GREEN GROWTH IN JAPAN

THE ROLE OF ALUMINIUM IN THE LOW-CARBON TRANSITION

CONTENTS

ABBREVIATIONS

BoJ – Bank of Japan

BREEAM – Building Research Establishment Environmental Assessment Method

CASBEE - Comprehensive Assessment System for Build Environment Efficiency

CT – Carbon Trust

EV – Electric vehicle

GHG – Greenhouse gas

GoJ – Government of Japan

HEV – Hybrid electric vehicle

IAI – International Aluminium Institute

ICE – Internal combustion engine

IEA – International Energy Agency

JAA – Japan Aluminium Association

JAMA – Japan Automobile Manufacturers Association

JBIC – Japan Bank for International Cooperation

JSIF – Japan Sustainable Investment Forum

LEED – Leadership in Energy and Environmental Design

METI – Ministry of Economy, Trade and Industry of Japan

MOE – Ministry of Environment of Japan

MOF – Ministry of Finance of Japan

MOFA – Ministry of Foreign Affairs of Japan

R&D – Research and development

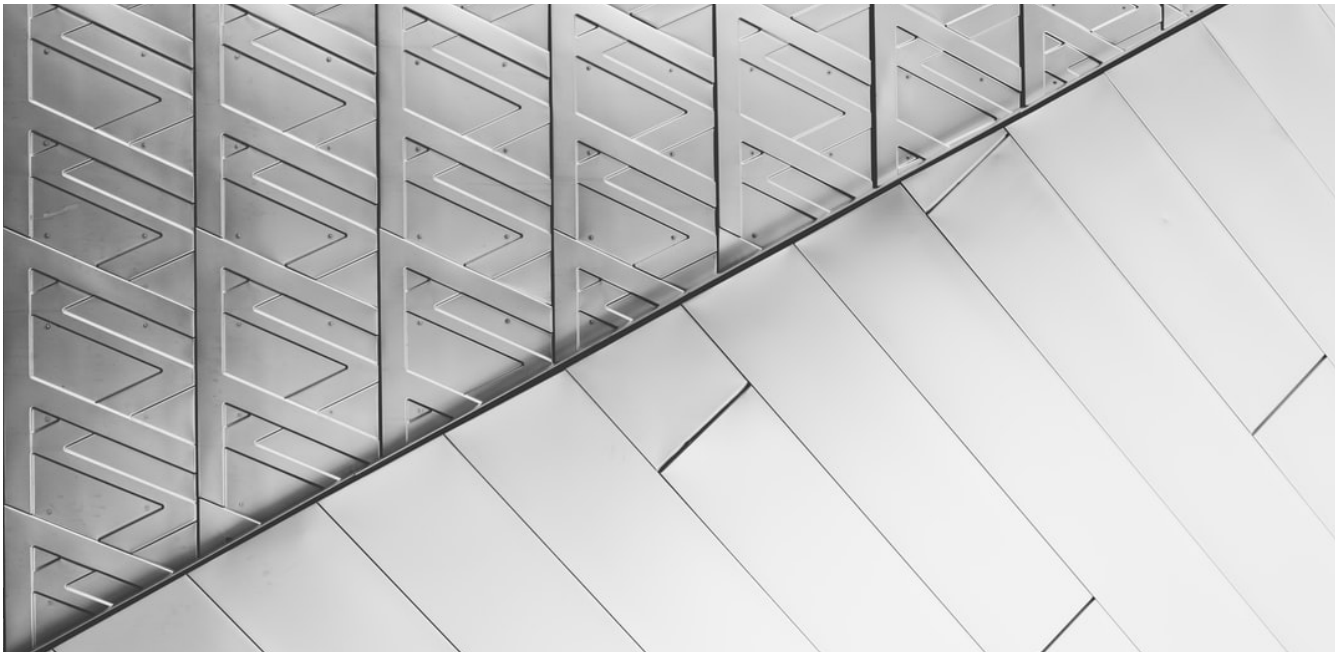
TCFD – Task Force on Climate-Related Financial Disclosures

TCFDC – TCFD Consortium

WEF – World Economic Forum

WGBC – World Green Building Council

EXECUTIVE SUMMARY



In its Green Growth Strategy released at the end of 2020, the Japanese government set out an ambitious roadmap for decarbonisation that will channel public and private funds into areas such as electric vehicles, green buildings, and renewable energy. The country is now committed not only to become net zero by 2050 but to slash emissions by 46% by 2030 (MOFA 2021). Combined with a boom in sustainable finance and an embedded circular economy, this impetus from the country's leadership is set to strengthen the competitive environment in Japan for green business growth and investment. However, with the government aiming to steer private companies to invest the cash equivalent of 240 trillion yen in the green transition (GoJ 2020, 2), there is a risk that the raw materials used in this monumental economic shift come with significant embedded emissions. Without addressing these hidden climate impacts, Japan's transformation would undermine its own objective, driving pollution abroad to build green industries at home.

Aluminium: A building block of the low-carbon economy—but not all is born equal

While Japan does not have a primary aluminium industry, it is a major importer of the metal, which is processed by downstream aluminium producers for use across a breadth of sectors.

Aluminium is primed to play a major role in the green transition:

- In Japan's automotive sector, where its lightweight properties are key to improving the efficiency of electric vehicles, aluminium demand is set to rise almost 29% between 2020 and 2025 (CRU 2021).
- The construction industry similarly values aluminium's lightweight properties, alongside its durability, reflectivity, and ease of extrusion. Demand for aluminium from construction growth in Japan is set to increase by over 10% between 2020 and 2025 (CRU 2021). This will be further stimulated by the increased integration of distributed renewable energy infrastructure into residential and commercial buildings under Japan's Green Growth Strategy, given aluminium accounts for approximately 85% of solar panel components (WEF 2020, 9).

Behind the opportunity, however, lies a challenge for Japan's downstream aluminium industry. The high energy intensity of aluminium production means raw materials imported to Japan can have vastly different embedded emissions. Primary aluminium produced using renewable energy, for example, can have an emissions intensity of less than 4 tonnes of CO_2 per tonne of aluminium (tCO_2/tAl) compared to a global average of 12.6 tCO_2/tAl, while innovative processes such as inert anode production are offering even lower figures.

From a sustainability perspective, Japanese producers benefit from almost 100% recycling rates for cast aluminium products, enabling significantly reduced lifecycle emissions. However, recycling of wrought aluminium remains at just 10% (JAA 2020, 9), meaning large volumes of primary metal will still be needed to meet the demand from areas such as the automotive and construction industries, which use a combination of wrought and cast inputs.

A challenge and opportunity for Japan's downstream aluminium producers

The gulf between average and low-carbon aluminium presents both risks and opportunities for Japan's downstream producers.

The rapid expansion of sustainable investment in the country, which saw green bond issuance almost quadruple between 2017 and 2019 (METI 2020a), presents the opportunity for low-carbon producers to access new or more competitive sources of finance. At the same time, investor pressure on end-users of aluminium to enhance their sustainability standards is increasingly pushing these companies to re-evaluate their supply chains and transition to low-carbon suppliers. In a survey by Japan's TCFD Consortium in 2020, 90% of non-financial institutions reported conversations with financial institutions about climate-related disclosure (TCFDC 2020, 2).

Trends among the customers of the downstream aluminium industry clearly show a growing preference for low-carbon sourcing. In the automotive industry, for example, companies are increasingly looking to compete on the basis of emissions. Currently, 83% of global automakers have stated commitments to reduce the lifecycle emissions of their vehicles, while almost three-quarters have set numerical targets. Meanwhile, in Japan's construction industry, demand for low-carbon materials is being supported through the lifecycle assessments included in the CASBEE green building standard and the Green Growth Strategy's push for lifecycle carbon minus buildings.

Recommendations

Japan's downstream aluminium producers are faced with a choice. By sourcing low-carbon materials they can get ahead of demand and gain a competitive advantage among customers increasingly looking to cut their climate impacts. In contrast, sticking with the status quo could leave some producers reacting too late to customer expectations and losing out to earlier movers in the industry. To guide them towards the opportunities that lie in the green transition, this paper makes a series of recommendations to downstream aluminium producers. These include for them to:

1. Work with suppliers to enhance emissions disclosure across the supply chain
2. Set phased decarbonisation pathways that encourage suppliers to transition to low-carbon production models
3. Accelerate decarbonisation efforts by coordinating research and development, investment, and advocacy across the value chain

The paper also recognises that, with major investments in the creation of a thriving green economy, the Japanese government has an opportunity to ignite significant growth in its downstream aluminium sector. To help unlock this potential, it suggests policymakers consider:

1. Setting standards for disclosing embodied emissions and providing support to businesses on compliance
2. Leveraging public procurement to establish benchmarks for what constitutes low-carbon aluminium and integrating these into environmental policies such as electrified vehicle subsidies or the potential automotive carbon trading scheme
3. Utilising foreign development funding to support low-carbon supply chains while extending existing emission-linked import duties to materials that use high volumes of coal or oil in production

With a track record for innovation, significant government investment, and burgeoning green industries, Japan provides a strong environment from which the country's aluminium producers can seize the opportunity of a global low-carbon transition. Those that successfully get ahead of demand for low-carbon materials will enjoy a win-win—what is right for profits and what is essential for our planet.

