produce positive market transformation and reduced environmental impacts (e.g. green concrete, low carbon steel).

Architecture 2030 Carbon Smart Materials Palette

CASE STUDY

Developed by Architecture 2030, with support from members of the Carbon Leadership Forum, the Carbon Smart Materials Palette provides attribute-based design and material specification guidelines for impactful, global embodied carbon reductions in the built environment.

Key characteristics

- Identifies key attributes that contribute to a material's embodied carbon impact and offers guidelines and options for emission reductions
- Designed to support and complement LCAs and EPDs, while providing guidelines for low/no carbon material selections and specifications
- Includes guidelines for high impact and naturally low carbon (carbon smart) materials, and whole buildings embodied carbon reductions

28 Buy Clean (2019) Curbing Carbon from Consumption: The role of Green Public Procurement

The opportunity for Asia Pacific

Knowing that embodied carbon has become a critical challenge to tackle globally, we must shift the predominant focus across Asia Pacific from operational carbon (in particular, energy efficiency) to whole life carbon, jointly addressing operational and embodied carbon emissions.

Great strides have been made in reducing operational carbon through Green Building Councils (GBCs) initiatives and government regulation. The region has seen the establishment of net zero energy and carbon certification schemes[29] across several markets including: Australia, India, Indonesia, New Zealand, Philippines and Singapore.

Progress has been made in implementing high energy efficiency standards led jointly by GBCs-government collaboration like in Singapore[30], and by the industry setting ambitious trajectories for the development of renewable energy sources in the region. For example, China Light and Power (CLP), one of the largest investor-operators of power assets in the Asia-Pacific region with operations in countries including India, Mainland China, Hong Kong and Australia, has set a target of 30% renewable and 40% non-carbon emitting energy share by 2030[31] as well as a carbon reduction intensity of 80% by 2050.

Progress in addressing embodied carbon has been slower as it is currently not well understood due to limited awareness, data and knowledge available. By harnessing the effort that has been undertaken historically for operational carbon and channelling this into action on embodied carbon, **a great opportunity awaits for Asia Pacific to create positive economic benefits, maintain business competitiveness, and minimise the consequences of catastrophic climate change in a vulnerable region.**

Policy: A COVID recovery that builds back better

There is currently a lack of incentives from policymakers encouraging reduction of embodied carbon, with most focused on improving efficiency within building operations. There are early signals and promising signs across the region. One example is China's Emissions Trading Scheme, which currently only covers power generation, but will expand to cover other sectors (including building materials[32]) over time.

Besides this, policymakers at national and subnational level have important purchasing power that is currently underleveraged. Public procurement has been shown to account for an average of 12% of gross domestic product (GDP) in Organisation for Economic Cooperation and Development (OECD) countries, and up to 30% of GDP in many developing countries[33]. Policymakers can influence actions outside of what they control. Some governments have been working with the whole value chain on decarbonisation roadmaps[34] which help to identify priority actions, increase ambition, and foster industry collaboration.

While the above are creating barriers to value chain action, governments and certification bodies are interested in doing more, especially right now with all governments focused on developing economic recovery stimulus packages to rebuild economies after COVID. A "Sustainable Recovery Plan" shows governments have a unique opportunity today to boost economic growth, create millions of new jobs and put global greenhouse gas emissions into structural decline[35].

By putting in place supportive policy, incentives, roadmaps and public procurement guidelines to address embodied carbon, we can build back better to drive demand and ambition from the private sector and keep climate action goals on track.

Business case: The benefits of implementing a whole lifecycle approach

With a lack of awareness within industry and limited data available to determine the embodied carbon of buildings and infrastructure, the business case for action has been hard to clarify. There is increasing interest from industry and GBCs in making this clearer. In 2018, 14 out of 23 green building certification systems in the region addressed embodied carbon[36]. All of these certifications at a minimum ask for reporting of embodied carbon calculations, but most are yet to incentivise performance through benchmarks and targets, due to uncertainty of data accuracy, scope, boundaries for inclusion and standardisation of methodologies.

As databases become more populated, benchmarks established, and project targets set this will increase market competitiveness and create incentives that can be leveraged. With predicted increases in supportive regulation, flows of green investment (discussed below) and supply chain pressures (discussed below), embodied carbon and a whole lifecycle approach will become critical for any new development to address to meet client and investor expectations. Working towards reducing embodied carbon can yield great results at little additional cost when undertaken from the outset of a project. By intervening at early stage design, embodied carbon can be reduced to the greatest effect and in some cases at no incremental cost[37]. This will help Asia Pacific companies to become recognised as global leaders and in line with global climate goals.

