World Trade Organization

TRADE AND CLIMATE CHANGE

Information brief nº 7

Decarbonization standards and the iron and steel sector: how can the WTO support greater coherence?

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DECARBONIZATION STANDARDS AND THE IRON AND STEEL SECTOR
HOW CAN THE WTO SUPPORT GREATER COHERENCE?[1]

KEY POINTS

- Proliferation and fragmentation of decarbonization standards poses challenges for climate and trade. In the steel sector, there at least 20 different decarbonization standards and initiatives, which creates uncertainty for producers, increases transactions costs and risks trade frictions.
- Promoting coherence and bringing developing country perspectives into decarbonization standards are essential. Greater coherence would lower verification costs and encourage greater scale and investment in breakthrough steelmaking technologies. Developing country needs and participation must be considered in efforts to advance and align decarbonization standards. Stakeholders have highlighted that 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.
- Although it does not set standards, the WTO has a key role to play in accelerating coherent and inclusive standards. The WTO's Agreement on Technical Barriers to Trade promotes the alignment of national standards and regulations of its 164 members to relevant international standards and provides guidance on how to develop these international standards to facilitate trade. The WTO provides a global forum for fostering international cooperation on trade-related climate measures, easing trade friction and promoting developing country participation in standard-setting.

1 INTRODUCTION

Decarbonization of the iron and steel industry value chain is of critical importance to achieving net zero targets. Iron and steel are essential inputs in nearly every facet of modern life, from construction to transportation and energy. However, iron and steel are among the most energy and emission-intensive industries globally. Iron and steel production is one of the largest coal consumers (Kim, *et al.*, 2022), accounting for approximately 8 per cent of annual CO_2 emissions (Sun, *et al.*, 2022).

Iron and steel production accounts for approximately 8% of annual CO_2 emissions.

Global steel production has nearly tripled over the past 50 years[2], and it is the most used and recycled metal worldwide, with 1,864 million tonnes of crude steel produced in 2020 (see Box 1).[3] Global steel exports reached 458 million tonnes in 2021, representing around 25 per cent of global steel production.[4] Emissions from steelmaking are generally difficult to reduce because existing efficiency and abatement options are limited and some alternative technologies are costly. It is therefore critical to accelerate global scale-up and commercialization of low-carbon steelmaking technologies, such as those for replacing carbon-based reduction with renewable electricity or green hydrogen, or the use of carbon capture, storage and usage (IEA, 2022a).

Box 1: Global steel production

- **Global production up nearly 3-fold since 1965**
- **Over 1.8 billion tonnes produced in 2020**
- **Global exports were 458 million tonnes in 2021**

Various public and private initiatives are working on the decarbonization of the sector, measuring emissions, setting targets and verifying reductions. These include steel-specific initiatives and standards at the international, regional, national or company level that address:

- facility-level carbon measurement methodologies;
- upstream verification of embedded emissions of steel products;
- emissions intensity performance thresholds;
- certification and labelling;
- recycling of steel scrap.

Government initiatives have also recently prioritized decarbonization of the sector and the measurement of embedded emissions, for example, the EU–US Global Arrangement on Sustainable Steel and Aluminium.[5] There have also been proposals for climate clubs that consider steel as a prime candidate for cooperation. One common challenge is ensuring coherent measurement, verification and traceability across the supply chain.

The right methodologies enable accurate information and comparisons across products, processes and technologies and deliver confidence in net zero claims.

Numerous standards exist, or are under development, to support these decarbonization efforts. However, it is still unclear which specific measurement methodologies will be used by these various coalitions and initiatives, and how this may impact trade and decarbonization efforts. Moreover, it needs to be clarified how to ensure comparability, transparency and consistency across different methodologies, technologies and countries, and with respect to competing materials such as aluminium or cement. Consistent and transparent measurement, traceability and verification of emission reductions are critical to underpin the spectrum of trade-related climate measures. 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.

Concerns about ensuring a level playing field arise as the decarbonization of the steel sector advances at different paces in a world of diverse economies and climate policies (IEA, *et al.*, 2022b; OECD, 2022). This reflects the bottom-up nature of the global climate policy framework as established by the Paris Agreement. The trade exposure and carbon intensity of the industry mean that under stringent climate policies or pricing first movers can suffer competitiveness losses compared to competitors in other jurisdictions, potentially leading to carbon leakage – including with respect to downstream products.

Applying common global standards can help to avoid first mover problems, but mainly if supported by new markets and demand for these products. Standards also help to create a market for green steel products, facilitate green public procurement support the circular economy, and can be linked to a low-emissions steel mark or label. Global cooperation can contribute to a just transition by ensuring that developing and least-developed countries can be part of the low-emissions steel value chain.

Global cooperation can contribute to a just transition by ensuring that developing and least-developed countries can be part of the low-carbon steel value chain.

There are multiple pathways and technologies to decarbonize steelmaking (e.g. hydrogen-based steelmaking, electrolysis, and carbon capture, storage and usage). However, many options are still relatively costly and require government action to provide the necessary framework for scale and global dissemination. Governments have a pivotal role to play in push and pull mechanisms for near-zero emission steel, including for the commercialization of breakthrough technologies and green public procurement (IEA, 2022a). Public–private partnerships are crucial in driving innovative technologies to decarbonize emission intensive industries. These include efforts to bring forward demand signals for near-zero and zero-emission products by creating buyer's clubs for these products.

Public–private partnerships are crucial in driving innovative technologies to decarbonize emission intensive industries.

A shift towards new technologies and processes for low-carbon steelmaking may involve the development of new supply chains and trade patterns to deliver the needed inputs (e.g. green hydrogen). This shift may create new opportunities for developing countries to integrate into green steel supply chains. Developing countries should be supported to exploit these opportunities given the expected future demand for steel products concentrated in developing markets and the need to ensure a just transition to a low-carbon economy.

This information brief presents the range of efforts underway to develop decarbonization standards in the steel sector, and the link to international trade. It concludes with a description of how the WTO's work and guidance can help to increase coherence to facilitate trade and decarbonization.

2 PROLIFERATION AND THE RISK OF FRAGMENTATION: CHALLENGES FOR TRADE AND DECARBONIZATION

A proliferation of standards and initiatives for decarbonizing the iron and steel sector is contributing to a risk of fragmentation and inconsistency.[6] Steel industry stakeholders have identified more than 20 different steel decarbonization standards and initiatives, many of which have different boundaries and methodologies.[7] Taking the mining, minerals and metals space as a whole, there are more than 150 sustainability standards and related initiatives.[8]

There is currently no globally accepted definition of green, near-zero or low-emission steel, although there are several ongoing efforts amongst some countries and companies to reach agreement and alignment of definitions (IEA, 2022a; IEA, *et al.*, 2022b). Nor is there a common global approach and methodology for assessing the lifecycle embodied emissions of specific steel products against performance criteria (ResponsibleSteel, 2022).

Fragmented standards impede decarbonization upstream and downstream in the iron and steel and value chain.

Proliferation of incompatible standards may cause uncertainty and confusion for producers and consumers, decrease efficiency and increase transaction costs. It may also give rise to trade frictions and hamper decarbonization efforts. Common internationally accepted standards for measuring embodied emissions in steel products are important to support policy-makers and green public procurement, enable the creation of lead markets, and allow for product differentiation and price premiums. International openness and alignment are important to the steel sector's decarbonization efforts, as around 22.9 per cent of steel products were traded across continents in 2020 and 358.9 million tonnes of steel containing goods were traded worldwide in 2019.[9] Fragmented standards impede decarbonization efforts both upstream and downstream in the iron and steel value chain. For instance, Steinlein *et al.* (2022) highlight that European and Chinese automakers use different standards, which can create barriers for data exchange and cooperation on decarbonization. The use of different standards by governments in trade-related climate measures can give rise to compliance challenges and trade tensions and can increase the costs of verification. Other studies have also found that the same tonne of raw steel could have a carbon footprint that varies four-fold depending on whether it was assessed under the methodology of emissions trading systems of the European Union or California.[10]

This publication examines the following three types of steel decarbonization standards:

- standards for measurement of process emissions;
- definitions and related emissions intensity performance thresholds for low-carbon, near-zero, and net-zero steel production; and
- product-level standards on lifecycle assessment (LCA) and carbon footprint for conveying information about embodied emissions to the market.