INTRODUCTION
JAPAN'S LOW-CARBON TRAJECTORY

"Gone are the days when countermeasures to global warming are considered as a cost or constraint to economic growth, the world has entered a new era to grasp them as a great opportunity for further prosperity"

Green Growth Strategy, Government of Japan (GoJ 2020, p.1)

46%

reduction target for greenhouse gas (GHG) emissions by 2030

0.5%

of GDP lost to damages from extreme weather events

In December 2020, on the back of its newly announced commitment to become carbon neutral by 2050, the Government of Japan set out its Green Growth Strategy. The strategy is, in one sense, a response to the looming threat of the climate crisis. By committing to carbon neutrality by the mid-century and later announcing a 46% reduction target for greenhouse gas (GHG) emissions by 2030 (MOFA, 2021), Japan is aiming to head off the major risks of extreme weather, air pollution and economic instability that would come from a continuation of the global status quo. According to the Global Risk Index, Japan suffered 290 fatalities from extreme weather events in 2019 and incurred $28.9bn of damages—the equivalent of 0.5% of GDP (Eckstein, Künzel, Schäfer 2021, 8). With such events set to become both more frequent and more destructive as a result of global heating, failure to act could impose huge economic and social costs.

The Green Growth Strategy is, however, about far more than mitigating risks. The Japanese government is aiming for a "transformation in the industrial structure and social economy" (GoJ 2020, 1) of country so that it can emerge from the transition as a global green superpower. Reflecting this ambition, the strategy is shaped not only to cut emissions but to unlock a "virtuous cycle of economy and environment" (GoJ 2020, 1).

As it looks to accelerate the green transition, Japan builds on some strong foundations. The country has reduced emissions by 14% since 2013—the third largest reduction among G7 nations behind only the UK and Germany. This shift has been spurred by initiatives such as the Global Warming Countermeasures Tax, which covers approximately 68% of domestic emissions and generated $2.4bn in revenues in 2018. Japan is also home to the largest number of institutions supporting the Task Force on Climate-Related Financial Disclosures (TCFD). However, recent years have also seen the country fall behind the race to build a thriving low-carbon economy. Japan was rated 60th in the world on MIT Technology Review's Green Future Index and just 63rd for clean innovation (MTR 2020). The Green Growth Strategy, with its repeated references to action in Europe, the US and Japan's Asian neighbours, is an ambitious attempt to reverse this trend. As a senior member of the country's Ministry of Environment told Nikkei:

"[The Ministry of Economy, Trade and Industry] is basically trying to protect Japanese industries, but they realise it's quite impossible to protect the industries as they are now"

Regalado & Sugiura 2021

At the heart of the Green Growth Strategy is a commitment "to muster all available and necessary policy measures such as budget, taxation, finance, regulatory reform/

standardization, and international cooperation" to build leadership in green industries of the future (GoJ 2020, 2). The Ministry of Economy, Trade and Industry has established a 2 trillion yen Green Innovation fund to support companies over the next decade that demonstrate ambitious green research and development (R&D) programmes (METI 2021a). Moreover, the Ministry of Finance has announced a 1 trillion yen low-interest loan system for companies that "ambitiously reduce CO_2 emissions" (MOF 2020), while an 80 billion yen Green Investment Fund is being implemented by the Development Bank of Japan (GoJ 2020, 10). To compliment these policies, the Bank of Japan announced in July 2021 that it would offer commercial banks interest-free loans to support lending to green projects and businesses (BoJ 2021, 3-4).

¥240tn

to be invested by private enterprises

In addition, the Japanese government is pursuing policy measures to "steer private enterprises in the direction of positively investing the cash equivalent of 240 trillion yen" (GoJ 2020, 2). To achieve this, it is raising the upper limit of tax deduction to 10% and introducing the option of 50% special depreciation for companies investing in products with a large decarbonisation effect (GoJ 2020, 7). Moreover, the upper limit of tax deduction is rising to 30% of total corporate tax for companies that are increasing R&D investment even though their sales have fallen by 2% or more as a result of the COVID-19 pandemic (GoJ 2020, 9). Companies investing in carbon neutrality will also be able to take advantage of a time-limited increase in the upper limit of tax deduction for loss carried forward to 100% (GoJ 2020, 8). Building on these tax deduction policies, the Japanese government is also establishing a performance-based interest subsidy system with funding of 1 trillion yen over three years to support businesses with long-term green transition plans (GoJ 2020, 10). Furthermore, the Green Growth Strategy commits the government to new disclosure rules and a tightening of regulations to stimulate the growth of new green technologies (GoJ 2020, 5, 12).

¥90tn

of positive economic impact generated by 2030

¥190tn

by 2050

By combining unprecedented levels of funding with targeted green policies, the Japanese government believes its innovation strategy can generate 90 trillion yen of positive economic impact by 2030 and 190 trillion yen by 2050 (GoJ 2020, 2). This rapid acceleration of the green transition will have a profound impact beyond the small set of innovative sectors targeted by government stimulus. As the Japanese government admits in the Green Growth Strategy, "many companies will have to fundamentally change the business models and strategies they have been using." Supply chains will have to adapt to new demands—from how raw materials are sourced to the establishment of a circular economy. Moreover, if the establishment of a low-carbon economy is to be consistent with the ultimate objective of combatting the global climate crisis, green industries will be increasingly directed by corporate leaders, public officials and their customers to ensure the full lifecycle of their products is sustainable.

This study explores these potential impacts through the prism of Japan's downstream aluminium industry. Japan's aluminium industry relies on imports of unwrought metal from around the world, which is then fabricated into finished materials for both domestic and export markets. Key corporates within this space include extruders, casting and forging businesses, and aluminium rolling companies. From electric vehicles to green buildings, recyclable packaging to renewable energy infrastructure, aluminium products manufactured by these companies are a vital input for businesses in the green economy. However, the position of Japanese producers in the middle of the supply chain presents a challenge. These businesses will increasingly face pressure from their customers in green industries to supply low-carbon materials. To meet this expectation, however, they will have to influence actors further up the supply chain. The systems needed to identify, source and verify the credentials of low-carbon materials cannot be established overnight, making it imperative for Japanese producers to begin engaging with their suppliers well ahead of an accelerating green transition. While the transition will require a significant collaborative effort, this paper illustrates the significant rewards available to those able to differentiate their materials on the basis of their low carbon

footprint.

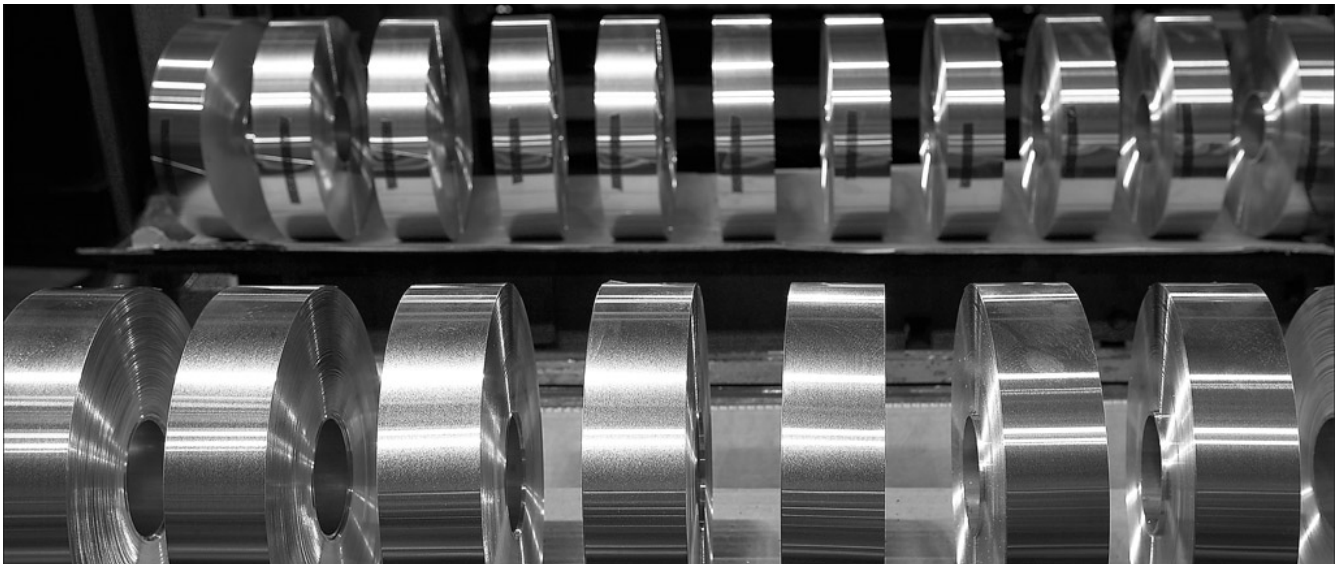
Chapter 1 begins by illustrating the spike in aluminium demand forecast as a result of the green transitions in Japan and around the world. It then highlights the potential damage to the climate that could occur if this demand for aluminium continues to be met with materials made using high-carbon power sources. It establishes how we might identify what constitutes low-carbon aluminium and highlights that green variants of the metal are already available at scale.

