FAST FORWARD ZERO

Towards a decarbonized, more circular and inclusive economy



New Perspectives on Aluminium Decarbonisation

AMAP 26th June 2025

Jerome Lucaes CEO



A chaotic moment for the aluminium sector



Trade	wars, wars			IRAQ	2	IRAN	N	AFGHANISTAN
Country	Trade action	What changed	Sta		tions cted		Strait of Ho	rmuz
US	Increase Section 301 tariffs	Tariff on Chinese aluminium increased from 7.5% to 25%	In effect Septem 2024			Modera	1	PAKISTAN
US	Increase Section 232 tariffs	Tariff on all aluminium imports increased from 10% to 25%	In effect 12 Marc		BAHRAIN QATAR -	ajor	Gulfot	
US	Removal of Section 232 exclusions	Removal of all country specific and product specific exclusions	In effect 12 Marc		SAUDI	U.A.E.	A STAN	man
US	Reciprocal tariffs on all regions	US introduced reciprocal tariffs towards the majority of the countries in the world.	2 April	200 M	ARABIA		OMAN	Arabian Sea
US-China	Reciprocal tariffs	Between 8-10 April a series of moves brought US tariffs on China to 145% above pre-Trump 2.0 level, and Chinese tariffs 125% above previous level.	8 April, 1		US-China	Major		
US-China	Reciprocal tariffs	US and China agree to lower their tariffs to 30% above pre-Trump 2.0 levels (Chinese exports to US), and 10% (on US exports to China).	12 May		US-China	Major		
US	Section 232	Tarif on aluminium imports from 25% to 50%	4 June		Global ex UK	Major		



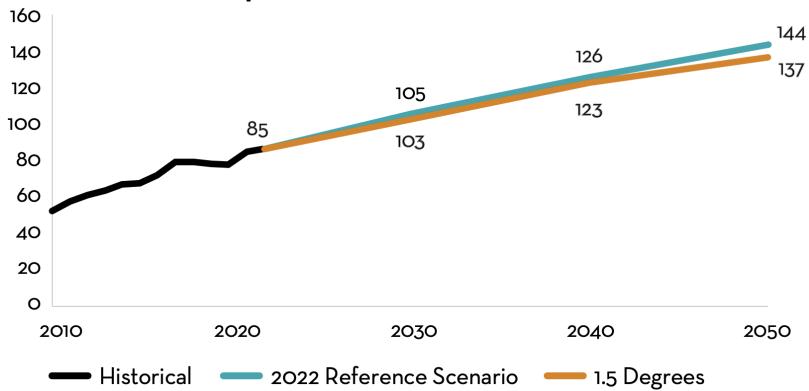
2000 1,556 1,512 1,426 1500 1,285 1,212 1,365 1,355 1,309 1,217 1,182 1000 1,020 1,095 1,112 840 810 640 500 250 340 53 200 120 0 2010 2005 2015 2020 2025 2030 2040 2035 2045 2050 - B2Ds** - 1.5 Degree scenario*** - BAU* - BAU (2022)* - Historical

Aluminium sector (million tonnes CO₂e) – 2023 update

Source: IAI, <u>https://international-aluminium.org/resources/greenhouse-gas-emissions-decline-in-aluminium-industry/</u>

