Brunel University London

UKRI Interdisciplinary Centre for Circular Metals

UK Research and Innovation

Circular Metals Knowledge stream

Thursday, September 28th

Hosted by Brunel University London

CIRCULAR DESIGN FORUM

The Team

Research Fellow

Alessio Franconi

Brunel University
London

Alessio Franconi, PhD, is a dedicated designer and researcher at the nexus of circular economy, design strategies, industry 4.0, and Product Service-System. Currently serving as a researcher at both Brunel University London and the Circular Economy Research Center in Paris, he contributes significantly to CircularMetal Research Center at Brunel, a prominent initiative backed by UK Research and Innovation's Strategic Priorities Fund. A Fulbright-Fondazione Simone Cesaretti fellow in 2018, Alessio advanced his doctoral studies at Rochester Institute of Technology, NY, USA. With a rich background in industrial design consultancy for major firms and SMEs, he boasts international research stints at esteemed institutions in the Netherlands, Turkey, and the USA. Recognized as a pioneering Blue Economy expert in 2016, Alessio is also the brain behind www.circulardesign.it, a pioneering open-source platform for circular design strategies.

Goals of this session

Global consensus is that achieving netzero emissions by 2050 is crucial for meeting the Paris Agreement's 1.5˚C target and achieving Sustainable Development Goals. Metals are widely present and play a crucial role in this transition. As we move towards a circular economy, our dependence on metals is projected to increase, emphasising the need to comprehend and innovate in this area. Efforts to combat climate change have primarily targeted energy efficiency in the metal industry on a global scale. While these efforts are important, research indicates that energy efficiency alone will only mitigate 60% of emissions. The remaining 40% of emissions related to supply chain management pose significant challenges, including the requirement for a change in business model. Addressing these challenges necessitates a comprehensive approach that integrates technical expertise, a profound comprehension of social dynamics, and a dedication to promoting sustainable practises and facilitating societal transition towards sustainability. The complexity of the path presents opportunities for innovation and the creation of a sustainable future. We invited three companies that are dealing with steel and aluminium to discuss how they are addressing this challenge and implementing strategies to transition to a circular metal economy.

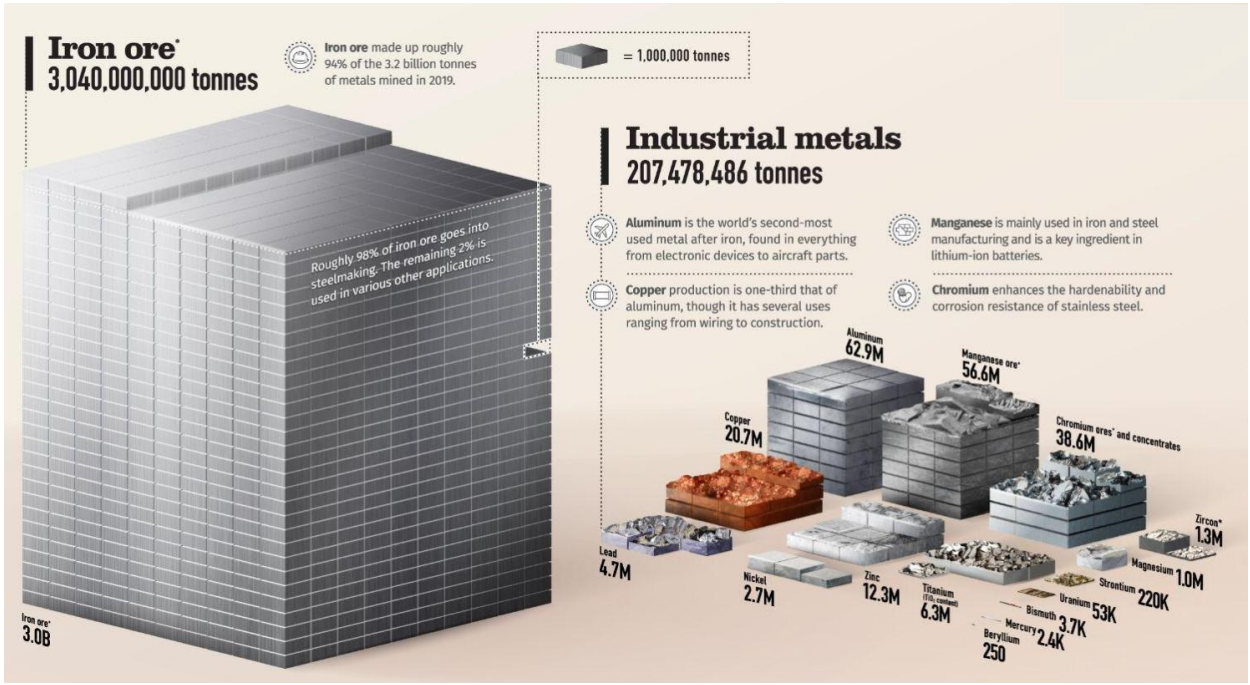
Executive summary

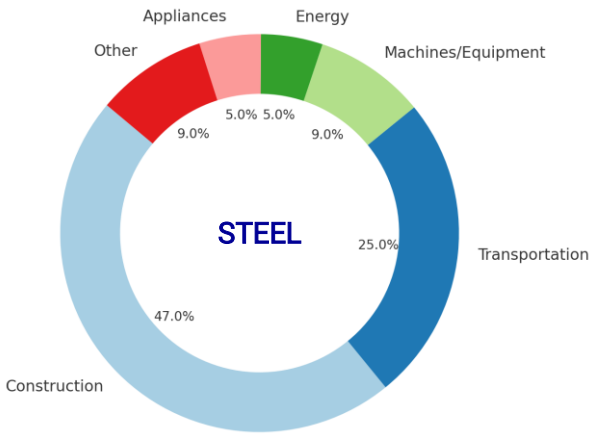
This knowledge stream explored how companies are addressing the circular metal challenge through changes in their business practises. The session emphasised the importance of compromise and balance between circularity, desirability, and solubility in product design. This provided valuable insights for designers and manufacturers to consider.

