Emissions Measurement and Data Collection for a Net Zero Steel Industry

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Abstract

The implementation phase for achieving a net zero steel industry will require robust methodologies for measuring emissions at the site- and product-level, together with data collection frameworks to facilitate comparison and track progress. An existing array of methodologies and frameworks for the steel industry provide a good starting point for efforts to achieve these outcomes, but much work remains to achieve interoperability, transparency and fitness for purpose for net zero. Following an evaluation of these existing methodologies and frameworks, this report provides "net zero principles" to guide potential next steps for their development and implementation, together with specific recommendations for G7 members.

In the context of Japan's G7 Presidency, the Ministry of Economy, Trade and Industry requested the International Energy Agency (IEA) to examine the topic of *Emissions Measurement and Data Collection for a Net Zero Steel Industry*. This work complements that undertaken during Germany's G7 Presidency in 2022 – *Achieving Net Zero Heavy Industry Sectors in G7 Members* – providing insights and direction for the G7 Industrial Decarbonisation Agenda with regard to tackling industrial emissions.

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Executive summary

The G7 can lead the way in defining a shared vision for the transition to a net zero steel industry. In May 2022, the G7 committed to accelerate the pace of decarbonisation in heavy industries, noting the "importance of decarbonising key industrial sectors to keep a limit of 1.5°C temperature rise within reach". Achieving this goal as part of a people-centred transition will require global effort. Through its economic weight and the international collaboration it can mobilise, the G7 is well-positioned to catalyse the net zero transition for the steel industry.

The steel industry faces challenges for substantially reducing its stubborn emissions while remaining competitive. The steel industry accounts for around 2.8 gigatonnes of CO_2 emissions per year, or 8%[1] of total energy system emissions**.** "Peak steel" may have come and gone for many advanced economies, but emerging market and developing economies are likely to see sustained growth in their domestic industries. Despite a strong push on material efficiency strategies, such as vehicle lightweighting or extending the lifetimes of buildings, steel will continue to be an essential input to infrastructure, buildings and mobility systems, as well as a critical enabler of the global energy transition. Near zero emission technologies for iron and steel production are still at early phases of development in many cases, and are often more costly than incumbent methods of production. This poses challenges for substantially reducing emissions from the steel industry, the products of which are traded in highly competitive global markets.

Common definitions require sound measurement and robust data. Common, practicable and internationally applicable definitions for GHG emissions performance enable multiple components of the policy toolbox for achieving deep emissions reductions in the steel industry. A commonly agreed emissions measurement methodology underpins a shared understanding of what constitutes near zero emission material production and products. G7 members have pioneered efforts to develop international standards that have facilitated positive change across many industries. The development of coherent, robust and consistent emissions measurement protocols, fit for a net zero steel industry, is an opportunity for the G7 members to demonstrate their technical capacities and abilities to forge international consensus.

Existing emissions measurement methodologies and data collection frameworks avoid the need to start from scratch. They provide a good starting

[1] 10% if indirect emissions from electricity generation are included.

point for efforts to establish a common basis for quantitative, comparative and international discussions on achieving a net zero steel industry. Several key emissions measurement methodologies for the steel sector are either currently under review or due to undergo review in the next two years. There is therefore an opportunity to work towards greater convergence and interoperability in order to strengthen emissions reporting in support of a net zero steel industry.

While several emissions measurement methodologies exist, further efforts are required to ensure that they are fit for purpose for a net zero steel industry. This report proposes net zero principles for emissions measurement methodologies for the steel industry that can serve as a basis for further discussion and iteration by G7 members and other stakeholders. The aim is for these common principles to guide ambition for revising existing methodologies and promoting convergence and interoperability in the medium term. An emissions measurement methodology should allow for comparison between production from all facilities. It should produce interoperable results for steel production and products, using an emissions boundary and scope appropriate for net zero and applying accounting rules for emissions credits and co-products that are compatible with the net zero goal. Finally, methodologies should incentivise the use of site- and product-specific auditable, measured data, as opposed to generic emissions estimates or factors**.**

Tracking progress on the transition to net zero will depend on improved data collection and reporting. A framework for collecting comparable data on steel sector emissions is an enabling mechanism for the net zero transition. This report proposes net zero data collection principles as a basis for the development and implementation of a Global Data Collection Framework for steel production and product emissions. A data collection framework that is fit for purpose for a net zero steel industry must facilitate maximum possible coverage and transparency, and accommodate the collection of highly granular data on GHG emissions. It should facilitate regular, parallel reporting using multiple measurement methodologies, while minimising the reporting burden as far as possible. No existing data collection framework – or combination thereof – fulfils all of these principles, although some aspects of existing frameworks provide a robust starting point.

G7 members can benefit from active engagement with the amendment and revision of emissions measurement methodologies. Clear standards for emissions measurement and data collection will be critical for incentivising and tracking emissions reductions in the steel industry, and G7 members can play a leading role in guiding future development of the industry. G7 members can also incentivise steel producers and other stakeholders in their countries to participate in efforts to make measurement methodologies and data collection frameworks fit for the net zero transition.

Recommendations for the G7

The G7 has led the world in developing standards, both via its members' national standard bodies and participation in international standard-setting organisations, and as part of various private sector initiatives. The Group's experience of pioneering efforts to initiate and propagate international collaboration mean that it can have a major impact on the rest of the world.

Time is of the essence. Many components of the policy toolbox for tackling emissions from heavy industries, as set out in the IEA's report for the 2022 G7 Presidency of Germany, rely on internationally coherent definitions of GHG emissions performance. Establishing an agreed emissions measurement methodology for the steel industry – and associated data collection frameworks – will be key to such efforts, and they should be in place by the middle of this decade. To this end, the IEA has developed five recommendations for consideration by G7 members:

1. **Avoid the creation of new emissions measurement methodologies for the steel industry and agree to focus efforts on tailoring existing international protocols, beginning with the five key emissions measurement methodologies identified in this report.** While acknowledging that existing methodologies require amendment and revision to achieve compatibility and fitness for purpose in the context of a net zero steel industry, the ISO 14404 series, ISO 20915, the worldsteel CO_2 and LCI methodologies and the ResponsibleSteel International Standard V2.0 (Principle 10) constitute a solid foundation for future work. These methodologies should be the focus of G7 members' initial efforts to achieve robust, transparent, and comparable emissions intensity data for steel production and products internationally. This initial list does not preclude the possibility of additions if deemed important by stakeholders engaged in revising the methodologies, but the list should remain focused to avoid unnecessarily prolonging the process.
2. **Endorse the "net zero emissions measurement principles" outlined in this report** as the guiding ambition for efforts to revise existing measurement methodologies, thereby promoting convergence towards best practice in the medium term. Sufficient interoperability should be achieved by the end of the next systematic review of the ISO 14404 and 20915 series, or by the end of 2025 at the latest. Notably, revisions should aim to achieve comparable emissions intensity data for crude steel production and intermediate products, for all existing and emerging process technologies, while noting the production route and the quantities of scrap and iron used.
3. **Engage actively in the amendment and revision processes for the existing five key emissions measurement methodologies, wherever possible.** In

dialogue with national standards bodies, G7 members should commit to engage actively in the forthcoming review processes of the relevant committees of the International Organization for Standardization (e.g. ISO/TC 17), with the aim of revising the ISO 14404 series and ISO 20915 standards in line with the "net zero emissions measurement principles" outlined in this report. G7 members should also strongly encourage steel producers operating within their jurisdictions to engage actively in the review processes and data collection exercises of worldsteel and ResponsibleSteel wherever possible, thereby supporting efforts to revise these methodologies in the pursuit of greater interoperability.

4. **Commit to implement a Global Data Collection Framework for steel production and product emissions in accordance with the "net zero data collection principles" outlined in this report.** The initial phase of implementation – using the existing worldsteel CO_2 (production) and LCI (product) methodologies – should be completed by the end of 2024, with the aim being an initial dataset for a high proportion of plants located in G7 member countries. This data would be submitted to one or more co-ordinating organisations for regional and site-based analysis, to further support the revision process. Potential candidates for the initial co-ordinating function include the IEA's Working Party on Industrial Decarbonisation, the Clean Energy Ministerial's Industrial Deep Decarbonisation Initiative and the OECD Steel Committee. The interim phase of implementation, in which multiple emissions measurement methodologies are used to compile increasingly interoperable datasets as the measurement methodologies are successively reviewed and amended, should be completed by the end of 2025. The transition to the final phase of implementation – ongoing tracking and measurement using interoperable and agreed measurement methodologies – should commence thereafter.
5. **Actively engage in inclusive technical dialogues and co-ordination activities for measurement methodologies and data collection for steel and other materials.** The landscape of different initiatives is increasingly crowded, reflecting growing interest from multiple countries on the topic of industrial decarbonisation, but this also poses challenges for co-ordination. The Industrial Decarbonisation Agenda of the G7 remains a leading forum for dialogue between governments. However, the Group should also engage in other dialogues, to support progress among a wider set of countries and minimise duplication, and to further engage with industry and other non-governmental stakeholders. G7 members should join and/or actively engage in technical dialogues on measurement methodologies and data collection, seek synergies with existing national data collection efforts, and extend the current focus on steel to other materials. The discussions in these fora should be elevated to other high-level dialogues (notably the Climate Club and the Group of Twenty [G20]) when political agreement is both necessary and plausible. The Breakthrough Agenda can support co-ordination to clarify the interactions between these various fora and initiatives.

Introduction

Emissions Measurement and Data Collection for a Net Zero Steel Industry is a report by the International Energy Agency (IEA), prepared for the 2023 G7 Presidency of Japan. The report provides reviews of existing greenhouse gas (GHG) emissions measurement methodologies and data collection frameworks for the steel sector. These reviews inform the report's recommendations for the Group of Seven (G7) on improving data availability, transparency and comparability, which if undertaken would constitute an important enabling step for the net zero transition of the steel sector.

Commonly agreed emissions measurement methodologies and emissions thresholds are the two principal components of definitions of what constitutes near zero emission material production and products. The report Achieving Net Zero Heavy Industry Sectors in G7 Members, prepared by the IEA as an input to the Industrial Decarbonisation Agenda (IDA) of the G7 in 2022, outlined the vital need for common definitions for accelerating progress on achieving substantial emissions reductions in these sectors. That report focused on emissions intensity thresholds for near zero and low emission steel and cement production, which were "recognise[d] … as a robust starting point" in the 2022 G7 Climate, Energy and Environment Ministerial Communiqué.

Box 1 Methodologies and standards

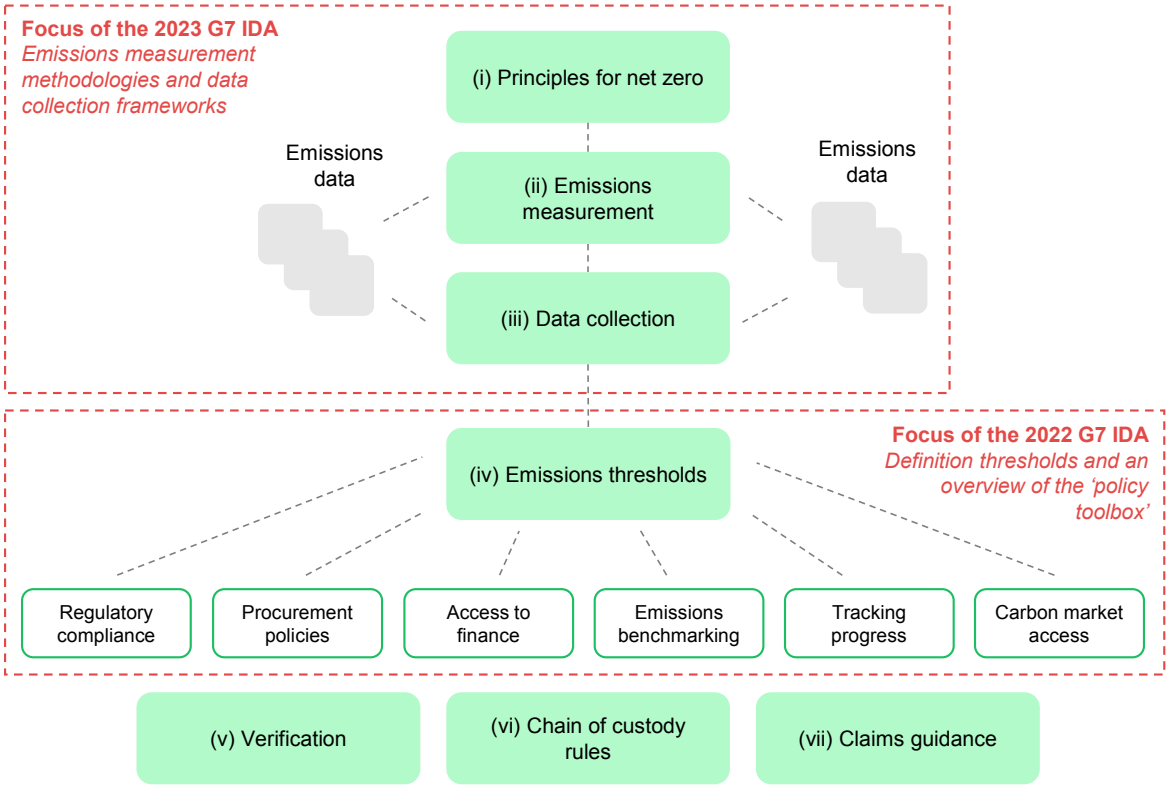
In common usage, the word standard can refer to both a measurement methodology and a normative threshold. The 2022 IEA report prepared for the G7 distinguished between measurement standards and normative standards, where the latter defines a specific threshold that may be reached using the measurement methodology. For greater clarity, given the use of these terms in different jurisdictions, this report refers to the measurement standard as a "measurement methodology", to avoid confusion with normative thresholds, which are not the focus of this report.

