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What is Green Steel?

Definitions and Scopes from Standards, Initiatives, and Policies around the World

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Executive Summary

Iron and steel manufacturing is one of the most energy-and carbon-intensive industries worldwide. The global steel industry emitted around 3.6 billion tons of carbon dioxide (CO_2) in 2019. This accounts for around 7% of global greenhouse gas (GHG) emissions and 11% of global CO_2 emissions. Over the past decades, expanding steel production has raised total energy demand and CO_2 emissions in the subsector. Driven by population and GDP growth, global steel demand will likely continue to increase. Substantial cuts in energy demand and CO_2 emissions will therefore be needed by 2030 and thereafter for the world to reach the target of the Paris Climate Agreement: to limit global warming to "well below" 2 ℃.

In decarbonizing the global steel industry, standards, protocols, initiatives, and government policies have a significant role to play. In recent years, major growth has been seen in the number of standards, protocols, initiatives, and policies focused on decreasing the emissions from iron and steel production. An additional level of complexity is introduced into the current efforts to decarbonize the steel industry whereby the standards, protocols, initiatives, and policies tend to focus on either the producers of steel, the demand side of steel procurement, the finance and funding side or some combination thereof. However, through the sheer number of standards, protocols, initiatives, and policies and the variation and complexity in features, target audience, assessment boundaries, targets, pathways, requirements, reporting, certifications, and validation procedures, there has not yet been a cohesive report that compiles the information in one place to support industry, government, and other stakeholders in achieving the goal to decarbonize the steel industry.

In this report, "What is Green Steel?", we aim to address this information gap and bring together a summary of the current major standards, protocols, initiatives, and government policies focused on reaching the goal of green/low-carbon steel production and decarbonization of this sector. Additionally, we provide clear indication of whether a standard, initiative, or policy directs its focus on the steel producers, the demand side steel procurement, and/or the finance and funding sectors. We assessed seven different standards and protocols (e.g. Responsible Steel Standards & Certifications, WRI's GHG Protocols for Steel, Climate Bonds Initiative's Criteria for Climate Bonds for the Steel Industry), eleven different initiatives (e.g. Industrial Deep Decarbonization Initiative (IDDI), Science Based Target Initiative for Steel (SBTI), First Movers Coalition Initiative, and the SteelZero Initiative) and several selected policies from some of the world's largest steel producing countries/region (i.e. the EU, U.S., China, India, Japan, South Korea, and Canada).

We additionally present a first of its kind cross comparison matrix that compiles the currently disaggregated standards, protocols, initiatives, and policies' key information into one table to aid industry, government, non-government organizations, and academia in quickly comparing major standards, protocols, initiatives, and policies currently or soon-to-be-released at the time of writing this report.

This in-depth review of the global standards, protocols, and initiatives related to the decarbonization of the global steel industry also investigates the steel market focus area (Table 1). Each of these are discussed in detail in the body of this report.

Table 1: Summary of the focus of the current steel industry standards, protocols, and initiatives

Steel Market Focus Area	Count	Examples
Producer Only	10	ResponsibleSteel, WRI GHG Protocols, World Steel Association, Science Based Targets Initiative, IEA
Demand Only	3	IDDI, First Mover's Coalition, SteelZero
Finance Only	3	Climate Bond's Initiative, RMI Center for Climate Aligned Finance Initiative – Sustainable Steel Principles, Climate Action 100+
Producer & Demand	2	Mission Possible Partnership's Net Zero Steel Initiative and Horizon Zero

As can be seen in the table, there are a significant number of standards, protocols, and initiatives that focus on steel producers. Of these steel producer-focused standards and initiatives, 3 (ResponsibleSteel, SBTi, and the IEA) provide specific numerical targets for the tons of CO_2 emitted per ton of steel produced (emissions intensity) and a common thread exists for the numerical target structure for emissions intensity between ResponsibleSteel, the IEA, and ArcelorMittal's Low Carbon Steel Proposal in which a scrap utilization proportional sliding scale with tiered product ranking values is proposed similar to that shown as a representative example from the IEA in Figure 1.

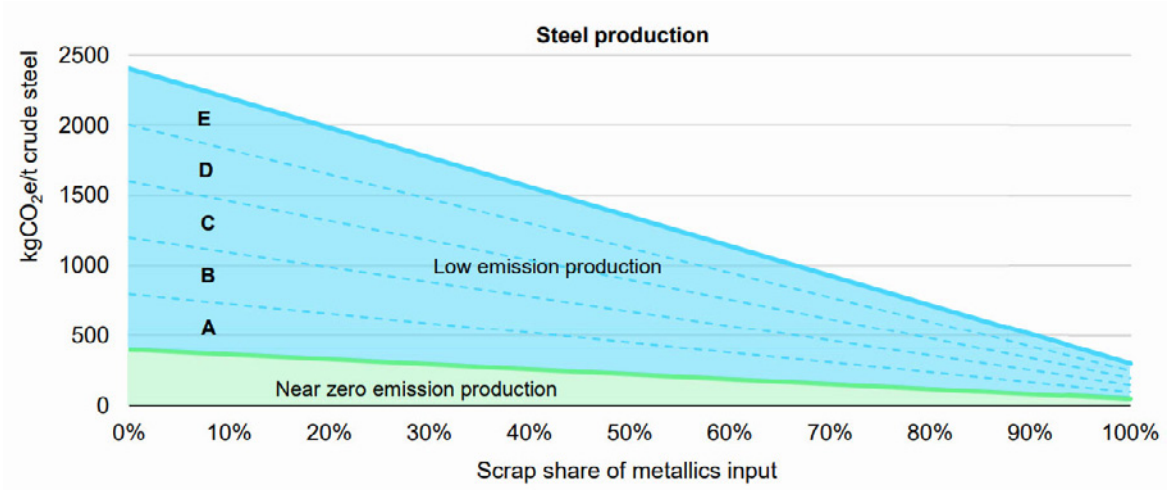

Figure 1: IEA's near zero emission crude steel production threshold as a function of scrap use and proposed classification system (Levi et al., 2022).

The emissions intensity for near-zero steel production for ResponsibleSteel and the IEA is defined as 0.05 to 0.4 tons of CO_2 per ton of steel depending on the ratio of scrap used. On the demand side, IDDI, the First Movers Coalition, and SteelZero take the same definition with varied steel procurement targets. Other stated targets for standards and initiatives include specific emissions reduction targets over time (SBTi, Climate Bonds Initiative, Climate Action 100+). The remaining production-focused standards and initiatives focus largely on establishing frameworks for emissions accounting and reporting (e.g. GHG Protocols, ISO Standards, and The World Steel Association).

However, the Global Steel Climate Council (GSCC), an international coalition of steel producers and stakeholders, has expressed concern with scrap utilization proportional sliding scale methodology as they argue that this definition focuses on improvements relative to today's emissions, rather than on total emissions and say that the IEA's sliding scale proposal may help to stimulate decarbonization of primary steel production but does so at the

expense of disguising the much greater emissions reduction delivered by scrap-based-electric arc furnaces (EAFs), particularly when coupled with low carbon electricity. However, it should be noted that the availability of scrap is limited and even in 2050 there is a need for 30%-40% iron ore-based primary steelmaking. We need proper incentives and measurement systems to ensure deep decarbonization of primary and secondary steelmaking and increase the availability and quality of recycled scrap globally.

This report also finds that the policies of the world's major steel-producing countries vary significantly. For example, the U.S., Canada, and Japan have stated targets of obtaining net zero steel production by 2050 and China by 2060. India, one of the world's largest and emissions-intensive steel-producing nations has a goal to reach carbon neutrality in 2070. To obtain these goals, individual nations can drive down their steel industry emissions by implementing Green Public Procurement (GPP) programs with emissions intensity thresholds for the steel they procure as is being done currently in California and the EU with planned GPP programs more broadly in development in the U.S. and Canada. Nations can additionally implement other policies and regulations and/or incentive programs to lower their steel production emissions intensities through adoption of technologies and measures such as energy efficiency, material efficiency, fuel switching to low/no-carbon fuels, technology shift to EAF, Direct Reduction of Iron (DRI) using green hydrogen, and CCUS.

Upon completing a thorough analysis of the various steel industry decarbonization standards, protocols, initiatives, and policies the following three key focus areas were identified as crucial to meeting Paris Agreement Goals and decarbonizing the steel industry.

1. That a standard, protocol, initiative, or policy should be aligned with the Paris Agreement 1.5°C target. To be aligned with the 1.5°C target, the global weighted average CO_2 emissions intensity of primary steelmaking should be below 0.9 and 0.1 ton CO_2/ton crude steel in 2040 and 2050, respectively. The global weighted average CO_2 emissions intensity of secondary scrap-based steelmaking should be below 0.2 and 0.1 ton CO_2/ton crude steel in 2040 and 2050, respectively. This is based on the carbon budget allocated to the steel industry by IEA up to 2050 in the 1.5°C scenario.

2. Standards, protocols, initiatives, and policies should consider Scope 1, 2, 3 emissions and provide clear boundary definitions for the calculation of their emissions guidelines. This will allow the industry to move forward consistently in achieving the deep decarbonization targets. For the primary steelmaking, the system boundaries should certainly include emissions related to the main ironmaking processes (blast furnace, sintering, coking) which account for around 90% of primary steelmaking's CO_2 emissions. The indirect emissions related to the electricity use (Scope 2) should also be included, especially for the EAF steel production. For the Scope 3 emission, system boundaries should ensure that emissions related to purchased pig iron and DRI are included. Finally, methane emissions from natural gas systems and coal mining are important and should be seriously considered in Scope 3 emissions in systems boundaries.

3. The reliability and availability of product- and plant-level data should be increased, which will be very important to continue to monitor the progress of the industry and help in the identification of areas for improvement to achieve deep decarbonization. It should be noted that steel companies and steel plants and most governments collect and have all the data needed to comply with the requirement of the standards, protocols, initiatives, and policies listed in this report. Although such data and information may not be publicly available.

Our study shows that there are several standards and protocols and many initiatives and policies related to the decarbonization of the steel industry. These standards, protocols, initiatives, and government policies often serve different purposes and address different segments or aspects of the steel value chain. Some target the demand side, while others target the supply side of the steel value chain. Some may be targeted toward the finance community, while some are for green public procurement policies. Therefore, it may not be possible to only have one standard for all purposes these initiatives and policies are trying to serve. In addition, given the different contexts in which the steel industry operates in different countries, it is impractical to assume that a single standard would be used in all countries for all purposes around the world. Instead, we may need a few high-quality standards and protocols that are aligned with each other as much as possible.

It is imperative that these few standards and protocols communicate and coordinate with each other to align their requirements and reduce the burden on the steel industry and other stakeholders as much as possible. Some aspects of standards that could benefit from global harmonization are emissions accounting boundaries, types of GHG covered, and definition or quantitative threshold of what qualifies as zero-emission or near zero-emission steel. Also, it is critical to bring major steel-producing emerging economies' perspectives (especially China and India) into decarbonization standards and initiatives.

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1 Introduction

Iron and steel industry is one of the most energy- and carbon-intensive industries worldwide. The global steel industry emitted around 3.6 billion tons of CO_2 in 2019 (Hasanbeigi 2022a). The iron and steel industry accounts for around 7% of GHG emissions and 11% of global CO_2 emissions. Global steel production has more than doubled between 2000 and 2020 (Hasanbeigi, 2022). Over the past decade, expanding steel production has raised total energy demand and CO_2 emissions in the subsector. Driven by population and GDP growth, global steel demand will likely continue to increase. Substantial cuts in energy demand and CO_2 emissions will therefore be needed by 2030 and thereafter for the world to reach the target of the Paris Climate Agreement: to limit global warming to "well below" 2 ℃.

In addition to technological advancements in decarbonizing the global steel industry, standards, protocols, initiatives, and government policies have a significant role to play. In recent years, major growth has been seen in the number of standards, protocols, initiatives, and policies focused on decreasing the emissions from steel production. However, through the sheer number of standards, protocols, initiatives, and policies and the variation and complexity in features, assessment boundaries, targets, pathways, requirements, reporting, certifications, and validation procedures, there has not yet been a cohesive report that compiles the information in one place to support industry, government, and academia in achieving the goal to decarbonize from the steel industry.

The World Trade Organization (WTO) also recognizes the current proliferation and fragmentation of steel sector decarbonization efforts. The WTO states that the current landscape creates uncertainty for producers, increases transaction costs and risks trade frictions. The WTO also stresses the importance of promoting coherence and bringing developing countries' perspectives into decarbonization standards and initiatives. Standards should be globally relevant and technology neutral, science-based and ambitious, have well-understood boundaries and scope, and ensure transparency in monitoring, reporting and verification. The right methodologies enable accurate information and comparisons across products, processes and technologies and deliver confidence in net zero claims. It is also important to develop the right methodologies for steel decarbonization standards in situations where governments decide to incorporate them into their domestic regulations (WTO 2022).

In this report, "What is Green Steel?", we aim to address this issue and bring together a summary of the current major standards, protocols, initiatives, and selected government policies focused on reaching the goal of low-carbon steel production and decarbonization of the industry. We assessed seven different standards and protocols, eleven different initiatives, and selected policies from some of the world's largest steel-producing nations. For each analyzed standard, protocols, initiative, and policy we provide details wherever applicable on the:

- definition of green or low-carbon steel,
- emissions boundary/scope,
- site or product level emissions definition,
- proportionality to scrap steel use,
- use of the full life cycle assessment (LCA) approach or environmental product declaration (EPD),
- numerical targets set,

- timelines,
- demand, producer, or finance side push of the initiative, standard, or policy
- consistency with the Paris Agreement 1.5°C target
- disclosure and reporting requirements
- reporting verification and enforcement
- who developed the standard or initiative?
- who is using or participating in the standard or initiative?
- the development status.

For the policy section of this report, we also discuss the status of government initiatives and regulations as well as the progress of national organizations and companies' efforts and goals of decarbonization of the steel industry.

In the report, we additionally present a first of its kind cross comparison matrix that compiles the currently disaggregated standards, protocols, initiatives, and policies key information into one table to aid industry, government, non-government organizations, and other stakeholders in quickly comparing major standards, protocols, initiatives, and policies currently or soon to be released at the time of writing this report.

2 Summary of Standards, protocols, initiatives, and Policies

Each of the various steel standards, protocols, initiatives, and policies has varied characteristics and requirements. In this document, standards are referred to as something set up by authority or by general consent as a rule for measuring, and initiatives are new plans or processes to achieve a goal or solve a problem. Of the standards, protocols, initiatives, and policies studied in this report three of them are considered both a standard and an initiative at the same time; the World Steel Associations Definition of Low Carbon Steel, RMI's Sustainable Steel Principles, and the Horizon Zero Initiative. There is also a variance in if the program is designed to target the steel demand side, the steel producers, the finance sector, or the regulatory/green public procurement side. There are differences in boundary definitions and the inclusion of Scope 1, 2, and 3 emissions, whether site level or product level emissions are considered as well as if a full life cycle assessment (LCA) or a more formalized LCA in the form of environmental production declaration (EPDs) is required. A cross-comparison matrix between the different standards, initiatives, and policies on these matters is presented on the next page in Table 2.

The numerical targets for each standards, protocols, initiatives, and policy also differ. There are a few cases where the numerical targets are similar however where the sliding scale, scrap proportional, tiered approach for defining near-zero steel and low carbon steel products are taken (first proposed by the Mission Possible Partnership's Net Zero Steel Initiative team), namely The Industrial Deep Carbonization Initiative, ArcelorMittal's Low Carbon Emissions Steel Proposal, the SteelZero Initiative, ResponsibleSteel, and the First Movers Coalition, they are similar to the IEA approach. However, some standards, protocols, initiatives, and policies have no set target stated. Some align closer with the Paris Agreement's 1.5 °C target, while others do not (see Table 2). There are also apparent differences in the disclosure requirements and verification processes across the board. Table 2 on the following page outlines these differences in a cross-comparison matrix.

The purpose of the cross-comparison matrix development is to provide a first-of-its-kind overview of all of the key elements of the major standards, protocols, initiatives, and selected policies relating to the steel industry that are discussed in more detail in the body of this report.

This cross-comparison matrix is followed by an emissions boundary comparison Figure 2 comparing the emissions boundary of several standards and initiatives. It should be noted that around 90% of CO_2 emissions in primary steelmaking is related to ironmaking processes furnace blast furnace, sintering, coking), which are included in all system boundary shown in Figure 2.

		Type			Steel Sector Side				Emissions Boudaries				Site/Product Level		EPD/LCA is Required/Encouraged	
No.	Standard/Initiative/Policy/Country Name	Standard/Protocol	Intiative	Policy/Regulation	Demand	Producer	Financial	GPP	Boundary Defined	Scope 1	Scope 2	Scope 3	Site/Company	Product	Yes	No
1	ResponsibleSteel Standards & Certification	X				X			X	X	X	X	X	X		X
2	WRI's GHG Protocol for Steel	X				X			X	X		X	X	X		X
3	Climate Bonds Initiative's Criteria for Climate Bonds for the Steel Industry	X					X		X	X	X	X	X	X		X
4	ISO 14067:2018 – Carbon Footprint of Products	X				X			X	X	X	Patrial		X	X	
5	ISO 14404 Series - Plant Level CO2 Emissions Intensity From Iron and Steel Production	X				X			X	X	X	Partial	X			X
6	American Iron and Steel Institute Steel Production Greenhouse Gas Emissions Calculation Methodology Guidelines	X				X			X	X	X	Partial	X	X	X	
7	World Steel Association's Definition of Low Carbon Steel	X	X			X			X	X	X	Partial	X		X	
8	RMI Center for Climate Aligned Finance – Sustainable Steel Principles	X*	X				X		X	X	X	Partial	X			X
9	Horizon Zero Initiative	X*	X		x	X			X	X	X	Partial	X	X		X
10	Industrial Deep Decarbonization Initiative (IDDI)		X		X			X	X	X	X	Parital		X	X	
11	Science Based Target Initiative for Steel		X			X			X	X	X	Partial	X	X		X
12	First Movers Coalition Initiative		X		X									X		X
13	SteelZero Initiative		X		X											X
14	ArcelorMittal Low-Carbon Emissions Steel Proposal		X			X			X	X	X	Partial	X	X	X	
15	Climate Action 100+ for Steel Initiative		X				X		X	X	X		X	X		X
16	IEA's Definition of Low-Carbon Steel		X			X			X	X	X	Partial		X		X
17	Mission Possible Partnership's Net Zero Steel Initiative		X		X	X			X	X	X	Patrial				X
16	EU-US Steel/Aluminum Embodied Carbon in Trade Negotiation		X	X	X	X		X								X
19	EU GPP and Other EU-Level Standards			X		X	X	X	X	X	X	Partial		X	X	
20	United States Federal Buy Clean Inititative			X		X	X	X							X	
21	California Buy Clean Program and Other U.S. States			X				X						X	Encouraged	
22	Canada Green Public Procurement			X		X	X	X					X		X	
23	China National Level and Industry Led Initiatives			X	X	X	X	X					X	X		X
24	Japan National Level and Industry Led Standards			X		X	X	X	X	X	X	Partial	X		X	
25	South Korea National Level and Industry Led Initiatives			X				X						X		X
26	India National Level Standards and Industry Led Initiatives			X				X								X

Table 2: Cross comparison matrix for the standards, protocols, initiatives, and policies discussed in this report.

		Targets & Modeling							Disclosure		Verification & Enforcement				Status		
No.	Standard/Initiative/Policy/Country Name	Numerical Target Stated	Numerical Target (tCO_2 per tsteel)	Scrap Proportional	Ratchet Up Timeline	Tiered Approach for Emission Intensity	Is the target 1.5°C Compatable?	CO_2 accounting & reporting method	To Standard Body	Public	Standard Body	Third Party	Enforcment Mechanism	Certification Granted	In Development	Released	Announced Updates
1	ResponsibleSteel Standards & Certification	X	**Basic:** 0.35-2.8 (100% - 0% scrap) **Level 2**: 0.25-2.0 (100%-0% scrap) **Level 3**: 0.15-1.2 (100%-0% scrap) **Near Zero:** 0.05-0.4 (100%-0% scrap)	X		X	YES	ISO 14044, ISO 14040, ISO 14067, GHG Protocol, EN 19694-2, PAS 2050	X	X		X	X	X		X	
2	WRI's GHG Protocol for Steel						Not explicetly stated	GHG Protocol								X	
3	Climate Bonds Initiative's Criteria for Climate Bonds for the Steel Industry	X	**New Steel Facilities:** No specified emission intensity. See report section for additional details **Operational Prior to 2022:** BF after 2007 decrease between 2022 and 2030 by 15% if emission intensity <1.8 and 20% if>1.8 BF before 2007 reduce emissions by 50% AND emissions intensity <1.8 Production with DRI Fossil Based 20% emissions intesity decrease and coal based 40% **Criteria for Companies:** Primary Steel 2.4 in 2020 to 0.2 in 2050 Secondary Steel 0.75 in 2020 to 0.2 in 2050	X	X		YES	ISO 14404, EN 19694-2, GHG Protocol	X	Encouraged		X		X		X	X
4	ISO 14067:2018 – Carbon Footprint of Products						Not explicetly stated	ISO 14067:2018								X	
5	ISO 14404 Series - Plant Level CO2 Emissions Intensity From Iron and Steel Production						Not explicetly stated	ISO 14404 Series								X	
6	American Iron and Steel Institute Steel Production Greenhouse Gas Emissions Calculation Methodology Guidelines						Not explicetly stated	EPA GHG Reporting Methodology								X	
7	World Steel Association's Definition of Low Carbon Steel						Not explicetly stated	ISO 14044, GaBi	X		X			X		X	
8	RMI Center for Climate Aligned Finance – Sustainable Steel Principles	X		X	X		YES	ISO 14044	X	Portfolio Alignment Score	X			X		X	X
9	Horizon Zero Initiative			X			Not explicetly stated	ISO 14044	X	X					X		
10	Industrial Deep Decarbonization Initiative (IDDI)	X	**Near zero steel:** 0.05-0.4 (100%-0% scrap) Utilizes the IEA definitions and A-E ranking for low emissions steel	X		X	YES	EPD (ISO 14025), ResposibleSteel, SBTi	X	X				X	X		X
11	Science Based Target Initiative for Steel	X	**Absolution Contraction Approach:** Linear 4.2% emission reduction per year or 42% bu 2030 Also includes company specific targets		X		YES	GHG Protocol	X		X			X	X		X
12	First Movers Coalition Initiative	X	**Near zero steel:** 0.05-0.4 (100%-0% scrap) All other emission intensities do not quality Members commit to procurring 10% of steel as near-zero by 2030	X			YES	Not explicetly stated	X	X				X		X	
13	SteelZero Initiative	X	Commit to procuring 50% net-zero steel by 2030, 100% by 2050 Net-Zero steel defined as ResponsibleSteel Certified, SBTi certified steel, or Near zero steel: 0.05-0.4 (100%-0% scrap)	X	X		YES	ResposibleSteel, SBTi	X					X		X	X
14	ArcelorMittal Low-Carbon Emissions Steel Proposal	Not explicelty stated	Tiered approach similar to IEA but no emissions intensity values	X		X	Not explicetly stated	EPD/LCA								X	X
15	Climate Action 100+ for Steel Initiative	X	Emission intensity compared to IEA Beyond 2°C scenario. Significant distance to alignment: >36% deviation Moderate distance to alignment: 15%-36% deviation Aligned or close to being aligned: <15% deviation			X	2°C	GHG Protocols	X			X		X		X	
16	IEA's Definition of Low-Carbon Steel	X	**Near zero steel:** 0.05-0.4 (100%-0% scrap) Utilizes the IEA definitions and A-E ranking for low emissions steel	X		X	YES	IEA modeling								X	X
17	Mission Possible Partnership's Net Zero Steel Initiative						YES	Steel Sector Transition Strategy Model								X	
16	EU-US Steel/Aluminum Embodied Carbon in Trade Negotiation						Not explicetly stated	Not explicetly stated							X		
19	EU GPP and Other EU-Level Standards	X	50% voluntary GPP target. 20% in Poland, <50% France and Latvia, 100% in The Netherlands		X		NO	Not explicetly stated	X	X			X			X	
20	United States Federal Buy Clean Inititative	X	98% of GPP as lower carbon products.				NO	EPD	X		X				X	X	
21	California Buy Clean Program and Other U.S. States	X	Hot rolled sections : 1.44 Hollow structual sections: 2.83 Plate: 2.12 Concrete reinfocing steel: 1.06	X			NO	EPD (ISO 14025)	X	X						X	X
22	Canada Green Public Procurement	X	Reduce steel emissions by 30% in 2025 and net-zero by 2050		X		YES	EPD, ISO 21930, wbLCA, LCA2	X		X		X			X	X
23	China National Level and Industry Led Initiatives	X	Steel industry peaking in 2030 and net-zero by 2060	X	X		NO	Not explicetly stated	X	X	X		X			X	X
24	Japan National Level and Industry Led Standards	X	46% reduction by 2030 comapred to 2013, net-zero by 2050	X	X		YES	JIS Q 20615, Eco Leaf EPD	X	X	X		X		X		X
25	South Korea National Level and Industry Led Initiatives	X	24.4% reduction by 2030 compared to 2017, Low Carbon Product Certification requires 3.3% reduction over 3 years				NO	Not explicetly stated	X						X		X
26	India National Level Standards and Industry Led Initiatives	X	Target to reach 2.4 emission intensity by 2030				NO	Not explicetly stated							X		

It should be noted that the 1.5 C alignment is self-declared and not third party vetted.

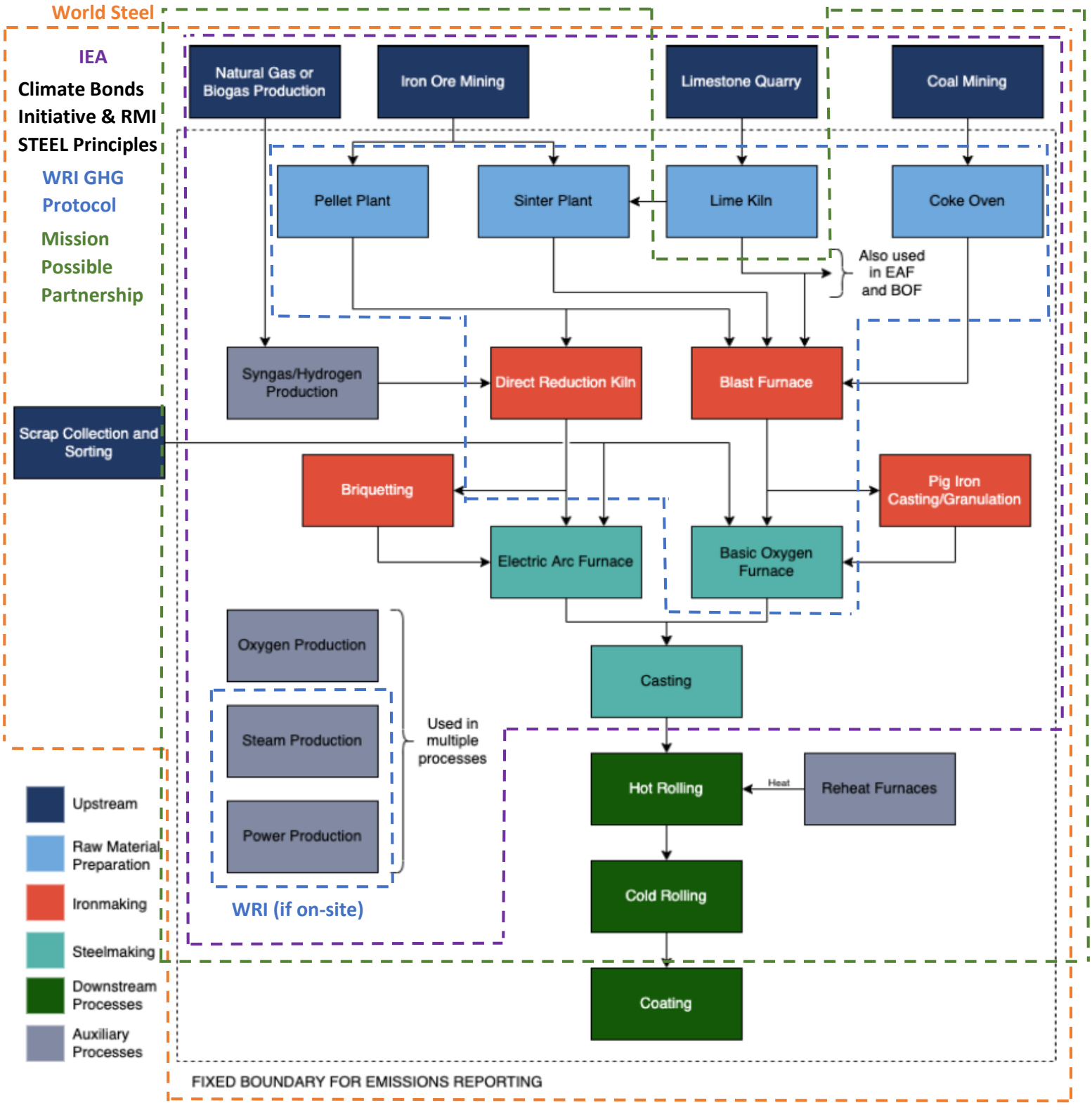


Figure 2: Comparison of system boundary of several steel decarbonization standards, protocols, and initiatives. (It should be noted that around 90% of CO2 emissions in primary steelmaking is related to ironmaking processes (blast furnace, sintering, coking), which are included in all system boundary shown in the figure.)