Chapter 2 analyses the drivers for low-carbon aluminium demand. It begins by highlighting the ways in which overarching changes in the Japanese economy are reinforcing the principle of low-carbon sourcing. It then focuses on the transformational shifts underway in the automotive and construction industries, illustrating the impact this will have on aluminium demand and the growing push for this demand to be met with low-carbon materials.

Finally, chapter 3 provides some brief recommendations to Japanese aluminium producers on how they might work with their suppliers to transition to low-carbon sourcing, as well as discussing ways policymakers may support the industry as it shifts to this sustainable footing.

While this paper focuses on the aluminium industry, many of its findings are applicable across a range of materials essential to the low-carbon economy. Fundamentally, it points to a win-win scenario for the economy and environment, in which Japanese manufacturers are both able to seize the opportunity of the green transition and spread influence up their supply chains to secure a more sustainable future.

CHAPTER 1:
LOW-CARBON ALUMINIUM IN THE GREEN TRANSITION



Ensuring raw materials match up to green ambitions

The Japanese government has committed to a green transition driven through innovation and aimed at strengthening its competitiveness on a global scale. While the rise of green innovations provides a compelling headline, the devil is in the detail. With increased demand from rapidly scaling industries, there is a risk that raw material inputs do not match up to the low-carbon credentials of their end-products. In this scenario, Japan's green transition would be half-baked. To the observer, Japan would be a country of clean energy, clean cars and clean cities. However, many of the emissions these innovations would look to have saved would be partially reversed by pollution in other countries. Away from the eyes of the general public, high-polluting industries would continue to impact our climate in order to supply the raw materials needed for ostensibly green products.

Shifting the source of emissions rather than eliminating them could have severe consequences that undercut the objectives of Japan's green transition. Prosperity from the low-carbon economy would be enjoyed but not sustained. Emissions released anywhere have consequences everywhere, causing the global climate to continue its steep decline. While green industries would mitigate some of the emissions contributing to the climate crisis, they would not be enough on their own to prevent worsening extreme weather events. This scenario would leave Japan at risk of dangerously high temperatures, increased flooding and more destructive typhoons, which have the potential to wipe out huge amounts of economic value and dramatically impact the lives of Japanese citizens.

The only way to avoid this scenario is to ensure the demands of the low-carbon economy are met using low-carbon materials and for businesses to engage the whole way up their supply chains in a process of collaborative decarbonisation.

Rising demand for aluminium

The aluminium industry in Japan presents a compelling case study for the risks of hidden emissions and the opportunities from a transition to low-carbon materials.

Around the world, the green transition is driving aluminium demand to unprecedented levels. As the International Aluminium Institute (IAI) notes:

"Lightweight, strong, durable, conductive and recyclable, aluminium products are essential enablers of a low carbon future. They provide energy-efficient and carbon-saving solutions to high emitting but critical service-providing sectors, including energy, transportation, buildings and food & pharmaceuticals."
IAI 2021a, 1

In 2018, global demand for aluminium was 95 million tonnes, of which two thirds was met with primary materials and one third recycled (IAI 2021b, 8). However, with aluminium playing a central role across the low-carbon economy, the acceleration of green transitions around the world—coupled with increasing global GDP and a rising population—means demand for the metal is set to grow 80% by 2050 (IAI 2021b, 3). While the supply of recycled aluminium is set to increase over this period, between 75 to 90 million tonnes per year of primary aluminium will still be required to meet demand (IAI 2021b, 9).

20%
increase in demand for aluminium semis by 2025

This global growth is reflected in demand trends for Japan. Driven in particular by shifts in the automotive industry, demand for aluminium semis is set to increase by almost 20% between 2020 and 2025 (Fig. 1, CRU 2021).

Aluminium Semi-finished products Consumption by regio and by end-use, annual '000t

Country	End-use	2019	2020	2021	2022	2023	2024	2025	CAGR 2020-2025
Japan	Transport	1731	1383	1600	1742	1772	1797	1780	5.2%
Japan	Construction	500	443	469	481	483	485	489	2.0%
Japan	Packaging	427	410	431	421	420	418	419	0.5%
Japan	Foil stock	103	109	114	117	117	118	119	1.7%
Japan	Electrical	150	141	151	157	160	164	167	3.4%
Japan	Consumer durables	39	36	40	42	43	44	44	4.1%
Japan	Machinery & Equipment	204	177	189	196	201	208	216	4.1%
Japan	Other	468	422	467	482	494	501	506	3.7%
Japan	**Total**	**3621**	**3120**	**3461**	**3638**	**3691**	**3734**	**3740**	**3.7%**
Recycled metal consumption		1720	1432	1611	1733	1741	1752	1737	3.9%
Primary metal consumption		1949	1715	1891	1938	1975	2000	2003	3.2%

Figure 1

Japan's high recycling rates mean it is better placed than many countries to balance the increasing demand for aluminium with the need to minimise emissions. Under the End of Life Vehicle Recycling Law, car owners, vehicle collecting businesses, automakers and importers are all given a legally defined role to ensure vehicles are recycled.[1] Similarly, the Construction Material Recycling Law requires contractors to sort out and recycle waste generated during the demolition or remodelling of buildings (MOE 2002).

1 See MOETI, "End of Life Vehicle Recycling Law", https://www.meti.go.jp/policy/recycle/main/english/law/end.html

48%

of downstream aluminium inputs made up by recycled aluminium

Japan's refined recycling system enabled the country to reduce final waste disposal by 76% between 2000 and 2017 (MOE 2020a), while in the downstream aluminium industry, recycled aluminium makes up 48% of inputs (JAA 2020, 9).

With recycled aluminium producing approximately 97% less emissions than the average primary aluminium, expanding the circular economy will be vital for keeping emissions from the industry under control (JAA 2020, 6). Over the coming years, downstream aluminium producers are set to benefit from increased availability of recycled inputs as the government continues to expand its support for resource circularity. While funding for establishing a "recycling-oriented society" has been cut under the latest budget from 112 billion yen to 67.4 billion (MOE 2021a), the Japanese government remains committed to ambitious targets under the 4th Fundamental Plan for Establishing a Sound Material-Cycle Society. Through this plan it aims to increase cyclical use rates to 18% by 2025—an 80% increase from 2000—while targeting a 77% decrease in final disposal compared to 2000, reaching just 13 million tonnes by the middle of the decade (MOE 2018, 3). To ensure these targets are delivered, the Ministry of Environment has launched a Circular Economic Partnership with the Ministry of Economy, Trade and Industry and the Japan Business Federation to coordinate policies on the circular economy and improve the competitiveness of Japanese companies in this area (MOE 2021b). The government will also inject funds into the circular economy by expanding public procurement of recycled products through the Green Purchasing Law (GoJ 2020, 63). Building on this support, the Ministry of Environment and Ministry of Economy, Trade and Industry launched the first disclosure and dialogue guidance for "promoting sustainable finance related to the circular economy." The ministries hope that the resource will help Japanese companies operating in the circular economy "to receive appropriate evaluations from domestic and foreign investors and financial institutions… and to attract investment and loans" (MOE 2021c).

18%

increase in cyclical rates by 2025

80% increase since 2000

75%

of aluminium products to be recycled by 2050

With support from the government's clear commitment to the circular economy, the Japan Aluminium Association (JAA) is aiming for recycling of aluminium products in Japan to reach 75% by 2050 (JAA 2020, 2). While this target demonstrates significant ambition, it also highlights the continuing importance of primary metal. Currently, close to 100% of cast aluminium products are recycled in Japan (JAA 2020, 2). However, challenges related to the mixing of alloys and degradation of purity means the recycling rate for wrought products is just 10% (JAA 2020, 9). While innovations in recycling technology are emerging to help close this gap, the JAA targets would see primary aluminium still used for 70% of wrought products by 2030 and 50% by 2050 (JAA 2020, 11). This is particularly significant given that sectors such as automotive and construction, where demand for aluminium is set to grow at a significant rate (see fig. 1), use a combination of both cast and wrought inputs. There is also a ceiling on the availability of secondary aluminium suitable for certain sectors. For example, in an examination of the mineral demands from solar panels, wind turbines and batteries, the World Bank predicted that secondary aluminium could at most meet 61% of these sectors' needs, even with a 100% end of life recycling rate (World Bank 2020, 14).