This report focuses on emissions measurement methodologies and their associated data collection frameworks. It comprises reviews of existing efforts for each (Chapter 1), which are used as a basis for the evaluations and suggested next steps (Chapter 2) for G7 members and other stakeholders. These include

phased approaches to how emissions measurement methodologies and data collection frameworks can be adjusted and developed to support the transition to a net zero steel sector, together with "net zero principles" to guide these iterative processes. Fitness for purpose must be appraised with a view both to existing methods of production and changes in global supply chains, as well as to innovative processes that can make a step change in the emissions footprint of steel production. Similar lessons can be drawn for other industrial materials.

Emissions measurement methodologies will be important for a number of applications in support of a net zero steel sector, including but not limited to emissions benchmarking, regulatory compliance, access to finance, procurement policies, progress tracking and carbon market access (see Figure 1). While there are likely to be a number of different measurement methodologies in use for these different purposes, it will be important that there is consistently measured data being collected and used by the steel industry, governments and stakeholders along supply chains.

Figure 1 The key building blocks for implementing standards in support of decarbonisation policies



This report focuses on the emissions measurement methodologies and data collection frameworks required to improve data availability, transparency and comparability in support of a net zero steel sector, building on previous IEA work on emissions thresholds and decarbonisation policies.

Note: IDA = Industrial Decarbonisation Agenda.

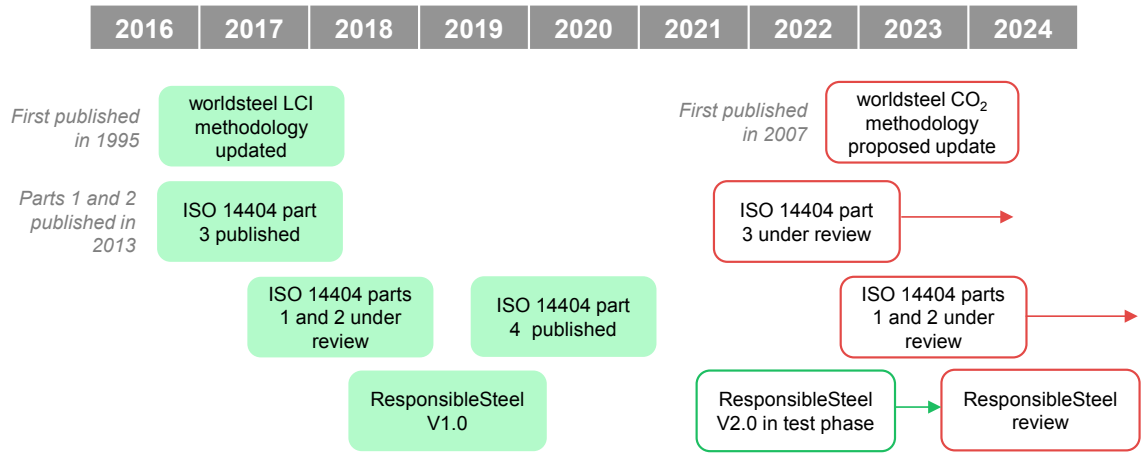
Chapter 1. Review of existing emissions measurement methodologies and data collection frameworks

Emissions measurement methodologies

An emissions measurement methodology is a measure, norm, or model used in comparative evaluations. More specifically, an emissions measurement methodology can typically be defined as a method or model used to evaluate emissions. In this review, emissions measurement methodologies fall into two broad categories: those that are specific to steel production or products; and those that are for general emissions reporting but can be applied to steel production (or some part of the supply chain).

Product-level standards are often associated with detailed lifecycle assessment (LCA) methodologies that factor in a range of environmental and other impacts, beyond just greenhouse gases (GHG). Production-level standards are used more frequently for performance benchmarking between facilities, and often require less granular data than existing product-level standards.

Figure 1.1 Timeline for the publication and review of key emissions measurement methodologies in the steel sector



Several emissions measurement methodologies for the steel sector are either currently under review or will be under review within the next two years.

Note: Red box indicates an opportunity for review or update to standard or methodology.

The scope of this review covers those emissions measurement methodologies that are: designed for use internationally; can produce site- and/or product-level GHG emissions measurements; and facilitate like-for-like comparisons between facilities (or have the potential to be adapted to do so). As a result, several more generic or less detailed protocols are not included or are briefly covered in the "other relevant emissions measurement methodologies" section towards the end of this chapter. A summary of this review is included in the following Table 1.1.

Table 1.1 Summary of emissions measurement methodologies for the steel sector

Measurement standard	Current status and frequency of review	Focus of the standard	Verification and accreditation
worldsteel CO_2 methodology	Latest guidance published in 2023, regular review is possible.	Production (all routes)	NA
worldsteel LCI methodology	Latest guidance published in 2017, regular review is possible.	Product (covering 17 finished products)	NA
ISO 14404 series	Part 1 and 2 under review from 2023, part 3 under review from 2022, part 4 under review from 2025. Systematic review every 5 years.	Production (all routes, specific standards for BOF, scrap EAF, DRI)	NA
ISO 20915: 2018	Under review from 2023. Systematic review every 5 years.	Product (exact products not specified)	NA
ResponsibleSteel	V2.0 published in 2022; V2.1 to be published Q4 2023 following a test phase Standard revision at least every 5 years; next version due Dec 2024.	Production (all routes) and products	Independent verification
WRI GHG Protocol Corporate Standard	Last published in 2008, no plans for update.	Production BOF, scrap EAF, DRI	Independent verification
Emissions trading systems, e.g. EU ETS	Last update published in 2018.	Production (all routes)	Independent verification
Science Based Targets initiative	Under consultation.	Production (all routes)	Under development
Sustainable STEEL Principles	Launched in 2022.	Production (all routes)	[checking]
CBI Steel Criteria	Launched in 2022.	Production (all routes)	Standard body

Notes: LCI = Life Cycle Inventory; BOF = basic oxygen furnace; EAF = electric arc furnace; DRI = direct reduced iron; WRI = World Resources Institute; EU ETS = European Union Emissions Trading System; CBI = Climate Bonds Initiative.

World Steel Association (worldsteel)

The World Steel Association (worldsteel) is an international industry association focused on the steel sector. It was established in 1967 and has activities covering health and safety, steel market analysis, education and training, and sustainability, among others.

Membership

worldsteel currently has 92 “regular members”, who are comprised solely of companies that have raw steel production and operate as a commercial enterprise. It also has a large number of “affiliated members” who are comprised of various associations of steel producers, technical societies and institutes related to the steel sector. Members of worldsteel represent around 85% of global steel production.

Governance process

As a private sector body, the work of worldsteel is guided by its industry members. An Executive Board of Directors oversees this work, supported by an Executive Committee, Audit Committee and Nominating Committee. Voting rights among the members are not made publicly available, although all members have at least one vote.

The process for reviewing, updating and confirming the worldsteel emissions accounting methodologies is carried out by separate expert stakeholder groups. More detail on these can be found below.

worldsteel CO_2 methodology

Measurement methodology overview

The worldsteel CO_2 methodology provides production-level emissions measurement guidelines, which calculates an overall site CO_2 intensity irrespective of the product portfolio or location of the site. The methodology is based on a site CO_2 balance, looking at inputs and outputs, covering all existing processes declared as essential (including downstream operations) in the worldsteel user guide. It was initially intended for use within steel companies to compare the performance of steel production facilities over time, as opposed to cross company comparison. The methodology for this data collection was used as the basis for the now published International Standard ISO 14404 (covered in more detail below).

The total emissions from a site are calculated by adding together the quantity of different fuels and materials being used at a facility or purchased as intermediate products (such as coke or sinter), multiplied by their respective emission factor, which also includes process emissions. This is divided by the crude steel production to derive an average CO_2 intensity. worldsteel publishes the global average emission intensity in their annual Sustainability Indicators report. The 2022 report published for the first time overall average emissions intensity by main process route, including blast furnace with basic oxygen furnace (BF-BOF), direct

reduced iron-electric arc furnace (DRI-EAF) and scrap electric arc furnace (scrap EAF). Emissions intensity data at a plant, national or regional level is not made publicly available.

The process for reviewing, updating and confirming the emissions measurement methodologies is carried out by worldsteel staff and supported by a sub-group of worldsteel members called the CO_2 expert advisory group. This is a smaller, geographically representative group of participants from steel companies. They meet on an ad-hoc basis, as per members' interest in revising or discussing certain elements of the emissions measurement methodology.

Coverage

worldsteel's current database (2022) includes data from more than 220 sites. These represent approximately 485 Mt of steel production, or 25% of global production. The potential coverage of such a data collection programme, assuming all worldsteel members submitted data, would total around 1 600 Mt of steel production.

Emissions scope

Direct: fossil fuel use in ironmaking, steelmaking and iron ore agglomeration, producing reducing agents; and downstream, on-site processes, e.g. rolling and direct-off gases. Indirect: electricity, heat and hydrogen; raw materials manufacture; fossil fuel transport and supply, e.g. upstream fugitive methane. Indirect emissions from transport of raw materials are not included.

This only includes CO_2.

worldsteel LCI methodology

Measurement methodology overview

The worldsteel LCI (life cycle inventory) methodology was established in the mid-1990s as a methodology for measuring the environmental impact from the production of a number of steel products. Data is collected on a process-by-process and site-by-site basis for all steel production routes. The most recent version of the methodology was updated in 2017 (LCI methodology report). Data has been submitted by worldsteel members in 1995, 2000, 2010, 2017, 2018, 2019, 2020, 2021 and 2022. The LCI datasets currently cover 17 different finished steel products.[2] Other products can be included if sufficient data are received from the worldsteel participating members. Prior to 2017, this data was

[2] Plate, hot rolled coil, pickled hot rolled coil, cold rolled coil, finished cold rolled coil, hot-dip galvanised steel, electro-galvanised steel, rebar, sections, UO pipe, welded pipe, seamless tube, wire rod, tinplate, tin-free electrolytic chrome coated steel, organic coated and engineering steel.

updated approximately every 5 years, but a proportion is now updated annually, with data older than 5 years being removed.

As part of the environmental impact assessment, GHG emissions can be calculated, alongside all other impacts such as acidification, ozone depletion and resource depletion. This type of impact assessment is based on ISO 14040:2006 and ISO 14044:2006, which cover generic LCA requirements, guidelines, principles and a framework. Likewise, the worldsteel LCI methodology is the basis for ISO 20915 (see below), which is a steel-specific LCA measurement methodology.

The process for reviewing, updating and confirming the methodology takes place in worldsteel's LCA Expert Group, which consists of LCA experts from member companies and associations around the world and which meets on a regular basis. Data checks and results generation are carried out by worldsteel staff, with the input of the data-providing steel companies.

Coverage

worldsteel currently collects LCI data from more than 160 sites from over 45 of its steel-producing members, equating to around 400 Mt of steel production. The potential coverage, assuming all members submitted data, would total over 1 600 Mt of steel production.

Emissions scope

Direct: fossil fuel use in ironmaking, steelmaking and iron ore agglomeration, producing reducing agents; and downstream, on-site processes, e.g. rolling, direct-off gases. Indirect: electricity, heat and hydrogen; fossil fuel transport and supply; raw materials manufacture; raw materials transport and supply; and waste treatment and associated processes.

All GHG emissions, including CO_2, CO, CH_4 and N_2O.

International Organization for Standardization (ISO)

The International Organization for Standardization (ISO) is an independent, non-governmental international organisation with a membership of 167 national standards bodies. Established in 1946, it has since established nearly 25 000 international standards, agreed and revised through 810 technical committees and subcommittees.

Membership

The 167 national standards bodies span all regions of the world. Countries with member bodies generate around 98% of the world's gross national income and

represent around 97% of the world's population. All countries in North America, Europe and Oceania have put forward either a full member body or correspondent member. Africa is currently the least well represented, although even in this region, only 9 out of 45 countries are not members of ISO. While all regions have an opportunity to participate, the participation in different technical committees varies widely, depending on members' interest and the nomination of relevant technical experts.

Governance process

International standards are prepared by technical committees made up of representatives from respective national standards bodies, as well as relevant technical experts and potential users from liaison organisations. Any member body interested in a subject covered by a technical committee is able to participate, either as a participating member or an observing member. Participating members are able to provide technical comments and vote to confirm, revise/amend, withdraw, abstain due to lack of consensus or abstain due to a lack of national expert input. Participants in ISO committees are asked to uphold the principles in the ISO Code of Conduct.

New technical committees are established when a member body (or multiple member bodies) submits an application to the Technical Management Board (TMB) that oversees the more than 250 technical committees that currently exist. The TMB aims to minimise duplication of standards, assess gaps in the standards landscape and monitor the overall work of the technical committees, among other tasks.

