LOW-CARBON ALUMINIUM

SOLUTION FOR SUSTAINABLE CONSTRUCTION & RENOVATION

Whitepaper - June 2020

One Click LCA

Executive summary

Aluminium is an essential construction material with unique properties, including light weight, ease of extrusion to any shape, and excellent durability. These properties, combined with global growth in construction and renovation, contribute to the growing demand for aluminium.

According to the UN Environment's *Changes in building and construction have great potential to slow global warming*, use of more environmentally friendly building materials allows reducing greenhouse gases. Low-carbon aluminium is one such material, and it can play a key role in reducing emissions in building and construction.

The construction materials manufacturing, use, and end of life cause 11 % of all global carbon emissions, also called embodied carbon. To meet global climate targets, World Green Building Council has called construction sector to reduce embodied carbon by 40 % by 2030 in their *Bringing Embodied Carbon Upfront* report.

ANNUALLY, PRIMARY ALUMINIUM MANUFACTURING ACCOUNTS FOR MORE THAN ONE GIGATON OF CARBON. LOW-CARBON ALUMINIUM CAN REDUCE THIS BY 60 %.

Primary aluminium, or aluminium produced made by smelting bauxite or nepheline ore, is an electricity-intensive raw material. Its production accounts for 4-5 % of the global electricity demand.

Low-carbon aluminium is an essential solution for more sustainable construction and renovation. In this paper, the concept of low-carbon aluminium refers to primary aluminium made with 100 % renewable energy.

Aluminium is a highly circular and fully recyclable material, which has significant potential to reduce product emissions. However, today recycling can only satisfy less than 30 % of global demand: according to the International Aluminium Institute, 75 % of aluminium ever produced is still in use. Additionally, growing demand for aluminium exceeds usable scrap, and more progress is required in sorting post-consumer and fabricated scrap.

New buildings use aluminium in facades, cladding, windows, panels, and partition walls. An education sector case study in chapter 2.3. demonstrates that aluminium can account for 42 % of total embodied carbon in wood-framed buildings. In such cases, low-carbon aluminium can reduce embodied carbon by up to one fifth. In commercial buildings with traditional structures and aluminium parts, low-carbon aluminium can reduce carbon by around 7 %.

LOW-CARBON ALUMINIUM CAN REDUCE EMBODIED CARBON OF WOOD-FRAMED BUILDINGS BY UP TO ONE FIFTH. IN TRADITIONAL BUILDINGS REDUCTION POTENTIAL IS 7 %.

Renovation and refurbishment projects also use aluminium and provide used aluminium parts for reuse and recycling. Tenant improvement projects, which may occur in connection with leasehold replacement, often replace internal partition walls with aluminium frames. In renovation projects, low-carbon aluminium can reduce up to 11 % of embodied carbon.

In the marketplace where construction product suppliers increasingly compete for lower carbon footprint, use of low-carbon aluminium will be a key competitive advantage. Low-carbon aluminium helps product suppliers win contracts and demonstrate low-carbon credentials, including compliance with several commercial rating systems, such as LEED, BREEAM, and HQE.

This white paper was prepared by One Click LCA Ltd, an independent firm of construction carbon specialists operating globally out of Finland. One Click LCA Ltd works with construction carbon regulations, research and standardization. One Click LCA Ltd is also the developer of the world-leading construction life-cycle assessment software One Click LCA.

The benchmark calculations in this paper are obtained using One Click LCA software and Carbon Heroes Benchmark Program, which is a global building embodied carbon benchmarking initiative collecting embodied carbon data from more than one thousand real projects. The included case studies were provided by stok and One Click LCA Ltd. The views presented herein, as well as any omissions and errors, are those of One Click LCA Ltd. Creation of this white paper was supported by EN+ Group.

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Glossary

The following terms are used in this white paper:

Carbon-dioxide equivalent (or CO_2e), which refers to global warming that is caused by all greenhouse gases released by activity. In addition of the CO_2, it includes the impact of other greenhouse gases which each are calculated to carbon-dioxide equivalents using their respective global warming potential factors.

Carbon-intensive primary aluminium is primary aluminium (see below) manufactured with fossil energy, thus causing high greenhouse gas emissions.

Greenhouse gas emissions means emissions of all greenhouse gases, carbon and others.

Embodied carbon means the total impact of all the greenhouse gases emitted by the supply chain of a construction material, including raw materials extraction, their transport to manufacturing, manufacturing process, transport of finished goods to construction site, construction site activities and material losses, materials use phase, repair, maintenance and replacement, as well as the end-of-life processing.

Environmental Product Declaration (or EPD) is a Type III environmental label created in line with ISO 14025, that is independently verified and provides transparency on the actual environmental performance of a product.

Life Cycle Assessment (or LCA) is a method of assessing the environmental impacts associated with all the stages of a product's or a building's life, from raw material extraction to its processing, manufacture, distribution, use, repair, maintenance, and end-of-life treatment or final disposal.

Low-carbon aluminium in this white paper means primary aluminium made with renewable energy (as opposed to aluminium made with fossil energy, or recycled aluminium which has a constrained availability). There's not yet a standardized performance-based definition for low-carbon aluminium, however the Carbon Trust's *The case for low-carbon primary aluminium labelling. Methodology statement to define the market category* proposes a greenhouse gas emissions threshold of 4 tons of CO2e per ton for low-carbon aluminium for aluminium smelter emissions (corresponding to International Aluminium Institute's Level 1 footprint).

Primary aluminium is aluminium made by smelting bauxite or nepheline ore (as opposed to recycled aluminium).

1 Aluminium Demand Grows – and Carbon Impact Follows

According to *The Circular Economy: A Powerful Force for Climate Mitigation*, global aluminium production is forecast to more than double by 2050, and its production accounts for 4-5 % of global electricity demand already today. Construction is one of the key sectors driving the growth of aluminium demand.

Primary aluminium, or aluminium made by smelting bauxite or nepheline ore, is one of the most electricity-intensive raw materials. According to International Aluminium Institute, smelting one ton of primary aluminium uses 14 MWh of electricity. According to the Global Carbon Project's *Global Carbon Budget 2019*, primary aluminium production was calculated to be responsible for over a gigaton of carbon emissions in 2019, or 2,9 % of global greenhouse gas emissions from fossil fuels and industry.

