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Net Zero+: The OECD Horizontal Project on Climate and Economic Resilience

NET ZERO+ Climate and Economic Resilience in a Changing World

The carbon footprint of everything

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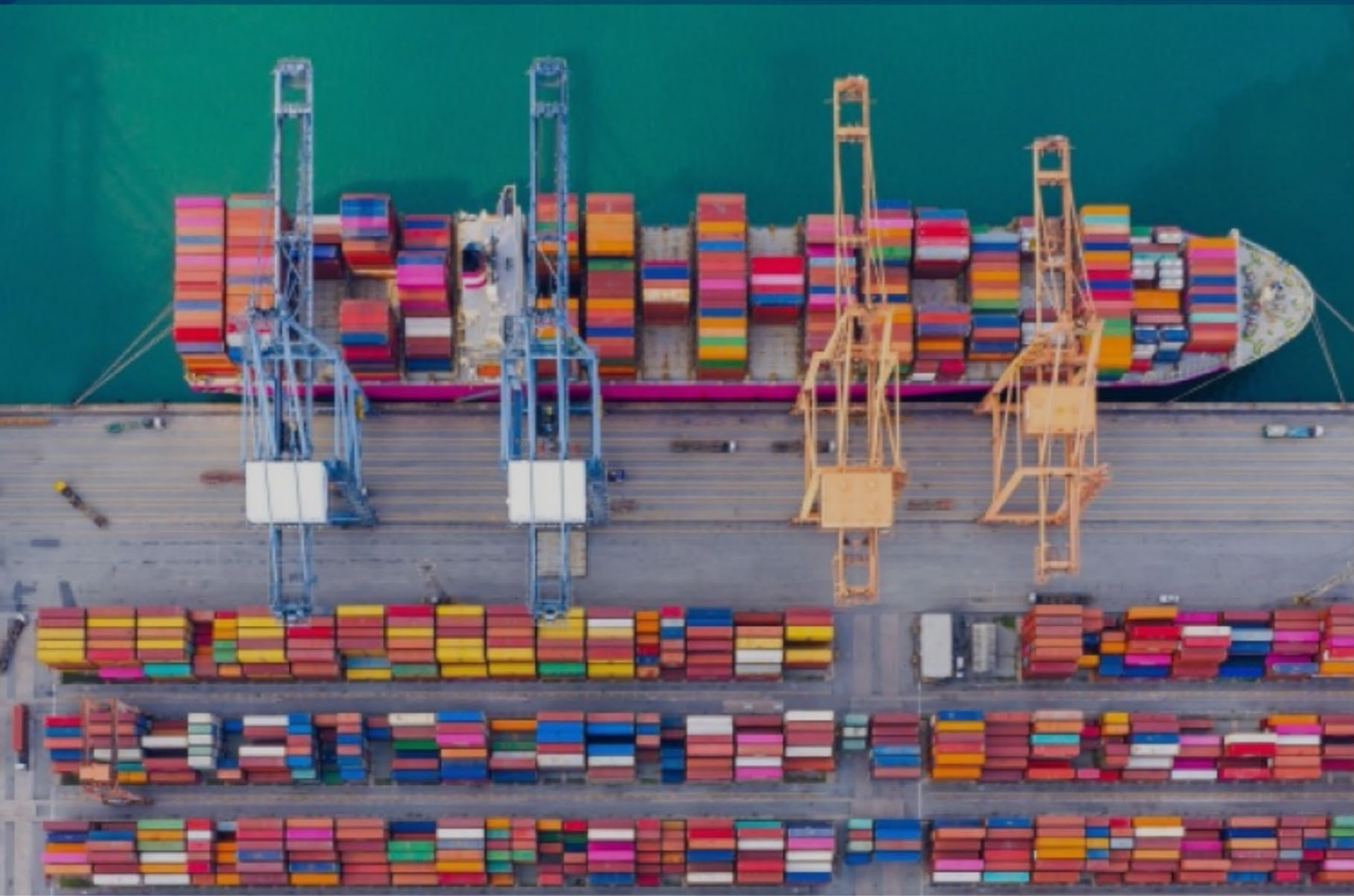

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Executive summary

This paper explores the potential of widespread and reliable information on the greenhouse gas emissions associated with any good or service or the activities of any firm – in short, the carbon footprint of everything. It considers what having information on the carbon footprint of everything would mean for climate action, what building blocks would need to be in place to achieve this, what it would take to put these building blocks in place, and how far we are from measuring a carbon footprint of everything. The paper builds on the work of several OECD committees, including (in alphabetical order): the Committee for Agriculture, the Economic Policy Committee, the Environment Policy Committee, the Committee for Fiscal Affairs, and the Trade Committee, and on work under the Inclusive Forum on Carbon Mitigation Approaches.

Demand for carbon footprint information is growing, as consumers, civil society, investors, and governments want greater transparency. Knowing the carbon footprint of everything would make it possible for governments to design policies and for consumer demand to create markets for low-carbon goods, both of which improve incentives for firms to decarbonise. Better information and better incentives would in turn help firms unlock financing needed for investments in decarbonisation.