3 Low-Carbon Steel in Standards and Protocols

3.1 ResponsibleSteel Standards & Certification

The ResponsibleSteel Standards and Certification aims to play a pivotal role in driving down GHG emissions and driving up standards in the steel supply chain, helping steel companies transition to a responsible, decarbonized future (ResponsibleSteel, 2022d). Together with members from all stages of the steel supply chain, civil society, and downstream users Responsible Steel developed an independent certification standard and program via a process that aims to align with the ISEAL Codes of Good Practice (ResponsibleSteel, 2022a).

Features

The ResponsibleSteel Standards and Certification applies to operational steel sites as well as related sites that process raw materials for steelmaking or produce steel products. Service providers, mines sites, transportation of raw materials and products, and sites producing final products made from steel components are excluded. Under the standard, a 'site' is defined as a physical site under management or control and could include multiple processing facilities. Responsible Steel's certification is only granted to those sites that are committed to achieving the goals of the Paris Agreement and demonstrate that commitment (ResponsibleSteel Standards and Certification, 2022).

Long-term company-level targets must be translated into specific targets and plans to reduce GHG emissions at the level of individual sites, and GHG emissions must be measured and monitored at the site level to determine whether targets are being met. ResponsibleSteel certified steel must achieve a minimum threshold level of performance for the intensity of GHG emissions for the production of crude steel. The threshold level of performance is determined in accordance with internationally consistent GHG accounting rules which require that all significant greenhouse gases must be taken into account, including methane as well as CO_2 (ResponsibleSteel Standards and Certification, 2022).

Sites producing crude steel determine the GHG emissions intensity for its production on an internationally consistent basis including their direct (Scope 1), indirect (Scope 2), and upstream indirect (Scope 3) emissions associated with the extraction, processing and transportation of input materials. The standard defines and distinguishes between four levels of performance from a basic threshold for ResponsibleSteel certification (level 1) through to the production of 'near zero' steel (level 4), allowing steel users, specifiers, and policy makers to design their own specifications, commitments, and incentives to maximize the speed of the steel industry's transition to the production of 'near zero' steel discussed in more detail in the targets section below (ResponsibleSteel Standards and Certification, 2022).

Finally, the standard requires that any ResponsibleSteel-certified product must be accompanied by a declaration of its product carbon footprint, in accordance with existing standards (ResponsibleSteel Standards and Certification, 2022).

Targets, Pathways, and Requirements

ResponsibleSteel's emissions intensity targets are broken down into four performance levels that include a sliding scale for the proportion of scrap utilized to obtain the final steel product. The Level 1 Basic Threshold starts at 2.8 tons of CO_2e per ton of crude steel if 0% scrap is utilized and slides to 0.350 tons of CO_2e per ton of crude steel if 100% scrap is utilized.

Performance Level 2, Performance Level 3, and Performance Level 4: Near Zero start at 2, 1.2, and 0.4 tons of CO_2e per ton of crude steel for 0% scrap utilization and slide to 0.25, 0.15, and 0.05 tons of CO_2e per ton of crude steel for 100% scrap utilization respectively (ResponsibleSteel Standards and Certification, 2022). Figure 3 below illustrates the sliding scale and break down of Responsible Steel's emissions intensity performance levels.

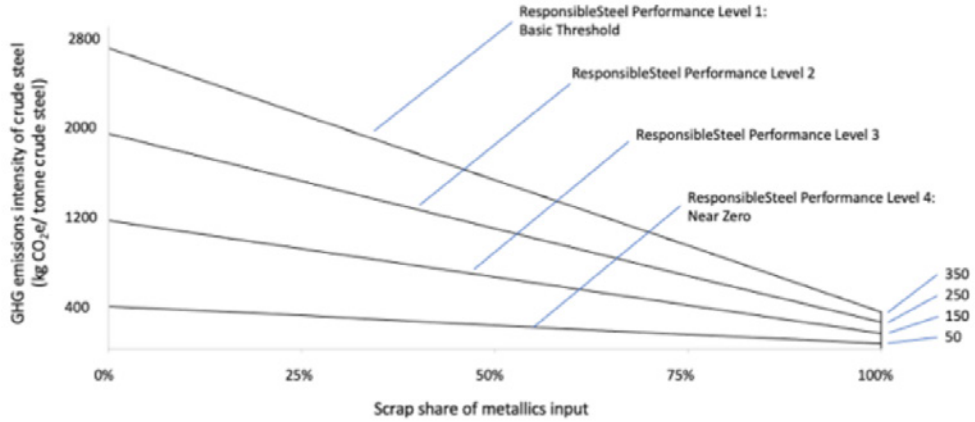


Figure 3: ResponsibleSteel's Performance Level breakdown for crude steel emissions intensity including a sliding-scrap utilization scale (ResponsibleSteel Standards and Certification, 2022).

The ResponsibleSteel standard also operates under the following 13 principles that must be met to achieve the organization's certification.

1. Corporate Leadership
2. Social, Environmental, and Governance Management Systems
3. Responsible Sourcing of input Materials
4. Decommissioning and Closure
5. Occupational Health and Safety
6. Labour Rights
7. Human Rights
8. Stakeholder Engagement and Communication
9. Local Communities
10. Climate Change and Greenhouse Gas Emissions
11. Noise, Emissions, Effluents, and Waste
12. Water Stewardship
13. Biodiversity

Awarding of the certification can be met with only minor non-conformities to any one of the above principles. Major non-conformities with any of the requirements under each principle will are not awarded certification. Full details of the other requirement to achieve Responsible Steel certification can be found in the cited version of the ResponsibleSteel International Standard Version 2.0 cited in this report (ResponsibleSteel Standards and Certification, 2022).

Disclosure, Reporting, and Quality Control

Public reporting and disclosure under each of the principles are required for certification. Independent third-party audit certifications are carried out and approved by ResponsibleSteel that are contracted by the site that is applying for certification. The audit report is reviewed by an

independent Assurance Panel appointed by ResponsibleSteel that can recommend certification by ResponsibleSteel of an applying site (ResponsibleSteel Standards and Certification, 2022).

The GHG emissions intensity performance of sites producing crude steel is disclosed, allowing downstream users and specifiers of steel, policy makers, and other stakeholders to support steelmakers in their efforts to reduce the GHG emissions of the steel industry through product specifications, purchasing commitments, financing and investment decisions, policy and other measures (ResponsibleSteel Standards and Certification, 2022).

Constituency

ResponsibleSteel is a non-profit organization with 52 participating members such as ArcelorMittal, BHP, U.S. Steel, and Cargill along with many others. There are 12 civil society members including the Clean Air Task Force, The Climate Group, IndustriALL, and many others (ResponsibleSteel, 2022c).

Current Certificate holders include

- Aperam Stainless Europe, Belgium, and France,
- ArcelorMittal Belgium,
- AcrelorMittal Belval & Differdange S.S
- ArcelorMittal Bremen GmbH
- ArcelorMittal Eisenhüttenstadt GmbH
- ArcelorMittal España S.A
- ArcelorMittal France
- ArcelorMittal Méditerranée
- ArcelorMIttal Poland
- ArcelorMittal Tubarão,
- Big River Steel
- BlueScope Australian Steel Products Manufacturing
- voestalpine Linz, Austria (ResponsibleSteel, 2022b).

Standards Development Status

There have been several rounds of the standard following the initial version drafted in 2017. Several public consultation periods have occurred since then. 5 draft versions were developed before Version 1 of the standards was adopted in 2019. The standards and requirements continued to be revised through rounds of meetings and public consultations. Version 1.1 of the standard was released in June of 2021 (ResponsibleSteel, 2022e).

ResponsibleSteel released the newest version of the ResponsibleSteel International Standards Version 2 on September 14th, 2022. Revisions to the standards were voted on in late August 2022 by the current members and stakeholders following a round of public consultation in April and June of 2021 to improve the standards (ResponsibleSteel, 2022e).

An “Implementation Instructions” document is under development to help correctly interpret the requirements, provide expectations related to conformity and the demonstration of conformity as well as examples of good practices to be followed. Responsible sourcing of raw materials guidelines is also in development and is being developed in conjunction with the Mining Association of Canada and the Initiative for Responsible Mining Assurance (ResponsibleSteel, 2022e).

3.2 WRI's GHG Protocol for Steel

The GHG Protocol established comprehensive global standardized frameworks to measure and manage GHG emissions for private and public sector operations, value chains, and mitigation actions. THE WRI GHG Protocol for Steel is not a governing body and solely sets a framework for GHG intensity calculation methods (Greenhouse Gas Protocol, 2016)

Features

The WRI GHG Protocol for Steel incorporates carbon dioxide (CO_2), methane (CH_4), and nitrous oxide emissions (N_2O) emissions for the manufacture of iron and steel and considers all three emissions under its GHG classification at the site level. A Global Warming Potential (GWP) is applied to each of these emissions to quantify the CO_2 equivalent (CO_2e) value for the facility. Figure 4 demonstrates the scope and boundaries of the WRI GHG Protocol for Steel (Russell, 2008).

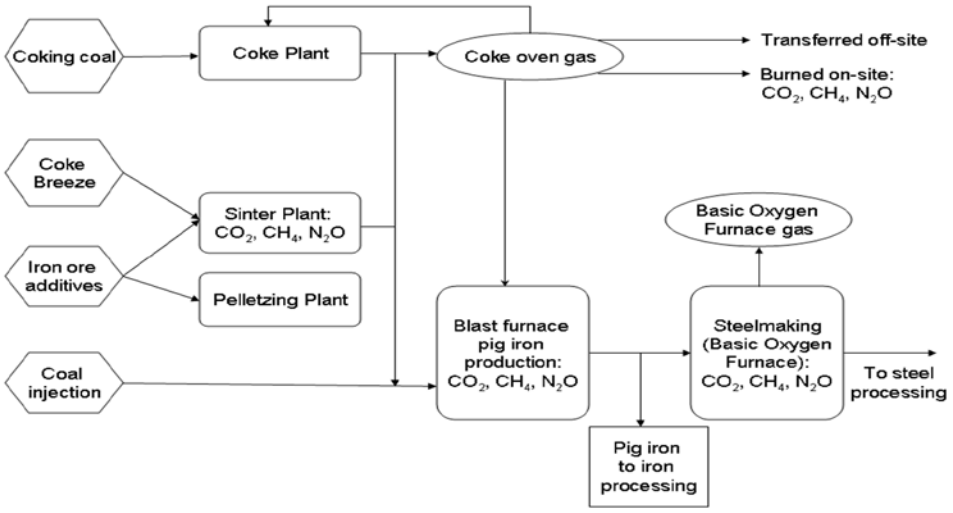


Figure 4: The main GHG emissions sources associated with iron and steel production included in the WRI GHG Protocol for Steel (Russell, 2008).

WRI allows for both organizational and operational boundaries to be drawn in their calculations where organizational boundaries for ownership of the emissions can be set based on the company's percentage equity share in the asset or the financial control/operational control. A company with financial control, defined as having financing control to direct both the financial and operational policies of an asset reports 100% of the emissions. The same is true for a company with operational control because it has full authority to influence operating practices at the facility. Operational boundaries for the facility include Scope 1 emissions, direct emissions from sources that are owned or controlled by the company, and Scope 3 emissions from the production of coke, limestone, and dolomite used in the process. Scope 2 emissions are not considered in the WRI GHG Protocol for Steel which would be the emissions associated with purchased electricity, heat, and steam.

The WRI GHG Protocol for Steel utilizes a Tier structure to estimate a facility's emissions that evolve from industry-wide to company/site-specific as it escalates from Tier 1 to 3. The Tier structure selected for each emissions source should be selected to be the most accurate representation of the facility but remain the same to avoid double counting. Utilization of Tier 3 methods is preferred. The Tiers are outlined below.

- Tier 1: Tier 1 methods estimate emissions by multiplying production data, such as the volume of fuel used or steel produced, by an industry-specific default emission factor. Tier 1 defaults are supplied for all of the methods in the Iron and Steel Tool, where appropriate.
- Tier 2: Tier 2 methods require less general data. For instance, a Tier 2 emission factor might reflect the typical industrial practices within a specific country, whereas a Tier 1 factor constitutes a global default value. Facility-specific data are not considered Tier 2. Tier 2 data might be available from national statistical agencies or industry associations.
- Tier 3: Tier 3 methods require facility-specific data, such as the composition of the fuel combusted at a facility, or the specific types of technologies employed at a facility.

For a full description of the WRI GHG Protocol for Steel, see the cited Calculating Greenhouse Gas Emissions for Iron and Steel Production 2008 tool cited in the Appendix of this report (Russell, 2008).

Targets, Pathways, and Requirements

The WRI GHG Protocols do not set a numerical target or timelines for steel or any other products and specifically do not set a “one size fits all” materiality threshold. This instead can be set by other GHG programs/initiatives discussed in other sections of this report. There are no additional reporting requirements that include the disclosure or social impact criteria for WRI GHG Protocols (Greenhouse Gas Protocol, 2022a)

Disclosure, Reporting, Enforcement, and Quality Control

There are no direct reporting requirements or quality verifications as the WRI and WBCSD are not regulating bodies themselves however the guidelines may be used by regulating bodies and any other entities interested in GHG accounting and reporting (Greenhouse Gas Protocol, 2022a)

Constituency

The GHG Protocol was developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) alongside governments, industry (such as Norsk Hydro, Tokyo Electric, and Shell), NGOs (such as the WWF, Pew Center on Global Climate Change, and The Energy Institute), businesses and other organizations with the first guidance being published in 2001. The GHG Protocol is funded by 68 different companies, organizations, and government bodies across various sectors. As of 2016, 92% of Fortune 500 companies directly or indirectly utilized the GHG Protocol (Greenhouse Gas Protocol, 2022a; Greenhouse Gas Protocol, 2016; Greenhouse Gas Protocol, 2022b).

Standards Development Status

The most recent GHG Protocol for Steel was published in 2008. There are currently no published plans to update the guidelines for the steel industry sector (Russell, 2008).

3.3 Climate Bonds Initiative's Criteria for Climate Bonds for the Steel Industry

The Climate Bonds Initiative is an international organization working to mobilize global capital for climate action by developing the Climate Bonds Standard and Certification Scheme, and its associated Steel, Policy Engagement, and Market Intelligence work. This work empowers organizations with tools and knowledge to navigate, influence, and instigate change. Within the Climate Bonds Initiative is the Climate Bonds Standard and Certification Scheme and The Steel Eligibility Criteria which are designed to be an easy-to-use screening tool that provides a clear signal to investors and intermediaries on the climate integrity of Certified Climate Bonds. The criteria outlined in the Standard and Certification Scheme sets climate change benchmarks for that sector that are used to screen assets and capital projects so that only those that have climate integrity, either through their contribution to climate mitigation and/or to adaptation and resilience to climate change, will be certified. The following can be certified under the criteria

- Use-of-Proceed (UoP) bonds financing decarbonization measures (e.g., retrofits)
- UoP bonds financing steel production facilities (i.e., assets and activities)

Following updates, to Climate Bonds Overarching Bonds Standard v4.0 the following can be certified

- Assets not linked to any specific financing instrument (Steel production facilities)
- Entities (steel production companies) and Sustainability Linked Bonds (SLBs) issued by those entities. (Climate Bonds Initiative, 2021; 2022a; 2022b, 2022d).

Features

The criteria cover assets and activities involved in the production of steel and companies that operate such assets or activities. The scope boundaries begin at the raw material preparation stage and end with the final steel product coming out of the rolling and coating stages. Within a Fixed System Boundary, applicants are responsible for reporting on all emissions within the same boundary, irrespective of ownership of various processes and regardless of whether they are an integrated or non-integrated producer. Iron making and auxiliary process are within the scope provided that the process is located on the same site as the steel production. Mining, coal mining, stainless and high alloy steels production, steel scrap collection and sorting, as well as raw material preparation and downstream processes are excluded from the scope. Entities out of the scop include pureplay iron ore mining companies, pureplay coal companies, pureplay stainless and high alloy steel production companies, pureplay steel collection scrap andsorting companies. Figure 5, aligned with the RMI's Sustainable Steel Principles, demonstrates the boundary to be considered, in which Issuers must take into account the contributions from all the processes involved in the production of their steel that is shown within the fixed boundary irrespective of whether they represent scope 1, 2, or 3 for the reporting company (Climate Bonds Initiative, 2022a; 2022b, 2022d).

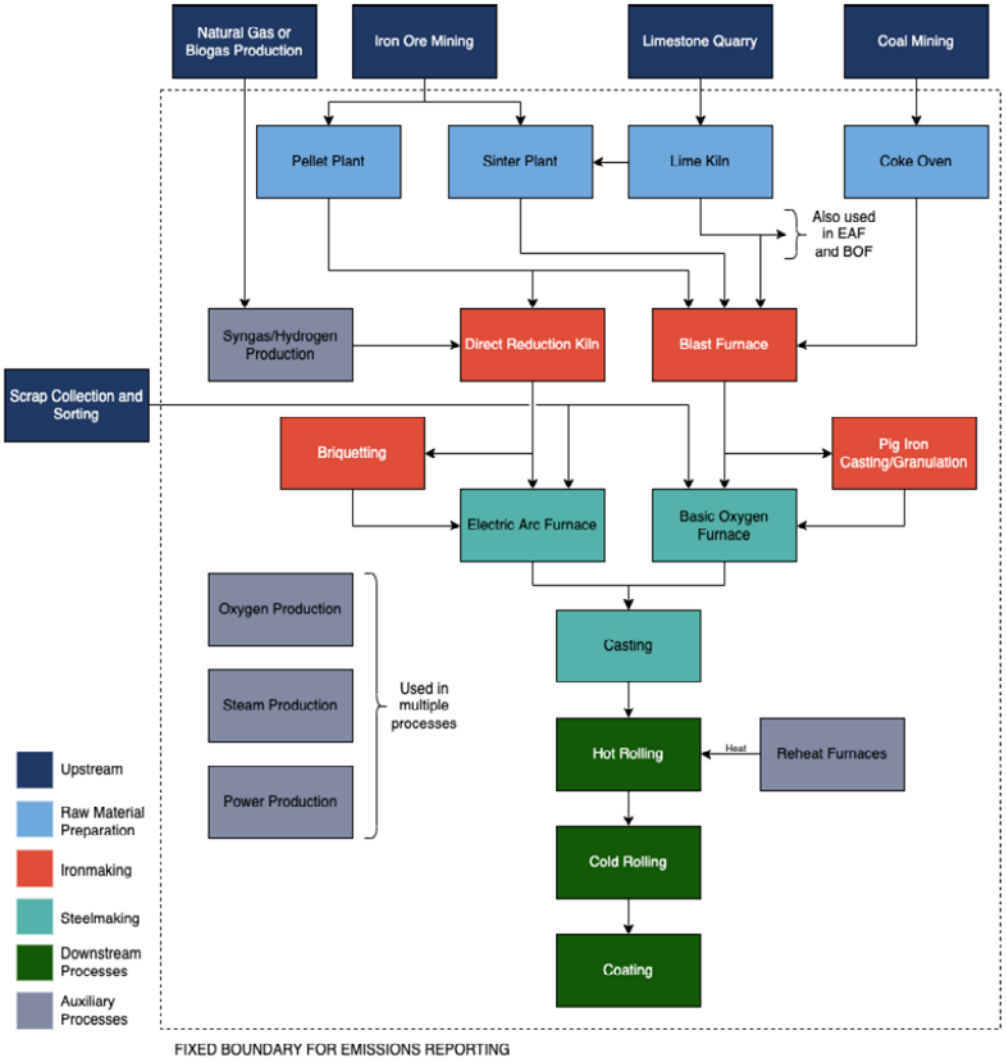


Figure 5: Fixed System Boundary for emissions intensity calculations of the Climate Bonds Standard and Certification Scheme (Climate Bonds Initiative, 2022d).

The Steel Eligibility Criteria of the Climate Bonds Standard & Certification Scheme also provides examples of the activities within a facility that could be certified for an integrated steelmaker as well as a non-integrated steelmaker shown in Figure 6 below.

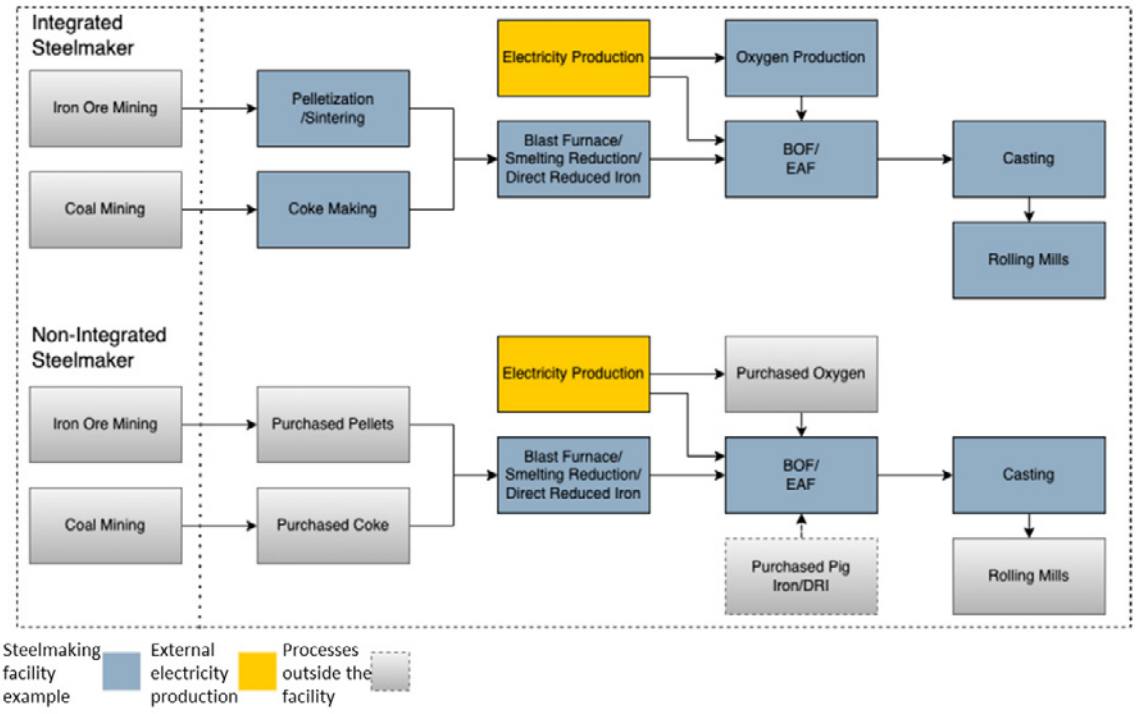


Figure 6: Examples of facilities that can be certified subject to meeting CBI Steel Criteria (Climate Bonds Initiative, 2022d).

Targets, Pathways, and Requirements

The GHG emissions assessment should follow ISO 14404, EN 19694-2, and the GHG Protocol on a product-level basis. The Climate Bonds Standard and Certification Scheme has set a target for the emission intensity of steel products that decreases over time and considers the amount of scrap used that applies at the company level of certification. See Figure 7 below in the "Criteria for Companies" section of requirements.

The Climate Bonds Standard and Certification Scheme has different requirements that must be met depending on whether a new facility is applying, an existing facility, or a whole company is. These requirements are discussed in detail below (Climate Bonds Initiative, 2022b).

New Steel Production Facilities

A new steel production facility must meet the criteria outlined below in Table 3 to be eligible for certification and must be in alignment with deep decarbonization of the sector.

Table 3: Eligible new iron and steel production facilities and applicable certification criteria for each type of facility under the Climate Bonds Standard and Certification Scheme (Climate Bonds Initiative, 2022d).

Eligible Facility	Facility-specific mitigation criteria
BF-BOF production line with integrated CCUS	CCUS should capture at least 70% of all emissions[1]. CCUS complies with criteria in Section 6.5 of The Steel Eligibility Criteria of the Climate Bonds Standard & Certification Scheme
Smelting reduction production line with integrated CCUS	
Fossil gas-based DRI-EAF production line with integrated CCUS	
Fossil gas based DRI with integrated CCUS	
Scrap based Electric Arc Furnace (EAF)	The facility: • Needs to use 70%[2] of scrap as total annual inputs; OR • The combined scrap and (100%) Hydrogen based DRI should add to at least 70% of the EAF total annual inputs
(100%) Hydrogen-based DRI	Hydrogen meets the criteria in Section 6.1 of The Steel Eligibility Criteria of the Climate Bonds Standard & Certification Scheme
(100%) Hydrogen-based DRI-EAF production line	
Electrolysis of iron ore steelmaking production line	A plan that describes how the use of renewable energy will be increased /introduced in the facility within the term of the bond through different strategies such as: a) Increasing renewable-based[3] captive power generation b) Increasing renewable-based power purchase agreement The plan shall be provided with evidence of the strategies that will be implemented. Progress of the implementation plan to be assessed every 36 months.

1 There are multiple sources of emissions in a steel mill, which poses an economical and technical challenge for the implementation of CCUS. With 70% capture rate we refer to an average of the emissions captured from all point sources. This aims at promoting investments in 90% capture at the highest emitting point source (e.g. the BF) that should translate in 70% for the overall facility. As technology advances retrofitting the rest of the facility to capture the remaining emissions shall become feasible.

2 Close to the global average use of scrap and used in the IEA G7 report https://www.iea.org/reports/achieving-net-zero-heavy-industry-sectors-in-g7-members as the threshold for scrap to distinguish between primary and secondary steelmaking.

3 Energy produced from renewable sources such as wind, solar, and small hydropower generation.

Steel Production Facilities Operational Prior to 2022

For facilities operational prior to 2022, mitigation criteria have been set to allow improvements in the emissions mitigating intended to not lock in technologies that may impede future decarbonization of the steel industry. The requirement for these facilities is shown below in Table 4.

Table 4: Eligibility criteria for steel production facilities in operation prior to 2022 under the Climate Bonds Standard and Certification Scheme (Climate Bonds Initiative, 2022d).