Here, low-carbon aluminium means primary aluminium made with renewable energy. Only less than 30 % of global aluminium production today is manufactured with renewable energy, according to the IAI. As an electricity-intensive raw material, aluminium greenhouse gas emissions are very sensitive to the carbon intensity of the manufacturing electricity, as shown in Fig. 1.1.

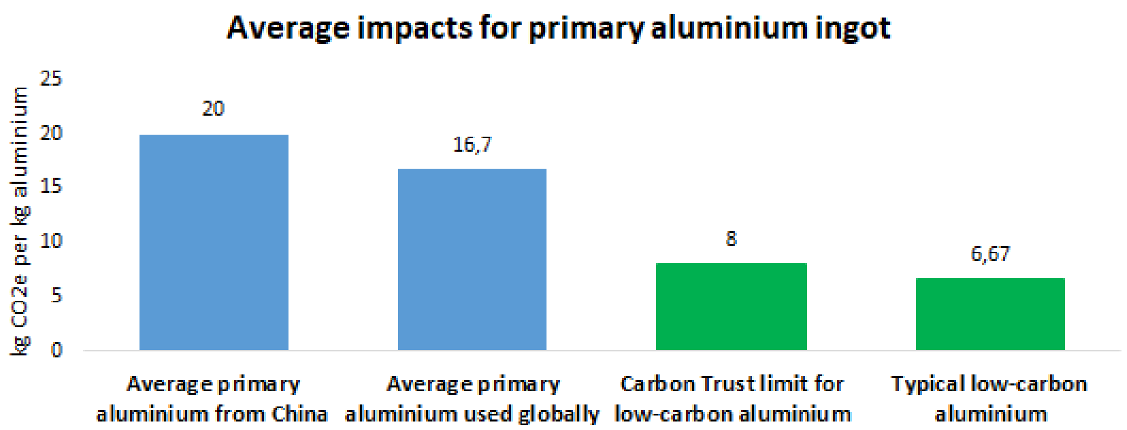


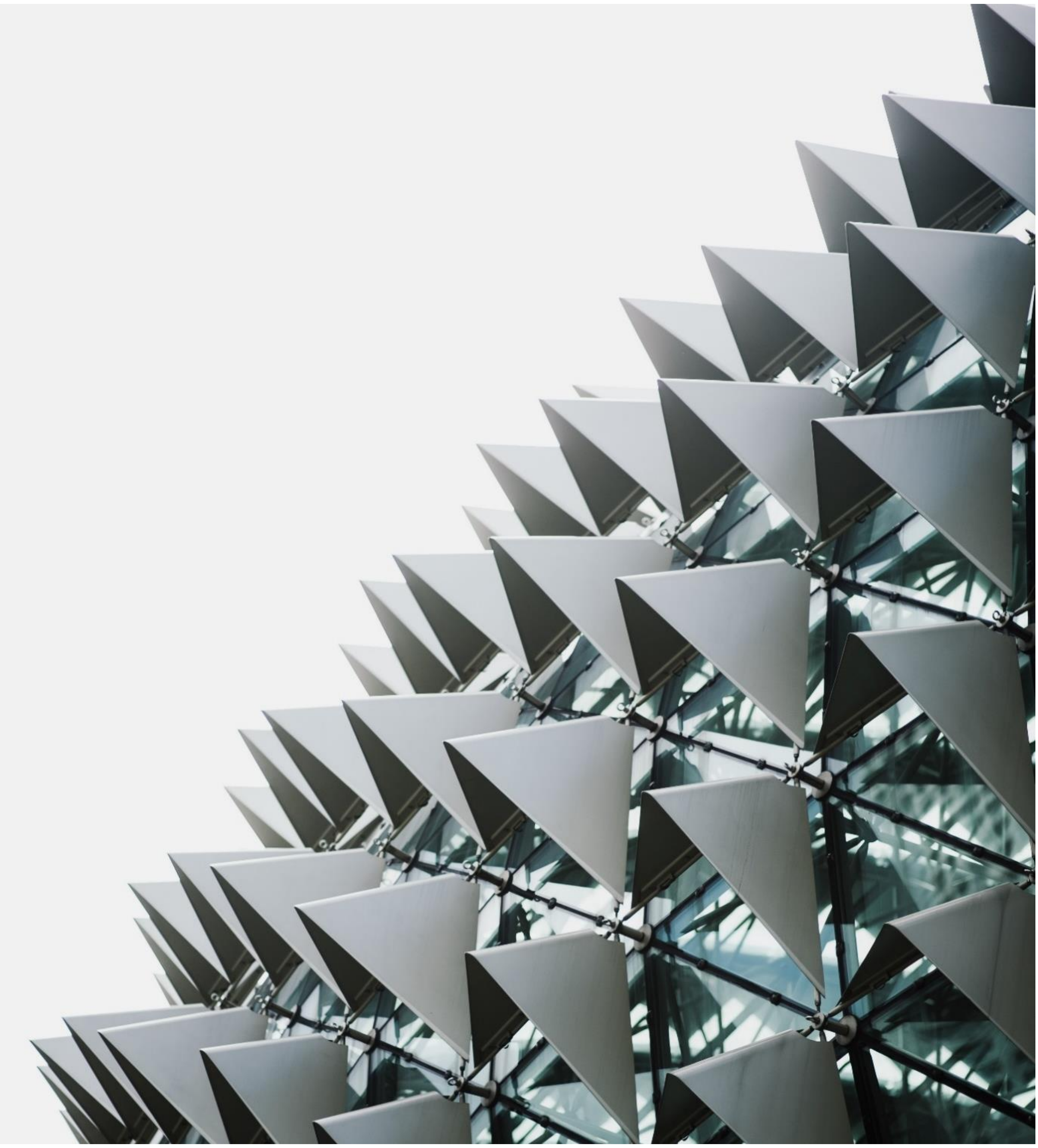
Fig. 1.1. Embodied carbon (carbon footprint) per kg of primary aluminium ingot

Aluminium is an infinitely recyclable, durable and circular material with a significant potential to reduce product emissions through reuse. Melting and purifying aluminium in recycling requires only five percent of the electricity used in primary aluminium production. This makes aluminium an excellent option to meet circular design principles and to work as a material in a circular economy.