29 WorldGBC, Net zero around the world
30 Singapore Green Building Council Advancing Net Zero Snapshot
31 CLP Climate Vision 2050: A More Sustainable World
32 IEA (2020) China's Emissions Trading Scheme
33 UNEP (2017) Factsheets on Sustainable Public Procurement in National Governments
34 See Fossil Free Sweden (2018) Roadmap for Fossil-Free Competitiveness Construction for an example
35 IEA (2020) Sustainable Recovery
36 Bionova (2018) The Embodied Carbon Review
37 Urban Land Institute Greenprint (2019) Embodied Carbon in Building Materials for Real Estate

Skills and capacity: Simplifying embodied carbon through tradition and innovation

Within the region, the skills and capacity to deliver embodied carbon reductions for projects and materials is currently limited. An increase in education and training is needed to raise awareness and deliver results. With the majority of new construction being from concrete and steel, some of the traditional construction practices that have used low carbon materials and processes have decreased. For example, the use of biogenic materials such as timber which has been used in Japan for centuries[38]. By rediscovering the use of timber for a modern context (such as mass engineered timber), traditional construction practices and approaches can be a quick way to address some skills and capacity gaps. Whilst industry is keenly aware of the need to establish benchmarks and baselines, confidence in measurements and methodologies needs to be improved first by providing more local based carbon emissions factors, standardised assumptions and robust databases. As this is being developed, simplified tools such as CIC's Carbon Assessment Tool and Bionova Planetary, the digitalisation of construction through pre-fabrication and the adoption of prescriptive based approaches presents a great opportunity to help address the capacity gap in delivering embodied carbon reductions. To meet the level of skill that will be required, cross-sector and cross-stakeholder collaboration and diverse continuing professional development will be important.

Green Investments: Rewarding companies that walk the talk

Green investments have historically focused on reducing operational carbon emissions through energy efficiency improvements and the use of renewables[39]. Through legislative initiatives such as carbon pricing (as seen in Europe and recently in China[40]), Europe's EU taxonomy[41], and through voluntary initiatives such as Principles for Responsible Investment, Taskforce for Climate Related Disclosure, Carbon Risk Real Estate Monitor (CRREM) and CDP Temperature Ratings, the focus is starting to shift towards setting requirements for environmental impacts across the lifecycle of buildings, infrastructure assets, materials and products. Importantly, investors are increasingly being positioned as a critical actor to finance the necessary technological and innovation advances needed to abate sectors as part of their investment cycles[42]. The growing influence of investors presents a dual opportunity to:

1. put pressure on companies to reduce embodied carbon from their products and projects and accelerate market transformation
2. be the driving force behind funding the interventions needed to decarbonise supply chains and provide solutions to demand side pressure

Supply chain: Futureproof competitiveness on the global stage

Buildings, infrastructure assets and materials are part of a complex and often fragmented supply chain. In 2019, only 34% of CDP respondents in Asia Pacific engaged with both upstream (suppliers) and downstream (customers) stakeholders[43]. With such limited engagement, when purchasing materials or products and there is no available EPD, there can be limited data on how a material or product has been made and its journey to the end user. More often than not, materials are imported involving large amounts of transportation. The influence of China as the dominant role in global materials manufacturing plays a large part in this. China is the largest consumer of both steel and cement in the world and currently accounts for the largest share of global industrial energy consumption (35%) and industrial CO_2 emissions (nearly 50%)[44].

There is growing pressure from responsible investors and demand side actors to understand how corporate activities are aligned with meeting net zero targets. This has led to the development of a range of corporate and investor-led commitments and initiatives seeking to understand and reduce scope 3 emissions, which are the indirect emissions that occur upstream and downstream in an organisation's value chain[45] as shown in **Figure 7.**

Further to this, CDP and GRESB, two of the world's leading global platforms for corporate disclosure, ask for data on scope 3 emissions while the Science Based Targets Initiative (SBTi) require a target to be set where scope 3 emissions account for more than 40% of total inventory[46]. With Asia Pacific expected to grow as the heart of manufacturing globally, manufacturers and supply side actors must take this opportunity to work with the value chain to further transparency, support standardisation and reduce emissions from their materials and products. By doing this, they will be able to futureproof competitiveness in a more accountable world.

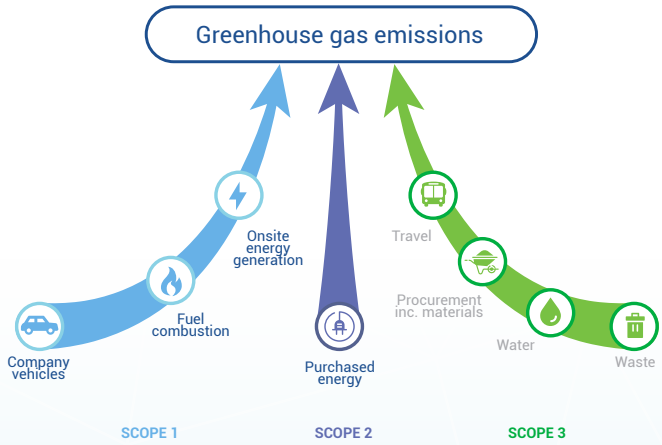


Figure 7: Simplified breakdown by scope of an organisation's greenhouse gas inventory across different scopes of emissions