To revise existing standards or measurement methodologies, each standard is subject to a 5-yearly systematic review, where member bodies under the relevant technical committee are given an opportunity to provide technical comments on the current standard. This, in turn, informs member bodies' decisions to either confirm, revise/amend, withdraw, abstain due to lack of consensus or abstain due to lack of national expert input.

To support the alignment of standards where necessary, ISO has established a Committee for Conformity Assessment (CASCO). CASCO publishes standards related to conformity assessment, but it does not perform conformity assessment activities itself. CASCO standards (ISO/IEC 17000 series) contain requirements for competence, impartiality and consistent operation, which serve as a basis for recognising the reliability of conformity assessment bodies.

Importantly for steel and other highly traded products, ISO applies the World Trade Organization (WTO) Technical Barriers to Trade (TBT) Six Principles in the

preparation of International Standards. The aim of these principles are to ensure that international standards do not create technical barriers to trade and are globally relevant.

In 2021, ISO approved the London Declaration, which commits the organisation to actively consider climate science and associated transitions in the development of all new and revised international standards and publications, and to enhance the role of civil society in the development of standards. As part of this work, ISO is undertaking a review of all existing standards to identify those that are highly relevant to climate action and to revise them in order to increase their impact. ISO will then carry out a gap analysis to assess whether any new standards will be required to support the transition to net zero. This process is ongoing, although steel will likely be a focus, given the emissions of the sector.

In 2022, ISO launched their Net Zero Guidelines at COP27. These provide information on defining net zero, setting high-level principles for climate neutrality, actionable guidance for getting there, and guidelines for how to transparently communicate, make credible claims and consistently report on emissions, reductions and removals.

ISO 14404 series: Calculation method of carbon dioxide emission intensity from iron and steel production

Measurement methodology overview

The ISO 14404 series is a set of three measurement methodologies and one guidance document that covers emissions from steel production by process route. This includes the BF-BOF route (part 1), scrap EAF route (part 2), and the DRI-EAF route (part 3). Part 4 of ISO 14404 comprises general guidance on using parts 1, 2 and 3, including on which measurement methodology to apply when a combination of steelmaking operations exists on site. ISO 14404 is based on the worldsteel CO_2 methodology, but is not identical to it.

Parts 1 and 2 were established in 2013 and last reviewed in 2018. They are up for review again from April 2023. Part 3 was published in 2017 and came up for review in 2022; the relevant ISO committee, Technical Committee 17 (ISO/TC 17), voted to open the review process, which is currently underway. Part 4 was first published in 2020 and will come up for review in 2025.

Coverage

ISO/TC 17 has 27 participating members and 40 observing members (as of March 2023). ISO 14404 has been adopted as a national standard or is available for purchase under the national standard body from 18 of the 67 members (in addition to the European Committee for Standardisation [CEN]). Use by companies varies

significantly by country. Should all members of TC 17 adopt ISO 14404, this would cover around 1 750 Mt of steel production, or close to 90% of global steel production.

Emissions scope

Direct: fossil fuel use in ironmaking, steelmaking and iron ore agglomeration, producing reducing agents, and downstream, on-site processes, e.g. rolling, direct-off gases. Indirect: electricity, heat and hydrogen; indirect raw materials manufacture. Indirect fossil fuel and raw materials supply are not included.

This only includes CO_2.

ISO 20915: Life cycle inventory calculation methodology for steel products

Measurement methodology overview

ISO 20915 is a product-level measurement methodology introduced in 2018. It was developed using the worldsteel LCI methodology as a guide. As a result, it is very similar to the worldsteel LCI methodology, with two main differences. First, the impact of scrap processing is outside the scope and boundary of this methodology. Secondly, ISO 20915 uses credits for process gases, based on the savings from replacing the marginal energy for the country where the facility is located (including both heat production and the electricity generation mix). ISO 20915 does not specify which products can be covered or not but is applicable to a wide range of key steel products. This standard is up for review in 2023.

Coverage

ISO/TC 17 has 27 participating members and 40 observing members (as of March 2023). The countries that have adopted ISO 20915 are not widely reported. Should all members of ISO/TC 17 adopt ISO 20915, this would cover around 1 750 Mt of steel production, or close to 90% of global steel production.

Emissions scope

Direct: fossil fuel use in ironmaking, steelmaking and iron ore agglomeration and producing reducing agents; and off-gases. Indirect: electricity, heat and hydrogen; indirect fossil fuel and raw material supply; and waste treatment and associated processes.

All GHG emissions, including CO_2, CO, CH_4 and N_2O.

ResponsibleSteel

ResponsibleSteel is an independent, non-governmental organisation with a multi-stakeholder membership base, including business and civil society. It focuses on standards and certification in the steel sector. The first version of the ResponsibleSteel International Standard was published in 2019, with an update published in 2022. The standard covers a range of environmental, social and governance (ESG) issues, going beyond GHG emissions. Members commit to recognise the ResponsibleSteel International Standard, with steelmaking businesses strongly encouraged to start the certification process for their sites.

Membership

ResponsibleSteel currently has 58 business members (as of March 2023), who consist of steelmakers, raw material suppliers, and downstream users. Members are relatively geographically diverse, with a concentration in Europe but also members in the United States, Brazil, Korea and India. These members cover around 272 Mt of global steel production, or 14% of global production. ResponsibleSteel also includes 13 civil society members and 66 associate members, including governmental organisations, trade associations, standards bodies, conformity assessment bodies and academic institutions.

Governance process

The ResponsibleSteel International Standard was developed over several years ,involving discussions with their members from across industry and civil society, as well as several public consultation periods. Ultimately, the requirements of the standard are approved through a membership vote, requiring a majority of both business and civil society membership groups. The standard development process and related governance considerations follow the International Social and Environmental Accreditation and Labelling Alliance's (ISEAL) Standard-Setting Code of Good Practice.

ResponsibleSteel International Standard V2.0 (principle 10)

Measurement methodology overview

The ResponsibleSteel International Standard V2.0 was released in September 2022, structured around 13 principles. These cover corporate leadership; social, environmental and governance management systems; responsible sourcing of input materials; decommissioning and closure; occupational health and safety; labour rights; human rights; stakeholder engagement and communication; local communities; climate change and GHG emissions; noise, emissions, effluents and waste; water stewardship; and biodiversity.

Principle 10, which relates to climate change and GHG emissions, includes seven subsections covering elements on financial disclosure, emission reduction targets and selling of products, as well as the emission accounting methodology. Criterion 10.3 covers site-level emissions accounting and 10.4 covers rules for embodied emissions at the level of crude steel production. 10.6.4 covers product requirements, which are aligned with the worldsteel LCI methodology and ISO 20915 requirements. The ResponsibleSteel Standard also covers definitions for low emission steel, which are not the focus of this report.

Where possible, ResponsibleSteel relies on existing emissions accounting guidance, including ISO standards (14404, 14064, 20915), the worldsteel LCI methodology, the GHG Protocol and EN 19694 (an emissions accounting methodology published by CEN).

To incentivise the reporting of primary data under this measurement methodology, ResponsibleSteel applies a "burden of doubt" approach, where conservative assumptions are used to fill data gaps. Depending on the fuel or material, this results in companies being required to use a top decile figure, the top end of the error bars for a range of LCA data within a database, or a default additional percentage (e.g. +20%, +60%). As a result, suppliers that have invested resources in measuring actual GHG emissions will benefit. This differs from the ISO and worldsteel methodologies, which tend to use default factors based on global averages.

Coverage

ResponsibleSteel currently has 58 corporate members, but not all of these yet have sites certified against the standard. Currently, 56 sites belonging to 7 member companies have valid certificates, covering 106 Mt of steel production, of which 36% are scrap EAF and 64% are BF-BOF sites. Additionally, 12 sites owned by 6 member companies are participating in ongoing or upcoming audits. No products have yet received ResponsibleSteel certification.

Emissions scope

Direct: fossil fuel use in ironmaking, steelmaking and iron ore agglomeration and producing reducing agents; and direct-off gases. Indirect: electricity, heat and hydrogen; and indirect fossil fuel and raw material supply.

All GHG emissions, including CO_2, CO, CH_4 and N_2O.

Emissions scope summary

The main difference in using these measurement methodologies is that they often use distinct emission scopes and factors, often to meet different purposes. As a result, use of the methodologies does not result in the collection of directly

comparable data, even if comparison can be made possible with an amendment or additional calculation. Table 1.2 summarises the emissions boundaries for the five key emissions measurement methodologies covered in this report.

Table 1.2 Summary of emissions boundaries for key measurement methodologies

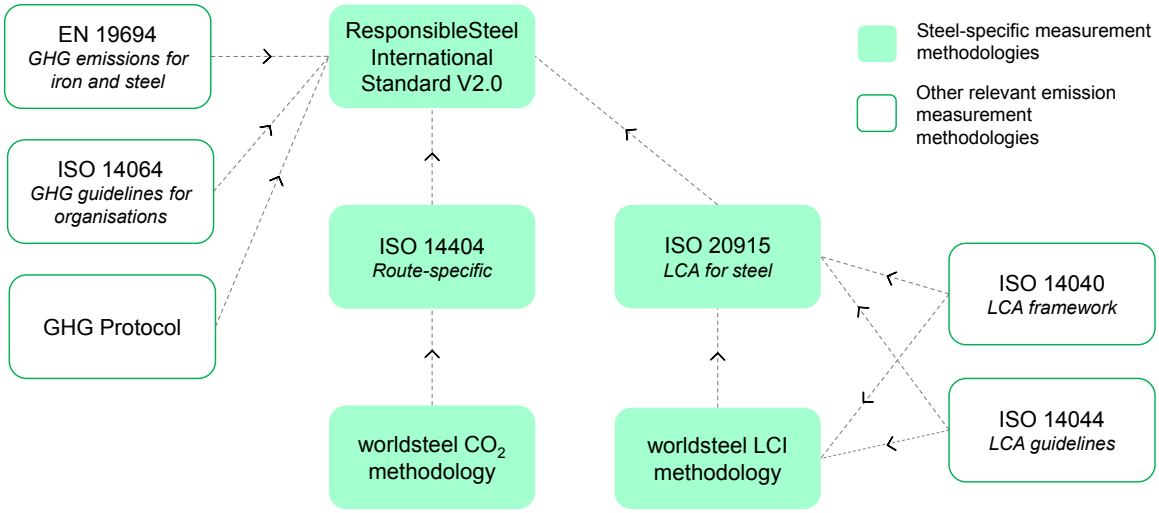
Emissions category		worldsteel CO_2 methodology	worldsteel LCI methodology	ISO 14404	ISO 20915	Responsible Steel International Standard V2.0 (Principle 10)
Direct	Fossil fuel use in ironmaking	✓	✓	✓	✓	✓
	Fossil fuel use in steelmaking and iron ore agglomeration	✓	✓	✓	✓	✓
	Fossil fuel use in producing reducing agents	✓	✓	✓	✓	✓
	Off-gases	✓	✓	✓	✓	✓
	Fossil fuel use in downstream, on-site processes, e.g. rolling	✓	✓	✓	✓	✓
Indirect	Electricity, heat and hydrogen	✓	✓	✓	✓	✓
	Fossil fuel supply, e.g. upstream fugitive methane		✓		✓	✓
	Raw materials manufacture	✓	✓	✓	✓	✓
	Raw materials supply		✓		✓	✓
	Waste treatment and associated processes		✓		✓	✓
GHGs		CO_2	All GHGs	CO_2	All GHGs	All GHGs

Interactions between key emissions measurement methodologies

Many of these measurement methodologies interact heavily with one another, relying on one or more standard or methodology to inform different elements of the measurement. This is to avoid duplication between these standards, where an

existing standard already provides adequate guidance. These interactions can become complicated in the instance that standards are revised in line with differing governance processes and review timelines at the various organisations. There are several formalised efforts to manage these interactions, either through agreed principles (e.g. WTO TBT Six Principles) or joint standardisation technical committees that aim to co-ordinate the work of multiple standards bodies (e.g. ISO/IEC JTC 1, which brings together ISO and the International Electrotechnical Commission [IEC] for work relating to information technology standards).

Figure 1.2 Main interactions of the existing emissions measurement methodologies for the steel sector



The existing emissions measurement methodologies for the steel sector interact with other standards, based on which existed first and the different intended purposes.

Note: Arrows indicate if a measurement methodology relies on or draws from another.

Other relevant emissions measurement standards, methodologies and guidance

ISO 14064:2018 is a series of standards that specifies principles and requirements for quantifying and reporting GHG emissions and removals at the organisation level. It is not specific to steel but has been applied to steel facilities. The standard was developed under ISO Technical Committee 207, which focuses on environmental management (including GHGs and climate change).

ISO 14067:2018 sets out the requirements and guidelines for quantifying the carbon footprint of products. This standard was also developed under Technical Committee 207 and is not specific for the steel sector but can be applied in multiple sectors.