1.1Gt

of GHG produced by aluminium industry per annum

2% of all global anthropogenic emissions

With primary aluminium set to play an important role over the coming decades for downstream producers in the Japanese market, a potential contradiction emerges from the accelerating green transition. Production of the metal is energy intensive, requiring highly charged anodes to convert aluminium oxide (alumina) into aluminium. According to data from the IAI, approximately 60% of this power comes from coal-powered energy sources.[2] The result is that the aluminium industry as a whole produces approximately 1.1 gigatonnes of greenhouse gases per annum, accounting for 2% of all global anthropogenic emissions (IAI 2021b, 3). In a business as usual scenario, this figure could reach 1.6 gigatonnes by 2050 (IAI 2021b, 7), whereas a scenario compatible with the United Nations' pathway for global warming below 2°C would require a reduction in emissions to 250 megatonnes (IAI 2021b, 8).

2 IAI, Primary Aluminium Smelting Power Consumption, https://www.world-aluminium.org/statistics/primary-aluminium-smelting-power-consumption/#data

60%

of aluminium emissions come from electrical energy

In Japan, the discrepancy between standard and low-carbon aluminium presents two possible scenarios for decarbonisation. As set out by the JAA, a scenario without innovations in primary aluminium smelting would limit emissions reductions in the production of wrought aluminium products to 44% by 2050. However, with the help of low-carbon developments, the emissions reduction could reach as high as 78% (JAA 2020, 15).

Fortunately, clear pathways already exist for the decarbonisation of primary aluminium. Since more than 60% of emissions released by the aluminium industry come from its use of electrical energy, switching to renewable power sources has a dramatic effect on producers' climate impact (IAI 2021b, 10). Aluminium produced in this way is already available at considerable scale, with international producers including Hydro, Rio Tinto, Alcoa and Rusal offering metal with a carbon footprint below 4 tCO_2/tAl (CT 2020, 3) compared to a global average of 12.6 tCO_2/tAl. While slightly different methodologies are used by each company to calculate these footprints, the Carbon Trust notes that these largely align with the IAI's level 1 guidelines, which include emissions from aluminium electrolysis, aluminium ingot casting, anode/paste production, as well as emissions from generating electricity and heat consumed in these processes. This paper therefore follows the Carbon Trust's precedent by defining low-carbon aluminium as any metal made with an emissions intensity below 4 tCO_2/tAl as measured according to level 1 of IAI guidelines.

As the integration of renewable energy into aluminium production continues to progress and the availability of secondary wrought material remains constrained, downstream aluminium producers in Japan face an increasingly stark choice between low-carbon and high-carbon forms of primary aluminium. As the next chapter will establish, the public and private sector forces driving the green transition are set to not only elevate overall demand for aluminium but provide Japanese producers with an opportunity to differentiate their products on the basis of low-carbon sourcing.

CHAPTER 2:
THE EMERGENCE OF LOW-CARBON ALUMINIUM AS A DIFFERENTIATOR

Low-carbon materials for a low-carbon economy

As the world embraces green innovations, governments, businesses, and consumers are increasingly supporting a parallel drive to ensure the materials used for this revolution are consistent with their environmental values. This movement is already underway in Japan but is set to accelerate over the coming years as the Japanese government implements its Green Growth Strategy and low-carbon industries continue to mature.

This chapter will highlight the structural changes taking place within financial markets, which are set to drive a general transition towards low-carbon business practices in Japan. It then uses specific examples from the automotive and construction sectors to illustrate the increasing rate at which low-carbon aluminium will become a differentiator for Japanese producers selling to these businesses.

A changing investment climate

As Japan commits to the Green Growth strategy, significant changes to the way markets function within the country have potential to restructure the incentives for green business practices and, as a result, the sourcing of low-carbon materials.

3.7x

increase in green bond issuance between 2017 and 2019

The most prominent of these changes is the rise of sustainable investing. Green bond issuance in Japan increased 3.7 times between 2017 and 2019 alone, reaching 823.8 billion yen (METI 2020a). Similarly, annual surveys by the Japan Sustainable Investment Forum (JSIF) have shown a sharp increase in sustainable investment from 43 prominent domestic institutional investors. Between 2018 and 2019, sustainable investment by the survey respondents increased 45% to 336 trillion yen (JSIF 2020). This figure marks a dramatic rise from 27 trillion yen in 2015 (JSIF 2016).

It is not only the volumes of sustainable investment that are changing; Japanese companies are being required to provide increasingly granular disclosure on

90%

of non-financial institutions reported climate-related disclosure conversations with financial institutions

environmental, social and governance (ESG) topics. In a survey by Japan's TCFD Consortium in 2020, 90% of non-financial institutions reported conversations with financial institutions about climate-related disclosure (TCFDC 2020, 2). Moreover, 40% of these respondents said they discussed the topic at least five times a year—double the number that replied with this answer five years before (TCFDC 2020, 11). Over the same five-year period, the number of respondents who never talked about climate-related disclosure halved from 20% to less than 10% (TCFDC 2020, 11). Combined, these survey results demonstrate a distinct shift in the way financial institutions are treating the climate impacts of Japanese companies. No longer are these a secondary consideration to be touched upon at most once a year. Instead, they are a key area of disclosure, constantly enriched over regular conversations.

The environment for climate-related disclosure is being strengthened by ongoing policies from the Japanese government. For example, under the Act on Promotion of Global Warming Countermeasures, emitters that consume energy equivalent to 1,500kL or more of oil per year are required to develop a plan of countermeasures. While there is no legal requirement to reduce climate impacts, organisations are required to report their emissions.[3] Moreover, the Global Warming Countermeasure Tax introduced in 2012 attaches a financial impact to emissions—albeit at a lower price to comparable systems in Europe (Kojima & Asakawa 2020).

The Japanese government has shown it intends to strengthen incentives for climate-related disclosure and drive investors to companies pursuing low-carbon business models. Ahead of the 2020 TCFD Summit, Kajiyama Hiroshi, Japan's Minister of Economy, Trade and Industry, published a list of "Companies Taking on the Zero-Emission Challenge." The aim of the list was to showcase to investors the companies in Japan that are "taking on innovations toward realization of a decarbonized society." The Japanese government also committed to "encourage efforts of these companies… [by] providing them with opportunities for holding dialogues with investors and other stakeholders" (METI 2020b). More generally, the Japanese government is pursuing a "Climate Innovation Finance Strategy" designed to "attract private investment into green, transition and innovative initiatives" (GoJ 2020, 10). It has proposed "a cooperation system with financial institutions to back up execution of the Green Growth Strategy, including enhanced collaboration with policy finance" (GoJ 2020, 11). Moreover, Japanese authorities are considering measures under the Green Growth Strategy to "accelerate ESG investment by… vitalizing the corporate bond market," as well as committing to leadership in "international discussions on taxonomy and transition finance" (GoJ 2020, 11).

The growing prominence of sustainable finance coupled with government efforts to channel funds towards green businesses is set to make environmental performance an increasingly important factor for accessing capital. At a base level, companies are now being expected to meet set criteria for ESG-related disclosure. However, as shown by the "Zero-Emission Challenge" launched by the Japanese government, leadership on decarbonisation increasingly presents opportunities to differentiate from competitors and attract new investors. As sustainable investment continues to mature and disclosure standards become more refined, the incentive is strengthening for businesses to consider all routes for reducing their climate impact. For aluminium producers, this presents both a risk and opportunity. Act now to secure low-carbon materials and there will be opportunities to acquire new customers who, under pressure from their investors, are looking to decarbonise their supply chains. Delay and there is a danger that, under this same pressure, existing customers begin to search elsewhere for their sourcing.

3 See LSE, "Act on Promotion of Global Warming Countermeasures", https://climate-laws.org/geographies/japan/laws/act-on-promotion-of-global-warming-countermeasures-law-no-107-of-1998#:~:text=Energy%20Demand%20Transportation-,Act%20on%20Promotion%20of%20Global%20Warming%20Countermeasures%20(Law%20No,107%20of%201998)&text=This%20Law%20is%20one%20of,GHGs%20derived%20from%20anthropogenic%20activities.

25%

global CO_2 emissions accounted for by transport

23m

EV sales in 2030, compared to 3m last year

20%

Japanese GHG emissions accounted for by automobiles

Demand for low-carbon aluminium in the age of zero-emission vehicles

Charting a sustainable future for transportation is a major challenge for societies around the world. Transport currently accounts for approximately a quarter of global CO_2 emissions, with road transport alone contributing 18% (Winkler et al. 2020, 4).

In response to the climate crisis, auto manufacturers are moving inexorably away from the internal combustion engine and towards new forms of transport—in particular, electric vehicles (EVs). In 2020, EVs defied a 14% decline in overall car sales to achieve 40% sales growth and a record market share of over 4% (Gorner & Paoli 2020). As McKinsey noted in September last year: "If the current tailwinds for EVs in China and Europe persist, electric mobility could emerge from the COVID-19 crisis in an even stronger position than pre-crisis estimates had predicted" (Gersdorf et al. 2020). On the back of this growing demand, annual EV sales are expected to reach 23 million in 2030, compared to 3 million last year, while the total number of EVs on the road will hit 130 million (Gorner & Paoli 2020).