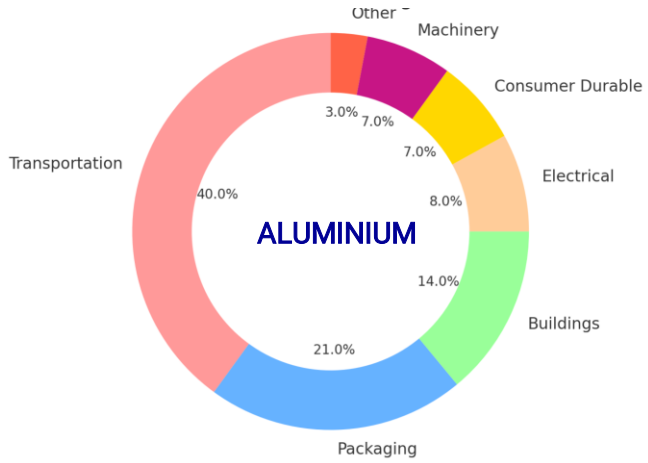
Rachel from **Oakdene Hollins** shared observations on how different manufacturers approach aftermarket and multiple life cycles for products, suggesting that strategies vary from in-house remanufacturing to hands-off approaches with independent actors. Marco from **Electrolux Professional** briefly touched on the difficulty and considerations involved in extending product life while maintaining ease of recycling, highlighting the need for a compromise between longevity and recyclability in product design. Luke from **Jaguar Land Rover** provided insights into the challenges and considerations of working with aluminum, emphasizing the importance of understanding and managing different alloys and the quality of scrap materials to ensure the production of high-grade end products.

Background

Metals production is responsible for 40% of industrial greenhouse gas emissions and consumes 10% of global energy. The majority of mined iron ore is utilized for steel production, which is indispensable in construction, automotive, shipbuilding, food packaging, and electrical appliance manufacturing. Aluminium, the second most extracted metal, although significantly less than iron ore, is extensively used in transportation, packaging, building, electrical, and consumer durables. Despite the ease of recycling both materials, the process is energy-intensive. With metal consumption projected to double by 2050, relying solely on recycling is unsustainable. **Hence, it's imperative to devise additional strategies to reclaim the value of these metals efficiently and sustainably.**







Source | Images 1: Minerals mined in the year 2019. Copyright 2019, VisualCaptialist. | Charts: www.explainthatstuff.com

Circular Metals' Panellists

Principal Consultant

Rachel Waugh

Oakdene Hollins

Innovation Designer

Marco Limani

Electrolux Professional

Senior Sustainability Engineer

Luke Bloodworth

Jaguar Land Rover

Talk 1: Exploring steel’s contribution to remanufacturing

Principal Consultant

Rachel Waugh

Oakdene Hollins

Rachel Waugh, a Principal Consultant at Oakdene Hollins, boasts a decade-long tenure with the company, specializing in resource and process efficiency within industrial consortia. With a PhD focused on halving CO2 emissions in the steel and aluminium sectors, Rachel has not only co-authored significant papers on emission reduction across various industries but also contributed to the noteworthy book, "Sustainable Materials With Both Eyes Open.” This publication, recognized by Bill Gates in 2015, delves into the impact of five crucial engineering materials on global carbon emissions. Since joining Oakdene in 2013, Rachel has been instrumental in securing and advancing remanufacturing projects, initially with the Centre for Remanufacturing & Reuse and presently through the Conseil Européen de Remanufacture.

Challenges with Steel Products

Challenge 1 - Steel is a predominant metal used in various sectors, with nearly 2 billion tons produced in 2021. Even though a substantial quantity of steel (680 million tonnes in 2021) is recycled, the demand far exceeds the supply, necessitating effective recovery and recycling strategies.

Challenge 2 - The average lifespan of many steel products is approximately 40 years, primarily due to their use in infrastructure and construction. These lengthy lifetimes pose difficulties for recycling and remanufacturing processes, as more iron ore must be mined to produce steel.

1,950.5 Mt crude steel produced in 2021

Generates between 7-9% of direct emissions from fossil fuels

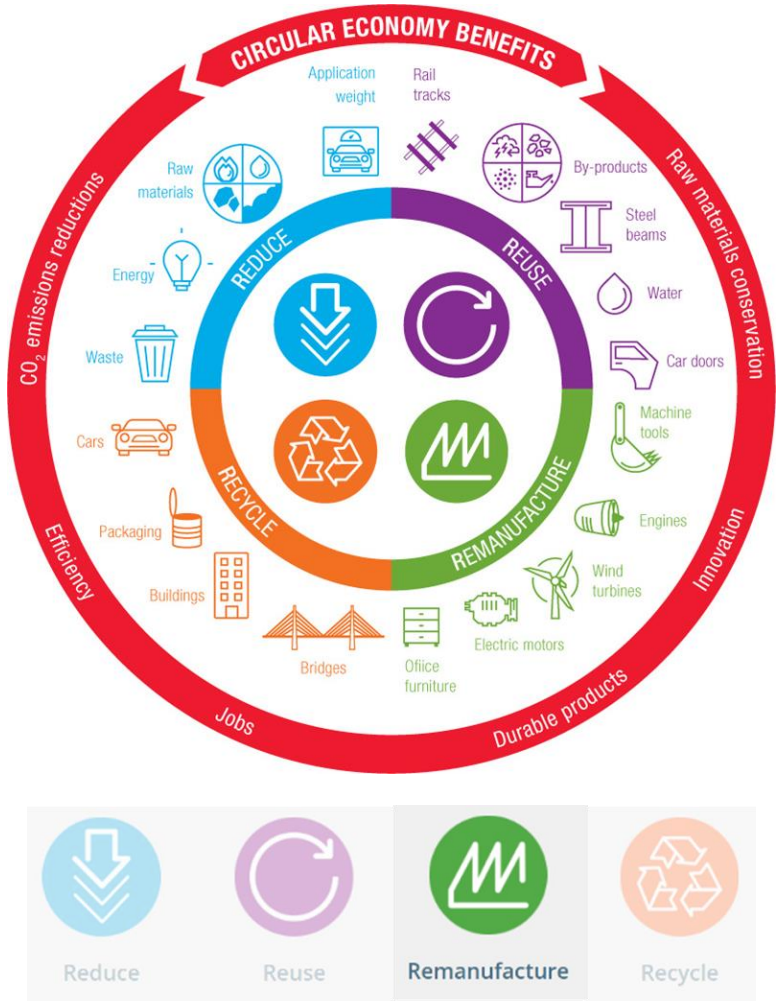
Average life for steel products is ~40 years

Around 680 Mt scrap recycled in 2021

Remanufacturing: An Introduction

In 2018, the World Steel Association identified four pillars crucial for the circular economy: reduction, reuse, recycling, and remanufacturing. While the industry is familiar with the first three pillars, remanufacturing is a less understood but essential component.

