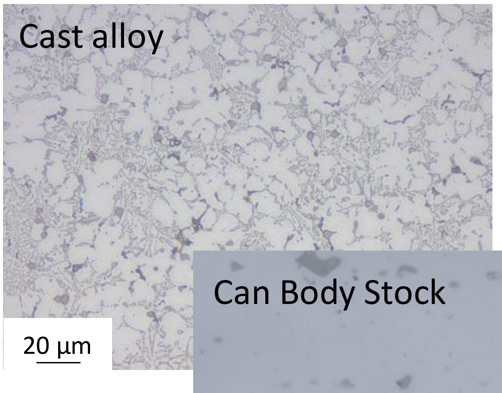
Can-to-Can Recycling: Metallurgy, Processing and Circularity

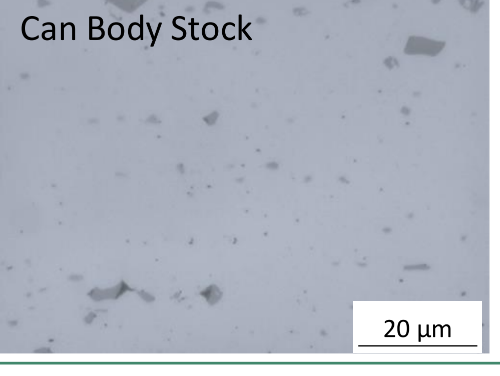
This factsheet explores the metallurgy and recycling of aluminium beverage cans, showing how alloy design and precise process control enable strength, formability and fully recyclability. Aluminium cans are a leading example of closed-loop circularity, where used material is continuously remade into new cans without loss of quality. This fact sheet highlights how effective can-to-can recycling reduces environmental impact, conserves resources and demonstrates the vital link between metallurgy, process efficiency and sustainability.

Alloy Chemical Compositions

Element	CBS AA3104	CES AA5182	UBC Scrap	Cast Alloy
Si	0.22	0.08	0.18	10.5
Fe	0.40	0.20	0.36	1.1
Cu	0.20	0.06	0.17	3.5
Mn	0.90	0.33	0.79	0.40
Mg	1.2	4.7	1.9	0.45

Typical chemical values, weight % of Can Body Stock (CBS), Can End Stock (CES), Used Beverage Can (UBC) Scrap and a secondary casting alloy.





Chemical composition is a cornerstone within metallic materials, determining their microstructure, mechanical properties, corrosion resistance and processability. **Precise control is essential to achieve consistent performance**, maintain alloy integrity and ensure recyclability without degrading material quality.

The typical chemical composition of Used Beverage Can (UBC) scrap allows the material to be utilised in casting alloys to produce typical secondary cast alloys (used in EDU's, engine blocks and other automotive applications) – this is due to the wider chemical specifications afforded to these types of alloys.

This wider chemical specifications result in vastly different microstructures (as shown to the left), which in turn influences material performance.

However once **in the 'Cast Sink'** it becomes **challenging to recover the original can material** back into can product due to interactions which take place when aluminium alloys are remelted

To produce **1000 kg of CBS** from cast alloy scrap, approximately **978kg of primary is** required to dilute Si levels.

Elemental Roles

Manganese (Mn): Primary strengthening/texture control in 3xxx series; contributes to strain hardening and controls earing during deep drawing.

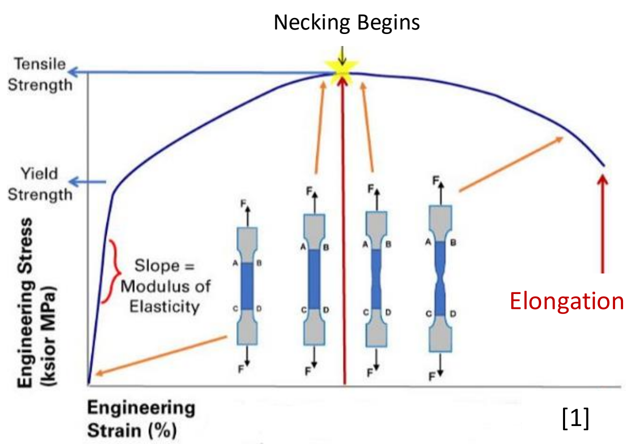
Magnesium (Mg): Used in 5xxx end stock, and a small amount in body stock, to increase strength. Mg also affects corrosion behaviour and influences intermetallic formation during remelting.