Aluminium demand will continue to increase



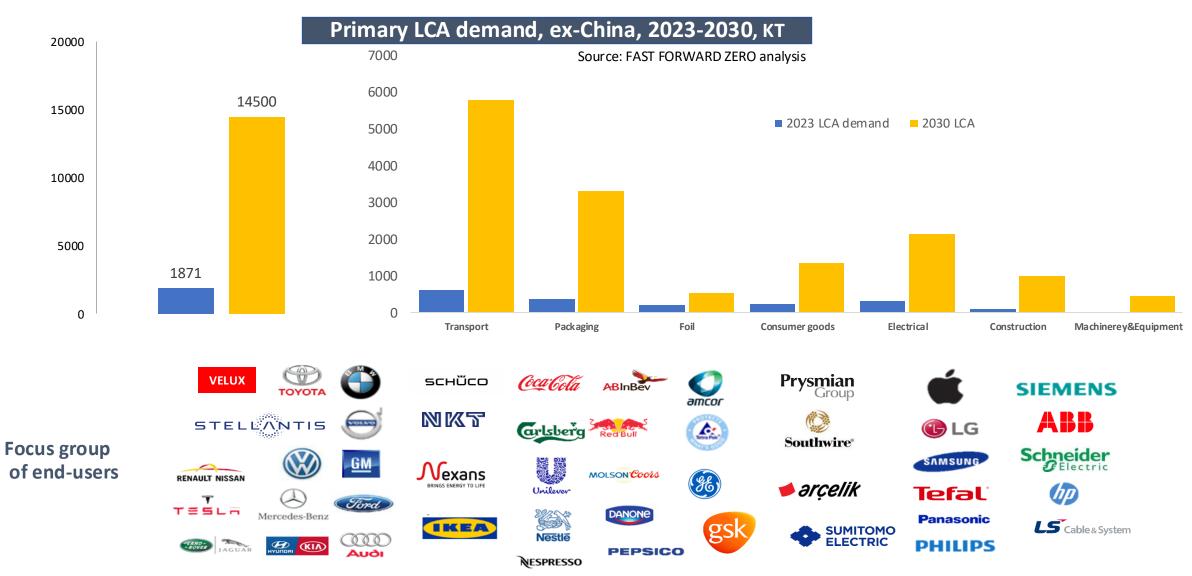


Final products demand (million tonnes)

Source: IAI, <u>https://international-aluminium.org/resources/greenhouse-gas-emissions-decline-in-aluminium-industry/</u>

The demand for Low Carbon Aluminium (LCA) is well established



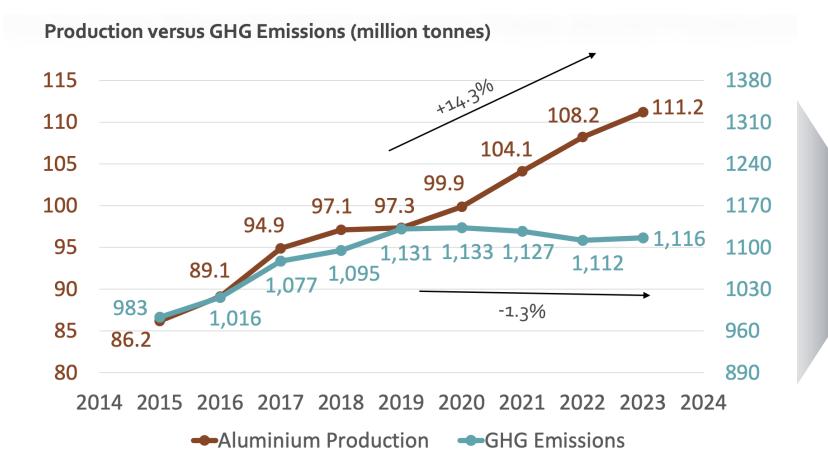


Source: FAST FORWARD ZERO analysis

Aluminium GHG emissions have decoupled from growth



Data release from IAI (March 2025)



Total emissions and intensity are declining

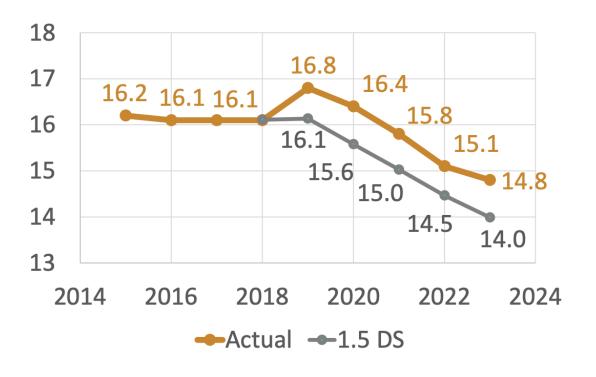
Cautious optimism: "start of trend", if investments & roll out continues

Not fast enough

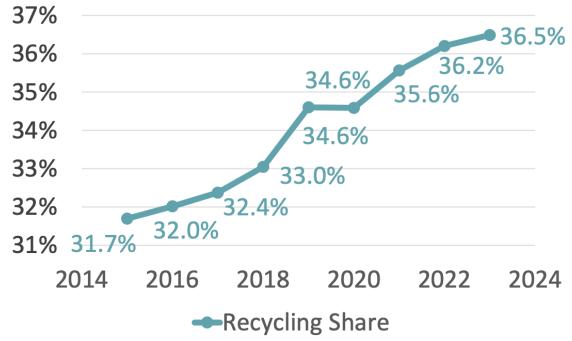
Here is why



Primary Aluminium - Decarbonisation Ongoing (t CO2e/t)