Definitions and performance thresholds aim to set the steel sector on a net-zero trajectory (usually aligned with 2050), built upon the foundation of consistent and comparable emission measurement standards. While there are several well-established measurement standards, there is a proliferation of competing definitions and performance thresholds that risk generating fragmentation. Moreover, there is limited guidance and international cooperation on product-level steel standards on lifecycle assessment (LCA) and carbon footprint, which presents an opportunity for collaboration to facilitate decarbonization and international trade.

2.1 Initiatives and organizations

Table 1 lists, in a non-exhaustive fashion, several initiatives and organizations active in developing measurement standards, definitions and performance thresholds. It is notable that most iniatiatives and organizations focus either on measurement standards, or definitions and thresholds, and few are active in both areas.

Table 1: Initiatives and organizations active in steel decarbonization standards and certification

Initiative/organization	Measurement standards	Definitions and thresholds
ResponsibleSteel Steel industry's global multi-stakeholder standard and certification programme	X	X
World Steel Association Through the Climate Action Programme data collection programme, steelmakers report on site-level emissions based on a common methodology, definitions and boundaries	X	
First Movers Coalition Global initiative that promotes decarbonization of "hard to abate" industrial sectors including steel by leveraging companies' purchasing power		X
Industrial Deep Decarbonisation Initiative Global public-private initiative coordinated by UNIDO working to stimulate demand for low-carbon industrial materials		X
International Energy Agency, G7 The Industrial Decarbonisation Agenda is working on alignment of the general definition of near-zero emission steel		X
International Organization for Standardization, European Committee for Standardization Develop standards for calculating emissions from steel production processes and standards for lifecycle methodologies for products	X	
Greenhouse Gas Protocol Iron and Steel Tool provides guidance on the estimation of greenhouse gas emissions associated with iron and steel production *Product Life Cycle Accounting and Reporting Standard* provides guidance on lifecycle emissions for products	X	
Sustainable STEEL Principles Provides a methodology for banks to measure and report the climate alignment of steel lending portfolios compared to net-zero emissions pathways	X	X

There are additional fora playing an active role in discussions of steel decarbonization standards, definitions, and thresholds. In particular, the OECD Steel Committee is exploring new work on steel decarbonization, and the Global Forum on Steel Excess Capacity has held discussion on steel decarbonization initiatives.

The following subsections turn to examine (i) standards for measurement of process emissions; (ii) definitions and related emissions intensity performance thresholds for low-carbon, near-zero, and net-zero steel production; and (iii) product-level standards on lifecycle assessment (LCA) and carbon footprint.

2.2 Standards for measurement of process emissions

Standards for measuring greenhouse gas (GHG) emissions are a valuable tool for carbon-intensive businesses, including steelmakers, to increase process and energy efficiency, track implementation of innovative low-emissions technologies, provide emissions data demanded by consumers and the marketplace, or, in some jurisdictions, for regulatory compliance (and financial reporting) (IEA, 2022a).

There is a range of existing measurement standards[11] in the steel sector that provide methodologies for measuring emissions associated with steelmaking processes (both blast furnace and electric arc furnace), including those developed by the European Committee for Standardization (CEN), the GHG Protocol, the International Organization for Standardization (ISO) and the World Steel Association. In addition, a multi-stakeholder consortium has recently developed the *ResponsibleSteel International Standard* (ResponsibleSteel, 2022), which covers various sustainability aspects, including GHG measurement.

These standards provide methodologies for facility-level emissions measurement. With some variation, they use a common metric of CO_2 intensity per unit of crude steel produced by a steelmaking facility. This typically involves assessing input and output (carbon mass balance approach) according to the production route used by the facility and designated emissions factors, to reach a CO_2 intensity measurement (or GHG, in CO_2 equivalent). The International Energy Agency (IEA) identifies four principal features of measurement standards (see Table 2):

(i) emission scope and targeted GHG (how are direct and indirect emissions included, across scopes 1, 2, 3)[12];
(ii) supply chain scope (which activities in the iron and steel value chain are covered);
(iii) granularity of application (facility, company, or production route; see Box 2);
(iv) measurement methodologies and data requirements (information needed, assumptions made).

Box 2: Main iron and steel production routes*

Basic oxygen furnace steelmaking

Making steel through oxidation by injecting oxygen through a lance above a molten mixture of pig iron and scrap steel.

Electric arc furnace steelmaking

In this process a furnace melts steel scrap using the heat generated by a high-power electric arc. During the melting process, elements are added to achieve the correct chemistry and oxygen is blown into the furnace to purify the steel.

Direct reduction

A group of processes for making iron from ore without exceeding the melting temperature. No blast furnace is needed.

*See https://worldsteel.org/about-steel/glossary/#d.

Table 2: Overview of measurement standards

Standard	Emissions scope and targeted GHG	Supply chain scope	Granularity	Measurement methodology and data
The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard[a] *Calculating Greenhouse Gas Emissions from Iron and Steel Production*[b]	Scopes: Scope 1 Scope 3 emissions from the production of coke and of limestone and dolomite only GHGs: CO_2, N_2O, CH_4	From coke production to crude steel production (BOF) Excludes: on-site transportation of materials and the consumption of purchased electricity, heat, steam	Company Routes: BOF production only	Tier 1, 2 and 3 calculation guidance: using input and output data and emissions factors, at increasingly levels of detail (general/global, country, facility)
World Steel Association Climate Action data collection[c]	Scopes: Scope 1 Scopes 2 (electricity generation) and Scope 3 including the production and use of lime fluxes, amongst others GHGs: CO_2	From iron ore agglomeration through to finished steel products, including upstream factors for e.g. light oil, heavy oil, kerosene, LNG Excludes: emissions associated with raw materials extraction, sorting and transportation	Facility/company[d] Routes: BOF, EAF, DRI	CO_2 intensity calculated through input, output and production data, according to common emission factors, site-measurement or regional standardised factors when available
Calculation Method of Carbon Dioxide Emission Intensity from Iron and Steel Production, ISO 14404:2013[e]	Scopes: Scopes 1 and 2 Scope 3 upstream emissions taken into account for certain raw materials and intermediate products, depending on production route GHGs: CO_2	From iron ore agglomeration through to finished steel products	Facility Routes: BOF, EAF, DRI	Derived from the method developed by the World Steel Association (see above)
Stationary Source Emissions: Greenhouse Gas (GHG) Emissions in Energy-intensive Industries, Part 2: Iron and Steel Industry, EN 19694-2:2016[f]	Scopes: Scopes 1 and 2 Scope 3 indirect emissions, other indirect GHG emissions shall be included for the calculation of performance indicators (mining and transport of natural raw materials and energy excluded; scrap use not fully considered) GHGs: CO_2	From integrated steelmaking (including coke making, sintering, pelletization, blast furnace ironmaking), BOF steelmaking, EAF steelmaking, other primary processes (gas-based direct reduction, coal-based direct reduction, smelting reduction), to roughing and rolling mills Excludes: downstream processes	Facility Routes: General (all production)	Methodology for assessing GHG emissions performance of each process and unit that is part of the facility against best practice, including reduction potential Can be aggregated at facility level to provide a CO_2 intensity metric (although not comparable with facilities with different process set-ups) When applied to the EAF route, it is less accurate due to the fact that CO_2 performance is strongly linked to the electricity consumption profile of the facility, which the carbon input performance assessment overlooks