38 Architect Magazine (2016) A History of Wood and Craft in Japanese Design
39 WorldGBC (2019) Bringing Embodied Carbon Upfront
40 IEA (2020) China's Emissions Trading Scheme
41 UN PRI EU Sustainable Finance Taxonomy
42 Energy Transitions Commission, Mission Possible
43 CDP (2019) Asia Pacific's Ambition Gap
44 IEA (2019) Material efficiency in clean energy transitions
45 Greenhouse Gas Protocol, Corporate Value Chain (Scope 3) Accounting and Reporting Standard
46 SBTi (2020) SBTi Criteria and Recommendations

Taking action

Summary

Reaching net zero embodied carbon by 2050 requires immediate action, with far deeper cross-sector collaboration. **Figure 8** shows actions that business, government and civil society can take today to raise awareness, drive demand and make substantial progress in reducing embodied carbon of projects, materials and products.

Government

- Deliver education and training
- Provide financial incentives
- Create national roadmaps
- Set low carbon public procurement policy
- Set benchmarks, targets and require disclosure

Investors

- Require a holistic whole lifecycle approach
- Provide sustainable financial products to incentivise low or zero carbon products/ projects
- Investor groups to agree and set embodied carbon benchmarks and targets
- Collaborate with stock exchanges

Developers

- Use LCA and whole lifecycle approach
- Optimise structural design
- Prioritise low carbon or carbon positive materials and require disclosure
- Seek innovative solutions
- Use financial incentives or contractual obligations

Designers

- Educate clients
- Specify low carbon or carbon positive materials
- Use LCA and whole lifecycle approach
- Optimise structural design
- Seek innovative solutions

Manufacturers

- Develop product specific EPDs
- Implement recycling and circularity principles
- Maximise process energy efficiency
- Implement renewable energy sources
- Work with industry to standardise EPDs
- Develop innovative low/ zero carbon construction materials and products

NGOs, networks and researchers

- Contribute to the collection of embodied carbon data
- Promote the findings of key research
- Work with government
- Work with public and private sector
- NGOs and networks deliver training
- Certification schemes require disclosure, EPDs and set measurement and performance targets

Figure 8: Taking action summary infographic

A deeper look at what you can do ▸

Government

Lead from the front, upholding ambitious embodied carbon reduction targets and enabling the market to act towards net zero embodied carbon.

Role:

Early and carefully designed policy and fiscal measures by governments are needed to enable the market to act. Governments must provide incentives to drive demand and raise awareness, creating the conditions that allow industry to prepare and ensure low and zero carbon products can compete successfully. Over time, governments must invest in research and development and work with the market to set standards and benchmarks to drive progressive action towards net zero embodied carbon.

Actions:

- Deliver education and training on embodied carbon to raise industry awareness and improve skills and capacity
- Provide financial incentives that promote action from private sector towards reducing embodied carbon
- Create national roadmaps with industry to set out milestones and targets
- Set low carbon public procurement policy for public projects
- Set benchmarks, targets and require disclosure of environmental data (e.g. EPDs, LCA)

City Policy Framework for Dramatically Reducing Embodied Carbon

CASE STUDY

Developed by the Carbon Neutral Cities Alliance and Bionova Ltd., in cooperation with Architecture 2030, The City Policy Framework for Dramatically Reducing Embodied Carbon identifies and ranks the most effective policies that cities can enact to reduce embodied carbon in infrastructure, buildings and construction.

Key Characteristics

- The framework provides guidance for cities considering policies that can deliver the highest impact within their geopolitical contexts and regulatory systems
- This policy framework is intended for cities and other government bodies to develop a strategy, action plan and policies they can adopt to dramatically reduce embodied carbon
- Over 50 existing policies from leading cities have been evaluated, categorised, and scored according to their potential, cost efficiency, ease of implementation, and enforceability
- The policies are grouped into five categories within which cities set policies: Zoning & Land Use, Building Regulations, Procurement, Waste & Circularity, and Financial Policies

Investors

Prioritise investments in support of net zero embodied carbon and trigger market demand.

Role:

Investors play a key role in advocating for stronger public policy, creating industry consensus and demanding more ambitious action from the private sector. They are well placed on both the supply and demand side to leverage their significant financial capital to encourage incorporation of embodied carbon analysis or metrics into any investments for public and private stakeholders.

Actions:

- Require a holistic whole lifecycle approach to be undertaken on all new investments incorporating both operational and embodied carbon
- Provide sustainable financial products that incentivise low or zero carbon products/projects and circular business models
- Investor groups to agree and set embodied carbon benchmarks and targets against global decarbonisation goals in collaboration with global reporting platforms
- Collaborate with stock exchanges to improve listing requirements and mandatory reporting of carbon emissions including embodied carbon

Compared to Europe and North America, Asia Pacific issuers and investors have historically been slower and more cautious to embrace the potential of sustainable finance, but this gap is narrowing[47]. In 2019 alone, green bond issuance in the region reached record levels raising over USD 18 billion from 44 green bond issuances[48]. Increasingly, investors are becoming more interested in sustainable and 'ESG' related investments in both the public and private markets, with dedicated ESG funds gaining more traction during the Covid era. The use of ESG rating systems, screening tools and reporting platforms is becoming common place in Asia as Investors begin to recognise that many of the impacts of climate change will be felt most acutely in Asia and emerging markets.

