FORGING AHEAD

A roadmap to net-zero greenhouse gas emissions for Aotearoa New Zealand's steel industry

SUSTAINABLE STEEL COUNCIL

BUILDING INNOVATION PARTNERSHIP

BRANZ Funded from the Building Research Levy

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FOREWORD FROM THE SUSTAINABLE STEEL COUNCIL

Steel is fundamental to modern life in Aotearoa New Zealand. It supports the buildings we live and work in, the bridges and transport networks that connect our communities, the renewable energy systems that power our future and the infrastructure that underpins our economy.

As New Zealand moves towards net-zero greenhouse gas emissions (GHG), steel must be part of the solution. Steel production is emissions intensive, and our industry must transform how steel is made, used, reused and recycled.

This roadmap sets out a credible pathway to reduce direct and electricity-related GHG emissions from steel used in New Zealand buildings and infrastructure by more than 90% by 2050. It is grounded in technical analysis and shaped by engagement across the steel value chain.

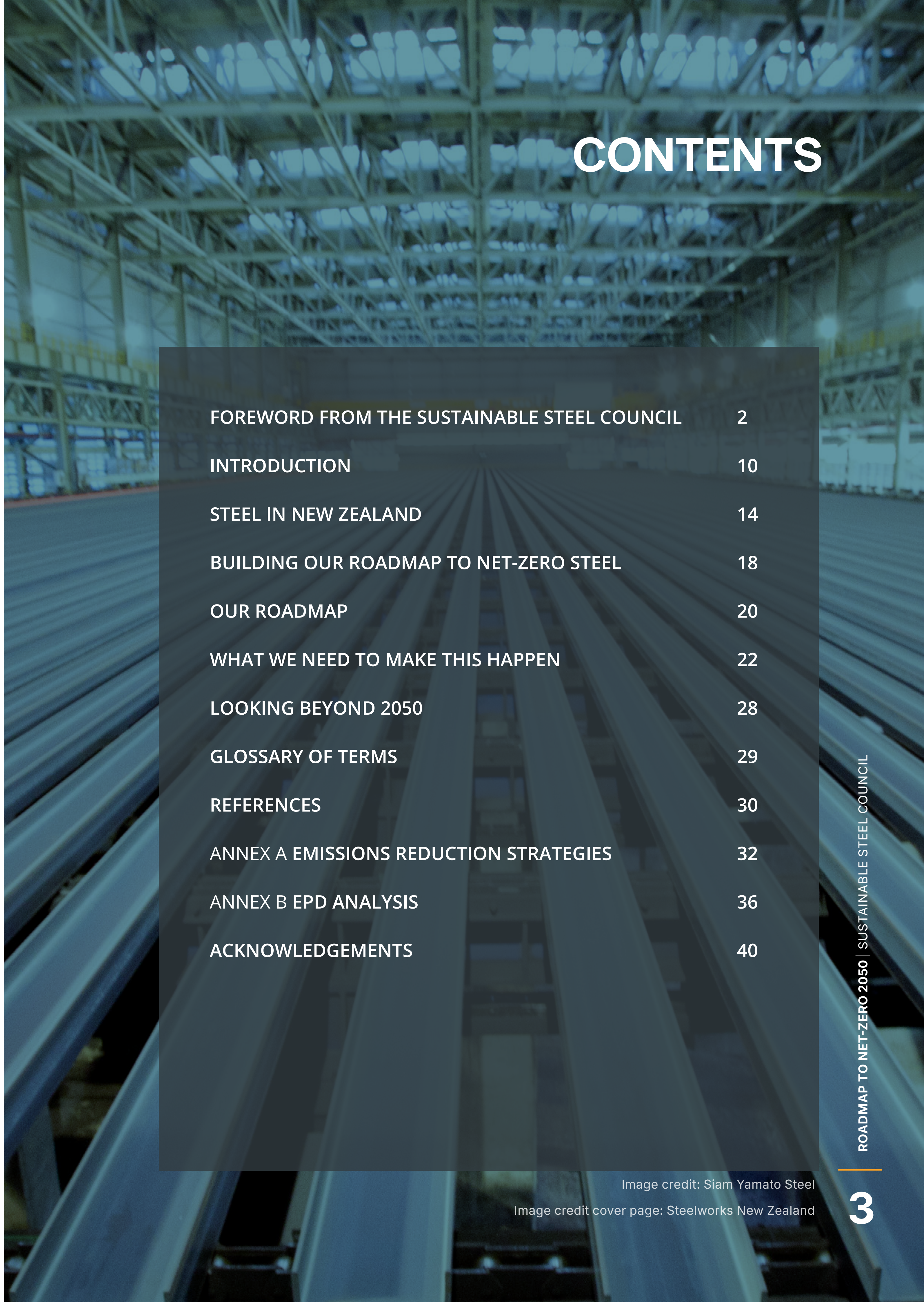
Achieving this transition will require increased use of recycled steel, expansion of scrap-based electric arc furnace production, decarbonisation of energy systems and continued development of low-emissions ironmaking. It will also require smarter design that uses steel efficiently and extends the life of existing assets.

This work is about stewardship. In Aotearoa New Zealand, kaitiakitanga reflects our responsibility to protect and enhance the environment for future generations. The materials we produce today will remain in use for decades. The decisions we make now will shape our environmental legacy for the next century.

Steel is a permanent material that can be reused and recycled infinitely without loss of quality. A net-zero GHG emissions steel system is therefore not only achievable, but aligned with a circular economy and our responsibility as kaitiaki.

The Sustainable Steel Council is committed to supporting this transformation. This roadmap is both a commitment and an invitation to work together to deliver a net-zero GHG emissions steel system for the Aotearoa New Zealand construction environment.

Jeremy Sole
Executive Officer



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EXECUTIVE SUMMARY: OUR ROADMAP TO NET-ZERO

The steel industry in Aotearoa New Zealand is committed to reducing the industry's greenhouse gas (GHG) emissions to net-zero by 2050. Our roadmap sets out a plan for how we will achieve this goal. It also supports New Zealand's climate targets under the Paris Agreement and the Zero Carbon Act.

We will reduce emissions through real changes to how steel structures are designed, and how steel is produced, reused and recycled. Achieving the targets in this roadmap will require increased demand for low-emissions steel alongside new technology for making that steel. Reaching net-zero will require action across the entire steel value chain. Manufacturers, importers, designers, engineers, builders, recyclers, asset owners and government all have a role to play.

WHAT THIS ROADMAP COVERS

This roadmap covers all steel used in New Zealand buildings and infrastructure between 2020 and 2050. It includes both steel produced domestically and steel imported from overseas.

The main body focuses on direct and electricity-related emissions from:

→ ironmaking
→ crude steel production
→ steel recycling
→ steel fabrication.

These are the emissions the steel industry can most directly influence.

Annex B provides a broader life cycle view aligned with Environmental Product Declarations (EPDs). It includes indirect life cycle emissions such as raw material extraction, coatings, transport and end-of-life processing.

Figure 1 illustrates the life cycle of steel. Coloured items are included in the body of this roadmap. Annex B includes the full steel life cycle, including all items shown in grey.

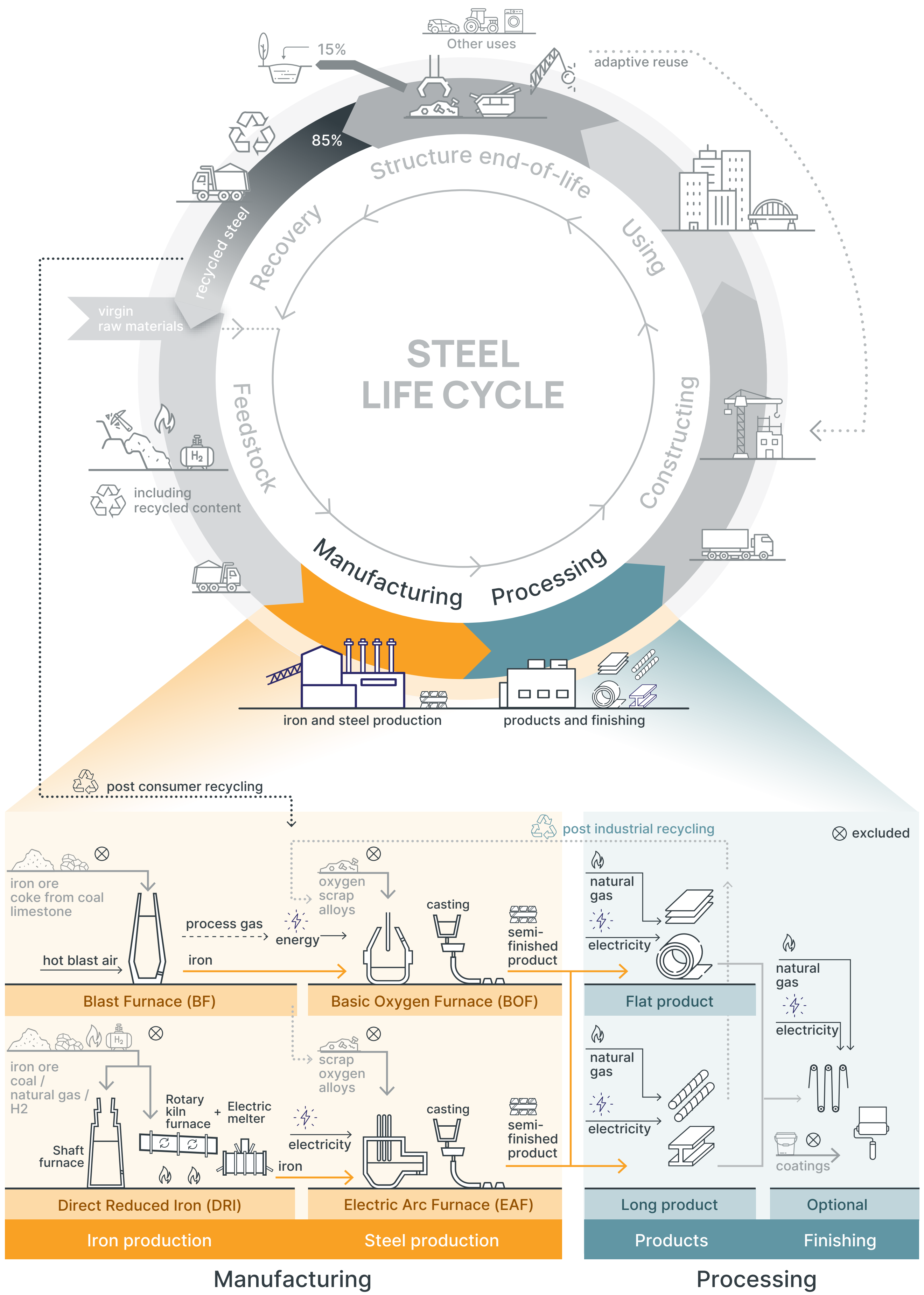
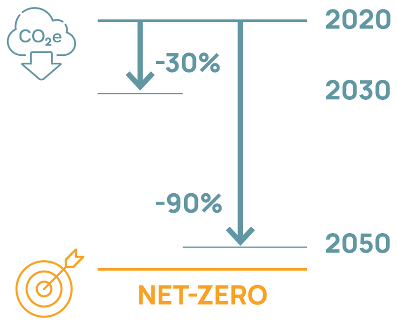


Figure 1. The life cycle of steel

TARGETS FOR 2030 AND 2050

We have set clear and measurable targets.