ResponsibleSteel International Standard[g]	Scopes: Scopes 1 and 2 Scope 3 emissions associated with the extraction, preparation, processing and transportation of input materials GHGs: CO_2, N_2O, CH_4	From extraction, preparation, processing and transportation of input materials to crude steel leaving facility gate Excludes: GHG emissions associated with further processing of the crude steel after casting (e.g. hot rolling, cold rolling, coating) Under this standard, "GHG emissions associated with the further processing of crude steel after first casting should be accounted for and recognised in the determination of the product's product carbon footprint"	Facility Routes: General (all production)	Uses methodology of the GHG Protocol, ISO 14404:2013 or EN 19694-2:2016 for basic reporting on crude steel GHG emissions intensity performance Additional methodological guidance and data requirements apply to sites that want to market or sell steel as "ResponsibleSteel certified", in terms of gases and scope boundaries Also requires consideration of local, regional or national grid-average emission factor (unlike EN 19694-2:2016)

[a] WRI/WBCSD (2004).

[b] Available from https://ghgprotocol.org/calculation-tools.

[c] Available from https://worldsteel.org/steel-topics/environment-and-climate-change/climate-action/climate-action-data-collection.

[d] World Steel CO_2 data collection project administrators are the only people who can see data submitted.

[e] See *Part 1: Steel Plant with Blast Furnace, Part 2: Steel Plant with Electric Arc Furnace (EAF), Part 3: Steel Plant with Electric Arc Furnace (EAF) and Coal-based or Gas-based Direct Reduction Iron (DRI) Facility, Part 4: Guidance for Using the ISO 14404 series.*

[f] ISO is developing a similar standard (see https://www.iso.org/standard/70746.html).

[g] ResponsibleSteel (2022).

The ISO 14404 series of standards provides a baseline approach for measuring CO_2 emissions from a steelmaking facility according to the steel production route (BOF, EAF, DRI). The more elaborate measurement standard, EN 19694-2:2016, *Stationary Source Emissions: Greenhouse Gas (GHG) Emissions in Energy-intensive Industries, Part 2: Iron and Steel Industry*, enables more specific measurement of CO_2 emissions of integrated steelmaking facilities of all types and production routes (including activities such as coke making, sintering, pelletization, blast furnace ironmaking or rolling mills) and internal performance assessment and benchmarking, but is not apt for making comparisons between facilities with different process set ups. This standard is currently being considered as a draft ISO standard.[13] The World Steel Association's approach to voluntary reporting by its member companies is the basis for ISO 14404:2013. It covers emissions from iron ore agglomeration through to finished steel products with a common boundary and emissions factors for all steel production routes.

The *ResponsibleSteel International Standard* (ResponsibleSteel, 2022) covers environmental, social and governance issues including GHG emissions. Specific provisions of the standard, including some of those on GHG emissions, are covered by a 12-month test phase to ensure that the new requirements are fit for purpose and may be subject to further stakeholder consultations. For those steelmakers and sites wishing to obtain certification under the *ResponsibleSteel International Standard* (ResponsibleSteel, 2022), there are additional measurement requirements and specificities to be met in addition to ISO 14404:2013 or EN 19694:2016, including coverage of all GHGs and scope and operational boundary that extends to emissions associated with extraction, preparation, processing and transportation of input materials (e.g. mining activities). The standard also includes an assessment of the final product GHG emissions using a full LCI or EPD methodology (see Section 2.4).

In addition to the standards in Table 2, related measurement standards are in place or under development. These include measurement requirements in government policy and legislation, such as the emissions trading systems of the European Union, California and others.

Under the EU emissions trading system, benchmark emissions intensity values are calculated, which are then used for the allocation of free allowances of permits to the steel industry and other emissions-intensive trade-exposed industries.

Alternative measurement methodologies have also been developed or proposed by non-governmental organizations and think tanks, such as the World Resources Institute, Resources for the Future, amongst others (WRI, 2021; RFF, 2022).

Financial disclosure standards are increasingly developing and including requirements on emissions measurement in the steel industry such as the International Financial Reporting Standards's International Sustainability Standards Board[14], the Global Reporting Initiative[15] or the Task Force on Climate-Related Financial Disclosures[16]. A group of banks have recently developed a methodology for assessing the climate alignment of potential steel industry borrowers under the Sustainable Steel Principles.[17] There are recently published dedicated eligibility criteria for the steel sector under the Climate Bonds Initiative[18], which aims to activate mainstream debt capital markets to finance and refinance climate friendly projects and assets. These finance sector initiatives tend to build on existing measurement standards such as those in Table 2, but in some cases include novel criteria.

2.3 Definitions and emissions intensity performance thresholds

This subsection examines standards setting definitions and emissions intensity performance thresholds. It begins with a review of the ongoing work to establish definitions and performance thresholds for low-carbon, near-zero, and net-zero steel production. Then, it turns to examining the efforts to develop relative performance scales and ranges underpinning the broader definitions and performance thresholds.

Definitions and performance thresholds for low-carbon, near-zero, and net-zero steel production

Setting definitions and thresholds is vital to stimulate investment in low-carbon steel markets.

There are multiple ongoing efforts to establish definitions and performance thresholds for low-carbon or near-zero steel – that is, that crude steel must be produced with equal to or less than a certain GHG emissions intensity, in line with the net-zero transition of the steel industry. Setting definitions and thresholds is vital to stimulate investment in low-carbon steel markets, to enable price differentiation and premiums and help mitigate carbon leakage, provide a basis for government policy to support low-carbon steel technologies and green government procurement, and provide information to buyers and end consumers. Some initiatives and organizations developing these include the IEA work for the G7, the First Movers Coalition, the Clean Energy Ministerial Industrial Deep Decarbonization Initiative, and ResponsibleSteel.

Definitions and thresholds should be built upon agreed, consistent, comparable and transparent measurement standards.

To be effective and credible, definitions and thresholds should be built upon agreed, consistent, comparable and transparent measurement standards (IEA, 2022a). A range of terms are used in these definitions. Performance thresholds are typically set in line with climate science and a modelling target or trajectory for the decarbonization transition of the steel industry to achieve net zero (IEA, 2022a). A key factor in any definition and threshold is how scrap steel is considered, given that this contributes to a significantly lower carbon footprint of EAF steel production as compared to iron ore-based steel production (BOF), and that the supply of scrap varies across countries and regions.

While there is a move towards greater alignment and consensus on terminologies for decarbonized steel, definitions are being refined and developed continually and are linked to different sliding scales of emissions performance. The terms that denote the highest decarbonization ambitions are:

- near-zero steel, which is as close as possible to reaching the lowest practicable emission for known, innovative technologies, albeit without the removal or offsetting for remaining residual emissions;
- net-zero steel, which is as close to the lowest practicable emissions for known, innovative technologies, with only remaining residual emissions removed or offset.[19]

The IEA has proposed a definition and quantitative threshold to the G7 that is in line with the First Movers Coalition (FMC) for near-zero emission steel, and the Industrial Deep Decarbonisation Initiative is also working on aligning definitions. However, the IEA and FMC definitions and thresholds use different system boundaries, and therefore may not be directly comparable. At the same time, other definitions are being proposed by ResponsibleSteel and ArcelorMittal in line with specific thresholds (see Table 3). SteelZero – an initiative led by Climate Group in partnership with ResponsibleSteel – is in the process of establishing quantitative thresholds for net-zero or near-zero steel, which in turn is expected to be based on the *ResponsibleSteel International Standard* (IEA, 2022a).