ISO 21930:2017 establishes the principles, specifications and requirements to develop an Environmental Product Declaration (EPDs) for construction products and services, including certain steel products. To produce an EPD, a common set of Product Category Rules (PCRs) are required to set guidance on the emission calculation methodology and emissions scope, similar to an emissions accounting standard. EPDs and PCRs are widely used in the construction sector, although are at an early stage of development and use in other steel end-use sectors. Guidance for steel products is either under development or already published in several jurisdictions, and it will be important for this guidance to align with existing accounting standards. One key example is the European Union's Product Environmental Footprint (PEF), which is designed to make emissions measurement and benchmarking more consistent and robust, while minimising proliferation of methods and the potential for greenwashing. A steel-specific PEF has not yet been developed, although metal sheets were investigated during the pilot stage.

The GHG Protocol from the World Resources Institute (WRI) is a widely used global standardised framework that provides guidance on the measurement of GHG emissions. The WRI is not a standards body and does not verify or certify measurements based on the GHG Protocol methodologies. The Protocol for Corporate Standard for steel covers CO_2, CH_4 and N_2O emissions at the site level. The GHG Protocol is widely used by the private sector, with 9 in 10 Fortune 500 companies using their methodology. The Corporate Standards and Guidance are currently under review and the steel guidance has not been updated since 2008.

The Science Based Targets initiative (SBTi) is a private sector initiative, which works with companies to first benchmark emissions, before setting emission reduction targets for different levels of ambition. The SBTi guidance for the steel sector is planned for launch in Q2 of 2023, following extensive consultation with industry and civil society. In line with wider SBTi Criteria for near-term targets, the consultation document proposes including 95% of scope 1 and 2 emissions and only including scope 3 emissions where this represents more than 40% of total emissions. For long-term (or net zero) targets, all scopes should be included in the assessment. Due to the specific use of SBTi targets and emissions accounting at a company level only, the approach proposed in the SBTi guidance is not suitable for comparing steel products between different producers.

Emissions trading systems (ETS) often require steel producers to gather data on emissions from steel production. For example, the European Union's Emissions Trading System (EU ETS) has been in place since 2005, requiring major steel production facilities to annually report direct emissions data covering CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. Currently, different ETS have different accounting methodologies, leading to potentially significant differences between the emissions being recorded for similar products.

The Sustainable STEEL Principles (SSP) are a measurement and disclosure framework for the financial sector that enables banks to assess and publicly disclose the alignment of their steel lending portfolios with the goal of net zero emissions by 2050, in line with the requirements of the UN-convened Net-Zero Banking Alliance. In order to do so, banks gather information on the emissions intensity and scrap charge of their clients in the steel sector. The SSP set out a fixed system boundary for reporting emissions that covers all scope 1 and 2 emissions and some scope 3 emissions (not including indirect emissions from fossil fuel transport and supply, e.g. upstream fugitive methane). The SSP will introduce a requirement that steel producers provide limited assurance on reported data starting in 2024. In 2023, the Sustainable STEEL Principles Association signed a Memorandum of Understanding with ResponsibleSteel to support further harmonisation between the two organisations' standards.

The Climate Bonds Initiative has developed Steel Criteria as a Climate Bonds Standard to assess projects for their inclusion in a Certified Climate Bond. To assess GHG emissions from projects, the Steel Criteria uses ISO 14404, EN 19694 and the GHG Protocol. The standard uses the same fixed system boundary as the Sustainable STEEL Principles and is also an Associate Member of ResponsibleSteel.

The Intergovernmental Panel on Climate Change (IPCC) updated their 2006 guidelines for national greenhouse gas inventories in 2019, including for the iron and steel sector. Three methods are provided: tier 1, based on national production data and default emissions factors; tier 2, which takes a carbon mass balance approach using national data on the inputs and outputs of carbonaceous materials; and tier 3, which is based on the use of stack measurements and/or modelling results. In all instances, the greatest level of granularity of reporting required is at the national level, even if this may be supported by more granular site-level data.

The Global Steel Climate Council (GSCC) is an international coalition of steel producers and steel associations that is planning to release a new standard in April 2023. The proposed standard will aim to include both emissions accounting rules and definitions for low emission steel, although specific details are not yet available.

Data collection frameworks

A data collection framework is defined as a common structure for multiple organisations to collect, manage and share data. Once collected, the data can be shared publicly or privately among a certain set of members within an organisation. The organisation that hosts such a data collection framework often plays a role in ensuring consistency between the submitted data. This report

provides a review of data collection frameworks that collect emissions data for the steel sector, in particular those that specify an emissions measurement methodology to ensure consistency of the collected data.

This section covers those frameworks that currently collect detailed data on steel sector emissions. This list is non-exhaustive and is summarised in Table 1.3.

Table 1.3 Summary of data collection frameworks for the steel sector

Data collection framework	Transparency	Granularity of reporting	Frequency
worldsteel CO_2 methodology	Global averages at the route level are published	Site-level data by process route	Annual
worldsteel LCI	Global and some regional average values by product are reported	Data collected for all main process routes and products, per process and per site	Annual is possible, although not all steel producers update annually
ResponsibleSteel	Currently no data published but companies have an option to publish site level data or across a group of sites	Data collected for all main process routes and products, per process and per site	Every 18 months
IEA World Energy Balances	Data highlights are public; payment required for full access	National level by sector	Global data updated annually
IEA Energy Efficiency Indicators	Data highlights are public; payment required for full access	National level by subsector	Global data updated annually
CEM IDDI	Not yet reporting	Not yet reporting	Initial reporting in 2023; frequency not yet known
GEM Global Steel Plant Tracker	All data is public	Site level capacity and process route only	Annual
UNEP International Methane Emissions Observatory	Estimates are intended to be fully disclosed	At the site level for methane only	Not yet reporting
EU Emissions Trading System	Sectoral totals are published	At the site level for direct emissions only	Annual

World Steel Association (worldsteel)

worldsteel collects site level CO_2 data from its members on an annual basis using its CO_2 methodology under the Climate Action data collection programme. Around half of the steel producers in worldsteel, or 25% of total global production, are currently providing this data on a voluntary basis. This data is made available to worldsteel members in the form of a confidential report, summarising the respective company-level emissions intensities on a site-by-site basis. A subset of this data is made public via worldsteel's Sustainability Indicators report, which publishes global average emissions intensity data (since 2007). The LCI data collection is undertaken annually and released for 17 global and regional products, although not all companies provide new data on an annual basis. Data that is

more than 5 years old is removed from the database. Further information can be found in their Life cycle inventory (LCI) study.

ResponsibleSteel

ResponsibleSteel collects emissions data from its certified sites. This amounts to 56 sites from 7 member companies, with ongoing or upcoming audits for 12 sites. Data are gathered and verified once every 18 months and each certified site is revalidated every 3 years. This data will be made public in future, as per the requirements of the standard. Claims and chain of custody workstreams on material traceability are under development to provide guidelines for sites and steel users wanting to make validated emissions and sustainability claims about ResponsibleSteel certification.

Other relevant data collection frameworks and initiatives

The IEA currently has two data collection frameworks in place that are relevant for the steel sector. These data are either provided by IEA member countries or collected from publicly available data sources. This includes the Greenhouse Gas Emissions from Energy data product, where emissions in the iron and steel sector are estimated from energy data in the World Energy Balances. This provides a national level estimate for energy and emissions from steel production and other manufacturing sectors, although it does not provide the site level data required to inform many of the potential uses set out in Figure 1.1. This data is made publicly available at a summary level.

The other data collection framework administered by the IEA that is relevant here is the Energy Efficiency Indicators database. This database contains annual data from the year 2000 onwards, covering energy consumption and emissions by energy product, and by end use, as well as associated indicators across four sectors of final consumption (residential, services, industry and transport) for IEA member countries and beyond. The data is submitted to the IEA via an annual questionnaire. Data on the manufacture and casting of iron and steel is collected as a subset of basic metals. There is also an option to submit data on subcategories of iron and steel production, including by BOF and scrap EAF routes. Again, the purpose of this database is the collection of data at the national level and therefore no details at the plant level are provided. This data is made publicly available at a summary level.

In 2021, the Clean Energy Ministerial launched the Industrial Deep Decarbonisation Initiative (IDDI) to focus on green public procurement, standards and data, with an initial focus on the steel and cement sectors. IDDI is a country-led initiative, in close collaboration with business and civil society organisations, and is focusing on the technical details around standards and procurement policy

to support its country members in making public commitments. IDDI is working towards a project to pilot embodied carbon data collection and sharing, with a focus on steel, cement and concrete. This project will initially start with up to three countries, with plans to scale to other countries in the future. The project aims to facilitate a better understanding of the real-world challenges of collecting, sharing and comparing such data, to inform future policy. It is not yet clear whether or not the data collected by IDDI will be made publicly available.

In terms of civil society efforts to gather and publish data on the steel sector, the Global Energy Monitor (GEM) launched the Global Steel Plant Tracker, which tracks steel plants that have been proposed since 2017, or retired or mothballed since 2020. This covers plant-level data on the development status (operating, mothballed, proposed, construction, closed), production method (by main routes) and capacity (for both iron and steel separately). The GEM database is updated on an annual basis and represents the most comprehensive effort to aggregate and disclose key production method and capacity data for public use. Given its open publication and free use, the GEM database has become a vital data source for the academic, NGO and advocacy community. However, detailed emissions data informed by actual production information at the site level is not available.

The UN Environment Programme (UNEP) launched the International Methane Emissions Observatory (IMEO) to improve the collection of methane emissions data and target strategic mitigation action. In relation to activities for the steel sector, UNEP is currently developing the Metcoal Methane Partnership (MMP) together with the coal industry and relevant initiatives, such as ResponsibleSteel. The aim of MMP is to make detailed methane emissions data available to steel companies to better inform them of their upstream emissions impact. In addition, metallurgical coal producers under MMP will commit to reducing their emissions from coal mining. The MMP can play a vital role in improving the data collection process for methane emissions, which will be important to include within the scope of both emissions measurement methodologies and normative thresholds. While it does not represent a complete solution in terms of gathering and publishing data on steel sector emissions – as that is not its stated aim – it will likely be an important initiative to facilitate reporting in line with the recommendations set out in this report.

As well as providing important guidance around methodologies for various products, emission trading systems also represent data collection frameworks that can support wider analysis. For example, under the EU ETS, data is made available to the public under a data viewer, which provides breakdowns by industrial subsector, including the production of coke, the production and processing of ferrous metals and the production of pig iron and steel. Site level data is collected but it is not yet made publicly available.

Chapter 2. Evaluation and potential next steps

The emissions measurement methodologies and data collection frameworks reviewed in Chapter 1 constitute a starting point for efforts to establish a common basis for quantitative, comparative and international discussions on achieving a net zero steel industry. This chapter begins with an evaluation of some of the key insights that emerge from those reviews. It focuses on the relative merits of five key measurement methodologies with respect to: their governance and participation; their current and potential future usage; and their fitness for purpose for international comparative assessments and a net zero steel industry. This is followed by suggestions for some potential next steps to advance the compatibility and interoperability of existing measurement methodologies and to establish a Global Data Collection Framework for their application.

Since it is not possible to predict the outcomes of each of these steps, nor the ability of the parties involved to take the necessary actions, we have supplemented these suggestions with "net zero principles" – for both measurement methodologies and data collection frameworks – to guide the processes that are eventually realised. These principles and next steps should be considered as a blueprint for a potential pathway forward, not an exhaustive plan that is immune to revision. The evaluations, principles and suggested next steps outlined in this chapter form the basis for the recommendations to G7 members presented at the beginning of this report.

Emissions measurement methodologies

There are five existing emissions measurement methodologies, from three organisations, that can form the basis for G7 member (and other) governments' efforts to achieve a consistent measurement regime for plant-level emissions associated with crude steel production and steel products:

- World Steel Association (worldsteel) CO_2 Methodology (production)
- worldsteel LCI methodology (products)
- International Organization for Standardization (ISO) 14404 series (production)
- ISO 20915 (products)
- ResponsibleSteel International Standard version 2.0 (Principle 10) (production and products).

These five key measurement methodologies have been identified on the basis that they: are designed for use internationally; can produce site- and/or product-level

greenhouse gas (GHG) emissions measurements; and facilitate like-for-like comparisons between facilities (or have the potential to be adapted to do so). All of the five measurement methodologies could be used today without modification to facilitate some degree of international comparison between the emissions intensity of steel production in G7 members. However, each has relative strengths in the areas of governance and participation, current usage and fitness for purpose for net zero.

This list of key measurement methodologies is not unalterable. Other measurement methodologies, such as Environmental Product Declarations, may prove relevant to these discussions. However, a manageable selection of existing key measurement methodologies has been identified in order to initiate a process of evaluation and development. Revision, consolidation and addition of methodologies are all essential features of the dynamic landscape of standards development. However, that dynamism should not be an excuse for inaction or paralysis, nor is it a barrier to seeking compatibility and interoperability of measurement methodologies – whether existing or forthcoming – in the interests of achieving a net zero steel industry.

Governance and participation

Three organisations – ISO, worldsteel and ResponsibleSteel – oversee the development and revision of the five key measurement methodologies, including the associated stakeholder engagement. Governance structures and processes at the three organisations represent best practice in the areas in which they operate (see Chapter 1 for details), but each organisation has a different set of governance principles and stakeholders.

