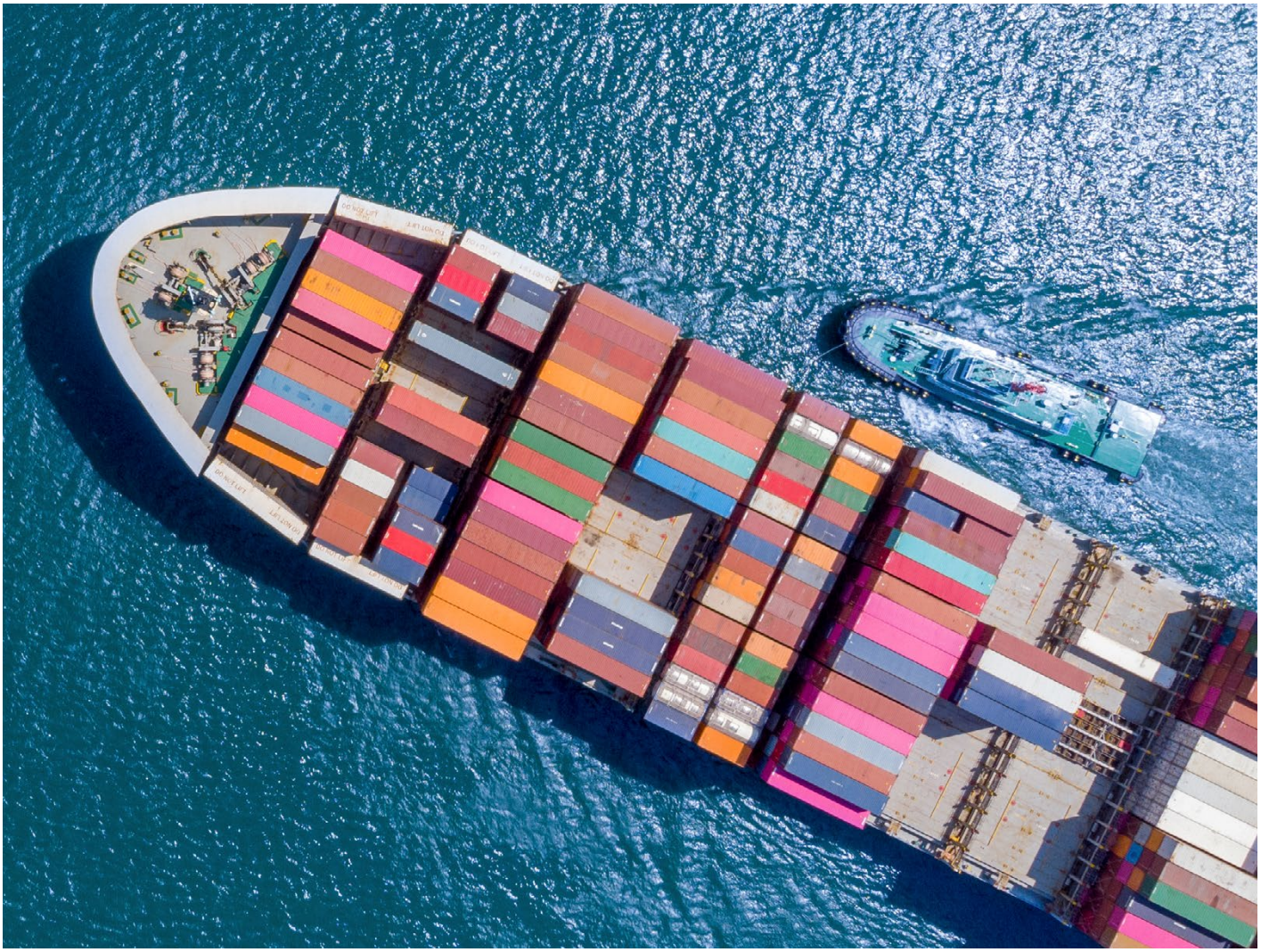
CARBON COMMONS



White Paper

The Future of Supply Chain Carbon Accounting

Mike Berners-Lee, Alex Boyd, Ben Lane, Victoria Harvey | 01 May 2025

Sage
SMALL WORLD CONSULTING
British Business Bank

Contents

“Failure to tackle climate-related risks in supply chains costs nearly three times more than the actions required to mitigate these risks.”

CDP Insights Report 2023[1]

[1] *https://www.cdp.net/es/insights/strengthening-the-chain*

Executive Summary

With global temperatures already surpassing 1.5°C threshold above pre-industrial eras, the need for realistic greenhouse gas (GHG) emissions accounting has become more urgent than ever. The complexity of supply chain carbon accounting is a problem common to businesses of all sizes. Compounding this issue is a lack of standardisation in current methodologies, and methodological flaws where such standardisation exists. These problems currently undermine the realism, comparability, and utility of supply chain emissions assessments.

In this paper, we firstly highlight the critical role of establishing reliable GHG reporting for effective climate mitigation, enabling organisations to identify emissions hotspots, set reduction targets, and comply with regulatory requirements. While Scope 1 (direct) and Scope 2 (indirect energy-related) emissions are relatively straightforward to measure under frameworks like the GHG Protocol, Scope 3 emissions – encompassing the supply chain – are far more complex. While supply chain emissions often account for 75% or more of an organisation's total footprint, this remains challenging to quantify due to fragmented data, inconsistent methodologies, and the fractal nature of supply chains.