Helping to drive the growth of EVs is a willingness from consumers to pay a premium for zero-emission vehicles. In a global survey, Deloitte found 40% of people would be willing to pay up to EUR 2,500 more for an EV (Deloitte 2020, 30). This figure increased for individuals from Gen Y/Z, almost 20% of whom said they would be prepared to pay over EUR 2,500 (Deloitte 2020, 31).

The pressure to decarbonize transport is particularly acute in Japan, where automobiles account for nearly 20% of GHG emissions (Gakuto 2020) and—at 2.5% of the country's GDP—global sales by automakers are vital to economic growth (Regalado & Sugiura 2021). The response until recently has been to embrace hybrid vehicles (HEVs) over EVs. Registrations of HEVs have increased from 481,000 in 2010 to 1.47 million in 2019 (Statista 2020), while sales are projected to continue rising until 2027, when they could to hit a peak of $792 billion (Edmondson & Wyatt 2020). In Japan, 45% of consumers say they would prefer to buy an HEV as their next vehicle, equalling the preference for internal combustion engine (ICE) vehicles and putting demand well ahead of markets in Europe and North America (Deloitte 2021). Japanese HEVs have been equally successful abroad, propelling the country's automakers into the top spot for electrified vehicle sales worldwide (Regalado & Sugiura 2021).

At present, investment in HEVs is a sensible approach to decarbonisation for Japanese auto manufacturers selling into the domestic market. While significant progress has been made over the last decade to transition Japan away from fossil fuel dependency, these non-renewable energy sources still accounted for 88% of total primary energy supply in 2019 (IEA 2021, 13). As such, an immediate shift to EVs would be limited in its ability to reduce GHG emissions, shifting pollution from tailpipes to the grid rather than delivering full decarbonisation. Without an energy transition, HEVs and, in the longer term, hydrogen powered vehicles could present a stronger environmental case. However, under the Green Growth Strategy, the Japanese government envisages renewables accounting for 50% to 60% of electricity demand by 2050, while targets proposed by Ministry of Economy, Trade and Industry would see clean energy contributing 36-38% of power production by 2030 (Adler 2021). As renewables become increasingly prevalent in Japan's energy supply, the environmental argument for EVs will strengthen. Moreover, with exports accounting for around half of Japanese auto production (JAMA 2020, 14), a strong EV proposition will be needed independent of the domestic energy transition.

While HEVs have flourished in Japan, a promising start for EVs with the globally popular Nissan Leaf has stalled in recent years. EVs and plug-in hybrids made up just 0.9% of Japan's auto mix last year, (Gakuto 2020) with sales of 0.04 million compared to 0.59 million in Europe, 0.33 million in the US and 1.1 million in China (IEA 2020). Japanese

automakers sit tenth in the world for EV exports, taking less than 5% of the market—a figure skewed by the success of the Nissan Leaf, which accounted for nearly 65% of vehicles sold (Dooley & Ueno 2021).

"Electrified vehicles account for 100% of new passenger vehicles sold each year no later than the mid-2030s"

HEVs present a growth market for Japanese automakers over the medium-term, particularly given the government's commitment to ensuring "electrified vehicles account for 100% of new passenger vehicles sold each year no later than the mid-2030s" (GoJ 2020, 31). However, the Japanese government recognises in the Green Growth Strategy that it needs to build long-term competitiveness specifically in EV production. Under the strategy, it commits to "vigorously push forward introducing electric vehicles, building world-leading industrial supply chains, including batteries, and creating a mobility society" (GoJ 2020, 31). As part of this, the government plans to "utilize fuel economy regulations, promote public procurement, expand charging infrastructures… [and] encourage car replacement" (GoJ 2020, 32) to boost uptake of EVs. Investment will be directed to R&D with the goal of achieving an automotive battery pack price of 10,000 yen/kWh by 2030, which would place EVs on economic parity with ICE vehicles (GoJ 2020, 34). Moreover, Japan's Environment Ministry has doubled the subsidy for purchasing EVs to 800,000 yen, provided the electricity used in the buyer's home or office is generated from renewable energy sources (METI 2021b). Perhaps most ambitious, the Japanese government is currently in talks on establishing a carbon offset market for the auto industry. This would require manufacturers to sell certain percentages of electrified vehicles within their product mix, with those not compliant made to purchase GHG credits from industry peers (Gakuto 2020).

The initiatives being implemented by the Japanese government will help accelerate the ambitious growth plans of the country's automakers to build a leading position in the global EV market. Toyota is aiming to introduce 15 all-electric models by 2025—an increase from 4 today (Regalado & Sugiura 2021). Honda meanwhile has announced all new cars will be either EVs or fuel-cell vehicles (FCVs) by 2040 and aims for these models to account for 15% of sales by 2030 (Regalado & Sugiura 2021). In a similar vein, Nissan, which recently passed 500,000 sales of its Leaf, plans to launch two more EV models by 2023 (Nissan 2020).

1kg

aluminium used in car production replaces 2kg steel

The global transition to EVs is set to become a major driver of aluminium demand, due in large part to the metal's lightweight properties. Every 1 kg of aluminium used in car production is able to replace 2 kg of steel (Fitzpatrick, Synagowitz & Snowdon 2020, 9)—an important factor considering that for every 100 kg of weight saved, an EV's milage increases by 10-11% and battery costs fall by 20% (Stall 2020). From a climate perspective, the lightweight properties of aluminium mean every tonne of the metal used to replace heavier materials can save between 13 and 23 tCO_2 over a vehicle's lifetime (Fitzpatrick, Synagowitz & Snowdon 2020, 9), with the environmental impact becoming more pronounced as the size of the vehicle increases. A combination of these factors means that the average amount of aluminium used in an EV is 30% higher than in an ICE vehicle (Desai 2020).

30%

more aluminium used in EV than an ICE vehicle

The higher volumes of aluminium required by EVs will have a significant impact on demand dynamics. Wood Mackenzie forecasts that aluminium demand from the automotive sector could nearly double between 2020 and 2025, with the auto industry consuming 3.3% of all primary material (Desai 2020). This growth trend is set to accelerate in the latter half of the decade, with aluminium demand from car manufacturers projected to be 10 times higher in 2030 than it was in 2017 (Dinsmore 2018). In this scenario, the road transport sector could account for approximately a quarter of total demand growth for aluminium between now and the end of the decade (Jones et al. 2019, 19). The aluminium demand trends seen at a global level are reflected in the domestic Japanese market, where consumption of semi-finished aluminium by the automotive sector is set to rise 29% between 2020 and 2025 (Fig.1, CRU 2021).

29%

rise in semi-finished aluminium by automotive sector between 2020 and 2025

60%

of vehicle's life-cycle emissions will be material emissions by 2040 compared to 18% today

Accelerating aluminium demand from the automotive sector could have severe climate impacts if low-carbon materials are not specified. Currently, materials production is responsible for 18% of emissions in the automotive industry. However, as noted by McKinsey, the decline in tailpipe emissions resulting from the transition to EVs means "emissions from vehicles' materials will increase both absolutely and relatively and soon become a larger share of life-cycle emissions." McKinsey estimates that "the growing market share of battery electric vehicles that have higher baseline material emissions—and the changing energy mix required to power them—will boost material emissions from 18 percent of vehicles' life-cycle emissions today to more than 60 percent by 2040" (Hannon et al. 2020).

While rising emissions from materials use in the automotive sector is a significant risk, effective and practical pathways exist for mitigating the potential climate impact. Analysis by McKinsey shows the industry could abate 66% of emissions from materials production at no extra cost by 2030. It notes that 60% of these costs-positive decarbonisation approaches involve aluminium or plastics, with the potential to abate more than 73% of emissions linked to aluminium through use of recycled materials or sourcing from low-carbon smelters (Hannon et al. 2020). A major impact could come from inert anode smelting technology, currently being developed by companies such as En+ Group and a joint venture between Rio Tinto and Alcoa. This approach to smelting uses anodes made from non-consumable materials such as ceramics or alloys rather than carbon, meaning they do not degrade during the aluminium production process. As a result, oxygen is created as a by-product rather than carbon dioxide. The potential of this technology as an industrial scale solution was shown in April of this year, with En+ Group producing aluminium that had process emissions of just 0.01 tCO_2/tAl (En+ Group 2021). McKinsey predicts that rollout of inert anode technology could eliminate 0.4 tCO_2 per vehicle. With the cost of transitioning to low-carbon materials shown by McKinsey to be relatively low for automotive manufacturers, only a small incentive will be required for these companies to begin making demands of their suppliers.