Recycled Aluminium - Recycling Share Increased by 5 Percentage Points since 2015



80% of global emissions come from 3 sources



14.8* TCO_2/tAl

CO₂ profile primary Aluminium – World average, 2023

Global	© FAST FORWARD ZERO					
(CO2e per tonne Al)	Bauxite Alumina	Anode	Electrolysis C	asting Total		
Electricity	0.03% 2.1%	0.2%	1 59.1%	0.2% <mark>62%</mark>		
NOX, Organic Carbon, PFC		0.0%	5.0%	5%		
Direct Process (CO2)		0.7%	9.9%	11%		
Ancillary Materials	2.9%	4.3%	0.5%	8%		
Thermal Energy	0.2% 11.0%	0.6%	0.0%	0.4% 12%		
Transport	1.5%		1.2%	3%		
Total	0.3% 17.6%	5.8%	75.7%	0.7% 100%		



represent 80% of the sectoral emissions

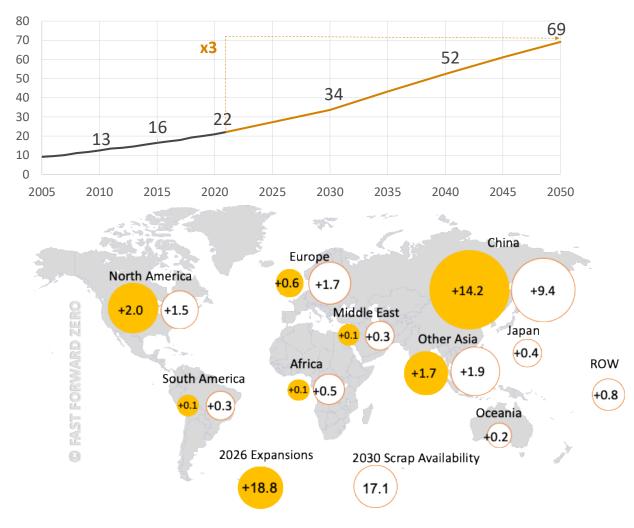


2 represent the largest realistic decarbonisation potential for the alu sector

By 2050, achieving the full potential for recycling will cover less than 50% of the aluminium demand



Recycled Aluminium from post-consumer scrap (million tonnes)



- By 2050, post consumer scrap recycling is set to triple, but will be far from covering the aluminium demand
- Current RER (Recycling efficiency Rate) is at 76%.
- Currently 7.3 million tonnes of scrap is unutilized

Challenges and solutions:

- Better collection
- New sorting technologies
- Increase of recycling capacity. The industry has already anticipated 19 million tonnes of additional recycling capacity by 2026 (base 2020)

Solutions for impactful decarbonisation



Global Emissions	Bauxite mining	Al L Refinery 185	Power 625	Smelter •••• Anodes 61	Electrolysis 165	Casting	Recycling
Mt CO ₂	5	105	025	01	105		
	Alternative fuels	H ₂ for boilers and calciner	Solar power / CSP, hydropower, nuclear power	CCS	CCS	H ₂ fired furnaces	Casting / recycling loss
	Electrification of mining equipment (e.g. excavator)	Electric heaters					
		Electric boilers	(PPA, RECs)	Plasma torch for			reduction
Solutions		Recovery of	© FAST F	anode ORWARD ZE	RO Inert anode	Electrification of	
Solutions	Electrification of other processes (transport, etc)	waste heat Thermal storage	CCS	H_2 based heat for anode baking	mercanoae	furnaces	Better collection and sorting
		(with PV)	Green H ₂ -based			Plasma torch for	
		CCS	power	Bio-based material	Carbochlorination		
		Plasma torch for calcination	Grid balancing services			furnaces	

Solution readiness evaluation based on multi dimensions: technical and economic. Developed by FAST FORWARD ZERO