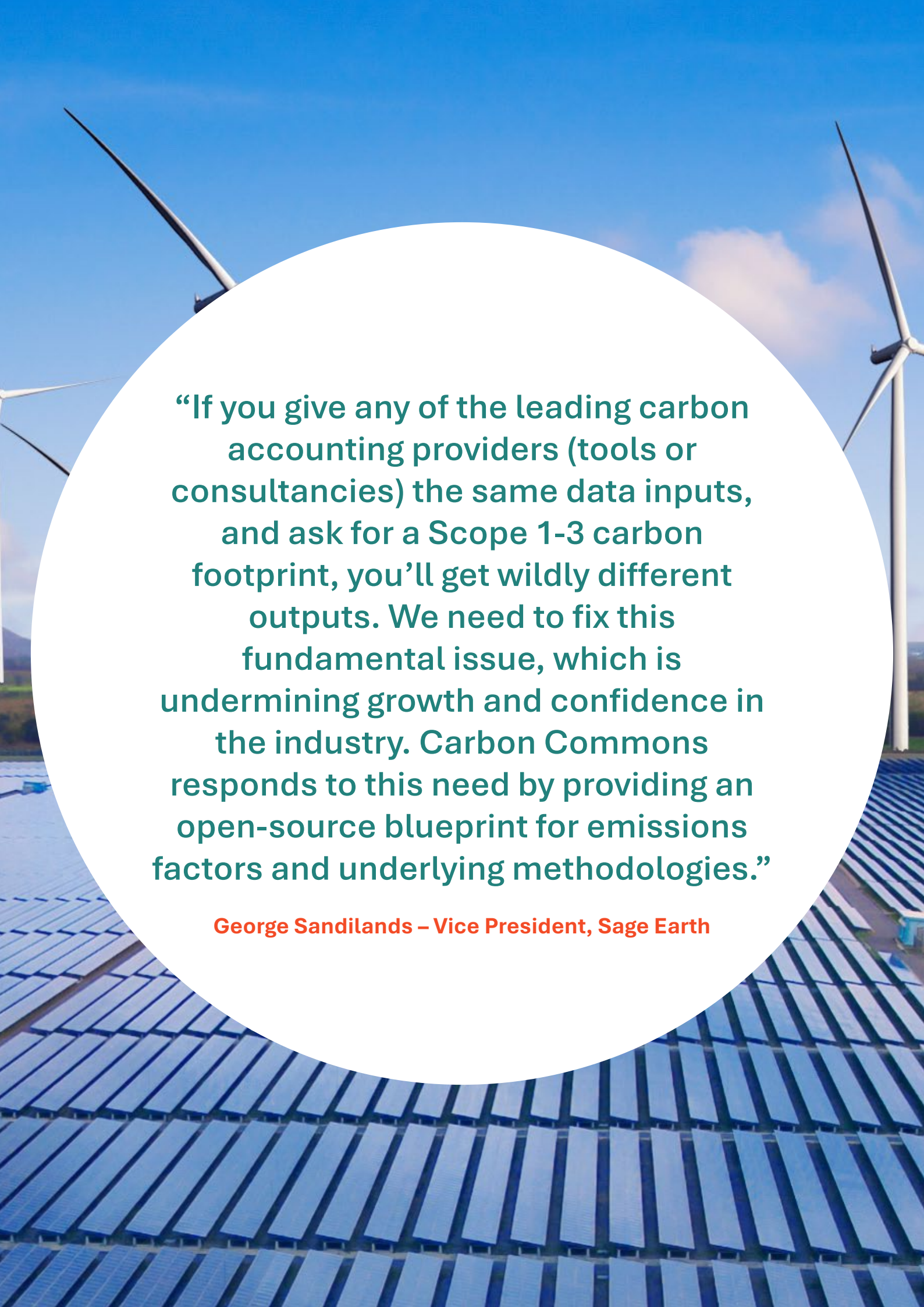
In order to leverage financial accounting data that is already tracked by organisations as well as physical data where this is available, it is currently common practice in carbon accounting to use a mixture of spend-based emissions factors and those derived from process life cycle analysis. However, this is highly problematic, since the two types of factors have very different criteria for what is included and what is left out. Although tempting to overlook, the resulting methodological inconsistency has dire consequences for the overall realism and comparability of results.

This paper introduces **Carbon Commons**, a practical and methodologically robust hybridised accounting approach which addresses problems that have plagued the field of supply chain carbon accounting for many years. The initiative combines spend-based and activity-based estimation techniques, in a way that is both practical and methodologically coherent. Critically, it addresses the limitations of both traditional process-based life cycle and environmentally extended input-output analyses and combines the complementary strengths of these two techniques.

Carbon Commons brings consistency, comparability and realism to supply chain carbon accounting, enabling organisations (not least SMBs which often lack resources for detailed carbon accounting) to better prioritise mitigation strategies and align with global climate goals. Built into the Carbon Commons methodology is the continual development of increasingly granular, quality-rated supporting data.

Ultimately, we call for a paradigm shift in supply chain carbon accounting – one that balances practicality with methodological rigour – and make the case that the hybridised datasets provided by Carbon Commons will play a key role in this transition. By addressing long-standing methodological flaws, whilst simplifying and standardising GHG accounting, the initiative will enable organisations of all sizes to measure their supply chain emissions with greater ease and realism. It will allow, for the first time, meaningful comparison between different organisations' GHG footprints and will simplify the process by which one organisation's carbon reductions can be reflected in its customers' supply chain accounting. Comparability will be further enabled by transparency guidelines that will be included within and modelled by the Carbon Commons initiative.

Governments will also benefit from the hybridised methodology. By bridging production-based and consumption-based reporting systems, Carbon Commons will enhance the transparency and robustness of international trade-related emissions reporting. The coherent hybridisation approach offered by Carbon Commons provides higher-quality data to inform climate policies and incentivise private sector participation by offering a practical and scalable solution. In doing so, Carbon Commons will foster global GHG reporting, so driving meaningful reductions in emissions across all sectors.



“If you give any of the leading carbon accounting providers (tools or consultancies) the same data inputs, and ask for a Scope 1-3 carbon footprint, you’ll get wildly different outputs. We need to fix this fundamental issue, which is undermining growth and confidence in the industry. Carbon Commons responds to this need by providing an open-source blueprint for emissions factors and underlying methodologies.”

George Sandilands – Vice President, Sage Earth

Project Context

With global temperatures breaching the threshold of 1.5°C above pre-industrial levels between mid-2023 and mid-2024, there is an urgent need for all industrial sectors to realistically quantify greenhouse gas emissions to better understand where to focus their mitigation efforts.

However, assessment of company and product supply chain emissions is notoriously difficult – due to the interconnectedness of global supply chains and the complexity of emissions pathways. Moreover, the world of supply chain carbon accounting has for decades been unable to standardise its assessment methods in such a way as to address methodological flaws and inconsistencies that have yet to be adequately addressed by the majority of its proponents.