Key messages

- Carbon footprints should ideally be calculated using primary data to send the clearest possible signals to help decarbonise the global economy. This requires accurate, timely, and granular emissions data with global coverage.
- Firms currently face significant challenges in obtaining primary data. There is a fragmentation in reporting standards and calculation methods, and uncertainties around data quality. Sharing data between supply chain actors can also lead to competition concerns.
- Several initiatives are underway to tackle these challenges, including ambitious initiatives in the private sector to increase the use of primary data, ensure greater reliability, and facilitate digital exchange across supply chains.
- Better carbon footprint data can help focus mitigation efforts. Given the high costs of decarbonizing the global economy, investment in better data is well justified. Even small advances can reap many of the benefits of better carbon footprint information.
- Many of the necessary building blocks are falling into place, and further efforts by public and private actors can help remove remaining obstacles. These efforts should be:
  - *proportional*, balancing precision and resource requirements and remaining aware of the needs of different sectors, products and use cases and changes over time;
  - promote *innovation and competition,* so that high costs of reporting do not end up favouring incumbents and stifling competition;
  - *interoperable*, making sure the rapidly growing number of initiatives are based on common foundations and build interfaces to allow data sharing.

The Net Zero+ project

The OECD's *Horizontal Project on Building Climate and Economic Resilience: Net Zero+* harnesses the multidisciplinary reach of the OECD to support governments to drive the swift transformational change needed to tackle climate change. The project provides analyses and insights for governments to accelerate and scale up climate action: driving a rapid and resilient transition to net zero while building economic and societal resilience to impacts of climate change.

Introduction

Imagine a world with widespread and reliable information on the carbon footprint of *everything*: a world where it is straightforward to find out the greenhouse gas (GHG) emissions embodied in any good or service, or the emissions related to the activities of any firm.

In such a world, firms could easily determine the emissions associated with their inputs and production processes, helping them identify opportunities to reduce their carbon footprint. They could also efficiently communicate the results of these efforts to their customers. Consumers, other businesses, and governments in turn could compare the carbon footprints of different suppliers when making purchasing decisions. Investors would have reliable signals to align their investment decisions with global emissions reduction goals. Governments could use carbon footprint information to set financial incentives, design emissions reduction policies, and guide public procurement, investment, and R&D policies.

The past few years have witnessed a spectacular rise in carbon footprint reporting across various industries. Demand for carbon footprint information is growing, as consumers, civil society, investors, and governments want greater transparency. For example, firms are increasingly expected to report not just emissions from their own operations (known as Scope 1 emissions) and their purchased electricity, steam, heat, and cooling (Scope 2) but also emissions occurring elsewhere in their supply chain, both upstream and downstream (Scope 3) (OECD/BIAC/WEF, 2023[1]) (OECD, forthcoming[2]). In parallel with growing demand, it is also gradually becoming easier to supply this information thanks to the development of reporting standards, calculation tools, databases, and data-sharing solutions (Deconinck, Jansen and Barisone, 2023[3]).

Significant challenges remain. Ideally, carbon footprints should be calculated using primary data (rather than approximations such as industry averages), to send the clearest possible signals to help decarbonise the global economy. An ideal system to quantify the carbon footprint of everything would therefore require highly accurate, timely, and granular emissions data with global coverage, ensuring no supply chain actors are excluded (OECD, forthcoming[2]). This is not easy. At the moment, obtaining primary data is difficult and costly for firms, even more so for smaller supply chain actors and firms in developing countries. When secondary data (such as industry averages) are used instead, inaccuracies are introduced. There are also problems stemming from fragmentation in reporting standards and calculation methods, and uncertainties around the quality of data. Sharing data between supply chain actors may also run into problems related to data ownership, trade secrets, or competition concerns. Differences in standards and methods could also create trade barriers (WTO, 2022[4]). The lack of a clear global governance framework does not help.

But the good news is that there are several efforts underway to tackle these challenges and turn the vision of a carbon footprint of everything into reality. Ambitious initiatives in the private sector are working to increase the use of primary data, ensuring greater reliability, and facilitating digital exchange across supply chains (OECD/BIAC/WEF, 2023[1]). Examples include cross-sectoral initiatives like PACT (2023[5]) and sector-specific projects such as Catena-X in the automotive industry and Together for Sustainability (TfS) in the chemicals sector (OECD, forthcoming[2]). These initiatives try to create harmonised reporting standards and methodologies, as well as a technical infrastructure to allow firms to digitally communicate carbon footprints with each other. Governments are also ramping up efforts, as seen in New Zealand's and Ireland's nation-wide initiatives to report and reduce the carbon footprint of the agricultural sector. The forthcoming *"Towards more accurate, timely, and granular product-level carbon intensity metrics:*

challenges and potential solutions: An IFCMA report" presents a more thorough review of the key challenges related to the calculation and use of sector- and product-level carbon intensity metrics and possible ways forward to overcome them (OECD, forthcoming[2]).