Key Characteristics

- The parent company of Google, Alphabet Inc. issued USD 5.75 billion of bonds in the largest corporate bond dedicated to environmental, social and governance purposes[49]. The bond is available for eligible projects across eight areas including energy efficiency, clean energy, green buildings, and circular economy and design
- The Institutional Investors Group on Climate Change (IIGCC), a European membership body for investor collaboration on climate change, has launched for consultation the Net Zero Investment Framework. This has been developed with over 70 global investors representing more than USD 16 trillion in assets. It aims to provide a comprehensive set of recommended actions, metrics and methodologies, which following finalisation, will seek to enable both asset owners and asset managers to effectively become 'net zero investors'
- According to Climate Bonds Initiative, the volume globally of green bond and loan issuance rose sharply by over 50%, from USD 171 billion in 2018 to USD 258 billion in 2019. Association of South-East Asian Nations (ASEAN) issuance almost doubled, reaching USD 8.1 billion in 2019 from USD 4.1 billion in 2018, supported by new regulations and guidelines. Two-thirds of the proceeds are allocated to the building and energy sectors
- DBS Bank has issued green bonds per their Green Bond Framework since July 2017. To date, 100% of the net proceeds have been allocated to Marina Bay Financial Tower 3 (MBFC T3) which has achieved Green Mark Platinum by Singapore's BCA. This has helped (MBFC T3) to save over 6,019 tonnes of CO_2 and have an energy use intensity 95 kWh/m^2 lower than average for mixed-use developments in Singapore
- City Developments Limited (CDL) ventured into green and sustainability-linked loans in 2019 and received two green loans totalling SGD 500 million from DBS Bank and HSBC to finance new property developments. In September 2019, CDL also secured a SGD 250 million Sustainable Development Goal (SDG) Innovation Loan, an innovation-focused sustainability-linked loan from DBS Bank. A first-of-its-kind financing concept pioneered by CDL, the loan aims to accelerate innovative solutions that are aligned with one or more SDGs

47 HSBC (2019), Sustainable Financing and Investing Survey 2019 (Asia Focus)
48 Financial Times (2019), Asia-Pacific issuance of green bonds hits record high of $18.9bn
49 Washington Post (2020), Alphabet Sells Largest Corporate ESG Bond at Record Low Yields

Developers

Influence and accelerate supply chain action by embracing the new business opportunity of net zero embodied carbon.

Role:

Developers have the ability to influence and accelerate the demand towards net zero embodied carbon. They are well positioned to educate and raise awareness across the supply chain and implement whole lifecycle thinking through their projects. Embracing digitalisation, new technologies, circular material markets and maximising reuse of buildings will position developers as clear industry leaders when regulatory and demand-side drivers come into place.

Actions:

- Use LCA and whole lifecycle approach to project design and development to inform key decisions
- Optimise structural design in conjunction with designers
- Prioritise low carbon or carbon positive materials and require disclosure of environmental data (e.g. EPDs, LCA) for projects and products as part of supply chain management
- Seek innovative solutions to promote circular principles and new models for business and collaboration
- Use financial incentives or contractual obligations to set prescriptive or performance-based requirements for embodied carbon targets or benchmarks

Swire Properties' Science-based Target on Embodied Carbon and Case Study for One Taikoo Place, Hong Kong

CASE STUDY

Swire Properties completed a detailed cradle-to-site carbon footprint measurement of One Taikoo Place, its newest triple-platinum-certified green office building in Hong Kong, and based on the detailed data calculations and LCA analysis, the company has established Hong Kong's first Science-based Targets (SBT) to reduce embodied carbon from future development projects.

Key Characteristics

- The total cradle-to-site carbon footprint of One Taikoo Place is 69,948,279 kg CO_2-e, and the carbon emission per construction floor area is 575 kg CO_2-e/m^2
- Detailed breakdown shows that embodied carbon in the building's concrete, rebar and structural steel contributes to nearly 90% of total emissions
- Adoption of low-carbon materials such as Construction Industry Council-certified PFA concrete, and rebar/structural steel with recycled content substantially reduced the embodied carbon
- Through LCA calculation, the company has identified measures to achieve carbon reduction in future development projects, including setting performance-based targets on embodied carbon for concrete, rebar/steel in other pipeline development projects, and improving the structural design of developments
- Swire Properties' approved SBT covers Scope 1 & 2 emissions, as well as Scope 3 emissions from the supply chain and downstream leased assets, which enables the company to drive long-term decarbonisation holistically along the whole building lifecycle
- In 2018, Swire Properties issued Hong Kong's first certified green bond (USD 500 million) to finance green projects. 100% of net proceeds have been allocated to fund projects including green building and low-carbon initiatives at One Taikoo Place. In 2020, two more green bonds totalling HKD 804 million and a HKD 1 billion green loan were launched