The IEA definition proposes 30 per cent scrap use as the cut-off below which primary near-zero emission production could be explicitly recognized. In this metric, primary steel can be classed near-zero emission for an emission intensity of 0.4 t CO_2e/t crude steel by 2050 (0 per cent scrap input) while scrap steel can be classed near-zero emission for an emission intensity of 0.05 t CO_2e/t crude steel by 2050 (100 per cent scrap input).

The First Movers Coalition has defined near-zero steel as falling between the emission intensities of <0.4 t (with 0 per cent scrap inputs) to <0.1 t (with 100 per cent scrap inputs) of CO_2 per tonne of crude steel produced.

Table 3: Terminologies and steel emission thresholds

Terminologies	Initiatives/organizations	Quantitative thresholds (t CO_2/t crude steel)	
		Iron ore-based steelmaking	Scrap-based steelmaking
Near-zero emission steel	International Energy Agency (G7)[20]	0.4	0.05
	Science Based Targets initiative[21]	0.5	0.2
	Climate Bond Initiative[22]	0.12	0.12
	ResponsibleSteel International Standard[23]	0.4	0.05
	First Movers Coalition (FMC)[24]	<0.4	<0.1
	Mission Possible Partnership	0.5	n.a.
	Sustainable STEEL Principles[25]	0.2	n.a.
Low-embodied carbon steel	SteelZero	forthcoming	forthcoming

Note: IEA (2022a) states: "The thresholds for 'near zero emission' production aim for levels of emissions intensity that are compatible with a trajectory for heavy industries in a pathway that reaches net zero emissions from the global energy system by mid-century". World Steel Association states: "If a balance can be achieved between the greenhouse gases put into the atmosphere when producing steel and emissions taken out of the atmosphere by sinks, the resulting steel can be referred to as carbon-neutral steel (or net-zero steel)"[26]. The definition and quantitative threshold for low-embodied carbon steel are forthcoming from SteelZero. The quantitative thresholds of the Science Based Targets initiative were being updated at the time of publication. Not applicable – n.a.

Relative performance scales and ranges underpinning definitions and performance thresholds

Initiatives and companies are also developing performance scales and ranges that underpin these definitions and thresholds. These are often based on technology maturity models with progressive bands or levels, setting out interim targets on the path toward near-zero steelmaking.

These performance scales vary depending on criteria. For instance, in addition to the IEA's near-zero/net-zero definition, it also proposes a "complementary – but distinct definitions for 'low emission production'", which seeks to recognize interim, incremental steps toward achieving net-zero targets (IEA, 2022a). In this regard, the IEA has developed a band range for steel production based on the percentage of scrap input. It states that this subdivision of the near-zero emission threshold takes into account the producers, countries and regions where transitions in the energy sector are already advanced. The intensity thresholds range from A-E and are "intended as a tool for tailoring the quantification of low emission production to fit a given regional, temporal or other context" (IEA, 2022a).

The IEA bands range from A being the highest performing, to E being the lowest performing and highest emitting (see Table 4). This is similar to the *ResponsibleSteel International Standard* (ResponsibleSteel, 2022), which has bands of Level 1 to Level 4 (near-zero) with the same quantitative values for near-zero steel.

Table 4: IEA low emission intensity thresholds

Band range	Emission (t CO_2e/t crude steel)
A to E	2.4
A to D	2
A to C	1.6
A to B	1.2
A to A	0.8

Source: Table A.1 of IEA (2022a).

Another way thresholds are delineated is through sliding scale timelines. For instance, the Climate Bond Initiative proposes emission intensity values (based on the IEA Net Zero by 2050 scenario) on a five-year basis, defining two tiers (see Table 5):

- Tier 1: The weighted average emission intensity across all of the company's production facilities meet the threshold values outlined up until 2050 at the time of certification.

- Tier 2: The weighted average emissions intensity across all of the company's production facilities will meet the threshold values outlined for 2030 by 2030.

Table 5: Climate Bonds Initiative performance scales

Tiers (performance scales)	Year	IEA Net Zero by 2050 trajectory	
		Primary intensity (t CO_2e/t steel)	Secondary intensity (t CO_2e/t steel)
Tiers 1 and 2	2020	2.38	0.75
	2025	2.09	0.54
	2030	1.81	0.32
Tier 1	2035	1.35	0.22
	2040	0.90	0.12
	2045	0.51	0.12
	2050	0.12	0.12

Source: Adapted from https://www.climatebonds.net/files/files/Steel%20Criteria%20document_Final%20version.pdf.

Another way these performance scales are defined are through broad climate targets. For example, the Sustainable STEEL Principles[27] outline emission intensity levels based on alignment to the 1.5°C carbon budget goal:

- 1.5°C-aligned: emissions intensity lower than the IEA Net Zero by 2050 scenario;

- well below 2°C: emissions intensity above the IEA Net Zero by 2050 scenario but below the Mission Possible Partnership's Technology Moratorium (MPPTM) scenario;

- misaligned: emissions intensity above the MPPTM scenario.

ResponsibleSteel (2022) proposes requirements that specify four performance levels for GHG emissions (see Table 6) as well as for progress on the responsible sourcing of input materials. The specified levels and thresholds will be reviewed periodically with the specific objective 'to achieve the fastest global transition to a near zero steel sector'. The German Steel Industry (Wirtschaftsvereinigung Stahl) has also proposed a labelling and classification for green steel with a sliding scale.[28]

Table 6: ResponsibleSteel performance scales

	ResponsibleSteel crude steel GHG emissions intensity performance using 0% scrap as input (t CO_2e/t crude steel)	Gradient	ResponsibleSteel crude steel GHG emissions intensity performance using 100% scrap as input (t CO_2e/t crude steel)
Level 1 threshold	2.80	2.45	0.35
Level 2 threshold	2.00	1.75	0.25
Level 3 threshold	1.20	1.05	0.15
Level 4 threshold	0.40	0.35	0.05

Source: ResponsibleSteel (2022).

Some standards ask for product emissions to be reported against certain thresholds. For example, ArcelorMittal has proposed a dual scoring system that comprises of a lifecycle assessment (LCA) value for finished products, as well as a decarbonization rating going from A+ (net-zero steel) to F (above minimum threshold) for production processes.[29] According to the ArcelorMittal proposal, the decarbonization score would be based on internationally recognized methodologies and regionally and internationally recognized LCA and environmental product declaration (EPD) standards for the product score.

Despite these promising signs of alignment of definitions and thresholds, there still appears to be some discrepancies between the various initiatives and their respective definitions and thresholds, particularly for what counts as near-zero emission steel (see Table 3). For instance, under the Mission Possible Partnership, near-zero steel could be defined at the threshold of 0.5 t CO_2e/t steel, a different value from ResponsibleSteel (2022) and the IEA metric. For the First Movers Coalition standard, primary steel classified as near-zero has an emission intensity of 0.4 t CO_2e/t crude steel and 0.1 t CO_2e/t crude steel for secondary steel.

In addition, the Science Based Targets initiative (SBTi), which is currently undergoing revision, adjusts the IEA metric according to its Sectoral Decarbonization Approach boundaries, and so the SBTi metric for near-zero steel is an emission intensity of 0.5 t CO_2e/t crude steel for primary steel and 0.2 t CO_2e/t crude steel for scrap steel by 2050.[30] The Climate Bond Initiative has also based its methodology on the IEA Net Zero by 2050 Scenario definition; however, its 2050 target is 0.12 t CO_2e/t crude steel for both primary and scrap steel.

Some of these differences can be at least partially explained by inconsistency in terms of which GHGs are covered (CO_2 only or all GHGs), emissions scopes (e.g. FMC only covers scopes 1 and 2, while others exclude some scope 3 emissions), and the underlying calculation methodologies.