Year	Target
By 2030	Reduce direct and electricity-related emissions from steel used in New Zealand by more than 30% compared with 2020.
By 2050	Reduce these emissions by more than 90%.



These targets are based on gross national GHG emissions, including domestic and imported steel. They assume that steel demand increases in line with projected population growth of around 31%, reaching approximately 6.7 million people by 2050. The emissions reductions are achieved through lower emissions per tonne of steel, not through reduced economic activity. They are based solely on direct emissions reductions and greenhouse gas removals. Carbon offsets are not used.

When indirect life cycle emissions are included, the projected reductions are:

- → around 25% by 2030
- → around 70% by 2050

This highlights the need for collaboration beyond the steel sector, including in transport, energy and materials supply. (See Annex B for further detail.)

HOW WE WILL ACHIEVE THIS

Achieving this level of reduction within 25 years will be challenging and requires coordinated action across the entire steel value chain. We must reduce demand for virgin steel, increase recycling, switch to clean energy and transform how iron and steel are made. Our plan focuses on five reduction strategies.

ADAPTIVE REUSE

The lowest-emissions building is the one we do not need to build. Adaptive reuse means extending the life of structural elements instead of demolishing and rebuilding. By keeping steel elements in use for longer, we reduce demand for steel.

DESIGN AND CONSTRUCTION

We can reduce emissions by using steel more efficiently. Better coordination between architects, engineers and builders can reduce over-specification and unnecessary material use. Early design decisions have the biggest impact.

RENEWABLE ENERGY

Renewable electricity is essential to low-emissions steel. Electric arc furnaces (EAF) use electricity to produce steel from scrap. Renewable electricity is also needed to produce green hydrogen for low-emissions ironmaking.

STEELMAKING

Steelmaking must shift away from coal-based processes. EAFs, which use recycled steel, are central to this transition. As demand for lower emissions steel increases, EAF production is expected to grow globally, enabled by an increase in scrap availability.

IRONMAKING

Ironmaking is the most emissions-intensive step in steel production. While recycled steel will play a larger role, virgin iron will still be required. Low-emissions alternatives include hydrogen-based direct reduced iron and carbon capture applied to existing plants. These technologies are developing and currently cost more than conventional production. They are expected to become more significant from the 2040s onward.

OUR PATHWAY TO NET-ZERO GHG EMISSIONS

The chart below shows the actions we expect to achieve net-zero GHG emissions from iron and steel consumed in New Zealand by 2050.

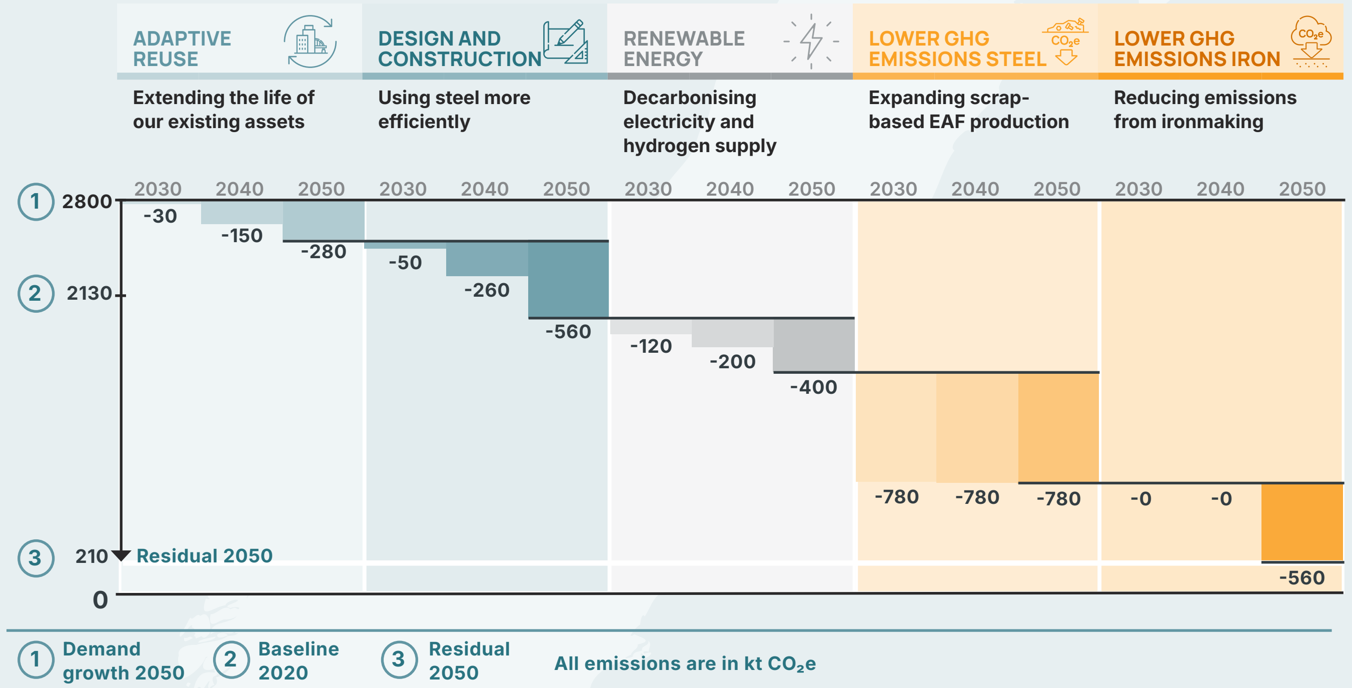


Figure 2. Decarbonisation roadmap of steel in Aotearoa New Zealand

WHERE OUR ACTIONS WILL MAKE THE BIGGEST DIFFERENCE

The pathway to net-zero requires early action, sustained investment, long-term transformation and commitment from across the steel value chain and wider economy. Different strategies will have the greatest impact at different times.

UNTIL 2030 →

The biggest gains this decade come from proven technologies and smarter demand. We are already making progress. By the end of 2026, direct emissions from steel used in New Zealand are forecast to fall by over 30% compared with 2020 levels. This is driven by:

- → commissioning the new EAF at Glenbrook
- → increasing use of recycled steel
- → sourcing more steel from lower-emissions EAF production overseas.

The main drivers to 2030 are:

- → expanding scrap-based EAF production
- → increasing renewable electricity supply
- → improving material efficiency in design and construction
- → beginning to embed adaptive reuse into planning and asset decisions.

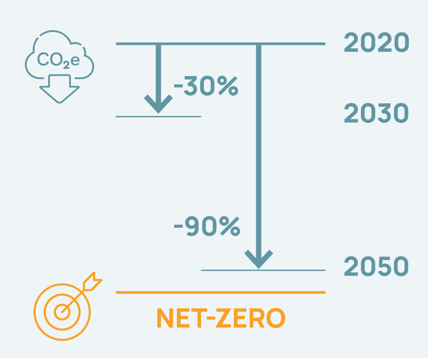


Figure 3. Targets 2020 to 2050

TO 2040 →

The 2030s are the critical transition decade. By 2040, we must be firmly on track to achieve more than 90% emissions reduction by 2050. During this period, the focus shifts to scaling emerging technologies and accelerating system-wide change.

On the supply side, this includes:

- → accelerating the global shift from Basic Oxygen Furnace (BOF) production to EAF
- → rapidly expanding renewable electricity generation
- → switching fuel in Direct Reduced Iron (DRI) plants, from coal/gas to green hydrogen
- → narrowing the cost gap between conventional and low-emissions steel.

On the demand side, this includes:

- → making adaptive reuse the default option where feasible, including reuse of existing assets and designing new assets so they can be adapted in the future
- → embedding carbon considerations alongside cost, quality and timeline in early design decisions
- → continuing to optimise structural design to reduce material use.

Progress by 2040 is a key checkpoint. We need to achieve savings of around 45% by 2040 to be on track towards our target of over 90% GHG reductions by 2050.

→ UNTIL 2050

By 2050, near-zero emissions steel must be the norm. On the supply side, steel used in New Zealand buildings and infrastructure must come from facilities operating with minimal GHG emissions. This may include:

- → scrap-based EAFs powered by renewable electricity
- → EAFs supplied with green hydrogen-based iron
- → conventional blast furnaces retrofitted with carbon capture, utilisation and storage.

On the demand side, this roadmap assumes:

- → a 20% reduction in steel use in new construction through better design
- → a 10% reduction in demand through greater adaptive reuse.

GLENBROOK EAF: A STEP CHANGE FOR NEW ZEALAND STEEL

This year, New Zealand Steel is commissioning a new EAF at Glenbrook, backed by around $300 million in co investment from BlueScope Steel and the New Zealand Government.

The furnace replaces the previous oxygen-blowing process and significantly increases the use of recycled steel scrap, allowing part of the site's ironmaking capacity to close.

From late 2026, it is expected to cut national greenhouse gas emissions by around one million tonnes per year - more than 1% of New Zealand's gross emissions.

It is the largest single-site emissions reduction initiative in New Zealand to date and signals a decisive shift toward a more circular, lower-emissions steel industry.

ENABLING THE TRANSITION

Achieving net-zero emissions from steel will require sustained action over the next 25 years. Industry has begun the transition, but success depends on coordinated effort across the entire construction ecosystem.

We need policy certainty, affordable and reliable renewable electricity, and investment in green hydrogen and low-emissions technologies. We need strong demand from asset owners and government for for materials with embodied carbon that is best in class. And we need continued improvements in design efficiency, recycling systems and supply chain transparency.

This roadmap shows that a reduction of more than 90% in direct emissions by 2050 is technically achievable without relying on offsets. Delivering it will require leadership, collaboration and long-term commitment from industry, government and end users alike.

Image credit: NZ Steel

INTRODUCTION

The steel industry has an essential role in Aotearoa New Zealand's response to climate change. It must both reduce greenhouse gas (GHG) emissions and support the delivery of climate-resilient infrastructure.