In this paper, we set out the difficulties and problems, and what can be done to improve the accuracy, comparability and fitness-for-purpose of supply chain carbon accounting. We pay particular attention to the practicalities of 'good enough' emissions reporting for companies of all sizes, from micro-businesses with limited resources, to large corporations for whom detailed interrogation of hotspots needs to dovetail into a complete and robust overview of the entire supply chain.

We then introduce Carbon Commons; a unique, effective, affordable and transparent methodology for organisations to quantify their supply chain emissions by employing a hybridised spend-based and activity-based estimation methodology. This approach both simplifies and improves the quality of supply chain emissions estimates. Carbon Commons has the advantage of enabling an assessment to start from a complete outline using an organisation's financial accounts, figures of which are already tracked by organisations in great detail, and then incorporates relevant activity-based assessments to improve the granularity of the GHG accounting as resources allow. Critically it allows this to be done without altering what is and what is not included within the supply chain and its fractal pathways.

Why is Carbon Accounting Crucial for Climate Mitigation?

Quantifying an organisation's GHG emissions is crucial as it reveals the extent to which each of the organisation's activities contribute to the total inventory and serves as a reference point to measure progress in reducing emissions over time. A realistic assessment also helps in setting achievable reduction targets and guiding strategic decisions on where to focus mitigation efforts. By identifying areas with the highest emissions, organisations can prioritise their initiatives and implement cost-effective solutions.

Quantifying emissions is also important for regulatory compliance, stakeholder engagement, and risk management. Furthermore, understanding emissions can lead to financial benefits through improved efficiency and resource minimisation. Overall, a well-defined GHG report is essential for organisations to contribute meaningfully to global climate goals and to ensure they are making informed decisions that align with their sustainability objectives and manage risks and opportunities.

The standard reporting approach is to follow the processes originally outlined by the GHG Protocol[2], a standard that has been used to frame the majority of subsequent approaches to the quantification of company and product emissions. Under the Protocol, all assessments must include the quantification of direct emissions generated by an organisation's activities such as the combustion of fossil fuels (Scope 1), and indirect emissions associated with energy use and electricity supply (Scope 2). While the reporting of supply chain emissions (upstream Scope 3) is strongly encouraged, this remains an "optional reporting category that allows for the treatment of all other indirect emissions".

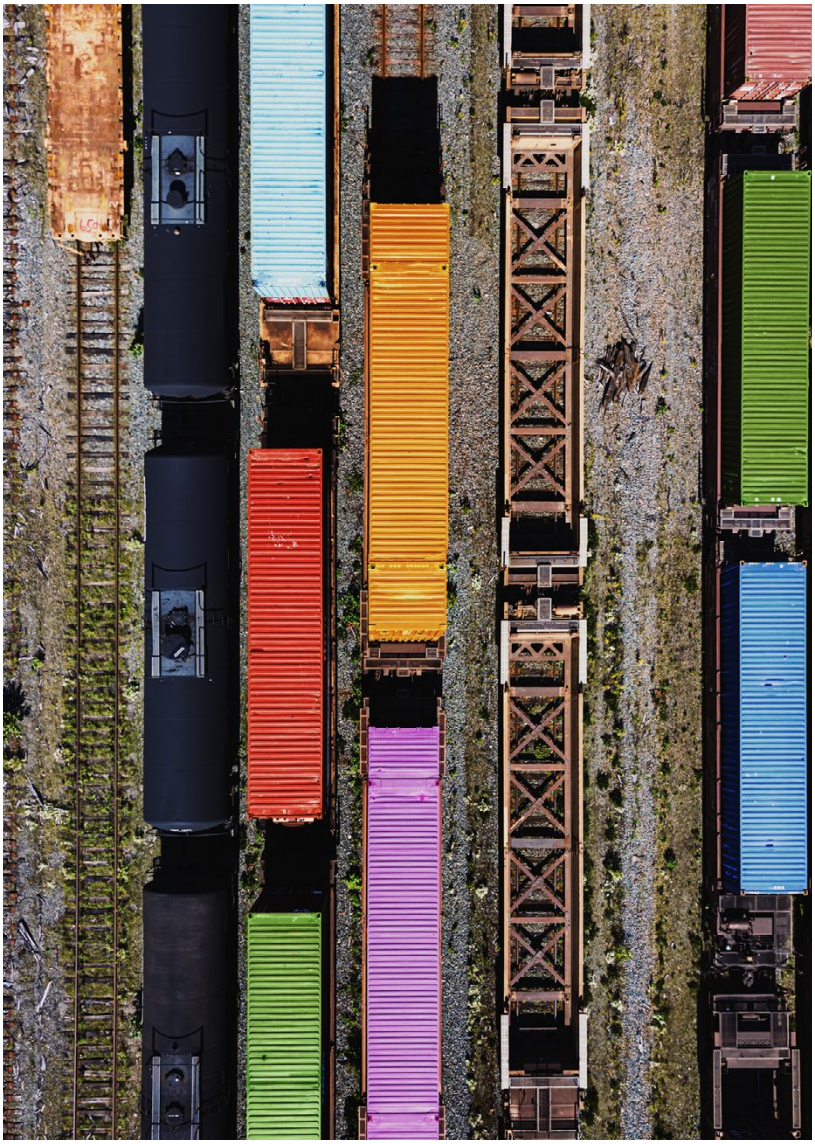
> "It's great to see the launch of the Carbon Commons approach - a practical and methodologically robust accounting approach which addresses many of the challenges we have seen on supply chain carbon accounting. We have been working with Small World Consulting following this approach and now hope that others will follow the Carbon Commons approach, resulting in a less fragmented and more coherent carbon accounting landscape."
>
> **Gabrielle Ginér,** Head of environmental sustainability at BT Group

[2] https://ghgprotocol.org/

What is Supply Chain Carbon Accounting and Scope 3?

Supply chain carbon accounting is the process of measuring and quantifying GHG emissions associated with an organisation's supply chain activities. These are classed as upstream Scope 3 emissions which encompass indirect emissions resulting from activities, such as raw material production, transportation, manufacturing as well as the activities that feed, in turn, into each of these processes and products. The supply chain therefore has a fractal nature.