This may create difficulties for comparability, transparency, measurement, reporting and verification. Moreover, it is not clear to what extent these definitions and thresholds are based on, or aligned with, commonly used measurement standards. Detailed measurement methodologies have yet to be developed for some of the definitions and thresholds, making it hard to assess potential commonalities and differences. A well-understood basis for measurement is needed for trust and cooperation in trade between commercial partners. Governments need to understand what is behind each of the thresholds to be able to evaluate options and decide whether to rely on such standards in their trade-related regulations and policies.

One critical way these definitions and performance standards vary is on their system boundaries and emission scopes. While many standards are attempting to be comprehensive and cover all three emission scopes, some are more detailed than others. For instance, the IEA metric covers scopes 1, 2 and 3 at the company level and includes aspects such as iron ore mining (extraction, transportation, processing), fossil fuel supply, imported electricity and production processes for material inputs to steelmaking. However, other standards like the ones developed by First Movers Coalition and the Sustainable STEEL Principles[31] only cover scopes 1 and 2. Even within the system boundaries outlined in these standards, the processes included in the different scopes vary greatly.

Another aspect that varies is on the steel production route. Some thresholds and definitions cover both primary steel made from iron ore as well as EAF production from scrap steel, however other standards only specify metrics for primary steel. For instance, the IEA, SteelZero, SBTi and ResponsibleSteel standards have set thresholds based on scrap usage. However, others such as the Mission Possible Partnership have only developed a metric for primary steel. A newly announced standard, to be developed by the Global Steel Climate Council, will focus on establishing performance thresholds and definitions that cover all steel production process, while recognizing the lower emissions intensity of EAF production.[32]

Carbon measurement standards and definitions for steel and steel products are crucial for ensuring objective and consistent comparisons between competing materials and their carbon footprints.

Finally, it is important that carbon measurement standards and definitions for steel and steel products are not viewed in isolation. First, decarbonization standards may have important implications on trade in terms of downsteam industries along the value chain. For example, if country A is mostly importing its steel from country B in order to produce cars, measurement standards, definitions and thresholds will have a significant impact on steel trade between countries A and B. Second, these standards are also crucial for ensuring objective and consistent comparisons between competing materials (e.g. concrete, aluminium) and their carbon footprints. They also have implications and linkages with other sectors and activities (e.g. co-products) that need to be considered (IEA, 2022a). This makes clear the importance of comparability and interoperability between measurement standards across sectors. This is already recognized in the context of the work of the IEA and the Industrial Deep Decarbonisation Initiative, which are considering the steel and cement sectors together, and further cooperation will be needed to reach comparable metrics across sectors.

2.4 Product-level standards on lifecycle assessment (LCA) and carbon footprint

Compared to the area of definitions and thresholds, there are fewer product-level standards for assessing and communicating embodied emissions of steel products to the market. While the measurement standards, definitions and thresholds mentioned above concern crude steel production, product-level standards on lifecycle assessment (LCA) and carbon footprint cover wider boundaries (additional stages of production and potentially use of the product) in assessing the embodied emissions of a specific steel product. There is international guidance on product carbon footprint and LCA in the steel sector, different government efforts on LCAs/EPDs which cover emissions and other environmental criteria, and different private initiatives on LCAs/EPDs of steel products for upstream applications such as in construction. EPDs are frequently used as the basis for green public procurement (Hasanbeigi, A., *et al.*, 2021).

Given the complexity of the steel industry and its large number of products, there may be a need for additional international cooperation on product-level steel standards to give the right information to buyers and consumers. These could be aligned with, and translated from, the above targets, definitions and measurement standards at the specific product level. As greater pressures are placed on steel companies and other businesses upstream in the steel value chain to decarbonize and disclose their emission reductions, they may be greater market or regulatory demand for such information. Indeed, these may also become important for compliance with trade-related climate measures to the extent that governments request more specific information about the carbon footprint of a specific finished or semi-finished steel product that is traded internationally (as opposed to the average emission intensity of a ton of crude steel, as per facility-level process measurements).

There is an opportunity for greater collaboration between stakeholders (manufacturers, suppliers, governments, standards bodies, other organizations) to develop product category rules and EPDs to transmit information across the supply chain and better meet market needs. Transparency along the supply chain is critical, to allow for the flow and exchange of data on emissions intensity of steel inputs and products. Digital technologies and solutions may play an important role in this respect.

In terms of international guidance, carbon footprint is often taken as a basis in standards such as:

- *Product Life Cycle Accounting and Reporting Standard* (GHG Protocol, 2011);
- ISO 14025:2006, *Environmental Labels and Declarations: Type III Environmental Declarations – Principles and Procedures*;
- ISO 14040:2006, *Environmental Management: Life Cycle Assessment – Principles and Framework*, for EPDs;
- ISO 14067:2018, *Greenhouse Gases: Carbon Footprint of Products – Requirements and Guidelines for Quantification*.

Steel-specific guidance is provided in ISO 20915:2018, *Life Cycle Inventory Calculation Methodology for Steel Products*, which "specifies guidelines and requirements for conducting life cycle inventory (LCI) studies of steel products reflecting steel's capacity for closed-loop recycling". In addition, the World Steel Association's *Life Cycle Inventory Methodology* provides a publicly available method widely used by steel companies (Worldsteel, 2021).

In terms of government efforts, the **EU Product Environmental Footprint Category Rules (PEFCR)**[33] provides guidelines for developing footprints for a wide range of products on the EU market, including metal sheets made of steel, aluminium, copper and lead.

Japan[34], the **Republic of Korea**[35]**, China** and **India** have also created similar systems that apply to steel products. The **Buy Clean California Act (BCCA)** sets global warming potential limits for carbon emissions associated with certain materials procured by certain state agencies, such as for the production of structural steel (hot-rolled sections, hollow structural sections, plate), concrete reinforcing steel, flat glass and mineral wool board insulation.

At the sectoral level, various regulations and standards with respect to the sustainability of building and construction materials also apply to steel products. The industry has generally reached a global consensus on definitions and methodologies of assessing embodied carbon in building and construction.[36] These standards include: the Building Research Establishment Environmental Assessment Method (BREEAM); PAS 2080:2016, *Carbon Management in Infrastructure*; and the Leadership in Energy and Environmental Design (LEED) certification, amongst others.

With respect to private initiatives, the **World Steel Association** (2021) has established a database of lifecycle inventory data for the production of a wide range of steel products based on data received from its members. **ResponsibleSteel** certification is providing a way to communicate emissions information to consumers across from the extraction and transportation of input materials to crude steel leaving facility gate, albeit not covering the full lifecycle.

Tata Steel is an approved EPD programme operator[37] and can create product specific EPDs for the construction sector that comply with: CSN EN 15804+A2, *Sustainability of Construction Works: Environmental Product Declarations – Core Rules for the Product Category of Construction Products*; and ISO 14025:2006.

Nippon Steel obtained the EcoLeaf certification[38], for structural steel plates and covers a wide range of businesses including shipbuilding, wind power generation, construction machinery and industrial machinery.

POSCO, a steel producer in the Republic of Korea, has the EPD certification from the Ministry of Environment for thirteen of its products (steel sheet, wire rod, hot rolled steel sheet, cold rolled steel sheet, hot-dip galvanized steel sheet, electroplated steel sheet, electrical steel sheet, stainless steel, PosMAC) for seven environmental indicators: ozone layer influence; acid rain; eutrophication; photochemical smog; and carbon, resource and water footprints.[39]

The **China Iron and Steel Association (CISA)** and **China Baowu Steel Group** have established an EPD platform with cooperation from stakeholders to develop different product category rules along the entire steel value chain (e.g. basic and special steel products, iron ore, springs). CISA has cooperated with different sectors to reach a mutual recognition for automobiles, construction products, home appliances, batteries and other carbon footprint labelling systems.