Moreover, while measuring carbon footprints comes at a cost, it is useful to keep in mind the cost of decarbonisation itself, for which capital spending has been estimated at USD 9.2 trillion per year for the next three decades (McKinsey Global Institute, 2022[6]). If better carbon footprint data improves the efficiency of that spending by only a small fraction, it would already justify a significant investment in better data.

To this end, this paper asks: What would it mean to know the carbon footprint of everything? What would it make possible? What would it take? And how far are we currently?

The carbon footprint of what?

The term “carbon footprint” typically refers to all GHG emissions, including non-CO_2 emissions, embodied in a product or service. The term can also be used to refer to total emissions of a firm, a sector, a country, or other levels of reporting (e.g. financial portfolios). Whenever emissions are expressed relative to a measure of total output (e.g. physical volume, economic value), the term “carbon intensity” is also used (OECD, forthcoming[2]). The calculations of product- and firm-level carbon footprints are increasingly intertwined due to the growing importance of so-called Scope 3 reporting.

At the **product** level, carbon footprint calculations are based on the life-cycle assessment (LCA) methodology, and can be done on a ‘cradle to grave’ basis (covering all stages of the product life cycle, including use and waste disposal) or a ‘cradle to gate’ basis (which covers all stages up to the point where the product leaves a given actor's premises). Cradle-to-gate assessments can form the basis of a decentralized approach to calculating carbon footprints: if each firm receives reliable cradle-to-gate product carbon footprint data from its suppliers, it can add its own emissions, allocate this across its products, and transmit the result to its customers (PACT, 2023[5]).

Firms are increasingly reporting the carbon footprint of their operations. Firm-level reporting standards were established by the GHG Protocol, a collaboration between the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI). The GHG Protocol also introduced the terminology of Scope 1 emissions (referring to a firm’s own operations), Scope 2 emissions (of a firm’s purchased electricity, steam, heat and cooling), and Scope 3 emissions (referring to emissions occurring upstream and downstream in a firm’s supply chain and other emissions indirectly related to the firm’s activities). One of the motivations behind Scope 3 emissions reporting is that it avoids firms spinning off their most polluting activities into separate entities to make their own numbers look better. Another motivation is that it can help mobilise supply chain actors to work together to reduce emissions.

There is growing pressure on companies to report not just Scope 1 and 2 emissions, but also Scope 3 emissions (OECD/BIAC/WEF, 2023[1]) (OECD, forthcoming[2]). The EU's Corporate Sustainability Reporting Directive (CSRD) mandates Scope 3 emissions reporting for large firms, SMEs listed on EU financial markets, and EU subsidiaries of foreign firms. Even where it is not mandatory yet, major firms are often already reporting Scope 3 emissions and in many cases setting reduction targets. By the end of 2023, the Science Based Targets initiative (SBTi) reported that 4 204 firms had committed to science-based emission reduction targets (which nearly always cover Scope 3 emissions), a doubling from the year before.[1]

Progress in reporting Scope 1, 2 and 3 emissions has been uneven across firms and jurisdictions (OECD, forthcoming[2]). However, the rising emphasis on reporting and reducing Scope 3 emissions is affecting upstream producers, as downstream firms increasingly request detailed carbon footprint information for their Scope 3 reporting (OECD/BIAC/WEF, 2023[1]). This is where firm-level and product-level carbon footprints intersect, since what is requested from upstream producers is essentially a cradle-to-gate product carbon footprint. Put differently, if suppliers could easily calculate reliable cradle-to-gate product carbon footprints, it would greatly facilitate their customers’ upstream Scope 3 reporting.

[1] See SBTi Monitoring Report 2023 - Science Based Targets Initiative (accessed 4 Sept 2024).

Emissions can also be calculated at a **sector** level, either as total emissions or relative to output (e.g. per tonne of steel, per dollar of value added). Such sector-level carbon intensity metrics are well established due to the availability of national emissions and output data (OECD, forthcoming[2]). They are comparatively easy to compute and serve as useful fallback values when more detailed product-level data is not available or when it is too costly to gather primary data. Additionally, they can help track countries' decarbonization progress. However, sector-level metrics are highly aggregated and hence may hide important variability within sectors. They also do not capture emissions upstream and downstream from the sector, although it is possible to calculate these by combining sector-level intensities with inter-country input-output tables.

At a **country** level, carbon footprint reporting is well established. Under the United Nations Framework Convention on Climate Change (UNFCCC), every Annex I country is required to provide its annual GHG inventory covering emissions and removals of direct GHGs. Guidance by the Intergovernmental Panel on Climate Change (IPCC) explains how countries can calculate their national emissions (IPCC, 2006[7]) (IPCC, 2019[8]). Country level reporting to the UNFCCC is based on where emissions are produced, not where final consumption takes place. Knowing the consumption-based carbon footprint of a country can provide useful complementary information to these production-based carbon footprints. For example, together these indicators make it possible to evaluate whether countries are "outsourcing" their emissions to other countries (Yamano and Guilhoto, 2020[9]) (Garsous, 2021[10]). Using input-output tables the OECD (2024[11]) has developed such consumption-based indicators, covering 76 economies from 1995 to 2020.