0.01tCO_2/tAl

process emissions in aluminium produced by En+ Group

90%

of consumers deem sustainable materials important factor for EVs

The incentive for change is already apparent in consumer sentiment. In a global survey by McKinsey, over 90% of consumers said they deem sustainable materials an important factor for EVs, with approximately 60% describing the issue as moderately or extremely important (Garibaldi et. al 2021). This trend was reflected in Asia, where sustainable materials were ranked as important by a higher proportion of respondents than low-emission manufacturing and end-of-life recycling (Garibaldi et. al 2021). At the opposite end of the spectrum, failure to demonstrate sustainable sourcing could reinforce existing resistance to EV adoption by the 39% of consumers who believe EVs have a comparable or worse impact on the environment compared to ICE vehicles (Deloitte 2020). In Japan, almost half of individuals who told a government poll they did not want to work to create a decarbonised society cited uncertainty about how effective countermeasures are against global warming. The fact that this was the most frequently cited answer among this group shows the potential for disillusionment from negative stories about the environmental impact of supposedly green industries (GoJ 2021).

Recognising the direction of consumer sentiment, automotive executives are rapidly shifting their approaches to sourcing—a transition that will have significant implications for aluminium producers in Japan aiming to remain competitive in the coming decades. In a global survey of automotive executives, KPMG found 98% believe sustainability is a key differentiator (KPMG 2020, 25). Moreover, 48% of executives said they view sustainability as a product feature, meaning it is integral for the product itself, rather than marketing, to demonstrate sustainability credentials (KPMG 2020, 24). If the product itself is viewed as core to differentiation on the basis of sustainability, the implication is that vehicles will need to be sustainable throughout their lifecycle, or risk being accused of greenwashing. This view is supported by research conducted by Capgemini, which

found sustainable supply chains ranked in the top five priorities for global automotive executives (Winkler et al. 2020, 11).

Around the world, we are seeing this executive sentiment translating into tangible actions designed to shift automotive supply chains towards low-carbon materials. In a review for this paper of sustainability policies at global automotive manufacturers, 83% were found to have specific commitments to addressing the lifecycle impact of their cars. Moreover, almost three quarters had numerical commitments on this issue.[4]

Commitments by global OEMs to tackling lifecycle emissions

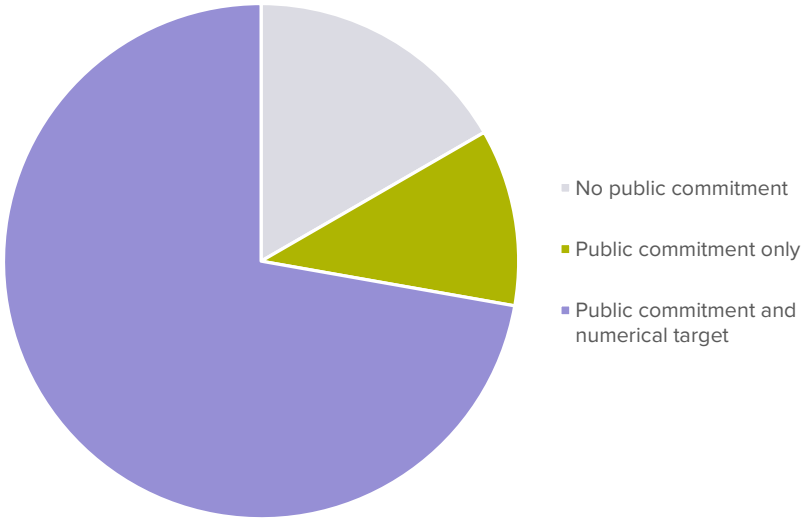


Figure 2

In a clear signal of the industry's trajectory, companies such as Jaguar Land Rover and Daimler have committed to carbon neutral supply chains. Meanwhile, in an interview with Business Green, Polestar's head of sustainability, Fredrika Klarén, stated the manufacturer's intention to achieve full sourcing transparency, transition to renewable energy throughout its supply chain and move to circular and innovative materials. Klarén stated: "We will not wait for customers to demand solutions—but instead take a proactive approach to educate and deliver attractive, sustainable offers to them" (Klarén 2021).

To back up these long-term commitments, automotive manufacturers are acting now to increase their proportion of sustainable sourcing, with numerous initiatives specifically targeting aluminium. In January of this year, Audi became the first car manufacturer to be awarded the Aluminium Stewardship Initiative's Chain of Custody certificate (Audi 2021). Its German rival, BMW, announced at a similar time this year that it would be sourcing aluminium made using solar electricity as part of its aim to reduce emissions in its supplier network by 20%. The company believes aluminium made using renewable energy can cut 2.5 million tCO_2, equivalent to 3% of its supply chain emissions (BMW 2021). Jaguar Land Rover, meanwhile, has said it plans to use recycled aluminium from drinks cans and end-of-life materials to reduce its emissions by up to 26% (Mace 2020). Volvo is pursuing a similar approach, launching a partnership with aluminium roller Novelis to create a closed-loop recycling system it hopes will cut the footprint of its aluminium sheet by 78% (Bloxsome 2019).

These trends extend to Japan, where both Toyota and Nissan have committed to reaching net zero lifecycle emissions for their vehicles by 2050.[5] Honda is following a similar path, with a commitment to halve lifecycle emissions by 2050 compared to 2000 (Honda 2020, 57), while Mazda is aiming for a 50% reduction from 2010 emission levels

4 OEMs studied include Toyota, Volkswagen, BMW, Volvo, GM, Mitsubishi, Ford, Honda, Daimler, Hyundai, Nissan, Mazda, Suzuki, JLR, Stellantis, Renault, Tata Motors and Mahindra

5 See Toyota, "Toyota Environmental Challenge 2050", https://www.toyota.co.uk/world-of-toyota/environment/environmental-challenge-2050 and Nissan, "Nissan sets carbon neutral goal for 2050", https://global.nissannews.com/en/releases/nissan-sets-carbon-neutral-goal-for-2050

"Zero CO_2 emissions in 2050 through the production, use and disposal of automobiles"

by 2030 and a 90% reduction by 2050.[6] Under the Green Growth Strategy, the Japanese government has committed to provide support in these lifecycle decarbonisation efforts with the aim of achieving "zero CO_2 emissions in 2050 through the production, use and disposal of automobiles" (GoJ 2020, 31). Japanese manufacturers will also benefit from the high volumes of recycled cast aluminium available in the Japanese market for parts such as engine blocks and cylinder heads. As shown in figure 3, cast products make up approximately three quarters of aluminium demand from Japan's automotive sector (Nalk 2021). However, it will be more difficult to reach full recycled content for wrought aluminium used in parts such as body panelling. In a scenario where availability of secondary aluminium is constrained, specific initiatives will be required to source low-carbon primary aluminium, as seen at the likes of Audi and BMW.

Shipments of Aluminium Products for Automotive Applications in 2020 (tons)

			2018	2019	2020	Y-on-Y% Chg
Rolled and Extruded Products	Wheels		955	1,086	933	85.9
	Motorcycles		7,651	7,667	7,125	92.9
	Passenger Cars		146,061	163,423	145,368	89.0
	Track & Buses		42,305	41,809	39,214	93.8
	Heat Exchangers		125,477	117,638	92,121	78.3
	Sub-total		322,449	331,623	284,761	85.9
		Rolled	(180,336)	(193,940)	(165,155)	85.2
		Extruded	(142,113)	(137,683)	(119,606)	86.9
Castings & Die Castings	Castings		424,352	410,960	319,754	77.8
	Die Castings	Motorcycles	24,597	23,107	18,744	81.1
		Passenger Cars etc.	941,442	896,899	736,289	82.1
	Sub-total		1,390,392	1,330,965	1,074,788	80.8
Forgings			32,142	31,318	28,742	91.8
Total			**1,744,983**	**1,693,906**	**1,388,291**	**82.0**

Figure 3

The international mix of automotive manufacturers committed to sustainable sourcing initiatives is particularly important for Japanese aluminium producers, which exported 171,000 tonnes of rolled and extruded products in 2020 (Nalk 2021). Even for aluminium producers not involved in exports, the trend in the automotive industry towards sustainable materials will only grow among domestic automotive and automotive parts manufacturers, who will be expected by customers both in Japan and worldwide to match the climate actions of their global peers.

For aluminium producers in Japan selling into the automotive sector, the impetus to source low-carbon aluminium is further strengthened when considered in the context of competition with the steel industry. As previously noted, aluminium's lightweight properties compared to high strength steel, means it has replaced the heavier metal in some auto parts. However, as focus shifts onto the carbon footprint of materials, favour could swing back towards steel, given its lower average emissions intensity combined with generally cheaper costs and incumbent relationships with industry in Japan. Only low-carbon aluminium has a carbon footprint competitive with steel. This has the potential to reach parity or even an environmental performance advantage for low-carbon aluminium once automakers factor in that they will need less batteries—and therefore less high-polluting battery components—given the lighter weight of their vehicles. The key determinant in this equation will be the low-carbon origin of the primary material—without this, the benefits of lightweighting alone will not enable aluminium to compete on carbon footprint with steel equivalents.