Despite Scope 3 being a voluntary reporting category under the GHG Protocol, the Carbon Disclosure Project (CDP) estimates that, on average, Scope 3 emissions account for around 75% of an organisation's emissions.[3,4,5] The importance of the supply chain varies considerably by sector ranging from under 30% for energy intensive heavy-industries such as steel and cement, to more than 90% for products, metals and mining, oil and gas, and almost 100% for financial services. Other studies show that the supply chains of eight sectors account for half of the world's GHG emissions and provide evidence that Scope 3 emissions from energy-intensive industries are increasing faster than their Scope 1 and 2 emissions[6].



[3] https://www.wri.org/update/trends-show-companies-are-ready-scope-3-reporting-us-climate-disclosure-rule

[4] https://cdn.cdp.net/cdp-production/cms/guidance_docs/pdfs/000/003/504/original/CDP-technical-note-scope-3-relevance-by-sector.pdf?1649687608

[5] https://www.gstatic.com/gumdrop/sustainability/google-2024-environmental-report.pdf

[6] https://www3.weforum.org/docs/WEF_Net_Zero_Challenge_The_Supply_Chain_Opportunity_2021.pdf

Mini Case Study: BT Group's Route to Net Zero Supply Chain

Small World Consulting has worked with BT Group since 2012,[7] delivering industry-leading supply chain carbon accounting, applying the principles that are integral to Carbon Commons to a sector in which supply chains are at their most complex and diffuse. The process of GHG reporting requires the combination of spend data, product life cycle data and supplier emissions data to provide complete and increasingly nuanced and realistic modelling of BT Group's supply chain. SWC's leading approach to carbon footprinting has allowed BT Group to confidently set ambitious science-based targets for carbon reduction, to drive change across their industry and to move towards a circular economy for their products.

The supply chain reporting process supports BT Group's objectives to: reduce supply chain emissions by 42% by March 2031 and work towards achieving net zero for its supply chain by March 2041; target its influence over its global supply chain to the suppliers with the highest emissions; help show the business and sustainability case for refurbishing products and setting circular economy targets; and provide customers with detailed carbon footprints of the specific products and services they use, gaining a competitive advantage.

For Matt Manning, Head of Circularity and Net Zero for BT Group, it's crucial to have confidence in the data. "Any kind of data or numbers we put out there, we want them to be credible, accurate and stand up to scrutiny", he says and adds that working with Small World Consulting means "we can confidently say that we've taken a really robust and thorough approach to this."

[7] BT Group is the parent company of well-known brands EE, BT, PlusNet and Openreach and provides managed telecommunications, security and network, and IT infrastructure services to customers across 180 countries.

What are the Challenges for Supply Chain Accounting?

Not only do supply chains usually contribute the single largest source of an organisation's emissions up to the point of sale or delivery but they are also the most challenging to quantify. Conventional process life cycle assessments (P-LCAs) fail to adequately account for supply chain emissions due to: (i) inconsistences of applying quantification methods including incomplete system boundaries, (ii) limited access to reliable supplier-specific data and the resource demands in collating large datasets, and most fundamentally, (iii) the complexity in tracking emissions across diverse global suppliers and activities.

A key problem with standard P-LCAs is that they fail to account for the fact that the supply chain is fractal in nature. A company's upstream supply chain can be thought of as consisting of connected 'nodes', representing, for example, manufacturing processes, transportation or mineral extraction. Since each node has its own supply chain, with no less complexity than that of the product under investigation, there is, mathematically, no end to the supply chain pathways that contribute to the total impact of any single product or service.

For some types of products, a small number of nodes are sufficiently dominant that it can be feasible to look at each of these in detail, and in doing so cover a clear majority of total supply chain impact. However, in other supply chains, impacts are much more dispersed, with the overall impact extending well beyond the first node and distributed more evenly through the second, third, fourth tiers of the supply chain and beyond. This renders almost impossible the task of approximating the totality by assessing individual elements of the supply chain. The overall significance of the truncation is highly dependent on the nature of the entity under investigation. To make matters worse, there will likely be little consistency in the selection of the truncated pathways and tiers within each pathway (which defines the system boundary) between different LCA practitioners rendering the upstream Scope 3 calculation highly subjective.

Even in cases where the LCA scope is very clearly defined, once activity-based data specific to each node of a supply chain has been obtained, converting to a climate impact requires the application of an emissions intensity factor.

The choice of factor is often problematic, requiring reference to different datasets, around which there is often neither accuracy, consistency nor methodological transparency.

For the reasons detailed above, there is therefore, an urgent need for organisations to have an easy-to-use, robust and fully consistent supply chain accounting method at their disposal, one that is fit-for-purpose for twenty-first century GHG accounting, that both easier to use and capable of providing more insightful evidence with which to design mitigation strategies, and a way to compare progress between companies and sectors.

As a minimum requirement, an assessment methodology must enable:

1. Organisations to cost-effectively quantify the total emissions associated with their direct activities and the entirety of their supply chain, enabling understanding of how they arise with sufficient realism that they can inform well targeted mitigation actions and track progress. The level of accuracy and specificity should be adjustable to meet requirements of all types and sizes of organisation.

2. Compatibility between company supply chain assessments such that a suppliers' assessment can nest into that of its customers, and such that meaningful comparisons can be made between products and companies.

3. Consistency between production-based and consumption-based reporting such that the footprint of goods and services can be traced across international borders.

Currently, these requirements are not in place for existing supply chain GHG accounting. There is high variability in supply chain system boundaries, data transparency, and comparability of emissions factor datasets. As a result, although current emissions assessments are often helpful for identifying hotspots, they do not generally provide meaningful emissions comparisons between processes and products, nor comparison with production-based assessments, such as company Scope 1 and 2 emissions and national carbon accounts.

Historical Note: A Missed Opportunity

A key missed opportunity came in 2008 with the UK development of PAS 2050, the publicly available standard on carbon footprinting. In a project commissioned by Defra, the draft methodology was sent out for an academic review and an international group of experts headed by the Stockholm Environment Institute clearly articulated the problems outlined in this paper: *Methods review to support the PAS process for the calculation of the greenhouse gas emissions embodied in goods and services.*[8]

The unequivocal conclusion was that the PAS 2050 methodology based on P-LCA methods was unfit for its core purpose. At the time, the UK government did not act on the report's recommendations, with the result that supply chain carbon accounting remains unnecessarily stuck in an inadequate methodological state. Seventeen years later that report is as salient as it was when it was written.