Facility type	Mitigation criteria specific to that plant
Electric Arc Furnace	A plan that describes how the use of renewable energy will be increased /introduced in the facility within the term of the bond through different strategies such as: c) Increasing renewable-based[4] captive power generation d) Increasing renewable-based power purchase agreement The plan shall be provided with evidence of the strategies that will be implemented. Progress of the implementation plan to be assessed every 36 months.
Production line with a blast furnace (BF) that became operational in 2007 or later	The investment shall not be for relining; AND A bundle of decarbonization measures has been/ will be implemented at the facility that has/ will reduce the facility's emissions intensity (tCO_2/t steel) between 2022 and 2030 by: - 20% if the pre-decarbonisation baseline emissions intensity is greater than or equal to 2 tCO_2/t steel; AND by 2030 the emissions intensity of the facility should be below 1.8 tCO_2/t steel; OR - 15% if the pre-decarbonisation baseline emissions intensity is less than 2 tCO_2/t steel; AND by 2030 the emissions intensity of the facility should be below 1.8 tCO_2/t A plan shall be provided with evidence of the decarbonisation measures that will be implemented. Progress against these decarbonisation targets to be assessed every 36 months, showing evidence that the decarbonization targets are being met.
Production line with a blast furnace (BF) that became operational prior to 2007	The investment shall not be for relining; AND A bundle of decarbonisation measures has been/ will be implemented at the facility that have/ will reduce the facility's emissions intensity (tCO_2/t steel) between 2022 and 2030 by 50%; AND The emissions intensity of the facility should be below 1.8 tCO_2/t steel by 2030 A plan shall be provided with evidence of the decarbonisation measures that will be implemented. Progress against these decarbonisation targets to be assessed every 36 months, showing evidence that the decarbonization targets are being met.
Production line with a DRI	Either: a) if plant is fossil gas based: A bundle of decarbonisation measures has been/ will be implemented at the facility that have/ will reduce the facility's emissions intensity (tCO_2/t steel) between 2022 and 2030 by 20% A plan shall be provided with evidence of the decarbonisation measures that will be implemented. Progress against these decarbonisation targets to be assessed every 36 months; OR b) if plant is coal based: A bundle of decarbonisation measures has been/ will be implemented at the facility that have/ will reduce the facility's emissions intensity (tCO_2/t steel) between 2022 and 2030 by 40% A plan shall be provided with evidence of the decarbonisation measures that will be implemented. Progress against these decarbonisation targets to be assessed every 36 months, showing evidence that the decarbonization targets are being met.

These measures must also follow an Adaptation and Resilience Checklist that is further detailed in The Steel Eligibility Criteria of the Climate Bonds Standard & Certification Scheme.

4. Energy produced from renewable sources such as wind, solar, and small hydropower generation.

Decarbonization Measures Within Existing Steel Production Facilities

For investments specific to an existing facility implementing decarbonization measures, the eligibility criteria for specific mitigation measures within steel facilities, takes into account the type of facility where the measure will be implemented. Asset and activity types that are eligible include (Climate Bonds Initiative, 2022c,d);

- Heat recovery
- Optimization of Blast Furnace
- Optimization of Basic Oxygen Furnace
- Optimization of Coke Plants
- Optimization of Sinter Plants
- Optimization of Electric Arc Furnace
- Optimization of Rolling and Finishing and Reheat Furnace
- Optimization of Casting
- Optimization of Monitoring and Control System
- Carbon Capture Utilization and Storage
- Fuel Switching
- Electrification of Heat

These requirements differ by the type of facility where the improvement is implemented. A Summary of these requirements is presented in Table 5.

These measures must also follow an Adaptation and Resilience Checklist that is further detailed in The Steel Eligibility Criteria of the Climate Bonds Standard & Certification Scheme.

Criteria for Companies

For investments that are intended for the transition of an entire company or entity Tier 1 and Tier 2 certifications are available. Tier 1 certifications are for companies that currently meet the emissions intensity qualification shown in Figure 7, adapted by the Climate Bonds Initiative from the RMI Center for Climate Aligned Finance Initiative – Sustainable Steel Principles, while Tier 2 certifications are for companies that are not currently meeting the emissions intensity qualification. Additional detail on other qualifications to meet the Tier 1 requirements can be found in the referenced Climate Bonds Initiative and The Steel Eligibility Criteria of the Climate Bonds Standard & Certification Scheme

Table 5: Criteria for specific decarbonization measures or retrofitting activities under the Climate Bonds Standard and Certification Scheme (Climate Bonds Initiative, 2022d).

Facility type	Mitigation criteria for measures
Electric Arc Furnace (EAF)	No additional criteria for mitigation measures implemented in EAF facilities
Measures associated to a production line with a blast furnace (BF) that became operational in 2007 or later	The investment shall not be for relining; AND The decarbonisation measure(s) has been/ will be implemented at the facility and has/ will reduce the facility's emissions intensity (tCO_2/t steel) between 2022 and 2030 by: - 20% if the pre-decarbonisation baseline emissions intensity is greater than or equal to 2 tCO_2/t steel; OR - 15% if the pre-decarbonisation baseline emissions intensity is less than 2 tCO_2/t steel; Demonstration of compliance shall be done as described in section 3.2.1.
Measures associated to a Production line with a blast furnace (BF) that became operational prior to 2007	The investment shall not be for relining; AND The decarbonisation measure(s) has been/ will be implemented at the facility and has/ will reduce the facility's emissions intensity (tCO_2/t steel) between 2022 and 2030 by 50%; Demonstration of compliance shall be done as described in section 3.2.1.
Measures associated to a Production line with a DRI	Either: a) if plant is fossil gas based: The measure(s) have been/ will be implemented at the facility and have/ will reduce the facility's emissions intensity (tCO_2/t steel) between 2022 and 2030 by 20% Demonstration of compliance shall be done as described in section 3.2.1; OR b) if plant is coal based: The measure(s) have been/ will be implemented at the facility and have/ will reduce the facility's emissions intensity (tCO_2/t steel) between 2022 and 2030 by 40% Demonstration of compliance shall be done as described in section 3.2.1.

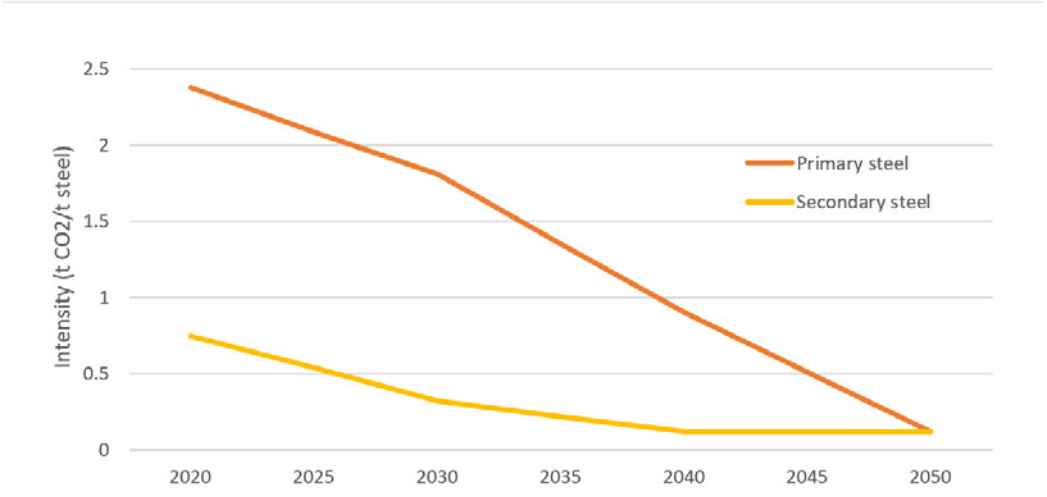


Figure 7: Decarbonization trajectory requirements for primary and secondary steel production in Climate Bonds Initiative's Steel Criteria to be aligned with IEA's net-zero emissions pathway (Climate Bonds Initiative, 2022c).

Disclosure, Reporting, and Quality Control

To demonstrate compliance for each of the types of certifications, a plan must be provided with evidence of the decarbonization measures that have been/will be implemented. Additionally a contract or agreement with a certified auditor demonstrating the emissions intensity must be approved over the term of the bond such that its performance meets those required in the previous section. Either a gradual improvement over time methodology assessed over 36 months showing measurable progress toward meeting the certification's goal can be selected or a front-loaded improvement in the initial years annual reporting is mandated for certified assets, projects, and companies to maintain certification. Verification is performed on reporting and application by an independent reviewer and is aligned with verification methods under the EU Green Bond Standard (Climate Bonds Initiative, 2019a).

Constituency

The Climate Bonds Initiative and the Climate Bond Standards Scheme are funded by grants from nonprofit and public organizations, revenue from public sector project contracts, and subscription fees from its partners. Some of the major funders include the EU's Horizon 2020, Inter-American Development Bank, The Rockefeller Foundation, and the Climate Works Foundation. The Climate Bonds Initiative has 108 partners including IHS Markit, Citi, and Nasdaq (Climate Bonds Initiative, 2009).

Standards Development Status

The current public version of the Climate Bonds Standard Version 3.0 was launched in December of 2019 and was preceded by the Climate Bond Standards V2.1 released in January 2017 and V2.0 released in December 2015. The Climate Bonds Initiative is currently working on a new version of the Climate Bond Standard to be released in 2022. Updates to the Climate Bonds Standard are based on feedback from green finance markets stakeholders, issuers, verifiers, and partners and are reviewed at least every three years. The development process for the Climate Bonds Standards includes engagement with these stakeholders as well as 60-day public consultation periods (Climate Bonds Initiative, 2019a; 2019b).

The sector-specific criteria for the steel industry under the Climate Bonds Standard and Certification Scheme are determined through a multistakeholder engagement process including a technical and industry working group convened and managed by Climate Bonds. The 27-member industry working group includes ArcelorMittal, Citi, Deloitte, Gerdau, and Tata Steel for the 2022 version released on November 2022 The criteria are subject to public consultation before final review and approval by Climate Bonds.

3.4 World Steel Association's Protocols

The World Steel Association is one of the largest industry associations in the world and has expressed goals to provide global leadership to the steel industry focusing on economic, environmental, and social sustainability. The World Steel Association fully supports the aims of the Paris Agreement and has developed several initiatives for its members in support of the Paris Agreement and United Nations Developments goals. Key programs pertaining to low carbon steel production include their Sustainability Charter, 9 principles and 20 criteria covering the areas of environmental, social, government, and economics (ESGE), and their 8 Sustainability Indicators covering environmental, social, and economic criteria. Additionally, the World Steel Association sponsors a Sustainability Champions program discussed in further detail in the requirements sections. The World Steel Association has published Life

Cycle Inventory Studies yearly for the industry and has methodology discussed in more detail below as well (World Steel Association, n.d.,c, d, j).

Features

The World Steel Associations Life Cycle Inventory (LCI) released in May of 2021, outlines the methodology in Section 3 of the report where they utilize ISO 14044: 2006 Section 4.2.3.1 as the baseline methodology. The methodology is further outlined in more detail in the 2017 LCI Methodology Report. The methodology assesses emissions on a product basis as 1 kilogram of steel product at the factory gate i.e. cradle-to-gate. The upstream emissions of the scrap utilized in the process are considered along with the credits associated with the end-of-life recycling of the steel product produced. In this boundary, all of the production steps from the extraction of the raw materials from the earth to the finished products ready to be shipped from the facility are considered. Manufacturing of downstream products from the steel product is not considered. The methodology focuses on the global warming potential, acidification potential, eutrophication potential, and photochemical ozone creation potential. Figure 8 and Figure 9 taken from the 2017 LCI Methodology Report represent the boundary system utilized without and with scrap respectively (World Steel Association, 2021b; 2017).

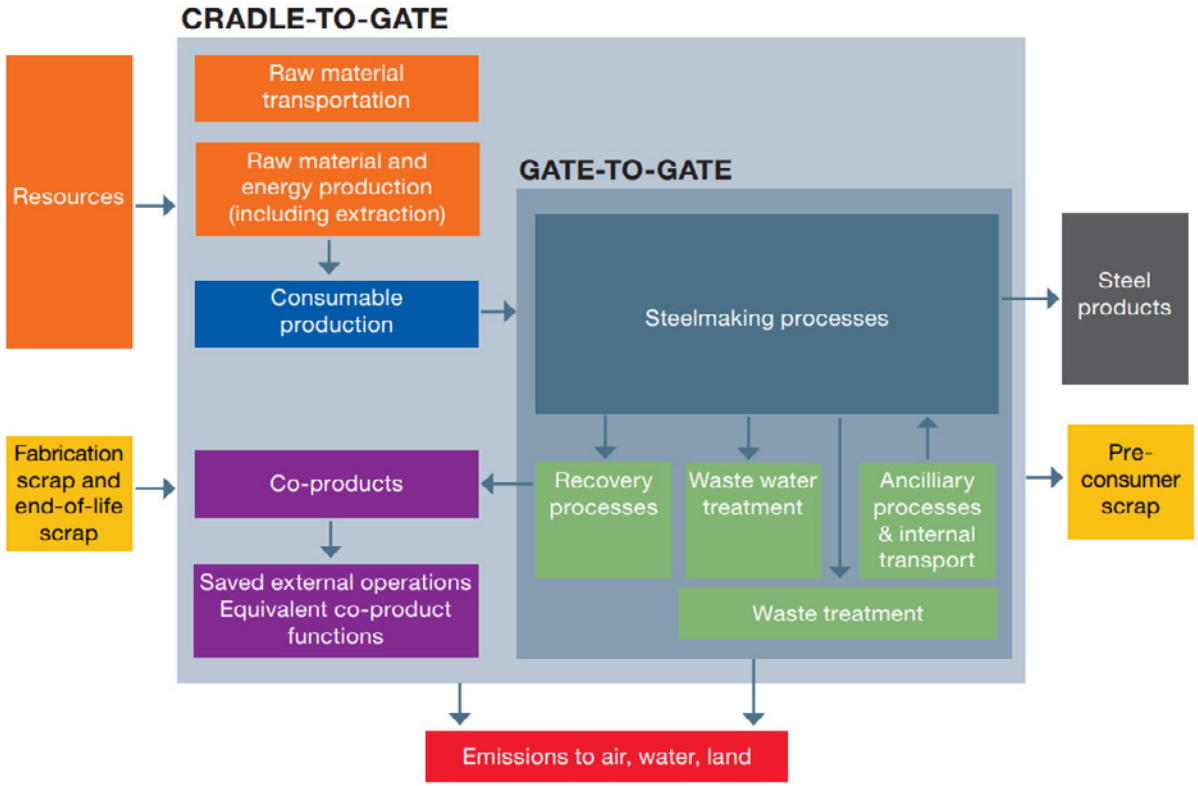


Figure 8: LCI Boundary for steel produced without scrap from the World Steel Association's LCI Methodology Report 2017 (World Steel Association, 2017).

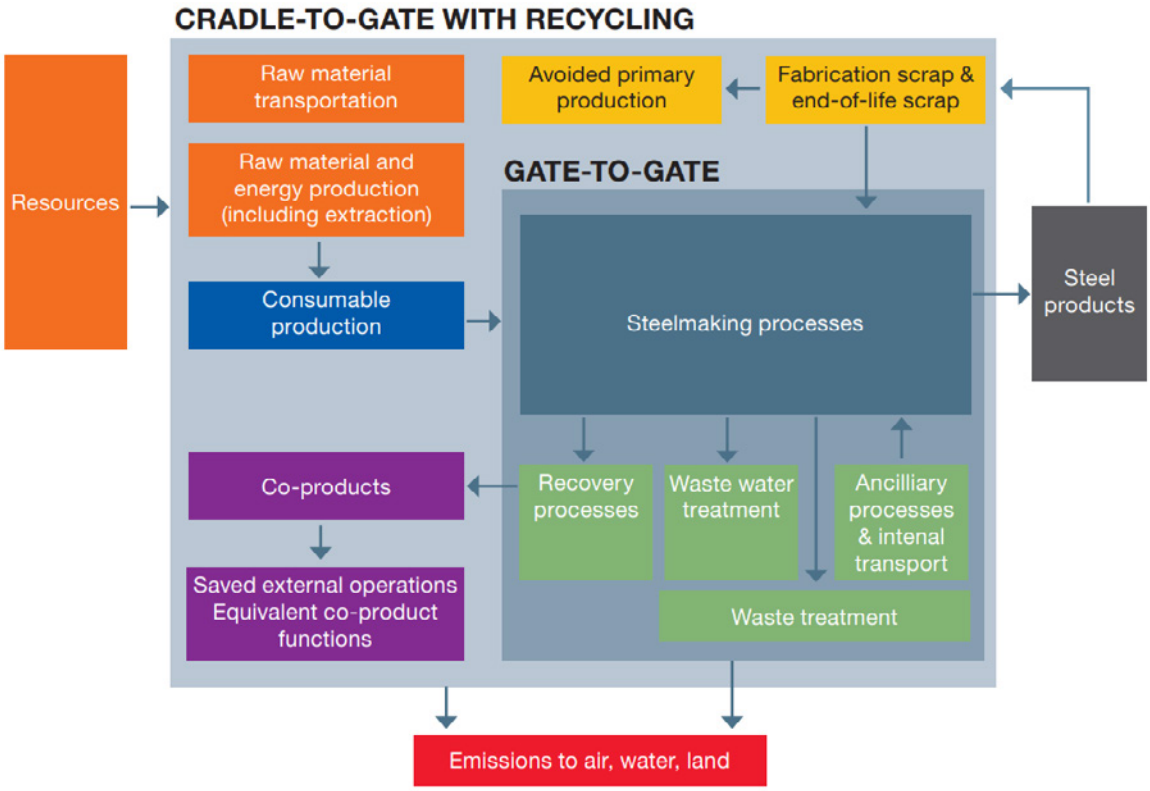


Figure 9: LCI Boundary for steel produced with scrap from the World Steel Association's LCI Methodology Report 2017 (World Steel Association, 2017).

The methodology allows for different approaches to be used, e.g., a cut-off approach can be specified as long as this is disclosed in the study.

Sustainability Charter Program

To be eligible under the Sustainability Charter, a company or association must be a member of worldsteel, must provide evidence relating to all 20 criteria below, and demonstrate they are active in projects or initiatives in each of the areas covered by the 9 principles. Lines marked in bold are part of other existing sustainability-related programs at worldsteel (World Steel Association, n.d.-l; 2022b).

Sustainability Champions Program

To be eligible for the Sustainability Champions Program the following criteria must be met (World Steel Association, n.d.-g).

1. **Steel companies must be a member of the World Steel Association**

2. **Commitment and Action: Charter Member**
    a. Companies must sign the worldsteel Sustainability Charter and become Charter Members and provide evidence relating to all the 20 criteria

3. **Measurement: LCI data provision**
    a. Companies must provide data on Life Cycle Inventory (LCI) data to worldsteel's data collection program covering more than 60% of the company's crude steel production and the data must be less than 5 years old
4. **Excellent: The Steelie Awards and Safety and Health Recognition**
    a. Must be shortlisted in one of the 6 categories of the worldsteel Steelie Awards; excellence in low-carbon steel production, innovation of the year, excellence in sustainability, excellence in life cycle assessment, excellence in education and training, or excellence in communications programs or (World Steel Association, n.d.-h), (World Steel Association, n.d.-g)
    b. Must be recognized in the Safety and Recognition Program

Table 6: The World Steel Associations Sustainability Charter 9 principles and 20 criteria (World Steel Association, 2022b) .

	Topic	Principle	Criteria
1	Climate action	Proactively address climate change and take effective actions to minimise the industry's GHG emissions.	**1. CO_2 emissions or energy consumption data provided to worldsteel** or national governments.
			2. Plans and goals established for CO_2/GHG emissions reduction.
2	The circular economy	Maximise the efficient use of resources throughout the life cycle of steel products and support society to achieve a circular economy.	**3. LCI data provided to worldsteel** and/or available through certified environmental declarations.
			4. Data on co-products, landfilled and incinerated material provided to worldsteel.
3	Environmental care	Conduct operations in an environmentally responsible manner.	5. Investment and/or implementation of environmental site-related improvement projects undertaken.
			6. Information published on air pollutants and on water use.
			7. Use of an environmental management system.
4	Safety and Health	Maintain a safe and healthy workplace and act on health and safety incidents, risks and opportunities.	**8. Safety data provided to worldsteel.**
			9. Use of a safety and health management system.
			10. Safety performance statistics published.
			11. Participation in worldsteel Steel Safety Day.
5	Our people	Enable our people to realise their potential while providing them with an inclusive and fair working environment.	**12. Employee training time provided to worldsteel.**
			13. Human resource management policies in place.
6	Local communities	Build trust and create constructive relationships with local communities.	14. Community engagement, investment, and/or involvement in CSR activities.
7	Responsible value chains	Lead responsible business practices through the value chain.	15. Use of supply chain and/or procurement management codes or systems.
8	Ethical & transparent operations	Conduct operations with high standards and transparent processes.	16. Code of business conduct in place.
			17. Publication of Sustainability or CSR report.
			18. Stakeholder engagement and communications.
9	Innovation and prosperity	Pursue innovations for technologies and products to achieve sustainable economic development.	**19. Investment in new processes and products (CAPEX + R&D) data provided to worldsteel.**
			20. Economic Value Distributed (EVD) data provided to worldsteel.

Targets, Pathways, and Requirements

Modeling for the LCI utilizes LCA software, GaBi version 10.0.1. 92 in the report referenced above. At the time of writing this report, no specific targets for the emissions intensity of steel products have been set by the World Steel Association (World Steel Association, 2017).

The two primary programs set forth by the World Steel Association are the Sustainability Charter and Sustainability Champions recognition programs which will be discussed in further detail below (World Steel Association, n.d.-f).

Disclosure, Reporting, Enforcement, and Quality Control

To receive either certification under the Sustainability Charter or Sustainability champion programs disclosure of data to worldsteel is required under the worldsteel Climate Action Data program where the data collection process is overseen by worldsteel staff and verified by a panel of experts. The data submitted in this program is held in confidence and will be known only to the company or site itself (World Steel Association, n.d.-c).

Constituency

The World Steel Association, founded in 1967, is a non-profit organization whose members account for 85% of the world's total steel production. The World Steel Association has members in every major steel-producing country and represents producers, national and regional steel industry associations, and steel research institutes. There are 91 regular members of The Worlds Steel Association including ArcelorMittal, U.S. Steel, Nucor, and TATA Steel to name a few. The association also has 50 Affiliated members including the American Iron and Steel Institute, German Steel Federation, and, UK Steel (World Steel Association, n.d.-e, k, & b).

The Sustainability Charter has recognized 39 producers and associations who are proactively engaged in the program including ArcelorMittal, China Steel Corporation, Nippon Steel Corporation, and U.S. Steel. The Sustainability Champions program has recognized 10 companies including ArcelorMittal, Tenaris, Tata Steel, and Nippon Steel (World Steel Association, n.d.-l; 2022b) .

Standards Development Status

The World Steel Association has developed numerous policies and guidelines since its inception advancing the sustainable development of the steel industry. Their Sustainable Development Policy was first enacted in 1993 with revisions made in 2002 & 2021. In 1995 they adopted the Life Cycle Assessment Policy with the latest policy revision published in 2021. A Climate Change Policy was adopted in 1996 that has been adopted by 181 companies in 50 countries as of 2021. The Sustainability Indicators were introduced in 2004 under which 93 companies contributed data towards 2021.

The World Steel Association also launched the CO_2 Emissions Data Collection User Guide in 2007 with an updated revision in 2021 that ties very closely with the ISO 14404 series. While the ISO 14404 series of standards and worldsteel "CO_2 Emissions Data Collection User Guide" share the same concept, they have different characteristics where the worldsteel's User Guide provides a method suitable for collecting data from steel plants across the world in a uniform way, and the ISO 14404 series provide methods suitable for the evaluation of CO_2 intensity of steel plant for each process route (ISO, 2020).

The Climate Action Program was launched in 2008 to collect annual CO_2 emissions data at the site or company level. The First Sustainability Charter was published in 2009, updated in

2018, and newly released in 2022. The Sustainability Champions Program launch in 2018 and recognized 9 companies in 2021. The Step Up program was launched to increase operational and CO_2 emissions efficiency in 2018. Most recently, the New Sustainability Principles were established in 2019 (World Steel Association, 2021a) .

3.5 ISO 14067:2018 – Carbon Footprint of Products

ISO 14067:2018 specifies principles, requirements, and guidelines for the quantification and reporting of the carbon footprint of a product (CFP), in a manner consistent with International Standards on life cycle assessment (LCA) (ISO 14040 and ISO 14044). Requirements and guidelines for the quantification of a partial CFP are also specified. The standard itself is not sector-specific, but it is developed for every sector. The sector-specific application requires the development of dedicated product category rules (PCRs). ISO 14067 is housed in a family of similar standards providing clarity and consistency for quantifying, tracking, reporting, and validating or verifying GHG emissions and removals to support sustainable development through a low-carbon economy (ISO, n.d.-a; n.d.-b; 2018)

Features

ISO 14067 provides a framework for determining the carbon footprint of an individual product that can be applied to industrial steel processes. “Carbon footprint of scenarios towards climate-neutral steel according to ISO 14067” by Suer et al. discusses and demonstrates the application of ISO 14067 for the steel industry. Which, the first step is to define the “goal and scope definitions” from a technical perspective with relative assumptions followed by a second phase, “life cycle inventory analysis” quantifying the GHG emissions themselves which can then be further expressed as Global Warming Potential (GWP) in the third stage. The referenced study provides an example of the boundaries utilized under ISO 14067 for the production of hot-rolled coil production within a classical BF-BOF (blast furnace-blast oxygen furnace) route .

The primary focus is on emissions associated with the production of steel products including the direct emissions as well as the upstream emissions from mining, production, and transport of the input materials to steel production. Co-products that can replace products from other industries can also be accounted for in taking credit for prevented emissions. For example, avoiding the use of virgin raw materials in another process allows benefits to the emissions calculations (ISO, 2018; Suer et al., 2021).

Targets, Pathways, and Requirements

ISO 14067 does not set any specific targets for the carbon intensity of steel products as it solely sets a framework for quantifying the emission intensity of products. Additionally, ISO 14067:2018 does not assess any social or economic aspects or impacts, or any other environmental aspects and related impacts potentially arising from the life cycle of a product. There are also no direct reporting mechanism requirements under ISO 14067 however Chapter 7 of the standard sets reporting standards. A sample of the reporting requirements is provided below, however, the standard itself should be referenced for full details (ISO, n.d.-a; n.d.-b; 2018; Suer et al., 2021)

- GHG emissions and removals are linked to the main life cycle stages in which they occur, including the absolute and the relative contribution of each life cycle stage;
- GHG emissions and removals arising from fossil carbon sources and sinks
- The study report should include a sensitivity check of the significant inputs and an assessment of the influence of alternative use profiles and end-of-life scenarios on the final result.

- Cut-offs
- Description of the data
- Scope
- System boundary
- Description of significant unit process
- Result of the life cycle interpretation including conclusions and limitations

Constituency

ISO is an independent, non-governmental international organization with 167 national standards bodies. ISO was founded in 1946. Individuals or companies cannot become ISO members but instead can participate in standardization work. As such the 2018 version of ISO 14067 received input from numerous interested parties and technical experts to further build on the standards outlined in the document (ISO, 2017),

Standards Development Status

Preparation of ISO standards is carried out through ISO technical committees that each member body has the right to be represented in. International organizations, governmental and non-governmental also take part in the development of the standards in liaison. The ISO 14067:2018 was specifically prepared by Technical Committee ISO/TC 207, Environmental management, Subcommittee SC 7, Greenhouse gas management, and related activities. ISO 14067:2018 was preceded by ISO/TS 14067:2013 (ISO, n.d.-a; n.d.-b; 2018).

3.6 ISO 14404 Series– Plant Level CO_2 Emissions Intensity From Iron and Steel Production

ISO 14404 series provides guidance for calculating the CO_2 intensity at iron and steel plants with all types of process routes, by defining the boundary, CO_2 emission factors, and the intermediate products for which upstream emissions are considered for all types of process routes (ISO, 2020). ISO 14404 is broken down into 4 parts where the scopes apply plants with the description shown below in Table 7.

Table 7: Facility type description applicable to its respective ISO 14404 Part

ISO 14404 Part	Facility Type Description
Part 1	• Steel plant with blast furnace
Part 2	• Steel plant with electric arc furnace
Part 3	• Steel plant with electric arc furnace (EAF) and coal-based or gas-based direct reduction iron (DRI) facility
Part 4	• Steel plants with different process routes from ISO 14404 Part 1, 2, or 3 • Steel plants with more than one process route • Steel plants purchasing pig iron from the outside • Steel Plants and rerollers purchasing part or all of crude steel from outside

ISO 14404-4: 2020 also includes the Universal Calculation Sheet, which covers all relevant emission sources from ISO 14404-1, ISO 14404-2, and ISO 14404-3 to assist in the calculation of CO_2 emissions. In addition, ISO 14404-4: 2020 guides the entire ISO 14404 series on the evaluation of exported slags, by-product gas, and stock and the selection of calorific values and emission factors for electricity and fuel (ISO, 2020).

Features

The ISO 14404 series specifies calculation methods for the carbon dioxide (CO_2) intensity of a steel plant from the amounts of the major inputs (purchased items) and outputs (sold items), such as natural resources, intermediate products, and energy. The standard operates with the conceptual shown below in Figure 10.