Other levels of carbon footprint reporting are possible too. For example, once carbon footprint information is available for firms, it also becomes possible to calculate carbon footprints for **financial assets and portfolios** (Noels and Jachnik, 2022[12]).[2]

The different levels of reporting do not operate in isolation. For example, IPCC guidance was originally developed for country level reporting but is also used as a reference for reporting at other levels. Standard setting organisations such as the ISO and GHG Protocol have also developed reporting guidelines that cover multiple levels. Better data at one reporting level can improve reporting at other levels: for example, reliable product-level carbon footprint data from suppliers would not only help firms calculate their own Scope 3 emissions but could also be an alternative data source to calculate consumption-based emissions at a country level. The remainder of this paper focuses on product-level carbon footprints, in part because these could greatly facilitate reporting at other levels as well.

[2] Another level of carbon footprint reporting is the project level, e.g. estimating the carbon sequestration created by a reforestation project. This is fundamentally different from the other reporting levels as the question here is how emissions have changed compared with a counterfactual where the project was not undertaken. In turn, these calculations can form the basis for carbon offsets or carbon credits used in voluntary or compliance carbon markets (Wetterberg, Ellis and Schneider, 2024[25]).

What would be possible if we knew the carbon footprint of everything?

To understand the potential of carbon footprint information, it is useful to think of different levers to decarbonise the global economy:

- First, in terms of final goods and services, demand needs to be shifted towards lower-carbon alternatives: for example, from domestic flights to train rides, or from animal-based foods to plant-based foods. This can be based on information regarding the *average* carbon footprint of goods and services.
- Second, for each product or service, demand needs to be shifted towards the lower-carbon producers: for example, from higher- to lower-carbon electricity providers, cement companies, or dairy processors. This requires producer-specific carbon footprint information.
- Third, producers should shift towards lower-carbon production techniques or should adopt emissions abatement technologies: for example, by shifting from natural gas to hydrogen derived from renewable energy in the production of ammonia, or by shifting from use of the blast furnace-basic oxygen furnace (BOF) to the electric arc furnace (EAF) in the production of steel. This requires detailed information so producers can make the right choices – but it also means that producer's carbon footprint information should be updated when they have improved their performance.

Progress on each of the three levers is currently obstructed by a lack of information, a lack of incentives, and a lack of investment and financing.[3] For example, consumers and firms often do not know the carbon footprint of what they are buying. Even if they do, they often lack the incentive to buy a lower-carbon alternative. This limits investments in those alternatives.

Knowing the carbon footprint of everything would make a big difference. It would solve the information problem, which in turn would make it possible for governments to design policies and for consumer demand to create markets for low-carbon goods, both of which improve incentives for firms to decarbonise. Armed with better information and the right incentives, it would then become easier for firms to unlock financing needed for investments in decarbonisation. Better metrics and data would also be useful in evaluating whether finance is aligned with climate goals (OECD, forthcoming[13]). Another way of looking at this is in terms of "use cases" – how consumers, governments, and firms could use carbon footprints (Table 1) (OECD, forthcoming[2]).

[3] For a detailed discussion of these and other obstacles to decarbonisation and how policy can address them, see D'Arcangelo et al. (2022[22]) and OECD (2022[23]). Forthcoming work by the OECD is reviewing the alignment of finance with climate goals (which countries agreed to in Art. 2.1c of the Paris Agreement).

Table 1. How carbon footprints can be used by consumers, governments, and firms

Who?	What?	How?
Consumers	Supporting the growth of the market for low carbon goods	Trustworthy product labels to steer choice towards lower carbon products
Governments	Designing carbon emissions reduction policies, evaluating impacts and setting targets	Using carbon footprints as basis for policies (e.g. taxes, subsidies) Identifying, quantifying and mitigating carbon leakage risks Setting mitigation targets, comparing progress across sectors, supporting policy design Stimulating green public procurement
Firms	Strengthening incentives to lower the carbon intensity of production and communicating to investors and consumers	Informing decisions aiming at lowering carbon intensity of production, including through the purchase of low-carbon intermediate goods Using carbon intensity metrics to help investors price climate risks and prevent greenwashing

Source: Based on OECD (forthcoming[2])

It is currently difficult for **consumers** to understand the carbon footprints of their choices. In many cases, information is simply not available. In other cases, information is available but is confusing and may be provided by firms with limited oversight, creating risks of greenwashing. One consequence is that the market for low-carbon goods is smaller than it could be, which reduces incentives for firms to invest in decarbonisation. Reliable information on the carbon footprint of everything would make it possible for firms to credibly advertise low-carbon alternatives – and for consumers to confidently buy them.

Government policies play a crucial role in decarbonisation. But they can only be efficient if better information on carbon footprints can guide the design of these policies, e.g. as a metric upon which policies are based or as a way to evaluate the impact of policies.