However, today recycling can only meet less than 30 % of global demand. Going forward, recycled content alone will not be able to satisfy the growing demand in building and construction sector. In this regard, low-carbon primary aluminium will remain to be essential.

Accelerating the transition to low-carbon aluminium is essential for the decarbonization of the global economy. Shifting market preference towards low-carbon aluminium will help upgrade the global aluminium smelter capacity to cleaner renewable energy.

While there is no standards-based definition for low-carbon aluminium, The Carbon Trust's *The case for low-carbon primary aluminium labelling. Methodology statement to define the market category* finds that the aluminium brands from major aluminium producers marketed as low-carbon tend to coalesce around 4 tons of CO2e per ton of aluminium for smelter emissions (corresponding to International Aluminium Institute's Level 1 footprint). This can be used as a basis for a global performance-based low-carbon aluminium standard.



2 Low-carbon aluminium as a solution for new buildings

2.1 Low-carbon aluminium and the construction climate challenge

Aluminium is an essential construction material with unique properties, including light weight, ease of extrusion to any shape, and excellent durability. These properties, combined with global growth in construction and renovation, are increasing the demand for aluminium. Aluminium is commonly used in curtain wall framing, windows, partitions, and supporting systems of elements, such as cladding. Aluminium plays a particularly important role in commercial construction.

After cement and steel which are used in commodity quantities, aluminium manufacturing is the third highest source of greenhouse gas emissions in the construction materials sector. The International Energy Agency estimates in their *Global Alliance for Buildings and Construction: Global Status report 2017*-report that the global building stock will double by 2060, further increasing the magnitude of the challenge.

According to the World Green Building Council *Bringing Embodied Carbon Upfront* report, the construction materials manufacturing, use and end-of-life cause 11 % of all global greenhouse gas emissions, also called embodied carbon. To meet global climate targets, the World Green Building Council calls construction sector to reduce embodied carbon by 40 % by 2030.

2.2 Businesses and regulators require low-carbon solutions

The *Embodied Carbon Review* identified two years ago 105 regulations, government procurement policies, standards, and green building certification systems globally with embodied carbon requirements. As Fig. 2.1 shows, embodied carbon is already a standard feature of the European and international standards and certifications.

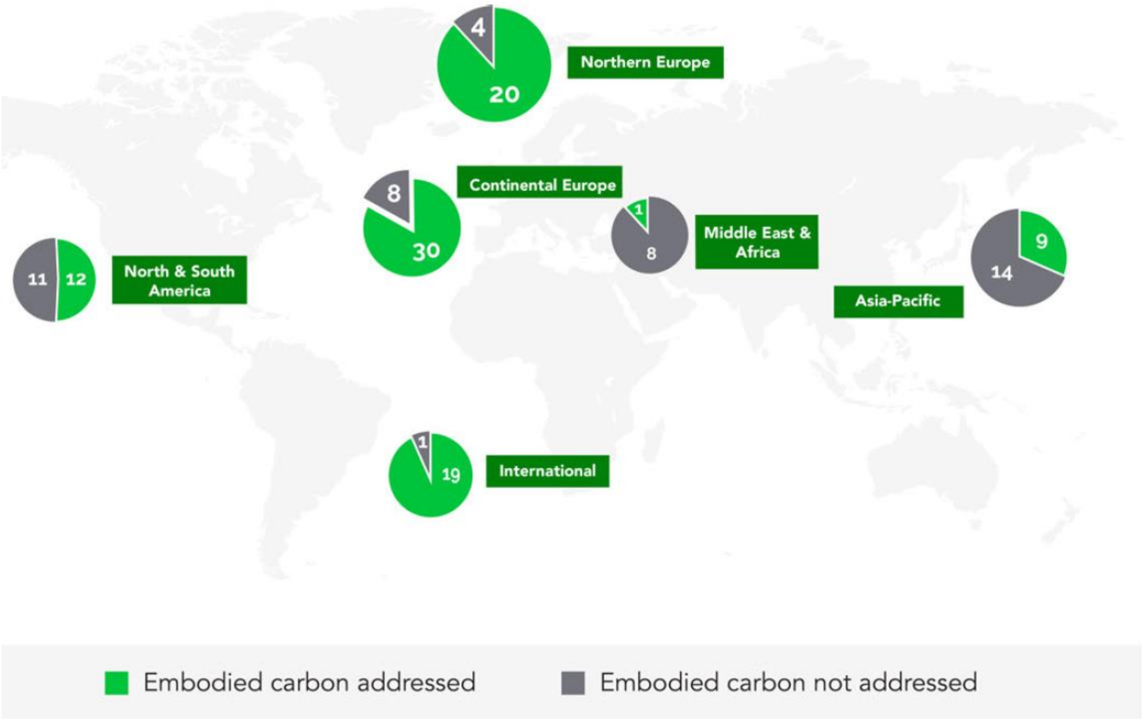


Fig. 2.1. Geographical distribution of embodied carbon regulations and standards

A follow-on research article *the unregulated energy use and carbon emissions from buildings – and how that is changing* identified ten leading governments moving embodied carbon agenda forward with regulatory preparations. These include Belgium, California in the USA, Finland, France, Netherlands, Norway, and Sweden.

Private investors are either adopting commercial green building certification systems, and the leaders are developing additional supply chain decarbonisation policies to reduce carbon intensity of their construction projects. Some investors and public procurement bodies have also set carbon intensity limits for their key construction materials, including aluminium.

Decarbonizing a growing volume of construction projects requires at once high impact, cost-efficient, and highly scalable solutions. Low-carbon aluminium meets these criteria. It is an essential solution for low-carbon building and construction and the related efficiency retrofits. The value of low-carbon aluminium in commercial certifications is discussed in chapter 2.5.

2.3 Case study: low-carbon aluminium impact in a wood building

The case study selected for this white paper is a wood-framed, low-carbon educational building located in the United States. The case study is provided by stok, a US-based high-performance real estate expert. stok pursues an environmentally restorative and socially equitable world. Its client base includes six of Forbes' top 15 World's Most Valuable Brands.