Silicon (Si): Important in controlling the intermetallic particles which form and plays a critical role in continuously keeping the can tooling clean during making. In addition, from a casting perspective, high silicon levels are required for fluidity during casting.

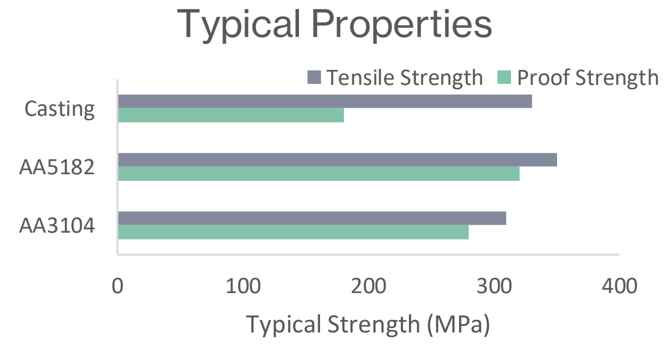
Copper (Cu): Contributes to strength and reduces strength drop off observed during lacquer curing of the can.

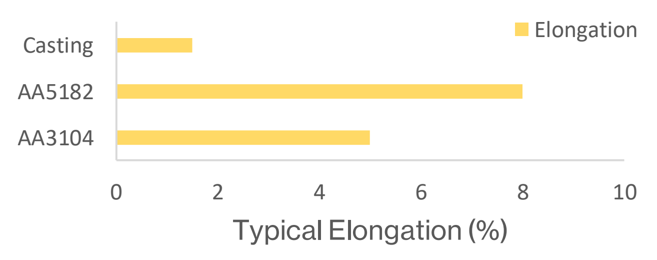
Iron (Fe): Fe forms intermetallics that can increase earing and harm drawability.

Zinc (Zn): Typically, 'tramp' or residual element from scrap streams that can affect surface finish.



Material properties





Precise chemical control is critical: excess elements such as copper or silicon, common in other aluminium alloys, degrade ductility and corrosion resistance. Maintaining tight composition limits ensure consistent deep-draw performance and mechanical strength under carbonation pressure.

Chemical Composition + Processing Method

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Mechanical Performance

Proof strength: the stress at which a small, specified permanent deformation occurs.

Tensile strength: the maximum stress a material can withstand before breaking.