Taxes linked to a product's carbon footprint increase the cost of carbon-intensive options, thereby reducing demand for such goods and stimulating demand for lower-carbon alternatives. Using product-level carbon footprints, such a tax could be applied either at the point of sale to consumers, or at each supply chain stage similar to a value-added tax (VAT) (Tovar Reanos et al., 2022[14]). Carbon footprints can also inform subsidies and other public support tools to reduce the price of low-carbon goods and technologies. France recently used the carbon intensity of production in calculating incentives for the purchase of low-carbon vehicles. Information on the carbon footprint of a housebuilding project could inform policy design for decarbonising the housing stock through grants, subsidised mortgages, mortgage guarantees or property tax discounts. Carbon footprint data can also be used to set voluntary or mandatory product standards (e.g. setting a maximum carbon footprint). Public procurement is another area where knowing the carbon footprint of everything would have a major impact. Public procurement accounts for nearly 13% of GDP in OECD countries (OECD, 2023[15]). Better carbon footprint information could help shift this spending towards lower-carbon options. An example is the Green Procurement Pledge (GPP) of the Industrial Deep Decarbonization Initiative (IDDI), which uses carbon intensity metrics to expand the public sector market for low-carbon goods (UNIDO, 2023[16]).

Furthermore, understanding carbon footprints is especially important in dealing with carbon leakage – the risk that efforts to reduce emissions in one country lead to greater emissions in other countries as firms in those countries gain a cost advantage (OECD, 2020[17]). Better information will improve risk assessments of carbon leakage. Policy responses to deal with the risk of leakage also often require information on carbon footprints. An example is the EU's Carbon Border Adjustment Mechanism (CBAM), which charges imports based on their embodied emissions.

Finally, carbon footprints can help government evaluate the impacts of policies, for example by tracking changes in carbon footprints over time. This could be done at different levels (e.g. country, sector, firm). Analysing the distribution of carbon footprints within a sector or product category can also lead to a better understanding of an industry's performance and the impact of policies.

In turn, these changes would improve **firms**' incentives to decarbonise, and knowing the carbon footprint of everything would give them the necessary information to do so. Firms could for example switch to lower-carbon suppliers, or invest in lower-carbon products or techniques.

Firms could also use carbon footprint information to communicate their progress to investors and unlock financing for investments. As noted earlier, firms are increasingly asked to report their emissions, including Scope 3. Even where reporting is not mandatory, firms have often started to report under pressure from investors. This is partly because of retail investors' growing interest in the Environmental, Social, and Governance (ESG) performance of their investments. But purely financial considerations may be an even bigger factor, as investors want to price risks such as the potential cost of more stringent future climate policies.[4]

Accurate carbon footprints can also help firms provide lenders and investors with credible information on their environmental performance and plans for improvement. For example, steel companies can use product or installation-level carbon intensity metrics to secure financing by demonstrating their alignment with net-zero pathways and national policies. These metrics and disclosures also help mitigate the risk of greenwashing in the green bond market (Schmittmann and Gao, 2022[18]).

[4] The FAIRR Initiative, a network of investors focused on sustainability in the animal protein sector, analyzes 60 publicly traded animal protein companies on environmental risks such as GHG emissions, deforestation, and water use, as well as on other risks like antibiotic use and animal welfare. Their goal is to "minimize risks and maximize profits" (FAIRR, 2022).

What would it take to know the carbon footprint of everything?

Knowing the carbon footprint of everything would thus greatly facilitate public and private actions to reach Net Zero. But what would it take to set up a system for reliable and widespread carbon footprints?

The previous discussion offers some hints. While average data (e.g. the average carbon footprint of a tonne of steel) or sectoral intensity metrics (e.g. emissions per dollar of value added in the cement sector) can be useful for some purposes, to really drive decarbonisation will require accurate, timely, and granular carbon footprints – which in turn requires primary data where possible. Where primary data is not available, reliable sources of secondary data should be used. To make sure carbon footprints are comparable and to avoid a "garbage in, garbage out" problem, shared reporting standards and scientifically sound measurement methodologies are needed. Building up product carbon footprints in complex supply chains requires ways of transmitting information between supply chain actors and assuring its quality. This is challenging even in short supply chains, such as cement and concrete. To make sure SMEs as well as firms in developing countries are not excluded, it may be necessary to provide technical assistance and other forms of support. Specific sectors may also face additional challenges.

This is a tall order, but many of the necessary building blocks are falling into place.