> "The field of supply chain carbon accounting has been a fragmented, incoherent mess for the decades I've known it. But it doesn't have to be this way, and a carbon-cutting world urgently needs it to change. Carbon Commons will deliver a step-change in carbon accounting, to make it easy to have realistic, compatible and dependable carbon footprints for organisations and products of all types and sizes."

Mike Berners-Lee, Director, Small World Consulting

[8] https://www.academia.edu/13468787/Methods_review_to_support_the_PAS_process_for_the_calculation_of_the_greenhouse_gas_emissions_embodied_in_goods_and_services

Issues with Standard Approaches to Carbon Accounting

Before we present Carbon Commons as an innovative solution to the challenges of current standard LCA approaches, it's worth recapping the two main methodological approaches for life cycle analysis, together with their relative strengths and weaknesses which need to be factored when designing an optimum methodology.

Process-LCAs

The most widely understood method is process-based life cycle analysis (P-LCA) which can provide a targeted assessment of the critical hotspots in a life cycle. This is considered a 'bottom-up' approach, because it assesses the carbon impact of a supply chain by mapping it out, calculating the emissions at each node in a chain, and summing these to attain an overall emissions estimate. This requires not only emissions data along a supply pathway, but also a process for attributing emissions across other supply chains with which it is connected.

Historically, P-LCAs form the standard approach of assessments to quantify emissions and underpin most of the activities of life cycle consultancies which quantify emissions on behalf of clients. Several of these consultancies also publish extensive emissions factors that are widely used for life cycle accounting. With sufficient resources and a well-executed analysis, P-LCAs are well suited to providing specific and detailed assessment of the critical hotspots in a product or process life cycle. They are also relatively easy to conceptualise, interpret and communicate between stakeholders.

Unfortunately, quality P-LCAs are highly resource-intensive because they require collating and analysing large amounts of data not usually held by the reporting organisation. Whilst the supply chain comprises an infinite network of processes, the P-LCA is always limited by available resources, and is only able to map out a finite number of supplier pathways. In practice, decisions must always be made as to what chains to include and what to leave out.

The inevitable exclusion of supply chain processes leads to a 'truncation error', meaning that certain emissions are unaccounted for in the final calculated life cycle carbon footprint.

For certain purposes, system incompleteness can be partially mitigated by adopting consistent criteria across life cycle stages and across different P-LCAs, but even when this is done the cut off criteria can have varying implications for different organisations, depending on the nature of their products and the detailed specifics of the relevant supply chains. In most cases, the truncation error, if not dealt with, is serious enough to invalidate the overall assessment as well as the comparability between organisations. To be clear, even in the case of a perfectly conducted P-LCA, the truncation error is a 'show-stopper' for comparability.

The work involved in conducting P-LCAs can be reduced using secondary emissions factors, for goods and services within the supply chain. However, this always comes at the expense of some specificity and will result in methodological incoherence unless the secondary emissions factors adhere to the same methodological decisions as the core P-LCA. These factors also contain truncation errors, often with different exclusion criteria to the overall study. Therefore, while the use of secondary emissions factors saves resource and adds practicality, they inevitably contribute to a reduction in accuracy and confidence.

Despite the difficulties involved, the inevitable truncation error and the subjectivity system of boundary decisions, at their best, P-LCAs have an important role in providing specific and detailed assessment of the critical hotspots in a life cycle.

[9] Examples include Ecoinvent, GaBi and SimaPro.

Input-Output LCAs

A complementary technique for life cycle analysis is environmentally extended input-output analysis (EEIO-LCA). This is considered a 'top-down' approach because it uses a macro-economic model to assign a financial carbon intensity to generic goods and services based on their economic sector and country of region of production. This approach can be intuitively understood as a pound spent with an industry such as the oil refining sector having a greater impact on climate change than a pound spent with the insurance sector.

Input-Output (IO) modelling was developed by the economist Wassily Leontief in the late 1930s to demonstrate how changes in demand for products and services stimulate or depress activity in industry sectors other than the supplying sector. It is widely used in economics to estimate the impacts of economic activities. This approach was subsequently environmentally-extended to include GHG emissions by combining economic information about trade between industrial sectors (IO tables forming a data matrix representing the impact of each sector on all others) with environmental information about the emissions (environmental accounts) arising directly from those sectors, to produce estimates of the emissions per unit of output from each sector (emissions factors).[10]

In a globalised world, goods and services often pass through several countries and are reassembled at various levels in the supply chain before reaching the end consumer. This issue necessitates an inter-regional approach to quantify and model ecological impact across many countries. The Multi-Regional Input-Output (MRIO) analysis therefore extends the concept of a single region input-output analysis by incorporating international data and the flows between regions. Not only are the IO tables that encode domestic trade of each sector within each country included in the model, but also the trade between every sector and country. [11]

The strengths of EEIO and MRIO approaches are that they provide a holistic view of the impacts of goods and services, are widely applicable and can be used to assess the climate impact of complex products or services that are not amenable to activity-based methods. Crucially, they do not incur the system boundary cut-offs and truncation errors that are inherent in P-LCAs. In other words, they do not systematically under-estimate the emissions but instead provide a system-complete assessment of the upstream supply chain. Whereas summing P-LCA emissions of all the world's goods and services (at the point of consumption) would lead to an under-estimation of the total emissions, an IO-LCA based assessment would, because of its system completeness, replicate the world's total footprint.

A key benefit of the IO approach is that since only financial data is required it is generally dramatically easier to undertake than P-LCAs. To produce a simple but complete assessment of supply chain emissions the data requirement is very small; no more than a purchase ledger, categorised by types of goods and services purchased. Unlike P-LCA methodologies that entail more subjective judgements regarding the setting of boundaries and the selection of secondary conversion factors, IO-LCAs are based on a transparently impartial process for calculating emissions factors.