In 2025, steel production accounted for around 2–3% of New Zealand's gross GHG emissions. Globally, steel production is responsible for approximately 7–9% of total GHG emissions (worldsteel, 2025; Crippa, et al., 2025). Reducing emissions from steel is therefore critical if New Zealand is to meet its climate targets under the Paris Agreement and the Zero Carbon Act.

Image credit: Metals NZ

At the same time, steel underpins modern society. It is used in buildings, bridges, water networks, transport systems and renewable energy infrastructure. As New Zealand transitions to a low-emissions economy, demand for steel is expected to remain strong. Decarbonising steel is not about doing less infrastructure. It is about producing and using steel differently.

This roadmap demonstrates that reducing direct and electricity-related emissions from steel used in New Zealand by more than 90% by 2050 is technically achievable. It sets out how.

WHAT IS STEEL?

Steel is an alloy of iron and carbon. The proportion of carbon, and the addition of other alloying elements, determine the steel's properties.

Common examples include:

→ mild steel, typically containing 0.05–0.30% carbon

→ stainless steel, which contains at least 11% chromium to improve corrosion resistance

Steel is the most widely used metal alloy in the world. On average, around 215 kilograms of steel are produced per person globally each year (worldsteel, 2025). While humankind has used iron and steel for millennia, mass production of steel only started in the late 1800s as new furnace technologies were developed.

WHY STEEL MATTERS

Steel's durability and high strength-to-weight ratio make it ideal for a wide range of applications. Around half of all steel goes into buildings and infrastructure, with the other half used in a wide variety of products, including vehicles, machinery, appliances and furniture (see Figure 4).

Steel offers resilience in earthquakes, making it an important construction material in seismically active countries such as New Zealand. Its ductility allows it to bend and absorb seismic energy without fracturing.

Steel is also an important contributor to the circular economy. It is highly recyclable and there has been a thriving market for steel scrap since the Iron Age. It can be reused directly and recycled repeatedly without loss of quality. In New Zealand, approximately 85% of steel is recovered for reuse or recycling at end-of-life (Soo, et al., 2021).

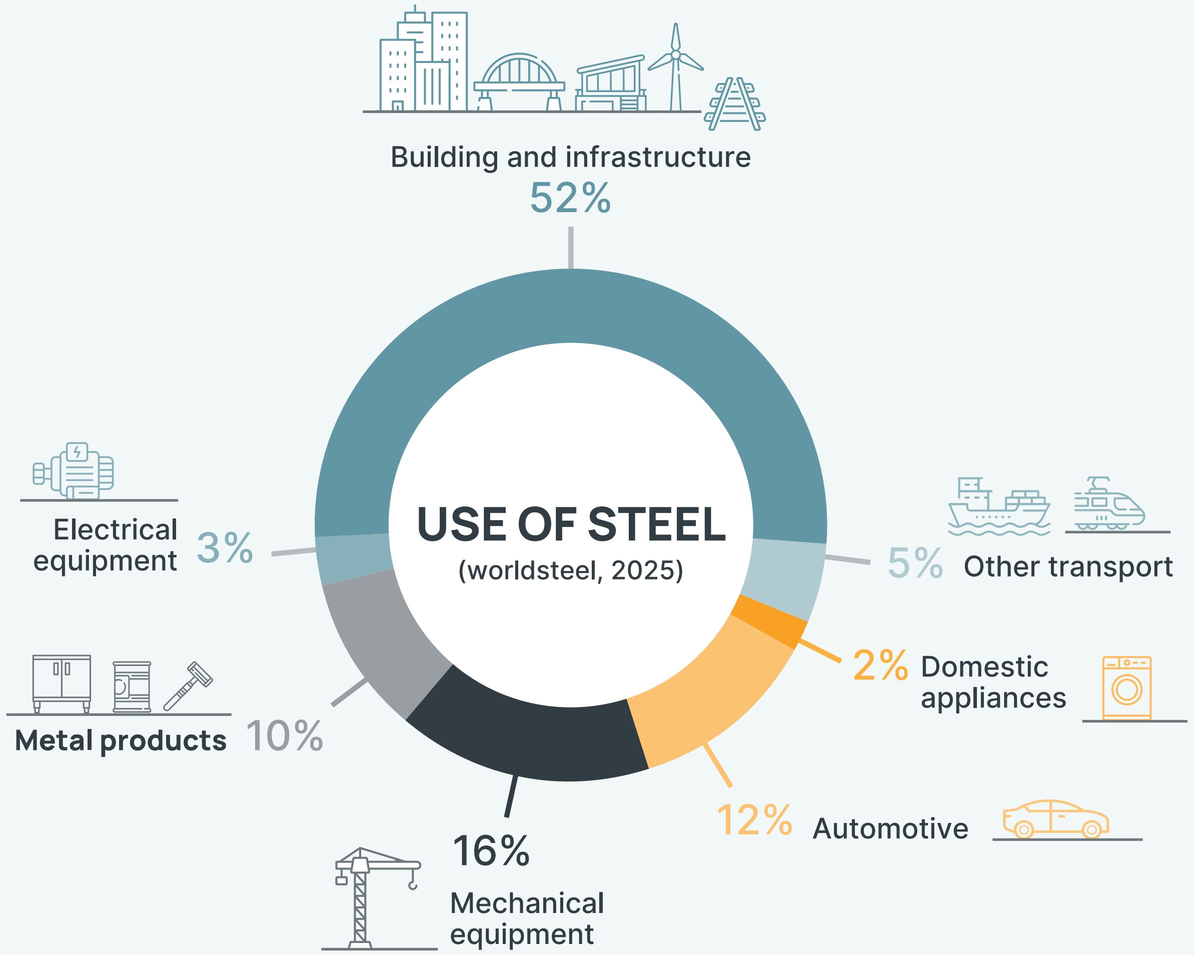


Figure 4. Use of Steel (worldsteel, 2025)

THE CARBON FOOTPRINT OF STEEL

Crude steel production was responsible for approximately 7% (3.6 Gt CO_2e) of gross global GHG emissions in 2024 (worldsteel, 2025; Crippa, et al., 2025). When downstream steelmaking stages are included, this figure increases to around 9% of global GHG emissions.

On average, producing one kilogram of crude steel results in around 2.18 kilograms of CO_2e emissions (worldsteel, 2026). However, emissions vary significantly depending on the production route and energy source, ranging from roughly 0.5 to 4 kg CO_2e per kilogram in the baseline year.

The carbon footprint of crude steel manufactured in New Zealand in the baseline year was at the high end of this range because it was produced entirely from primary iron sand using a coal-based reduction process.

As global production of steel has increased, the energy intensity (and therefore the carbon footprint per tonne of steel) has reduced (see Figure 5). The energy intensity of steel production fell by around 60% from 1960 to 2005.

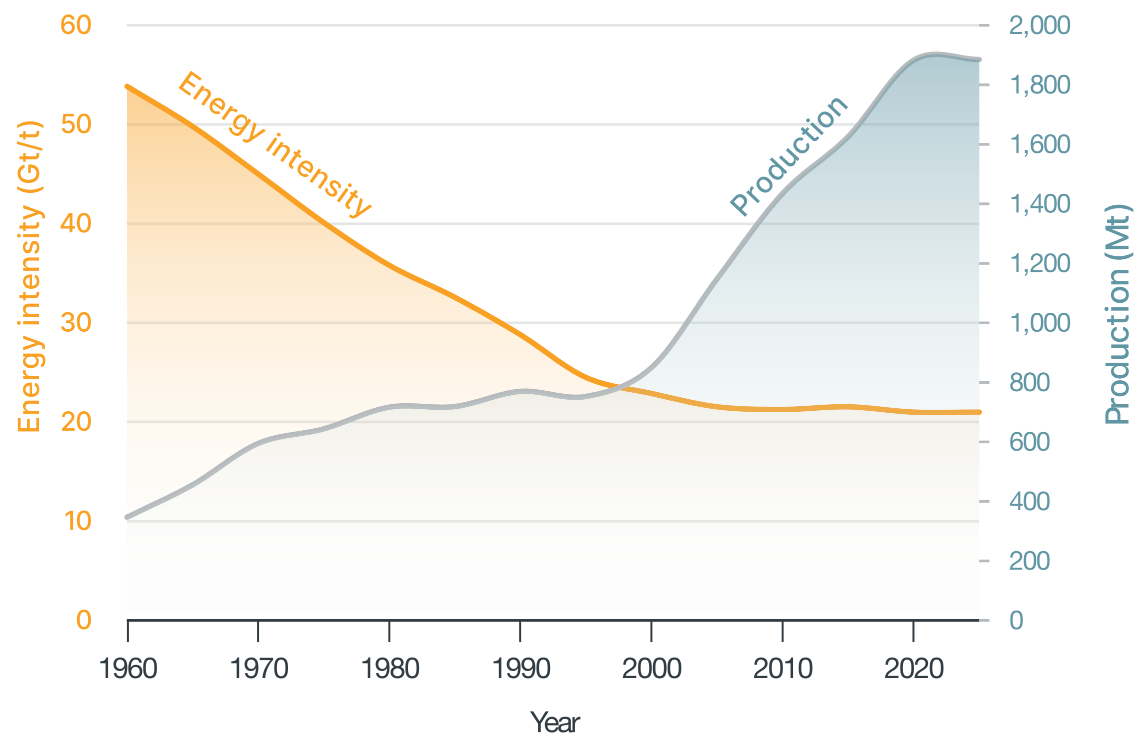


Figure 5. Steel production and energy intensity 1960-2025 (data sources: worldsteel, 2021; worldsteel, 2025)

TWO MAIN WAYS STEEL IS MADE

Globally, steel is produced using two dominant routes:

Blast furnace–basic oxygen furnace (BF–BOF): iron ore is converted to iron in a blast furnace using coal. The iron is then converted to crude steel in a basic oxygen furnace. This route accounts for around 70% of global crude steel production in 2023 (worldsteel, 2025) and is emissions-intensive.

Electric arc furnace (EAF): Steel scrap is melted using electricity to produce crude steel. Some virgin iron may also be added to control chemical composition. This route accounts for around 29% of global production (worldsteel, 2025). When powered by renewable electricity, it has significantly lower emissions than BF–BOF production.

Most countries use a mix of both routes.

WHERE EMISSIONS OCCUR

The largest contributor to the carbon footprint of steel is iron. Current ironmaking technologies release carbon dioxide to the atmosphere in two ways:

→ the chemical reactions used to convert iron ore to pure iron, and

→ heating the iron ore to over 1000°C for these chemical reactions to take place.

We already have industrial processes to make iron with near-zero emissions, with many additional technologies still in the early stages of development and some showing promise.

Scaling up these technologies will require further technology development, new renewable energy infrastructure and – perhaps most importantly – investment. Current near-zero emissions technologies are predicted to carry a cost premium of 20-70% (MPP, 2022). As such, we will only be able to scale these technologies up if we have a commercial and political environment – both locally and globally – that enables them.