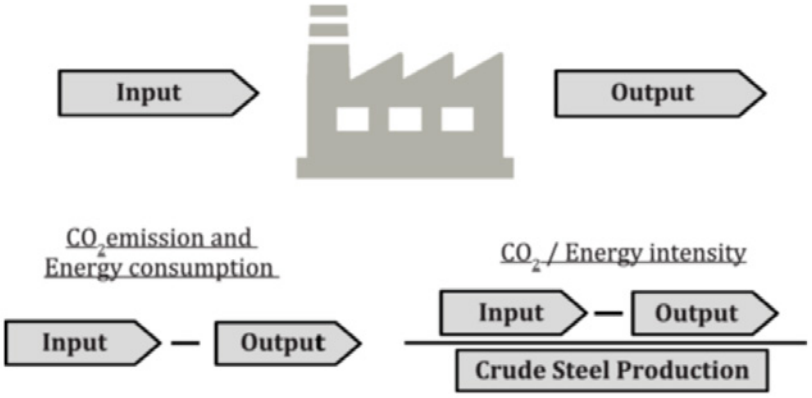


Figure 10: Conceptual framework for the calculation of emissions from steel production in ISO 14404-4: 2020 (ISO, 2020) .

The calculation method uses basic imports and exports that are commonly measured by the plants thus not requiring the measurement of specific efficiency of individual equipment or process or dedicated measurements of the complex flow and recycling of materials and wase heat. ISO 14404-4:2020 provides an additional conceptual diagram of the boundary conditions to be included in calculations as shown below in Figure 11.

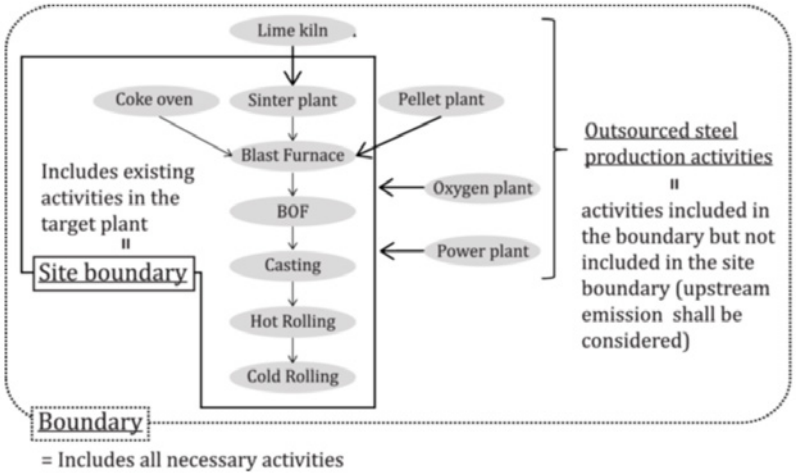


Figure 11: ISO 14404 diagram of emissions boundary and site boundary (ISO, 2020).

In this boundary, intermediate products with the possibility for consideration of upstream emissions include electricity and steam, substances produced in the basic activities in the target process route such as purchased coke, and substances that substitute the iron source of the process route even if they do not exist in the target process route such as purchased DRI. Further details of the emissions that should be included in the calculation method can be found in the ISO 14404 documentation.

Targets, Pathways, and Requirements

ISO 14044 does not set any specific targets for the carbon intensity of steel products as it solely sets a framework for quantifying the emission intensity of products. Additionally, the ISO 14044 series does not assess any social or economic aspects or impacts, or any other

environmental aspects and related impacts potentially arising from the life cycle of a product. There are also no direct reporting mechanism requirements under the ISO 14044 series however standard itself should be referenced for full details.

Constituency

ISO is an independent, non-governmental international organization with 167 national standards bodies. ISO was founded in 1946. Individuals or companies cannot become ISO members but instead can participate in standardization work. As such ISO 14044 received input from numerous interested parties and technical experts to further build on the standards outlined in the document.

Standards Development Status

Preparation of ISO standards is carried out through ISO technical committees that each member body has the right to be represented in. International organizations, governmental and non-governmental also take part in the development of the standards in liaison. ISO 14044 was specifically prepared by the Technical Committee ISO/TC 207. The most recent versions ISO 14404-1 and 14404-2 were published in 2013 while 14404-4 and 14404-4 were published in 2017 and 2020 respectively. Each standard is reviewed every 5 years and updated if/as applicable.

3.7 American Iron and Steel Institute Steel Production Greenhouse Gas Emissions Calculation Methodology Guidelines

The American Iron and Steel Institute (AISI) works to influence public policy and educate public opinion in support of a strong, sustainable American steel industry committed to manufacturing products that meet society's needs (AISI, 2022b). In support of this vision, the AISI developed the Steel Production Greenhouse Gas Emissions Calculation Methodology Guidelines to provide consistent and comprehensive data across the steel industry on GHG emissions from steel production. AISI developed the guidelines with the intent to inform efforts already underway by other organizations to directly or indirectly develop GHG emissions calculation methodologies and is not proposing the guidelines as a new standard (AISI, 2022c).

Features

The American Iron and Steel Institute (AISI) Steel Production Greenhouse Gas Emissions Calculation Methodology Guidelines focus on both product-level disclosures and corporate-level GHG emissions reporting. The scope of these emissions to be included in the calculations includes all of the processing steps required to manufacture a defined product inclusive of the extraction of raw materials through to the final step before a refined product leaves the manufacturing plant gate, commonly referred to as "cradle-to-gate". Within this scope include all major production processes including serial extraction or collection, fuel production, transportation of raw materials and fuels, ironmaking, and steelmaking through to finished steel products. The scope of emissions includes all Scope 1, 2, and some Scope 3 emissions with exclusions of purchased goods and services, fuel and energy-related activities not included in Scope 1 or 2 as defined by the U.S. EPA, upstream transportation and distribution, and waste generated in operations. Figure 12 demonstrates AISI's recommended system boundaries for steel industry GHG reporting (AISI, 2022d).

AISI's guidance states that Scope 1 emissions should be calculated using the EPA GHG Reporting Rule methodology for U.S.-based facilities, with the addition of those facilities below the 25,000 metric tons CO_2e per year reporting threshold. Direct Scope 1 emissions should also include ancillary sources of on-site GHG emissions that are not included in the EPA GHG Reporting Rule methodology (AISI, 2022d).

GHG emissions from purchased electricity (Scope 2 emissions) must be derived from local electricity grid factors for construction product EPDs in accordance with applicable Product Category Rules (PCR) requirements. AISI encourages reporting of GHG emission results inclusive of renewable/clean power purchase agreements (PPAs) and renewable energy credits (RECs) as additional information in EPDs, and this additional information should also be used as the basis for product-specific trade and procurement programs. To ensure credibility, these instruments must satisfy traceability and additionality requirements. PPAs and RECs meeting these criteria should also be incorporated into industry-wide and corporate-level GHG emissions reporting in accordance with specific requirements of the applicable standards, such as the market-based approach in the GHG Protocol (AISI, 2022d).

Figure 12: AISI's recommend system boundaries for GHG reporting in the steel industry (AISI, 2022d).

AISI also provides guidance that GHG emissions should be calculated at the product level for trade, procurement, and EPD purposes. A company-wide basis should be used for corporate reporting and include Scope 1, 2, and upstream raw materials, energy, and transportation Scope 3 emissions (both absolute emissions and emissions intensity) (AISI, 2022d).

Targets, Pathways, and Requirements

The AISI Steel Production Greenhouse Gas Emissions Calculation Methodology Guidelines does not provide a specified target for the emissions intensity of steel product as the guidelines are intended to provide a consistent framework for GHG emissions calculation methodology and reporting.

For emissions calculation, AISI guidance states that primary data should be used wherever possible, including from steel industry suppliers. Emission factors for purchased materials must be derived from reputable data sources and be regionally and temporally representative. The source of data should be disclosed for transparency purposes, particularly for imported materials and fuels. EPA data should be prioritized for purchased electricity (based on eGRID regions) and for transportation fuels.

Additionally, offsets or carbon credits from GHG reduction activities outside a company's value chain should be excluded from GHG emissions calculations for EPD, trade, or procurement purposes. The use of offsets in corporate-level reporting should follow requirements in applicable standards such as the GHG Protocol, including transparent documentation, and derivation using credible accounting standards.

AISI Steel Production Greenhouse Gas Emissions Calculation Methodology Guidelines state that identification of specific processes, materials, and energy sources included in the scope of the assessment, an explanation of methodological considerations like co-product allocation, and identification of key data sources and emission factors used in the assessment should be clearly stated in reporting (AISI, 2022d).

Constituency

AISI is made up of 9 American producer members including ArcelorMittal, Nucor, and Tenaris, and has an additional 80 associate members (AISI, 2022a).

Standards Development Status

The **AISI** Steel Production Greenhouse Gas Emissions Calculation Methodology Guidelines were developed over a months-long collaboration with AISI staff and key American steel producers and was released in November of 2022. This version of the guidelines is the first of its kind released by AISI and are to be updated as new guidance, procedures, rules, or regulations emerge with annual reviews by the AISI Sustainability Committee(AISI, 2022d).

4 Low-Carbon Steel in International Initiatives

4.1 Industrial Deep Decarbonization Initiative (IDDI)

The Clean Energy Ministerial Industrial Deep Decarbonization Initiative (IDDI) is a coalition of public and private organizations that are working to stimulate demand for low-carbon industrial materials including steel. The work of the IDDI focuses on standardizing carbon assessments, establishing public and private sector procurement targets, incentivizing investment in low-carbon product development, and designing industrial guidelines (UNIDO, n.d.). The two key gaps the Initiative hopes to close are data and standards as well as green public procurement (GPP) policy. The IDDI has identified the following three pathways to achieve these results with associated milestones.

1. Building the foundations to enable a thriving global market
    a. Develop consistent standards for low-carbon steel, cement, and concrete
    b. Develop standard reporting mechanisms for the cement, concrete, and steel industries
    c. Develop an evaluation process and digital tools for project bids that incentivize and reward public contractors

2. Empowering governments to buy zero-carbon materials for their public works
    a. Develop a globally recognized target for the public procurement of near-zero carbon steel, cement, and concrete and voluntary guidelines for governments to write policy and implement the targets
    b. Develop Industrial decarbonization training and knowledge for manufacturers/companies
    c. Launch a free or low-cost certification service

3. Encouraging governments to disclose and reduce embodied carbon emissions in public construction projects.
    a. Ambition Level 1:
        i. Starting no later than 2025, disclose the embodied carbon in cement, concrete, and steel used in public construction projects.
    b. Ambition 2:
        i. Starting no later than 2030, conduct whole project life cycle assessments for all public construction projects, and achieve net zero emissions in all public construction projects by 2050.
    c. Ambition Level 3:
        i. Starting no later than 2030, require low emission steel and cement in public construction projects, applying the highest ambition possible under national circumstances.
    d. Ambition Level 4:
        i. Starting in 2030, source a share of cement and/or crude steel from near zero emission material production, aiming at 10 percent on signature construction projects or procurement programs (IDDI, 2022a)

Features

The GPP pledge accounts for product level emissions on a tonne of CO_2 emissions per ton of steel basis and includes a whole project lifecycle assessment that follows international

standards, or national standards where they exist. The definition for near-zero and low emissions steel is in line with the IEA definitions outlined in "Achieving Net Zero Heavy Industry Sectors in G7 Members" which provides a sliding scale based on scrap steel utilization and includes a categorization of low-emissions steel products ranked based on their emissions intensity. The boundaries for steel emissions intensity calculations are consistent with those proposed by the IEA and are discussed in further detail in the IEA's Achieving Net Zero Heavy Industry Sectors in G7 Members section of this report below (IDDI, n.d.-a; n.d.-b; 2022b).

Targets, Pathways, and Requirements

The specific targets and emissions intensity ranking system plotted against scrap utilization for IDDI based on the IEA's Achieving Net Zero Heavy Industry Sectors in G7 Members requires that for steel to be considered "near zero" the threshold of 0.4 tonnes of CO_2 equivalent per tonne of crude steel for a scrap percentage equal to zero. For crude steel produced with 100% scrap steel, this threshold slides to 0.05 tonnes of CO_2 equivalent per tonne of crude steel. Additional quantification of "low emissions" steel is also provided on the same scale with a ranking from A-E based on the product's emissions intensity. (IDDI, n.d.-a; n.d.-b; 2022a; 2022b).

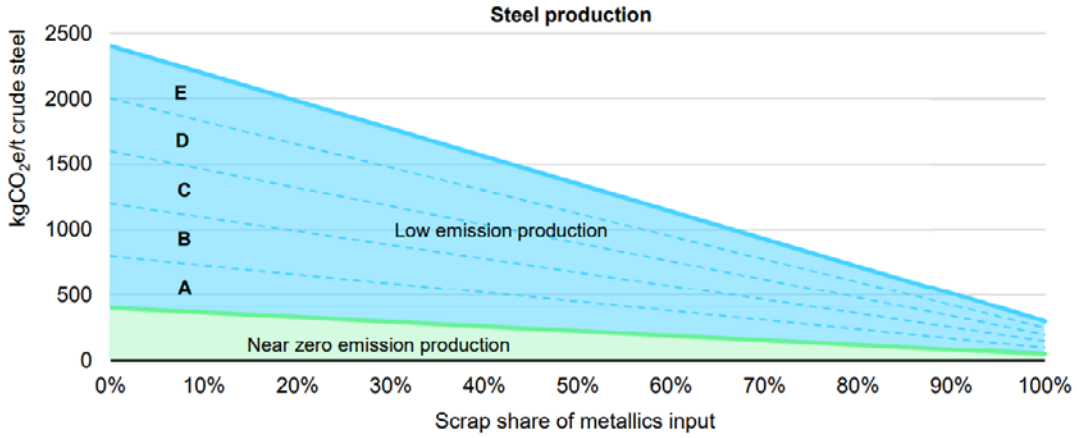


Figure 13: IEA's near zero emission crude steel production threshold as a function of scrap use and proposed classification system (IDDI, 2022a).

When a government commits to the IDDI pledge they have the option to commit to any of the ambition levels outlined below above.

Disclosure, Reporting, and Quality Control

As stated above, governments must provide disclosure of embodied carbon emissions of at a minimum structural material (such as steel, cement, and concrete) used in major public construction projects, starting no later than 2025. IDDI has not yet made public how quality control and verification of the data submitted by each country will be carried out if at all (IDDI, 2022a).

Constituency

The IDDI is coordinated by the United Nations Industrial Development Organization (UNIDO) and is co-led by the United Kingdom and India with additional members including Germany and Canada. The IDDI also includes a collation of related initiatives and organizations including Mission Possible Platform, the Steel Zero Campaign, The Climate Group, the Leadership Group for the Industry Transition, and the World Bank (UNIDO, n.d.).

Standards Development Status

This initiative is still under development and not finalized. Three technical working groups (WG) bringing together government, private sector, and leading expert organizations support the development of IDDI (IDDI, 2022b). The groups and their responsibilities are outlined below.

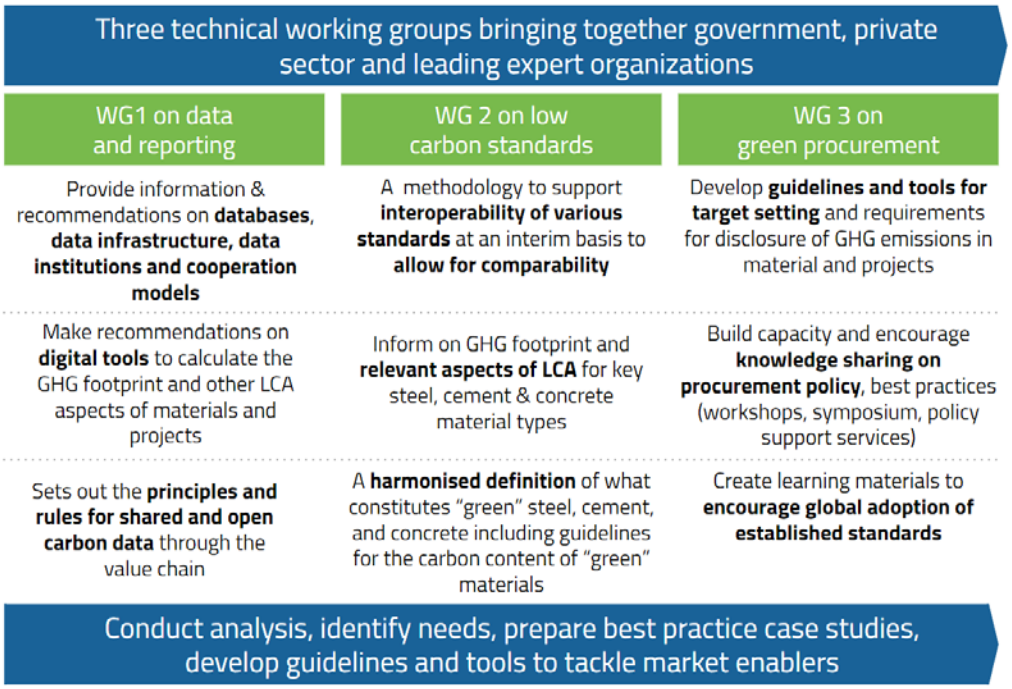


Figure 14: IDDI's development process, working groups, and responsibilities for WG (IDDI, 2022b).

These WGs kicked off in February of 2022 with the development of recommendations on GPP target reduction by 2030 and additionally work iteratively to develop recommendations, guidelines, learning materials, tools on GPP, low carbon, and data and reporting for embodied carbon. The goal is to have countries announce commitment to GPP interim targets at the Clean Energy Ministerial (CEM) 13, followed by early movers announcing the adoption of the GPP interim target at COP27, with additional countries to follow at COP28 (IDDI, 2022b). Additional detail on IDDI's timeline is provided in Figure 15.

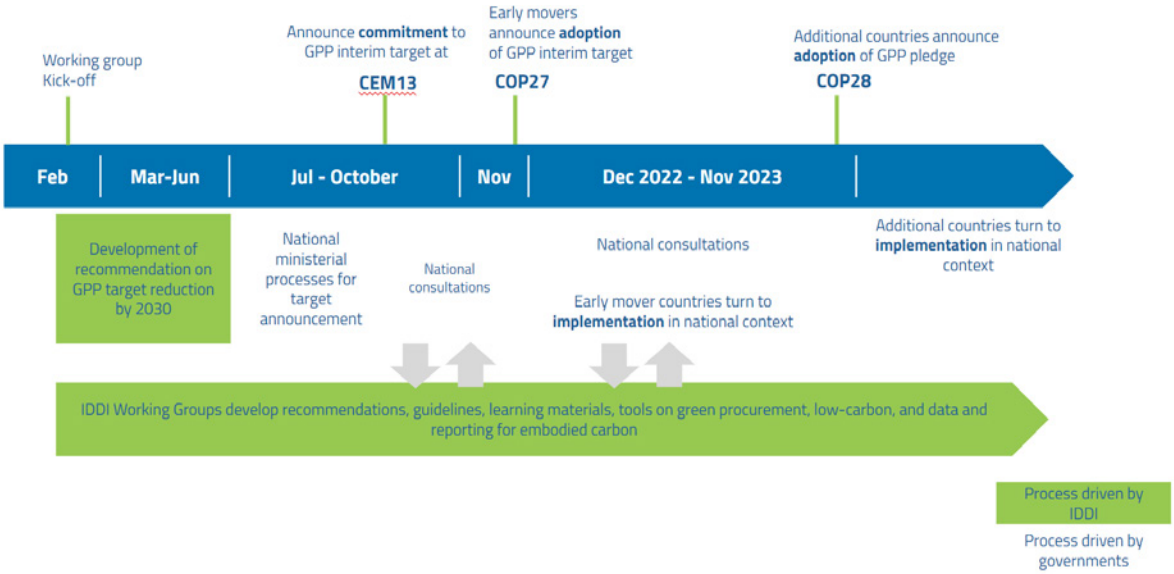


Figure 15: IDDI development timeline and process (IDDI, 2022b).

4.2 Science Based Targets Initiative for Steel

The Science Based Targets Initiatives (SBTi) provides a clearly-defined path to reduce emissions in line with the Paris Agreement goals for various sectors. Targets are considered 'science based' if they are in line with the latest climate science deemed necessary to meet these goals (Science Based Targets, n.d.-e; n.d.-c).

Features

For the steel industry, the SBTI published a 2.0°C pathway ("sector guidance") in 2015 and several companies have already made commitments based on this pathway. The Steel Science-Based Target Setting Guidance for 1.5°C was released in draft form in November of 2022. The Net-Zero Standard Framework under SBTi requires near-term (5-10 year) emission reduction targets to be in line with 1.5°C targets, long-term targets to reduce emissions to a residual level in line with 1.5°C scenarios by no later than 2050, and neutralization of those residual emissions when the company has achieved their long-term target through permanent removal and storage of carbon from the atmosphere. SBTi recommends companies take action to mitigate their emissions beyond their value chain by purchasing high-quality, jurisdictional Reducing Emissions from Deforestation and forest Degradation (REDD+) credits or investing in direct air capture and geologic storage as examples.

Under the 1.5°C Steel Science-Based Target Setting Guidance, a steel industry facility must demonstrate that their emissions per ton of crude steel show sufficient ambition in line with 1.5°C targets from the Sectoral Decarbonization Approach (SDA) also known as the "sector-specific intensity convergence" approach or absolute contraction approach (minimum annual linear reduction of 4.2% or a 42% reduction over 2020-2030). . The draft 1.5°C Steel Science-Based Target Setting Guidance proposes the following system boundary for emissions inclusion shown in Figure 16 (Science Based Targets Initiative, 2022a, b) (Science Based Targets, n.d.-d; 2021a); 2021b; Carrillo Pineda et al., 2015).

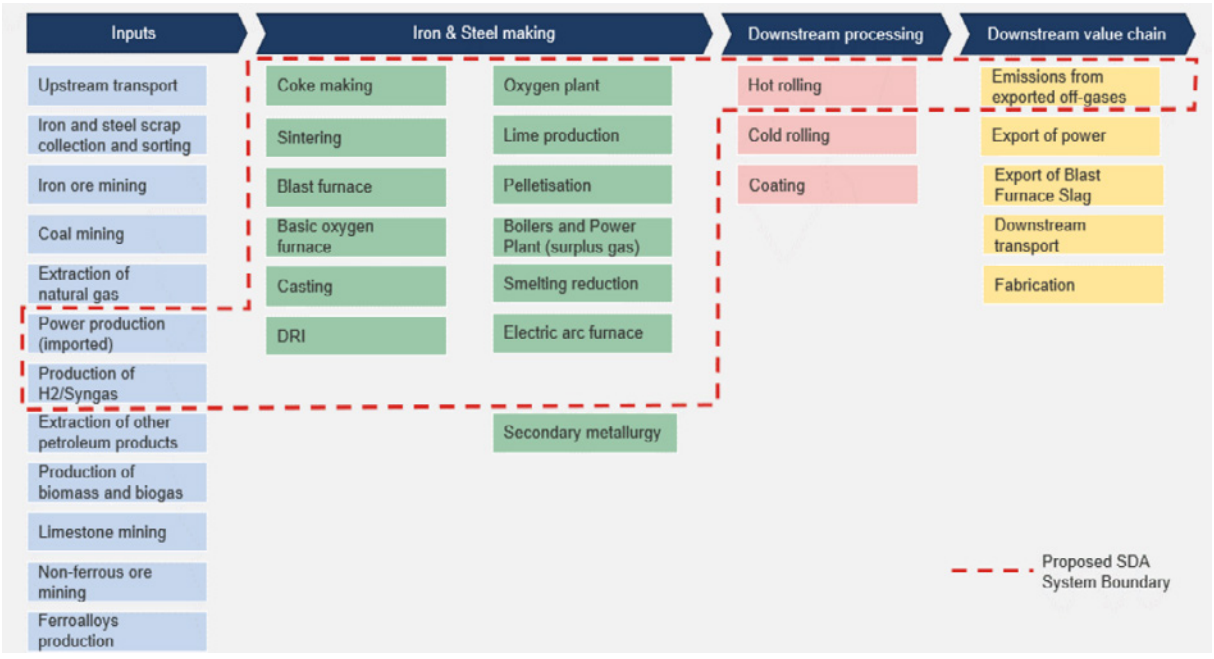


Figure 16: Iron and steel industry core SDA boundary proposed on the draft 1.5°C Steel Science-Based Target Setting Guidance.

The system boundary proposes a consistent treatment of processes required to make steel regardless of whether they are in a company's scope 1, 2 or 3 emissions. Upstream fossil fuel-related emissions are excluded from the boundary, but a mandatory scope 3 target is proposed and discussed in more detail below. All processes included in the iron & steel core SDA boundary will fall under the iron & steel SDA target-setting method, irrespective of whether they are scope 1, 2, or 3 emissions for a given entity. Emissions from purchased products and processing of sold products, falling within the core boundary will also be included. At least 95% of the Scope 1 & 2 emissions from purchased coke, syngas, hydrogen, power, lime, oxygen, iron pellets, or other forms of agglomerated iron, hot briquetted iron, or other form of iron must be included. Emissions outside the SDA boundary

Targets, Pathways, and Requirements

For near-term targets at least 95% of all Scope 1 and 2 emissions shall be included. If a company's relevant scope 3 emissions are 40% or more of total scope 1, 2, and 3 emissions, a scope 3 target is required. The coverage must be at least 67%. All companies involved in the sale or distribution of natural gas and/or other fossil fuels shall set 1.5°C-aligned scope 3 targets for the use of sold products, irrespective of the share of these emissions compared to the total scope 1, 2, and 3 emissions of the company. For long-term targets, the coverage shall be at least 95% for scopes 1 and 2, and 90% for scope 3.

The generic rules that apply to steel producers include:

- Steel producers must include at least 95% of their emissions from activities falling under the iron & steel core SDA boundary in targets, regardless of whether these are scope 1, 2, or 3 emissions.
- Near-term steel company SBTs shall include at least 95% of their purchased intermediate products emissions falling within the core boundary (i.e., these emissions, which would otherwise be considered scope 3 category 1 Purchased goods and services, must be covered as part of the core target calculated using the SDA)
- Mandatory scope 3 targets for fuel- and energy-related emissions not covered in other targets.

This report provides a summary of the requirements stated in the draft 1.5°C Steel Science-Based Target Setting Guidance. Additional details can be found in the referenced guidance document.

The iron and Steel SDA is also based on a scrap-input dependent pathway that is company specific and is calculated from the company's scrap input and how it changes over time and considers the different emissions profiles of scrap-based steel making overtime. The pathway is calculated from two separate, fixed, 1.5°C-aligned sector pathways: a 100% scrap-based (secondary) pathway and a 0% scrap-based (primary) pathway. An example of a company's 10% activity growth over 2020-30, 2.4 t CO_2/ t hot rolled steel and 30% scrap input in 2020, and 40% scrap input in 2030 is shown below in Figure 17.

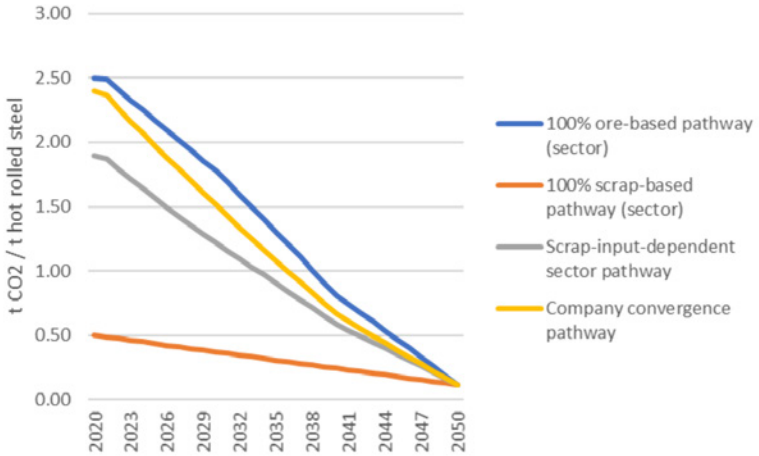


Figure 17: Example company target scrap-input-dependent pathways from draft 1.5°C Steel Science-Based Target Setting Guidance.