The case study project is a 13 000 m2 (140 000 sq ft) educational building targeting significant carbon reductions. The building has a structural frame made of timber. Aluminium was widely used in several building parts, including support system for natural stone cladding, vertical fins, composite wall panels, metal panels, and curtain wall frame.

One of stok's embodied carbon experts performed a fifty-year life-cycle assessment using One Click LCA software for the project to account for its carbon. The analysis encompassed structure and envelope of the building and life-cycle from cradle to grave, excluding energy use. Aluminium parts, except natural stone cladding support system, would need one replacement during life-cycle. End-of-life benefits were not deduced from the results.

THE ANALYSIS REVELEAD THAT 42 % OF THE EMBODIED CARBON FOR THIS WOOD-FRAMED BUILDING WAS CAUSED BY ALUMINIUM.

According to stok's embodied carbon analyses, the embodied carbon reduction potential from using low-carbon aluminium instead of carbon-intensive primary aluminium is 18 % for building enclosure and structure and 31 % for the enclosure alone (see Fig. 2.2).

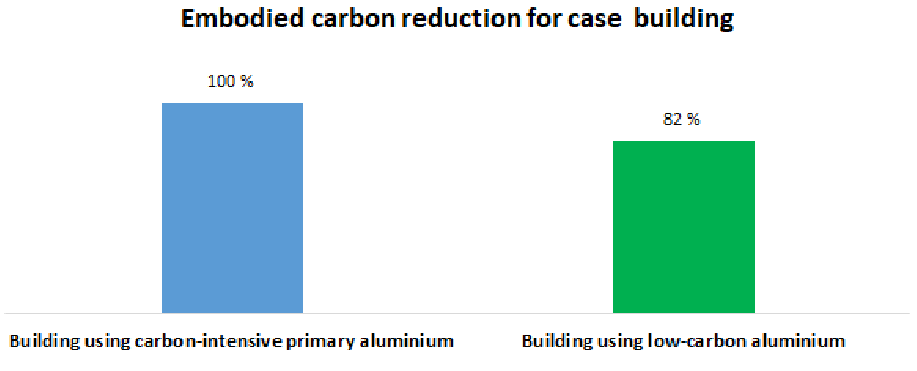


Fig. 2.2. Case study: Embodied carbon savings through the use of low-carbon aluminium

According to the stok embodied carbon expert working on this project: "*Aluminium is used extensively in the enclosure of this project's curtain wall framing, cladding support, substructure of shading elements, and composite panels. Due to the unique properties of aluminium (light weight, easy to extrude into any shape, durability, etc.) it cannot be replaced by a less carbon intensive metal. Because of this, substituting standard aluminium with a low-carbon alternative may be the best option for reducing embodied carbon.*"

A complementary sensitivity analysis by One Click LCA found that the greenhouse gas emissions reductions could achieve 23 % for this case study building.

2.4 Low-carbon aluminium impact in typical commercial buildings

A typical commercial building was simulated using a statistical building profiles from One Click LCA's *Carbon Heroes Benchmark Program*, which is a global building carbon intensity benchmark program. The benchmark program has collected and curated data from more than 1000 real-life buildings, and it has detailed statistical profiles on the contribution on each key raw material on the building embodied carbon impacts using a standardized methodology.

The following building types were included in the study: cultural, educational, hospital and healthcare, hotel, office, sport, and transport buildings. All buildings that did not report any use of aluminium were left out of the dataset. This resulted in a total of 572 buildings, predominantly in Europe. The average building had a total mass of 2,3 tons per square meter, including foundations. Average embodied carbon for these buildings was 625 kg CO2e / m2. On average, these buildings used 4,8 kilograms of aluminium per square meter.

Depending on the carbon intensity of the aluminium used, this ranges from 5 to 13 % of total building embodied carbon. Using carbon-intensive primary aluminium, embodied carbon from aluminium alone would be 80 kg CO2e / m2. Using low-carbon aluminium, these emissions would be only 32 kg CO2e / m2, or 60 % lower for aluminium itself and 7 % lower for the entire building.

IN THE COMMERCIAL BUILDINGS ANALYZED, ALUMINIUM CREATES 5-13 % OF EMBODIED CARBON. LOW-CARBON ALUMINIUM CAN SAVE UP TO 7 % OF BUILDING IMPACTS.

Analysis of the actual aluminium specified in the sample shows that the market is receptive to this. As the sample buildings were pursuing carbon reductions, the average aluminium used in those buildings had greenhouse gas emissions already quite comparable to low-carbon aluminium. Within the sample, there was a high variation of aluminium use, and buildings that did not use aluminium were excluded. These findings are shown in Fig. 2.3.

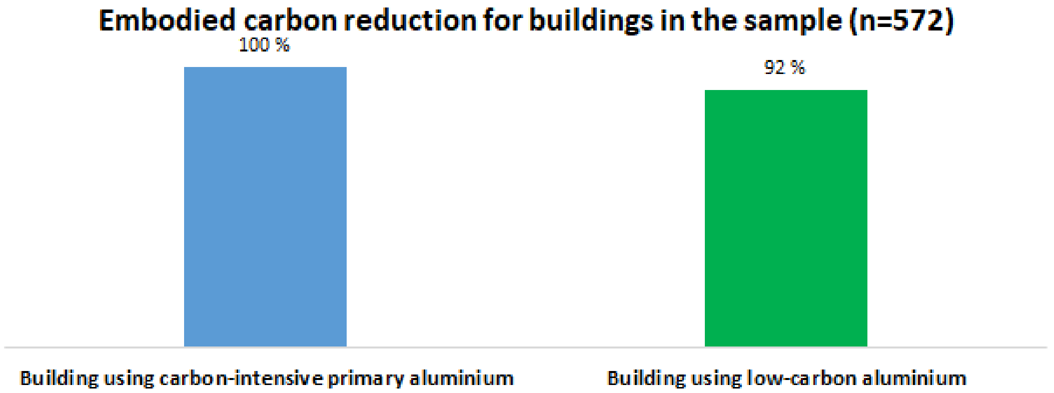


Fig. 2.3. Comparison of embodied carbon in buildings using carbon-intensive vs low-carbon aluminium

2.5 Low-carbon aluminium earns certification credits & compliance

As demonstrated by the *Embodied Carbon Review*, measuring and optimizing embodied carbon is a standard requirement in green building rating systems. This is particularly true of international systems, such as LEED and BREEAM, as well as for national/regional certifications like HQE and DGNB. Such systems adopt different technical requirements, but the overarching, shared intent is always to decarbonize the construction materials used.