ISO and ResponsibleSteel are both standard-setting bodies. The inception, development and revision processes for their standards are governed by their members. ReponsibleSteel's members include both business and civil society organisations, with associate membership open to governmental organisations. ISO's core members are countries represented by national standard-setting bodies. Both ISO and ResponsibleSteel's measurement methodologies are intended for use by both public and private sector actors, anywhere in the world.

worldsteel is not a standard-setting body, and its CO_2 methodology is not intended to be used as a measurement standard. However, the fact that the ISO 14404 series and ISO 20915 standards were developed based on worldsteel methodologies reflects the organisation's competence and influence in the realm of emissions measurement methodology design. worldsteel's members – primarily steel companies and industry associations thereof – oversee developments to the organisation's methodologies and data collection processes through participation

in various committees (e.g. the CO_2 Reporting Advisory Group and lifecycle assessment (LCA) Expert Group).

Without any modification to the current memberships of the three organisations, the ISO standards have the largest potential for application, both among G7 members and globally. ISO has 167 country members – including all G7 members – representing 100% of global steel production. The ISO 14404 series and ISO 20915 can be used as "off-the-shelf" emissions measurement methodologies at steel plants everywhere, and governments could theoretically mandate their use.

All G7 members, via their national standards bodies, are able to join the ISO's various Technical Committees (TC), including ISO/TC 17, which oversees the development of the ISO 14404 series and ISO 20915. ISO/TC 17 currently has 28 Participating Members and 40 Observing Members. Among the G7, Canada and the United States are not currently members of ISO/TC 17, although the United States was a participating member until 2020. All other G7 members are members; Japan's Industrial Standards Committee is the Secretariat. From a G7 member government perspective, this sets ISO and its standards apart from the other two organisations. At least a handful of governments have adopted parts of ISO 14404 as a national standard, however no governments are known to be using the standards in national regulations.[3] ISO/TC 17 has six organisations in liaison: the European Commission, the International union of railways, the United Nations Economic Commission for Europe, the United Nations Economic and Social Commission for Asia and the Pacific, the World Customs Organization and worldsteel.

Governments do not participate directly in the activities of worldsteel, in line with the organisation's aim: it is an industry association explicitly representing the interests of businesses. ResponsibleSteel is open to governmental organisations participating as associate members, and its standard is developed through public consultation, but its core membership is made up of businesses and civil society organisations. Governments could incentivise membership of these organisations for steel companies headquartered or operating within their jurisdictions, such that they may use the measurement methodologies/data collection frameworks the organisations provide. However, this would still leave no avenue for governments to directly influence or oversee the development of the measurement methodologies being mandated. Non-member companies cannot submit data to either organisation, with the exception in the case of ResponsibleSteel for the test

[3] The ISO/TC 17 collected survey data on use of ISO 14404-1 and ISO 14404-2 in 2018, with four governments reporting adoption or intention to adopt as a national standard; data was also collected in 2022 on use of ISO 14404-3, with eight governments reporting adoption or intention to adopt as a national standard. Several additional governments reported use of the standards in their country without national adoption. In both surveys, no governments reported reference to the standard or its adoption in national regulations.

phase of V2.0 of its International Standard, which runs until September 2023. Globally, worldsteel's membership represents around 85% of global steel production, and ResponsibleSteel's 15%. The IEA estimates that 64% of crude steel capacity in G7 members is run or owned by worldsteel member companies, and a corresponding figure of 25% for ResponsibleSteel. Meanwhile, the coverage in terms of reporting on emissions in G7 members is estimated to be 57% and 7% of steel production, respectively. These figures exclude the membership of national or regional associations that are members of worldsteel and ResponsibleSteel.

Current and potential future usage

Developed in 1995 and 2006 respectively, the worldsteel LCI and CO_2 methodologies have been in use the longest among the five key measurement methodologies identified here. They are used annually in conjunction with their associated data collection frameworks (see below) in data collection exercises. The CO_2 benchmarking methodology covers around one quarter of the world's steel plants (or more than half if the People's Republic of China [hereafter "China"] is excluded)[4] and the LCI methodology covers over 160 sites.

The detailed results of these data collection exercises are confidential. worldsteel publishes only the global average results by process route from the CO_2 benchmarking data collection, and the global (as well as regional in some cases) results for 17 products from the LCI data collection. Members have access to the full dataset but are not permitted to disseminate it, with the exception of their own company's data. All worldsteel members could potentially participate in the current rounds of data collection, which for the CO_2 benchmarking methodology closes for data submissions at the end of May 2023, and for the LCI data collection closes at the end of July 2023. G7 members could incentivise, or mandate, all existing members of worldsteel operating within their jurisdictions to participate, and incentivise non-members to join worldsteel. Alternatively, worldsteel could choose to allow non-members to submit data to the annual exercise.

ISO 14404-1 (covering the blast furnace-basic oxygen furnace (BF-BOF) route) and ISO 14404-2 (the electric arc furnace (scrap EAF) route) of the ISO 14404 series were first established in 2013, with ISO 14404-3 (for the direct reduced iron-electric arc furnace (DRI-EAF) route) following in 2017. The ISO 20915 standard was first established in 2018. The systematic review for each part of this standard proceeds on a 5-year rolling basis. It is not known exactly to what extent the ISO 14404 series and ISO 20915 are in regular use. However, 18 out of the 67 countries' national standard bodies that are members of TC 17 (plus the European

[4] Note that Chinese companies are currently not able to participate in worldsteel's CO_2 data collection due to restrictions in existing government policies.

Committee for Standardization) have either adopted the ISO 14404 at the national level, or sell the International Standard under their national standard body. All ISO standards are also available directly from ISO, regardless of the extent of national adoption.

Version 2.0 of ResponsibleSteel's International Standard – specifically the GHG emissions measurement methodology component that is relevant here (Principle 10), for both production and product-level emissions – was released in 2022. The latest substantive updates to the GHG emissions component of the standard have been applied at 50 sites and 7 are expected to be audited this year. Twenty-five of these sites are currently within G7 member countries. The standard is in a testing phase that runs until September 2023, and will be subject to subsequent rounds of review (at least every 5 years) once an initial dataset is established.

With respect to future application to other industrial sectors, it is not the intention of worldsteel or ResponsibleSteel to develop measurement methodologies for the production of other materials and commodities besides steel, given their current memberships and remits. Nonetheless, many aspects of the measurement requirements and emissions boundaries of these standards are likely to be applicable to other materials and sectors (e.g. accounting for indirect emissions from off-site electricity generation for use in industrial processes). The same is also likely to be true of the ISO 14404 series and ISO 20915 specifically, due to their situation within ISO/TC 17 (steel), but not of the ISO standards more broadly. An ISO measurement methodology for cement production is currently under development (ISO 19694-3), and a range of other standards overseen by ISO/TC 207 (Environmental management) potentially could be used, and/or form the basis for tailored approaches to specific industries (e.g. ISO 14064, ISO 14067, ISO 14040, ISO 14044). Furthermore, ISO's London Declaration and Net Zero Guidelines embody a commitment to considering climate science and associated transitions in the development of its new and existing standards, which includes other materials and sectors beyond steel.

Fitness for purpose for net zero

ResponsibleSteel's measurement methodology is at the forefront among the shortlist of methodologies identified with respect to fitness for purpose for a net zero steel sector. The emissions boundary used in the measurement methodology extends significantly upstream of the direct emissions accounted for in the ISO 14404 series (which it recognises as an acceptable standard for accounting for direct emissions, alongside the GHG Protocol and EN 19694). It covers non-CO_2 GHG emissions, and provides guidance on the use of emerging technologies, such as electrolytic hydrogen and carbon capture, utilisation and storage (CCUS). The ResponsibleSteel Standard is also specifically designed to establish quantitative results that are comparable between process routes and steel

products, even if some of the measurements required can be provided using standards that are route-specific.

The worldsteel CO_2 methodology and the ISO 14404 series were not initially conceived with the net zero transition in mind. They are designed to be route-specific, facilitating some degree of comparison between sites within a specific technology arrangement. As the lines between technology arrangements may change in the future (e.g. DRI-melter-BOF, smelting reduction-BOF) and trade in iron could become more common, guidance that is either more detailed or more generalised will be required. They also exclude from their boundary of consideration several significant categories of emissions (e.g. from fossil fuel extraction, mining and transportation of raw materials). These measurement methodologies are therefore likely to require revision or expansion to ensure they remain relevant, particularly in areas where the current analytical boundary would no longer reflect the full GHG benefit of adopting emerging technologies.

The worldsteel LCI methodology and ISO 20915 measurement methodologies for steel products encompass a significantly wider boundary of emissions than their counterparts for steel production (the worldsteel CO_2 methodology and the ISO 14404 series). The “cradle-to-grave” lifecycle assessment approach entails accounting of emissions both further upstream (e.g. including the mining, extraction and transportation of certain raw materials and fossil fuels) and downstream (e.g. hot-dip galvanising, tinplating and cold-rolling as applicable for various products). While a wider boundary is beneficial to some degree, for these standards to yield measurements that are compatible and interoperable with steel production standards, a clear mapping of equivalent cut-off points in the supply chain would need to be established, so that the standards are composed of comparable “building blocks”. The methodologies for allocating emissions to co-products and by-products, along with the treatment of scrap, would also need to be made consistent with the “emission credit” methodology adopted for the production measurement methodologies. Ideally, following efforts to align on emissions boundaries and analytical scopes, product standards should deliver measurements that are compatible with those of production standards for the same product (e.g. crude steel) at the same site.

There is also a need to promote greater use of high-quality site- and product-level data. While generic factors are a useful substitute for missing information, standards should be designed in such a way that primary measured data is incentivised and can be independently verified in a robust manner. This would, in turn, incentivise operational practices and procurement decisions that deliver emissions reductions across the supply chain, in line with customer demands. For example, the ResponsibleSteel measurement methodology applies a “burden of doubt” approach, in which default values are conservative and thus likely to penalise companies that do not collect primary data. This type of approach is

particularly important for factors that make a large contribution to the overall GHG footprint of production and products, and can have high degrees of variability (e.g. fugitive and vented methane emissions from fossil fuel supply, CO_2 intensity of imported electricity and hydrogen).

An area requiring further discussion and consultation is what is deemed "net zero compatible" with regards to co-product credits and other credits. At present, all five measurement methodologies provide a credit for exported energy co-products (such as off-gases exported to be used for electricity generation). The worldsteel LCI methodology and ISO 20915 also provide credits for material co-products (such as slag used in cement production as a supplementary cementitious material) and – when a cradle-to-grave assessment is completed – for "net exported scrap" (that is, giving primary production a credit for eventually contributing scrap that can be recycled in the future). Two key considerations for net zero compatibility are 1) whether the co-product credits prioritise and incentivise actual emissions reductions from steel production, and 2) that any assumption of a counter-factual or product displacement should assume a world moving towards net zero, in which other sectors are also taking measures to decarbonise.

At the point at which net zero emissions is reached system-wide, when electricity generation, transportation and mining operations are all decarbonised (or even generating atmospheric carbon removals), it is hard to envisage emissions credits for co-products being justified. However, in the transition phase, credits that incentivise incremental improvements relative to a conservative counter-factual could be beneficial, but such a system would need an adjustment mechanism to reflect the progress in reducing emissions elsewhere in the energy system, and therefore the likely diminishing system-level benefit of the activity being credited. Crediting systems that are compatible with net zero would likely require agreement among relevant sectors (e.g. cement, electricity generation) to make sure that the sum of all credits does not exceed the sum of all emissions reductions to which they are attributed. In the absence of such agreement and consistency, it may be more robust in measurement terms to forgo crediting systems for co-products.

Table 2.1 Evaluation of key measurement methodologies against net zero principles

Net zero measurement principle	worldsteel CO_2 methodology	worldsteel LCI methodology	ISO 14404	ISO 20915	Responsible Steel International Standard V2.0 (Principle 10)
Facilitates like-for-like comparison from all facilities	Not comparable results; covers some innovative process routes	Comparable results; covers some innovative process routes	Non-comparable results; does not cover innovative process routes	Non-comparable results; does not cover innovative process routes	Comparable results; covers innovative process routes
Produces interoperable results for production and products	Uses similar boundaries but methods differ		Uses similar boundaries but methods differ		Uses similar boundaries but methods differ
Emissions boundary appropriate for net zero	Does not include upstream emissions and non-CO_2 GHGs	All main supply chain steps included and non-CO_2 GHGs included	Does not include upstream emissions and non-CO_2 GHGs	All main supply chain steps included and non-CO_2 GHGs included	All main supply chain steps included and non-CO_2 GHGs included
Net zero compatible accounting rules for credits and co-products	Credits for energy co-products only; credit is based on global average reference values	Credits for both energy and material co-products	Credits for energy co-products only; credit is based on global average reference values	Credits for both energy and material co-products	Credits for energy co-products only; credits decrease over time with progress towards net zero
Incentivise use of actual measured data	Default values for some parameters use global averages	Default values for some parameters use global averages	Default values for some parameters use global averages	Default values for some parameters use global averages	Uses conservative default values to incentivise measured data

Notes: For co-product credits, further evaluation and stakeholder discussions are needed to agree to what, if any, credits are deemed fair and compatible during the transition to net zero. For the worldsteel LCI methodology and ISO 20915, credits for scrap "net exports" are included for cradle-to-grave assessments but not for cradle-to-gate assessments.

Net zero emissions measurement principles

From the review of the emissions measurement methodologies conducted in Chapter 1, and based on the evaluations summarised above, the following "net zero measurement principles" are derived to guide future development of emissions measurement methodologies for the steel industry.