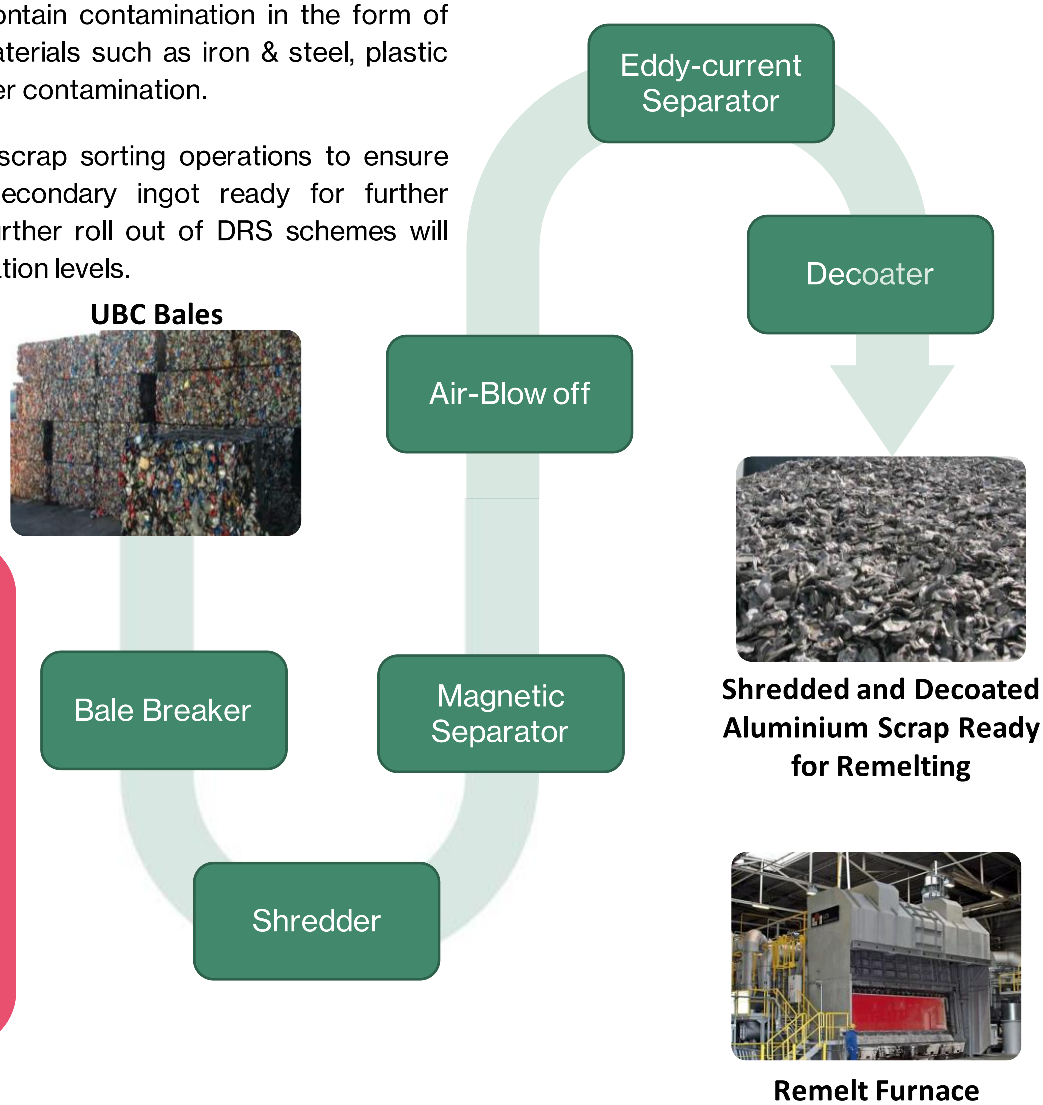
Elongation: the percentage increase in sample length before fracture

Fe, Cu and Si are difficult to remove during aluminium re-melting because they form stable intermetallics with Al, do not and cannot be selectively removed.

From UBC to Remelt Ingot

UBC, often baled can contain contamination in the form of moisture & unwanted materials such as iron & steel, plastic bottles, rubber and copper contamination.

This requires extensive scrap sorting operations to ensure efficient remelting to secondary ingot ready for further processing. However, Further roll out of DRS schemes will help to reduce contamination levels.



* Scrap from **Decoater** usually goes into a sidewell vortex, exploiting heat from the delacquering kiln and **eliminating the need for remelting** RSI ingots.

Process	Description
Bale Breaker	Breaks up highly compressed blocks of cans (bales) to feed cans to subsequent stages
Shredder	Breaks down cans into smaller pieces to allow contaminants to be removed
Magnetic Separator	Separates magnetic materials (iron, steel) from aluminium
Air Blow-Off	Removes lightweight contaminants such as plastics, paper and sand
Eddy Current Separator	Separates non-ferrous materials such as stainless steel, zinc, brass, lead, etc.
Decoater *	Removes lacquers and surface contaminants to improve melting performance

Importance of Delacquering

1. Improved Metal Recovery: Removing the coatings results in a higher yield of quality aluminium from melting due to reduced oxidation and dross formation.

2. Environmental Protection: The process minimises atmospheric emissions and pollutants by treating the volatile organic compounds in a controlled environment.

3. Enhanced Safety: The controlled removal of these coatings increases the safety of the processing environment.

UBC Processing [2]	**Melting technique**	**Overall Recovery (UBC)**
None (Direct Charge)	Reverberatory furnace	70 – 80%
None (Direct Charge)	Rotary salt furnace	75 – 83%
Shredded, Sorted & Decoated (Can-to-Can)	Reverberatory furnace	85 – 92%
Shredded, Sorted & Decoated (Can-to-Can)	Vortex sidewall furnace	95 – 97%

With controlled delacquering, the energy released from the lacquers is used to fuel the process.

Without a delacquering kiln, the volatile compounds and other products that result from incomplete combustion fumes from burning lacquers requires the melting furnace's scrubber system to work much harder and may overload the emission control system.

The heat generated from delacquering can be recovered, reducing the need for external energy sources!