Reman definition - A standardized industrial process that takes place within industrial or factory settings, in which cores are restored to original as-new condition and performance or better. The remanufacturing process is in line with specific technical specifications, including engineering, quality and testing standards, and typically yields fully warranted products



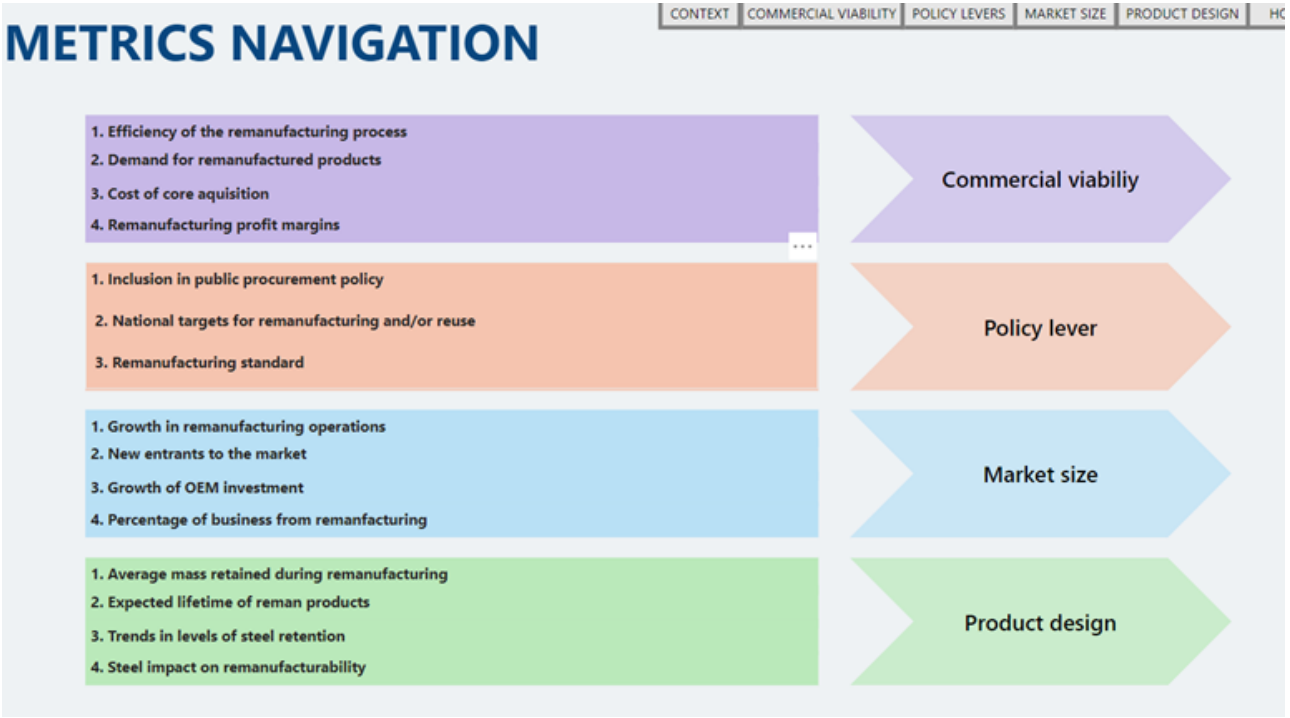
Remanufacturing Scope and Impact

Research conducted under the European Remanufacturing Network's Horizon 2020 project aimed to quantify remanufacturing activities in Europe, particularly their impact on the steel industry amidst the transition to a circular economy. The research spotlighted the significance and potential impact of remanufacturing on transitioning towards a circular economy, with a particular focus on the steel industry. It examined the anticipated demand for steel, the delay in generating recyclable steel scrap, and identified opportunities where steel usage enhances a product's remanufacturing appeal.

Product	Steel content (%)	Steel retained during remanufacturing (%)
Starters	90	88
Steering systems	60	95
Gasoline injection systems	35	99
Diesel injection systems	75	98
Electronics	10	95
Engines	50	85
Cylinder heads	100	95
Turbochargers	85	37
Brake callipers	95	95
CV driveshafts	95	95
Automatic transmissions	85	95
Manual transmissions	50	80
Clutches	90	95
Aircon compressors	95	95
Alternators	89	83
Tyres	16.5	100