VIRGIN STEEL AND RECYCLED STEEL

Virgin steel is steel manufactured primarily from iron ore.

Recycled steel is steel manufactured primarily from steel scrap.

Both routes will remain important. There is not enough steel scrap globally to meet total demand, and virgin iron is still required to control chemical composition and dilute impurities.

Image credit: NZ Steel

STEEL IN NEW ZEALAND

Roughly half of all steel consumed in New Zealand is produced from crude steel manufactured domestically, with the other half produced overseas.

All domestic crude steel is manufactured at the Glenbrook steel mill, near Auckland. This mill typically produces around 650,000 tonnes of steel per year and is operated by New Zealand Steel, a subsidiary of BlueScope Steel Limited.

Many different companies import steel into New Zealand. Steel can be imported in a semi-finished state for finishing in New Zealand or imported as finished steel ready for use.

While there are a handful of large companies operating in each segment of the steel value chain, most of New Zealand's steel industry is made up of small to medium-sized enterprises (SMEs), primarily operating as fabricators, wholesalers/retailers and metals recyclers.

Image credit: NZ Steel

WHY NEW ZEALAND STEELMAKING IS UNIQUE

The Glenbrook steel mill is the only plant in the world that manufactures crude steel from iron sand rather than mined iron ore. This requires a specialised direct reduction process involving rotary kilns and electric melters.

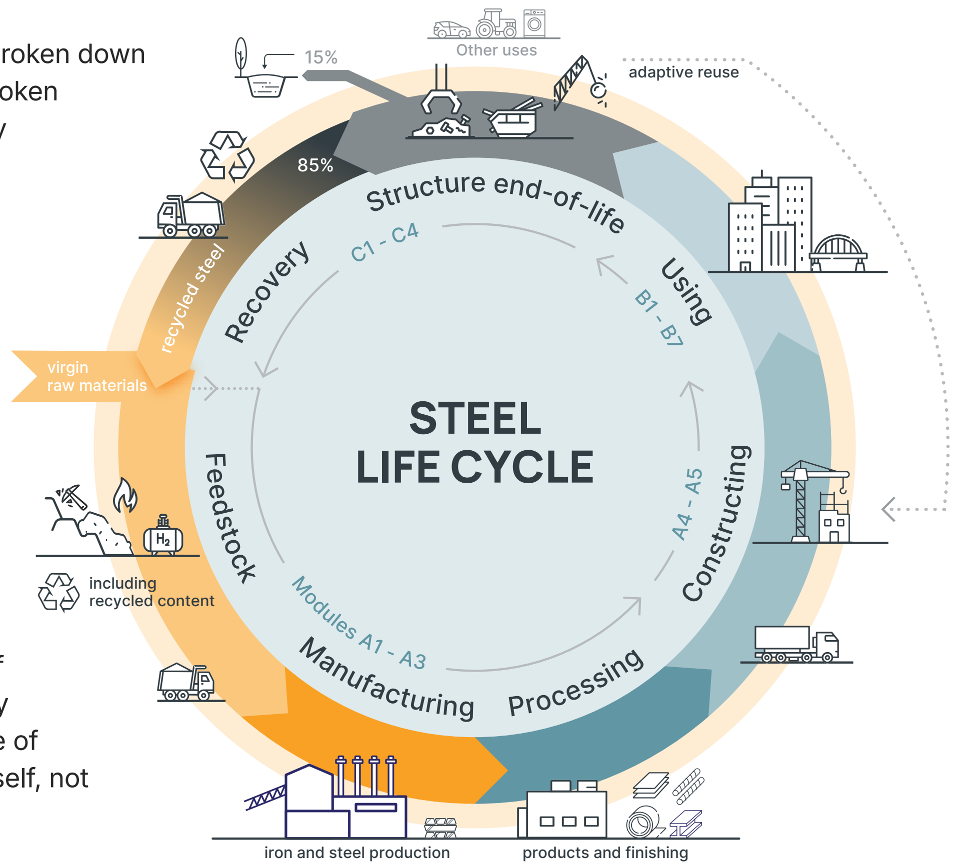
Until 2026, the molten iron was converted to crude steel using an oxygen-blowing furnace. In 2025/26, an electric arc furnace was installed to replace that furnace. The EAF will use recycled steel scrap alongside molten iron, allowing part of the ironmaking capacity to be decommissioned and reducing GHG emissions.

Image credit: NZ Steel

THE LIFE CYCLE OF STEEL

The life cycle of steel is commonly broken down into five stages, which are further broken down into modules. This terminology comes from European standards EN 15978 (CEN, 2011), EN 17472 (CEN, 2022) and EN 15804 (CEN, 2021), and international standard ISO 21930 (ISO, 2017). Understanding these stages helps clarify which emissions this roadmap addresses, and which are examined separately in Annex B.

These stages relate to the life of the building or infrastructure asset where the steel is used, rather than the life of the steel itself. Steel can outlast the structures it is part of and may be reused or recycled many times. This highlights the importance of considering the life of the product itself, not only the life of the asset.



PRODUCT STAGE (A1–A3): MAKING STEEL PRODUCTS

The product stage covers everything that happens before a steel product leaves the factory gate. Production of crude steel occurs in three main phases:

RAW MATERIALS AND ENERGY

Mining of iron ore, coal and limestone, recovery of steel scrap, and generation of electricity used in production. These inputs are transported to steel plants and prepared for processing.

IRONMAKING (WHEN VIRGIN IRON IS REQUIRED)

Iron ore (or iron sand in New Zealand) is converted into metallic iron through a reduction reaction where oxygen is removed at a high temperature. This is the most emissions-intensive step.

STEELMAKING

Molten iron and/or steel scrap are refined to achieve the required composition. Carbon levels are adjusted and alloying elements added. The steel is cast into slabs, billets or blooms - semi-finished products known as crude steel.

Most of the direct and electricity-related emissions addressed in this roadmap occur in this stage, particularly during ironmaking and crude steel production.

CONSTRUCTION STAGE (A4–A5): FROM FACTORY TO SITE

The construction stage covers transport of steel products to site and their installation into the building or infrastructure asset.

Steel is delivered by road, rail or sea, then assembled, bolted, welded or encased in concrete. While emissions here are smaller than in manufacturing, transport and construction activities still require energy. Installation methods can also influence whether steel members can later be reused.

USE STAGE (B1–B7): DECADES OF SERVICE

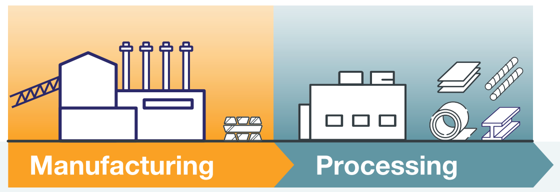
Once installed, steel often remains in service for many decades. Maintenance, such as repainting or recoating, helps protect steel from corrosion. In some cases, components are replaced during the building's life.

END-OF-LIFE STAGE (C1–C4): RECOVERY AND RECYCLING

At end of a building's service life - where the building structure is not reused - steel elements are dismantled, cut or shredded. Some components can be reused directly. More commonly, steel is processed into scrap and recycled into new crude steel. In New Zealand, around 85% of steel is recovered for reuse or recycling at end-of-life. End-of-life is therefore usually the beginning of another product life cycle and might be better termed end-of-current use.

MODULE D: BENEFITS BEYOND THE BUILDING

This phase accounts for the benefits of reuse and recycling in future product systems. Reusing a steel member avoids the need to manufacture new steel and the additional CO_2 emissions associated with that production. Recycling scrap reduces the need for emissions-intensive ironmaking. These avoided emissions are important when considering steel's full life cycle impact. Module D is not considered within this roadmap since its focus is direct emissions reductions, not avoided emissions.



WHAT THE ROADMAP COVERS

This roadmap focuses primarily on emissions from the product stage - especially ironmaking, crude steel production, recycling and fabrication - and the electricity used in these processes. These are the emissions the steel industry can most directly influence.

Indirect emissions across the wider life cycle are examined in Annex B to provide a full life cycle view aligned with EPDs. Understanding these stages helps explain why this roadmap emphasises recycled steel, clean electricity, low-emissions ironmaking and design for longer life and reuse.

BUILDING OUR ROADMAP TO NET-ZERO STEEL

This roadmap is grounded in technical analysis and industry engagement. We began by establishing a robust baseline of steel flows and GHG emissions in a defined base year. We then identified credible emissions reduction strategies and modelled how they could scale over time to 2050.

This roadmap is goal-oriented. It starts from the ambition of reducing direct emissions from steel consumed in New Zealand by more than 90% by 2050 and works backwards to identify the steps required to get there. The result is a pathway that reflects both technical feasibility and practical industry insight.

SCOPE AND BOUNDARY

The roadmap takes a consumption-based approach. This means it covers all steel consumed in New Zealand for buildings and infrastructure between 2020 and 2050, regardless of whether that steel is produced domestically or imported. This reflects the climate impact of New Zealand's building and infrastructure demand, not just domestic production.

It excludes:

- → steel exported from New Zealand
- → steel imported in assembled products, such as cars and furniture.

The main body of this roadmap focuses on direct and electricity-related emissions from:

- → ironmaking
- → crude steel production
- → steel recycling
- → fabrication.

These are the emissions the steel industry can most directly influence.

Indirect emissions - including mining, alloy production, coatings, transport and end-of-life processing - are examined separately in Annex B. These indirect sources contributed approximately 20% of total life cycle emissions for steel used in buildings and infrastructure in 2020. This approach aligns with international steel roadmaps, e.g., (MPP, 2022), and the roadmap of the New Zealand concrete industry (SSC, BIP & BRANZ, 2023).

BASE YEAR AND DEMAND ASSUMPTIONS

The base year is designed to reflect typical material flows around 2020, excluding the disruption caused by the Covid-19 pandemic. It was calculated as an average of the calendar years 2018, 2019, 2021 and 2022.

Future steel demand is assumed to grow in line with population. New Zealand's population is projected to increase by around 31%, from 5.1 million in 2020 to approximately 6.7 million in 2050.

The modelling therefore assumes that, without intervention, steel demand would increase proportionately over this period.

Emissions reductions in this roadmap are achieved through lower emissions per tonne of steel and reduced material demand - not through reduced economic activity.

TECHNICAL ANALYSIS AND MODELLING

The technical analysis and emissions modelling that underpin this roadmap were carried out by sustainability consultancy thinkstep-anz, working on behalf of the Sustainable Steel Council and project partners.

Baseline emissions were calculated using:

- → import and export statistics at the HS10 level (Stats NZ)
- → industry estimates of domestic steel consumption by category
- → EPDs for products on the New Zealand market.