A company wishing to submit to the SBTi must do the following:

1. Commit: submit a letter establishing your intent to set a science-based target
2. Develop: work on an emissions reduction target in line with the SBTi's criteria
3. Submit: present your target to the SBTi for a complete validation
4. Communicate: announce your target and inform your stakeholders
5. Disclose: report company-wide emissions and track target progress annually

SBTi requires that companies submit their targets at a company-wide level including their subsidiaries consistent with the GHG Protocols and include all relevant GHG emissions. The verification of the company-level commitments is based on the averages required of the whole steel industry globally. SBTi's team of experts independently reviews and verifies a company's submission and validates it against their science-based criteria to determine if it is in line with the SBTi (Science Based Targets, n.d.-c).

Constituency

As of November 2022, 1,957 companies across numerous sectors have committed to SBTi and 4,061 are taking action to meet the Paris Agreement targets. Concerning the steel industry, the 1.5˚C Sector guidance expected to be published in 2023 will be the basis of all new commitments. The 1.5˚C Sector Guidance is developed within a project launched in October 2021. Some 30 stakeholders of which one-third are representing NGOs:s/ thinktanks are engaged in the Expert Advisory Group. The ETC contracted a Technical Partner with the task of preparing the draft guidance by November 2022. SBTI has developed pathways for the steel industry partnered with the Mission Possible Partnership (MPP) which is an alliance led by the Energy Transitions Commission, The Rocky Mountain Institute, the We Mean Business Coalition, and the World Economic Forum as well as various members of an Expert Advisory Group (EAG) that includes 29 industry and non-industry representatives including ArcelorMittal, World Steel Association, and Potsdam Institute for Climate Research The 1.5°C Steel Science-Based Target Setting Guidance is specifically partnered with CDP Worldwide, the United Nations Global Compact, the World Resources Institute, and the World Wildlife Fund. (Science Based Targets, n.d.-a) .

Standards Development Status

In October 2021 SBTi launched a project with the aim of developing a 1.5°C sector guidance based on a significantly smaller carbon budget. The Draft was to be submitted to public consultation in November 2022 before final approval by the end of May 2023. The process for revision will include with following

1. Integration of new pathways in SBTi's target setting tool to allow modeling of targets at the sub-sector level (primary and secondary sources) and integration of sub-sector level targets at the company level.

2. Identification and assessment of scenarios for modeling of 1.5°C-aligned near-term and long-term net-zero targets for primary and secondary steel production.

3. Update the SBTi target setting tool to integrate the adjusted SDA calculation method.

4. Road-testing of new target-setting resources.

5. Development of guidance for science-based target setting in the steel industry (Science Based Targets, n.d.-b; n.d.-d).

4.3 First Movers Coalition Initiative

The First Mover Coalition is a global initiative harnessing the purchasing power of companies to work towards decarbonizing the Aluminum, Aviation, Chemicals, Concrete, Shipping, Steel, and trucking industries along with funding innovative carbon removal technologies by its members committing in advance to purchasing a proportion of their industrial materials from suppliers using near-zero or zero carbon solutions (First Movers Coalition, 2022c; 2022a).

Features

For the steel industry, The First Movers Coalition has set a product level CO_2 threshold per ton of crude steel that includes Scope 1 and 2 emissions as defined by the GHG Protocols. The threshold includes a sliding scale proportional to the percentage share of scrap utilized in the production of the crude steel product (First Movers Coalition, n.d.).

Targets, Pathways, and Requirements

The First Movers Coalition's has set a threshold of fewer than 0.4 tonnes of CO_2 emitted per tonne of crude steel if the scrap proportion is 0% that slides down to less than 0.1 tonnes of CO_2 emitted per ton of crude steel with 100% scrap inputs. The sliding scale utilized to determine if a procured steel product meets the threshold of the commitment is provided below in Figure 18 (First Movers Coalition, n.d.).

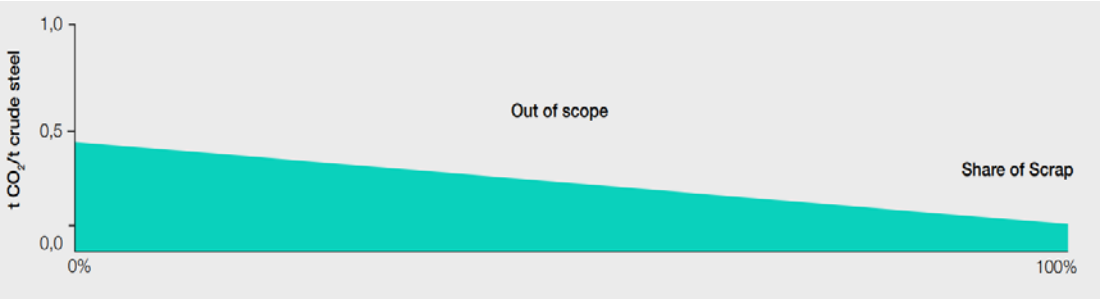


Figure 18: The First Movers Coalition's scrap proportional sliding scale required to meet the definition of near-zero emissions steel (First Movers Coalition, n.d.).

Members commit to procuring 10% of their steel as near-zero-emissions steel as defined above by 2030. The utilization of carbon offsets acquired by the crude steel producer does not contribute to the emissions calculations (First Movers Coalition, n.d.).

Disclosure, Reporting, and Quality Control

The First Movers Coalition does not explicitly enforce adherence to a member's commitment due to the voluntary nature of the commitment. Progress towards commitments will however be reported through a State of the First Movers Coalition published report. The First Movers Coalition does not explicitly comment on conducting validation of a member's self-submitted progress report (First Movers Coalition, 2022b).

Constituency

Commitments for the first four sectors including steel were launched in November of 2021 at COP26 with other industrial sectors scheduled to be added to the First Movers Coalition in 2022 and 2023. The First Movers Coalition is a public-private partnership launched by the U.S. State Department and the World Economic Forum and is supported by the U.S. Department of Commerce. The coalition includes 10 government partners with India, Sweden, and Japan serving as Steering Board Partners and the United States of America as the Co-Chair. Breakthrough Energy is the Primary Implementation Partner that brings together private and public partners to advance technology deployment and provide reporting and analytics to measure progress. Carbon Removal Partners include Breakthrough Energy Catalyst, Carbon Direct, Frontier, and South Pole. Boston Consulting Group serves as the Knowledge Partner supporting the formulation of sectoral commitments and working with members to support the delivery of commitments.

Sixteen organizations and NGOs serve as the Design Committee providing input to the sectoral commitments including the IEA, Rocky Mountain Institute, and the Climate Group. The First Movers Coalition has 55 total members with 18 of those members committing to the procurement of near-zero or zero carbon steel including Engie, Ford Motor Company, Mahindra, Trane Technologies, and Vestas (First Movers Coalition, 2022b; d; e).

Standards Development Status

The Design Committee for the steel commitment sector included Climate Group, Net Zero Steel Initiative, and Energy Transitions Commission. At the time of writing this report, there are no published plans to revise the guidelines for the steel industry (First Movers Coalition, n.d; 2022b).

4.4 RMI Center for Climate Aligned Finance Initiative – Sustainable Steel Principles

The Center for Climate Aligned Finance (The Center) was established by the Rocky Mountain Institute (RMI) to help the financial sector transition the global economy toward a zero-carbon 1.5°C future. The Center works to develop decarbonization agreements within high-emitting sectors, build global frameworks for climate alignment, and support financial institutions in decarbonizing their lending and investing portfolios. At the firm level, the Center supports individual financial institutions to implement climate alignment commitments through collaboration with complementary initiatives. At the sector level, the Center enables collective action with solutions ranging from target problem-solving efforts to wholesale sector climate-aligned finance agreements. At the system level, the aim is to shape the operating

environment and address system barriers common to financial institutions such as data availability and regulatory clarity through engagement, facilitation advisory positions, and partnerships (Center for Climate Aligned Finance, 2022a; 2022c).

The Center's Sustainable STEEL Principles provide a sector-specific measurement and disclosure framework for banks enabling them to support the decarbonization of the steel industry in compliance with the Net Zero Banking Alliance (NZBA) (Center for Climate Aligned Finance, 2022b).

Features

The Sustainable STEEL Principles provide a framework for lenders to measure and disclose the CO_2 emissions associated with their steel loans. The framework currently excludes other greenhouse gas emissions such as methane, but they intend to consider expanding the scope to include methane in future methodological updates. The methodology utilizes an asset-level approach of tons of CO_2 per ton of steel produced for each steelmaker. Lenders use this data to calculate the total emissions intensity of their loan book compared to two net-zero scenarios and disclose the climate-alignment of their overall lending portfolio. The quantification of the emissions intensity considers the boundaries shown in Figure 19 as recommended by the Net-Zero Steel Pathway Methodology Project (NZSPMP) (Sustainable Steel Principles, 2022a).

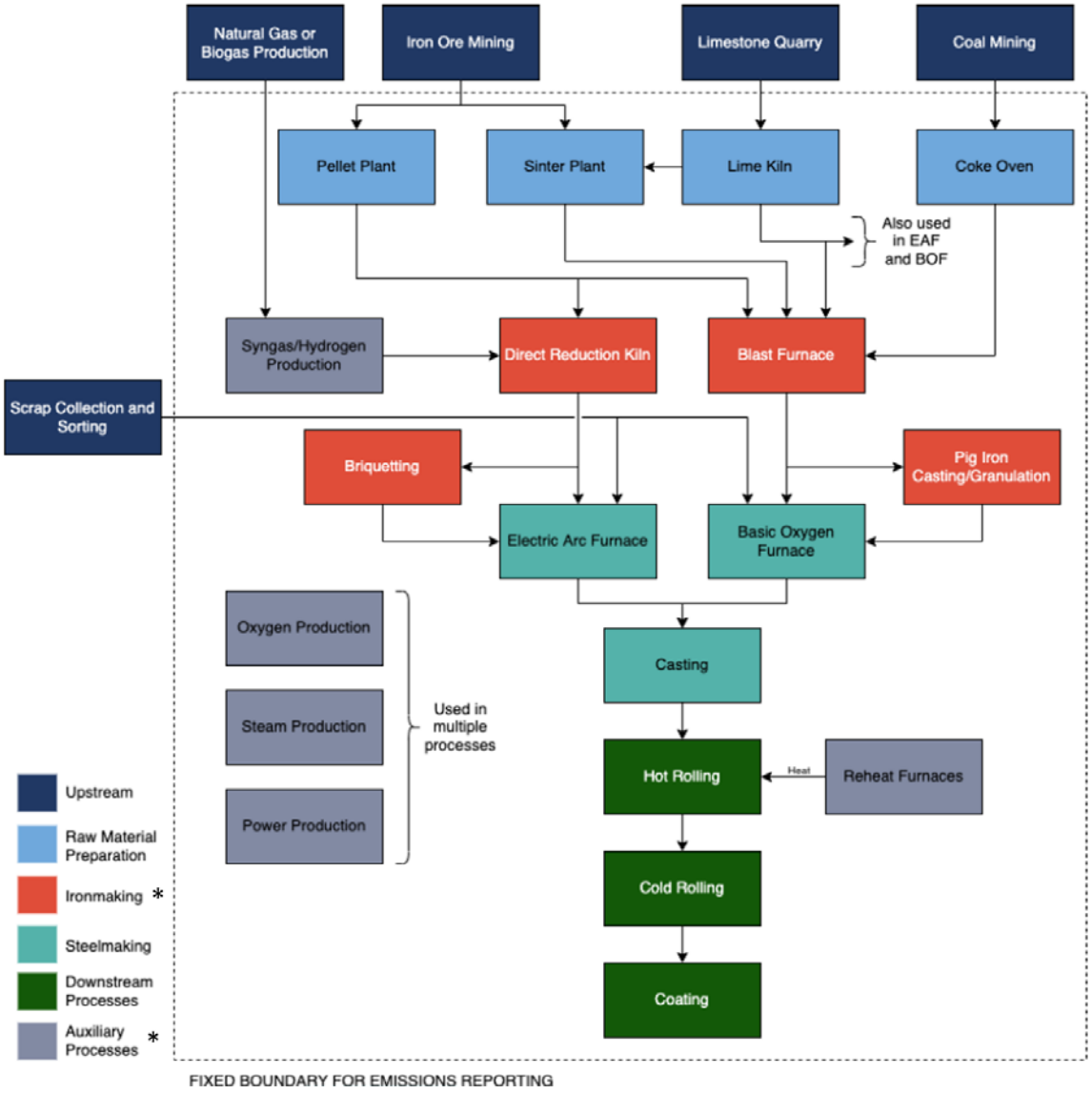


Figure 19: Fixed System Boundary of the RMI's Sustainable STEEL Principles (Sustainable Steel Principles, 2022b).

Included in this boundary are all of the steelmakers' Scope 1 and Scope 2 emissions and some of the Scope 3 emissions. The inclusion of Scope 1, 2, and 3 emissions under the Sustainable STEEL Principles are further demonstrated in Figure 20 (Sustainable Steel Principles, 2022a).

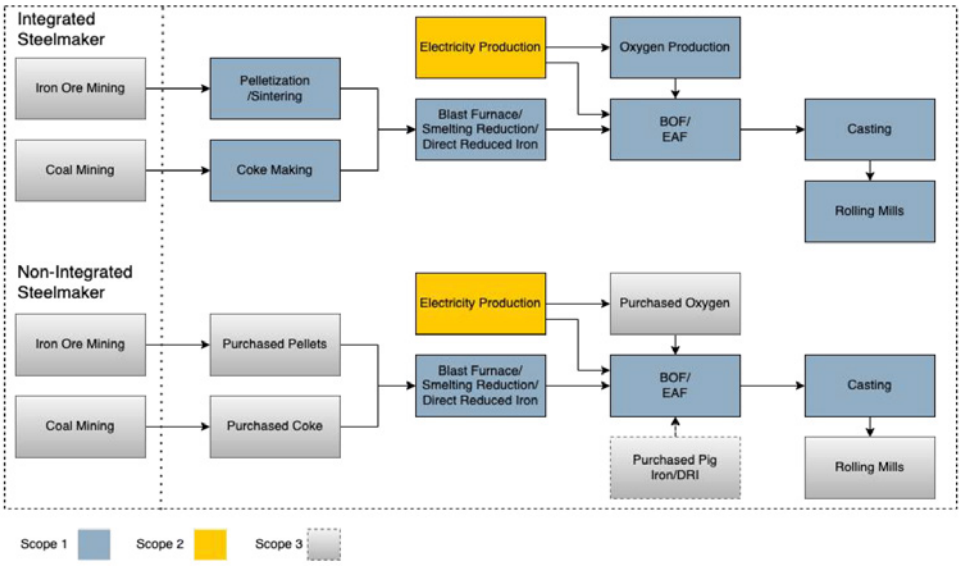


Figure 20: Example of Scope 1, 2, and 3 emissions within the Fixed System Boundary for the RMI's Sustainable STEEL Principles (Sustainable Steel Principles, 2022b).

Quantification of the percentage of scrap steel used in the production process is also required. Steelmakers are evaluated based on their specific usage of scrap meaning each steelmaker's decarbonization target is company-specific and weighted based on their use of scrap (Sustainable Steel Principles, 2022).

Targets, Pathways, and Requirements

A specific target is then set for each steelmaker dependent on the weighted use of scrap in the steelmaker's production process. A steelmaker who is a borrower from a signatory receives an Alignment Score based on their emissions intensity and scrap charge. An example of the scoring structure is provided below in Figure 21 based on a 25% scrap utilization where the emissions intensity must ratchet down over time. (Sustainable Steel Principles, 2022).

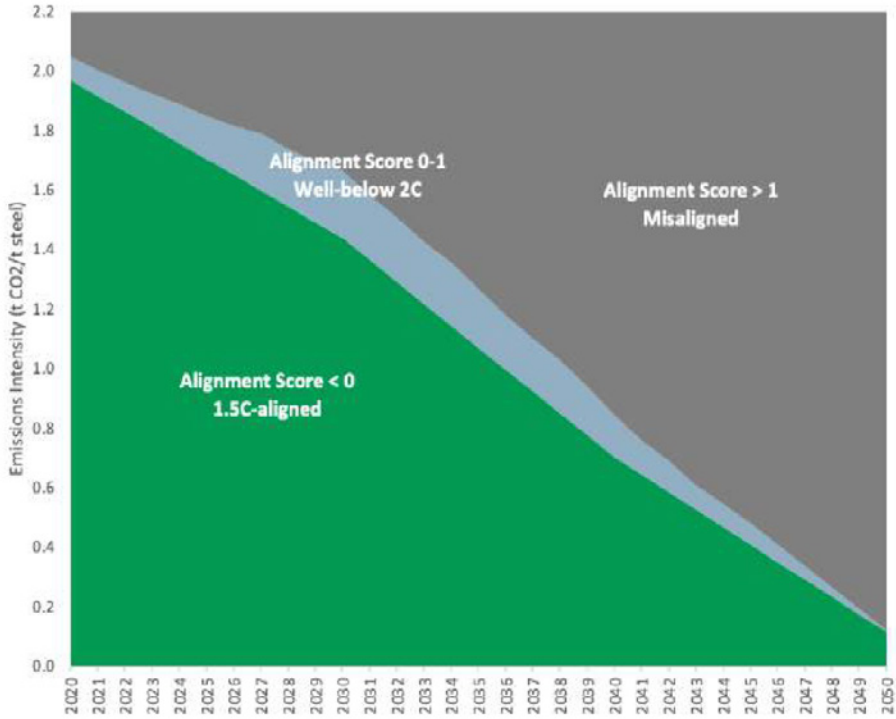


Figure 21: Alignment zone example for a steel producer utilizing 25% scrap in the RMI's Sustainable STEEL Principles (Sustainable Steel Principles, 2022).

Specific methodology for calculating the alignment score based on a steelmaker's emissions intensity and scrap utilization are provided in further detail in the referenced The Sustainable Steel Principles September 2022 guidelines (Sustainable Steel Principles, 2022).

There are five key Sustainable STEEL Principles that signatories commit to outlines below

1. **Standard assessment of climate alignment**
    a. Annual assessment of a signatories climate alignment according to the Sustainable STEEL Principles guidance and methodology
    b. Providing measurements of the carbon intensity and resulting climate alignment of their steel portfolios
    c. Providing measurements of their portfolio represented by emissions reduction targets
2. **Transparent Reporting**
    a. Public acknowledgment of being a signatory to the Sustainable STEEL Principles
    b. Annual reports are to be provided to Sustainable STEEL for public disclosure of their
        i. Portfolio Alignment Score and parameters used for reporting
        ii. Narrative providing context into their score and insight into their institution's strategies for climate alignment

iii. Forward looking indicator of their portfolio is represented by a net-zero target and interim emissions reduction target (on an optional basis)

c. Annual publishing of their Portfolio Alignment score

3. **Enactment**
    a. Signatories will perform required borrow and portfolio level calculations with data sourced from borrows where available and use best efforts to contractual require reporting from borrowers.
    b. Where data is not available, signatories can source data through Sustainable STEEL Principles approved third-party data provider
4. **Engagement**
    a. Engage with clients to advance emissions reductions in line with 1.5°C
    b. Engage with clients to discuss their transition plans, the financial products available to support their transition, and the bank's expectations for emissions reductions.
5. **Leadership**
    a. Signatories are encouraged to set steel portfolio emissions targets and provide the target dates, when the targets were set, and the specific target scenario.
    b. Participation in updating the framework of the Sustainable STEEL Principles
    c. Advocating for the Sustainable STEEL Principles (Sustainable Steel Principles, 2022).

Disclosure, Reporting, and Quality Control

The Sustainable STEEL Principles Secretariat, hosted by RMI, will use the data disclosed by the signatory through the required reporting process and generate an annual report, containing the portfolio alignment score of each participating bank. Data on individual steelmakers is aggregated into the portfolio alignment score and therefore the emissions intensity and scrap use of individual steelmakers are kept confidential. Banks are required to publicly disclose their overall loan portfolio climate alignment scores. (Sustainable Steel Principles, 2022).

Constituency

The RMI Center for Climate Aligned Finance was launched in 2020 and is funded through philanthropic gifts from a range of donors. The founding partners include Bank of America, Goldman Sachs, JPMorgan Chase & Co., and Wells Fargo. Strategic partners include CIBC, Citi Bank, TD Bank, RBC, and ING. Supporters include Climateworks Foundation and William + Flora Hewlett Foundation. The Center has ten partners including Energy Transitions Commission, Ceres, Mission Possible Partnership, 21 Investing Initiative, and Climate Bonds Initiative.

The Sustainable STEEL Principles were developed through a Working Group, led by ING and Societe Generele, with participation from Citi, Standard Chartered, and UniCredit who are leading lenders to the global steel industry. More than 80 stakeholders from the financial sector, including 30 steelmakers, and decarbonization experts reviewed and informed the development of the Sustainable STEEL Principles over 12 months. (Center for Climate Aligned Finance, 2022a), (Center for Climate Aligned Finance, 2022b; 2022).

Standards Development Status

The Sustainable STEEL Principles were unveiled at the NYC Climate week in September 2022 and are inspired by the Poseidon Principles for shipping. The current version of the

Sustainable STEEL Principles applies only to banks and their lending portfolios however, expansion to include export credit agencies and capital markets are planned in the future at an undisclosed time. Additionally, the scope of emission may expand to include other GHG emissions from the steel industry in an effort to align the STEEL Principles with ResponsibleSteel and SBTi (Center for Climate Aligned Finance, 2022a; 2022b; 2022).

4.5 SteelZero Initiative

SteelZero is a global initiative aimed at driving market demand for net zero steel. Organizations that join SteelZero make a public commitment to procure 100% net zero steel by 2050, with an interim commitment of using 50% responsibly produced steel by 2030. This sets out a clear and immediate pathway to meet the net zero target. Targeting net zero steel from the demand-side of the supply chain gives this initiative the potential to have a significant impact on investment, policy, manufacturing, and production in the sector. By harnessing their collective purchasing power and influence, steel purchasers are sending a strong demand signal to shift global markets and policies toward responsible production and sourcing of steel. (Climate Group SteelZero, n.d.-a).

Features

To demonstrate compliance with an organization's commitments they must demonstrate procurement through one or more of the following

- ResponsibleSteel Certified Steel, or equivalent
- Steel produced by a steelmaking site's corporate owner has medium-term, quantitative science-based GHG emissions targets for the corporation including a target approved by the Science Based Targets initiative (SBTi)
- Low Embodied Carbon Steel, with a defined specific emissions intensity that takes into account the proportion of end-of-life scrap (Climate Group SteelZero, 2021a; 2021b; 2022).

Targets, Pathways, and Requirements

Organizations that join SteelZero commit to procuring, specifying, or stocking 100% net zero steel by 2050, and an interim commitment to procuring, specifying, or stocking 50% of its steel requirement by 2030.

Submission of annual reports to the Climate Group are required to show an organization's progress towards their SteelZero commitment that must include summaries of the quantity and embodied carbon of steel produced. SteelZero requires self-generated reporting of data and does not specifically mention enforcement and data quality verifications (Climate Group SteelZero, 2021a), (Climate Group SteelZero, 2021b; 2022).

Constituency

SteelZero is an initiative run by the Climate Group and SteelZero. At the time of this report, 27 organizations have joined SteelZero. Table 8 outlines the companies that have committed to SteelZero and their commitment timelines.

Table 8: Companies committed to SteelZero and their respective commitment timelines (Climate Group SteelZero, 2022).

Company Name	50% Low Emissions Steel Procurement Commitment Timeline	100% Low Emissions Steel Procurement Commitment Timeline
Ørsted	2030	2040
A.P. Moller - Maersk	2030	2040
B+M Steel	2030	2050
Barrett Steel Limited	2030	2050
BHC	2030	2050
Billington Structures Ltd.	2030	2050
Bourne Group	2030	2050
Deconstruct UK	2030	2050
Eiffage Métal France	2030	2050
Grosvenor Property UK	2030	2050
Iberdrola	2030	2050
Landsec	2030	2050
Lendlease	2030	2040
Mace Group	2030	2050
MetStructures	2030	2050
Morrow + Lorraine	2030	2050
Multiplex Construction Europe	2030	2050
Severfield PLC	2030	2050
Siemens Gamesa	2030	2040
Skanska UK	2030	2050
SKF	2030	2050
Smulders	2030	2050
Vattenfall BA Wind	2030	2040
ViaCon Group	2030	2040
Volvo Cars	2030	2050
William Hare	2030	2050
WSP UK	2030	2050

Standards Development Status

Steel Zero integrates the ResponsibleSteel Standard into its commitment framework. The ResponsibleSteel certification provides buyers independent assurance and accountability that the steel they are buying meets rigorous lower embodied carbon credentials, is responsibly produced, and is part of a trusted track and trace mechanism to provide market integrity. The approach has been included by multiple coalitions and organizations as one of their approved standards for the steel industry's GHG accounting, reporting, and target setting, including the First Movers Coalition and International Deep Decarbonization Initiative (IDDI) run by UNIDO. (Climate Group SteelZero, 2021a; 2021b; 2022).

4.6 ArcelorMittal Low-Carbon Emissions Steel Proposal

ArcelorMittal, a global leader in steel production has proposed criteria for low-carbon emissions steel with the goal of providing transparency and consistency across products for customers the Life Cycle Assessment (LCA) values, or Environmental Product Declaration (EPD) values in construction products. Additionally, the goal is to incentivize decarbonization by allowing policymakers to create differentiated lead markets for low-carbon emissions steel production that will provide steelmakers with a premium to fund capital investments (ArcelorMittal, 2022a).

Features

The ArcelorMittal Low Carbon Emissions Steel Standard proposes a product-level approach in tonnes of CO_2e emitted per ton of hot rolled steel produced including a sliding scale based on the percentage of scrap steel used in production. ArcelorMittal has proposed the following system boundaries for the quantification of emissions intensity shown below in Figure 22 (ArcelorMittal, 2022b).

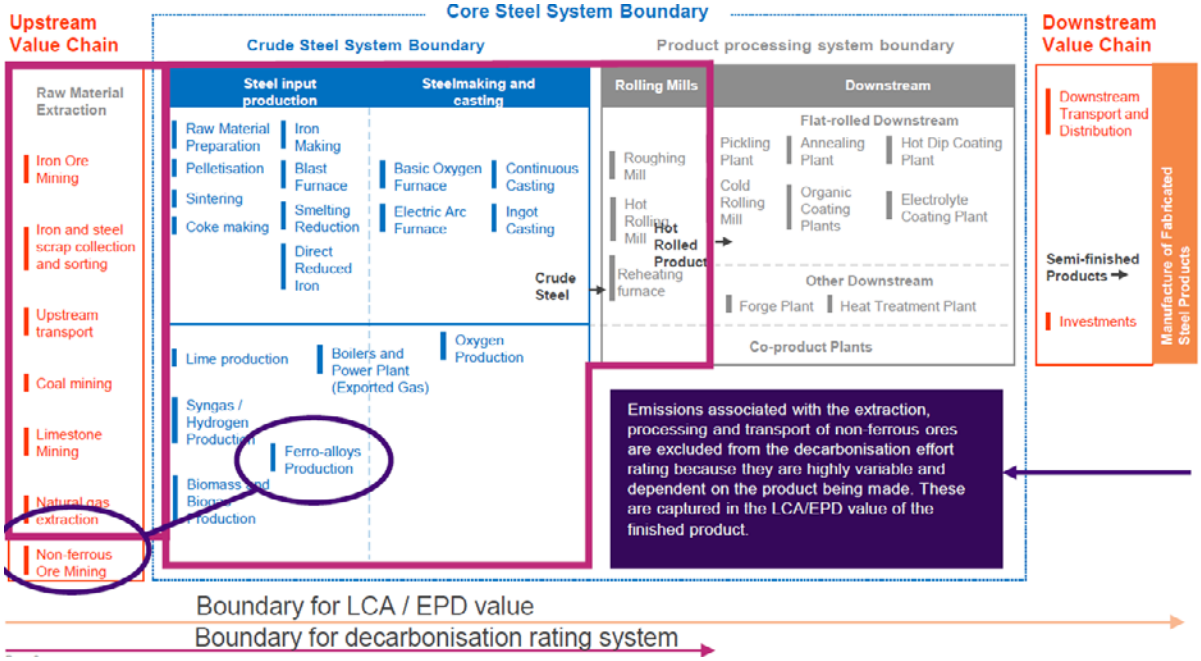


Figure 22: ArcelorMittal proposed system boundaries for their Low-Carbon Emissions Steel Standard (ArcelorMittal, 2022b).