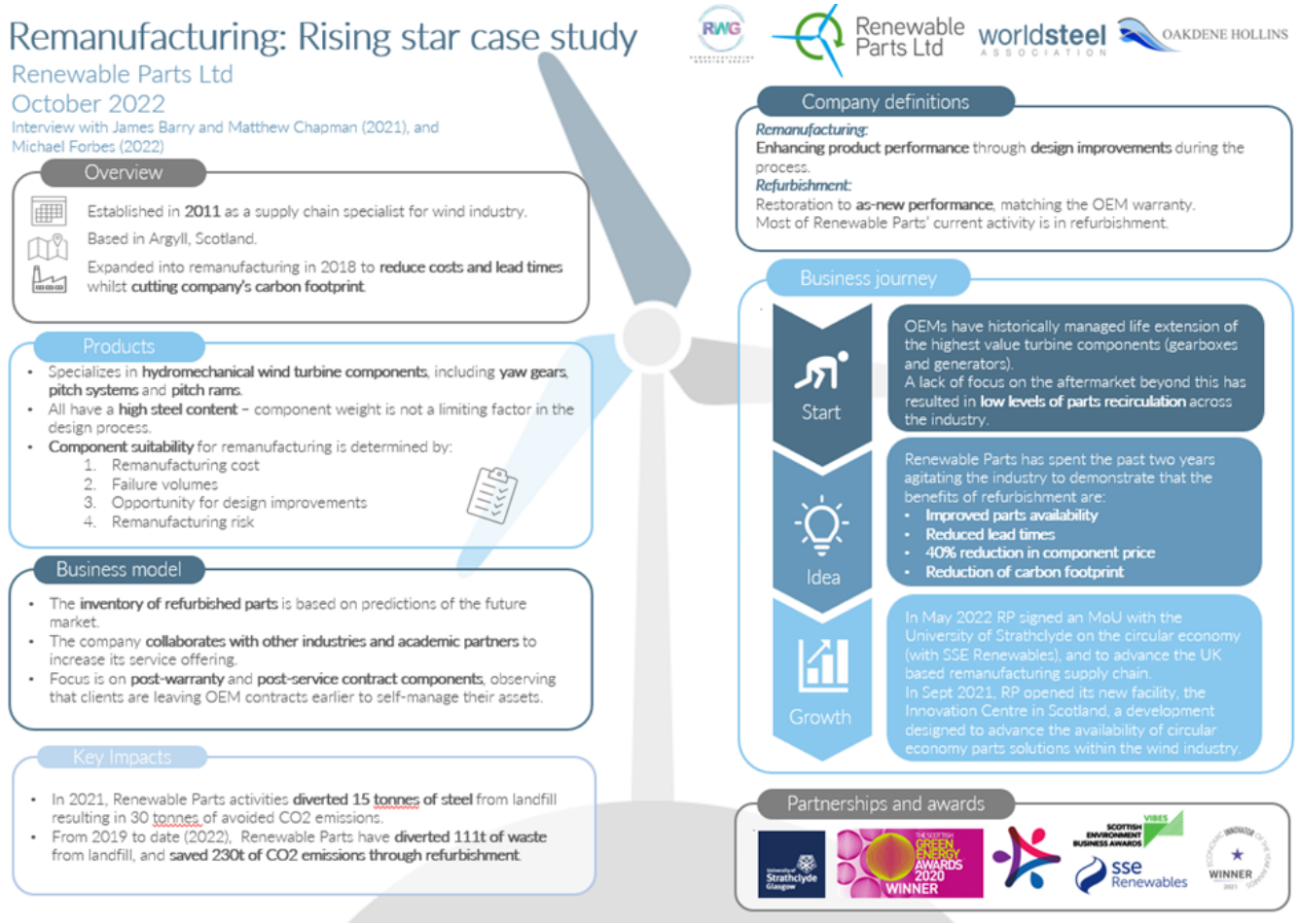
Remanufacturing Scope and Impact

The identification of opportunities arose from the utilisation of steel in remanufactured products, which not only enhanced their appealing qualities but also bolstered their longevity, so becoming remanufacturing economically and technically feasible. The project additionally implemented a monitoring system consisting of 15 indicators and a collaborative team to oversee and promote the growth of remanufacturing in Europe. This approach aims to facilitate cooperation and the exchange of knowledge and potential benefits among different sectors.



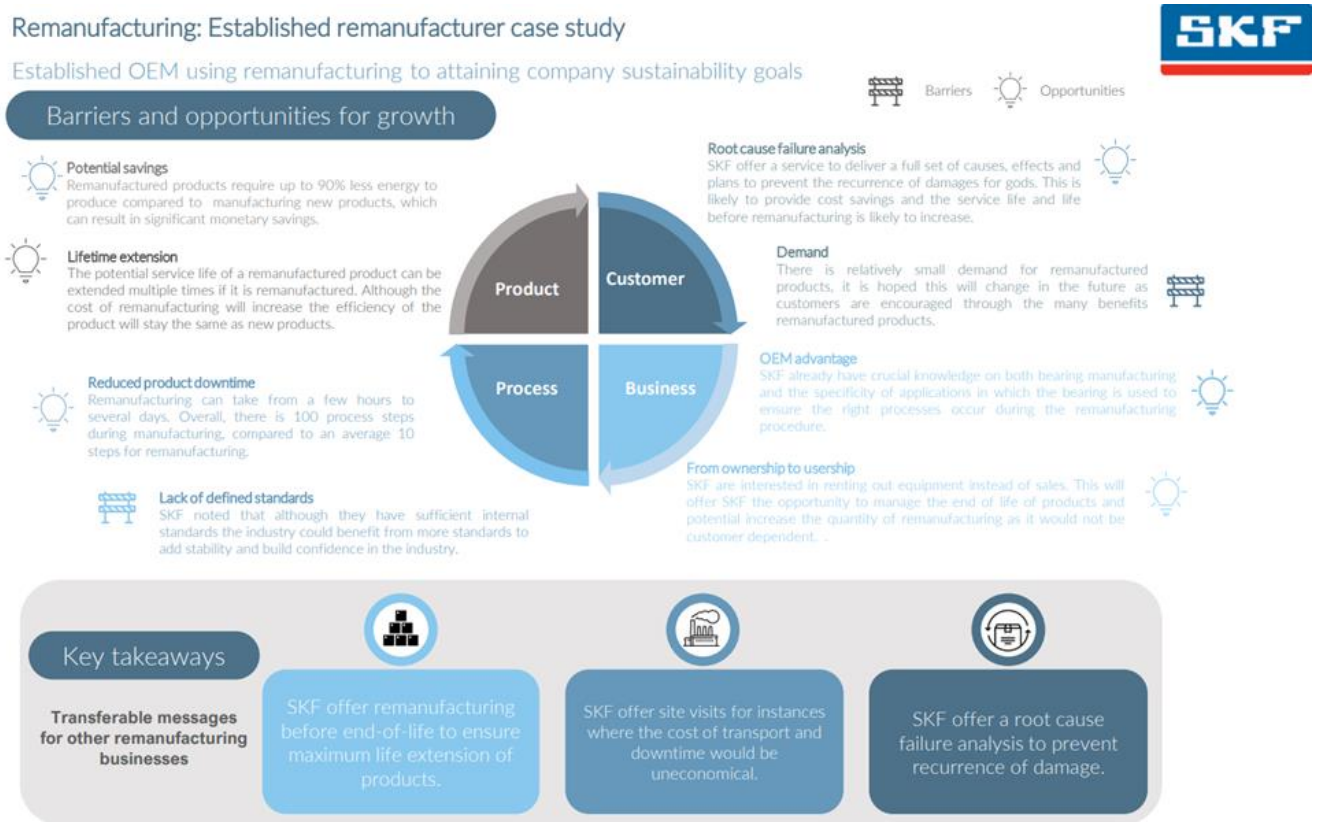
Case study 1: Renewable Parts Ltd

Renewable Parts Ltd was established in 2011 as a supply chain specialist for the wind industry. The company is based in Argyll, Scotland. In 2018, it expanded into remanufacturing to reduce costs and lead times whilst cutting the company's carbon footprint. In 2021, Renewable Parts Ltd activities diverted 15 tonnes of steel from scrap and landfill thanks to its remanufacturing activities, resulting in 30 tonnes of avoided CO2 emissions. From 2019 to 2022, Renewable Parts Ltd diverted 111 tonnes of waste from landfill and saved 230 tonnes of CO2 emissions through remanufacturing.



