



MATERIALS SERVICES

CO₂-reduced aluminium

thyssenkrupp Materials Services are increasing transparency of supply chains so that you can make informed decisions regarding recycling rates and production methods.

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INTRODUCTION



Aluminium is the most common metal on the planet; however, pure aluminium does not occur naturally. The production process is complex and requires vast amounts of electricity. Aluminium production generates around 1.1 billion tonnes of CO₂ each year, largely due to reliance on energy-intensive smelters ([Cousins, 2021](#)) **this is equivalent to the energy of 257,611,241 houses for a whole year**. With demand for aluminium anticipated to rise by almost 40% by 2030, the sector will need to produce an additional 33.3 million tonnes to meet demand from 62.2m tonnes in 2020 to 119.5m tonnes in 2030 ([CRU, 2022, in ALFED, 2022](#)). Currently, energy used in alumina refining and aluminium smelting accounts for more than 90% of the industry's carbon emissions, decarbonisation of electrical supply to smelters in the aluminium production process offers the most significant opportunity to reduce carbon emissions to net zero by 2050 ([Tabereaux, 2023](#)). Thyssenkrupp materials services' sustainability initiatives, and greenability offering focus on the carbon dioxide emissions from an entire cradle-to-gate perspective of all our materials. We have a complete carbon-reduced product range and offer complete supply chain transparency through our DNV-validated product carbon footprint calculator. thyssenkrupp are thinking ahead so that you can act sustainably, we are your partner for future-oriented materials and CO₂ savings along the entire supply chain. Companies can only achieve their environmental goals with transparency. A detailed insight into the carbon footprint of your own products is essential for optimisation decisions. Our PCF declarations and reports provide precise information on the CO₂ emissions of materials, from production to delivery to you. You receive the necessary data at asset level 1, which is required for reporting in accordance with CSRD and, in some cases, CSDDD guidelines. With our PCF reports, you can ensure that your products comply with the applicable environmental and sustainability laws.

Aluminium is a popular metal due to some key characteristics: 100% recyclable, high strength to weight ratio, easily machinable and formable as well as an excellent conductor of heat and electricity. With the demand for aluminium only increasing, sustainability within the industry offers immense potential for innovation, technological improvement, and collaboration world-wide.

Hence, this whitepaper will begin by studying the future sustainability of aluminium through assessing decarbonisation within its production methods. The second section will explore the positive effects of recycling aluminium whilst also recognising recycling's limitations as a sustainability metric. The paper will then introduce a case study of 3 different aluminium products to corroborate the findings so far, before concluding with thyssenkrupp materials' role in the sustainability movement within the aluminium industry through carbon-reduced materials, our use of data and emphasis on transparency in our product carbon footprint declarations.

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ALUMINIUM PRODUCTION METHODS

The aluminium production process can be broken down into three stages; first bauxites, containing aluminium, are extracted from the ground; secondly, these bauxites are processed into alumina or aluminium oxide; and finally, pure aluminium is produced using electrolytic reduction whereby aluminium oxide is broken down into its components using electric current (Aluminium Leader, n.d). The aluminium production process is hugely energy and carbon intensive, intervention is required for the industry to reach the target of net zero emissions by 2050.

The ore most used for extraction process is bauxite, which is impure containing appreciable amounts of iron compounds hence its characteristic red colour, together with silica and titanium dioxide (Alfed, n.d). The bauxite is processed to aluminium oxide (alumina) through the Bayer process before being processed to aluminium, the metal, in a primary smelter via the Hall- Hérault production method (Alfed, n.d).