A GHG emissions measurement methodology that is fit for purpose for a net zero steel industry must:

- Facilitate like-for-like comparison between production from all facilities, including innovative near zero emission routes, noting the production route, the quantities of scrap and iron used and the types of steel produced.
- Produce coherent and interoperable results for both crude steel production and finished/semi-finished steel products (whether in separate or combined standards for each case).
- Have an emissions boundary and scope that covers – as a minimum – the following sources, whether on-site or off-site: energy-related and industrial process emissions (CO_2, CH_4 and N_2O GHG emissions[5]) from ironmaking, steelmaking, iron ore agglomeration, the production of reduction agents, the use of lime fluxes and electrodes, raw material supply, fossil fuel supply, low-emissions fuel and electricity supply. For steel products, the relevant semi-finishing/finishing processes and alloying elements should be included.
- Apply accounting rules for emissions credits and co-products that are compatible with a global pathway to net zero emissions for the energy system.
- Incentivise the use of site- and product-specific auditable measured data, as opposed to generic emissions estimates and other factors (for example through conservative default values).

This list of principles is not intended to be exhaustive, but rather a starting point to build on in discussions among G7 members, other governments, industry and other relevant stakeholders. Principles and guidelines pertaining to other facets of the net zero transition, such as corporate financial reporting rules (e.g. General Sustainability-related Disclosures), corporate pledge guidelines (e.g. Net-Zero Emissions Commitments of Non-State Entities), guidelines for developing international standards for trade (e.g. the World Trade Organization [WTO] Technical Barriers to Trade [TBT] Six Principles) and broader standards guidelines (e.g. ISO Net Zero Guidelines), which are beyond the core scope of this report, should also be considered during their development.

Potential next steps to achieve interoperability among existing measurement methodologies

In the 2022 report Achieving Net Zero Heavy Industry Sectors in G7 Members, the IEA recommended that "the creation of new measurement standards should be avoided unless none already exists for a particular material". This recommendation was subsequently referenced in an annex to the G7 Climate, Energy and Environment Ministers' Communiqué. Five existing measurement methodologies (two for production, two for products, one for both) have been identified as a starting point for efforts to achieve a common emissions measurement protocol globally. Each have their strengths. The ISO has robust, inclusive and transparent governance processes, with almost no ceiling on

[5] Other GHG emissions are likely to be small enough that they could be excluded to reduce the reporting burden.

potential participation globally, including avenues for governments' interests to be reflected via their national standards bodies. worldsteel's two methodologies are long-established and pioneering, forming the basis for the associated ISO standards, with nimble review processes, serving a large private sector membership. ResponsibleSteel's International Standard is leading with respect to fitness for purpose for a net zero steel industry, but some sections of the current version are still in the testing phase and it is in an early stage of adoption.

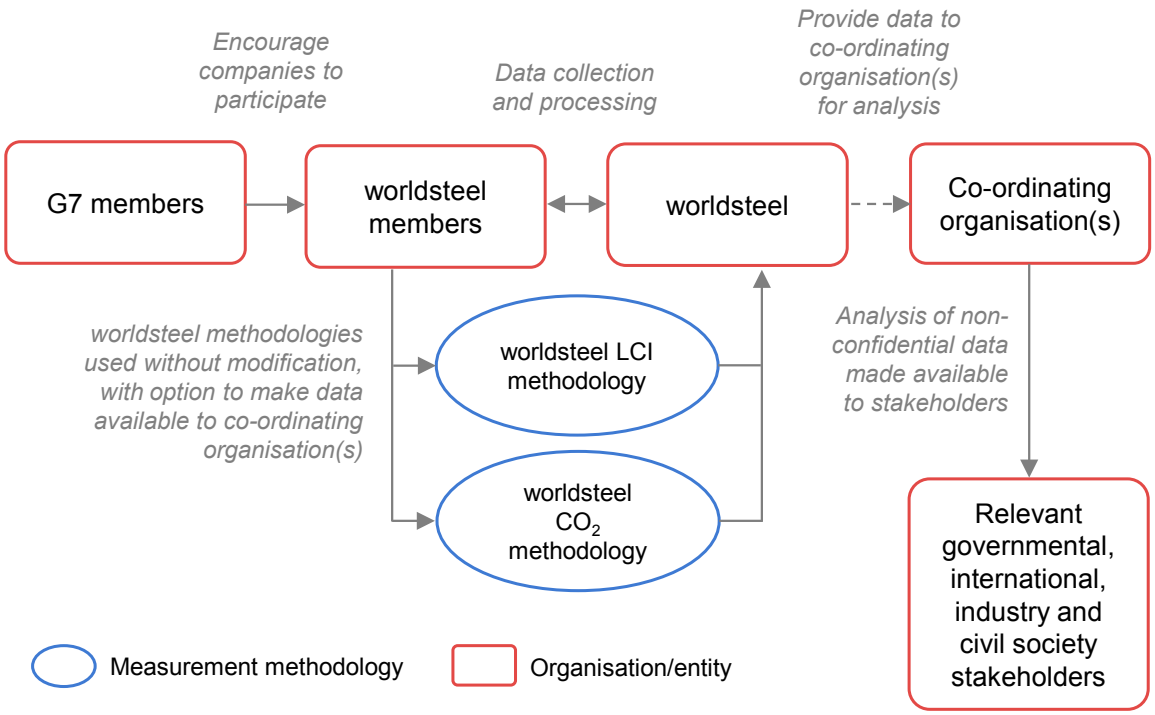
The existing architecture and momentum on emissions measurement methodologies for the steel industry constituted by these three organisations' efforts can be seen as a strength rather than a weakness. Starting a new series of measurement methodologies would take considerable time, even if the "blank slate" offered by such an endeavour would offer more flexibility in some respects, and thus is not recommended. However, much work remains to be done to achieve interoperability and fitness for purpose for net zero across this existing landscape of measurement methodologies. This work will require the involvement and inclusion of multiple stakeholders throughout, to ensure robustness of technical considerations, to maximise fairness and suitability of the methodologies, and to facilitate maximum possible consensus and buy-in. This section proposes an initial plan to advance progress, but it is acknowledged that the details and the process may evolve as the work progresses.

As a starting point, G7 members could officially recognise the five emissions measurement methodologies identified in this report as a robust starting point for work on interoperability and adherence to the net zero measurement methodology principles above. Supporting the development of five methodologies from the outset, rather than selecting only one (or one for each of production and products), has several advantages. First, while the methodologies currently differ in several key areas (see Chapter 1), there has not, as yet, been a concerted effort undertaken to harmonise them. Therefore, making a selection based on the relative merits of one methodology or another as they exist currently, may constitute a false or unnecessary choice. Second, the existing differences between the methodologies provide an opportunity to draw upon the relative strengths of each during the comparison and revision process. Third, multiple methodologies, if suitably revised and sufficiently aligned, could co-exist effectively in the future, serving different stakeholder groups in parallel. Choosing between them would eliminate that potential outcome. Finally, backing multiple avenues to compatibility reduces the chances of failure, in the event a single avenue becomes unworkable.

The work on revising the five existing methodologies could be implemented in two overlapping phases. In an initial phase (illustrated by the schematic in Figure 2.1), starting this year and concluding in 2024, G7 members could work towards the milestone of a preliminary comparative exercise using the worldsteel CO_2

benchmarking and LCI methodologies. This would yield production- and product-level data, and make use of the existing versions of the methodologies to establish an analytical starting point, with an acknowledgement that revisions would be needed thereafter. These methodologies are "tried and tested" – companies have been submitting data for 15 years – and there is already an associated data collection framework in place (see sections below), facilitating rapid implementation.

Figure 2.1 Initial phase of revision to emissions measurement methodologies



Outcome: By the end of 2024, produce initial emission intensity datasets for production and products for a preliminary comparative exercise, using existing worldsteel methodologies

A first step towards revising emissions measurement methodologies could focus on comparing emissions data submitted via the 2023 worldsteel data collection survey, aided by G7 member governments encouraging steel company participation.

In the initial phase, one modification would be required to the worldsteel methodologies and data collection exercises. This would be to provide the option for companies to make the data they submit available to one or more co-ordinating organisations for regional and site-based analysis, either at the time the data are collected, or through a subsequent approval process. Robust confidentiality procedures would need to be put in place, including, for example, a default protocol for data to be anonymised, with an opt-in process for companies wishing to make their data freely accessible and identifiable. Confidentiality processes and agreements could be put in place with the co-ordinating organisation(s) for

handling plant-level data, and only data that were sufficiently aggregated could be published (e.g. countries with fewer than three plants would only be reported in aggregates and not at the country level). The final presentation of the published aggregated data would also need to be considered carefully, noting that the mode of aggregation (e.g. by region, by furnace type) can strongly impact the interpretation of the data.

The identification of one or more co-ordinating organisations is an important component of the initial phase of the revision process for measurement methodologies. The following criteria could inform these considerations:

- A mandate to work on emissions and energy-related data for steel and/or the broader industry sector.
- Sufficient technical expertise on the steel industry to process and analyse the data.
- Robust frameworks and procedures in place to handle confidential data.
- Global reach, and the ability to handle data from steel plants reporting from anywhere in the world, including for countries that are not members of the organisation or initiative.
- The ability to facilitate in-depth consultation with steel sector stakeholders to draw on their technical knowledge.
- The ability to facilitate consultation with stakeholders from other industrial sectors to ensure that decisions taken for steel are compatible with work ongoing for other relevant sectors (e.g. cement, electricity generation).

It is imperative that the three organisations overseeing the five key methodologies identified, as well as the steel industry more broadly, have confidence in the organisation(s) selected, thereby increasing their willingness to participate. There are several existing organisations and initiatives that could fulfil this role, and creating a new organisation would likely lead to duplication. Potential candidates include the IEA's Working Party on Industrial Decarbonisation, the United Nations Industrial Development Organization through its role in co-ordinating the Clean Energy Ministerial's Industrial Deep Decarbonisation Initiative (CEM IDDI) and the OECD Steel Committee. Regardless of which organisation(s) is identified as having the co-ordinating role, all relevant organisations and initiatives could participate in the broader stakeholder engagement process once the data collected are sufficiently aggregated for dissemination. There would also likely be a role for the Breakthrough Agenda to support co-ordination between the processes for revising emissions measurement methodologies and initiatives relevant to other aspects of steel decarbonisation, and those of the other sectors it covers.

Given that data collection for the 2023 cycle of the worldsteel CO_2 benchmarking and LCI data collection exercises have already begun, it would be ideal for an opt-in approval process – including the necessary confidentiality agreements – to

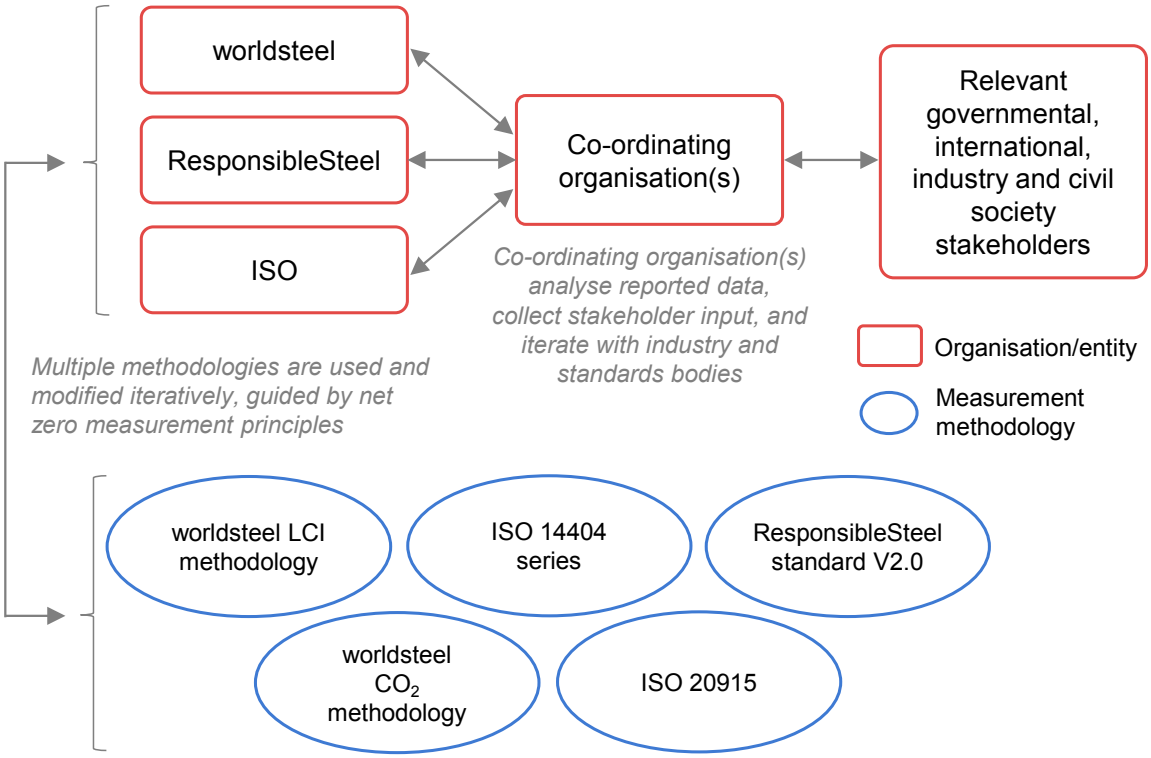
be initiated for the data being collected this year, so as not to delay the initial phase of implementation. For subsequent cycles, the data collection surveys could be modified to include an option for data sharing from 2024 onwards. The collected data could subsequently be published in a sufficiently anonymised format (see initial phase of the developing and implementing the proposed Global Data Collection Framework below). Any dataset produced using these methodologies will not yet fully facilitate like-for-like comparison, but it will provide a partial picture and a robust starting point for further discussions throughout the second phase. In parallel, ResponsibleSteel is establishing an initial dataset of comparable site-level GHG data from its members to complement the modelled data it has on existing sites, with the aim of completing this exercise in the first half of 2023. If these data were made available to the co-ordinating organisation, this could strengthen the initial phase of comparison and potentially establish an early connection to some of the activities suggested for the second phase.