Urban Land Institute Greenprint Center for Building Performance: Embodied Carbon in Building Materials for Real Estate report

CASE STUDY

Embodied Carbon in Building Materials for Real Estate, created by the ULI Greenprint Center for Building Performance (ULI Greenprint), a worldwide alliance of leading real estate owners, investors, and strategic partners, prepares the real estate market for a low-carbon materials future, makes the business case for why real estate should pay attention, highlights smart steps to reduce embodied carbon, and showcases developers already addressing the issue.

Key Characteristics

The report details multiple steps that constructors and developers can take to reduce their embodied carbon including:

- considering low-carbon structural materials, such as green concrete, recycled steel, or mass timber
- reducing the total materials in building design, which can result in lower costs
- repurposing used materials as much as possible
- specifying lower-carbon materials when offering a request for proposal (RFP), as low carbon material selection often comes at no additional cost
- calculating the embodied carbon of the materials in the project, to understand the emissions' impacts and prepare the building for eventual embodied carbon reporting regulations which may be enacted by local municipalities
- promoting the embodied carbon reductions of the project to grow market awareness and adoption of lower embodied carbon buildings

Designers

Challenge convention and unleash tomorrow's designs that incorporate whole life carbon thinking and greatly reduce embodied carbon from the outset.

Role:

Designers have high potential for influencing embodied carbon reduction, especially upfront carbon, by implementing a whole lifecycle approach at an early design stage. Through the design process, they can facilitate awareness, educate clients, and propose cost effective and innovative technical solutions. At the same time, designers can also influence their supply chain by requesting EPDs and specifying low carbon or carbon positive materials. With this data, they can help to drive better standardised methodologies for LCA and contribute to benchmarks for target-setting.

Actions:

- Educate clients on the importance of reducing embodied carbon
- Specify low carbon or carbon positive materials throughout the design as much as possible
- Use LCA and whole lifecycle approach for design and specification of materials for buildings and infrastructure. Present the corresponding costs and benefits to clients
- Optimise structural design to substantially reduce embodied carbon
- Seek innovative solutions to promote new business and collaboration models and circular principles