In the ArcelorMittal proposed Hot Rolled System Boundary, all steel products are directly comparable and all Scope 1 & 2 emissions are quantified with some Scope 3 emissions considered. The current proposed phase utilizes the NZSPMP crude steel system boundary (ArcelorMittal, 2022b).

Targets, Pathways, and Requirements

No specific product level target has been proposed by ArcelorMittal however they propose that like ResponsibleSteel and IEA proposals, the threshold for near-zero steel should be set at a level that supports all potential decarbonization routes. A high-level figure has been provided by ArcelorMittal to demonstrate their proposal where steel producers' products receive a grade considering the carbon intensity of their produced steel on the scrap utilized sliding scale. The proposed structure is shown below in Figure 23 (ArcelorMittal, 2022b).

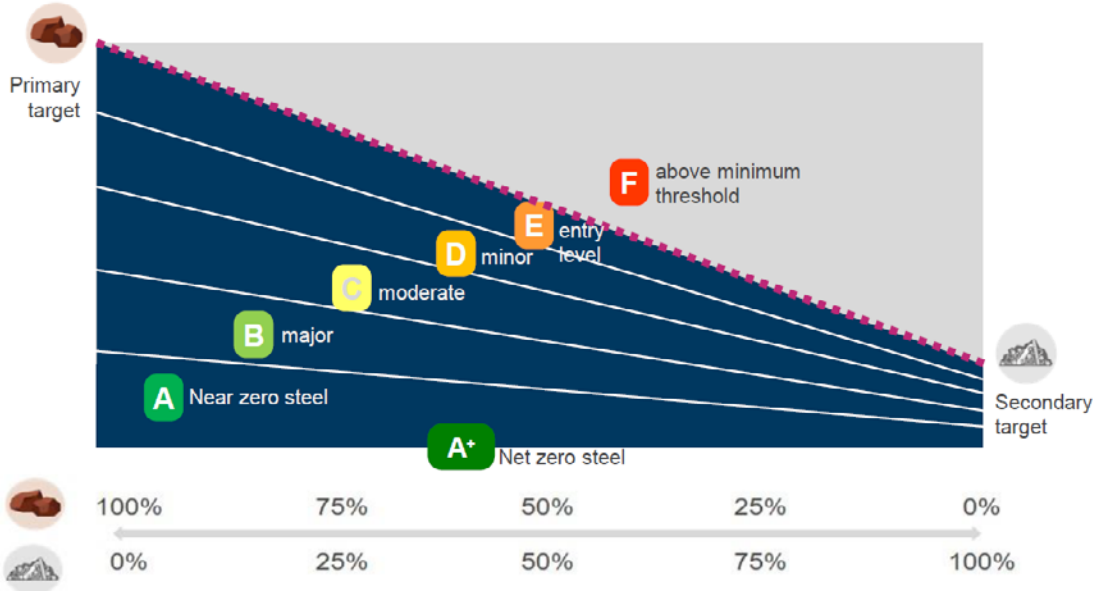


Figure 23: ArcelorMittal proposed Low-Carbon Emissions Steel Standard scoring system considering steel emissions intensity and scrap utilization (ArcelorMittal, 2022b) .

Also shown in Figure 23, ArcelorMittal's proposed product labeling system provided information to purchasers about the steel producer and the product's embodied carbon and scrap steel utilization percentages.

ArcelorMittal is a steel producer proposing the Low-Carbon Emissions Steel Standard and has not stated any further requirements other than those discussed above (ArcelorMittal, 2022a; 2022b).

Disclosure, Reporting, and Quality Control

ArcelorMittal is a steel producer proposing the Low-Carbon Emissions Steel Standard and will therefore not be responsible for administering disclosure, reporting, enforcement, or quality control. If the proposed system is adopted, these responsibilities would be taken on by the body that takes on the proposed Low-Carbon Emissions Steel Standard (ArcelorMittal, 2022a; 2022b).

Constituency

ArcelorMittal is the world's 2nd largest steel producer manufacturing in 16 countries and creating 69.1 million tonnes of crude steel in 2021 (World Steel Association, 2022a).

Standards Development Status

ArcelorMittal develop the proposed Low-Carbon Emissions Steel Standard internally and released its proposal in June of 2022. ArcelorMittal proposes to add value chain emissions, excluding non-ferrous ores (mining, processing & transportation) to the decarbonization effort rating in the second stage followed by primary upstream data in the 3rd stage of development (ArcelorMittal, 2022a).

4.7 Horizon Zero Initiative

The RMI Horizon Zero initiative aims to establish differentiated commodity markets to drive the decarbonization of key industrial sectors by creating emissions accounting guidance and establishing data standards to link supply chain participants. The initiative is developing

guidance for several sectors including steel based on the common principles of product-level accounting, maximizing the use of primary data, and use of a fixed boundary to enable comparison and inclusion of sector-specific metrics to ensure incentives for decarbonization are aligned.

For product-level GHG accounting, Horizon Zero aims to utilize a harmonized framework that can be compared across supply chains and products where companies will be able to calculate the emissions impact of the products they purchase or sell. Horizon Zero also developed an open-source technical architecture with the goal to increase the visibility of product-level emissions intensities across all sectors and stages of a product's life cycle from raw materials to final products (Horizon Zero - RMI, 2022).

Features

The Horizon Zero initiative has released draft guidance at the time of writing this report on best practices for product-level carbon accounting for the steel industry called Steel Emissions Reporting Guidance, based on the following features:

- Reporting on emissions intensity at the product level includes a common end-point that can allow buyers to compare the emissions performance of products.
- Reporting on the scrap used in the product that ideally includes a breakdown of pre- and post-consumer scrap use.
- Emissions in the context of scrap-use such as the sliding scale, performance against a trajectory based on scrap fraction, or additional disclosure of emissions incurred in the parts of the supply chain processing ore and scrap.
- Reporting on the fraction of primary data used to develop the emissions footprint calculation.
- Reporting of any credits (e.g., for exported by-products) separately to the overall emissions footprint (Wright, 2022).

The proposed boundary for emissions reporting in the Steel Emissions Reporting Guidance document is shown below.

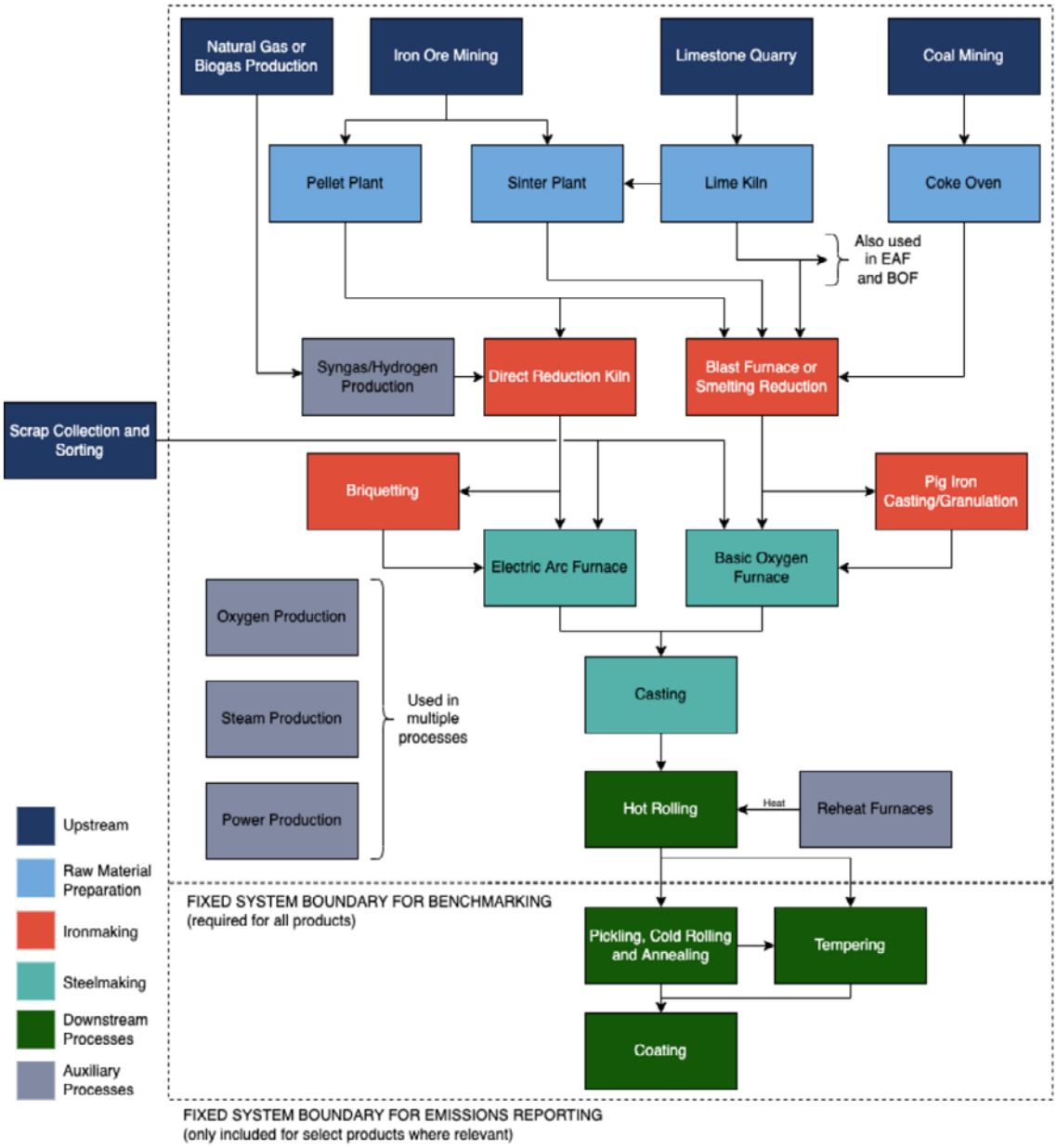


Figure 24: Emissions Reporting and Benchmarking boundaries for emissions in RMI's Steel Emissions Reporting Guidance (Wright, 2022)

Targets, Pathways, and Requirements

No specific product level target has been proposed in the RMI Steel Emission Reporting guidance. The guidance suggests that steelmakers provide the data to buyers to differentiate their products both in terms of 1) incremental emissions reductions through increased scrap and more efficient processing and 2) transformational emissions reductions through technology changes in ore-based production (e.g., green hydrogen-based direct reduction).

Constituency

The Horizon Zero steel guidance was developed in consultation with WBCSD's Partnership for Carbon Transparency and academic partners from the Coalition on Materials Emissions

Transparency. In particular, it was informed by consultations within the WBCSD A-PACT automotive working group including major steel purchasers such as BMW, Toyota, and Volkswagen as well as other steel industry experts (WBCSD, 2022).

Standards Development Status

The draft steel guidance was released for public consultation in September 2022 and aims to publish a final version early in 2023. Pilot testing of the required data disclosures and associated data formats is planned for 2023.

4.8 Climate Action 100+ for Steel Initiative

Climate Action 100+ is an investor-led initiative to ensure the world's largest corporate greenhouse gas emitters take necessary action on climate change. 700 investors, responsible for over $68 trillion in assets under management, are engaging companies in improving climate change governance, cutting emissions, and strengthening climate-related financial disclosures. Climate Action 100+ has become the largest-ever global investor engagement initiative on climate change, with growing influence and impact. 166 focus companies have been selected for engagement, accounting for up to 80 percent of corporate industrial greenhouse gas emissions (Climate Action 100+, 2022a).

The Climate Action 100+ Net Zero Benchmark assesses the performance of the focus companies against their emissions reduction, governance, and disclosure and presents a key measure of corporate progress on climate action and the move to achieve net zero emission by 2050 and their alignment with the Paris Agreement goal to limit global temperature rise to 1.5°C (Climate Action 100+, 2022d).

Climate Action 100+ released its first Global Sector Strategy report for the steel industry titled "Global Sector Strategies: Investor Interventions to Accelerate Net Zero Steel" in August of 2021 developed by the Institutional Investors Group on Climate Changes (IIGCC) (Climate Action 100+, 2022c). The report provides an overview of the status of decarbonization in the steel industry, and what is needed to overcome the challenges posed by the transition to net zero, and informs investors' engagements with steel companies. The report specifically identifies

1. The level of decarbonization needed in the steel industry is consistent with limiting the rise in global temperature to 1.5°C (referred to as "net zero" in this report).
2. The principal measures that can be taken to reduce emissions in the steel industry.
3. The specific challenges to delivering net zero in the steel industry.
4. The actions steelmakers and others should take align with net zero.
5. How investors can accelerate progress (Gardiner & Lazuen, 2021).

Features

The Climate Action 100+ Net Zero Benchmark categories assessments into two types of indicators, Disclosure Framework Indicators that evaluate the adequacy of corporate disclosure, and Alignment Assessments that evaluate the alignment of company actions with the Paris Agreement goals.

The Disclosure Framework utilizes public and self-disclosed data from companies to assess companies against the following 10 indicators:

1. Net-zero GHG Emissions by 2050 (or sooner) ambition

2. Long-term (2036-2050) GHG reduction target(s)
3. Medium-term (2026-2035) GHG reduction target(s)
4. Short-term (up to 2025) GHG reduction target(s)
5. Decarbonization strategy
6. Capital allocation alignment
7. Climate policy engagement
8. Climate governance
9. Just Transition [Beta]
10. TCFD disclosure

These indicators are further broken down into sub-indicators which can be further broken down into individual metrics. A score is awarded for each indicator and sub-indicator. The scores are not aggregated to an overall score and no ranking of companies occurs. Details on the sub-indicators and metrics can be found in the source cited. For the steel industry specifically, Scope 3 emissions are not considered applicable in the Net Zero Benchmark assessment (Climate Action 100+, 2022e).

The Alignment Assessments are broken down as follows

Capital Allocation Alignement (CTI)

Primarily focuses on the oil and gas and electric utility focus companies and does not apply to steel (Climate Action 100+, 2022e).

Climate Policy Engagement Alignement (InfluenceMap)

InfluenceMap's alignment assessments provide detailed analyses of corporate climate policy engagement and the alignment of company climate policy engagement actions (direct and indirect via their industry associations) with the Paris Agreement goals. Their assessments cover all focus companies (Climate Action 100+, 2022e).

Capital Allocation Alignment (2DII)

For the steel industry, the alignment assessments analyze companies' planned economic outputs and associated emissions intensities relative to selected climate change scenarios. The steel emissions intensities are calculated per tonne of crude steel production and exclude rolling and casting steps. Asset-backed company-level data for the steel and cement sector is used to derive production values for each physical plant. Scope 1 (direct emissions from iron and steel furnaces) and scope 2 (electric arc furnaces) emissions for the production of both iron and steel are considered. Scope 3 emissions are excluded. The company-level emission intensity is calculated as the weighted average of its production plant, with the weighting based on the production capacity of each plant (21 Investing Initiative, 2022).

A comparison of current production to International Energy Agency (IEA) 10-year scenario targets for emissions is conducted. The companies' emissions intensities targets are compared to the IEA Beyond 2°C Scenario (B2DS) and the percent improvement required to converge with the scenario is determined. The focus company is graded as having "significant distance to alignment with B2DS" if there is a greater than 36% negative deviation, "moderate distance to alignment With B2DS" if there is a 15-36% negative deviation, and "aligned or close to being aligned with B2DS" if the is less than a 15% deviation (21 Investing Initiative, 2022).

Climate Accounting and Audit (Provisional) (CTI and CAAP)

The Climate Tracker Initiative (CTI) and the Climate Accounting and Audit Project (CAAP's) alignment assessment evaluates whether a focus company's accounting practices and related

disclosures and the auditor's report thereon, reflect the effects of climate risk and the global move towards a 2050 (or sooner) net zero emissions pathway and the Paris Agreement goal of limiting global warming to no more than 1.5°C. This assessment covers all focus companies and is considered provisional (Climate Action 100+, 2022e).

Targets, Pathways, and Requirements

The Global Sector Strategies: Investor Interventions to Accelerate Net Zero Steel identifies the five key measures for decarbonizing the steel industry below.

1. Increasing the proportion of steel produced by the scrap-EAF process
2. Enhancing material efficiency of steel products to limit steel demand growth
3. Further incremental improvements in the energy efficiency of existing steel production capacity
4. Invest in low-emission DRI-EAF capacity (including hydrogen-based) for primary steelmaking
5. Apply CCS/CCUS technology to fossil-based steel production plants where feasible (Gardiner & Lazuen, 2021).

These key measures and their approximate estimated contributions to reducing the CO_2 emissions for the steel industry to reach net zero by 2050 are displayed in Figure 25.

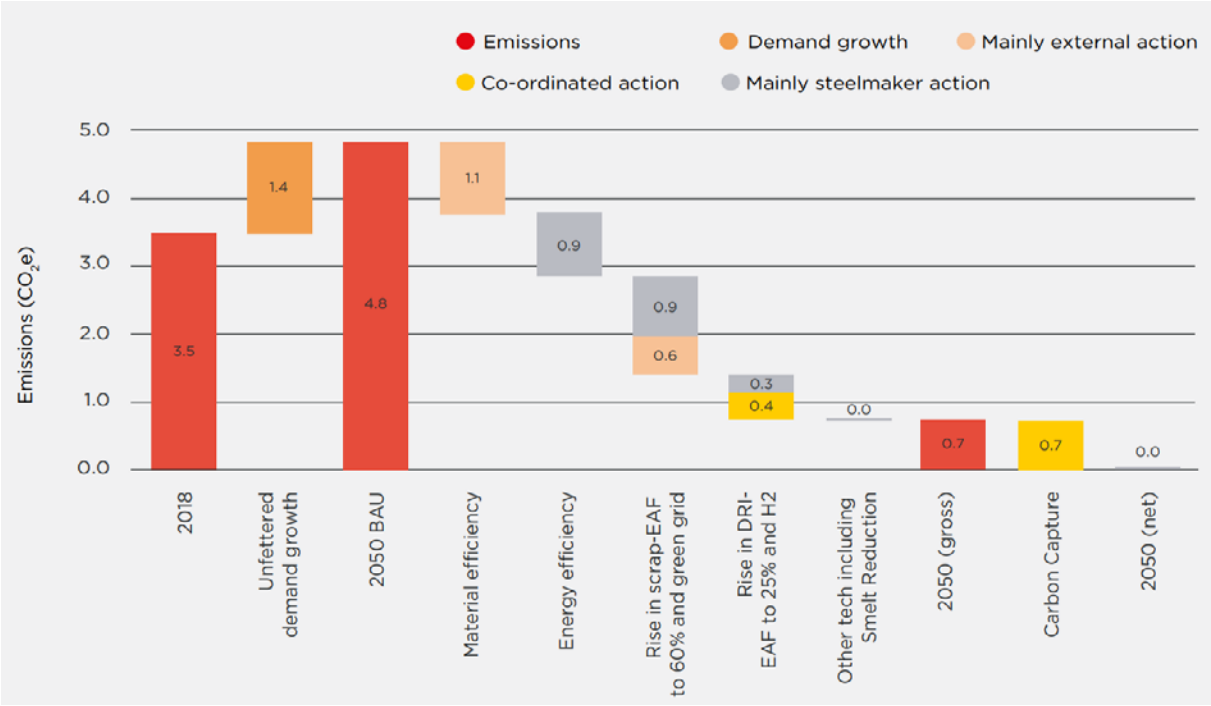


Figure 25: Major measures to reach net zero for the steel industry by 2050 and their projected contributions according to Climate Action 100+ (Gardiner & Lazuen, 2021).

Where material and energy efficiency plays a significant role in emissions reductions as well as a rise in scrap EAF utilization to 60% with a green grid. The rise in DRI-EAF to 25% and hydrogen utilization demonstrate less of an impact. The remaining emissions would need to be made up of CCUS to obtain a net zero by 2050 for the steel industry (Gardiner & Lazuen, 2021).

Constituency

The Climate Change Action 100+ was launched in December 2017 and is made up of 5 regional investor networks: Asia Investor Group on Climate Change (AIGCC), Ceres, Investor Group on Climate Change (IGCC), Institutional Investors Group on Climate Change (IIGCC) and Principles for Responsible Investment (PRI) and is supported by a global steering committee. The global steering committee establishes initiative strategic priorities, governance, and infrastructure and also reviews companies that have been subject to corporate action and decides on a case-by-case basis if they should be removed from the focus list. A technical working group brings together selected organizations that assess companies' preparedness for the transition to a net-zero emissions economy and have provided technical expertise along with company-specific research and analysis to inform initiative progress tracking. The technical advisory group is made up of the following organizations: 2 Degree Investing Initiative, Carbon Tracker, InfluenceMap, and Transition Pathway Initiative. Funding is supplied by contributions from participating partners such as CliamteWorks Foundation, Children's Investment Fund Foundation, Laudes Foundation, and Sea Change Foundation (Center for Climate Aligned Finance, 2022a).

From the steel industry at the time of writing this report 8 steel producing companies have been focused on by Climate Action 100+ and they are (Climate Action 100+, 2022b):

- ArcelorMittal S.A.
- Bluescope Steel Ltd.
- China Steel Corp.
- Nippon Steel Corp.
- POSCO Holdings Inc.
- Severtal PAO
- SSAB AB
- ThyssenKrupp AG

Signatories with Climate Action 100+ commit to the following actions:

- Implement a strong governance framework that clearly articulates the board's accountability and oversight of climate change risk;
- Take action to reduce greenhouse gas emissions across the value chain, consistent with the Paris Agreement's goal of limiting global average temperature increase to well below two degrees Celsius above pre-industrial levels, aiming for 1.5 degrees. Notably, this implies the need to move towards net-zero emissions by 2050 or sooner; and
- Provide enhanced corporate disclosure in line with the final recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) and sector-specific Global Investor Coalition on Climate Change (GIC) Investor Expectations on Climate Change guidelines (when applicable), to enable investors to assess the robustness of companies' business plans against a range of climate scenarios, including well below two degrees and improve investment decision-making (Climate Action 100+, 2022f).

The Global Sector Strategies: Investor Interventions to Accelerate Net Zero Steel was led by the IIGCC with support from the Asia Investor Group on Climate Change, Ceres, the Investor Group on Climate Change, and Principles for Responsible Investment. The work engaged with signatories and steel companies in the development of the report and solicited feedback from those groups (Gardiner & Lazuen, 2021).

Standards Development Status

Climate Action 100+ launched in 2017 at the One Plant Summit in Paris with an initial list of 100 focus companies and 225 signatories. Since then the initiative has frowned to include 700

investors with 166 focus companies that account for 80% of the world's corporate CO_2 emissions. The initiative's Net-Zero Company Benchmark was formally released in March of 2021 assessing the world's largest corporate GHG emitters on their progress in the transition to net zero. The Global Sector Strategies workstream launched in August of 2021 with the first sector, steel, being published at that time. Since then, updates have been made to the benchmarks and new rounds of assessments are released yearly (Climate Action 100+, 2022c).

4.9 IEA's Definition of Low-Carbon Steel

The International Energy Agency (IEA) published definitions for near zero steel production in their 2022 Achieving Net Zero Heavy Industry Sectors in G7 Members Report. This report focuses on the implementation of policies aimed at drastically lowering CO_2 emissions from heavy industries in G7 countries and beyond. The report summarized the numerous current standards and definitions of near-zero steel and proposed a common definition for the industry that is in line with the IEA's Net Zero Emissions by 2050 Scenario (Levi et al., 2022).

Features

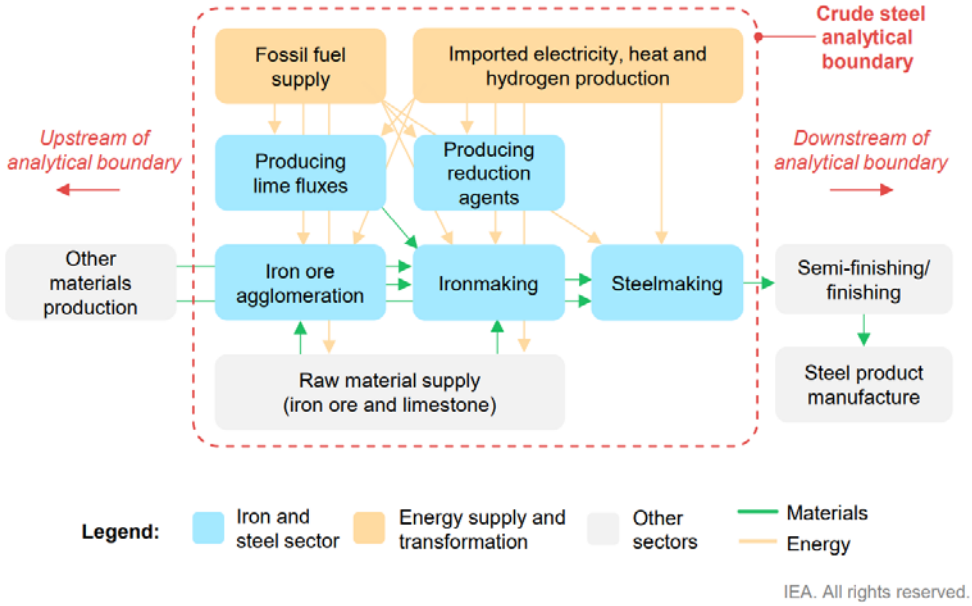
The IEA provides a product-level definition for near-zero steel emissions intensity in tonnes of CO_2 emissions per tonne of crude steel produced. The boundaries for quantifying the IEA's near-zero steel definition emissions include the direct emissions below

- Fossil fuel use in iron ore agglomeration, including any coke, coal, and natural gas that are used in the sintering and pelletizing process
- Fossil fuel use in ironmaking including fuel consumption in blast furnaces, DRI furnaces, or other iron-making processes including CCUS equipment
- Fossil fuel use in steelmaking including fuel use introduced in oxygen-blown converters and electric furnaces
- Producing reduction agent, including coke production emissions and on-site hydrogen generation emissions
- Lime fluxes and electrodes including the emissions associated with lime fluxes that form slag and remove impurities and the direct emissions associated with electric furnaces
- Off-gases include coke oven gas, blast furnace gas, and basic oxygen furnace gas when combusted directly onsite to generate heat or produce electricity

Indirect emissions within the boundary of the definition include

- Imported electricity, heat, and hydrogen including the fossil fuel emissions associated with their production
- Fossil fuel supply, including the emissions associated with their production, processing, and transportation
- Raw material supply including the emissions associated with the extraction, benefication, and transportation of iron ore or limestone

The boundary explicitly excludes the sorting and transportation of steel scrap, any further semi-fishing and finishing process and steel product manufacturing after casting, and the production processes and transport for other material inputs to the steel-making process such as the production of refractory lining for furnaces, electrodes, or ferroalloy production. Direct methane and nitrous oxide emissions are not included in the boundary. Figure 26 developed by the IEA provides a representation of the boundaries for their definition of near-zero steel (Levi et al., 2022).



Notes: "Other materials production" refers to the production of material inputs to the iron and steel sector besides iron ore and limestone, including electrodes, alloying elements and refractory linings.

Figure 26: IEA's analytical boundary for defining near zero emission steel production (Levi et al., 2022).

The IEA's threshold definition for near zero still additionally utilizes a sliding scale proportional to the percentage of scrap used in the crude steel production process discussed further below.

Targets, Pathways, and Requirements

The IEA sets an emissions threshold of 0.4 tonnes of CO_2 equivalent per tonne of crude steel for a scrap percentage equal to zero. For crude steel produced with 100% scrap steel, this threshold slides to 0.05 tonnes of CO_2 equivalent per tonne of crude steel. The IEA's definition also states that steel must utilize at least 30% scrap steel and fall underneath the constraints of the sliding scale to be considered near zero steel. In addition to the definition of near-zero steel, the IEA has also proposed a mechanism for classifying the steel product from Class A to E based on the carbon intensity of the product and the scrap utilization Figure 27 demonstrates the IEA's proposed sliding scale for defining near-zero steel and the classification system (Levi et al., 2022).