The second phase (illustrated by the schematic in Figure 2.2) could commence in parallel to the initial phase. It involves more stakeholders and will take longer to complete. This phase comprises a revision and amendment process for all five measurement methodologies, guided by the net zero measurement principles above, with the aim of progressing towards interoperability and compatibility in scope by the end of 2025. The revision process should focus on improving the quality of the methodologies in the areas where each is weakest, rather than seeking alignment in a way that could lead to adoption of the “lowest common denominator” features of each. The objective of interoperability implies that the methodologies would have the same “building blocks”, and thus would produce comparable results for emissions at the production level (in the case of both production and product methodologies) and the product level (in the case of product methodologies only). It does not imply that the measurement methodologies need to become identical. For example, it is possible that one methodology would require more granular data than another, or that one would have data collection requirements extending beyond emissions (e.g. other ESG information), while another would not.

The comparative exercise from the initial phase could provide key insights for the second phase, but additional inputs and feedback would also be gathered and additional comparisons undertaken. This could be done as an iterative process involving a broader range of stakeholders – including governments, industry, relevant initiatives and non-governmental organisations – which could be convened by one or more co-ordinating organisations. The co-ordinating organisations could keep governments regularly informed of the specific timeframes and actions of each measurement methodology’s review process. This would build on the momentum of an initial commitment by G7 members by raising awareness and gaining buy-in among a wider group of countries.

To avoid a protracted series of revisions, the second phase should target completion by the end of 2025, with the achievement of a high degree of interoperability among the methodologies. The exact end state will depend on how the comparison and revision process proceeds. It could be that the exercise results in consolidation of methodologies. If revisions result in two or more methodologies becoming very similar, there could be an agreement to use only one of them. This could occur between a production and product methodology, if the production "building block" within the product methodology is determined to be a robust way to collect production data. This could also occur between two or more production methodologies, or two or more product methodologies, led by different organisations, if they became sufficiently similar during the revision process. However, it may be the case that, even after the revision process concludes, multiple interoperable methodologies are retained, with, for example, differences in the level of detail of data collected to serve different purposes. As consensus on the use of a single measurement methodology could take time, interoperability may be a sufficient end state, at least in the medium term, to avoid delay.

Figure 2.2 Second phase of revising emissions measurement methodologies



Outcome: By the end of 2025, produce interoperable emission measurement methodologies for steel production and products, fit for purpose for a net zero steel industry

In the second phase, a broader group of stakeholders could contribute to revision and working towards interoperability of the five key measurement methodologies through an iterative feedback process.

Note: "ResponsibleSteel Standard V2.0" refers specifically to Principle 10 on GHG emissions.

Data collection frameworks

In the context of a global steel industry pursuing efforts towards reaching net zero, the rationale for needing improved emissions data collection is as follows:

- Provide a sound basis to guide the revision process for existing emissions measurement methodologies (see above).
- Facilitate like-for-like comparison of current emission levels for both conventional and emerging production pathways, and products thereof.
- Facilitate global tracking of progress towards the goal of achieving a net zero steel industry.
- Provide a sound basis for establishing targets for quantities of production and/or procurement of near zero and low emission steel.
- Provide information to steel purchasers on the availability and sources of near zero and low emission steel, thus helping facilitate market uptake.

There is no existing data collection framework or combination of frameworks that fully facilitates these activities, even though certain aspects of existing frameworks provide a robust starting point. Focusing on steel will require taking account of the technical specificities of the sector, and convening the most relevant stakeholders. In the future, similar processes could be undertaken to review and advance net zero compatible measurement methodologies and data collection frameworks for other industrial materials and sectors, with the possibility to either develop compatible parallel data collection systems for each industrial sector, or a combined multi-sectoral data collection system.

Fitness for purpose of existing global data collection frameworks

Given that one of the key reasons for improving data collection is to support the revision process for the five key existing measurement methodologies (see above), the most relevant existing frameworks are those associated with the existing methodologies. The data supplied under the worldsteel CO_2 and LCI methodologies feed into well-established data collection frameworks, with detailed data on products and production provided at regular intervals. However, these data collection frameworks are currently designed for internal use by worldsteel's members, with only aggregated summary data being made available to the public. A different model may need to be developed, potentially requiring external sources of funding, if the worldsteel data collection framework and its associated processing requirements are to be used by non-members in the pursuit of greater coverage. ResponsibleSteel GHG data collection for the latest iteration of its standard is at an early stage, with 56 sites currently providing information. None of this data is yet public, although some level of detail will be made public in the future, as per the requirements of the standard.

Table 2.2 Evaluation of key data collection frameworks against net zero principles

Net zero data collection principle	worldsteel CO_2 data collection	worldsteel LCI data collection	ResponsibleSteel data collection
Current and potential coverage	25% of production*; Voluntary submissions, membership currently required	20% of production; Voluntary submissions, membership currently required	5% of production; Mandated submissions (certified sites only), membership currently required
Transparency	Global average values by process route are publicly available	Global and some regional average values by product are publicly available	Data must be published by production site for crude steel and for company and product data using 3rd party standards
Accommodates reporting from multiple measurement methodologies	No	No	Not for crude steel intensity Yes for product carbon footprint data
Granularity of reporting	Site-level data collection but only for certain process routes	Data collected for all main process routes and products, per process and per site	Site-level data collection for crude steel and product-level data for products from certified sites
Frequency	Annual collection with 1-year reporting lag	Annual collection with up to 5-year reporting lag	Data updated with an audit every 18 months
Minimises reporting burden	Currently not aligned with other data collection systems	Currently not aligned with other data collection systems	Currently not aligned with other data collection systems, although product-level reporting can rely on other existing measurement methodologies

Note: *Chinese companies currently do not report to the worldsteel CO_2 data collection; as such, the 25% of global coverage represents just over 50% of coverage if China is excluded.

No data collection framework associated with the regular use of ISO 14404 or ISO 20915 was identified during the preparation of this report. ISO is a standard-setting body, and there is no precedent for the organisation operating a data collection function. This could be an avenue to explore in the future. Governments could potentially collect data directly from steel producers using the two ISO standards. This could offer several advantages, including the fact that existing data collection processes for compiling national statistical information on energy consumption and industrial production could be used. This would also avoid the need for steel companies to become members of a specific industry association or initiative, and governments could potentially mandate reporting. Synergies and efficiencies could be created by conducting similar data collection processes across multiple industry sectors, and there would be direct government oversight of the process. A potential disadvantage, however, would be the additional resources required for governments to collect considerably more detailed data than they are currently collecting for these sectors in many instances. Participation of all national governments with sizeable steel industries would be required to achieve (near-)global coverage, and an international organisation would likely be needed to compile the national statistics into a global dataset.

Net zero data collection principles

From the review of the data collection frameworks, and based on the conclusions drawn above, the following "net zero data collection framework principles" have been derived to guide the development of data collection frameworks for the steel industry.

A data collection framework that is fit for purpose for a net zero steel industry must:

- Facilitate maximum possible coverage, whether mandated or strongly incentivised.
- Facilitate the maximum possible degree of transparency, targeting publication of site- and product-level data by production route, if data requested is anonymised and/or sufficiently aggregated to protect confidentiality.
- Facilitate parallel reporting from any of the five key measurement methodologies identified above, as well as any additional methodologies that are identified as key during the review process, including a system to combine them into one unified dataset, avoiding duplicate entries in any instance where a plant may have reported via more than one methodology.
- Accommodate the collection of highly granular data on GHG emissions – as per the requirements of the five key measure methodologies – together with underlying site- and product-level data on material and energy flows.
- Accommodate an annual reporting frequency with a maximum 2-year lag, targeting more frequent and timely data collection in the future.
- Minimise the reporting burden to the extent possible, through seeking synergies with major existing national or regional-level emissions and energy reporting systems, and implementing digital and automated solutions where possible.

As with the net zero measurement principles, this list is not intended to be exhaustive, but rather a starting point to build on in discussions among G7 members and other stakeholders. Where possible, synergies with existing platforms for data collection should be used, including government processes for compiling national statistical information, the existing data collection activities of worldsteel and ResponsibleSteel, and those of cross-cutting initiatives (e.g. the Carbon Disclosure Project and the Net Zero Public Data Utility).

Potential next steps to advance a Global Data Collection Framework

The IEA proposes the development and implementation of a Global Data Collection Framework for GHG emissions, energy and other associated data for the steel industry, building from one or more existing data collection frameworks. A phased approach could be used to facilitate progress as rapidly as possible, while maximising involvement and inclusion of all interested stakeholders, and aligning with and supporting the two phases of revision of the key emissions

measurement methodologies outlined above. A three-phase approach could be conceived as follows, with the possibility to adapt the process as the work progresses:

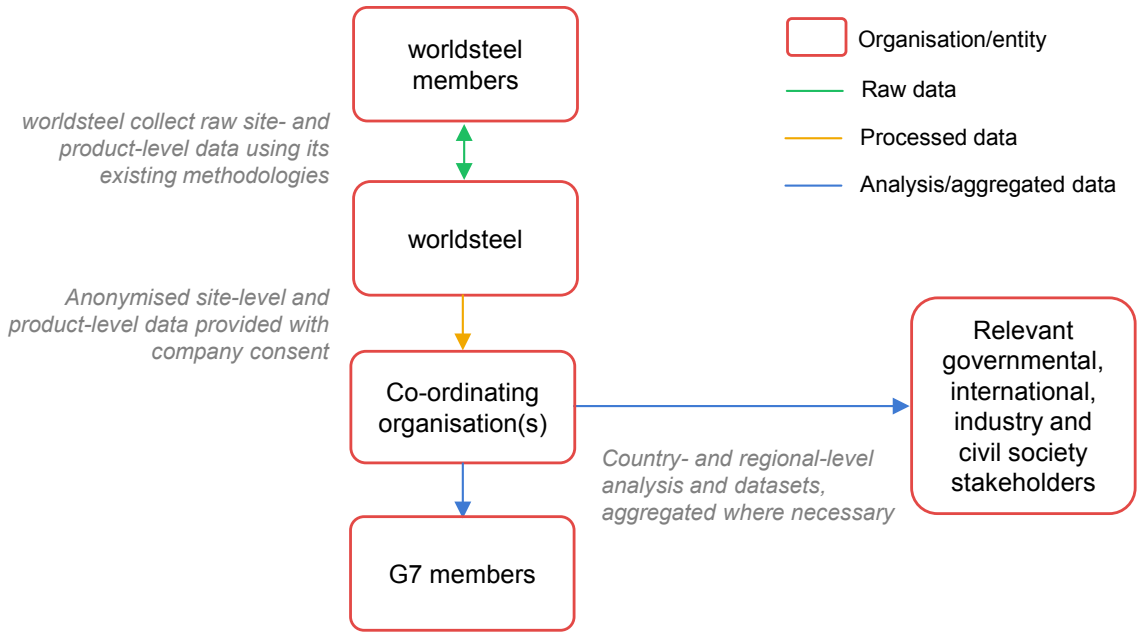
- An **initial phase**, in which the existing data collection frameworks hosted by worldsteel for steel production and products are used to produce a partially comparable dataset, on a voluntary – but strongly encouraged – basis (2023-2024).
- An **interim phase**, in which data is reported using any of the five key emissions measurement methodologies – steel companies may choose to report using one or several of the methodologies, and so there may be duplicate data for some sites – with the aim of supporting the second phase of the measurement methodologies revisions process (2024-2025).
- A **final phase**, whereby interoperable measurement methodologies that embody the net zero emissions measurement methodologies principles outlined above are used to produce – on an ongoing basis – like-for-like data on emission intensities and quantities of production and products, to assist with tracking, benchmarking and the implementation of various policies outlined in the report Achieving Net Zero Heavy Industry Sectors in G7 Members (2025 onwards).

The main exchanges of data that would take place in the initial phase would mirror those taking place currently (illustrated by the schematic in Figure 2.3). worldsteel members would continue to report data to worldsteel as part of the annual data collection exercises associated with the CO_2 benchmarking and LCI methodologies. This would comprise detailed site- and product-level data that worldsteel would process and aggregate, as they have in previous years.