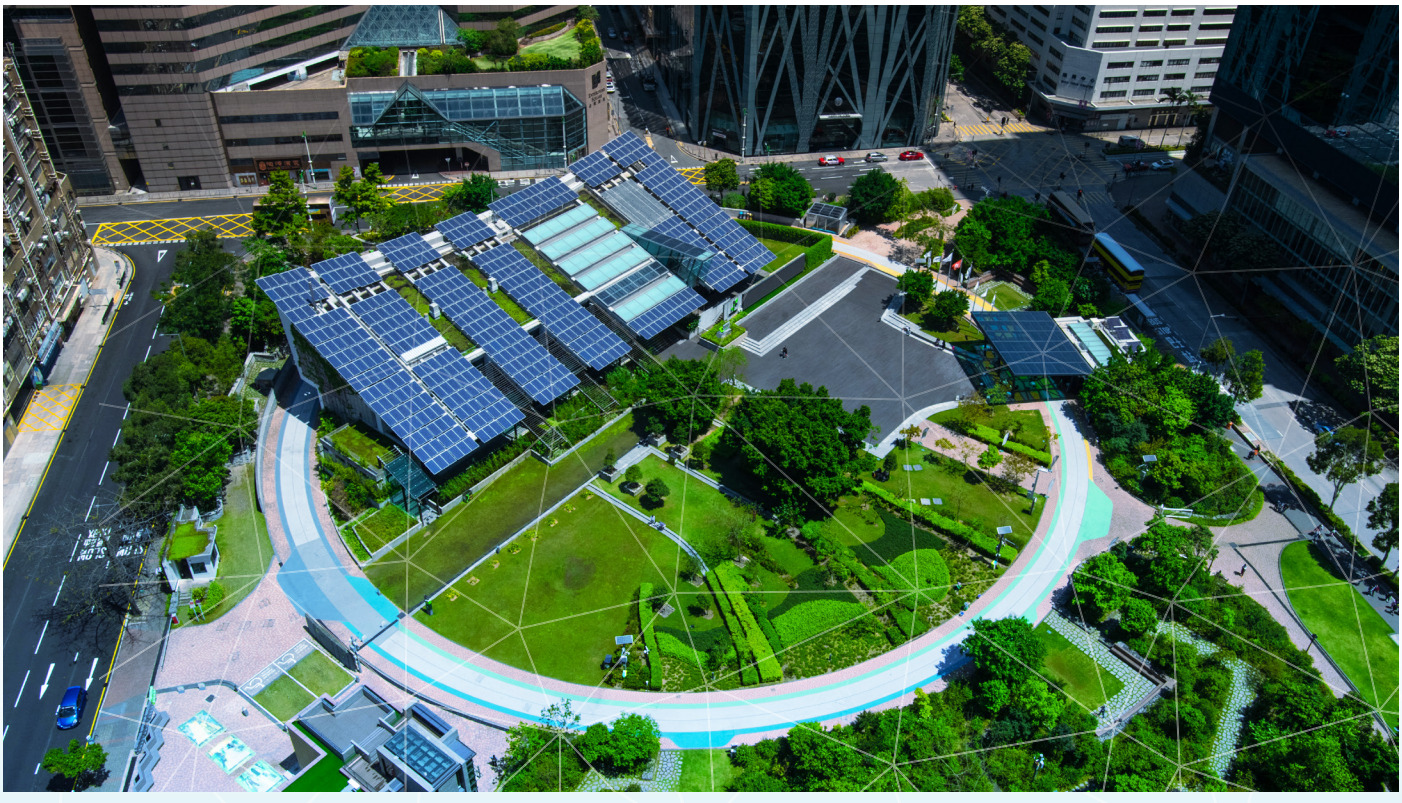
CIC-Zero Carbon Park - Hong Kong

CASE STUDY

CIC-Zero Carbon Park (CIC-ZCP) is home to the first zero carbon building in Hong Kong, developed by CIC in collaboration with the HKSAR Government. The philosophy of the building's design places a priority on reducing the whole life carbon of the building by incorporating climate-responsive passive design, low embodied carbon materials and construction methods.

By integrating the original land's existing vegetation with more than 100 different varieties of flowers and trees at CIC-ZCP, it is hoped that this landmark building can function as a "city lung" and breathe new life and clean air into Hong Kong.

- Carried out embodied carbon assessment during the concept design stage to optimise the building's structure
- Used a high pulverised fly ash (PFA) content cement substitute for reinforced concrete structure (25% for foundation; 35% for superstructure)
- Adopted a green and lean design approach with an emphasis on resource conservation to use less materials and generate less waste (e.g. no decorative false ceiling, fair-faced concrete, galvanised metal works left unpainted)
- Adopted a balanced cut and fill design for site formation. Rocks and debris salvaged from demolition work were re-used to construct a wall of gabion planters to minimise waste and associated environmental load
- Used low embodied carbon materials such as:
  - regionally manufactured materials (e.g. eco-pavers, stone pavers, gypsum block walls)
  - salvaged tree trunks and used timber to make upcycled furniture and fixtures
  - rapidly renewable materials such as bamboo used for flooring and decor
- Set an on-site renewable energy target to offset the building's operational and embodied carbon over the building's life cycle
- The Electrical and Mechanical Modular Integrated Construction for Stormwater Air-conditioning System (emMiC) collects stormwater to use as a condensing medium for CIC-ZCP's air-conditioning system
- The Air Improvement Photovoltaic (AIPV) glass canopy generates renewable energy using a nano layer of photovoltaic technology while also providing shade for CIC-ZCP visitors



From Carbon Footprint to Social Economic Benefits – the Design Thinking behind Mactan-Cebu International Airport Terminal 2

CASE STUDY

Mactan Cebu International Airport (MCIA) was the first airport in the Philippines awarded under a public-private partnership to the Megawide-GMR Consortium in 2014. Integrated Design Associates (IDA) was commissioned to design the new 55,000m² Terminal 2. Terminal 2 was completed in mid-2018 and set a benchmark to showcase the partnering benefits for future airport projects in the country.

Key Characteristics

- The terminal superstructure is built entirely of glulam timber – a radical first in Asia and a paradigm shift in mindset from conventional construction of steel
- IDA adopted a Design Thinking approach using rationale that are easy for all stakeholders to understand:
  - The design must empathise with people's aspiration of the locality, associating resorts (hospitality / warmth) and airport (calm / efficient).
  - The benefits of switching to timber structure must be measurable for the client in terms of cost, time saving and risk mitigation.
  - The building process must involve local industries to ensure the building's future upkeep comes from a sustainable pool of resources and skills found locally.
  - The construction process adopting extensive prefabrication must aim to minimise energy used and to achieve no material waste on site.
  - Full size prototype is built in order to verify all key design intents and targets are met before production.

Manufacturers

The engines of the embodied carbon transition, leading industry in delivering products that support the vision and goals of net zero embodied carbon.

Role:

It is crucial for policymakers and demand side actors to support manufacturers in the transition to low carbon materials, a whole lifecycle approach and net zero embodied carbon. By encouraging greater awareness, incentivising green finance and implementing supportive policy, the right conditions for manufacturers to take radical action can be created. It is critically important that manufacturers disclose the embodied carbon emissions in their products and materials for other value chain actors to make informed product decisions.