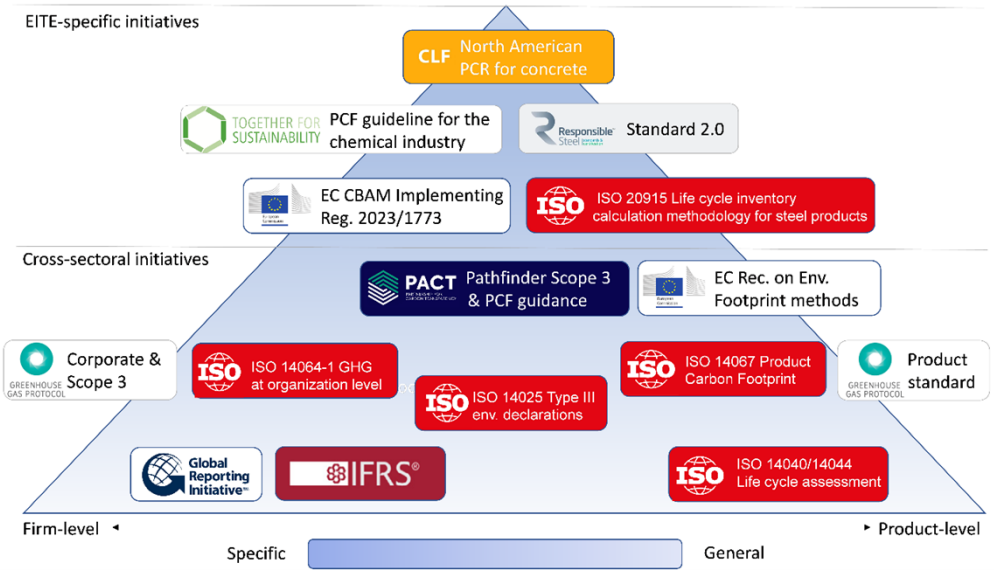
Reporting standards and guidelines

Clear and consistent reporting standards and guidelines play a crucial role in aligning carbon footprint calculations across firms, sectors, and supply chain stages. They provide guidance on which activities to include, which methodologies to use, and the level of detail required for reporting. This ensures that carbon footprint calculations are comparable and facilitate informed decision-making.

Over the past two decades many standards and guidelines have emerged (OECD, forthcoming[2]). It is easiest to think of this landscape as a pyramid, with more general standards at the base and more specific ones at the top. Figure 1 shows an example with standards relevant for industrial sectors; similar diagrams can be drawn for other sectors. On the left of the pyramid are firm-level reporting standards; on the right are product-level standards.

Near the base of the pyramid are standards by the Greenhouse Gas Protocol (GHG Protocol) and ISO. Both have standards for firm-level and product-level reporting, which are fairly similar. Firm-level reporting mostly uses the GHG Protocol Corporate Standard while product-level carbon footprints mostly use the ISO 14067 standard. Near the top of the pyramid are sector- and product-specific standards, such as the Together for Sustainability (TfS) guidelines for the chemical industry. These answer questions that are specific to a sector.

Figure 1. Reporting standards and methodologies relevant for industrial sectors



Source: OECD (forthcoming[2])
Note: Diagram shows standards most relevant for firm- and product-level carbon footprint reporting in emissions-intensive and trade-exposed (EITE) sectors.

Because not all of the standards and guidelines are fully aligned, initiatives have emerged to try to improve compatibility. One example is the PACT Pathfinder guidance shown in the middle of the pyramid. This cross-sectoral initiative aims to harmonise guidance across sectors as well as across product-level and firm-level reporting.

Science-based methods for quantifying emissions

While reporting standards and guidelines specify *what* needs to be reported, science-based methods specify *how* emissions can be quantified. Ideally, emissions would be measured directly to generate primary data. This is feasible in some cases but in some sectors such as agriculture it is rarely practical. Thus, a wide range of methods exist to estimate emissions. An important question is therefore how to choose between the available methods.

Fortunately, there exists guidance developed by the IPCC (IPCC, 2006[7]) (IPCC, 2019[8]). While the IPCC guidance was developed for national reporting, it forms a useful starting point for firm- and product-level reporting too. The guidance covers all sectors of the economy and distinguishes three "tiers" of methods, from least sophisticated (Tier 1) to most sophisticated (Tier 3). For example, to quantify methane emissions from North American dairy cows, the Tier 1 approach is to multiply the number of dairy cows by a fixed emission factor of 138 kg of methane per year, which is the emission factor for North American dairy cattle provided by IPCC (2019[8]). The more refined Tier 2 approach lets the emission factor vary based on animals' gross energy intake and a methane conversion factor. Countries can develop their own methane conversion factor, but if these are not available, IPCC (2019[8]) provides default values which depend on milk production levels and on feed quantity and quality. Tier 3 methods can consist of a wide range of methods which can provide more accurate estimates, but require more data as input. For example, these could include more detailed statistical models for emission factors, or process-based models. IPCC does not list all possible Tier 3 methods but provides guidelines for their development and validation.

While this provides a baseline, more research is needed to develop better methods (especially for low- and middle-income countries) and to validate the reliability of existing methods. Research should also investigate how different data collection and calculation methods impact results.

Primary data

Ideally, carbon footprints are calculated using primary data. This would account for firm-specific differences in e.g. production methods, efficiency, and choice of suppliers. It would make carbon footprints more accurate and would also create the right incentives, as otherwise firms making an effort to reduce their carbon footprints would not be able to communicate this.