However, IO approaches when used on their own have severe limitations. Input-Output models are dependent on data on trade between countries and industries, which does not exist with high granularity and reliability. These models also assume homogeneity of direct emissions and the demands placed on other sectors, per unit of output within each sector. They can therefore only provide highly generic emissions intensity factors for goods and services, based on the industry sector that produced them and the country of demand or production. IO models used on their own cannot reflect the specifics of the supply for a particular product.

[10] Leontief, W., 1986. Input-Output Economics. Oxford University Press. Miller, R., Blair, P., 1985. Input-Output Analysis: Foundations and Extensions. Prentice Hall. https://liremarx.noblogs.org/files/2020/02/Wassily-Leontief-Input-Output-Economics-Oxford-University-Press-USA-1986.pdf

[10] Small World Consulting's MRIO model assesses 105 industrial sectors.

Overall, Input-Output analysis can provide a low-resource and relatively simple route to a crude yet system-complete quantification of supply chain emissions. However, it severely lacks the specificity that a P-LCA at its best can provide. The downside of not being directly linked to physical processes is that the results are more generic, and less suited to identifying specific changes in technologies and/or behaviours.

For any given level of resources, well-conducted hybridisation enables more realistic results than can be obtained through either input-output or process lifecycle analysis alone. Ensuring no double counting occurs, thoughtful hybridisation provides a robust technique that 'fills-in the gaps' of unaccounted-for P-LCA elements in the supply chain with an estimate drawn from macro-economic models, rather than discounting them.

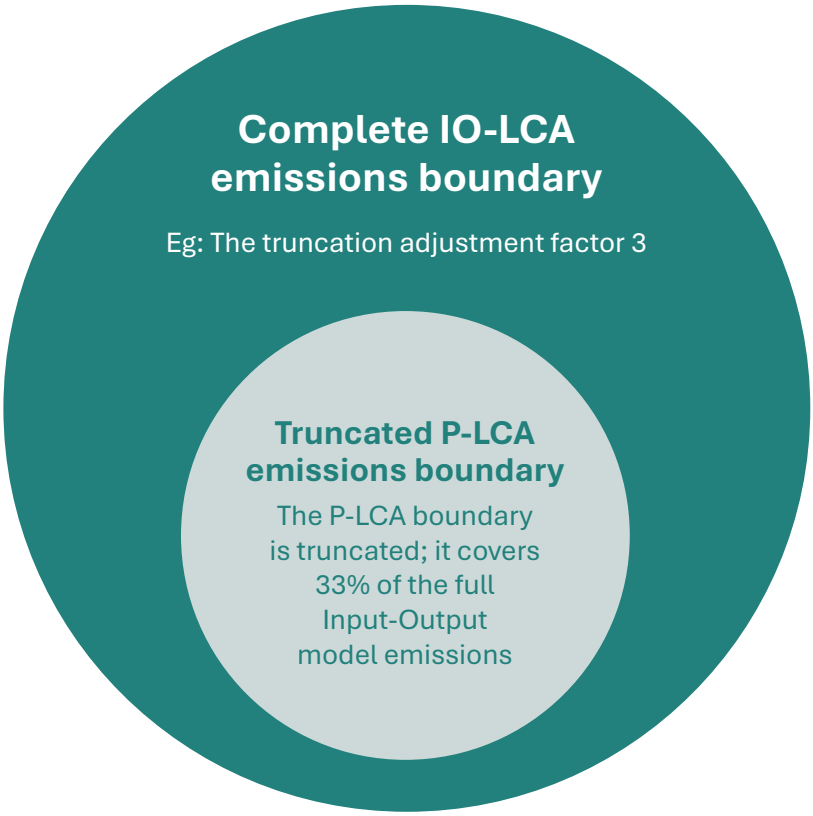


***Figure 1**: Estimating the adjustment factor for a truncated P-LCA emissions boundary*

> "Supporting initiatives that advance technical best practices in carbon accounting is a core objective of the CAA, so we're delighted to be partnered with SWC and Sage on the Carbon Commons project to develop a hybridised approach to Scope 3 emissions measurement that may help solve challenges that carbon accounting professionals face on a daily basis in quantifying complex supply chains in a scalable and robust way."

Andrew Griffiths – Co-Founder, Carbon Accounting Alliance

Table 1: Comparison of P-LCA and IO-LCA approaches

	Pros	Cons
P-LCA	• Simple for stakeholders to understand and communicate – as a result this approach is widely used • Can be implemented at low or high resolution depending on resources • Can provide a targeted assessment of the critical hotspots in a life cycle	• Quality implementations are highly resource intensive • Truncations errors that vary between product types/studies - these generally preclude meaningful quantification of total impacts and comparisons between goods and services • Many emissions factor datasets available but most inconsistent
IO-LCA	• Eliminates 'truncation errors' as analyses all supply chain within region • Data requirement relatively small – typically, a purchase ledger, categorised by types of goods/services purchased • Can be used to estimate emissions of complex activities, such as purchase of intangible services	• Highly generic, and not well suited to identifying specific changes in technologies and/or behaviours • Lack the specificity that high quality P-LCA are able to provide • Underlying models require access to large standard datasets

[12] https://www.jnr.ac.cn/EN/10.11849/zrzyxb.2015.07.015, https://www.sciencedirect.com/science/article/abs/pii/S0959652618329640

The Future of Supply Chain Accounting

Whilst it is not feasible to eliminate all uncertainties in supply chain GHG assessments, it is possible to insist on quantification practices that require at a minimum:

1. Adopting consistent approaches to system boundaries to enable comparable results. This includes adjusting P-LCA-derived emissions factors to account for truncation errors so that they can be used in conjunction with spend based emissions factors;
2. Clear (and published) transparency criteria against which methodologies and calculations can be assessed;
3. An expanding dataset of realistic secondary emissions intensity factors that conform to the same system boundary criteria, and which have been impartially scored against key suitability criteria (transparency, robustness of underlying method, and relevance).