Adopting a full recycling operation for UBC, including delacquering **improves melt recovery rates**, on average by **18%** when compared with unprocessed, direct charging approaches.

Calculations conducted by Innoval using remelting & casting sustainability models considering these different recovery rates, in turn shows **a reduction in CO2e & Energy** usage by approximately **15%** during remelting and casting operations.

Where does the increased efficiency come from?

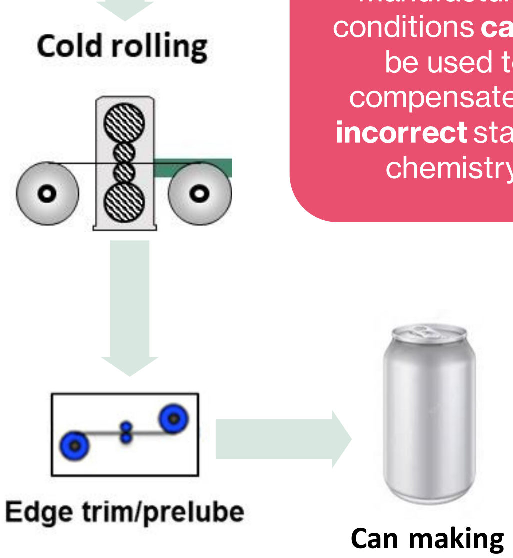
1. Less oxidation: Removing the coatings results in ~10% higher yield of quality aluminium from melting due to reduced oxidation and dross formation.

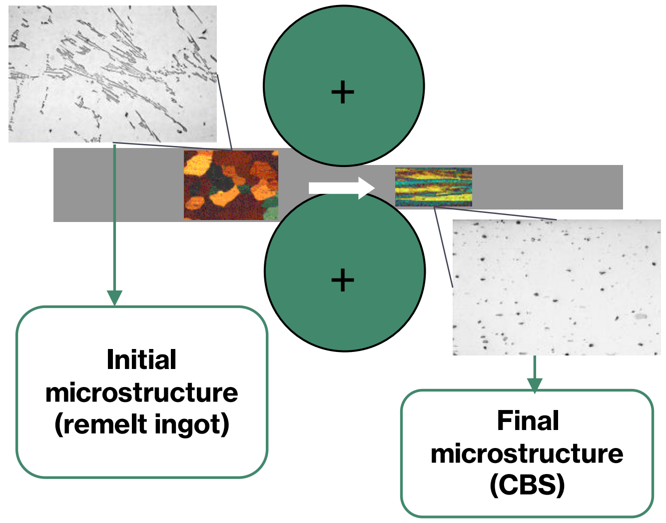
2. Avoiding salt flux: Salt flux is needed for UBCs that have not been delacquered to separate aluminium from oxides and contaminants. This generates salt cake which creates a hazardous waste stream that is costly to dispose of.

UBCs after delaquering (IDEX) [3]

From Remelt Ingot to Beverage Can

Chemical composition of the starting Direct Chill (DC) cast ingot is the most critical attribute to control to ensure correct mechanical and product performance.





During processing of the Direct Chill (DC) Cast ingot to produce the CBS sheet important microstructural changes occur that **optimise the mechanical properties** of the sheet, such as strength, formability and earing control.

Can body/alloy behaviour is highly sensitive to particle size, **distribution of intermetallics**, texture from rolling and anneal schedules. Recycled metal that preserves the alloy chemistry and low tramp element levels will allow hot/cold rolling and D&I processing with **minimal re-engineering**. Elevated Fe, Cu or Ni concentrations change intermetallic morphology and **can degrade formability, ductility and toughness**.

Manufacturing conditions **cannot** be used to compensate for **incorrect** starting chemistry.

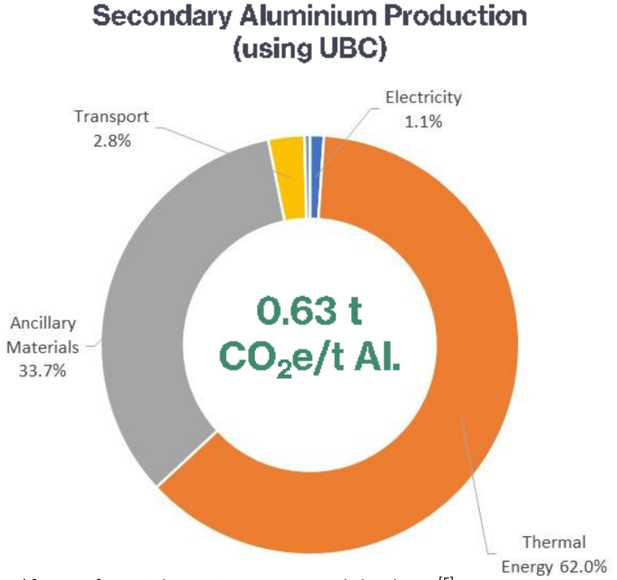
The relevance of each step...