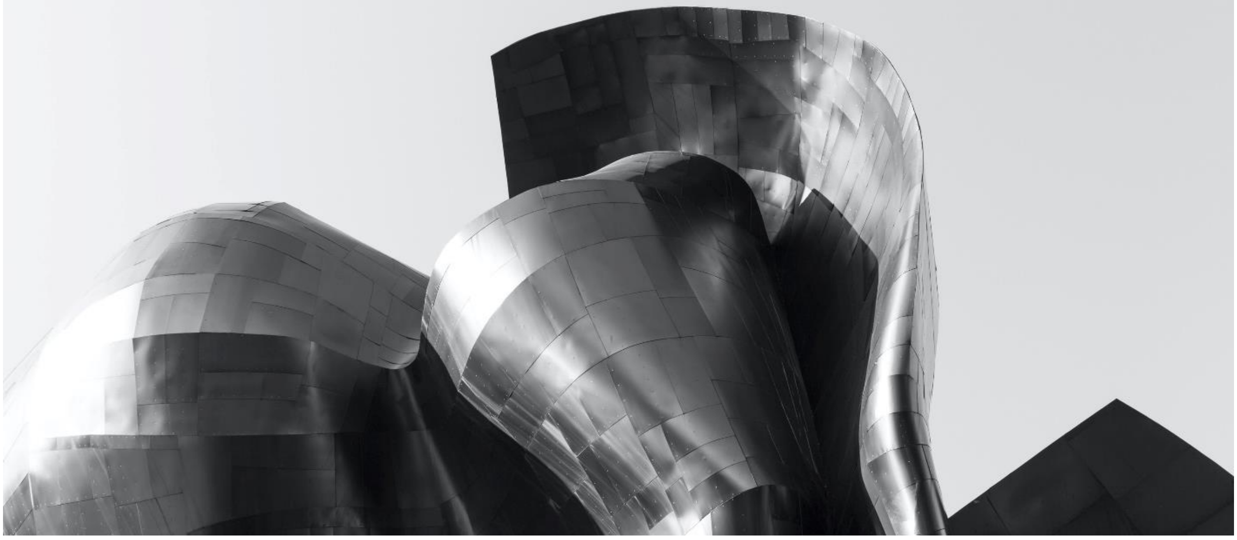
As part of these schemes, projects need to measure embodied carbon for the whole building, or at least most important building parts, and often also to demonstrate greenhouse gas reductions or compliance with carbon targets in order to achieve more credits or to comply. Below table summarizes how low-carbon aluminium supports common certification systems.

Table 2.1. Embodied carbon in green building certifications

Certification	How low-carbon aluminium is used in the certification
LEED v4.0 & 4.1	- Procurement of Low-carbon Construction Materials: one credit for demonstrating that the embodied carbon of the procured materials is lower than the market average, two points possible if applying the same to show overall materials embodied carbon reduction achieves 30 % of the nominal benchmark value - Building Life-Cycle Impact Reduction: up to 4 credits can be achieved by demonstrating environmental impact reductions against the project's baseline design. For greenhouse gas reductions of 5 %, two points are awarded, for 10 % reductions, three points are awarded and for 20 % reductions, four points are awarded. Credit requires that other environmental impact categories than greenhouse gases reduce their impacts too. - Building Product Disclosure and Optimization: 1 credit for using materials worth either 10 % of cost of materials, or 10 products from at least three manufacturers that can demonstrate third-party verified environmental impacts reduction of at least 10 % in greenhouse gas emissions. The weight of single product can be doubled if the product can reduce greenhouse gas emissions by at least 20 %.
BREEAM International and national versions	- Up to 7 credits for measuring and improving carbon performance and use of products with Environmental Product Declaration (EPD). International version does not have a reduction target. - In UK version, impact reduction credits apply, and the weight of the total credit is up to 10 credits. Impact reductions from using a lower carbon material as option are eligible in the design stage. - In Norwegian version, one greenhouse gas reduction credit is given for reducing impacts by at least 20 % and two for reducing impacts by at least 40 %. Low-carbon aluminium helps this. - In Dutch version, emission reductions credits are available

Certification	How low-carbon aluminium is used in the certification
Living Building Challenge	- Reduce carbon to a minimum, then compensate all residual embodied greenhouse gas emissions by own energy export or buying offsets. Low-carbon aluminium reduces the necessary offset purchase thus saving money for the project.
DGNB DE 2018 / DK /International	- Highest scores are achieved by reducing impacts from the reference value. 13.5% of total credits are related to the lifecycle performance of materials. Low-carbon aluminium reduces impacts across different categories, and thus supports this credit.
E+C- (France)	- Mandatory carbon level is set as a fixed value that must be met. Incentives may be earned. Low-carbon aluminium helps achieving the targeted performance level. Final construction products that use the low-carbon aluminium need to be recorded in INIES database (not primary aluminium but the construction products).
MPG (Netherlands)	- All new buildings shall achieve a maximum cap for embodied impacts. Final construction products that use the low-carbon aluminium need to be recorded in NMD database (not primary aluminium but the construction products).
NollCO2 (Sweden)	- Carbon impacts from materials need to comply with a maximum cap, and rest compensated. Low-carbon aluminium reduces the necessary offset purchase thus saving money for the project.
Green Star (Australia + New Zealand)	- Projects must achieve a 10 % reduction against a self-declared baseline. Low-carbon aluminium reduces impacts across different categories, and thus supports this credit. Green Star Australia is being revised during 2020.

In addition of certification schemes that already have adopted embodied carbon within their scope, low-carbon materials are prized by environmentally conscious designers everywhere. Further, domestic certification schemes in advanced Asian economies, including Japan, South Korea and Taiwan can be expected to incorporate embodied carbon requirements. These certifications include for example CASBEE, EEWH and NABERS.