One approach that addresses these criteria is to adopt a **Hybridised Life Cycle Assessment (H-LCA)** in such a way as to combine the strengths of a P-LCA and an IO-LCA to form an optimum solution that enables comprehensive reporting and comparability between sectors. This approach, one that is extensively supported by the academic literature, draws on the strengths of activity-based and environmental input-output approaches whilst heading off the weaknesses of each when used on their own.[12]

[12] https://www.jnr.ac.cn/EN/10.11849/zrzyxb.2015.07.015, https://www.sciencedirect.com/science/article/abs/pii/S0959652618329640

Hybridised H-LCAs

Hybridisation seeks to combine the strengths of P-LCAs and IO-LCAs, whilst mitigating the weaknesses inherent with both approaches. A hybridised approach can either take a P-LCA as its starting-point and add the truncated omissions using input-output data (often appropriate for product focused assessments), or alternatively can take a system complete IO-LCA and substitute the relevant elements of an activity-based LCA into the model in order to improve the accuracy and specificity in key areas (if these have already been quantified).

Whichever hybridisation approach is adopted, care needs to be taken over delineation of the system boundaries where the two approaches are combined, so that each emission element is included only once without double counting. *Indeed, beyond the essential approach of combining product and input-output LCAs, it is the method used to join the two techniques that is key in generating a robust and consistent hybridised dataset.*

Once the system boundaries are well defined, each system boundary of the P-LCA is mapped onto a 'structural path decomposition' of the corresponding IO spend-based emissions factors to estimate the proportion of the input-output system which lies outside the process-based assessment. Since many LCA guidelines adopt similar boundary criteria, a pre-prepared set of industry-specific adjustment mark-up factors is used.[13]

Adjustments must be made for differences in the system boundary conditions and the truncation errors that are inherent in P-LCAs. This can be highly significant and depends upon the type of product or service sector, as well as the specific methodological choices made in the P-LCA. While any number of adjustments can be made in principle, through experience, Small World Consulting has developed a set of the most pertinent adjustment factors that account for whether the following factors are included:

1. Tertiary activities that are not physically part of the end product (e.g. product design and marketing, the cleaning of a factory, the running of office facilities);
2. The significance the selected cut-off level; P-LCAs generally have cut-off criteria that allow the exclusion of smaller supply chain pathways whose significance is estimated to be below a certain level (e.g. 1% - 5% of the total). IOs are system-complete, with no cut-offs;
3. Capital investment which is often excluded from standard assessments (e.g. whether the emissions generated building a factory are considered as part of the product impact);
4. Radiative forcing effects of high-altitude emissions from aviation based on the latest science (leading to an additional impact for a given tCO2e).[14]

By comparing the emissions factors for all permutations of the MRIO data calculated including and excluding these four factor groups, with the emissions factors from the standard version of the model, it is possible to ascertain the percentage of emissions included within each set of boundary conditions for each sector (resulting in an adjustment factor). When applied to the P-LCA emissions estimate, this is then used to scale-up the value to represent the total supply chain emissions (now accounting for those that were previously truncated). The process is depicted diagrammatically in Figure 1.

[13] SWC follow GaBi system boundary principles to determine typical inputs within boundaries of LCA. GaBi are transparent and well-documented, and other LCA standards are largely similar.

[14] https://www.sw-consulting.co.uk/_files/ugd/f0a44c_693b1e6773164e74968bbe9a7ebbdeac.pdf

Carbon Commons: Hybridisation Made Simple

Carbon Commons is set to redefine global supply chain carbon accounting by creating the first universally accessible and standardised methodology for hybridised emissions assessment. This initiative will enable organisations of all sizes to access transparent, reliable, and compatible emissions factors, empowering them to simply quantify their emissions, to better understand and reduce their climate in impact.

At its core, Carbon Commons integrates financial accounting and physical consumption data into a cohesive framework for calculating emissions across the whole supply chain. This approach simplifies emissions estimation as it uses, as its starting point, the financial accounting already undertaken by organisations to calculate supply chain emissions using spend-based emission factors. Furthermore, by consistently adding relevant P-LCA data using an innovative approach, it overcomes the methodological flaws of conventional LCAs that often suffer from truncation errors and/or rely on fragmented emissions intensity factors. The result is a hybridised GHG estimate which combines the granularity of product-level data with the scalability of spend-based emissions assessment.

Importantly, the initiative will also provide guidance on how to use the datasets, including how to maintain a coherent system boundary, how to assess and import bespoke emissions factors from outside the Carbon Commons dataset without incurring system boundary problems, and guidance on transparency.