Actions:

- Develop product specific EPDs covering the whole life cycle to allow designers and buyers to make informed choices
- Implement recycling and circularity principles in end of life processes for products
- Maximise process energy efficiency during manufacturing
- Implement renewable energy sources for processes as much as feasibly possible
- Work with industry to standardise EPDs for easy comparability
- Develop innovative low/zero carbon construction materials and products[50]

50 These materials and products should have high resource efficiency, follow circular principles and include alternative materials and processes to achieve low/zero carbon.

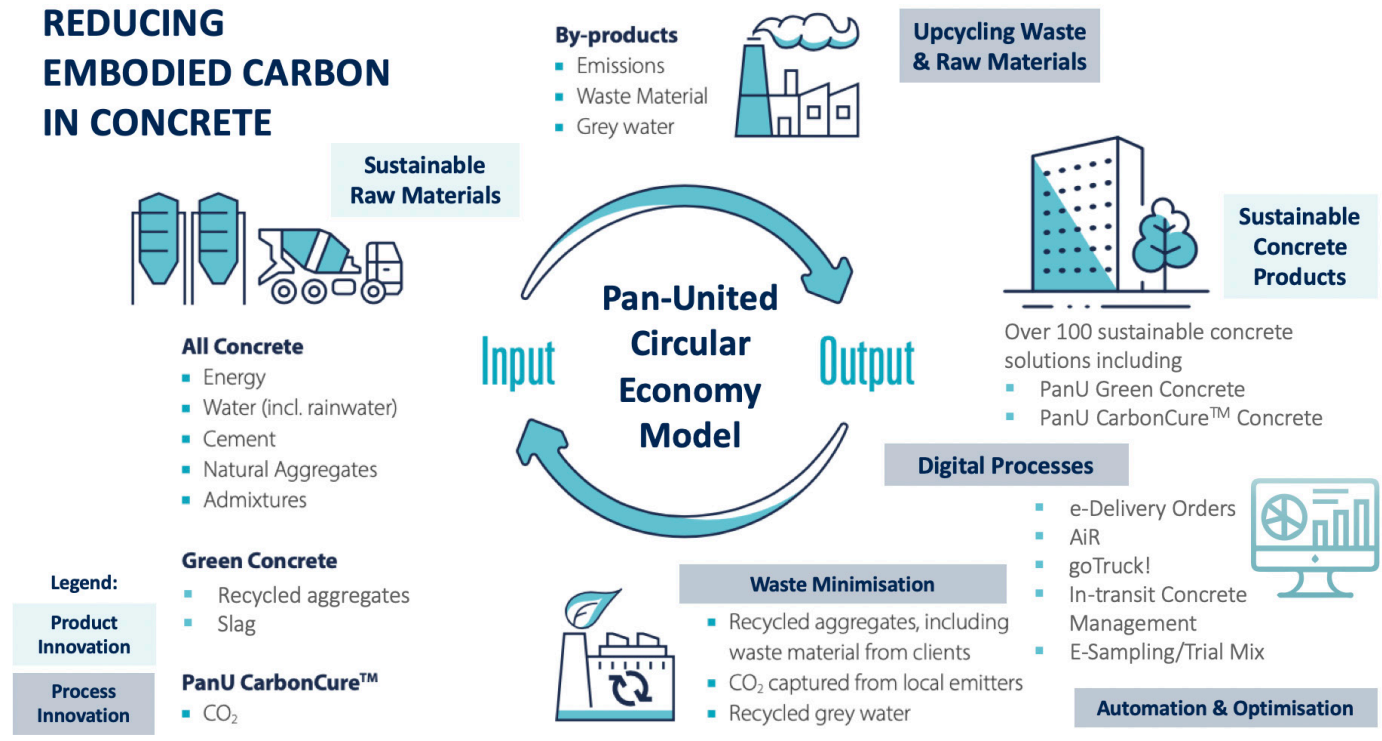
Pan-United: Using Concrete as a Sustainable Means to Reduce Embodied Carbon

CASE STUDY

Concrete innovation company Pan-United Corporation Ltd uses a circular economy model involving product and process innovation to reduce embodied carbon in concrete. Its model comprises a fully integrated ready-mix concrete supply chain - from raw materials, production and logistics to waste minimisation – to achieve low-carbon concrete.

Key Characteristics

- The Circular Economy Model revolves around three core criteria:
  - **Product innovation** enables the use of recycled materials including recycled concrete aggregates, cementitious materials such as granulated blast-furnace slag (GGBFS), and recycled waste materials
  - **Process innovation** incorporates domain knowledge and the development of bespoke digitalisation technologies to achieve new dimensions in supply chain optimisation
  - **Waste minimisation** involves the recycling of superfluous concrete into reusable concrete aggregates. Additionally, water recycling systems are installed at concrete batching plants to wash trucks and equipment, and maintain dust suppression
- Carbon sequestration technology in a new product called PanU CarbonCure™ permanently traps industrially-emitted carbon dioxide (CO_2) during the concrete production process. The mineralised CO_2 strengthens the concrete and reduces the quantity of cement required in the mix, lowering the embodied carbon in concrete
- AiR Digital, the acronym for Artificial Intelligence for Ready-mixed concrete, is a fully digitalised platform that optimises concrete batching plant operations, logistics and manpower resources
- AiM, the acronym for Artificial Intelligence Mixing, is an in-transit concrete management system that enables reductions in cement usage, diesel consumption, mixer truck waiting time and concrete rejections
- Pan-United has created over 300 specialised concrete products with over half being certified nationally in Singapore as green and low-carbon products