Hot Rolling controls earing that forms during can making

Cold rolling controls strength, formability **& can** thickness

Edge trimming and lubricant improve can formability

Climate Change Impact Potential of Can-to-Can Recycling



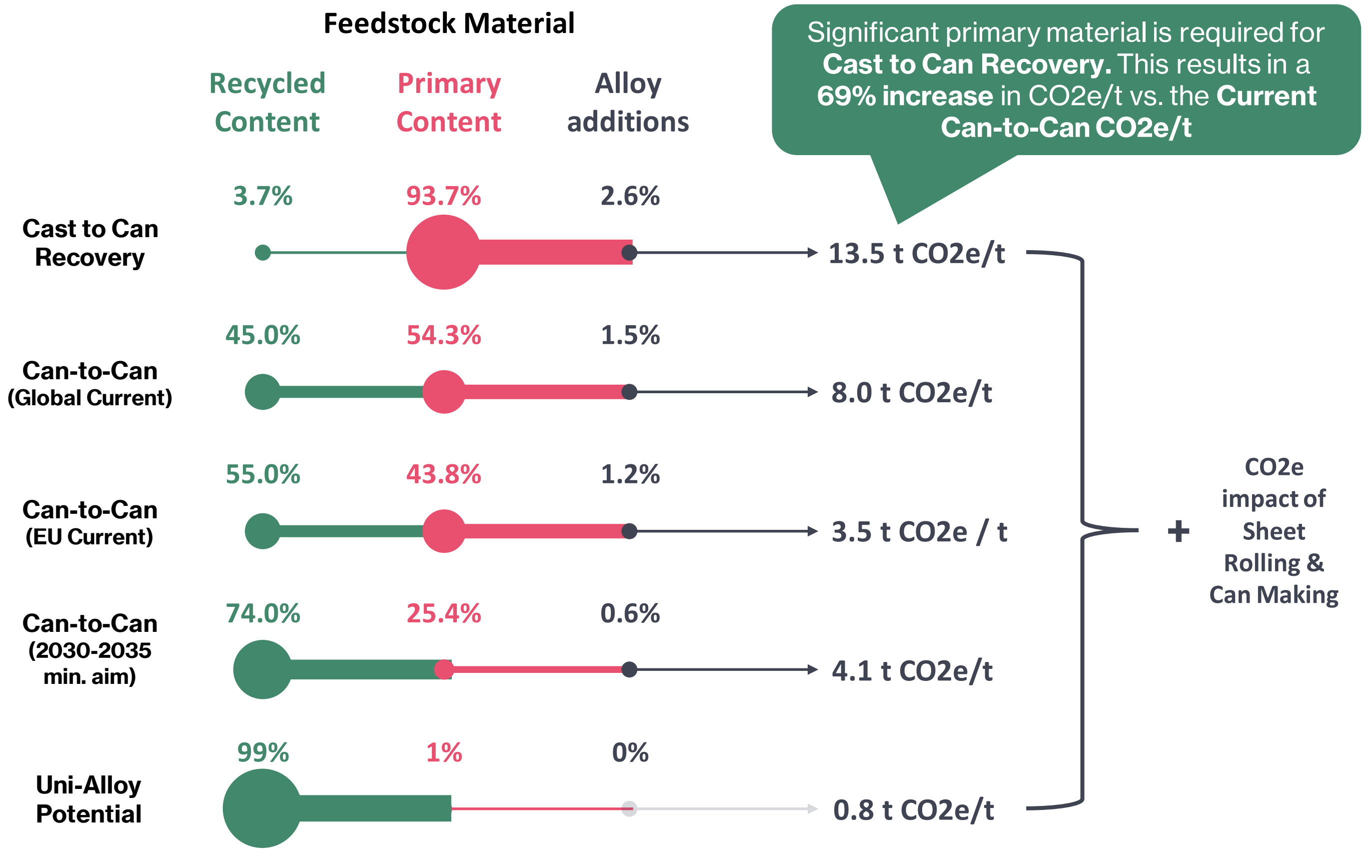
**figures from Sphera LCA FE managed database* [5].