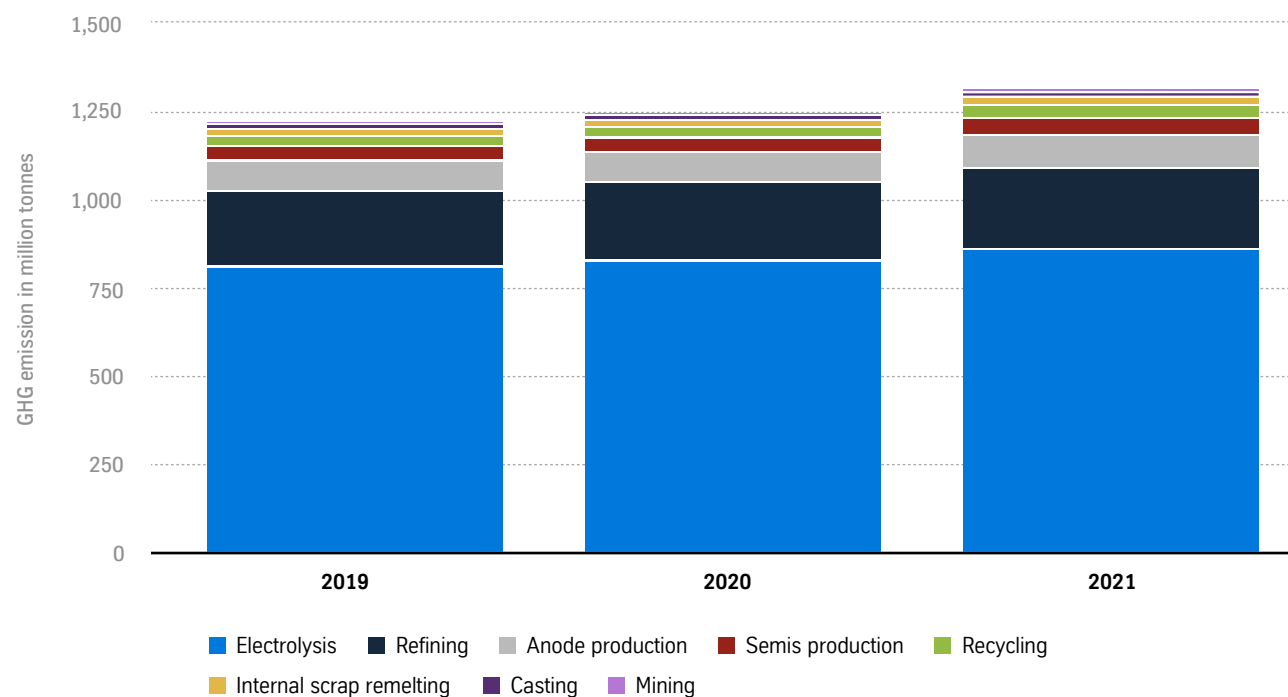


Figure 1: greenhouse gas (GHG) emissions of the global aluminium sector from 2019 to 2021, by process (in million tonnes of CO2)

Figure 1 demonstrates the extensive contributions of GHG emissions from electrolysis in aluminium production, it is also evident that emissions from electrolysis have not fallen significantly between 2019 and 2021. Intervention is required to shift to cleaner energy sources in the aluminium production process.

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DECARBONISATION OF PRODUCTION METHODS

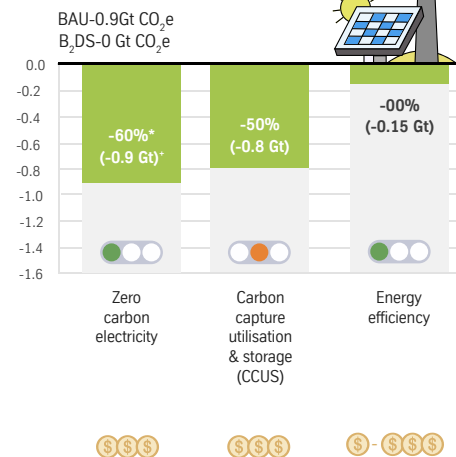
The International Aluminium Institute has identified three vital pathways to reduce greenhouse gas emissions, based on the IAI's unrivalled data and leading analysis of the global aluminium industry.

The three pathways include: electricity decarbonisation, direct emissions reduction (fuel combustion, process emissions, etc.) and recycling and resource efficiency. Throughout literature, emphasis is largely placed on shifting power sources to renewable energy.