3 Low-carbon aluminium as a solution for retrofits

While aluminium itself is highly durable, it is used in building parts requiring replacements during the life cycle of buildings. Aluminium and wood-aluminium windows are typically replaced at least once during a building's life cycle. Also, when tenants upgrade their leases or change spaces in office buildings, partition walls and internal doors that often use aluminium may require replacement to allow for new tenant to make best use of the space. However, there are also renovation projects that do not use aluminium in any significant quantity.

As a case study, One Click LCA Ltd's highly circular office renovation project is included here. The project is a 300 m2 office floor space in Helsinki, Finland. The project aimed for high circularity and material efficiency practices, by reusing all available materials, and all new materials were carefully selected.

Greenhouse gas emissions of the project are mainly created by ventilation systems, partition walls, flooring, and sanitary products. The project included several aluminium-glass partition walls. Five of the existing partition walls were retained from the original construction, and two new ones were installed. Two of the existing partition walls were reused with minor modifications within the project.

THE CASE STUDY TENANT IMPROVEMENT ACHIEVED A 6 % REDUCTION WITH LOW-CARBON ALUMINIUM, WHICH COULD INCREASE TO 11 % IN SOME RENOVATION PROJECTS.

In the actual renovation project, with particular emphasis on circularity, the two new glass-aluminium partition walls accounted for 10 % of the total renovation impacts. The project reused two existing partition walls within the project. Therefore, the impact of aluminium in a project not choosing to reuse the parts would have doubled reaching 19 %. In the actual retrofit scenario, using low-carbon aluminium can reduce embodied carbon by 6 %. The carbon reduction in the actual retrofit from using low-carbon aluminium is shown in Fig. 3.1.

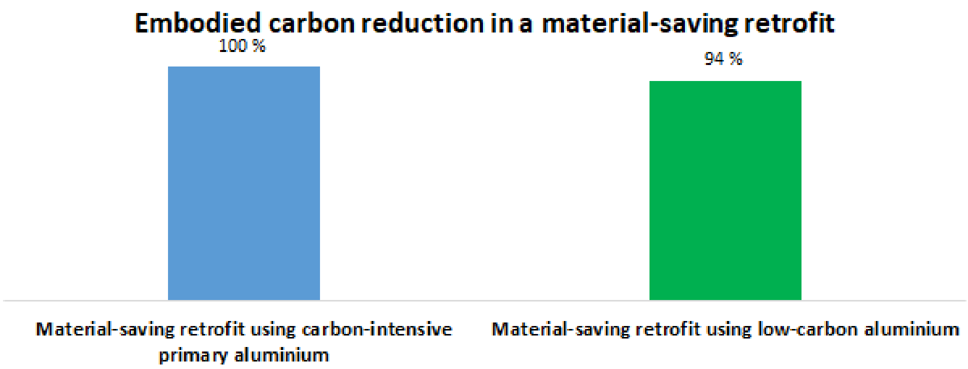


Fig. 3.1. Comparison of embodied carbon in retrofit using carbon-intensive vs low-carbon aluminium

4 Low-carbon aluminium as a solution for manufacturers

4.1 Business case for low-carbon products

Saint-Gobain's *SCORE puts Sustainability at the CORE of Saint-Gobain's business* shows that 72 % of the customers expect manufacturers to produce more sustainable construction materials. This makes for a very strong business case for product manufacturers to deliver sustainable solutions.

Construction product manufacturers supplying aluminium using products are in an excellent position to benefit from low-carbon aluminium as a source of competitive advantage. Low-carbon aluminium can be sourced and used at scale across entire product portfolio, thus branding the manufacturer as a leader in the low-carbon segment. This makes it possible to increase the sustainable performance of the entire product range in a scalable manner.

Low-carbon aluminium is not only a solution for carbon reductions, but also helps unlock credits and compliance for commercial building certification systems (see chapter 2.5.) These credentials help product manufacturers achieve an advantageous position for winning high-profile projects, which often use significant quantities of aluminium products.

4.2 Low-carbon aluminium impact for certification credits

Compliance with green building certifications is one key parameter for winning business to supply construction products to large commercial construction projects. Many investors set targets for the green building certification rating levels that projects must achieve. In addition, these certification schemes set requirements for materials used in the projects. Therefore, construction projects are keen to ensure compliance with these material sourcing requirements to avoid missing the targeted certification level.

Large commercial construction projects provide major business opportunities for construction product manufacturers. Being able to respond to requirements from green building certifications allows manufacturers to position their products as the preferred solutions already in the specification phase, and supports success in tenders as well.

Nearly all green building certification systems, including LEED and BREEAM, favour products and suppliers that can demonstrate low-carbon products and solutions. Each certification system has its own particularities, as discussed in chapter 2.5.

Low-carbon aluminium supports construction product manufacturers to comply with and win business from projects applying green building certifications.

4.3 Product comparison parameters

To illustrate the impact of low-carbon aluminium on different glazing systems, three scenarios are presented in this white paper. All comparisons are performed on systems with double glazing. The comparisons are done with material quantities and specifications from actual products from the European market. Raw material emission factors used are typical for European market. All calculations are done for 1 m2 of the applicable product.

Each product comparison includes three scenarios: one with primary aluminium (global market average), one with a mix of 70 % primary aluminium and 30 % recycled aluminium using data provided by International Aluminium Institute and one with low-carbon aluminium (all primary, manufactured with renewable energy). As aluminium is used in the products in extruded form, it's emissions (irrespective of scenario) are increased by 0,7 kg CO2e / kg aluminium to represent extrusion, which matches the European Aluminium's *Life-Cycle inventory data for aluminium production and transformation processes in Europe*.

4.4 Low-carbon aluminium impact for aluminium partition walls

Aluminium is a widely used material for partition walls. Aluminium is durable and easy to process, and supports daylight distribution as aluminium frames take relatively little space. Partition walls are used to provide acoustic privacy while allowing daylight distribution in office and other commercial spaces. The partition wall in question is equipped with an 8 mm clear glass and a 6 mm tempered glass layers for protection, and uses steel and copolymer.