Future emissions were modelled using:

- → population projections (Stats NZ)
- → construction forecasts by floor area (BRANZ)
- → typical material intensities by building type (literature)
- → industry-informed uptake rates for emissions reduction strategies
- → emissions modelling for emerging iron- and steel-making technologies.

The modelling aligns with other sectoral roadmaps in New Zealand and internationally, including the Mission Possible Partnership's net-zero steel pathway (MPP, 2022).

Further technical detail is provided in the supporting technical report (thinkstep-anz, 2026).

ENGAGEMENT AND VALIDATION

We developed this roadmap in collaboration with stakeholders across the steel value chain.

Participants included:

- → domestic steel producers
- → importers of semi-finished and structural steel
- → reinforcing steel and light steel framing producers
- → stainless steel fabricators
- → steel recyclers
- → specifiers, architects, engineers and asset owners
- → academics.

Workshops were held to present initial research, gather data and assess the technical and commercial feasibility of different emissions reduction strategies. Targeted follow-ups were conducted to fill data gaps and refine modelling assumptions.

Draft versions of the roadmap were reviewed by the project steering group and workshop participants before finalisation. This collaborative process ensures that the pathway presented in this roadmap reflects both analytical rigour and industry reality.

Image credit: Macaulay Metals

OUR ROADMAP

Reducing emissions from steel by more than 90% by 2050 requires structural change across the entire value chain. The waterfall diagram below Figure 6) shows how five strategies combine to deliver this outcome, even as steel demand increases by 31% in line with projected population growth to 6.7 million people by 2050.

Each step in the waterfall represents a measurable reduction in direct and electricity-related emissions from steel used in New Zealand buildings and infrastructure. Together, these steps form a credible pathway to net-zero.

STRATEGIES FOR REDUCING GHG EMISSIONS

STRATEGY	ADAPTIVE REUSE	DESIGN AND CONSTRUCTION	RENEWABLE ENERGY	LOWER GHG EMISSIONS STEEL	LOWER GHG EMISSIONS IRON
	Extending the life of our existing assets The lowest emissions steel is the steel we do not need to produce. Adaptive reuse extends the life of buildings and infrastructure, avoiding the need for new virgin steel. This includes repurposing existing structures, upgrading assets rather than replacing them, and designing today's buildings so they can be reused in future.	**Using steel more efficiently** Optimising structural design reduces the amount of steel required without compromising safety or performance. This includes early peer review, digital modelling, better coordination between designers and contractors, and moving beyond routine over-specification. Efficiency in fabrication and construction further reduces material use and waste.	**Decarbonising electricity and hydrogen supply** EAFs rely on electricity. Ironmaking pathways such as direct reduced iron (DRI) can use hydrogen instead of coal or natural gas. As New Zealand and global electricity systems increase renewable generation, and as green hydrogen becomes economically feasible at scale, the emissions intensity of steel production declines.	**Expanding scrap-based EAF production** Shifting from BF-BOF routes to scrap-based EAF steelmaking reduces direct and electricity-related emissions and supports a more circular economy. This includes maximising the use of domestically recovered steel scrap and sourcing lower emissions steel from international suppliers.	**Reducing emissions from ironmaking** Ironmaking is the most emissions-intensive step in producing virgin steel. Emissions can be reduced through hydrogen-based DRI, novel technologies such as low temperature electrolysis and metallothermic reduction, or retrofitting carbon capture, utilisation and storage (CCUS) to existing blast furnaces where feasible.

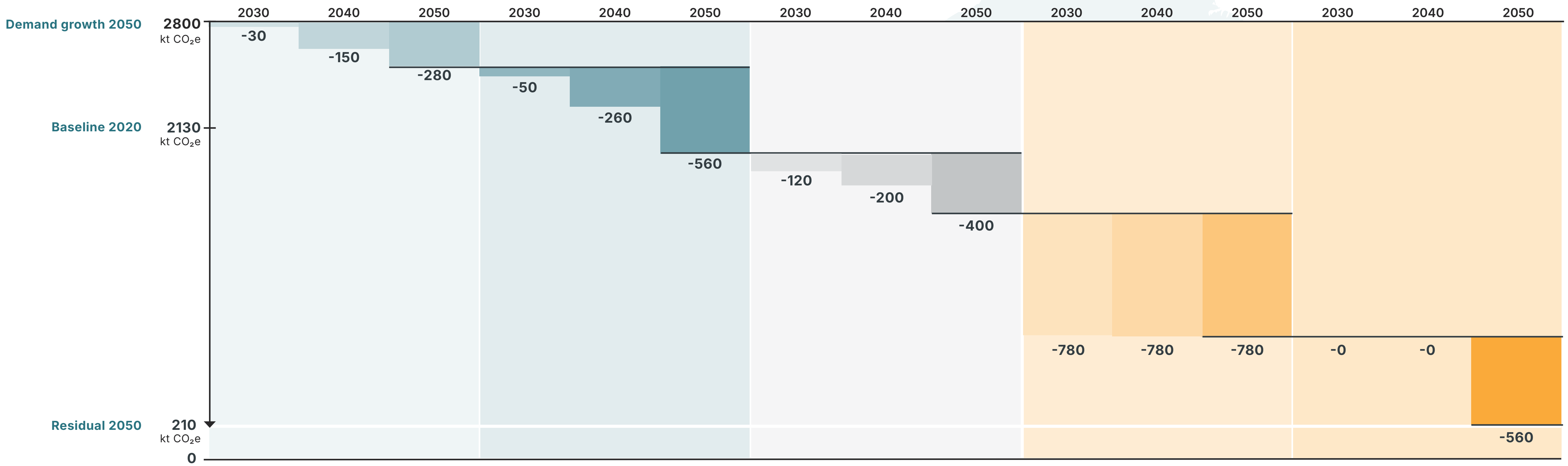


Figure 6. Decarbonisation roadmap of steel within Aotearoa New Zealand

WHAT WE NEED TO MAKE THIS HAPPEN

Achieving net-zero GHG emissions for steel consumed in Aotearoa New Zealand will require coordinated action across policy, infrastructure, markets and capability. Industry cannot deliver this transition alone.

This chapter sets out the key enabling conditions required to deliver the roadmap from:

1. **Government:** Government as an enabler
2. **Customers:** Demand for low emissions outcomes
3. **Suppliers:** Supply of low emissions steel

Image credit: HERA

1. GOVERNMENT AS AN ENABLER

The New Zealand Government has a critical role to play in helping our country and our economy to transition to a low-emissions footing, by:

- → setting a clear path towards net-zero GHG emissions
- → creating a level playing field to allow industry to work towards that goal
- → enabling renewable electricity infrastructure
- → enabling green hydrogen infrastructure
- → enabling lower-emissions freight infrastructure
- → leading by example, e.g., through green rating of buildings and infrastructure.

In New Zealand's open and competitive market economy, policies must apply fairly to both domestic steelmakers and steel importers, the steel industry and other industries.

Important examples of government action already underway include:

- → Establishment of the New Zealand Emissions Trading Scheme (NZ ETS) in 2008 and ongoing work to ensure it remains fit for purpose.
- → Cross-party support for the Climate Change Response (Zero Carbon) Amendment Act 2019, providing broad climate policy certainty.
- → Setting a national target of net-zero GHG emissions by 2050 (excluding biogenic methane), supported by Emissions Reduction Plans for each carbon budget period.
- → Co-investment in New Zealand's transition to low-GHG emissions steel. The co-investment in New Zealand Steel's new EAF at Glenbrook will reduce New Zealand's annual GHG emissions by around 1% from late 2026.
- → Reform of the resource management system to simplify and improve the predictability of consenting for major projects. For example, the Fast-track Approvals Act 2024 included National Green Steel's proposal for a scrap-based EAF in the Waikato.
- → Support for research and development, including Endeavour Fund support for Victoria University of Wellington to develop hydrogen-based direct reduced iron from iron sand.
- → Work to increase renewable electricity generation and firming capacity.
- → Co-funding of this roadmap and the sister roadmap for the concrete industry.

These actions provide an important foundation. However, further steps are required to reach net-zero GHG emissions by 2050.

CREATING THE CONDITIONS FOR NET-ZERO STEEL

POLICY CERTAINTY

Long-lived industrial assets require long-term policy stability. Cross-party support and predictable regulatory settings increase the likelihood of investment in low-emissions technologies. Industry is more likely to invest in capital-intensive, low-emissions assets when policy settings are stable and durable.

RENEWABLE ELECTRICITY AND HYDROGEN

Renewable electricity is the cornerstone of a low-emissions steel industry. It is required:

- directly to power electric arc furnaces
- indirectly to produce green hydrogen
- for electrification of transport and industrial heat.

Demand for renewable electricity will increase as ironmaking, steel fabrication and heavy transport decarbonise. Affordable and reliable electricity supply is also critical for the commercial viability of green hydrogen.

The Mission Possible Partnership estimates that the steel industry will consume 5–7% of global renewable electricity and 9–15% of global green hydrogen by 2050 (MPP, 2022). This assumes significant expansion of supply.

New Zealand must ensure renewable electricity remains globally competitive, reliable and scalable. A national hydrogen roadmap should clearly articulate the expected role of green hydrogen in steelmaking and heavy transport.

A LEVEL PLAYING FIELD

The NZ ETS regulates domestic production, yet steel and other building materials are globally traded commodities.

New Zealand should continue to explore whether policy approaches such as the European Union's Carbon Border Adjustment Mechanism (CBAM) are appropriate. Such mechanisms aim to reduce carbon leakage while maintaining a fair-trading economy. Any approach should remain material-neutral and avoid unintended distortions across sectors.

TREAT STEEL SCRAP AS A STRATEGIC RESOURCE

Greater recycling of steel scrap is the single most important short-term strategy in this roadmap. Recovered steel scrap should be treated as a resource rather than part of the waste industry. Policy settings should:

- support domestic processing and recycling
- enable efficient collection and sorting
- remove unnecessary regulatory barriers to reuse.

TRANSITIONING ENERGY SYSTEMS

A national transition strategy for natural gas is required. Long-term strategies should support domestic industry to transition towards:

- direct electrification
- green hydrogen
- biogas and solid biomass.

These alternatives can be produced domestically and reduce reliance on global fossil fuel markets.

LEAD BY EXAMPLE

Government procurement has a powerful market-shaping role. Leading by example includes:

- incentivising, measuring and reporting embodied carbon in public buildings and infrastructure
- phasing in amendments to the Building Act and Building Code to introduce carbon reporting and targets against a standardised methodology, as originally envisioned in the Ministry of Business, Innovation and Employment's response to the first Emissions Reduction Plan
- building on cross-agency work in partnership with industry, recognising the multiple policy touchpoints across the steel value chain.