GREENHOUSE GAS EMISSIONS REDUCTION PATHWAYS

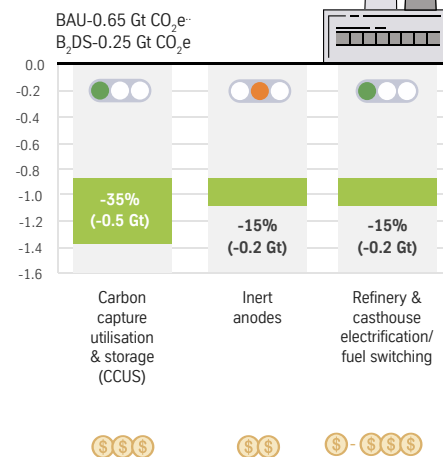
Pathway 1

Electricity decarbonisation potential



Pathway 2

Direct emissions potential



Pathway 3

Recycling & resource efficiency potential

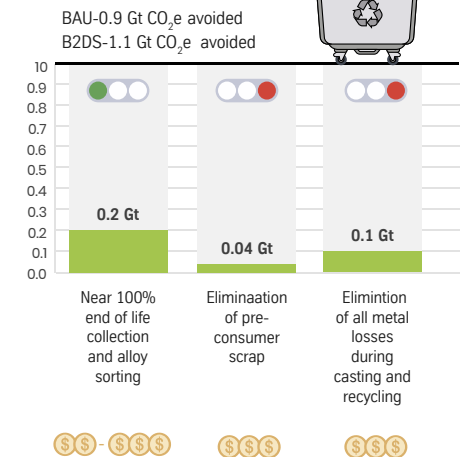


Figure 6: The Three Greenhouse Gas Emissions Reduction Pathways identified by IAI (International Aluminium Institute, 2021)

POSITIVE IMPACTS OF RECYCLING WITHIN THE ALUMINIUM INDUSTRY

It is significantly more cost effective to recycle aluminium than produce prime, new metal, with estimates that recycled aluminium requires 5% of the energy required to extract and produce new aluminium. Because of both the cost effectiveness and reduced greenhouse gas emissions, wherever possibly aluminium manufacturers will always use recycled material. In Europe, recycling rates are over 90 percent in the automotive and building sectors due to well-developed collection systems particularly for vehicles reaching their end-of-life as well as building scrap ([European Aluminium, 2022](#)). The aluminium recycling process requires only 5% of the energy needed to produce primary metal, resulting in greenhouse gas emissions of 0.5 tonne CO₂ e / tonne recycled aluminium (gate-to-gate) ([Ibid](#)).

The environmental benefits of recycling aluminium are indisputable, however determining the recycled content of aluminium poses many challenges which will be outlined in the succeeding section. These difficulties in determining recycled content, question its validity as a sustainability metric, with little to no producers obtaining external verification for the recycled content of their material. At thyssenkrupp, materials services we therefore promote the use of carbon footprint as the critical indicator of sustainability within the materials manufacturing industry. Whilst still accounting for reduced emissions due to recycled content, carbon footprint goes further to recognise the emissions relating to production methods and their energy sources. We think ahead so that you can act sustainably.

Greenhouse Gas emissions of primary aluminium production and recycling process

Source: Coal based production and global average: Life cycle inventory data and environmental metrics for the primary aluminium industry, World Aluminium, 2015. Addendum, August 2018. Other: Environmental Profile Report 2018, European Aluminium