The rapid expansion of the global EV market coupled with the Japanese government's

6 See Mazda, "Long-term vision for technology development, 'Sustainable Zoom-Zoom 2030'", https://www.mazda.com/en/csr/environment/sustainable/

ambitious moves to increase market share presents a major growth opportunity for the aluminium industry over which producers around the world will be competing. It is clear from recent initiatives launched by automotive manufacturers that low-carbon materials will become a key differentiator. It is therefore imperative for Japan's aluminium producers to engage with their supply chain to ensure they have the low-carbon inputs they need to remain competitive at home and abroad.

Low-carbon aluminium at the foundation of a green building boom

50%

of carbon footprint of new construction forecast to be produced by embodied emissions between now and 2050

As we progress towards the middle of the century and the world's population approaches 10 billion people, the global building stock is expected to double in size (Adams et al. 2019, 7). With buildings currently responsible for 39% of global energy-related carbon emissions, this steep increase in new building could have a profound impact on the state of the planet. In response to the climate crisis, the World Green Building Council (WGBC) is putting pressure on the construction companies to realise the 84 gigatonnes of CO_2 savings possible across the industry by 2050 (Dean et al. 2016).

While there is considerable focus on the potential for energy efficiency to deliver reductions in operational emissions from buildings, tackling the climate impacts embodied in construction materials is also critical. In total, approximately 28% of emissions linked to buildings come embodied in construction materials, accounting for 11% of total global energy related carbon emissions worldwide (Adams et al. 2019, 16). This figure is rising, with embodied emissions forecast by the WGBC to be responsible for half of the entire carbon footprint of new construction between now and 2050 (Adams et al. 2019, 17). As a result, the WGBC is leveraging its global network of green building councils to push for a 40% reduction in embodied carbon emissions by 2030 and for buildings, infrastructure and renovations to reach net zero embodied carbon by 2050 (Adams et al. 2019, 16).

Surveys of both decision makers in the construction industry and consumers in numerous countries suggests an alignment with the World Green Building Council's vision for reduced embodied emissions. Collecting information from specifiers, installers and distributors in the construction industry, Saint-Gobain found 76% want their suppliers to be transparent about the impact of their products and 72% want manufacturers to provide sustainable products (Saint-Gobain 2018). Meanwhile, in a survey of consumers in the United Kingdom, United States and Germany, En+ Group found over half of people in these countries believed governments should deny new building requests to projects with higher carbon footprints (En+ Group 2020, 10).

1/3

Japanese CO_2 emissions are building related

The Japanese government is targeting carbon neutrality for new buildings by 2030

The global trend towards green building is reflected in the Japanese market. Recognising that building-related emissions are responsible for approximately a third of the country's total CO_2 emissions (Climate Transparency 2019, 10), the Japanese government is targeting carbon neutrality for new buildings by 2030 and for the average housing stock by the second half of the century (Regalado & Sugiura 2020). This target sets up a major transformation in the construction sector. While 70% of newly built detached houses currently meet specific standards for energy efficiency under Japan's Building Energy Efficiency Act (GoJ 2020, 59), building-related emissions in the country remain more than double the G20 average at 3.22 tCO_2/capita (Climate Transparency 2019, 10). To reverse this trend, the Green Growth Strategy sets out plans to introduce subsidies and tighten regulations to expand the construction of lifecycle carbon minus (LCCM) buildings, which are carbon negative from construction to dismantling and re-use, as well as zero energy buildings (ZEBs), which incorporate energy efficient design, high-performance insulation and capacity for renewable energy generation (GoJ 2020, 59).

The Green Growth Strategy also sets out significant support for the development of distributed renewable energy systems designed to help reduce the demand from buildings for fossil fuel generated power. In the strategy, the Japanese government

commit to "encourage the introduction of renewable energy such as photovoltaics" (GoJ 2020, 60) with the aim of equipping new buildings with next-generation solar cells by 2040 (Regalado & Sugiura 2020). The government notes:

"If the thin and lightweight next-generation solar cells, which Japan has strengths in, are put to practical use, installing solar panels on the roofs of existing houses and buildings with a small load capacity, and on the walls and windows of houses and buildings, which are now technically difficult, will become possible"

(GoJ 2020, 58)

In addition to supporting solar panel installation, the government is seeking to drive development of home-storage systems that will both stabilize the grid and enable homeowners to maximise the benefits of their buildings' renewable energy generation. Under this programme of activity, the Green Growth Strategy aims to develop a home-use storage system at the price of 700,000 yen/kWh or less (including construction costs), at which point solar panels combined with storage batteries would become economical to Japanese households (GoJ 2020, 34).

As global construction continues to expand, demand for aluminium is forecast to rise, with the green building movement likely to direct sourcing increasingly towards low-carbon materials. Lightweight, easy to extrude and durable, aluminium is a go-to material in areas such as curtain wall framing, windows, and partitions. Aluminium's reflective properties also make it popular for cladding in energy efficient buildings. The reflective cladding can help manage natural light in ways that reduce the need for electric lighting, keep the building cool when sunlight is strong and provide an insulating layer for cold weather. Moreover, aluminium foil is a popular component in insulation, offering both the ability to reflect infrared heat and an impermeable barrier to light and moisture.

10%

increase in demand from construction industry between 2020 and 2025

As a result of aluminium's versatile uses, buildings account for 24% of all demand for the metal (WEF 2020, 9). In Japan, demand from the construction industry is set to increase by over 10% between 2020 and 2025—the largest source of demand after the automotive industry (CRU 2021). Use of aluminium will rise yet further as a result of the Japanese government's focus on distributed renewable energy. The metal accounts for 85% of most solar panel components (WEF 2020, 9), making it an essential element for the installation of renewable generation capacity in new and existing buildings.

85%

solar panel componenets made of aluminium

As with the rise of EVs, the increased demand for aluminium from a growing construction sector presents a potential contradiction to Japan's aspirations for a green transition. Currently, aluminium manufacturing is the third highest source of GHG emissions in the construction materials sector (BioNova 2020, 8). However, recent research by BioNova has suggested that significant abatement can be achieved through the specific selection of low-carbon aluminium. It found that aluminium can account for 42% of total embodied carbon emissions in wood-framed buildings, but that switching to a low-carbon variant of the metal could reduce this climate impact by up to a fifth (BioNova 2020, 2). This is particularly significant in Japan, where 80% of low-rise houses use a wooden structure and where the government has committed under the Green Growth Strategy to "disseminate and promote the use of timber" (GoJ 2020, 61). BioNova found similar potential for commercial buildings, where low-carbon aluminium could reduce emissions by 7% (BioNova 2020, 11), and in retrofits, where emissions fell 11% (BioNova 2020, 3). The BioNova study also examined the embedded emissions of individual building components made from aluminium. For partition walls, curtain walls and windows, replacing conventional aluminium with low-carbon aluminium reduced embedded emissions by 29%, 32% and 43% respectively (BioNova 2020, 16-18).

20%

reduction in climate impact when switching to a low-carbon variant

The emissions reduction potential of low-carbon materials is already reflected in Japan's leading building standards, the Comprehensive Assessment System for Build

Environment Efficiency (CASBEE). Created by the Institute for Building Environment and Energy Conservation, CASBEE certification currently covers almost 1,000 buildings across Japan. Under the standards, buildings are given an overall score for both quality and environmental impact. As part of the evaluation for environmental impact, buildings are required to undergo a lifecycle assessment of CO_2 emissions which is compared to reference values for a standard equivalent building. This provides an opportunity for developers to demonstrate outperformance on environmental considerations, including emissions embedded in building materials, energy efficiency and renewable energy generation. The final results are communicated on a chart attached to the building's certification, showing its lifecycle emissions as a percentage of the emissions for the reference building.

As uptake of the CASBEE certification system increases and developers push to reduce lifecycle emissions, it will be ever more important for aluminium producers to secure low-carbon primary metal. Ensuring emissions embodied in materials are as low as possible will also be essential for Japanese aluminium producers aiming to export to global customers in the construction sector. As BioNova points out: "Measuring and optimizing embodied carbon is a standard requirement in green building rating systems" and is "particularly true of international systems, such as LEED and BREEAM" (BioNova 2020, 12).

Through the continued growth of the construction sector and the increasing importance of energy efficiency and distributed power generation, Japanese aluminium producers can secure a strong market for their materials. However, with green building practices becoming ever more embedded in the approaches taken by the public and private sector, producers will have to differentiate themselves, ensuring they have the low-carbon materials to match visions of a more climate-conscious society.

CHAPTER 3:
CONCLUSION & RECOMMENDATIONS

From the rise of electric vehicles to a boom in green building, the low-carbon transition provides an unprecedented opportunity for aluminium producers around the world. The dynamics in Japan are favourable, with the government setting clear commitments to a green economy and building on established systems for innovation and finance. Within this context, downstream aluminium producers in Japan are well-placed to reap the benefits of a burgeoning domestic market and growing demand from green industries around the world. However, as illustrated by moves in the automotive and construction industries to address lifecycle sustainability and embedded emissions, Japanese producers will need to ensure the climate impacts of their metal aligns with the environmental vision of their customers, governments and consumers around the globe. Fail to act fast enough and they risk being left behind.