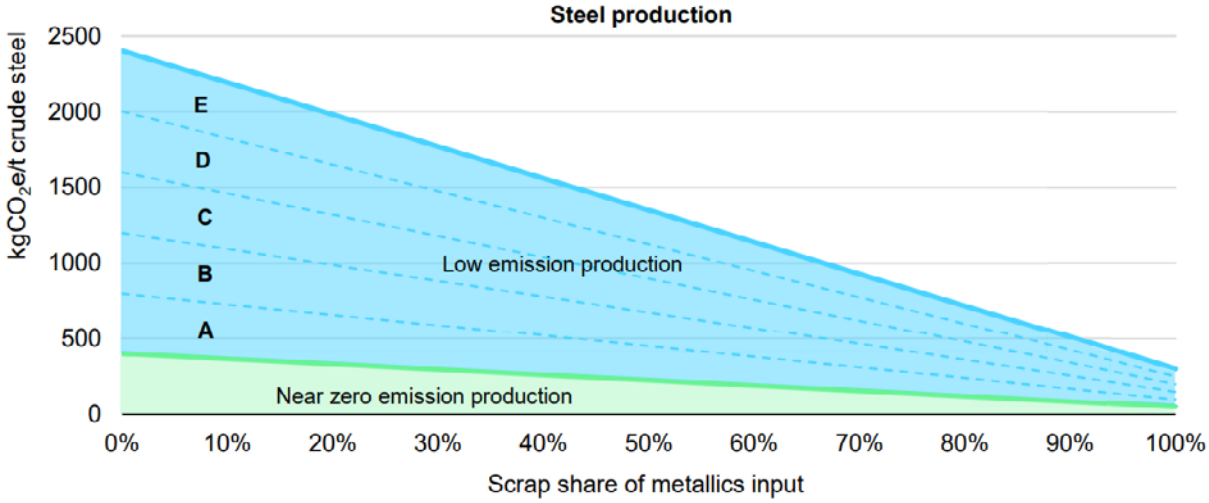


Figure 27: IEA's near zero emission crude steel production threshold as a function of scrap use and proposed classification system (Levi et al., 2022).

As the IEA has only proposed a definition for near-zero steel, there are no other requirements to meet this definition that consider other environmental or social impacts. The modeling utilized by the IEA for their definitions utilizes the GHG Protocol definitions for Scope 1, 2, and 3 emissions. The modeling is also compatible with the IPCC's guidelines and ISO standards (Levi et al., 2022).

The IEA does not grant certification of their near-zero steel definition and therefore requires no disclosure, reporting, enforcement, or quality control to meet their proposed definition (Levi et al., 2022).

However, the Global Steel Climate Council (GSCC), an international coalition of steel producers and stakeholders, has expressed concern with this methodology as they argue that this definition focuses on improvements relative to today's emissions,rather than on total emissions and say that the IEA proposal may help to stimulate decarbonization of primary steel production but does so at the expense of disguising the much greater emissions reduction delivered by scrap-based EAFs, particularly when couple with low carbon electricity (Allwood, 2022). However, it should be noted that the availability of scrap is limited and even in 2050 there is a need for 30%-40% iron ore-based primary steelmaking.

However, it should be noted that while there will be a shift towards scrap-based steel production in the coming decades for sure with scrap-route increasing up to 60%-70% of total steel production by 2050, the availability of quality scrap and the timing at which the scrap will be available in coming decades is an issue that needs to be resolved. Primary steelmaking using iron ore will always be needed and still likely to account for 30%-40% of global steelmaking by 2050; so the outcome of the absence of IEA's proposed sliding scale is incentivizing shuffling around existing scrap to maximize its use to claim credit. Given that the cost and technology challenge to get iron ore-based steelmaking to net zero is significantly higher than that for scrap-based route, we do need to incentivize primary steelmakers to get cleaner and their effort needs to be recognized.

Constituency

The IEA is made up of 31 member countries including the United States, Japan, France, Australia, and Germany with 8 association countries including China, Brazil, and South Africa. Additionally, there are 3 accession countries; Chile, Columbia, and Israel (IEA, 2022).

Standards Development Status

The definition for near zero steel was developed by the IEA internally. In the Achieving Net Zero Heavy Industry Sectors in G7 Members Report, the IEA states that the current definition for neat zero steel will serve as forming the basis for product or project-focused definition establishment in future work. At the time of writing this report, there is no public statement on changing the current definition (Levi et al., 2022).

4.10 Mission Possible Partnership's Net Zero Steel Initiative

Mission Possible Partnership's Net Zero Steel Initiative (MPP NZSI) aims to put the global steel industry on a path to net-zero by 2050 by partnering with international steel industry leaders, bringing zero-carbon primary steel production technologies to market by 2030, accelerating the growth of scrap production, focusing on supply dimensions and demonstrating how steel can contribute to a net-zero economy and ensuring no new high-carbon steel producing assets are built after 2030. To do this, MPP NZSI has set goals to convene stakeholders to drive steel decarbonization at scale, develop a net-zero by 2050 roadmap, develop statements to

the government in critical steel production geographies and consumption and provide policy positions that reflect international competitiveness challenges, develop private and public demand through collaboration with other low-emission steel initiatives, and unlock investment in low-emissions primary steel production assets (Mission Possible Partnership, 2021a, Vink, et al., 2021, Mission Possible Partnership, 2022).

Features

The Mission Possible Partnership's "Making Net Zero Steel Possible" released in September 2022 developed and utilized a model called the Steel industry Transition Strategy Model (ST-STSM) established in the Mission Possible Partnership's 2021 "Net Zero Steel industry Transition Strategy" report that calculates pathways to net-zero emissions by 2050 for the steel industry by assessing the business case for switching to new technology each time a steel plant faces a major investment decision. The model considers 20 technology archetypes and considers feedstock, fuel, energy consumption, associated emissions, and operating capital expenditures gathered from publicly available data sources. Scope 1 and 2 emissions are the primary focus of the model while also considering some Scope 3 emissions and are consistent with the boundaries utilized by the World Steel Association. The architecture of the model as well as the boundaries are included in Figures 28 and 29 (Mission Possible Partnership, 2022, Vink et al., 2021).

Targets, Pathways, and Requirements

The modeling in the Mission Possible Partnership's "Net-Zero Steel industry Transition Strategy" identifies two core scenarios on how a net zero transition could take place in the steel industry, a Technology Moratorium and Carbon Cost frameworks. The two scenarios could reduce Scope 1 and 2 emissions by 10%–33% by 2030 and 90% by 2050 with each scenario presenting different implications for steelmaking technologies, emissions, energy requirements, and financing needs that are further discussed in the report. The projected emissions up to 2050 are shown in Figure 30 along with the considerations used for each scenario in Figures 28 and 29 (Mission Possible Partnership, 2022, Vink et al., 2021).

Figure 28: The Steel Sector Transition Strategy Model (ST-STSM) architecture from Mission Possible Partnership's "Net-Zero Steel industry Transition Strategy" (Vink et al., 2021).

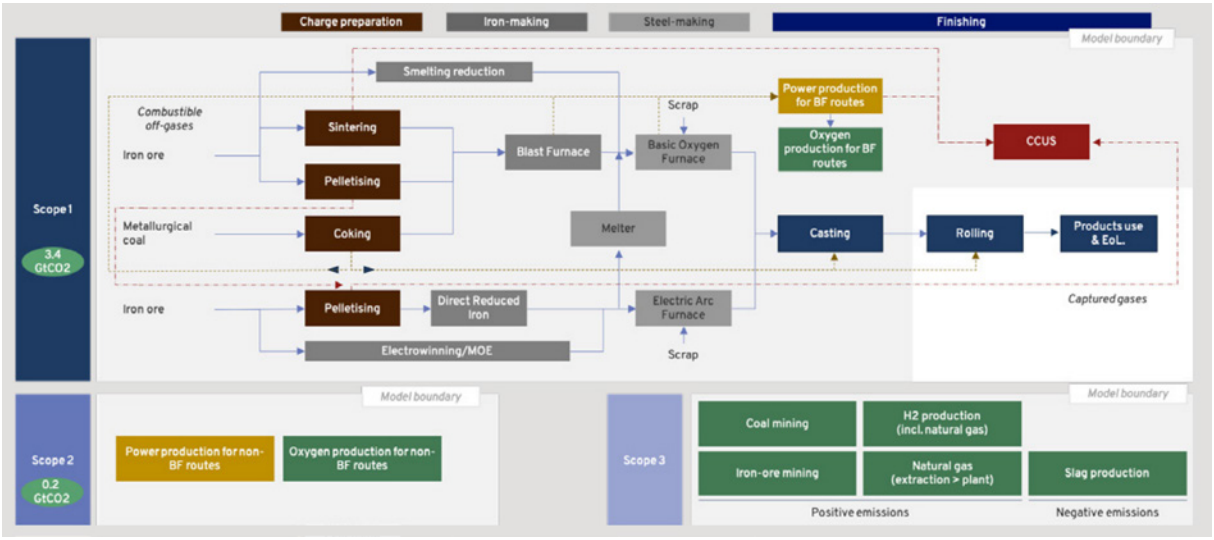


Figure 29: Scope and emissions boundaries from Mission Possible Partnership's "Net-Zero Steel industry Transition Strategy" (Vink et al., 2021).

The results of the modeling indicate that the Carbon Cost scenario has a greater impact on reducing emissions than the Technology Moratorium in the near term by reducing emissions by 33% compared to 10% by 2030. By 2050, a Carbon Cost scenario results in a net of 16 gigatons more emissions reduction than the Tech Moratorium scenario while both scenarios ultimately achieve a 90% reduction by 2050 (Mission Possible Partnership, 2022).

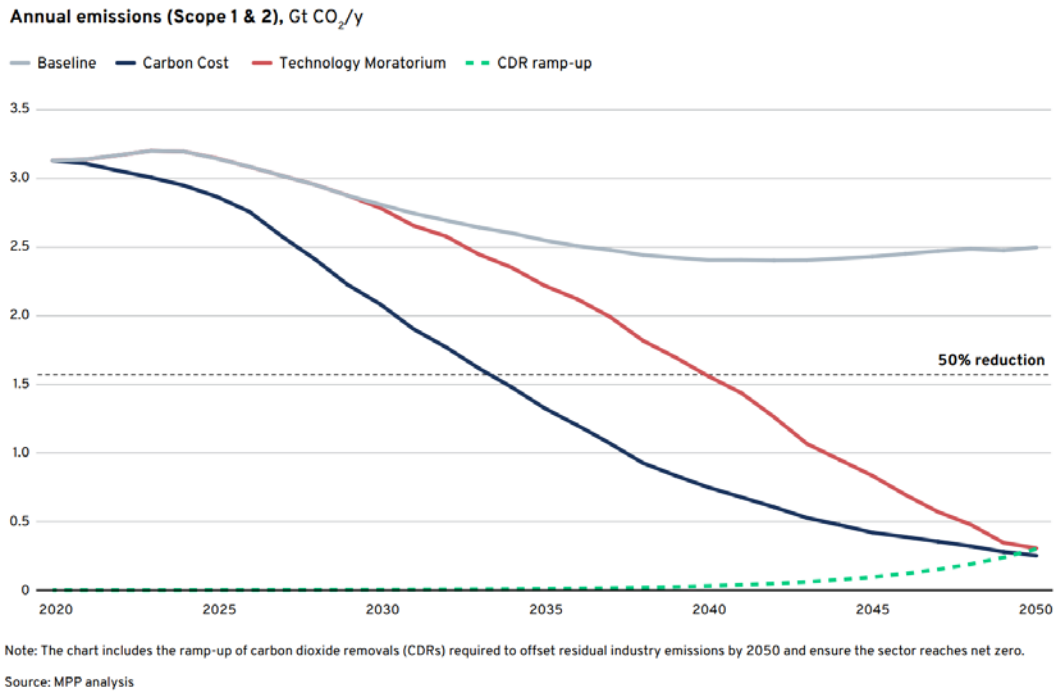


Figure 30: Steel industry carbon emissions under Carbon Cost and Technology Moratorium Scenarios from Mission Possible Partnership (Mission Possible Partnership, 2022).

Constituency

The Energy Transitions Commission, RMI, the We Mean Business Coalition, and the World Economic Forum launched the Mission Possible Partnership (MPP) in 2021 to accelerate the decarbonization of industries representing 30% of global emissions. Members of the Net-Zero Steel Initiative include ArcelorMittal, Severstal, Boston Metal, SSAB, Liberty, TATA Steel, RioTinto, and Thyssenkrupp Steel Europe AG (Mission Possible Partnership, 2021a), (Mission Possible Partnership, 2021b), (Vink et al., 2021).

Standards Development Status

The Mission Possible Partnership's "Making Net Zero Steel Possible" was developed in partnership with the Energy Transitions Commission, RMI, We Mean Business Coalition, and the World Economic Forum and was supported by ArcelorMittal, SSAB, Liberty, TATA Steel, Rio Tinto, Thyssenkrupp Steel Europe AG and others (Mission Possible Partnership, 2022).

4.11 European Union-United States Steel/Aluminum Embodied Carbon in Trade Negotiation

In October of 2021, the United States and the European Union reached an agreement to negotiate the world's first carbon-based sectoral arrangement on steel and aluminum trade by 2024 (The White House, 2021). In the agreement, an interim arrangement was set that removes the Section 232 tariffs on EU steel and aluminum products and replaces that with a tariff-rate quota under which 3.3 million metric tons of steel can enter the U.S. market duty-free in exchange for the removal or retaliatory tariffs on several U.S. goods such as bourbon and motor vehicles (Office of the United States Trade Representative, 2021; Hillman & Tippett, 2021; Allen & Tucker, 2021).

This 3.3 million metric ton will be divided up into 54 different sub-categories of steel, allocated quarterly, with individual quotas for each of the European Union's twenty-seven-member states, of which 10 are steel-producing countries. The quotas are to be filled on a first-come-first-serve basis. (Hillman & Tippett, 2021)

Leading up to the 2024 agreement timeline, both the U.S. and the EU have stated that they will establish a working group to create a common methodology for assessing the emission associated with steel and aluminum production. At the time of writing this report, however, no official definition of low-carbon steel or quotas for low-carbon steel specifically have been expressed by either country. The current agreement holds in place the tariffs imposed on steel produced in other nations like China and India. (Hillman & Tippett, 2021; Allen & Tucker, 2021).

One of the goals of the agreement is to restrict or disincentivize access to higher emission-intensity steel from countries outside of the U.S. and EU due to the lower emission intensity of steel produced in the U.S. and EU. The U.S. and EU have higher utilization of EAF technologies, generally, lower emitting electricity grids, and utilizing cleaner burning fuels than some foreign steel producers.

The agreement also aims to prevent the dumping of low-cost, high-emitting steel products from some of these foreign nations. Additionally, the hope of the agreement is to send a signal and drive investment in low-carbon steel production in the US, EU, and the world (The White House, 2021; Office of the United States Trade Representative, 2021; Hillman & Tippett, 2021; Allen & Tucker, 2021).

5 Low-Carbon Steel in National and Regional Policies

There are other steel industry decarbonization policies in these countries and regions discussed below which are not included in our discussion explicitly. This analysis mainly focuses on GPP in countries and regions where they exist as an example of how low-carbon steel is defined in those policies. The purpose of this review was not to include every steel decarbonization policy however a sample of the steel industry decarbonization policies employed in different countries is briefly included.

5.1 European Union Green Public Procurement and Other EU-Level Standards

Collectively the European Union's 27 member countries have the 2nd largest production volume of crude steel in the world with the emissions intensity of crude steel products at approximately 1.3 tons of CO_2 per ton of crude steel (Hasanbeigi, 2022). It is estimated that 5% of the EU's emissions are from the steel industry. The EU steel industry has halved emissions since 1960 with a goal to reduce to 80-95% by 2050 compared to 1990 levels with hydrogen-based steel production as the primary methodology as well as DRI carbon capture technologies and Electric Arc Furnace (EAF) technology (EU Science Hub, 2022).

Within the EU, public procurement accounted for 2.3 trillion euros at approximately 19% of GDP in 2018. The majority of EU member states have adopted a voluntary approach to GPP; however, Austria, the UK, and the Netherlands have introduced mandatory green procurement for their central governments. In France, green procurement is mandated for selected product

groups. Voluntary approaches tend to be more common in decentralized countries, leaving as much autonomy as possible to the sub-central government level (Hasanbeigi et al., 2019).

The EU GPP criteria are based on available scientific information and data (including eco-labeling), a life-cycle approach, and stakeholder engagement. The EU criteria contains two levels of stringency: which is designed for ease of use while reducing key environmental concerns, and comprehensive criteria, which are more ambitious requirements for agencies that want to go further in supporting environmental and innovation goals the EU has set a voluntary target of at least 50% of procurement following GPP criteria. Many countries have set their own targets, ranging from as low as 20% in Poland to less than 50% in France and Latvia to as high as 100% in the Netherlands. In some countries, green procurement's scope and targets have not been set (Hasanbeigi et al., 2019).

For the steel industry, GHG emissions are regulated through the EU Emissions Trading System (EU ETS) however the steel industry has historically been receiving a free allocation of emission allowances to prevent carbon leakage. Before 2010, the EU steel industry largely focused on energy efficiency and marginal emissions reductions however several programs such as Horizon 2020, Horizon Europe, NER300, and the Innovation Fund have increased efforts to implement technological innovation to reduce emissions within the EU steel industry after 2010 (Vogl et al., 2020). Figure 31 provides a breakdown of EU programs supporting the decarbonization of the steel industry however GPP for steel is not specifically outlined across the EU.

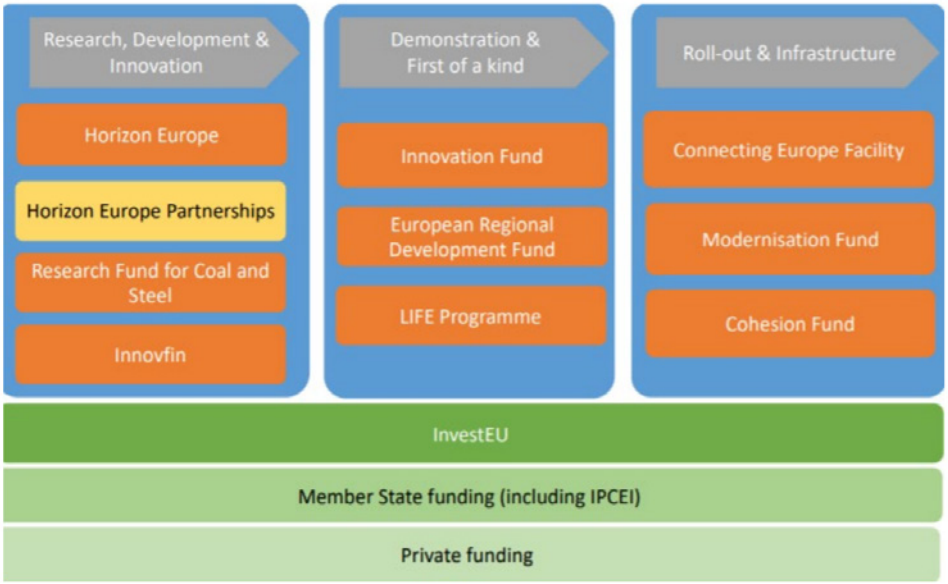


Figure 31: EU programs supporting the decarbonization of the steel industry (Opinska et al., 2021).

Features

The European Union supports the use of project-level analysis in GPP criteria based on a point system. Points can be awarded based on the improvement of life cycle assessment (LCA) performance in comparison with business as usual or competing designs. A weighting system is applied to combine various LCA indicators including global warming potential (GWP), depletion potential of the stratospheric ozone layer (ODP), and acidification potential of soil and water (AP) into an overall score. In the absence of an LCA, the GWP from a carbon footprint (CF) assessment can be used. In the absence of both, points can be calculated from proxy data such as the reduction of CO_2 equivalent emissions from the transportation of materials

and recycling of demolition waste (European Commission 2022). Environmental product declarations (EPDs) are also a key source of this information and serve as a reporting mechanism for product-level emissions intensity for steel products. EU is leading the way in EPD development and utilization globally (Hasanbeigi et al., 2019), (Hasanbeigi et al., 2021).

Within the EU, The Netherlands has the most robust GPP system covering 45 product groups and monetizes the environmental impacts of their production. A software program called DuboCalc quantifies the life cycle environmental effects of materials and energy that are used to then compute an environmental cost indicator. In this system, procurers can set a maximum cutoff for this indicator above which a supplier becomes ineligible or procurers can subtract a monetized value below the standard from the bids. The Netherlands also utilizes a five ranged CO_2 performance ladder for products such as steel and subtracts a monetized value from a big based on the rung classification of the material (Krupnick, 2020).

5.2 United States Federal Buy Clean Initiative

The United States was the world's 4th largest producer of crude steel in 2021 and is the 7th largest total emitter of CO_2 of steel-producing nations. The emissions intensity of U.S. steel production is ranked the 2nd lowest among major steel-producing countries, behind Italy, at approximately 0.9 tons of CO_2 emissions per ton of crude steel produced. The significant share of scrap-based EAF steel production in the U.S., the high rate of utilization of natural gas as fuel, and the lower carbon electric grid in the U.S. are attributed to the U.S.'s lower emissions intensity (Hasanbeigi, 2022). Despite the domestic low-carbon steel production in the U.S., it is the world's largest importer of steel and imported 26.3 million metric tons of steel in 2019 down 15% from 30.8 million in 2018. Of these imports approximately 50% came from Canada, Brazil and Mexico combined (Steel Imports Report: United States, 2020). In 2018, approximately 25% of the U.S.'s total steel consumption of 101 million metric tons was imported (Hasanbeigi et al., 2021).

To spur the development of low-carbon construction materials made in America the Biden-Harris administration announced the Federal Buy Clean Initiative in September of 2022. The initiative will prioritize the purchase of key low-carbon construction materials covering 98% of the materials purchased by the U.S. Federal Government. Which, steel, glass, concrete, and asphalt material production in the U.S. account for 50% of industrial emissions. The Federal Buy Clean Initiative includes the Bipartisan Infrastructure Law, Inflation Reduction Act, and the CHIPS and Science Act all aimed at increasing low-carbon manufacturing in the U.S.. The initiative builds on the Buy Clean commitments made by the administration earlier in 2022 which included standing up the Federal Buy Clean Task Force (The White House, 2022).

The U.S. Federal government is the largest direct purchaser in the world and in the U.S. approximately 18% of the total nation's steel consumption was utilized in public construction projects in 2018. (The White House, 2022) (Hasanbeigi et al., 2021). In the U.S., public procurement accounts for 12% of the GDP, and 18% of the nation's emissions can be attributed to public construction projects. It is estimated that the Buy Clean Initiative could directly reduce 2-10 million tons of CO_2 emissions from the steel industry alone with potentially double the indirect emissions reductions as U.S. steel manufacturing companies decarbonize to meet federal government project demands (Hasanbeigi et al., 2021).

Features

The Federal Buy Clean Initiative is focused on steel, concrete, asphalt, and flat glass and has several key features outlined below:

Prioritizing the purchase of materials that have lower levels of emissions

The Federal Government will purchase key construction materials when they have fewer GHG emissions associated with their manufacturing, transportation, installation, maintenance, and disposal. The Buy Clean Task force will provide instructions to agencies for integrating Buy Clean into federal procurement and funding processes (The White House, 2022).

Expanding lower-carbon construction materials used in federally funded projects

Buy Clean will also cover federally funded projects in addition to federal procurement. Under Buy Clean the Department of Transportation is developing an agency-wide Buy Clean policy and establishing an Embodied Carbon Work group (The White House, 2022).

Convening states to partner on Buy Clean

The Initiative is partnering with Federal and State governments to align state-based Buy Clean policies with federal incentives to expand the market for clean manufacturing. The partnership aims to share knowledge and build capacity for public construction projects that support U.S. manufacturing and lower carbon emissions (The White House, 2022).

Increasing data transparency through supplier reporting to help track and reduce emissions

The administration will expand the reliability, transparency, and verification of environmental product declarations (EPDs) including GHG emissions reporting for the supply chain production of these materials. The Initiative is partnering with the Environmental Protection Agency (EPA) and providing $100 million for program costs and $250 million for grants and technical assistance (The White House, 2022).

Launching pilot programs to advance federal procurement of clean construction materials

Pilot programs under the Buy Clean Initiative have been launched across the U.S. in partnership with regional contractors and subcontractors including engineering, architecture, and material firms. The pilot programs are also receiving technical support from the Department of Energy (DOE), EPA, and the United States Department of Agriculture (USDA) (The White House, 2022).

Targets, Pathways, and Requirements

Under the Buy Clean Initiative, the Buy Clean Task Force is developing a recommendation on policies and procedures to expand consideration of embodied emissions and pollutants of materials in federal procurement and funded projects. The group is identifying materials and pollutants to prioritize for consideration in Federal procurement and projects. Additionally, the group is working to increase the transparency of embodied emissions of products through supplier reporting and includes incentives and technical assistance to help U.S. manufacturers better report and reduce embodied emissions of their products (Federal Buy Clean Initiative | Office of the Federal Chief Sustainability Officer, 2021).

Constituency And Development Status

Established under Executive Order (E.O.) 14057 on Federal Sustainability, the Buy Clean Task Force is co-chaired by the Federal Chief Sustainability Officer and the White House Office of Domestic Climate Policy The Task Force includes representatives from the Departments of Commerce, Defense, Energy, Homeland Security, Housing and Urban Development, Health and Human Services, Interior, State and Transportation; the Environmental Protection Agency; the General Services Administration; the National Aeronautics and Space Administration; the

Veterans Administration; the White House Office of Management and Budget; and the White House Domestic Climate Policy Council. Together, the Task Force agencies account for 90% of all federally-financed and purchased construction materials. (Federal Buy Clean Initiative | Office of the Federal Chief Sustainability Officer, 2021).

5.3 California Buy Clean Program and Other U.S. States

There have been several green public procurement (GPP) initiatives set forth at the federal level in the United States including Executive Orders 13423 in 2007 and 13514 in 2009. These orders largely support the acquisition of materials that are biobased, environmentally preferable, energy efficient, water efficient, and include recycled content. The primary focus of the orders however is on utilizing 30% recycled content in paper products and requiring 95% of electronics procured to be ENERGY STAR labeled (Hasanbeigi et al., 2019), (U.S. EPA, 2021). At the federal level, the CLEAN Future Act has been drafted to expand GPP programs and was introduced in March of 2021 but has not yet been voted on. A more detailed discussion of the CLEAN Futures Act and he U.S Federal Buy Clean Initiative can be found in their respective section of this report. (CLEAN Future Act, 2021).

The state of California is a leader in establishing state green building regulations and standards for the United States of America and provides a model for other jurisdictions considering embodied carbon regulations discussed in more detail below (Hasanbeigi et al., 2019). At the time of writing this report, New York, Washington, and Oregon are the only other states working to pass major GPP legislation (Krupnick, 2020).

Features

The Buy Clean California Act focuses on structural steel, carbon steel rebar, flat glass, and mineral wool insulation products and instructed state agencies to request bidders to provide environmental product declarations (EPDs) that state the environmental performance of a product through a life cycle assessment of that product for all state-funded building products. Successful bidders are required to submit facility-specific EPDs for the project in 2019. For the structural steel industry specifically hot-rolled sections, hollow structural sections, plate, and concrete reinforcing steel must meet a global warming potential (GWP) threshold to be used in the project and must have an independently certified EPD in 2020 and 2021. Emissions included within the boundary are those associated with the production of the steel at a given facility and do not include the upstream emissions or the downstream emissions such as fabrication. The thresholds are planned to be ratcheted down over time but there are no explicit statements in the activities that focus on the utilization of scrap materials in the steel production process (Hasanbeigi et al. 2019; Krupnick, 2020; Mantle Developments, 2021).

Targets, Pathways, and Requirements

The thresholds for GWP for steel products under the Buy Clean California Act came into effect in July of 2021 and are outlined below on a 1 metric ton of steel basis (Mantle Developments, 2021).

Table 9: GWP thresholds for steel products under the Buy Clean California Act (Mantle Developments, 2021).

Steel Type	Limit (metric tons CO_2 equivalent)
Hot-rolled sections	1.44
Hollow structural sections	2.83
Plate	2.12
Concrete reinforcing steel	1.06

These thresholds were calculated as an average value collected over two years plus a tolerance to account for uncertainty set a 35%, 20%, and 15% for hoot rolled sections and plates, hollow structural sections, and concrete reinforcing steel respectively (Mantle Developments, 2021)

To be considered a valid EPD, the EPD must be

- From a facility-specific manufacturer
- Independently verified in accordance with ISO 14025 (Type III environmental declarations – Principles and procedures)
- Developed according to the guidelines of the applicable Product Category Rule (PCR) as identified by DGS
- Validated by a date that has not expired
- Represented as an eligible material (Mantle Developments, 2021).