CREATING INCENTIVES

Provide fast-tracks when consenting buildings that can prove they meet an embodied carbon target.

RESEARCH, DEVELOPMENT AND SKILLS

Further investment is required in:

- hydrogen-based ironmaking
- novel ironmaking technologies
- carbon capture, utilisation and storage
- workforce capability and education across the steel value chain.

Demonstration projects and co-investment, such as the Glenbrook EAF, show how partnership between industry and government can accelerate emissions reductions.

Image credit: NZ Steel

2. DEMAND FOR LOW-EMISSIONS OUTCOMES

Demand from end users will help to accelerate the transition to low-emissions steel. End users can also prioritise reuse of existing assets and materials, reducing demand for new materials. The table below presents demand-side drivers.

Table 1. Demand-side drivers.

Project stage	What drives demand	What helps make it happen
Client demand	Reducing demand for virgin steel through no-build options and adaptive reuse	→ Greater uptake of certifications such as Green Star and Homestar, supporting higher asset values and occupancy rates → Access to green finance, including green loans and green bonds → Government acting as an early adopter → Willingness to pay a premium for low-emissions materials and incorporating this into business cases from the outset
Planning	Reducing demand for virgin steel through no-build options and adaptive reuse	→ Policies and codes that make it easier to reuse existing materials rather than classifying them as wastes or requiring special disposal → Better developed testing and approval regimes for reused structural materials
Design	Architects and structural engineers work together to optimise material use	→ Making GHG emissions a key consideration in early design (with cost, quality and timeline) → Peer review at early design stages, with one aim to explore how to reduce material use → Use digital product passports for materials to set the building up as a material bank
Procurement	Procurement contracts with upper limits for embodied carbon of different material types	→ Industry benchmarks to allow well-founded embodied carbon targets to be set → Mechanisms to gather data from construction companies to validate that any intended low-emissions materials haven't been value engineered out
Construction	Builders confident using low-emissions materials and techniques	→ Improved digital workflows from design to construction to allow exact specification of the products needed, rather than relying on generic, off-the-shelf materials
Post construction	Verification of as-built material performance	→ Tools to confirm that specified materials were used and in what quantities → Consolidation of digital product passports to enable buildings to function as material banks

3. SUPPLY OF LOW-EMISSIONS STEEL

Innovation and continuous improvement will be essential to deliver net-zero GHG emissions in the steel sector. Some technologies are already commercially available, while others require further testing, scale-up or cost reduction.

Research and development priorities span the full value chain - from ironmaking and steelmaking to recycling, digital systems and material reuse. Progress in these areas will reduce risk, lower costs and accelerate adoption of low-emissions solutions.

The table below outlines priority areas for research and development across the steel industry. It highlights where further technical development, demonstration or collaboration is needed to support the transition to low-emissions steel.

Table 2. Priority areas for research and development across the steel industry.

Initiative	Rationale	Stakeholders*	Timeline
SSC Responsible Products Certification	Certification encourages steel supply chain to meet an agreed standard	SSC, NZGBC	<2030
Specification guides for low-emissions steel	Provide the tools for the specifier community to write low carbon specifications into their contracts	HERA, SESOC, specifiers	<2030
Digital material passports	Encourages reuse of steel members at the end of a structure's life, keeping steel in its highest form of value	HERA, NZGBC, NZAMR	<2030
Low-emissions circular design guidance and optimised tools	Identify specific design approaches to reduce embodied carbon, building on existing work (e.g., ShahMohammadi et al., 2025a)	HERA, BRANZ, NZIA, NZGBC, SECOC, Engineering NZ	<2030
Transition the steel industry off natural gas	Natural gas is an important transition fuel, but it must be replaced by direct electrification, green hydrogen or biogas	EECA, MBIE, SSC	<2040
Low-emissions ironmaking for New Zealand	Further R&D on low-emissions ironmaking from iron sand, with the aim of setting up a commercial scale pilot	NZ Steel, MBIE, VUW, CullBeck	<2040

*
NZGBC = New Zealand Green Building Council | Te Kaunihera Hanganga Tautaiao;
SESOC = Structural Engineering Society New Zealand (Inc.);
BRANZ = Building Research Association of New Zealand;
NZIA = New Zealand Institute of Architects | Te Kāhui Whaihanga;
VUW = Victoria University of Wellington | Te Herenga Waka;
EECA = Energy Efficiency and Conservation Authority | Te Tari Tiaki Pūngao

LOOKING BEYOND 2050

This roadmap sets out a credible pathway to reduce direct and electricity-related emissions from steel used in New Zealand buildings and infrastructure by more than 90% by 2050. But 2050 is not the end point.

Some of the most important circular economy benefits will be realised beyond 2050. Most buildings constructed today will still be standing then. Design for disassembly and design for reuse are therefore long-term strategies. Their full emissions benefits sit outside the modelling period of this roadmap.

If designed well, today's buildings will become tomorrow's material banks. Steel sections can be recovered and reused. High-quality scrap can be recycled repeatedly without loss of performance. Digital material passports and better documentation of as-built materials will make this possible.

HERA's Low Carbon Circular Design Hierarchy (Figure 7) and specific guidance for low-rise buildings (ShahMohammadi, et al., 2025b) set out a series of design principles that should be considered for new-build construction and reuse of existing buildings.

Looking beyond 2050, the opportunity is not only low-emissions steel, but a fully circular steel system. The choices made in the 2020s and 2030s, in design, technology, infrastructure and policy, will determine whether that future is realised.

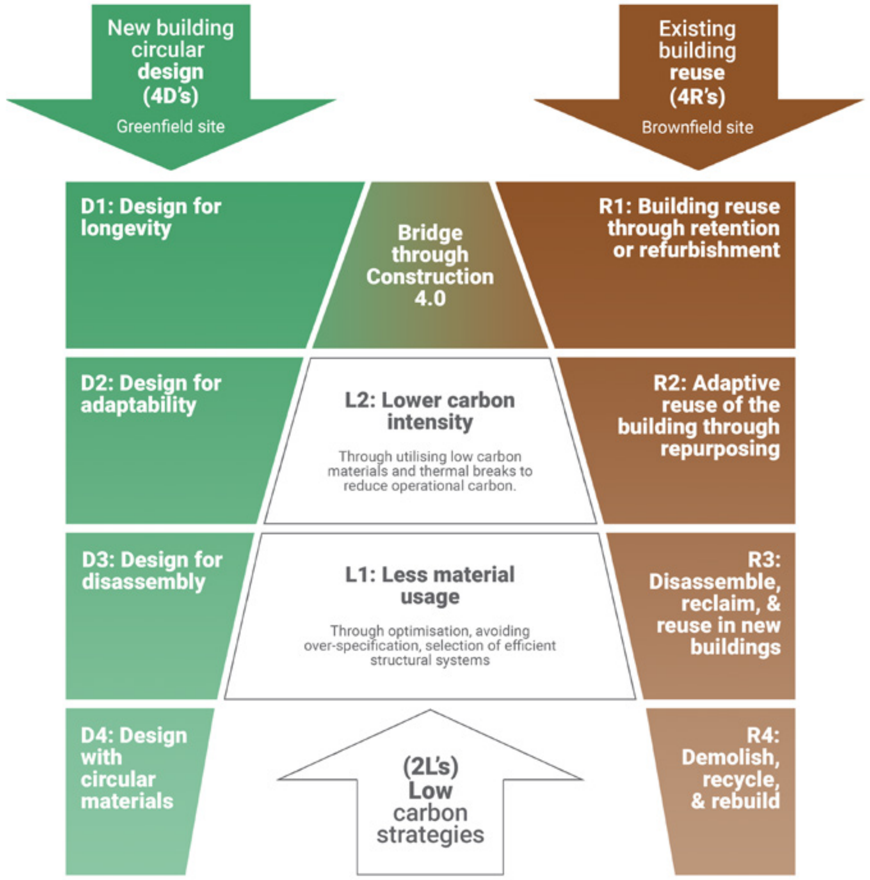


Figure 7. HERA's Low Carbon Circular Design Hierarchy (ShahMohammadi, et al., 2025a)

GLOSSARY OF TERMS

Basic oxygen furnace (BOF)
A steelmaking furnace that converts carbon-rich molten pig iron (usually from a blast furnace) into steel by blowing pure oxygen through it. The oxygen removes impurities via oxidation, a process which generates heat and keeps the iron in a molten state. Solid steel scrap is added as a cooling agent to maintain the optimal temperature.

Blast furnace (BF)
An ironmaking furnace that uses coking coal and limestone to convert iron ore to pig iron and slag.

Carbon capture, utilisation and storage (CCUS)
Technologies that capture carbon dioxide emissions from industrial processes and either store them permanently underground or use them in other applications.

Consumption-based approach
An accounting approach that attributes emissions to the country where materials are used, regardless of where they are produced.

Direct and electricity-related emissions
Greenhouse gas emissions from ironmaking, crude steel production, recycling and fabrication, including emissions from fuels used on site and purchased electricity.

Direct reduced iron (DRI)
Iron produced from iron ore below its melting point using a reducing gas which contains elemental carbon (produced from natural gas or coal) and/or hydrogen. Most DRI plants produce sponge iron, so called because of its porous, spongy appearance. Sponge iron can be compacted to form hot briquetted iron. DRI is an established technology but either requires high grade iron ores or an extra smelting step.

Electric arc furnace (EAF)
A steelmaking furnace that produces steel primarily from steel scrap. Heat is generated from an electric arc formed between electrodes and the steel. New iron (typically DRI) and other alloying elements are often added to control the chemical composition of the finished steel.

Environmental product declaration (EPD)
A standardised document that reports the environmental impacts of a product across its life cycle, based on international standards.

Indirect life cycle emissions
Greenhouse gas emissions that occur outside direct steelmaking processes, including raw material extraction, alloy production, coatings, transport and end-of-life processing.

Net-zero carbon
Net-zero is used throughout this document with respect to the industry and its products and relates to the reduction of CO_2 emissions, across the whole life cycle, to zero. Carbon capture by our industry at our industrial plants is included in our actions to reduce carbon emissions to zero. Offsetting measures such as planting trees or other nature-based solutions are not included in the calculations to get to net-zero.

Greenhouse gas (GHG)
A gas that absorbs and re-emits infrared radiation (heat), thereby trapping heat in the Earth's atmosphere and contributing to the greenhouse effect and climate change. Carbon dioxide (CO_2) is the main greenhouse gas produced by the steel industry.

Green hydrogen
Hydrogen produced using renewable electricity, typically through electrolysis of water, with little or no associated greenhouse gas emissions.

Net-zero GHG emissions
A state where greenhouse gas emissions are reduced as close to zero as possible, with any remaining emissions balanced by permanent greenhouse gas removals.