Case study 2: SKF

SKF is the world's largest bearing manufacturer, they offer industrial bearing remanufacturing of all major brands used in industries such as Metals, Mining, Mineral processing and Cement, Renewable and Traditional Energy, Pulp and Paper and Marine. Bearing remanufacturing can significantly reduce carbon emissions, consuming around 10% of the energy of making a new one. By extending bearing service, remanufacturing avoids the scrapping of components and wasteful use of natural resources. The lead time on a remanufactured bearing will also be shorter than for a new one.



Talk 2: Electrolux Professional Commitment to Extending Metal Life

Innovation Designer

Marco Limani

Electrolux Professional

Marco Limani, a 2019 graduate from Università Iuav di Venezia, has been collaborating with Electrolux Professional's design and innovation department since 2018. Funded by Electrolux Professional, he pursued an industrial PhD at Università Iuav di Venezia under supervisor Laura Badalucco, researching the impact of design thinking on innovation. Upon earning his PhD in 2023, he formally joined Electrolux Professional as an Innovation Designer.

What Electrolux professional does?

Electrolux Professional is a Swedish multinational professional appliance manufacturing company, headquartered in Stockholm. It is one of the leading global providers of food service, beverage and laundry solutions, serving a wide range of customers globally, from restaurants and hotels to healthcare, educational and other service facilities. The company is leading the industry in innovation and energy efficiency, with a focus on specific sustainability goals: reducing CO2 emissions by 50 percent by 2030 and becoming climate neutral in our industrial operations by that same year.

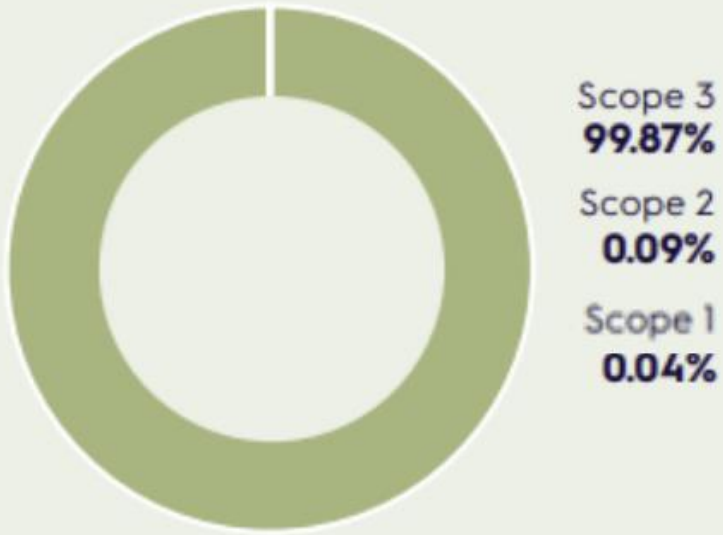
Food

Laundry

Beverage

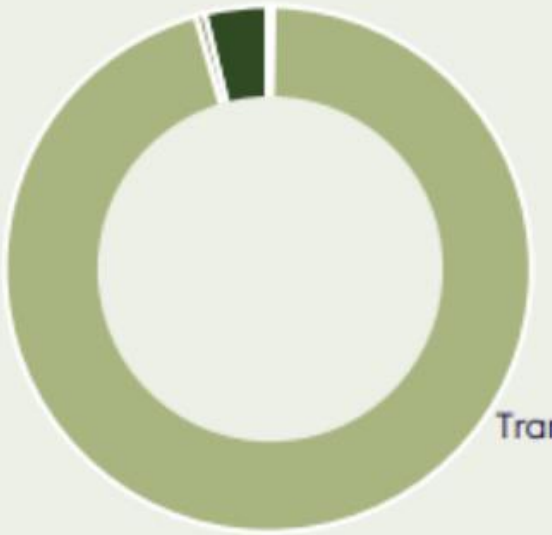
What Electrolux professional does?

Distribution of our carbon footprint (Scope 1, 2, 3), %*



* Based on 2019 data, inlcuding Unified Brands

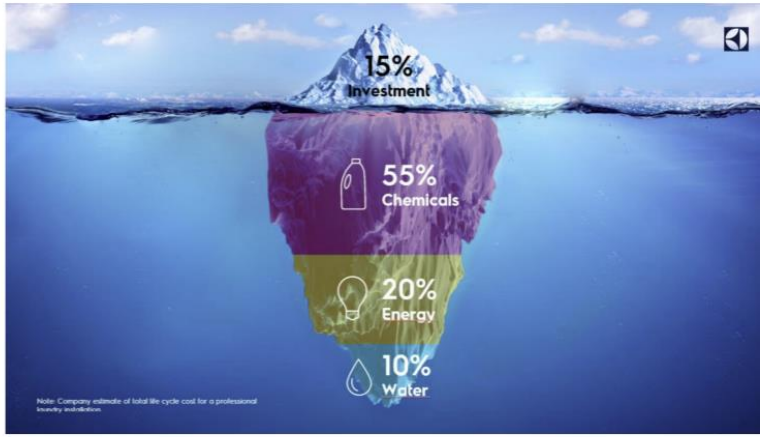
Distribution of our carbon footprint (Scope 3), %*



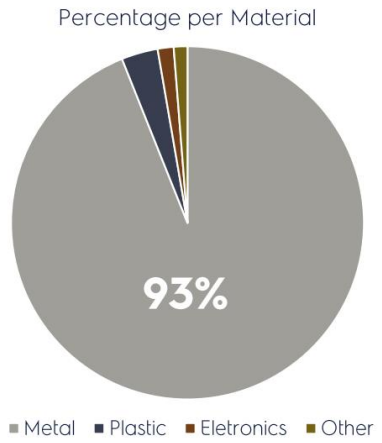
* Based on 2019 data, inlcuding Unified Brands

Challenges with Electrolux

Challenge 1 - A significant focus is on scope 3 emissions, which constitute 99% of their total carbon footprint, with 95% of scope 3 emissions coming from product use. Professional appliances have a long lifespan (10-15 years or more) and heavy-duty usage. Efforts are directed towards improving efficiency and technology in machines to minimize energy, water, and chemical consumption.



Challenge 2 - Metal components constitute approximately 93% of the total weight of their professional appliances. The management of material resources is crucial, considering the products' long lifespan.