Tonne of CO₂-eq/tonne of production

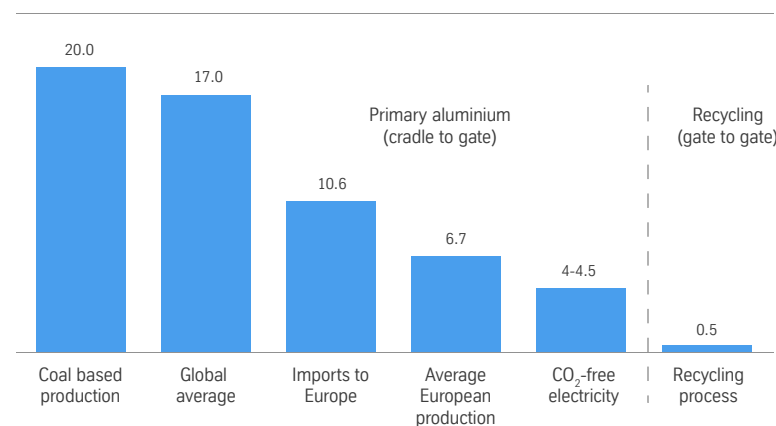


Figure 8: Tonne of CO₂e/tonne of production (European Aluminium, 2022)

Figure 5 demonstrates the effects of recycling process, as well as CO₂ free electricity in the aluminium production process. Recycling has the greatest influence on CO₂ emissions, with CO₂-free electricity also proving to greatly reduce emissions in the production process. The use of CO₂-free electricity within the recycling process would further decrease the emissions of aluminium produced.

An analysis by Reuters, using data from the Carbon trust, shows that the overall sustainability of aluminium depends greatly on the recycled fraction and on the origin of the energy used for melting and for generating the additional primary material (Raabe, et al., 2022).

LIMITATIONS OF RECYCLED CONTENT AS A SUSTAINABILITY METRIC

For years sustainability has emphasised the importance of recycling, reusing and reducing material usage and the aluminium industry is no different. As the previous section outlined recycling does play a vital role in sustainable solutions for aluminium. Issues arise however, when recycled content is utilised as a single sustainability metric.

Primarily, requesting aluminium with a minimum of 'X'% recycled content is unattainable, and undeterminable until after purchase.

Recycled aluminium requires thorough care, storage and treatment (alloying) to ensure the material properties required. Therefore, it is not only impossible to achieve 100% recycled material on most occasions, but also the process itself can be very carbon intensive. It is more important that the energy source required in making recycled aluminium is from a sustainable power source such as hydroelectric power, as explored above.

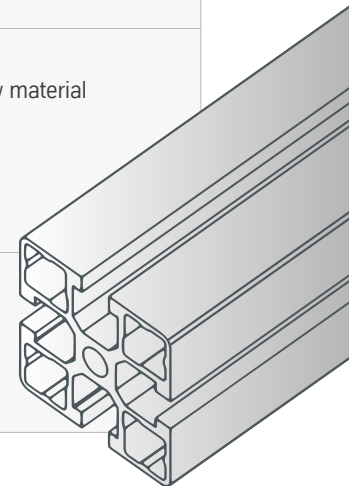
Another pivotal limitation of a primary reliance on recycling to create a more sustainable aluminium industry is that scrap is limited. There is not enough scrap metal available with the properties required to reproduce certain grades of aluminium, this limitation will be demonstrated in the case studies in the forthcoming section.

To summarise, the sustainability of the aluminium industry cannot be adequately measured by recycled content alone, as this approach oversimplifies the complex realities of production. Not only is it unrealistic to guarantee specific percentages of recycled content before purchase, but even aiming for high recycled content introduces significant technical and environmental challenges. The intricate process of recycling aluminium—encompassing careful sorting, cleaning, and alloying—requires substantial energy input, which can be counterproductive if not sourced from renewables. Furthermore, the global supply of scrap aluminium is insufficient to meet the industry's needs, particularly for producing higher-grade materials. This scarcity showcases the limitations of relying heavily on recycling as a standalone solution, revealing that a more holistic view is necessary—one that integrates energy sourcing, resource availability, and the full lifecycle of aluminium products into the sustainability equation. By considering these factors, the industry can move towards a truly sustainable future, rather than relying on a single metric that may mask deeper issues.