Primary aluminium represents ca. 50 % of embodied carbon of double-glazed partitioning walls. Switching to low-carbon aluminium can reduce product impacts by 29 %. The results of this comparison are presented in Table 4.1 and Fig. 4.1.

Table 4.1. Comparison of embodied carbon of aluminium partition walls

Partitioning walls	**Carbon-intensive primary aluminium**	**With 30 % recycled aluminium**	**Low-carbon aluminium**
Double glazing 1 m2	101 kg CO2e	87 kg CO2e	72 kg CO2e

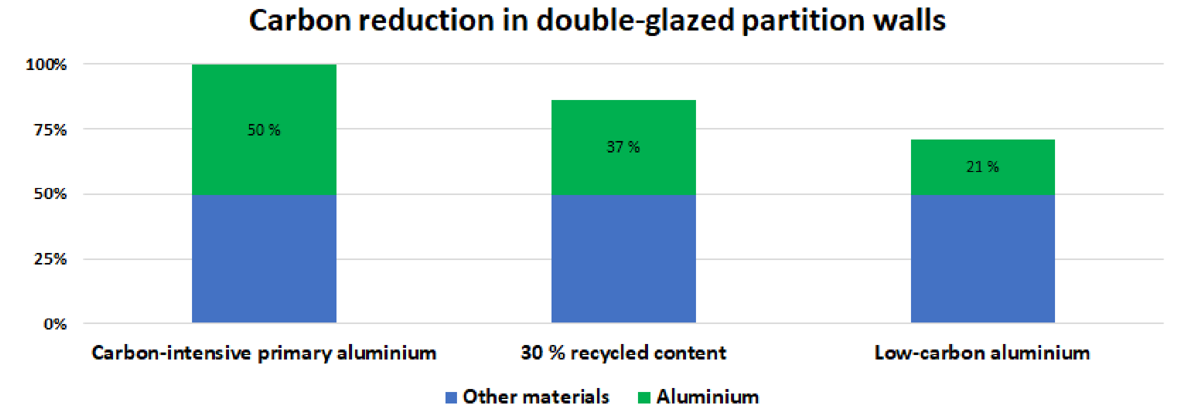


Fig. 4.1. Carbon reduction in different aluminium partition wall scenarios

4.5 Low-carbon aluminium impact for aluminium curtain walls

Aluminium is a used for curtain walls for durability, lightness and ease of extrusion, as well as visual opportunities it provides for architects. Glass-aluminium curtain walls are commonly used in commercial buildings. The curtain wall in question has 16 mm of tempered glass, and uses additionally steel, silicone, insulation and copolymer materials.

Primary aluminium represents ca. 56 % of embodied carbon of double-glazed curtain walls. Switching to low-carbon aluminium can reduce product impacts by 32 %.
The results of this comparison are presented in Table 4.2 and Fig. 4.2.

Table 4.2. Comparison of embodied carbon of aluminium curtain walls

Curtain wall	Carbon-intensive primary aluminium	With 30 % recycled aluminium	Low-carbon aluminium
Double glazing 1 m2	183 kg CO2e	155 kg CO2e	124 kg CO2e

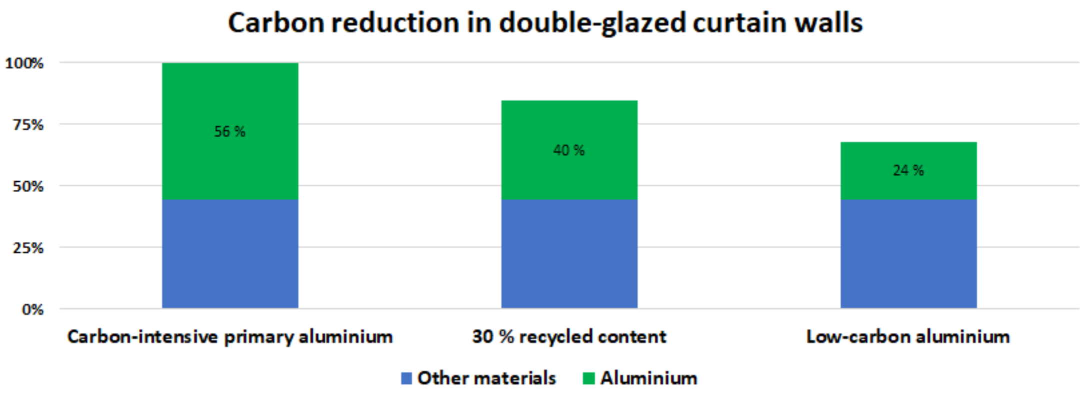
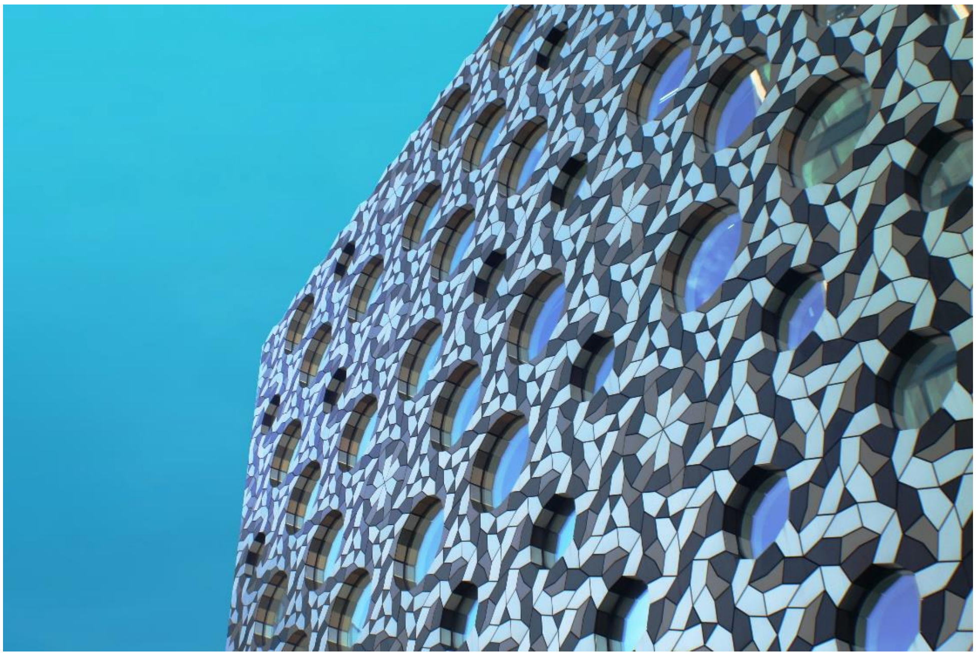