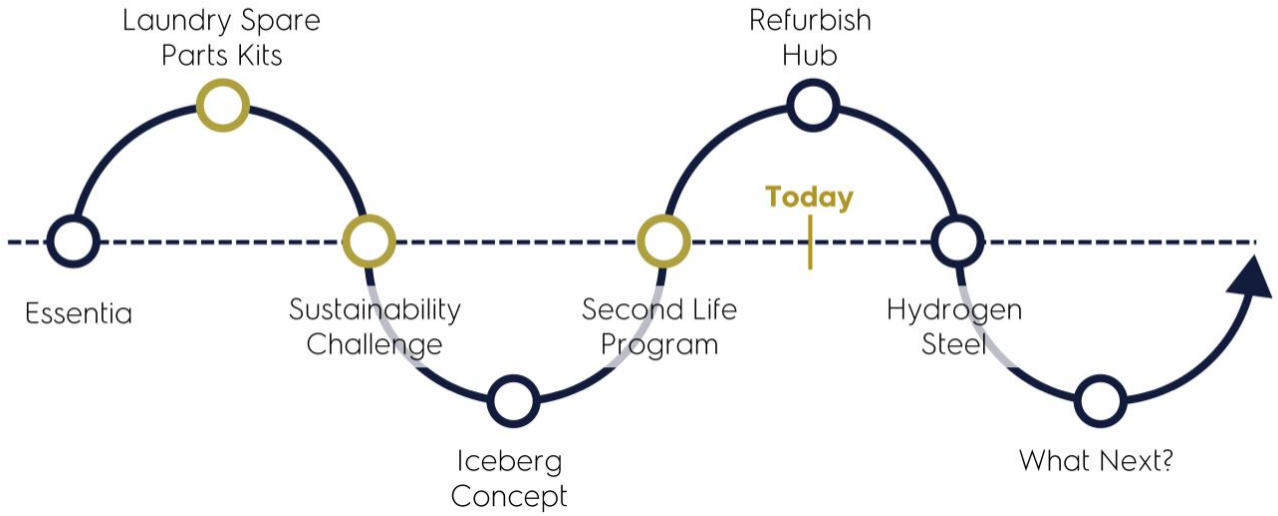


Electrolux Professional Responsable Initiatives

Past: They started with providing repair services and spare parts to extend appliance lifespan.

Present: Currently, they offer refurbishment services for machines, exchanging old machines for new ones, and then refurbishing and delivering the old ones back to customers.

Future: The company is exploring remanufacturing, designing products that are more efficient, sustainable, and suitable for remanufacturing.



Key Takeaways from Electrolux

Acknowledge the Full System: Engage all stakeholders and share the value generated by circular models.

Shape the Right Context: Cultivate an environment where sustainability is valued and supported.

Start Simple: Begin with small initiatives and expand gradually.

Demonstrate Success: Show tangible results to inspire and communicate success stories.

Scale Up: Start locally but think globally.

Talk 2: Circular Metals at Jaguar Land Rover

Senior Sustainability Engineer

Luke Bloodworth

Jaguar Land Rover

Luke Bloodworth is a senior sustainability engineer at JLR working within the product sustainability team which encompasses the sustainability, circularity, and provenance of JLR products. Luke has worked as part of JLR body engineering teams for the last 8 years within several teams and projects. With his current role he is the commodity lead for exterior & chassis and leads metal decarbonisation for the product sustainability team. He is passionate about sustainable transport and within his role is engaged in driving lower CO2e materials into JLR products through recycled content, renewables, and circular systems. Luke received his bachelor's degree in applied engineering from the university of Warwick and is part of JLR's pilot of the sustainable automotive materials engineering postgraduate course accredited by the university of Warwick.

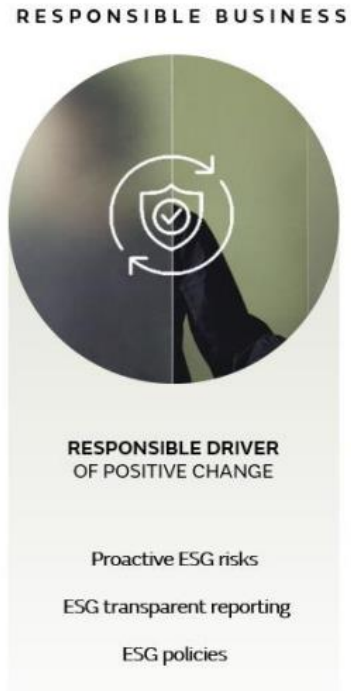
JLR's Sustainability Efforts

The “Reimagine” strategy focuses on sustainability and aims to achieve zero carbon emissions across JLR’s supply chains, products, and operations by 2039. The strategy is divided into three categories:

Engage For Good - “Acting as a Global Corporate Citizen to take care of the communities and environments we operate in and make a positive, lasting impact for the world”.

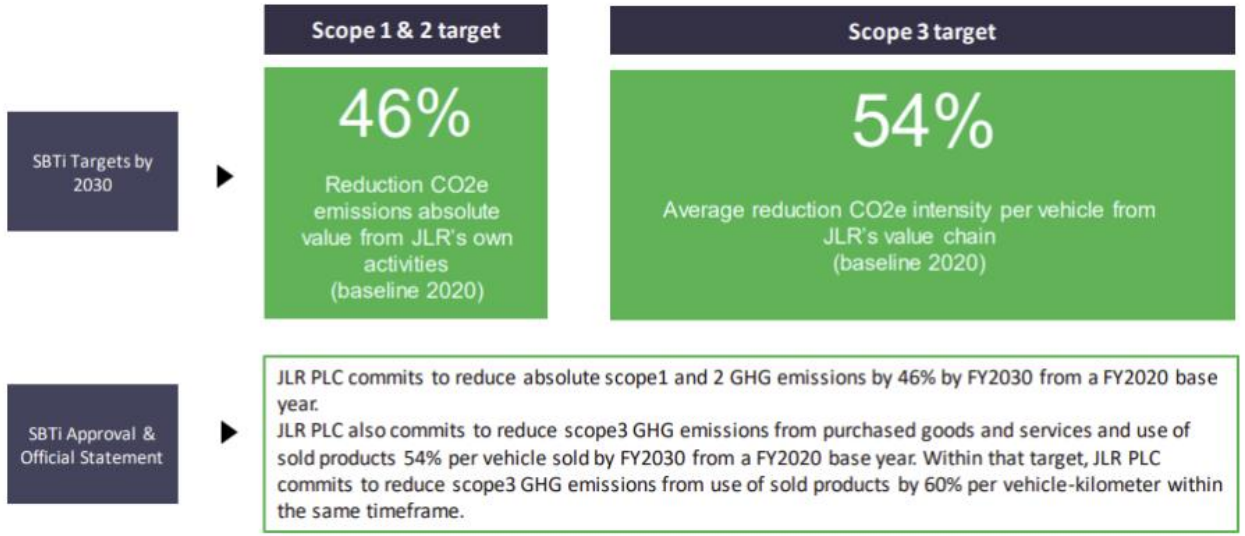
Planet Regenerate - “Transforming our business across the full value chain for net-zero, circular economy and biodiversity”.