Virgin iron / virgin steel
Iron or steel manufactured primarily from iron ore. Also known as 'primary', or 'unrecycled' iron and steel.

Recycled steel
Steel manufactured primarily from steel scrap. Also known as 'secondary' steel.

Steel scrap
Recovered steel from manufacturing offcuts or end-of-life products and buildings, used as a raw material in electric arc furnace steelmaking.

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Image credit: Phoenix Metal Recyclers NZ

ABOUT THE SUSTAINABLE STEEL COUNCIL

SUSTAINABLE STEEL COUNCIL

The Sustainable Steel Council NZ Incorporated (SSC) is a group of industry leaders committed to the circular economy and New Zealand's low-emissions future.

Our programme of work will support New Zealand's steel sector through:

- → supporting the sector in building skills, capacity and processes for maximising steel's contribution to a sustainable, low-emissions and climate-resilient society
- → developing New Zealand's first sustainable steel certification programme
- → developing resources for the sector
- → advancing steel's role in the circular economy.

ABOUT THE BUILDING INNOVATION PARTNERSHIP

BUILDING INNOVATION PARTNERSHIP

The Building Innovation Partnership (BIP) is an eight-year (2018-2026) $12.5m programme of applied research, based in Civil and Natural Resources Engineering at the University of Canterbury.

The purpose of the BIP is to improve the affordability and performance of New Zealand's infrastructure by supporting the uptake of digital technologies and other innovations by industry. The programme is delivered through four themes covering horizontal infrastructure and buildings.

THEME 1	THEME 2	THEME 3	THEME 4
Better investment decisions	Digital technologies	Fit-for-purpose building components	Low carbon and climate-resilient infrastructure
(Three Waters)	(BIM, AI and digital twins)	(Seismic performance)	(Low carbon materials and buildings)

← DATA METHODS AND ANALYTICS →

Image credit: NZ Steel

ANNEX A **EMISSIONS REDUCTION STRATEGIES**

This annex provides more detail on the emissions reduction strategies that will allow the steel industry to reach our goal of net-zero GHG emissions by 2050.

ADAPTIVE REUSE

The lowest emissions building is the one we didn't need to build because we reused what was already there. Adaptive reuse is an important strategy to make the most of the historic GHG emissions invested in existing assets. Examples include conversion of old office towers to apartment towers and old warehouses to community centres and loft apartments. It also includes life extension of existing infrastructure assets and optimisation of the new-space/area requirement versus a business-as-usual approach.

This roadmap estimates that a 10% reduction in the need for new building materials at the national level can be achieved by 2050 through greater adaptive reuse of existing assets.

DESIGN & CONSTRUCTION

The construction industry is understandably conservative as no one wants to be responsible for a collapsed building or bridge. As a result, safety factors are standard practice in building codes and everyday design practice. Engineers and specifiers are also often asked to apply 'member rationalisation', i.e., to reduce the number and variety of materials sent to the construction site to simplify and de-risk the construction process. Taken together, these practices lead to roughly 20–50% greater structural material use than is strictly necessary (Poole, 2020).

This roadmap estimates a 20% reduction in steel use is possible by 2050 by greater optimisation of design and supply of materials to site. Achieving this level of optimisation will require co-operation between engineering designers, architects, developers and builders.

In this future world, structural engineers would actively seek out early peer review with the shared intent of taking steel out of the design where it is not strictly necessary. Software tools and design approaches would then support greater optimisation of structural steel through design and take the results right through to construction.

HERA has developed a guide for specifying low-emissions structural steel with targeted year-on-year reductions (Coyle & Andisheh, 2025). SESOC will soon release a similar guide, covering steel, concrete and timber.

RENEWABLE ENERGY

Scrap-based EAFs powered by renewable electricity already achieve emissions intensities below 0.50 kg CO_2e/kg crude steel, e.g. (Pacific Steel, 2025). This is an emissions reduction of around 80% compared to BF-BOF steel (i.e. 5 times lower) (worldsteel, 2025).

To achieve reductions of over 90% aligned with a net-zero GHG emissions target, electricity needs to move to nearly 100% renewable. Renewable electricity is needed directly for EAFs, but also indirectly to produce green hydrogen for ironmaking and to power the heavy goods vehicles needed to transport steel. This analysis uses a market-based (rather than a location-based) approach to calculating GHG emissions, meaning that purchases of credible Renewable Energy Certificates (RECs) are allowed within the analysis.

STEELMAKING

Greater use of EAF steelmaking is the primary strategy in this roadmap for the 2020s and 2030s. It relies on proven technology, it is cost competitive, it decarbonises as electricity decarbonises, and it contributes to a more circular domestic economy (rather than exporting scrap and then reimporting steel products).

Significant volumes of steel imported into New Zealand are already manufactured via the EAF route, including reinforcing bar and hot rolled structural sections. In the domestic market, New Zealand's only previous large-scale EAF – at Pacific Steel in Otahuhu, Auckland – closed in 2015, meaning that all of New Zealand's steel scrap was exported in the decade from 2016 to 2025. In 2026, New Zealand Steel is commissioning a new EAF at Glenbrook, Auckland, which will use roughly half of New Zealand's total steel scrap, with the remainder exported.

IRONMAKING

Iron is the main ingredient in steel and ironmaking is the most emissions-intensive step in steelmaking. While recycled steel can be manufactured without iron in an EAF, there isn't enough steel scrap in the world to make all the steel we need via this route. New iron is also used to dilute impurities (known as tramp elements) in steel alloys.

Globally, 70% of all steel was manufactured from iron via the BF-BOF route in 2025 (worldsteel, 2025). This share is expected to fall to 60% by 2050 as scrap availability improves (MPP, 2022). This means that primary steelmaking from iron will continue to be the dominant steelmaking route globally during the timespan covered by this roadmap.

Ironmaking in blast furnaces is the most emissions intensive step in steelmaking globally. There are three key reasons for this:

→ The chemical reaction to convert iron ore to pure iron: $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

→ The chemical reaction to produce carbon monoxide from coking coal: $2C + O_2 \rightarrow 2CO$

→ The high temperatures needed for these chemical reactions to take place.

DRI is an alternative ironmaking pathway with lower GHG emissions than a conventional blast furnace when natural gas is used as the reductant (worldsteel, 2025). DRI is already widely used and is particularly common in India. Conventional DRI uses natural gas or coal as the primary reductant and fuel; however, it can be run using hydrogen instead.

As of 2025, the average emissions intensity of DRI-EAFs is 1.66 kg CO_2e/kg crude steel (38% lower than BF-BOF) and scrap-based EAFs is 0.71 kg CO_2e/kg crude steel (70% lower than BF-BOF) (worldsteel, 2026).

Iron with zero GHG emissions is possible. Iron used in DRI-EAF plants can be produced using green hydrogen instead of gas or coal. Novel ironmaking technologies such as electrolysis and metallothermic reduction can also achieve zero GHG emissions. Conventional BF-BOF plants can also be retrofitted with CCUS, where conditions allow.

A key challenge is the cost of production. Ironmaking technologies with zero emissions lead to crude steel that is 20%–70% more expensive than conventional technologies (MPP, 2022). Beyond cost, there are also challenges in ore quality (as DRI requires high quality ore) and in the management of hydrogen, which is highly explosive.

Projects such as NeoSmelt in Australia seek to develop iron smelting technology at scale, which will be important to allow for a wider variety of ores to be processed into iron after a DRI process, then into the subsequent EAF or BOF and downstream steelmaking chain.

This roadmap envisages that low-emissions iron will not make a meaningful contribution to emissions reductions until the 2040s. While some suitable technologies already exist, they are in their infancy and not yet cost competitive, reducing their potential uptake in the short- to medium-term.

Image credit: Phoenix Metal Recyclers NZ

ANNEX B **EPD ANALYSIS**

The main body of this document presents a roadmap to net-zero GHG emissions considering direct and electricity-related emissions only. These are the emissions that the steel industry itself has the most direct control over and are the focus of other global roadmaps.

This annex presents the results of a carbon footprint analysis of both direct and indirect emissions, designed to align with the system boundary used in environmental product declarations (EPDs).

Both approaches use the same underlying data, including the volume of iron and steel, the share of domestic production and imports, and the types of products produced. However, they apply different system boundaries and methods to calculate emissions.

Table 3 outlines the differences in scope between the main report and this annex. This annex aims to capture the full life cycle of iron and steel, as illustrated in Figure 8.

Table 3. Differences in scope between the main report and this annex.

Emissions source	Main report	This annex
Direct and electricity-related emissions from ironmaking, steel recycling, steelmaking and steel fabrication		
The electricity required to produce green hydrogen and pure gases (e.g., oxygen and nitrogen) is included		
Production of upstream raw materials (e.g., iron ore and coal)	X	
Production of alloying elements	X	
Production of coatings (metals, paints)	X	
Transport at all stages (upstream raw materials, finished products and scrap)	X	
Demolition/deconstruction of buildings and infrastructure assets to recover steel scrap	X	
Manufacture of capital goods	X	(electricity only)
Maintenance of steel in use	X	X
Indirect emissions due to downstream use of sold products (e.g., steel in vehicles)	X	X
Impacts related to employees, e.g., employee commuting and business travel	X	X