AkzoNobel paints and coatings for carbon neutral buildings

CASE STUDY

AkzoNobel is a global paints & coatings manufacturer who, through their PeoplePlanetPaint programme, are aiming to become climate neutral in their operations in 2050, targeting a 50% carbon reduction by 2030 and becoming a zero-waste company in the same year. AkzoNobel strives to continue to offer one of the most sustainable product portfolios in the paint and coatings industry by developing low embodied carbon products and innovative solutions for the design of carbon neutral buildings.

Key characteristics

- As part of the Company's planet ambitions, AkzoNobel is investing in energy efficient manufacturing and installing solar panels on their facilities. The Amata Industrial Park in Vietnam was built in accordance with advanced sustainable design principles such as solar panels, rainwater collection systems and solvent recovery systems
- Continuously innovating high performing products towards low embodied carbon and providing positive impacts across a building's lifecycle. Some examples include:
  - reducing the amount of energy needed for cooling through sun light and heat reflectant coatings for facades and roofs (such as Weathershield KeepCool, Interpon D2525 ECO and Intercrete)
  - converting from solvent based to water-based solutions through their international Waterway programme
  - providing clear and transparent data (e.g. low emission test reports and environmental product declarations)
  - developing solutions that protect buildings and building elements longer, meaning less maintenance, repair and replacement is needed
  - creating products with low emissions (VOC & other) and products that can purify indoor air

NGOs, networks and researchers

Together they are catalysts for the radical whole value chain collaboration needed to drive market transformation towards net zero embodied carbon.

Role:

These organisations often work together to drive market transformation and play a key role in communicating the importance and feasibility of taking action to government and wider industry. NGOs and networks must foster radical whole value chain collaboration to drive collective action. The research and academic communities have a crucial role to play in helping to develop new technologies, tools and methodologies, and by making improvements to existing ones where needed. Green Building Councils will play a key role in educating industry, gauging the readiness of markets to make the transition to net zero embodied carbon and help industry set out nationally specific action roadmaps for getting there.

Actions:

- Contribute to the collection and public release of high-quality embodied carbon measurement data
- Promote the findings of key research with industry bodies and practitioners
- Work with government to implement and promote wide uptake of standardised embodied carbon calculation tools, and low carbon design guidance
- Work with public and private sector to innovate and mature promising technologies or science that reduce whole life carbon
- NGOs and networks deliver training to help develop skills and capacity within industry
- For certification schemes:
  - require disclosure of embodied carbon performance data
  - require EPDs for major building components (structure and envelope)
  - set measurement and performance targets

Carbon Leadership Forum

CASE STUDY

The Carbon Leadership Forum (CLF) accelerates the transformation of the building sector to radically reduce embodied carbon in building materials and construction through collective action. As an industry supported collaboration hosted at the University of Washington, CLF pioneers research, creates resources, fosters cross-collaboration, and incubates member-led initiatives to bring embodied carbon emissions of buildings down to zero. CLF members include architects, engineers, contractors, material suppliers, building owners, and policymakers who care about the future and are taking bold steps to decarbonise the built environment, with a keen focus on eliminating embodied carbon from buildings and infrastructure.

Key Characteristics

- **CLF Research** projects investigate the pathways for maximising carbon reductions and lead collaborative research with material experts, NGOs, industry partners and policymakers. Recent projects include the Embodied Carbon Benchmark Study, the Buy Clean Washington Study, and LCAs for MEP systems, tenant improvements, and mass timber optimisation
- **CLF Resources** accelerate learning by developing, crowdsourcing and disseminating knowledge that empowers our members through videos, white papers, books and other publications, news and event listings, LCA inventories and data, and curated links
- **CLF Networks** bring together architects, engineers, contractors, material suppliers, building owners, policymakers and associations, through environments designed to connect inspired advocates and spark unprecedented collaboration. The CLF Community (previously known as the Embodied Carbon Network) is an online discussion platform with regional hubs supporting global collaboration. The CLF Roundtable convenes NGOs from around the world to align on benchmarks, targets, language, events, tools, and strategies to reduce embodied carbon
- **CLF Initiatives** accelerate market transformation by empowering members to advance new ideas through impactful collaborations such as the Embodied Carbon in Construction Calculator (EC3) now hosted by Building Transparency, a new NGO, and the Structural Engineers 2050 Challenge, now a programme of the ASCE's Structural Engineers Institute

ADVANCING
NET ZERO

WORLD
GREEN
BUILDING
COUNCIL