Can-to-Can recycling offers **significant climate change impact potential and energy consumption benefits** when compared with primary aluminium production.

Datasets, specific to Aluminium can recycling - which includes scrap mining, processing, decoating, melting and casting indicates that Can-to-can recycling offers a **93.6% reduction** in climate change impact potential (CO2e) when compared with equivalent primary production.

Global primary aluminium production is modelled as **14.4 t CO2e/t Al** [6], with 7.2t CO2e/t Al [7] used for EU scenarios.

Potential scenarios modelling different recycled compositions and feedstock blends to achieve the correct chemical specification. These have highlighted the importance of increasing can-to-can recycling volumes in downstream sheet and can making process*.



*****_The above figures are illustrative based on generalised data. Specific producers' with vary based on operational recycled content mixes used._

Next Steps...

[8]

Summary / Future Developments.

The aluminium beverage can is an excellent example of materials science and engineering working in harmony with modern manufacturing techniques. The complex interactions between alloy chemistry, microstructure, processing and properties are carefully balanced to ensure consistent quality and operational efficiency for producers of the 400+ billions cans consumed around the world each year.

The recycling of used beverage can (UBCs) within a can-to-can loop, provides a pathway to substantially lower GHG emissions and improved energy efficiencies, especially when compared with the use of primary aluminium production.

It is essential to maintain and follow established metallurgical principles and protect the carefully controlled chemical composition specification for beverage can sheet. In practice this is achieved by making use of developed UBC recycling infrastructure and the optimised scrap processing routes highlighted within this paper, in addition to retaining UBC scrap within the can circularity loop. If lost from the loop and mixed with other scrap streams, recovery of the can stock becomes environmentally expensive, requiring significant amounts of primary aluminium.

0.63t CO2e/t Al
Can Recycling
(Scrap to Ingot)

14.4t CO2e/t Al
Primary production
(Mine to Ingot)

Optimised UBC recycling improves melt recovery by 18%

Optimised UBC recycling reduces GHG & energy by 15%

Meeting 2030-2035 can-to-can recycling targets reduces CO2e from 8.0 t CO2e/t to 4.1 tCO2e/t

It is vital that more effort is invested in closing and maintaining the can-to-can loop. This depends on supportive policies, which further promote and encourage can-to-can recycling. Such policies may include preferential treatment for can-to-can recycling in extended producer responsibility schemes or a global UBC trade code. Outflow of material from the can-to-can loop must be discouraged, and a Deposit Return Scheme is expected to play a central part in that. Further technical developments, particularly in material design and enabling the uni-alloy can concept are also required. This would streamline can recovery streams further and enable increases in recycled content up to 99%, significantly reducing GHG emissions.

References

[1] MetalForming Magazine, magazine@pma. org (2020) Tensile testing-part 2: Terminology, MetalForming Magazine. Available at: https://www.metalformingmagazine.com/article/?%2Fquality-control%2Fmaterial-testing%2Ftensile-testing-part-2-terminology (Accessed: November 2025).

[2] EVANS, R., GUEST, G., "The Aluminium Decoating Handbook", Stein Akinson Stordy Ltd., Chapter 8, pp 45.

[3] www.insertec.biz furnaces & refractories where engineering becomes heat (no date) IDEX System Decoater and Dryer. Available at: https://www.insertec.es/wp-content/uploads/2023/08/IDEX-System-LR-En-10-06-19.pdf (Accessed: November 2025).

[4] Novelis (2019) Novelisrecycling, Novelis Recycling. Available at: https://www.novelisrecycling.co.uk/wp-content/uploads/2019/01/Novelis-iBrochure-24012019-Linked.pdf (Accessed: November 2025).

[5] Sphera Solutions GmbH, RNA: Aluminum can scrap recycling, 2016, Sphera (2025.1)

[6] Primary aluminium greenhouse gas emissions intensity (2024) Primary Aluminium Greenhouse Gas Emissions Intensity. Available at: https://international-aluminium.org/statistics/greenhouse-gas-emissions-primary-aluminium/ (Accessed: November 2025).