The **American Institute of Steel Construction (AISC)** has developed several EPDs for steel products, including in cooperation with the **Steel Tube Institute**, covering products such as hot rolled structural steel sections[40], steel plates[41] and hollow structural steel sections[42]. These are only meant for use by EAF facilities in the United States to meet building sustainability rating systems (e.g. LEED) and green building codes, and are certified by the safety organization UL.

In some cases, companies have developed their own labels and certifications for low-emissions steel products. For example, **Nucor**'s Econiq certification for net-zero steel indicates that the steel product is produced with 100 per cent renewable energy, and that any direct emisisons are offset. **ArcelorMittal**'s XCarb green steel certificates are designed for their flat rolled products made in a blast furnace, and can used by customers to report their reductions in scope 3 emissions. **Outokumpu**, a Finnish stainless-steel producer, has created the Circle Green label for its stainless steel, and uses low-carbon fuels and renewable energy such as biogas, biodiesel, bio coke and low-carbon electricity in its production. The German Steel Industry (**Wirtschaftsvereinigung Stahl**) has proposed a Green Steel Labelling System.[43] There are a range of other examples, including **Tata Steel's** Zeremis[44] (Netherlands) and Optemis[45] (UK), **Nippon Steel**'s NSCarbolex[46], **Voestalpine**'s GreenTec Steel[47], **Liberty Steel Group**'s Green Steel[48], **Thyssenkrupp**'s Bluemint Steel[49], the Hybrit[50] joint venture of **SSAB**, **LKAB** and **Vattenfall**, amongst others.

The **World Business Council for Sustainable Development**'s *Pathfinder Framework* (WBCSD, 2021) focuses on data exchange of cradle-to-gate product carbon footprints. The framework is aimed to align with existing standards and methodologies including the *Product Life Cycle Accounting and Reporting Standard* (GHG Protocol, 2011) and relevant ISO standards.

In tandem with these product standards, it is crucial that verification is performed to enhance validity and credibility. Standards such as the ISO 14064 series, *Greenhouse Gases*, provide a framework for GHG accounting and verification to organizations looking to quantify and reduce GHG emissions.

3 CONSIDERATIONS FOR COHERENCE AND SUPPORT FOR DEVELOPING COUNTRIES

While there may be good reasons for the emergence of different standards, definitions and thresholds, avoiding a "spaghetti bowl" of standards and aligning around common interoperable approaches would result in a clear win for both climate and trade.[51] Converging on common methodologies for carbon content measurement will be vital for putting in practice definitions and performance thresholds, while ensuring transparency, consistency and comparability. Efforts to promote convergence ex-ante could prove much less costly than having to manage ex-post a web of fragmented and possibly incompatible standards.

Converging on common methodologies for carbon content measurement will be vital for putting in practice definitions and performance thresholds, while ensuring transparency, consistency and comparability.

The range of considerations for promoting coherence of steel decarbonization standards, definitions and thresholds include various issues identified by initiatives and organizations, as well as those identified by stakeholders at a technical roundtable organized by the WTO in September 2022.[52] Some key considerations can be summarized in five main areas:

- globally relevant and technology neutral;
- science based and ambitious;
- well-understood boundaries and scope that are measurable;
- transparency in monitoring, reporting and verification;
- needs and participation of developing countries.

At the same time, feedback from stakeholders suggests that it might be difficult to converge on a single global standard for GHG emissions in the steel sector. Different standards exist for different purposes and focuses, and full harmonization may be neither desirable nor practical. Several different measurement standards, definitions and thresholds may need to co-exist, at least in the near- to medium-term. In this context, efforts could be productively focused on developing incremental "building blocks" in key areas of the iron and steel value chain to gradually achieve more industry-wide convergence. This could include reaching a common understanding on scope, boundaries and measurement approach, as well as verification and validation, which could be progressively aligned across different methodologies, definitions and thresholds.

3.1 Globally relevant and technology neutral

One overarching consideration is ensuring that steel decarbonization standards are globally relevant and technology neutral. This is important for providing incentives for cutting emissions from all current and future steel production routes (BOF, EAF, DRI) in facilities worldwide.[53] This means that decarbonization standards should be performance-based wherever possible, rather than based on or design or prescriptive elements, to allow flexibility for innovative technologies in line with the requirements of the WTO's Agreement on Technical Barriers to Trade (TBT) (see Box 3).

Box 3: Article 2.8 of the WTO's Agreement on Technical Barriers to Trade

Article 2.8 states:

"Wherever appropriate, Members shall specify technical regulations based on product requirements in terms of performance rather than design or descriptive characteristics."

In this respect, the process of aligning standards needs to focus on both conventional steelmaking technologies and emerging near-zero emission technologies (IEA, 2022a). One key consideration is how BOF production is treated as compared to EAF production, and how to account for different levels of scrap use in steelmaking. On the one hand, there should be incentives provided for primary steel production, which has a limit on the amount of scrap that can be used due to the nature of the process (and given that the supply of scrap is limited globally, and varies from region to region). On the other hand, however, there is a need to appropriately recognize the significantly lower carbon footprint of electric arc steelmaking.[54]

3.2 Science-based and ambitious

A second cross-cutting consideration identified is ensuring that any standard is based on climate science and is sufficiently ambitious (Forren and Sparkman, 2022). This is very much related to the carbon budget allocated to the steel industry to achieve global reductions in emission, aligned with the Paris Agreement. Steel and other heavy industry sectors will need to reduce direct CO_2 emissions by 90-95 per cent by 2050 to meet this target (IEA, 2022a).

The performance thresholds presented in Table 3 aim at delivering such a trajectory and uptake in new technologies to deliver the needed absolute reductions in emissions, based on different modelling approaches and assumptions. Interim targets may also be defined to ensure short and medium-term incentives to keep the industry on track against targets.

An important consideration is how standards will incentivize long-lived investments in the latest technologies for near-zero or net-zero steelmaking.

With respect to ambition, another important consideration is how standards will incentivize long-lived investments in the latest technologies for near-zero or net-zero steelmaking (e.g. carbon capture and storage, hydrogen based, electricity based). In terms of providing certainty to the marketplace, one principle adopted by the IEA is that a new steelmaking plant built today with best near-zero technologies, and that currently meets the IEA performance threshold, would continue to meet this threshold throughout its lifetime unless the threshold were changed (IEA, 2022a).

Another question is the extent to which a standard is ambitious enough to drive significant reductions in GHG emissions from primary steelmaking through the BOF route, including innovation and changes in this production process.[55] Some stakeholders have suggested performance scales as a way of providing incentives to decarbonization steps made by both BOF and EAF producers[56], while others do not support such scales as an appropriately ambitious or credible solution.[57] The ambition of standards (and the degree to which they are aligned internationally) and pace of technological change they engender may disrupt trade flows, as new market segments emerge to meet governments and consumer demand for near-zero steel products, and as new suppliers potentially enter value chains to tap into natural comparative advantages (IEA, *et al.*, 2022b).

3.3 Measurable boundaries and scope

A third main consideration is around the boundaries and scope of a standard. All stakeholders emphasize the importance of covering both direct and indirect emissions from steelmaking (scopes 1, 2, 3) – but there are different views about where to start and where to end.[58] Existing measurement standards, definitions and thresholds take different approaches to emissions scope and system boundaries (see Tables 2 and 3). In terms of the starting point, for instance, there are different views about whether to include emissions relating to the extraction and transportation of raw materials, or to rather start at the point processing of those raw materials. Similarly, there are different approaches to how to take account of the GHG intensity of electricity grids, and therefore reward those producers that are able to source renewable electricity.