The challenges of primary data collection vary across firms and sectors due to differences in emission profiles and the extent of global supply chain integration. In some sectors it is difficult for firms to gather or estimate their own emissions. This is the case for agriculture, where most farmers have limited capacity, direct measurement is impractical, and biological variability adds to the complexity. In other sectors such as the automotive industry, firms may be able to gather their own emissions data but may struggle in collecting primary data from thousands of upstream actors in intricate global supply chains. Despite these challenges, an increasing number of private and public actors are developing robust and precise activity data to increase the granularity and quality of emissions data. One example is BASF, which calculates product carbon footprints for its 45 000 products using primary data.[5] Some large firms (e.g. Unilever) are also working with their suppliers to improve emissions reporting.[6]

Generally, the aim to gather extensive primary data should be balanced against costs and practicalities across different sectors and contexts. As methods and tools improve, it may become increasingly feasible for firms to gather and share primary data. Some firms (e.g. SMEs) may need help overcoming specific challenges, as discussed below.

Secondary data

Because collecting primary data is not straightforward, secondary data plays an important role in filling the gaps.

Secondary data are often found in Life Cycle Assessment (LCA) databases. These offer estimates of carbon footprints and other environmental impacts for a wide range of products, often derived from industry averages or extrapolated from detailed studies. LCA databases are well established and cover a large number of products and geographies. The GHG Protocol identified more than 50 databases including industry-specific databases (e.g., Worldsteel Association, ICE for building materials), country-specific databases (e.g., US Lifecycle Inventory Database, Australian Life Cycle Inventory Database, Chinese Life Cycle Database), and multisector databases such as Ecoinvent that aggregate multiple datasets. Sector-level carbon intensity metrics are another source of information, as noted earlier.

Despite the availability of multiple databases, secondary data is not always of good quality. Databases may use different reporting standards and guidelines, or different underlying methodologies (e.g. IPCC Tier 1, Tier 2 or Tier 3 models). There are also data gaps, as not all products, activities, and geographies are equally well covered, and data may not be recent. Low- and middle-income countries are typically underrepresented. A deliberate strategy is needed to identify and address these data gaps.

[5] See Product Carbon Footprint (basf.com) (accessed 4 Sept 2024).

[6] See Scaling up our climate collaboration with suppliers | Unilever (accessed 19 July 2024).

Communicating carbon footprints along supply chains

One way to calculate carbon footprints in complex supply chains using primary data is the previously mentioned “cradle-to-gate” approach, where each firm focuses on those emissions they understand best – their own. But how can data be effectively communicated between the different supply chain actors?

Many firms already use specialized carbon accounting software for firm-level and product carbon footprint reporting. Effective communication of carbon footprint data along the supply chain requires connecting different software solutions. On this front, there has been significant progress in recent years. The Partnership for Carbon Transparency (PACT) has developed specifications to make sure different carbon accounting software solutions can exchange carbon footprint data across industries.[7] In the chemicals sector, the Together for Sustainability (TfS) initiative has set up a digital platform, based on the PACT Framework, for exchanging product carbon footprints.[8] Other sector-specific initiatives develop open-source, peer-to-peer data-sharing systems to make digital tools interoperable (e.g. Catena-X in the automotive industry or the EU-funded ATLAS project in agriculture). Further collaborative efforts between governments, industry bodies, and private-sector initiatives are needed to create interoperable eco-systems of carbon calculation tools, LCA databases, and standard setters.

But data exchange along supply chains also raises legal and regulatory questions about data ownership, security, and restrictions on data sharing (OECD, forthcoming[2]) (Stenzel and Waichman, 2023[19]). Product-level data might be competitively sensitive, and competition laws may therefore limit the exchange of such data to prevent collusion. Limiting the detail in carbon footprint data can help.

Some countries are also implementing data localization measures (Del Giovane, Ferencz and López González, 2023[20]), which could complicate data sharing (Stenzel and Waichman, 2023[19]) (OECD, forthcoming[2]). Another set of issues revolves around data governance, including ownership, access, and the distribution of value derived from the data. Well-designed platforms can address these issues. In the agricultural sector, for example, the DjustConnect platform (https://www.djustconnect.be/en) enables farmers to securely share their data with interested firms with the farmer's consent.

Data verification and quality assurance

As a manufacturer shares its product carbon footprint estimate with a customer, how can the customer be confident that the estimate is reliable, especially when it involves upstream emissions from a complex supply chain? Some form of third-party assurance can help. Various ISO standards outline the general principles and requirements for these bodies and offer specific guidance on verifying environmental data, including GHG emissions data.[9]

In the case of product carbon footprint claims, third-party verification typically consists of two steps. First, the verification body checks whether the calculation followed the methodology it claims to use. Second, it checks the reliability of the primary data used in the calculation. While this is an important check, it may still leave a gap, as third-party verification itself does not evaluate whether the chosen methodology, tool, or secondary databases were the most appropriate ones. Several solutions are possible, however: for

[7] See PACT: Partnership for Carbon Transparency (carbon-transparency.org) (accessed 4 Sept 2024).

[8] See Sharing secure and trustworthy product carbon footprint data - TFS Initiative (tfs-initiative.com) (accessed 4 Sept 2024).