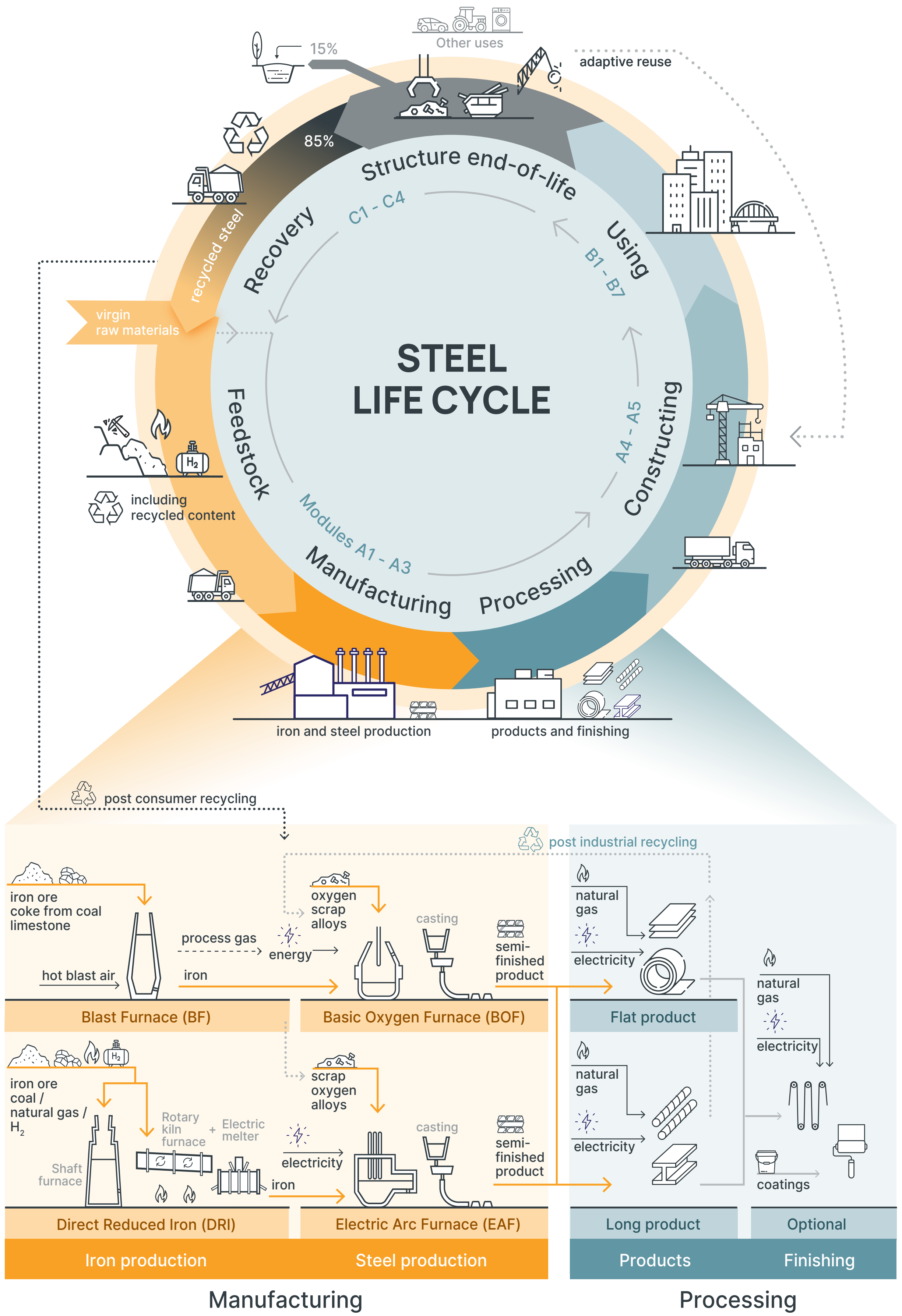


Figure 8. The full life cycle of iron and steel

EPD ANALYSIS

Our EPD analysis is based on publicly available information including:

- → published emission factors
- → EPD documents released by the industry
- → economic and growth statistics and population data for New Zealand
- → data obtained from the industry consultation we conducted for this roadmap.

The data takes into account the upstream activities involved in the steel sector. This includes the indirect emissions from extracting, processing and transporting raw materials, such as iron ore, coal and zinc.

The analysis does not include any contribution from steel that might be used in steel products.

THE RESULTS

The bottom bar (dark teal) shows the results from the body of this report. The next bar (lighter teal) shows the upstream (Scope 3) GHG emissions, e.g., the production of coatings. Transport (orange) emissions are relatively small and were calculated as a weighted average of domestic production and imports. End-of-life emissions (from cutting, transport, etc.) are relatively small.

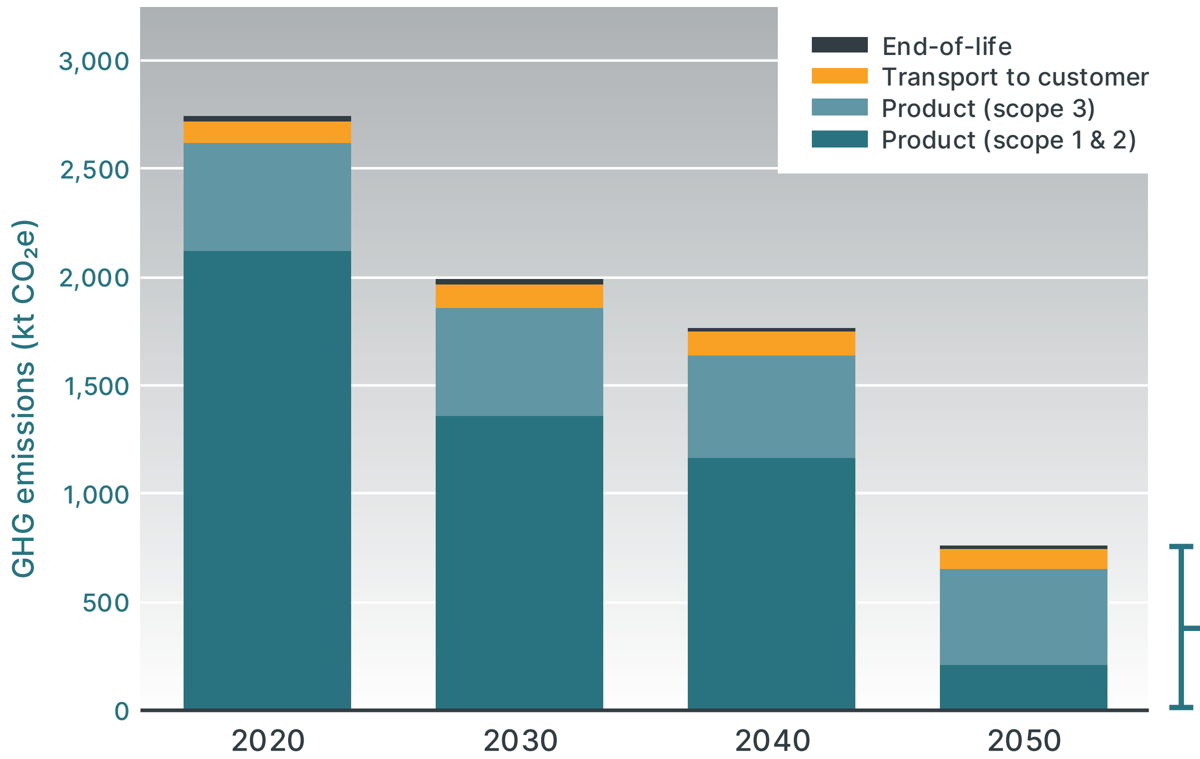
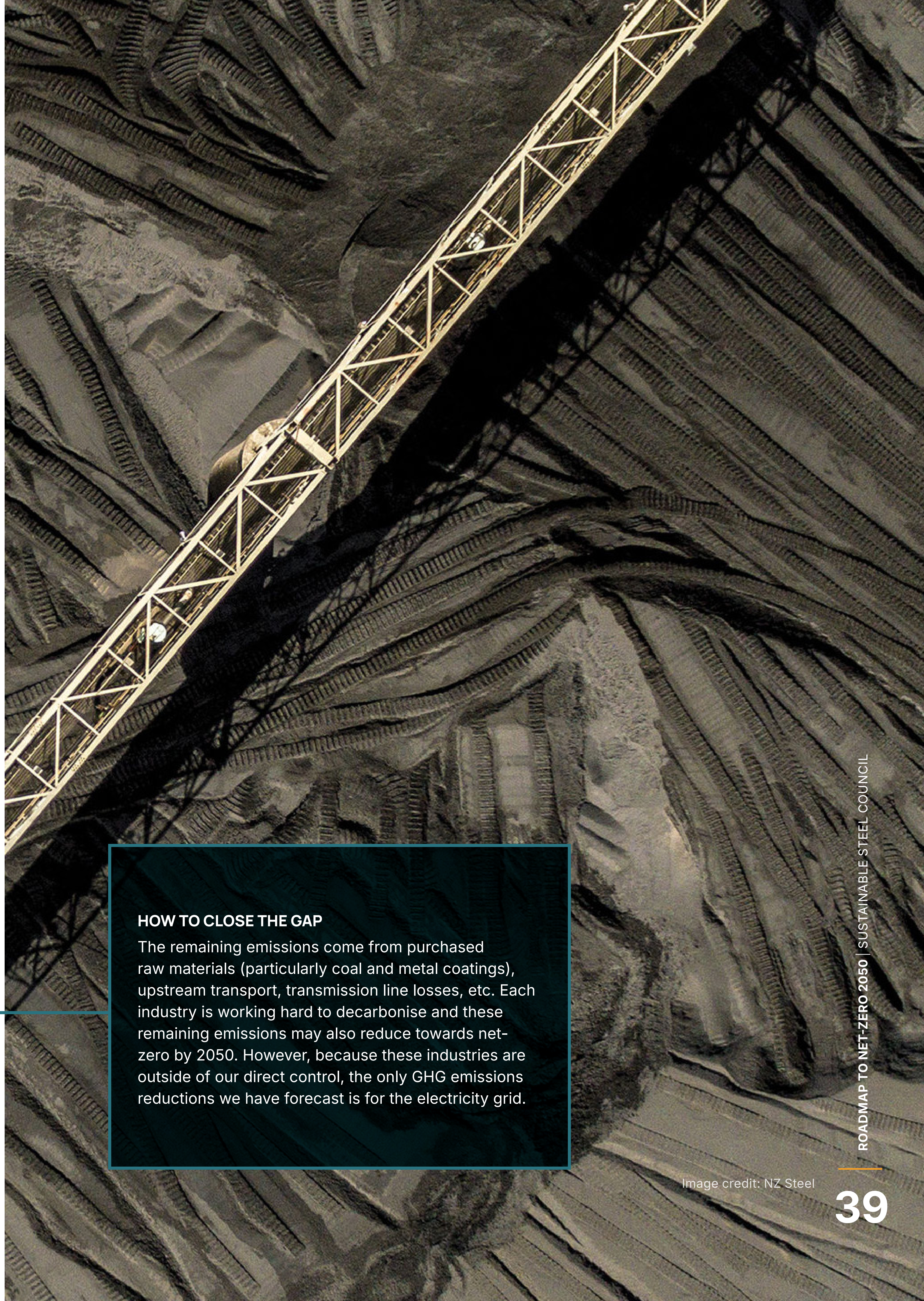


Figure 9. Decarbonisation: The results of this report, Scope3, transport to customer and end-of-life.



HOW TO CLOSE THE GAP

The remaining emissions come from purchased raw materials (particularly coal and metal coatings), upstream transport, transmission line losses, etc. Each industry is working hard to decarbonise and these remaining emissions may also reduce towards net-zero by 2050. However, because these industries are outside of our direct control, the only GHG emissions reductions we have forecast is for the electricity grid.

Image credit: NZ Steel

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- → Sustainable Steel Council NZ Incorporated (SSC)
- → Ministry of Business, Innovation and Employment (MBIE)
- → NZ Heavy Engineering Research Association (HERA)
- → Metals New Zealand (Metals NZ)
- → Steel Construction New Zealand (SCNZ)

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