In terms of where to stop, some view crude steel as the appropriate end point (ResponsibleSteel, 2022), while others suggest ending at the step of hot rolling (Arcelormittal proposal). Other stakeholders view full LCA, from cradle to grave, as the most appropriate basis to set standards and target "hot spots" in the production process. This also helps to ensure more accurate information can flow in the supply chain and enable emissions reductions in final products. In these choices, there are inherent trade-offs in terms of complexity and administrative burden on the one hand and accuracy on the other.

Whatever boundary is selected, it is important that companies have sufficient direct and indirect leverage on the emissions covered. Another key consideration is how the definition of boundaries may affect emissions accounting for other economic activities and competing materials (e.g. cement, aluminium), and the need to avoid shifting burdens or diluting responsibility for the core activities of steelmaking processes that represent the most significant emissions.

Verification processes, both at the facility level and at the border, play an important role in delivering confidence to regulators and the market.

3.4 Transparency in monitoring, reporting and verification

A fourth key consideration relates to transparency in monitoring, reporting and verification. Many stakeholders highlight the importance of having trust in measurements and achievement of performance thresholds. Verification processes, both at the facility level and at the border, play an important role in delivering confidence to regulators and the market. However, given the growing number of standards and thresholds, there is the potential of trade barriers arising from a proliferation of uncoordinated verification requirements.

In order to avoid unnecessary costs and trade obstacles, stakeholders suggested cooperation in the area of verification. This could take the form of mutual recognition between standards or verifications, or the use of international accreditation arrangements (e.g. International Laboratory Accreditation Cooperation/International Accreditation Forum) to facilitate the acceptance of verification results. The TBT Agreement encourages WTO members to accept verification and other conformity assessment results from other members, including through international and regional systems for conformity assessment, as a means to facilitate trade (Articles 6 and 9).

The availability of data plays an important role in monitoring, reporting and verification of emissions in line with decarbonization standards.[59] The type and granularity of data required under standards needs to consider both availability and confidentiality concerns. In some cases, steelmakers may not have reliable information available on scope 3 emissions associated with raw materials, which could create challenges in verification. Furthermore, relevant data may contain business confidential information, and steelmakers may not want to provide competitors or commercial partners with access to the information underlying calculations. Verification bodies can help to protect the confidentiality of underlying data, while giving confidence in the carbon footprint number provided to consumers.

Given the complexity of the steel industry and its large number of products, and the desire to avoid resource shifting and carbon leakage, there may also be a need to translate standards, definitions and thresholds to the level of specific steel products that are traded and verified internationally (as opposed to the current focus on process or facility-level measurement of crude steel emissions intensity). Such information is already being demanded by buyers and end-consumers. As mentioned above, there are various product-level efforts on EPDs and LCA (see Section 2.5) that may offer guidance in this direction, but there may be opportunities for greater international cooperation on priority steel products and verification.

One study focusing on the United States context, suggests concentrating efforts on finished products, including sheets, plates, bars, beams, pipes, and tubes (WRI, 2021). In any identification of products and associated verification, trade-offs between accuracy and practicality need to be considered, and associated data requirements and administrative burdens.

3.5 Developing country perspectives

A fifth consideration is fully considering the needs and participation of developing countries in efforts to advance and align decarbonization standards and GHG emissions measurement. These efforts should be inclusive of developing countries' perspectives and challenges so that standards reflect the realities in those economies. This is particularly important as emerging markets and developing countries are projected to account for around three-quarters of future growth in steel demand by 2050 (IEA, *et al*., 2022b; IEA, 2022a). Developing country producers can enjoy natural competitive advantages in low-carbon production (e.g. due to natural resources, climate or geography). However, they may bear the brunt in the net-zero transition, since they may lack data, capacities, technologies and resources to measure and verify the carbon content of their products.

Data requirements and assumptions

The data requirements and assumptions behind different standards and thresholds can create pitfalls for producers in developing countries. For instance, the use of default metrics for assessing emissions by those producers that cannot provide data is a potential pitfall, since it may disadvantage developing country producers that do not have historical data at their disposal, even in situations in which their steel products might have a low-carbon comparative advantage. If there are variances in the level and quality of data, different methodologies with different boundaries may not translate to all contexts.

In addition, the steel technology development pathway may not be linear for developing countries, and so their situation may not be well captured by a sliding scale of thresholds and measurements. Developing countries may start from a different performance baseline, such that much higher relative improvement at the facility level may be required to meet low or near-zero thresholds, as compared to steelmaking facilities in developed countries. For example, applying the GHG intensity metric of electricity grids may disadvantage developing country producers, to the extent it is considered (especially important for EAF), which may be at earlier stages of decarbonizing their electricity grid.[60] All of these divergences and assumptions can render the thresholds and timelines for steel decarbonization less appropriate for developing country producers.

Limited representation

Another challenge relates to limited representation of developing countries and their stakeholders in existing efforts to develop iron and steel decarbonization standards. While many of the ongoing initiatives are focused on being global, actual participation in their development is mainly from Europe and North America. Further efforts could be made to expand participation and to ensure inclusivity of these perspectives. Widening participation can extend the timeline of the standardizing process for reaching consensus. However, it can help to ensure a globally relevant standard that is widely used. Moreover, as explained below, developing country participation is one of the WTO's TBT six principles for international standards and is part of establishing which standards are in fact "international" for the global trading system.

New opportunities

At the same time, the transition of the steel industry and investments in breakthrough steelmaking technologies, in line with decarbonization standards, can present new opportunities for developing countries. New supply chains may open as steelmaking shifts to near-zero technologies and new inputs such as green hydrogen, and natural comparative advantage of developing countries could be exploited to allow them to integrate into these networks (IEA, 2022b). For example, there is potential for South Africa to enter into green primary iron production value chains (Trollip, *et al.*, 2022). Harmonizing decarbonization standards across the iron and steel value can be beneficial for developing countries to exploit these new opportunities.

Technical assistance and capacity building

Technical assistance and capacity building can help address these challenges and take advantage of opportunities. This could relate to supporting and building capacities in developing countries for emissions measurement and verification, so that they can effectively integrate into green global value chains and decarbonization measures do not create obstacles to their trade. Another area in which technical assistance can play an important role is on supporting effective participation in standard-setting efforts. Helping developing countries build a robust national quality infrastructure would boost their capabilities to measure and substantiate claims with respect to the carbon efficiency of their iron and steel inputs and products and to strenghten their participation in international standard-setting activities. Providing further support to developing countries in this area is essential for a just transition.

The urgency of stemming emissions from steel and other heavy industries calls for creative solutions to allow different groups to move at different paces.

The urgency of stemming emissions from steel and other heavy industries calls for creative solutions to allow different groups to move at different paces. Some countries and regions are ready to push forward with ambitious thresholds for decarbonization, while others will need additional time and support to make the transition.

4 ROLE OF THE WTO

The WTO can be part of the solution to ensuring harmonization, compatibility and comparability of decarbonization standards. While the WTO is not a standard-setting organization, it plays a central role in promoting international cooperation to enhance transparency in standards. The WTO, in bringing together a broad and inclusive membership of 164 members, offers a unique multilateral forum to harness international collaboration for decarbonization standards by:

- providing a robust global legal framework and guidance on the preparation, adoption and application of standards, including the promotion of international standards harmonization;
- offering transparency mechanisms and space for discussion of trade concerns to avoid trade tensions arising from a proliferation of different decarbonization standards;
- hosting specialized bodies and initiatives on trade, standards and environmental matters, which bring trade expertise to the table on decarbonization standards.