Standards Development Status

The current framework for the Buy Clean California Act began in 2012 with an amendment to the California Green Building Standards Code (CALGreen) that includes an optional life-cycle assessment pathway that requires emissions reduction against a baseline along with several performance measures related to energy efficiency. This pathway is an alternative to prescriptive requirements for materials selection. Building projects can use CALGreen to pursue other sustainability initiatives such as LEED (Hasanbeigi et al., 2019).

In October 2017, California passed Assembly Bill (AB) 262, the Buy Clean California Act, a new law requiring state-funded building projects to consider the global warming potential (GWP) of certain construction materials during procurement. The bill requirements are two-pronged: manufacturers of eligible materials must submit facility-specific EPDs, and the eligible materials must demonstrate (through submitted EPDs) GWP below the product-specific compliance limits defined by the state Department of General Services (DGS), which will regulate policy implementation. The eligible materials include structural steel, carbon steel rebar, flat glass, and mineral wool insulation. An amendment (Assembly Bill 1817) to the original Buy Clean California Act Curbing Carbon from Consumption: The Role of Green Public Procurement 68 passed in June 2018, extending the timeline for compliance (USGBC website). Further development of the Act was discussed above and includes 2019, 2020, and 2021 updates to the Act (Hasanbeigi et al., 2019).

The Buy Clean California Act thresholds are planned to be reviewed again in 2024 and reset. The thresholds will be decreased progressively and are planned to be updated every 3 years (Mantle Developments, 2021).

5.4 Canada Green Public Procurement

Canada is the world's 15th largest producer of crude steel with the emissions intensity of steel produced at approximately 1.2 tons of CO_2 per ton crude steel. It has the 5th lowest average carbon intensity of steel production among major steel producing countries (Hasanbeigi, 2022b).

Canada spent approximately CA$ 218 billion (13% of GDP) on public procurement in 2020 and its large-scale purchasing power gives the government leverage in driving markets towards the development of low-carbon goods and services. In Canada, some elements of Buy Clean policy are already in place and 29% of public procurement was spent on steel products in 2018. The federal Greening Government Strategy announced in 2017 established a goal of net-zero emissions by 2050, including the procurement of goods and services. The government will reduce embodied carbon by 30% starting in 2025 through the use of recycled and lower-carbon materials including steel, material efficiency, and performance-based design standards, and conduct a whole building life-cycle analysis by 2025 for major projects. In service of this, the government is building a repository of reliable emissions data through the Low Carbon Assets through Life Cycle Assessment (LCA^2) initiative (Hasanbeigi et al., 2022b).

The Canadian Steel Producers Association (CSP) members pledged to achieve net zero CO_2 emissions for the sector by 2050 and the sector has already reduced emissions by 25% compared to 1990 levels(CIPEC News, 2021). The Canadian government has additionally provided support to the sector in these goals by investing CAD 400 million in 2021 in ArcelorMittal's Direct Reduced Iron (DRI) – Electric Arc Furnace (EAF) project at their facility in Hamilton, Ontario which will reduce emissions from the steel production process by up to 60% (ArcelorMittal, 2021).

In 2021-2022, Canada also approved a CAD 1.3 billion project called the Buyers for Climate Action (BCA) that aims to establish a coalition of large green buyers to accelerate green procurement and supplier disclosure in areas such as net zero and climate-resilient buildings, low carbon construction materials, zero-emission fleets, and green information and communications technology (ICT) (Government of Canada, 2020). Canada additionally utilizes a carbon tax that has encouraged the steel industry to reduce its emissions (Marowits, 2021).

Features

Canada's LCA^2 initiative has announced that it will develop important outputs that create a science-based approach to support the selection of materials and designs that offer the lowest carbon footprint while offering the lowest total cost of ownership. The outputs from this work will include infrastructure-specific LCA guidelines/tools, related procurement specifications, low carbon benchmarks, and a Canadian life cycle inventory (LCI) database. The initiative is focused primarily on buildings and at the time of writing this report so far, Canada has published the "National Guidelines for Whole-Building Life Cycle Assessment" in August of 2022.

Within these guidelines, the utilization of the wbLCA data provides the emissions intensity of steel products in construction and can account for scrap use in that steel product. The wbLCA data set is intended to capture the full life cycle impact of a specific product. Environmental product declarations (EPDs) can also be utilized under this system and where an EPD does not account for the full life cycle ISO 21930:2017 Clause 5.5 provides details on the conditions that must be met before using that EPD in the LCA. At a minimum, the LCA for a project should report the global warming potential, acidification potential, eutrophication potential, smog potential as well as non-renewable primary energy. Full details of the required LCA methodology can be found in the cited guidelines (Canada, 2019; Bowick et al., 2022).

Constituency

Canada LCA[2] initiative is led by Canada's Natural Resource Council (NRC) and is managed collaboratively with the NRC's Energy, Mining, and Environmental Research Centre and the Construction Research Centre. The initiative is being conducted through a collaboration between other federal departments, academia, non-government organizations, industry partners, and low-carbon asset experts (Canada, 2019).

5.5 China's National-Level and Industry-Led Initiatives

China accounted for 53% of global steel production in 2020 and is the largest producer of crude steel in the world and accounts for 54% of the industry's global emissions. The emissions intensity of Chinese steel is the third highest of any nation, second only to India and Ukraine, at 1.9 tons of CO_2e per ton of crude steel produced. China is also the 5th largest exporter of steel, exporting approximately 13.5 million tons in 2020. China's large share of primary steelmaking using BF-BOF (90% of total steel production) and a substantial utilization of pig iron and coal-based DRI as feedstocks to EAF instead of scrap contributes to high emissions intensity of steelmaking in China compared with most other major steel-producing countries (Hasanbeigi, 2022). In 2020, China publicly committed to its steel production CO_2 emissions peaking in 2030 and reaching net zero by 2060 (Hu, 2020).

National Initiatives

China has developed 24 industry and enterprise greenhouse gas emission accounting methods and reporting guidelines, 11 of which have been converted into national standards. Standards for the steel industry were first issued in 2015 followed by the promotion of ultralow emissions standards in 2019 (Guangming, 2022). These standards currently focus on decreasing particulate matter, sulfur dioxide, and nitrous oxide pollutants. China's continuous emissions monitoring system covers 70%-90% of the nation's iron and steel production facilities. The Chinese government stated that 80% of the nation's steel capacity should be upgraded to meet the ultralow emissions standards by 2025 although only about 30% have done so as of November 2020.

The implementation of these standards has led to significant pollution reduction. Bo et al (2021) shows that between 2014 to 2018, particulate matter and Sulphur dioxide emissions fell 47% and 42% respectively while nitrous oxide pollution only rose 3% total despite increased production by 14% (Bo et al., 2021). Continued adherence to these national standards is expected to be met through the higher adoption of EAFs, increased scrap utilization, and utilization of low-carbon fuels (e.g. green H2). All of which have currently been plagued by high costs of electricity, scrap collection, and hydrogen (Hu, 2020).

In 2021, China issued a cap on steel production mandating a no year-on-year increase in steel production compared to 2020 and also reduced steel production by removing tax rebates on exports of cold-rolled sheets, color-coated coils, hot rolled coils, high alloyed rebar, seamless pipes, stainless steel sheets, and plates. Taxes on pig iron exports were raised while scrap exports remained unchanged. The Chinese government has also pushed for increased scrap utilization in steel production as well as supply. The target for scrap utilization in Chinese-produced steel is set to raise from 10% in 2020 to 30% by 2025 (Zhong, 2022).

In August of 2022, China's National Development and Reform Commission, the National Bureau of Statistics, and the Ministry of Ecology and Environment jointly issued the "Implementation Plan for Accelerating the Establishment of a Unified and Standardized Carbon Emission

Statistical Accounting System" that will apply to the nation's steel industry. The proposed system aims to promote the establishment of a scientific, unified, and standardized carbon emission statistical and accounting system in China, consolidate the carbon emission data foundation, and improve the quality of carbon emission data (Guangming, 2022).

China has also released the Green Bond Principles in 2022 that establish a unified standard for green bond issuance that requires 100% of the funds to go towards the green project. The bonds may follow the Common Ground Taxonomy, developed by China and the EU, and the EU Taxonomy Climate Delegated Act and establish a domestic green bond issuing catalog (Yifan, 2022).

Industry Led Initiatives

China's four leading steel companies, China Baowu Group, HBIS Group, Ansteel Group, and Baotou Steel Group have all announced roadmaps to decarbonize their steel production by 2050 with HBIS Group and China Baowu Group pledging to peak emissions in 2022 and 2023 respectively (Zhong, 2022). China Baowu Group, the world's largest steel producer, has committed to reducing carbon emissions by 30% in 2035 compared to 2020 (China Baowu, 2021). HBIS group has pledged to reduce peak carbon emissions by 10% and reduce carbon emissions by 30% in 2030 (Hegang Group, 2022). Several hydrogen-based DRI projects have also been announced by HBIS Group and China's 2nd largest steel producer, Jianlong Group. The China Iron and Steel Association (CISA) created a Low Carbon Steering Committee in 2021 with steel producers, universities, and research institutes, to organize training sessions on carbon emissions reductions and set up relevant industry standards for lowering carbon emissions (Zhong, 2022).

GPP In China

China's GPP program prioritizes the following environmental and related goals: reducing air pollution, mitigating climate change, conserving energy, reducing hazardous substance use, protecting human health, protecting local environmental conditions, protecting natural resources, using resources efficiently, protecting soil, minimizing waste, conserving water, and reducing water pollution.

GPP applies to all national, state/regional, and local public authorities. Central government institutions formulate the policy framework, and sub-central government entities procure supplies and services in accordance with the policies. All central government agencies are required to procure the products identified in the nine categories on the Energy Conservation Products (ECP) list. Products in other categories can be voluntarily procured from the ECP or environmental labeling products (ELP) list. In addition to governmental agencies at all levels, institutions and organizations that use public funds for procurement are required to prioritize purchasing products on China's ELP and ECP lists

China has the largest total number of products certified for GPP – more than 93,000 products in 44 categories. 29 percent of all national-level public procurement followed China's GPP regulations. Of that, 80 percent was the procurement of energy-efficient and environmental labeling products. In terms of market impacts, the introduction of the ELP and ECP policies appears to have contributed to a significant increase in the number of companies manufacturing certifiable products. 14% of total governmental procurement expenditures in 2011 were on green products and services. Currently, however, there is no specific GPP requirement for steel products in China (Hasanbeigi et al., 2019).

5.6 Japan's National-Level and Industry-Led Standards

Japan has announced goals to achieve carbon neutrality by 2050 where steel production currently makes up for 15% of the nation's total GHG emissions. Japan is the 4th largest

steel-producing nation in the world (Renewable Energy Institute, 2021). Despite the progress in Japan's GPP programs discussed below, the nation's steel industry has one of the highest emissions intensities per ton of steel produced with approximately 1.8 tons of CO_2e per ton of crude steel (Hasanbeigi, 2022). Japan has recognized this however and in 2021 set GHG emission reduction targets to reduce to 46% of 2013 levels by 2030 and carbon neutrality by 2050 (Renewable Energy Institute, 2021). Additionally, the Japan Iron and Steel Federation (JISF) adopted the Japanese Industrial Standard "Life Cycle Inventory Calculation Methodology for Steel Products" (JIS Q 20915) in 2019 which mirrors ISO 20915 to further support decarbonizing the nation's steel production (The Japan Iron and Steel Federation, 2021).

Japan is the pioneer, both in Asia and the world, in developing a GPP framework. Japan's policies and regulations to promote and implement GPP has been in place since the late 1980s, starting with the Eco Mark environmental labeling program.

The first edition of the "Basic Policy for the Promotion of Procurement of Eco-Friendly Goods and Services" (Basic Policy on Promoting Green Purchasing or Green Purchasing Law) appeared in 2001; the most recent version appeared in 2016. The law requires that government agencies apply green purchasing criteria when procuring products in a wide array of categories.

Japan's "Basic Policy concerning the Promotion of Contracts considering reduction of GHG Emissions by the State and Other Entities" (Basic Policy on Promoting Green Contract or Green Contract Law) was adopted in 2007 with the most recent revision in 2014 and compliments the Act on Promoting Green Purchasing. This law requires government agencies and public institutions to follow green contracting requirements when purchasing electric power, automobiles, energy services, or building design services.

Following the 2001 adoption of the Act on Promoting Green Purchasing, the market share of environmentally friendly products increased in Japan. GPP is estimated to have reduced GHG emissions by 210,000 tons of CO_2 equivalent. Japan's green procurement list includes 246 items in 19 product categories (Hasanbeigi et al., 2019).

Japan's Ministry of Economy, Trade, and Industry (METI) developed a Carbon Neutrality Plan for the Japanese Steel Industry in 2020 which is a multitrack approach to develop ultra-innovative technologies that will help the Japanese steel industry achieve carbon neutrality by 2050. The plan focuses on several key methods such as expanding the use of scrap, energy efficiency, EAFs, ferro-coke utilization, hydrogen utilization in steel making, and CCUS (JFE Steel Corporation, 2022). In May 2021 METI worked with the Ministry of Environment (MOE) and Financial Services Agency (FSA) to develop the "Basic Guidelines on Climate Transition Finance" and the Technology Roadmap for Transition Finance in the Iron and Steel industry" in October of 2021 that both promote financing for projects to decarbonize large CO_2 emitting industries in Japan like steel (Ministry of Economy, Trade, and Industry, 2022). Within Japan's steel industry, JFE Steel Corporation (JFE), Japan's 2nd largest steel producer, was a recipient of one of the bonds with funding from Japan's $17.6 billion Green Innovation Fund to support the development of super-innovative steel production processes, energy saving efforts, and efficiency improvement (Ministry of Economy, Trade, and Industry, 2022).

JFE released its Carbon Neutrality Briefing in September of 2022 including a Carbon Neutrality Action Plan in which JFE is introducing low carbon steel processes during its transition period to 2030, reducing emissions by 30% and accelerating its decarbonization efforts through an innovation period to 2050 through R&D and implementation of ultra innovative technologies (JFE Steel Corporation, 2022).

In 2022, Japan's METI and the Japan Exchange Group (JPX) also announced plans to establish the nation's first market for trading CO_2 emissions that will start in 2023. The plan requires participants to set emission reduction targets by 2030 with surplus reductions being certified as carbon credits. 440 Japanese companies have expressed willingness to participate including Nippon Steel (Yuasa & Matsumoto, 2022).

Features

JIS Q 20615 defines the functional unit for the LCA of Japanese steel as one kg of steel product at the factory and includes all activities within the steelworks and the main upstream processes including production and transportation of raw materials, energy sources, scrap recycling, and consumable materials used at steelworks. Outside of the boundary are the assembly and manufacture of final products, and their use. Figure 32 illustrates the system boundaries under JIS Q 20615 (The Japan Iron and Steel Federation, 2021; The Japan Iron and Steel Federation, n.d.).

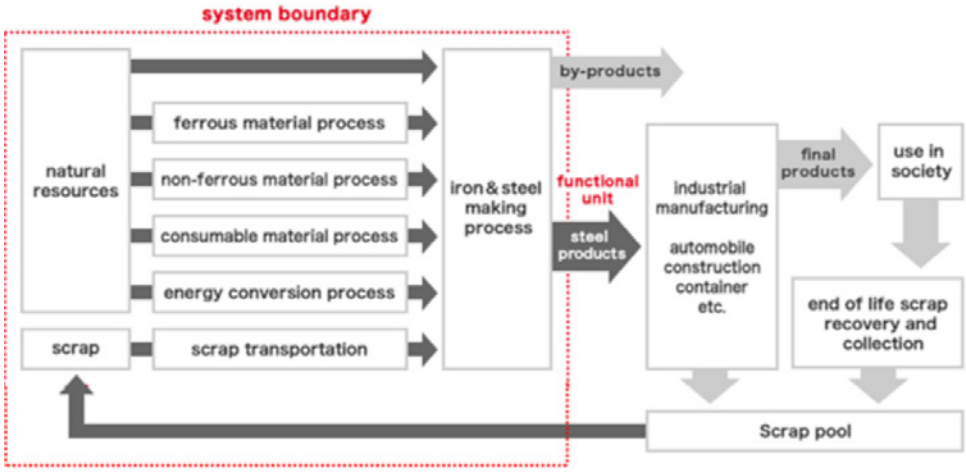
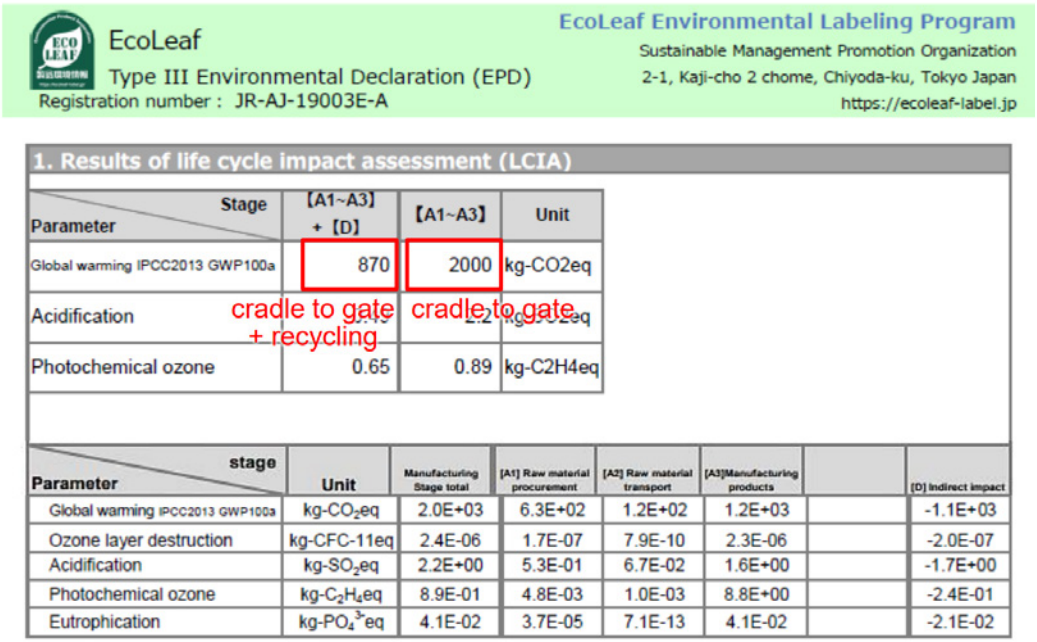


Figure 32 System boundary under JIS Q 20615 (The Japan Iron and Steel Federation, n.d.).

The JISF developed the Product Category Rules (PCRs) for all steel products in order to comply with the EcoLeaf environmental labeling certification Program of the Japan Environmental Management Association for Industry (JEMAI). In 2019 the PCR was approved covering steel products and secondary steel products for construction and non-Construction use. An example of this label is shown below in Figure 33 which highlights scrap utilization in the products (The Japan Iron and Steel Federation, 2021; n.d.-a).



EcoLeaf
Type III Environmental Declaration (EPD)
Registration number : JR-AJ-19003E-A

EcoLeaf Environmental Labeling Program
Sustainable Management Promotion Organization
2-1, Kaji-cho 2 chome, Chiyoda-ku, Tokyo Japan
https://ecoleaf-label.jp

1. Results of life cycle impact assessment (LCIA)

Parameter \ Stage	【A1~A3】+【D】	【A1~A3】	Unit
Global warming IPCC2013 GWP100a	870	2000	kg-CO2eq
Acidification	2.15	2.2	kg-SO2eq
Photochemical ozone	0.65	0.89	kg-C2H4eq

cradle to gate + recycling

cradle to gate

Parameter \ stage	Unit	Manufacturing Stage total	[A1] Raw material procurement	[A2] Raw material transport	[A3]Manufacturing products		[D] Indirect impact
Global warming IPCC2013 GWP100a	kg-CO_2eq	2.0E+03	6.3E+02	1.2E+02	1.2E+03		-1.1E+03
Ozone layer destruction	kg-CFC-11eq	2.4E-06	1.7E-07	7.9E-10	2.3E-06		-2.0E-07
Acidification	kg-SO_2eq	2.2E+00	5.3E-01	6.7E-02	1.6E+00		-1.7E+00
Photochemical ozone	kg-C_2H_4eq	8.9E-01	4.8E-03	1.0E-03	8.8E+00		-2.4E-01
Eutrophication	kg-PO_4^{3-}eq	4.1E-02	3.7E-05	7.1E-13	4.1E-02		-2.1E-02

Figure 33: Japan's EcoLeaf label for steel products example (The Japan Iron and Steel Federation, 2021).

Japan maintains an Eco-Products database of information about products and services and their rating under the Green Purchasing Guidelines that the EcoLeaf label obtaining products can be listed under (The Japan Iron and Steel Federation, 2021; Hasanbeigi et al., 2019).

Targets, Pathways, and Requirements

Individual government agencies and public institutions develop and implement their own procurement policies, evaluate implementation, and report performance to the Minister of the Environment. Certification bodies and non-governmental organizations (NGOs) provide information about certification criteria and environmentally friendly products and services for both consumers and suppliers (Hasanbeigi et al., 2019). For the steel industry, there are currently no direct requirements for GPP and no direct target for scrap use or steel emissions intensity set at a national level. The JISF has set a target for the nation's steel industry however to reduce production process emissions by 30% by 2050 (The Japan Iron and Steel Federation, 2018).

Disclosure, Reporting, and Quality Control

According to the JISF, for a company to obtain EcoLeaf certification for its steel products, the company will be required to quantify and disclose the environmental impact of steel products through the LCA process, reflecting recycling effects (The Japan Iron and Steel Federation, 2021).

Japan's Ministry of Environment (MOE) monitors decentralized GPP activities. Procuring agencies report their purchases to a central body annually. This office compiles the data and estimates the GHG emissions reduction using the share of green products purchased and the difference between the average emissions of a green product and a conventional one (Hasanbeigi et al., 2019).

Constituency

Public procurement in Japan is decentralized, with each ministry or department carrying out its own activities; there is no central procurement agency managing GPP. All central

government ministries, 47 prefectural governments, and Japan's 700 cities are subject to GPP policies. GPP is mandatory for all central government and incorporated administrative agencies. It is voluntary for local government and local administrative agencies. Japan has the highest percentage (70%) of agencies implementing GPP policies compared to other countries in the world (Hasanbeigi et al., 2019). JISF is made up of 52 of the major Japanese steel and iron producers including Nippon Steel, Mitsubishi Steel, JFE Steel, and Diado Steel (The Japan Iron and Steel Federation, 2021; n.d.-b)

Standards Development Status

The JISF is working closely with the nation's steel producers and the Japanese government to encourage national support for the decarbonization of the nation's steel and iron industry (The Japan Iron and Steel Federation, 2021; n.d.-c).

5.7 South Korea's National-Level and Industry-Led Initiatives

South Korea is the world's 6th largest producer of crude steel and has the 7th highest emissions intensity per ton of crude steel produced among the major steel producers at approximately 1.6 tons of CO_2 in 2020 (Hasanbeigi, 2022). Steel production in South Korea accounted for 15% of national GHG emissions in 2019. South Korea has announced targets to cut GHG emissions to 24% below 2017 levels by 2030. To do this, the South Korean government has reported teaming up with industry to develop and encourage the use of hydrogen fuels to reduce emissions from the steel industry with a goal of demonstrating and developing the technology by 2025 (The Government of the Republic of Korea, 2020).

However, an August 2022 study by NEXT Group and Solutions for Our Climate titled "Revisiting Korean Green Public Procurement Policies to Promote Green Steel Demand" found that of the 109 items subject to South Korea's Minimum Green Standard Product Purchase Program (MGS) run by the Public Procurement Service (PPS), steel products are not included (Eun Ko & Kim, 2022).

This same study also found that there are 17, low-carbon steel products, all produced by POSCO, the nation's largest steel producer, under the nation's Low Carbon Product Certification Program. However, the maximum carbon limit in the program is not applicable to steel and the minimum standard only applies where a steel product must achieve a CO_2 intensity reduction rate of 3.3% over 3 years to achieve certification regardless of the absolute intensity of the product. The carbon footprint of the products is also not disclosed for steel products under this program (Eun Ko & Kim, 2022).

Despite the current lack of policy related to low-carbon steel in South Korea, the government's Ministry of Trade, Industry, and Energy launched the Green Steel Committee in February of 2021. The committee is made up of industrial, academic, and government representatives discussing the goal of 2050 carbon neutrality in the nation's steel industry agreed upon by South Korea's largest steel producers, POSCO, Hyundai Steel, Dongkuk Steel, KG Dongbu Steel, Seah Steel, and SIMPAC in 2021 (Green Steel, 2021; Min-hee, 2021; Tingyao Lin, 2021).

In a September 2022 study by InfluenceMap, POSCO, Hyundai Steel, and the Korean Iron and Steel Association (KOSA) were reported to frequently contribute to policy forums regarding the decarbonization of the steel industry in Korea. POSCO publicly supported the government's 2050 carbon neutrality target and advocated government investment in green hydrogen infrastructure and renewable energy. Hyundai Steel was reported to advocate for transitions from blast furnaces to EAF, and hydrogen utilization (InfluenceMap, 2022).

5.8 India's National-Level Standards and Industry-Led Initiatives

India is the world's second-largest producer of crude steel and is second only to Ukraine with the highest average CO_2 emissions intensity among major steel producing countries at approximately 2.15 tons of CO_2 per ton of crude steel in 2019 due to its predominant use of coal-based BF and coal-based DRI in the sector, high emissions in the power sector, and a large number of old and inefficient plants. The CO_2 emissions intensity of primary steel production in India is around 3 ton CO_2 per ton crude steel (Hasanbeigi, 2022). To comply with India's National Determined Contributions (NDCs) for GHG emissions, the Indian primary steel producers must reduce carbon emissions intensity to 2.4 tons of CO_2 by 2030 (Argus Media, 2022; Green Steel World, 2022).

Nationally, India currently does not have a GPP program relating to steel procurement nor has national targets for steel production emissions intensity goals. India does have general financing rules which are a set of guiding regulatory principles for public procurement focused on efficiency, economy, transparency, and promotion of competition. In 2011, India's Ministry of Environment and Forests formed a committee to develop GPP guidelines. A year later, the Government of India introduced the Draft Public Procurement Bill-2012, which states that the evaluation criteria for procurement may include: (a) price; (b) the cost of operating, maintaining, and repairing goods or works; and (c) the characteristics of the object being procured, such as the functional and environmental attributes (UNEP 2013, Kumar 2014).

In 2012 the Ministry of Micro Small and Medium Enterprises (MSME) passed an executive order mandating a 20% minimum procurement amount from micro and small enterprises where energy efficiency, GHG emissions reduction, re-use or recycling, energy conservation, reduction in the use of hazardous substances, protection of local environmental conditions and biodiversity, efficient waste disposal, and resource recovery are the main focus. A Task Force in Sustainable Public Procurement was created in 2018 to review other GPP programs internationally, assess India's current GPP status and recommend further action and steel s one of the six primary industrial targets (Hasanbeigi, 2022; Hasanbeigi et al., 2019; Argus Media, 2022; Green Steel World, 2022; India Ministry of Steel, 2022).

In 1991, India launched a voluntary eco-labeling scheme called Eco-Mark that focused on both environmental and product quality criteria. Ecolabels and environmental standards are not commonly considered as part of the public procurement of products, works, and services in India's public sector, and the Eco-Mark label has so far not been widely adopted by manufacturers or buyers (Hasanbeigi et al., 2019).

Despite the lack of national programs or standards, the Indian Steel Association (ISA) has called for the government to support low-carbon steel production by:

1. Introducing standards for green steel and a percentage of green steel in GPP
2. Establishing a carbon credit mechanism
3. Facilitating Carbon Capture Storage and Utilization (CCUS)
4. A renewable power transmission charges waiver
5. Calling for collaboration on research and development
6. Funding demonstration project of GHG reduction practices and technology in India
7. Calling for an EU Carbon Border Adjustment Mechanism (Argus Media, 2022; Green Steel World, 2022; India Ministry of Steel, 2022).

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