TEV 4-5

Technico-economic viability*

TEV 8-9

TEV 6-7

TEV 1-3

Sources: Source: IAI, IEA, FAST FORWARD ZERO

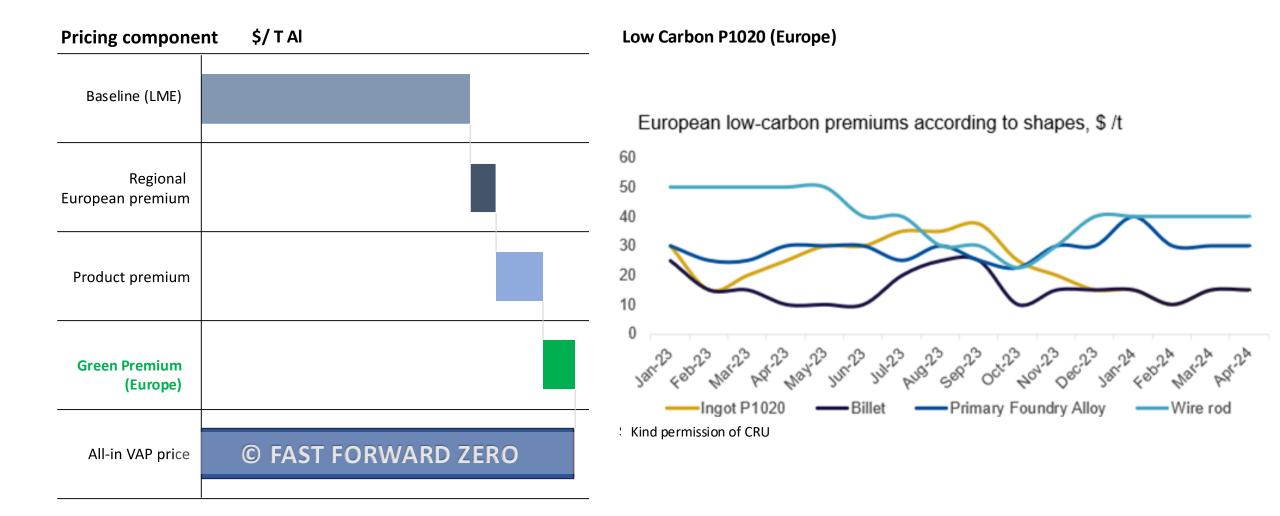
Leading primary producers have differentiated decarbonisation strategies



202 BRAND	3.8 Scope1&2 (Smelter casthouse)	Hydro Hydro 1.6Mt 4.0 full scope	Alcoa Alcoa Coce Alcoa 4.0 Scope 1, 2, partial 3	EGA CELESTICL SOLAR ALUMINUM 0.08Mt <4.0 full scope 0.2 – 2.2Mt	CHALCO Yunnan Aluminium 2.0Mt 3.8 ? full scope 3.0Mt	RUSAL ANOW 2.6 Mt 4 – 6.5 Full scope 3.2 Mt
PRIMARY ALUMINIUM	 15% and emissions intensity by 30% by 2030 (vs 2018) - Group Power transition - solar & wind in Australia smelters (4 GW RFP w ENERGETICs) Hydrogen feasibility study at Yarwin refinery AP60 plant expansion +160 kt ISAL carbon capture project - CARBFIX 	 To reduce CO2 emissions by 10% 2025, 30% by 2030 and zero emissions by 2050. Hydrogen at alumina refinery in Brazil Hydrogen at Casthouses in Norway HALZero R&D development Ardel/ Sunndel tech upgrades Reduxa 2.0 by 2030 BIO ANODES 	 To reduce GhG emission intensity by 30% by 2025, 50% by 2030 vs 2015. San Ciprian, Spain => Wind power by 2024 Sai Lu e, Brai P Aresta P. d. 7.027., Hydro power Alumina => MVR technology Smelter renewable energy use from 78% 2020 to 85% 2025 ELYSIS 	PLANT	 No longer investment in new smelting capacity using thermal power. Transfer capacity to Yunnan province Wind and Solar electricity: RMB 400 million green bond for wind-power projects on Jun 2. 2022 FHEST Technologies to reduce smelter AC consumption by above 500KWh/t-Al 	 Reduce GHG emissions by 35% by 2030 (vs 2018) Hydro power expansion (TAISHET) INERT ANODE (INERTA) Switch oil & coal fuel to gas at alumina refinery. Change alumina source Upgrade smelting technology (exit Soderberg) Divestments
RECYCLING	 Recycling ≥50Kt + 400 kt Matalco 30 kt new recycling capacity (Arvida) PFA production with EOL wheels (Beauharnois) Billets with recycling content >25% (NZAS) 50% Investment in MATALCO 	 Recycling capacity 1,7 M t by 2025, incl 660 kt of PCS Add PCS into primary aluminium VAP, pilot in Norway by 2022 75R – Billet with >75% PCS 	 Recycling ≥ 50Kt ASTRAE. Purification EOL scrap up to 99.98%. Pilot in Canada by 2023 Brand. Billets with recycling content >50% 	 Recycling plant - 170 kt in Al- Taweehah quisition of LEICHTMETAL Aluminium recycling coalition withTadweer, Coca-Cola, Pepsico, Canpack, Crown, Veolia. 	 CO2 emission (scope 1&2) for unit aluminium production at 12.71 tons in 2020, down 4.4% yoy. 	 RHEINFELDEN, 30 kt Primary with PCS pilot at Kubal