The one modification to this process would be for worldsteel to offer the option – on a voluntary (but strongly encouraged) basis – for its members to make the processed plant-level data available to one or more co-ordinating organisations or initiatives (see above for suggested criteria for identifying the co-ordinating organisation(s)), for use in country- and regional-level comparison exercises. Each steel company could choose if they prefer for the data to be anonymous, in which case sufficient measures would be taken to remove any information that could make the firm or the site identifiable, including the country in which the plant is located, for countries with a small number of plants.

G7 member governments could strongly encourage steel companies in their jurisdiction who are already members of worldsteel to participate. The co-ordinating organisation(s) could then produce an analysis for G7 members (that would also be made publicly available) comparing (albeit imperfectly) aggregate emissions intensities by product and production route for different countries, regions, and process routes, highlighting the aspects of the initial dataset that inhibit direct comparison. This initial dataset and analysis could be used as a key quantitative input to support the ongoing discussions in the second phase of the revision process for the five key measurement methodologies (see above).

Figure 2.3 Initial phase of the proposed Global Data Collection Framework



In the initial phase, existing data collection frameworks hosted by worldsteel for steel production and products would be used to produce a partially comparable dataset for G7 members to review.

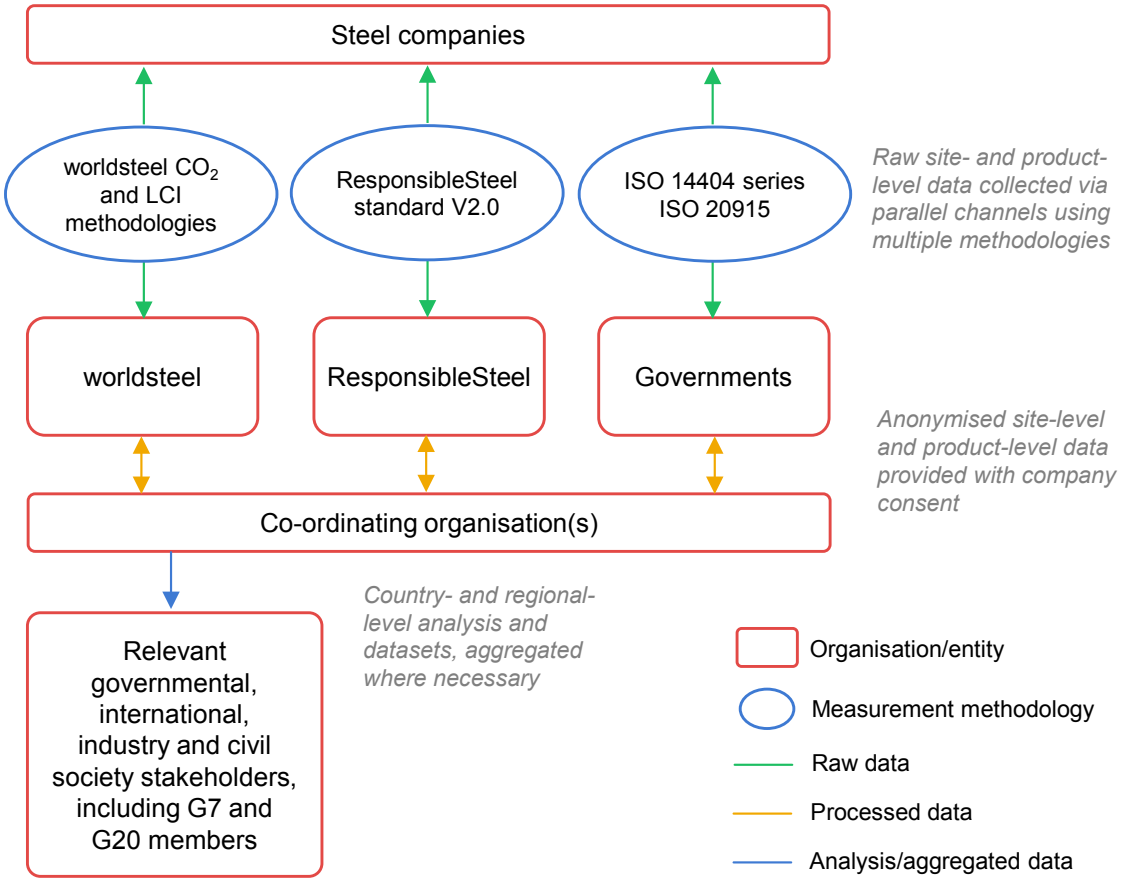
In a second, interim phase (illustrated by the schematic in Figure 2.4), the data collection could expand from the use of the two existing worldsteel datasets (CO_2 benchmarking and LCI methodologies) to any of the five key measurement methodologies. Companies could report data to worldsteel or ResponsibleSteel, or both, using their existing data collection infrastructure. This could be done using revised versions of the methodologies, if revisions have been undertaken by then, and should incorporate any necessary additional procedures to agree to the permitted level of data sharing and confidentiality. If some companies report to both organisations, this will provide useful data that can be directly compared and will shed light on the quantitative differences when using different measurement methodologies for the same site. To facilitate this efficiently, worldsteel and ResponsibleSteel would need to agree to a common approach for identifying and then anonymising duplicate sites, while ensuring the level of confidentiality requested by the steel producer.

As a third avenue for data reporting, governments could choose to encourage or mandate reporting by steel producers operating in their jurisdiction, using the ISO 14404 series and ISO 20915, over which they could have direct influence via their national standards bodies. This option could be facilitated by expanding existing data collection frameworks that governments use to collect national statistical data on energy and CO_2 emissions for industry and other sectors of the economy. This option would likely require a co-ordinating function at the international level to compile the national statistics into a global dataset – this

could be the same or a different organisation from that co-ordinating the emissions measurement methodologies review.

The data collected via each of these three avenues would then be made available to the co-ordinating organisation(s). An iterative mode of data exchange and feedback could then be established, to facilitate progress towards interoperability between the measurement methodologies (see above). These iterations would yield an increasingly comparable analysis of the emissions intensities of production and products, together with a specific set of revisions to be undertaken at each iteration. The findings of these updated analyses could be discussed with G7 members initially, but then also be used to drive progress across larger groups of countries, such as the Group of Twenty (G20). Industry stakeholders, initiatives working on steel decarbonisation, and relevant non-governmental and international organisations would also be included in these discussions where appropriate. Synergies and interoperability with other data collection systems – including those addressing sectors beyond steel – should also be considered during this development phase.

Figure 2.4 Interim phase of the proposed Global Data Collection Framework

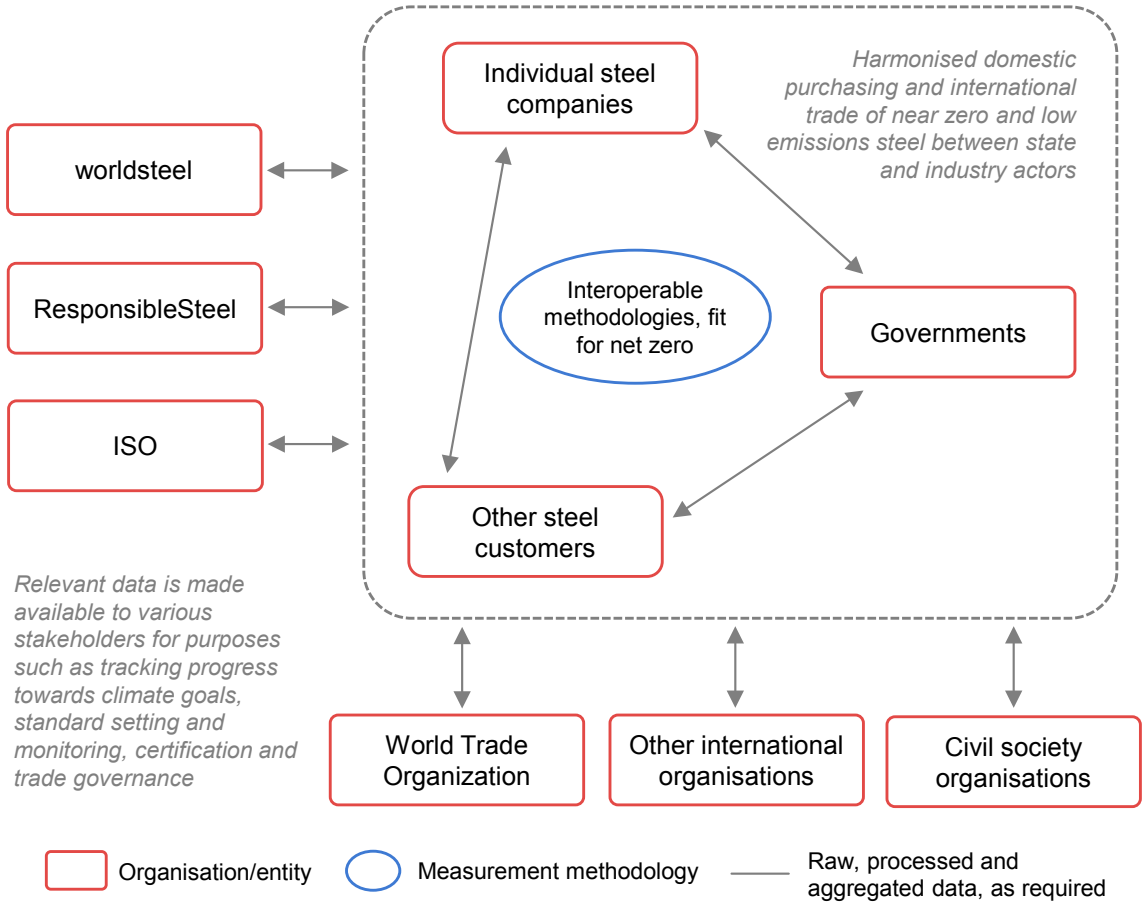


In the interim phase, data would be reported using any of the five key emissions measurement methodologies to support the second phase of the measurement methodology revision process.

Note: "ResponsibleSteel Standard V2.0" refers specifically to Principle 10 on GHG emissions.

The interim phase of the proposed Global Data Collection Framework would conclude once sufficient interoperability between the five key emissions measurement methodologies is achieved, and/or a single methodology is agreed by a critical mass of companies, governments and non-governmental organisations. At this stage the data collection framework would transition to its final phase (Figure 2.5), in which consistent data on emissions intensity, quantities of production at a given emission intensity, or agreed threshold and capacity thereof, is collected regularly as part of the ongoing operations of the steel industry. If multiple measurement methodologies and avenues for reporting data are maintained, procedures would need to be in place to identify any duplicate and/or overlapping entries, in order to create a unified dataset that avoids double-counting.

Figure 2.5 Final phase of the proposed Global Data Collection Framework



In the final phase, the interoperable measurement methodologies would be used to produce regularly updated like-for-like emissions-related data to assist with tracking, benchmarking and policy implementation.

The data in this final phase would need to be sufficiently granular for auditing and claims purposes, even if much of the data associated with a specific plant or an individual product transaction would remain confidential (as is the case today). Sufficient measures would also need to be put in place to ensure that data is

independently verifiable, regardless of whether the data is collected by a private sector or governmental body. Given the need for regular reporting – such that the data in the framework accurately reflects current performance – steel companies may need to adopt measures that make granular data collection less resource-intensive than it is today. These measures could include enhanced metering, digital and automated measurement tools, and data management systems. While this would require some upfront investment, some of these measures would likely add value for customers of steel products, by providing up-to-date information on emission intensities and product footprints, which they in turn could provide to their customers.

Aggregated data would need to continue to be made available to institutions tasked with tracking progress towards energy and climate goals (e.g. the IEA), those governing trade (e.g. the WTO) and those engaged in standard-setting and monitoring (e.g. ResponsibleSteel, ISO). Identifying the exact destination and responsibility for these harmonised data is beyond the scope of this report, but worldsteel remains a clear potential option for collecting and reporting such information in the private sector (e.g. in future releases of its Statistical Yearbook). Government statistical offices and agencies are another option, with compilation at the global level by an existing international organisation. Whichever arrangement is chosen for co-ordinating this final phase, the principles of inclusiveness (i.e. facilitating and having the ability to incentivise maximum participation globally), accountability (i.e. verifiable data and claims), and efficiency (i.e. minimising the reporting burden and any duplication of processes) will be critical to the success of a robust and lasting framework for data collection for the steel and other industry sectors.

Abbreviations and acronyms

BF-BOF	blast furnace-basic oxygen furnace
BOF	basic oxygen furnace
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CCUS	carbon capture, utilisation and storage
CEM	clean energy ministerial
CEN	European Committee for Standardisation
DRI	direct reduced iron
DRI-EAF	direct reduced iron-electric arc furnace
EAF	electric arc furnace
EPD	Environmental Product Declaration
ETS	emissions trading system
FMC	First Movers Coalition
GEM	Global Energy Monitor
GHG	greenhouse gas
GSCC	Global Steel Climate Council
G7	Group of Seven
G20	Group of Twenty
H_2	hydrogen
IDA	Industrial Decarbonisation Agenda
IDDI	Industrial Deep Decarbonisation Initiative
IOE	iron ore electrolysis
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LCA	lifecycle assessment
LCI	lifecycle inventory
MMP	Metcoal Methane Partnership
N_2O	nitrous oxide
PCR	Product Category Rules
SBTi	Science Based Targets Initiative
SF_6	sulphur hexafluoride
SSP	Sustainable STEEL Principles
UNFCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
worldsteel	World Steel Association
WTO	World Trade Organization

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