[9] See ISO 14064-3:2019 (Specification with guidance for the verification and validation of greenhouse gas statements), ISO 14065 (General principles and requirements for bodies validating and verifying environmental information), ISO 14066 (Competence requirements for greenhouse gas validation teams and verification teams), and ISO 17029 (General principles and requirements for validation and verification bodies).

example, standard setters could themselves list the tools and databases that are consistent with their requirements.

Another challenge is that third-party verification is costly, and may be especially burdensome for smaller actors. It will be important to find pragmatic solutions. For example, digital tools could help by creating an "audit trail", which would make third-party verification faster and easier.

Helping producers with specific challenges

Some actors – small and medium-sized enterprises, producers in low- and middle-income countries, firms in specific sectors – may need extra help to be able to measure and report carbon footprints. Smaller firms may not have the capacity to do so themselves, or may lack the financial means to pay others to help them. In developing countries, reliable data sources and skills to quantify emissions may be lacking. Some sectors face specific challenges in measuring and reporting their carbon footprints, e.g. because of complex supply chains, a lack of maturity of reporting standards and methods, or the inherent complexity of quantifying emissions (as in agriculture).

Private or public efforts can equip actors with the knowledge, skills, and tools to measure and report carbon emissions. Large companies like Unilever, for instance, have launched supplier engagement programs to reduce Scope 3 emissions. In Ireland and New Zealand, public-private collaborations have made it possible to scale up emissions reporting in the agriculture sector to cover the vast majority of producers.[10]

Several actions can reduce barriers for firms in low- and middle-income countries. For example, standards, methodologies, and tools for carbon footprint reporting could be developed in collaboration with these countries to make sure their specific challenges and contexts are taken into account. Technical assistance can help develop the "quality infrastructure" (standards, third-party verification providers, etc.) in these countries (WTO, 2022[4]).

Continuous improvement

Scientific insights and technological possibilities are continuously evolving. Standards, methods, and data sets will therefore need frequent updates as well. For example, if a new technology is developed which helps reduce emissions in the cement industry, calculation methods for emissions in that sector should be updated to allow producers to indicate whether they are using the new technology. Standards and guidelines may need to be updated to clarify the most appropriate methods for quantifying the impact of the new technology. As the technology spreads, secondary databases should be updated too, to reflect lower emissions.

Balancing the need for change and the need for stability is crucial, as frequent updates can also be costly, create uncertainty, and complicate comparisons between products, companies, and countries. Currently, there is no deliberate approach to continuously improving the different "building blocks" (standards, methods, data sets, etc). Most initiatives do not have a pre-defined process for updating. One notable exception are the ISO standards which are reviewed every five years. Establishing clear, regular update processes for reporting standards, scientific methodologies, calculation tools, and secondary databases would reduce uncertainty and foster continuous improvement.

[10] For Ireland, see Carbon footprinting Irish farms (origingreen.ie) (accessed 4 Sept 2024). For New Zealand, see Know your numbers | Ag Matters (accessed 4 Sept 2024).

Towards the carbon footprint of everything

Knowing the carbon footprint of products, sectors, firms, countries, financial portfolios – in short, the carbon footprint of everything – would make it possible to design better policies and to empower firms, consumers, and investors to make better choices on the path to Net Zero. But this will require carbon footprint data to become more granular, more accurate, more timely, and more widely available.

Achieving the carbon footprint of everything will not be easy. Primary data is generally most accurate, but may be costly to collect. A proliferation of standards, initiatives, and methods that vary across sectors and regions can increase firms' reporting costs and fragment global supply chains. Verifying and sharing data along the supply chain also faces barriers. Some producers (e.g. SMEs, firms in low- and middle-income countries, firms in specific sectors) face greater hurdles in computing carbon footprints.

At the same time, many of the necessary building blocks are falling into place, and efforts by public and private actors can help remove obstacles. Given the high costs of decarbonizing the global economy, investing in better data is warranted. Moreover, it is not necessary to achieve perfection in order to reap many of the benefits of better carbon footprint information.

Under the auspices of the IFCMA, OECD (forthcoming[2]) has proposed economic principles that can help:

- First, ensure **proportionality.** Moving towards the carbon footprint of everything does not necessarily mean that all firms need to report everything right away to the highest level of precision. It is important to strike a balance between precision and resource requirements. That balance may differ across sectors, products and use cases, and may change over time as measuring and sharing carbon footprint data becomes easier.
- Second, promote **innovation and competition**. High costs of reporting requirements may benefit incumbents and may reduce competition. Overly prescriptive regulations could reduce experimentation with new approaches. For example, calculation methods should be flexible enough to incorporate new technologies; otherwise the incentive to develop and adopt these new technologies are weak. But if firms are allowed to exchange detailed carbon footprint data, this could also make it easier for them to engage in tacit collusion, reducing competition. Competition assessments may be helpful in designing approaches for measuring and reporting carbon footprints.
- Third, **foster interoperability**. Many initiatives are underway, leading to a wide range of standards, guidelines, methods, tools, and data sets focusing on different geographies, sectors, or products. It is important to make sure these initiatives can "speak" with each other, by agreeing on common foundations and by building interfaces to allow data sharing between different systems.

Box 1. Further reading on carbon footprints

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