Fig. 4.2. Carbon reduction in different aluminium curtain wall scenarios



4.6 Low-carbon aluminium impact for aluminium windows

Aluminium is a commonly used material for window frames. It is used in both aluminium windows as well as wood-aluminium windows. Aluminium frames provide very long-term durability for the windows, leading also to longer product lifetime. The window in question has two 4 mm glass panes, making it the least glass-heavy product in the comparison. In addition, it has steel fittings, copolymer joints and polyamide thermal breaks.

Primary aluminium represents up to 74 % of embodied carbon of double-glazed windows. Switching to low-carbon aluminium can reduce product impacts by 43 %.
The results of this comparison are presented in Table 4.3 and Fig. 4.3.

Table 4.3. Comparison of embodied carbon of aluminium windows

Aluminium windows	Carbon-intensive primary aluminium	With 30 % recycled aluminium	Low-carbon aluminium
Double glazing 1 m2	174 kg CO2e	138 CO2e	99 kg CO2e

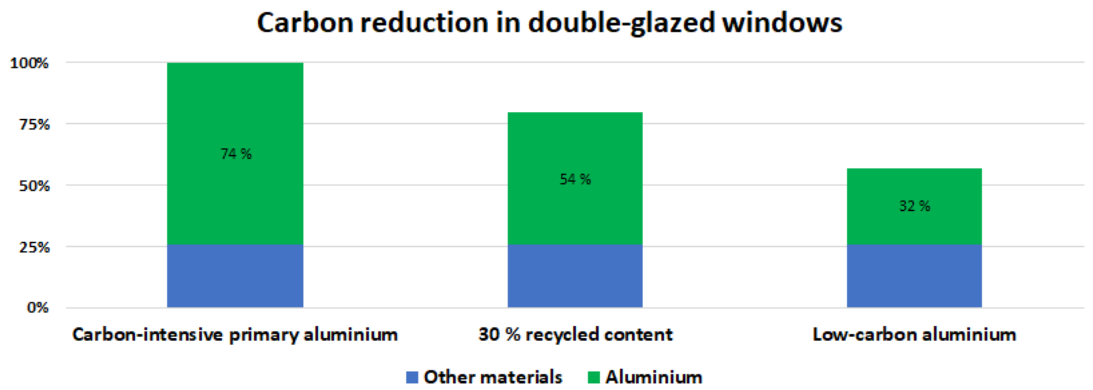


Fig. 4.3. Carbon reduction in different aluminium window scenarios

5 Uncertainty and variability factors

The key sources of uncertainty and variability considered in this white paper are following:

Energy mix used in aluminium production. When primary aluminium manufacturing is compared to low-carbon aluminium, the specific energy mix of the primary aluminium manufacturing has significant impact on the results. In a context where primary aluminium is manufactured with an energy mix consisting of both renewable and fossil energy, the difference between that specific primary aluminium and low-carbon aluminium may be narrower than on the market in general.

Variable share of primary and recycled aluminium. Recycled aluminium is twenty times more energy efficient to manufacture than primary aluminium, and it also does not incur process emissions that occur in the primary aluminium manufacturing. Therefore, it also has lower emissions. In any scenario substituting recycled aluminium with low-carbon aluminium (primary aluminium manufactured with renewable energy) would lead to higher emissions. At a global level (system level in LCA terms), availability of recycled aluminium covers only approximately 20 % of aluminium demand, and therefore both recycled aluminium and low-carbon aluminium should be used as priority sources of aluminium.

New building and renovation design and material choice variability. New buildings and renovations can be designed with any material palettes and in case of renovations, with different extent(s). The use of aluminium-using products will vary based on the project type, code and zoning regulations, client and architectural preferences, as well as many other factors. A construction project can either use a minimal amount of aluminium, or significant quantities. Therefore, the results have to be considered in proportion to the actual aluminium use foreseen for any specific project.

Additional sources of variability include the following:

Aluminium-using product variability. Examples provided here represent specific, actual products. Other types of product designs exist, and they may use more or less aluminium, glass and other raw materials. A case in point are wood-aluminium windows, which use less aluminium than aluminium-framed windows, but can still reduce their emissions by using low-carbon aluminium instead of primary aluminium.

Variability in product emissions among low-carbon aluminium suppliers. Aluminium manufacturing emissions can also be influenced by other means than source electricity, for example by replacing the anodes used in aluminium reduction process. Typically used carbon anodes are consumed as part of the process and therefore, cause greenhouse gas emissions. New technologies are being developed to be able to reduce these emissions further, which increases further the benefits of using low-carbon aluminium made using such technology. Other, mostly lesser sources of emissions variance between manufacturers also exist.

References

The following sources have been used in this white paper.

One Click LCA Ltd: Carbon Heroes Benchmark Program.

One Click LCALtd: The Embodied Carbon Review

One Click LCA Ltd: The unregulated energy use and carbon emissions from buildings – and how that is changing

The Carbon Trust: The case for low-carbon primary aluminium labelling. Methodology statement to define the market category.

European Aluminium: Life-Cycle inventory data for aluminium production and transformation processes in Europe

The Finnish Innovation Fund SITRA: The Circular Economy: A Powerful Force for Climate Mitigation

Global Carbon Project: Global Carbon Budget 2019

International Aluminium Institute: Addendum to the Life Cycle Inventory data and environmental metrics for the primary aluminium industry

International Energy Agency: Global Alliance for Buildings and Construction - Global Status report 2017

Saint-Gobain: SCORE puts Sustainability at the CORE of Saint-Gobain's business

UN Environment: Changes in building and construction have great potential to slow global warming

World Green Building Council: Bringing Embodied Carbon Upfront