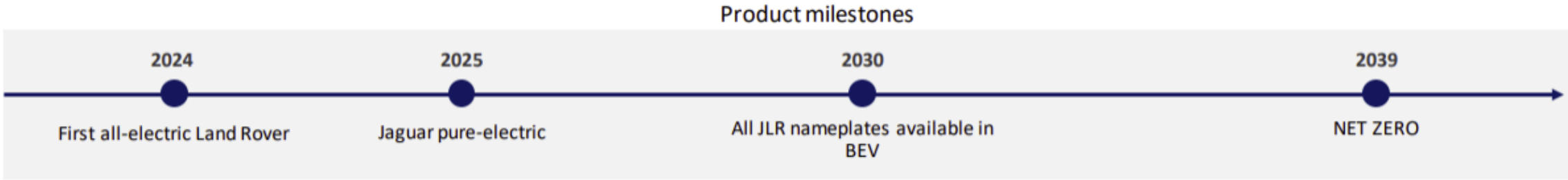
Responsible Business - “Proactively minimising risks embedded in our business beyond legal compliance, transparently reporting performance, openly aligning with policy”.



Carbon Emission Reduction Targets

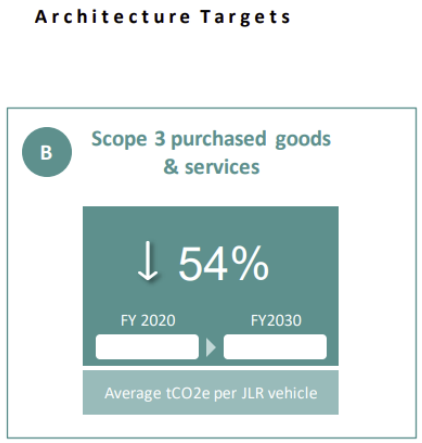
The company is transitioning to electric vehicles, which impacts the distribution of emissions across scopes. By the end of the decade, Jaguar Land Rover will reduce its direct greenhouse gas emissions across vehicle manufacture and operations by 46% in absolute value compared to a 2019 baseline. The company has also committed to reduce greenhouse gas emissions per vehicle by an average of 54% across the entire value chain, including a reduction of 60% in the vehicle use phase.

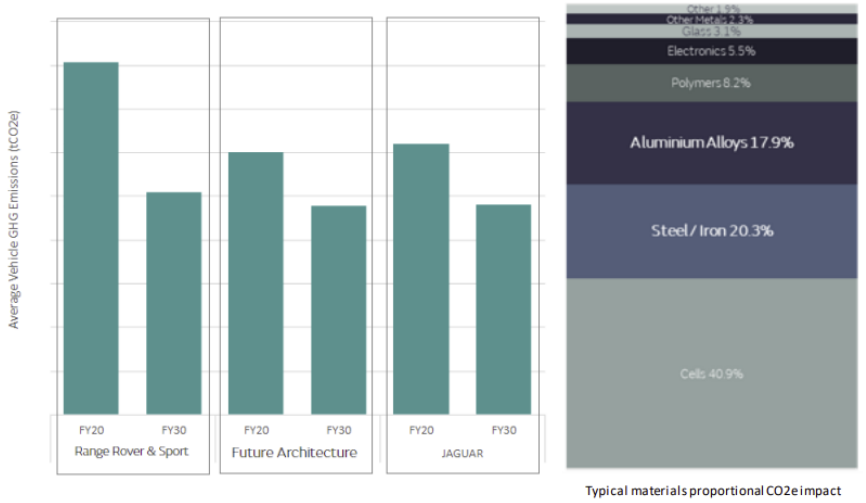




Metal Utilization and Decarbonization

JLR uses significant amounts of metal in their vehicles, particularly steel and aluminium. The company is aiming to increase the use of secondary and recycled content, explore new material grades, and reduce overall material usage.

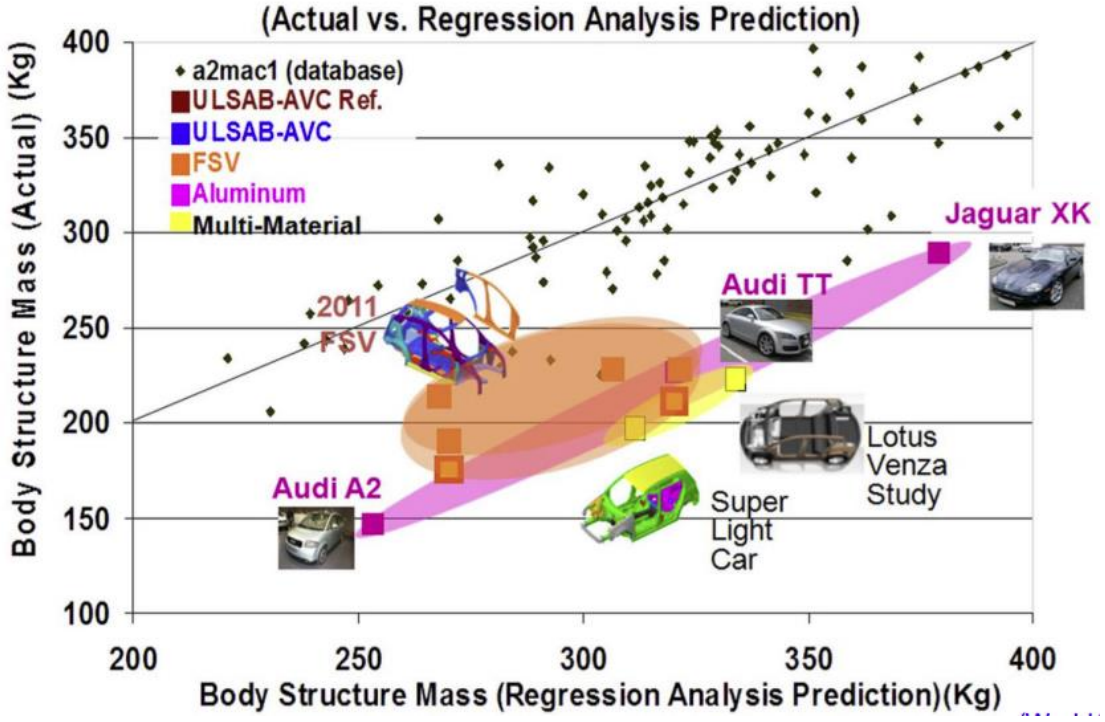




Challenges with JLR

Challenge 1 - Optimal Design Queries: Selecting the right material and joining method for car body structures is difficult. The connecting methods should improve vehicle quality and safety, while the materials must be robust, cost-effective, and ecologically friendly. These methods should also simplify assembly and disassembly for efficient recycling.