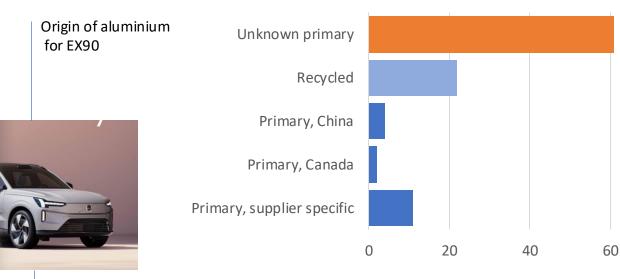
The price signals for Low Carbon Alu are not sufficient yet to justify significant decarbonisation efforts





Carbon Data Trust across the supply-chains is essential





Volvo EXC90/XC90 model

For EX90, latest Volvo model, 61% of all aluminium consumed comes with unknown primary sources Suppliers specific data are essential to drive real carbon footprint performance

Harmonized calculcations for product carbon footprint are required

Digital Product Passports needs to happen fast



Citizens & Customers *"It is not* up to me to act first" **Regulators & Businesses** Governments

Aluminium :

5 priority drivers to decarbonize by 2030

- 1. Recycling
- 2. Greening electricity at smelters
- 3. Decarbonizing heat at refineries
- 4. Carbon Data trust across the value-chain
- 5. Regulatory instruments (governments and markets)





Jerome Lucaes

CEO, FAST FORWARD ZERO

IAI, Strategic Advisor (since 2022)

25 years in the aluminium sector

Experience (highlights) :

RUSAL, Director - Low carbon aluminium program Rio Tinto

- Global Product sustainability director
- Product Director, Primary aluminium

Pechiney / Alcan (now Constellium)

Co-creator of the Aluminium Stewardship Initiative (2011-2014)

Few World Firsts in ALUMINIUM / SUSTAINABILITY

- First announced **Net zero carbon strategy** for a global mining & metal (Jan 2021)
- First two low carbon aluminium brands (RENEWAL, 2016, ALLOW, 2017)
- First low carbon partnerships from mine to consumers (Rio Tinto, Rusal -> Nespresso, Apple, Budweiser)

Initiator of several collaborative groups :

- Co-creation of the Aluminium Stewardship Initiative (ASI)
- Aluminium Forward 2030 (IAI)
- Aluminium for Climate (WEF/ Mission Possible Partnership)



What we do

From Insight to Impact Aluminium | Metals | Supply-Chains | Decarbonisation

Strategic analysis & Roadmaps From Options to Business Case and FID BUSINESS Narratives ٠ **STRATEGIES** Go-to-Market – Low carbon products ٠ Stakeholder engagements ٠ **Education & Training** Advisory to boards NET ZERO, CIRCULAR, & FAIR TRANSFORMATIONS

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ALUMINIUM

- Deep expertise: global aluminium value chain
- Recycling and circular models
- Environmental impacts
- Supply security, cost management

SUPPLY-CHAINS

• Supply-Chain decarbonisation

Decarb strategies & Technologies

- Traceability tools and sytems
- Engagements and Partneships
- Mine to products partnerships



FAST FORWARD ZERO

Advisory & Education & Coalitions

Climate resilient business transformations Decarbonation |Circularity models |Metals supply-chains

- Business Development
- Supply-chain Decarbonisation
- GoToMarket Low Carbon Products
- Coalitions Collaborative Engagement