[7] Sphera Solutions GmbH, RER: Aluminium ingot mix – production mix, 2024, Sphera (2025.1)

[8] Ball Beverage Ends & Tabs - Ball, Packaging. Available at: https://www.ball.com/packaging/beverage-ends-tabs (Accessed: November 2025).

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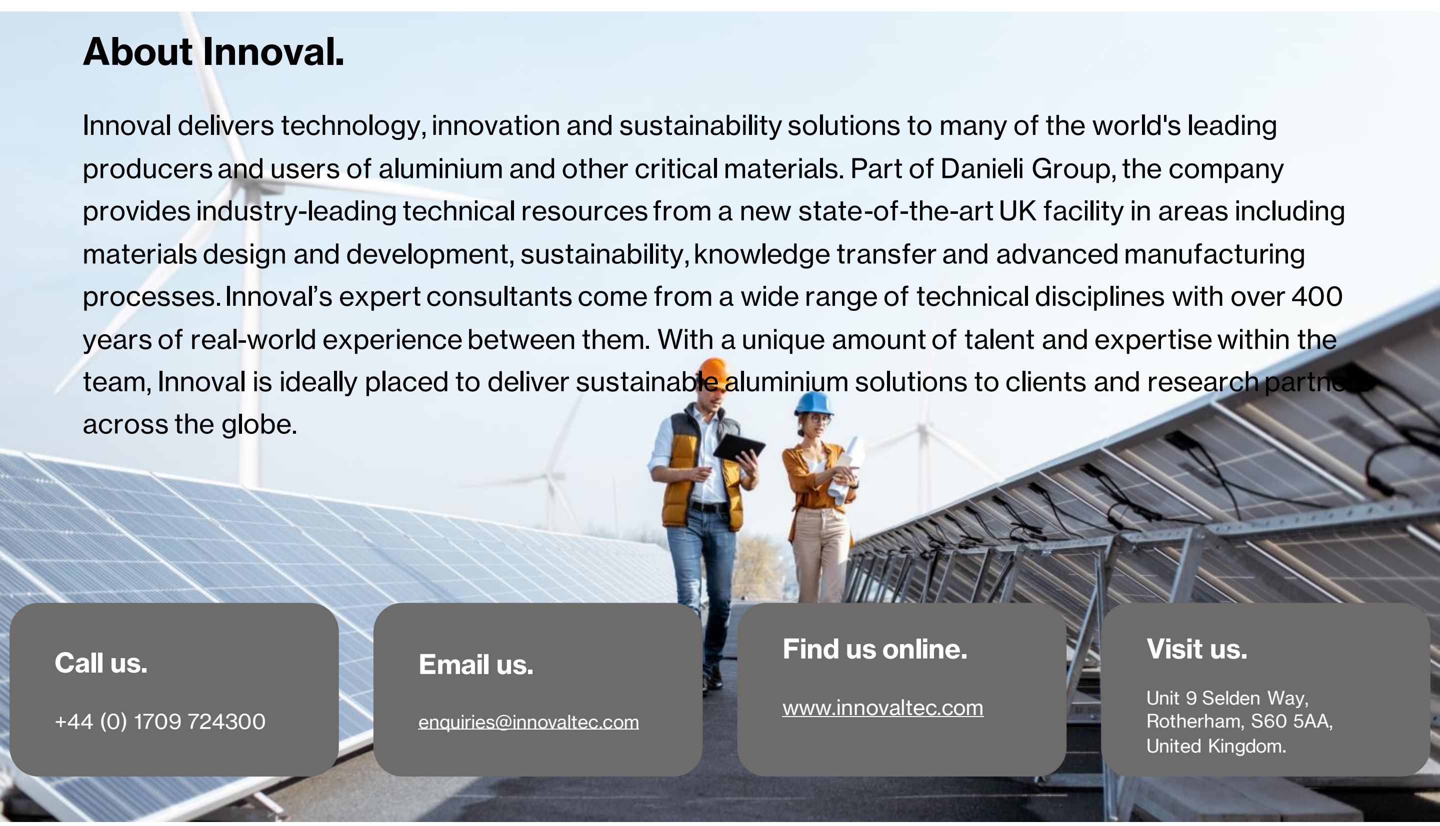

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