Challenge 2 - Material Choice and Recyclability: Choosing between single or mixed material architectures is complex. While single materials are easier to recycle, combined materials perform better. Modular designs simplify part upgrades and replacement, but they must be carefully planned to enable vehicle recycling at the end of its life. Industry must reconcile creative designs with end-of-life recyclability.

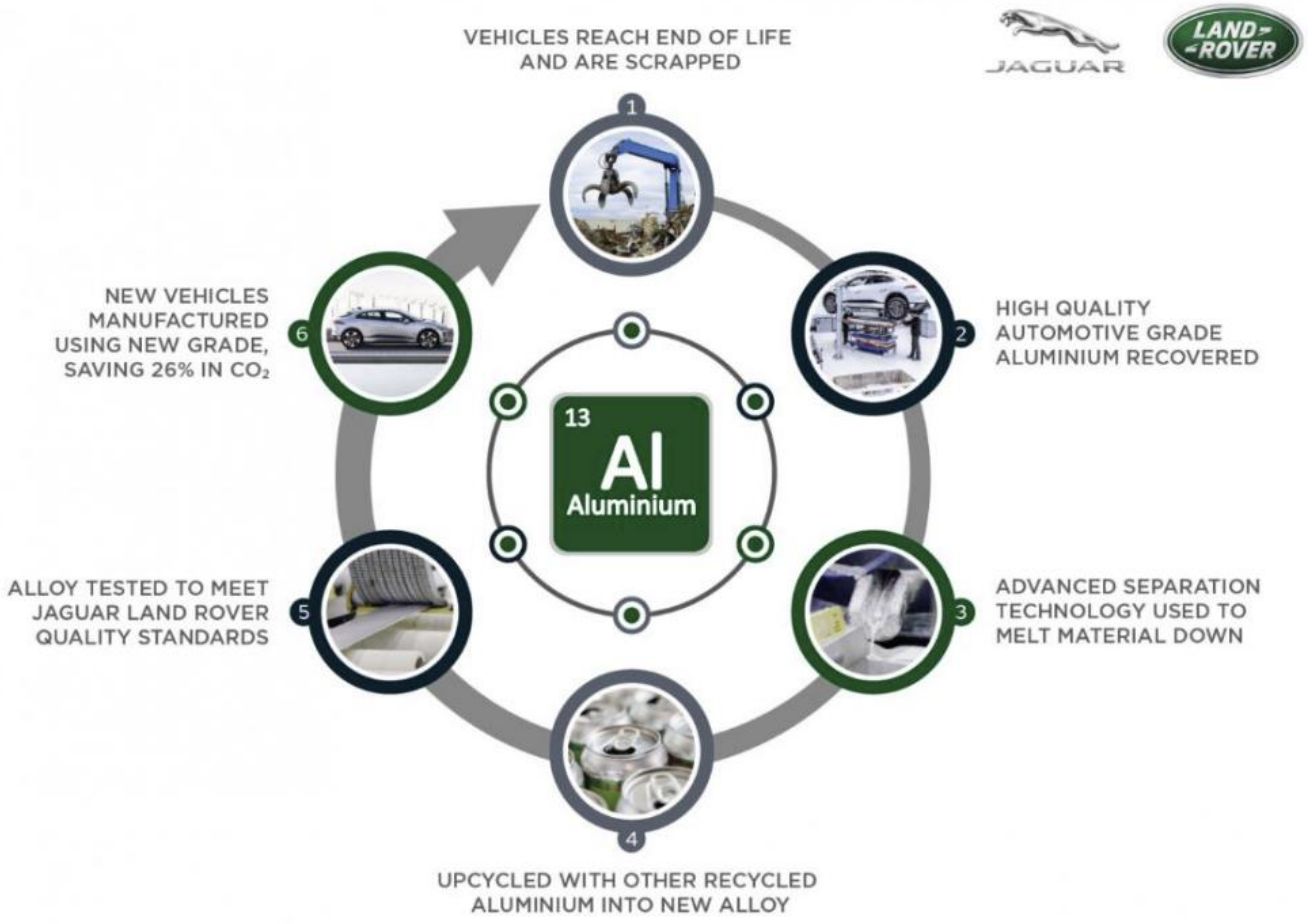


Key Decarbonisation Levers for Steel & Aluminium

Opportunity	Risk
Increase in secondary/recycled content – New Aluminium Grades, EAF for Steel	• Cost implications. • Material Validation. • Access to scrap material
Reducing material use – downgauging, increase utilisation, rationalisation of grades, de-spec	• Cost implications. • Engineering & Material Validation.
EOL – recovery & recyclability partnerships, closed loop materials – pre & post	• Access to sufficient EOL volumes. • Engineering & Material Validation.
Procurement of Low Carbon & Ultra Low Carbon Prime Aluminium	• Potential Cost implications. • Engineering & Material Validation. • Availability
Procurement of Green Steel – EAF & H2-DRI-EAF Grades	• Potential Cost implications. • Engineering & Material Validation. • Availability

Circular Economy Approach

Adopting circular economy principles, the focus is on maximizing material utility through recycling and reusing waste and materials, developing second lives for electric vehicle batteries, eliminating single-use plastics, and reforming aluminium from used vehicles for new models. Pioneering in aluminium construction reduces vehicle weight, supporting powertrain innovation. The 'REALITY' project, a £2 million collaboration with Brunel University, enables the recovery of premium automotive-grade aluminium from scrapped vehicles for the first time, extending closed-loop capabilities and reducing the need for virgin aluminium, thereby saving approximately 90% of the energy required to produce new aluminium.



Key Takeaways from JLR

1. Collaboration across the industry – manufacturers, stampers, service centres for recycling.

1. Want to take our fair share without monopolising LCP/green steel etc.

1. Looking for partners to join us on our sustainability journey.

1. The circular economy and circular metals are essential for delivery net zero.