SUSTAINABLE ALUMINIUM EXTRUSION CASE STUDY

	Option 1	Option 2	Option 3
What's the catch	Although very high recycling rate, use of energy sources contributed to a higher carbon footprint	EPD only covers Billet; Smelting not taken into account Might be best option but not verified	Although the recycled content is not high, the carbon footprint is optimal
RECYCLED CONTENT	minimum 99.5% scrapped products	minimum 80% recycled content	minimum 20% recycled content
RENEWABLE RESOURCES	renewable vs non-renewable energy sources used	supplier's mix containing 48% renewable energy	23.9% of electricity is from renewable resources
CO2 EMISSIONS	4.7 kilo CO2e per kilo aluminium extrusion	2.4 kilo CO2e / kg billet	maximum 4.0kg CO2e / kg
VERIFICATION	EPD	recycled content: Bureau Veritas EPD	DNV-GL verified by raw material supplier Raw material supplier certification by EPD
AVAILABILITY	available in small, on-demand batches due to limited scrap availability	flexible	flexible



THE ROLE OF THYSSENKRUPP MATERIALS SERVICES IN THE TRANSITION TO SUSTAINABLE ALUMINIUM

thyssenkrupp Materials Services are prioritising the transition to a sustainable aluminium industry, it is prioritised at all levels within the organisation. Knowing that 95% of our company emissions are attributed to the materials themselves we recently launched our sustainable brand 'greenability', with its central aim being to reduce carbon emissions through more sustainable production methods and providing emissions transparency for entire supply chains.

Perhaps: with the central aim of enabling our customers to make the most informed decisions through greenability, hence, the reason of this whitepaper. Providing transparency allows for informed decision making and more environmentally conscious material selection.

Greenability encompasses three main brackets of sustainability: CO₂-reduced materials, product carbon footprint calculations and sustainability services (see figure 9 below).



Figure 9: greenability overview (thyssenkrupp materials services, 2024)

THE ROLE OF THYSSENKRUPP MATERIALS SERVICES IN THE TRANSITION TO SUSTAINABLE ALUMINIUM

Our material product offerings are classified on a scale from classic, to benefit, to advanced determined by the kilograms of CO₂ e / tonne of material in the material's production. As referenced throughout this paper, we rely on carbon emissions as the central metric for sustainability within the industry. This allows for ease of comparison between suppliers and provides a metric that we can contribute to with our internal scope 1 and 2 emissions for increased reporting. Secondly, greenability offers the first and only DNV-verified product carbon footprint declaration. These carbon footprint reports are available on a product by product or order basis and provide cradle-to-gate emissions data providing the highest available levels of CO₂ transparency. PCF declarations provide our customers with a complete emissions breakdown by lifecycle stage including material production, supplier delivery, internal warehousing and processing and delivery to the customer gate. Greenability services encompasses any other sustainability requirements, for example bespoke packaging review for our customers, support with CBAM, and advanced levels of data collection and reporting.

At thyssenkrupp materials services we want to work in collaboration with our suppliers, customers and industry experts to pioneer a more sustainable, carbon-reduced aluminium industry. Through our greenability offering we help our customers to realise the true benefits of CO₂ reduced aluminium by providing transparency, consultation and reduced environmental impacts of materials.

References:

ALFED, (2022), 'CRU report expects aluminium demand to rise 40% by 2030' Aluminim Federation, available at: [CRU report expects aluminium demand to rise 40% by 2030 - ALFED](#) date accessed: 09/08/2024

Cousins, S., (2021) 'The 75% Problem: aluminium's carbon footprint' , Modus, RICS, available at: [The 75 per cent problem: aluminium's carbon footprint | Modus | RICS](#), date accessed: 09/08/2024

CRU, (2022)

European Aluminium, (2022) 'A Strategy for achieving aluminium's full potential for circular economy by 2030' Circular Aluminium Action Plan, available at: [2020-05-13_european-aluminium_circular-aluminium-action-plan_executive-summary.pdf](#) date accessed: 09/08/2024

Edwards, Les, et al., (2022) "Quantifying the Carbon Footprint of the Alouette Primary Aluminum Smelter," JOM, Vol. 74, September 2022, pp. 4,909–4,919