4.1 WTO's Agreement on Technical Barriers to Trade

The framework provided by the WTO's TBT Agreement sets out important disciplines for the preparation, adoption and application of regulatory measures and promotes harmonization with relevant international standards. Indeed, the TBT Agreement strongly encourages the use of relevant international standards when members enact technical regulations (see Box 4).

The WTO's TBT Agreement strongly encourages the use of relevant international standards when members enact technical regulations.

Box 4: Article 2.4 of the WTO's Agreement on Technical Barriers to Trade

Article 2.4 states:

"Where technical regulations are required and relevant international standards exist or their completion is imminent, Members shall use them, or the relevant parts of them, as a basis for their technical regulations except when such international standards or relevant parts would be an ineffective or inappropriate means for the fulfilment of the legitimate objectives pursued, for instance because of fundamental climatic or geographical factors or fundamental technological problems."

The TBT Agreement lends a presumption of conformity to measures that are prepared and adopted in accordance with international standards. Thus, technical regulations in accordance with relevant international standards are, *a priori*, considered not to create unnecessary obstacles to international trade (see Article 2.5). This is important in situations where governments decide to incorporate steel decarbonization standards, definitions and thresholds into their domestic regulations.

The TBT Agreement is also relevant to voluntary standards developed by government and non-governmental bodies. The Code of Good Practice for the Preparation, Adoption and Application of Standards, contained in Annex 3 of the TBT Agreement, sets out substantive and procedural disciplines on standards in general, such as the need to avoid discrimination and unnecessary trade barriers.

4.2 WTO guidance on developing international standards

The TBT Committee's Six Principles for the Development of International Standards, Guides and Recommendations[61] guide WTO members and standards setting bodies in the development of international standards, including organizations working to develop decarbonization standards. The way international decarbonization standards are set will have a decisive impact on the extent to which those standards could be used as a basis for convergence and thus facilitate trade.

The Six Principles aim to help international standards better facilitate global trade and to provide guidance in the areas of:

- transparency;
- openness;
- impartiality and consensus;
- effectiveness and relevance;
- coherence;
- development dimension.[62]

Applying the Six Principles ensures that, amongst others: (i) standards are transparent and made available to all interested parties; (ii) sufficient opportunities for written comments are provided; (iii) conflicting international standards are avoided; and, importantly, (vi) constraints facing developing countries are considered. These principles are widely followed by standards bodies seeking international relevance and are also increasingly incorporated in bilateral and regional trade agreements as an agreed way to identify international standards (McDaniels, *et al.*, 2018).

4.3 Benefits of convergence

Global proliferation of different decarbonization standards could create unpredictability for producers and lead to trade tensions. Situations in which climate change mitigation policies are based on different standards and carbon accounting methodologies may lead to businesses uncertainty and higher costs, and put the breaks on investment. Moreover, regulatory divergences across WTO members, mainly when they rely on different standards or verification systems, may unnecessarily restrict international trade.

If there is fragmentation of standards and verification systems, a producer exporting to several markets may find itself in a situation in which it needs to adapt to multiple methodologies and comply with different verification procedures. Without further convergence on carbon measurement standards and verification systems, countries may encounter difficulties implementing and cooperating on certain trade-related climate policies to decarbonize international trade. Ultimately, a proliferation of different standards and verification mechanisms may reduce the effectiveness of efforts to reduce carbon emissions from heavy industry.

A proliferation of different standards and verification mechanisms may reduce the effectiveness of efforts to reduce carbon emissions from heavy industry.

4.4 WTO forums

Owing to its broad and inclusive membership, specialized bodies on trade, standards and environmental matters, and transparency mechanisms, the WTO provides a unique forum in which members and other stakeholders could deepen international cooperation on decarbonization standards. Discussions at the WTO build awareness and mutual confidence in different members' systems. WTO members frequently share experiences and expertise, which helps to bring approaches closer and can open pathways for further convergence, including on decarbonization standards. The WTO provides several specialized trade forums to discuss decarbonization standards and to minimize unnecessary barriers to trade.

WTO Committee on Technical Barriers to Trade

The TBT Committee has discussed trade aspects relating to carbon footprint policies and methodologies.[63] This work of the TBT Committee in discussing specific trade concerns helps to promote transparency, provide clarification on proposed measures, and enhance alignment with international standards. It also serves as an interface between member governments and standard setting organizations that are observers to the TBT Committee to identify needs and gaps in standard development from a trade and regulatory point of view.

The work of the WTO TBT Committee in discussing specific trade concerns helps to promote transparency and clarification on measures and to enhance alignment with international standards.

The TBT Committee's work with standard setting organizations has helped address potential trade frictions and implementation challenges for members at different levels of development, and provides feedback which strengthens standards review and development. This makes the TBT Committee a valuable forum for technical discussions at the multilateral level on trade-related aspects of carbon measurement methodologies and verification procedures, as well as on ways to support developing countries in this area.

WTO Committee on Trade and Environment

Similarly, the WTO Committee on Trade and Environment (CTE) is an important forum for members, including developing countries, to exchange best practices and present and comment on recent regulatory proposals relating to climate change, including border carbon adjustments and sustainable supply chains. Discussions at the CTE have also addressed trade-related aspects of carbon footprint policies and methodologies.[64] Discussions at the CTE have underscored the importance of enhancing the availability of comparable and reliable information on the environmental impact of products.

Trade and Environmental Sustainability Structured Discussions

Other ongoing initiatives at the WTO could further support heavy industry decarbonization. For instance, the participants in the Trade and Environmental Sustainability Structured Discussions (TESSD), launched in 2020, work towards concrete actions to expand opportunities for sustainable trade, including by, identifying and compiling best practices in the development of trade-related climate measures. Decarbonization standards are an important element in discussions of the TESSD Working Group on Trade-Related Climate Measures, which, inter alia, envisages to undertake a review of the different forms of carbon measurement standards and measures intended to lead to a reduction in carbon emissions from a sectoral perspective.[65] Particular attention is given to the challenges and opportunities of micro, small and medium-sized enterprises, as well as developing and least-developed members.

International cooperation

There is room for further international cooperation on decarbonization standards at the WTO among its members, standards setting bodies and other relevant stakeholders. Cooperation on a sector-by-sector basis may be an effective means of building trust among stakeholders and serve as an incubator for further convergence on decarbonization standards at the multilateral level.

5 CONCLUSION

Decarbonizing the iron and steel industry value chain is critical for addressing climate change. However, a proliferation of initiatives, standards, definitions and performance thresholds for decarbonizing the iron and steel sector is contributing to a risk of fragmentation and inconsistency. This proliferation may give rise to uncertainty, transaction costs and trade frictions.

While there are a handful of well-established measurement standards, competing low-carbon or near-zero steel definitions and performance thresholds exist. There also needs to be more guidance and international cooperation on product-level steel standards, which presents an opportunity for collaboration to facilitate decarbonization and international trade.

Efforts to promote coherence of standards, definitions and performance thresholds need to ensure developing country perspectives are heard and addressed. Other key considerations identified are that standards 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 WTO can play a positive role in enhancing coherence and transparency of standards. WTO rules and guidance promote harmonization and best practices in the development of international standards, notably for developing country participation. Existing WTO forums, such as the TESSD, the TBT Committee and the CTE, can be harnessed for dialogue and cooperation on steel decarbonization standards and help to avoid unnecessary negative trade impacts.

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ENDNOTES

1 This is an information note which represents research in progress. It is based on consultations held with stakeholders at a private technical roundtable organized by the WTO in September 2022. The opinions expressed in this paper are those of its authors. They are not intended to represent the positions or opinions of the WTO or its members and are without prejudice to members' rights and obligations under the WTO. Any errors are attributable to the authors. The note was written by Mateo Ferrero, Devin McDaniels, Michelle Mokaya and Erik Wijkström.

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