Recommendations for Japanese aluminium producers

1. *Work with suppliers to enhance emissions disclosure across the supply chain*

Tackling emissions in the aluminium supply chain will not be easy. It will require collaboration up the supply chain and a clear articulation to customers that, while change cannot happen overnight, a plan is in place that aligns decarbonisation of materials with the journey towards a low-carbon economy. A starting point will be for downstream aluminium producers to ask for transparency on carbon emissions from their suppliers. As recommended by the Carbon Trust, this should begin with a requirement for emissions disclosure in line with the IAI Level 1 guidelines, which cover emissions from aluminium electrolysis, aluminium ingot casting, anode/paste production, as well as emissions from generating electricity and heat consumed in these processes (CT 2020, 14). Disclosure requirements could then be expanded over the course of a few years until they encompass full lifecycle emissions, giving upstream producers time to collect the information they need to make these sometimes-complex calculations.

Working collaboratively to build a robust system of emissions disclosure would boost the confidence customers have in low-carbon aluminium and can play a vital role in

Japan's green transition, given 45% of the public who are not yet motivated to create a decarbonised society cite a lack of information as a key factor (GoJ 2021).

2. *Set phased decarbonisation pathways that encourage suppliers to transition to low-carbon production models*

In parallel to the phased expansion of disclosure, a decarbonization pathway might be collaboratively agreed between downstream aluminium producers and their suppliers. This would begin with the areas that are easiest to control at the smelter and company-owned energy assets while providing more time for upstream producers to engage with external energy providers as well as suppliers of alumina or bauxite. A clear requirement that metal is not produced using coal-based electricity could be considered by companies as a steppingstone to more sophisticated requirements based on emissions intensity and, eventually, integrated assessments of overall sustainability such as Aluminium Stewardship Initiative certification.

Engagement with suppliers is preferable, as it will ensure the aluminium industry successfully transitions to low-carbon modes of production. However, where suppliers do not provide any pathway to decarbonisation, Japanese aluminium producers will be able to clearly signal their support for a green transition by sourcing low-carbon materials widely available from numerous international suppliers.

3. *Accelerate decarbonisation through collaboration across the value chain*

Progress on decarbonisation could be accelerated through richer collaboration between Japanese aluminium producers and their suppliers. This could include joint research and development, channelling investment to promising innovations and coordinating advocacy in areas such as renewable energy expansion or recycling infrastructure. Such initiatives could be given further weight by drawing in aluminium customers to support efforts. A potential model for this coordination could be the 100+ Accelerator founded by AB InBev and supported by major companies such as Unilever, Coca-Cola and Colgate-Palmolive. By collaborating across the value chain, the initiative is helping fund and develop everything from circular packaging innovations to renewable heat solutions.[7]

Recommendations for policymakers

While there is a market incentive for aluminium producers in Japan to engage with their suppliers, there are also actions policymakers in the country can take to help with this transition.

1. *Set standards for disclosing embodied emissions and provide support on compliance*

First, Japanese authorities can make it easier for purchasers of aluminium to distinguish low-carbon from conventional materials. Building on the example of the Act on Promotion of Global Warming Countermeasures, this could begin by setting mandatory guidelines on lifecycle emissions disclosure for companies above a certain size. These should come with guidance for companies on how to make these calculations given the complexities involved for some supply chains.

Such a policy could be implemented in phases, beginning with key exporting industries that have high embodied emissions, such as the automotive industry. Guiding these companies towards more comprehensive disclosure would incentivise action on embodied emissions in the industries where it matters most while also ensuring exports are able to compete in a global low-carbon market.

Phasing could also be applied to the methods required, beginning with a simple calculation based on average emission intensities for key materials and processes

7 See AB InBev, "Accelerator 100+", https://www.100accelerator.com/

before transitioning to more detailed and specific assessments. Conducting this process over a period of five years would enable the government to involve more companies in mandatory lifecycle assessments from the start and guide them on the path to a more refined understanding of their climate impacts.

In addition to disclosure regulations, the government could drive transparency in supply chains through its own research programmes. This kind of initiative is already underway for the automotive industry, with the government committing under the Green Growth Strategy to "visualizing life-cycle CO_2 emissions from batteries." This programme of research should be considered a pilot and, if successful, expanded to similar mapping exercises for materials key to the green transition. The World Bank's report from 2020 on minerals used in key low-carbon technologies provides credible guidance on what materials should be prioritised, including aluminium, graphite, nickel, cobalt, copper and lithium (World Bank 2020). .

2. *Leverage public procurement to establish benchmarks for what constitutes low-carbon aluminium*

While public procurement would only cover a small proportion of products made using aluminium, it can play a valuable role defining what constitutes low-carbon versions of the metal. This would help provide the broader market with a trusted benchmark for private sector sourcing.

The Basic Policy on Promoting Green Procurement currently includes guidance for public authorities across a range of products. Among these are guidelines for vehicles, under which any vehicle purchased is not only required to "generate significantly less environmental impact… by using new technologies" but should use "recycled material as much as possible" and be designed "so that reuse of its materials is facilitated after its useful life." While recycled materials should remain a priority area, providing an additional guideline on using low-carbon materials where possible would help drive further reductions in climate impact.

To ensure consistency, the standard used in green procurement policies should follow the recommendations made by the Carbon Trust, setting a carbon footprint of 4 tCO_2/tAl according to the IAI's Level 1 guidelines as the initial standard for low-carbon aluminium and expanding the scope of mandatory disclosure over a three year period. Enshrining this benchmark in public procurement would support the establishment of a distinct market for low-carbon aluminium. The creation of such a market would empower Japanese businesses to source low-carbon materials while having to invest considerably less time and effort identifying which suppliers meet the right standard.

A well-established benchmark for low-carbon materials would also help with the integration of a lifecycle approach into other policies. For example, with multiple automakers already committing to lifecycle emission reductions, the Japanese government could look to drive concrete action by awarding additional credits in its proposed automotive carbon trading scheme to manufacturers meeting the benchmark for low-carbon materials sourcing. Alternatively, graduated subsidies could be implemented for the purchase of EVs and HEVs that exceed certain proportions of low-carbon or recycled materials.

3. *Utilise foreign development funding to support low-carbon supply chains*

Under the Green Growth Strategy, the Japanese government launched a 1.5 trillion yen Post-Coronavirus Growth Facility through the Japan Bank for International Cooperation (JBIC) (GoJ 2020, 10). The facility is designed to support projects carried out by Japanese companies that advance decarbonisation overseas. It offers to cover 60% of the total co-financing amount in areas such as "renewable energy, energy savings, green mobility solutions… air pollution prevention, water supply, water pollution prevention and waste

disposal." For projects involving small or medium sized Japanese businesses, the co-financing increases to 70% (JBIC 2021, 1). Given many Japanese firms hold interests in overseas smelters, the JBIC should proactively target cooperation with these entities to decarbonise production facilities. Such targeting would not only help decarbonisation efforts in foreign countries, but enable Japanese companies supplied by these factories to become more competitive as the green transition accelerates.

If support from the JBIC is positioned as a carrot for decarbonisation, the Japanese government could also look to the principles behind the Petroleum and Coal Tax for a stick. The measure currently applies a carbon tax to imports of fossil fuels at a rate of 289 yen for every tonne of CO_2 embedded in the fuel (Nakano & Yamagishi 2021, 3). Following a similar logic, the government could look to institute a duty on imports of materials known to use high amounts of coal or oil in their production process. Delayed implementation of such a measure, combined with the offer of financing support through the JBIC, would incentivise decarbonisation of overseas supply chains for materials key to Japan's green transition. Success in this area would help combat the climate crisis, mitigate exposure to stranded assets overseas and ensure Japanese businesses have access to the low-carbon materials they need to be competitive in a global green economy.

The green wave is set to sweep away many of our old polluting systems and in their place leave something new—a tide of innovations with incredible potential to enhance livelihoods, nurture the planet and enhance economic prosperity. However, achieving a truly sustainable transition will require collaboration beyond the headline projects of EVs and green buildings. From green innovation will come a surge in demand for materials like aluminium, which, if not sourced in a sustainable manner, could undo much of the good work instituted through climate policies. The importance of a lifecycle approach to decarbonisation is increasingly recognised across governments and by international businesses. With major commitments from government, a strong history of innovation and burgeoning green industries, Japan provides a strong environment from which the country's aluminium producers can seize the opportunity of a global low-carbon transition. Green businesses are set to be a driver of growth for the Japanese aluminium industry; however, with sustainable businesses increasingly demanding materials to match their low-carbon vision, producers will need to collaborate with their suppliers to meet this need. Failure to align with the climate goals of customers, be they in the private or public sector, could leave producers out in the cold. However, those that successfully get ahead of these demands and have low-carbon materials ready to supply will enjoy a win-win—what is right for profits and what is essential for our planet.

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