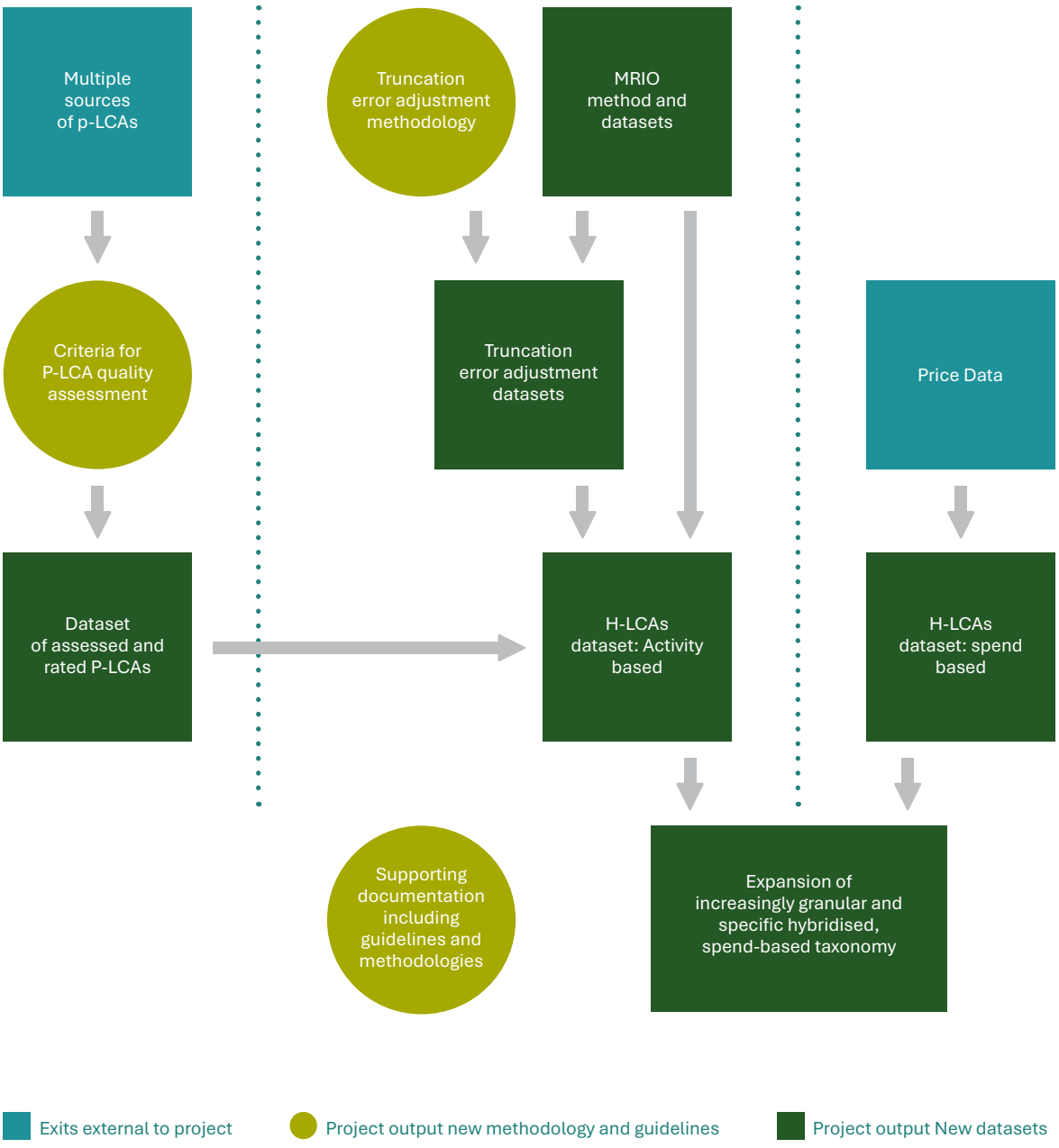


***Figure 2**: Carbon Commons flowchart showing development and delivery of hybridised datasets*

Carbon Commons solves the global carbon accounting challenge by addressing the lack of reliable, transparent and accessible emissions intensity factors in three important ways:

1. Carbon Commons combines two established carbon accounting techniques (spend-based and process-based life cycle assessments) to create an extensive and coherent hybridised dataset of international emissions factors. The dataset is simple to use and supported with extensive documentation.
2. To maximise accessibility and adoption, and stimulate much-needed collaboration in the carbon accounting domain, the methodology and emissions factor database will be available for use under commercial and open-source licenses. Carbon Commons will also collaborate with key stakeholders within the carbon footprinting sector to maximise adoption and dissemination.
3. As an open-source project, Carbon Commons will encourage user engagement to foster trust and accelerate the database's growth and improvement. It will create opportunities for organisations to contribute new data in alignment with agreed quality standards, positioning the resource as a global benchmark for credible carbon accounting.

Carbon Commons is therefore committed to creating industry-standard and ready-to-use hybridised emissions factors to support organisations' carbon accounting activities. The initial aim is to create a set of 750 hybridised factors for each of 65 countries. In many cases these will be provided via a Creative Commons open-source licenses to maximise adoption and enable user contributions.

Central to the initiative is a commitment to openness and transparency that ensures equitable access, fosters innovation, and supports a global movement toward credible and actionable carbon accounting. As such, it has already been welcomed by the carbon accounting industry (SWC is an active member of the Carbon Accounting Alliance – see Project Partners).

Due to its inclusion of supply chain emissions at the system level, Carbon Commons also has important implications for national government. As the alignment of the system boundaries of product supply chain emissions with production-based reporting is fundamental to the hybridised methodology, Carbon Commons will enhance the transparency and robustness of international trade-related emissions reporting. It is therefore a key ambition of the project that the methodology becomes adopted as a government standard emissions accounting tool, and that the approach be used to quantify the national carbon budgets. To this end, Carbon Commons is already engaged as a key stakeholder in the B4NZ SME Sustainability Data Taskforce (see Project Partners).

Due to its inclusion of supply chain emissions at the system level, Carbon Commons also has important implications for national government.

“The British Business Bank is determined that smaller businesses have opportunities to benefit from the transition to a low-carbon economy and do not get left behind. It will also be difficult for the UK economy to meet its climate goals without small and medium businesses. That’s why we are pleased to support the Carbon Commons project as a collaborative initiative aimed at creating simplicity and useful insights for businesses from the very complex world of carbon accounting.”

Tony Greenham – Managing Director, Sustainability, British Business Bank

In Conclusion

Carbon Commons will provide a step change in the quality of supply chain carbon accounting. Not to be confused with the GHG Protocol 'hybrid method', which focuses solely on supplier Scope 1 and 2 data, the hybridised approach advocated in this white paper encompasses the entirety of upstream Scope 3 emissions and does so in such a way as to tackle the broader challenges of completeness and comparability that have long plagued the practice of supply chain carbon accounting.

Carbon Commons will provide datasets as an open-source product delivered at low cost (according to users' ability to pay), designed to radically simplify emissions accounting. It improves accuracy and increases motivation of users to implement GHG mitigation measures. A further transformative aspect of this initiative will be the integration of price data, enabling translation between financial and physical emissions factors. This will result in an ever increasing granular, system-complete dataset that will be suitable for use with any mix of financial and physical data. The project promises a new era of GHG assessment, equipping organisations of all sizes with the tools they need to make informed, comparable, and actionable contributions to the global net zero transition.

Grounded in well-established and transparent scientific principles, Carbon Commons seeks to implement hybridised GHG accounting at scale by producing emissions factors that are consistent, transparent, and reliable. This will enable diverse industries and supply chains to measure and manage their GHG footprints with greater confidence and consistency. It will also enable government agencies to track national inventories more efficiently and assess progress in meeting Nationally Determined Contributions (NDCs).

Project Partners

Led by Small World Consulting (SWC) with Sage Group PLC as an insights and financial partner, Carbon Commons is a highly collaborative project that includes key stakeholders who are committed to standardising GHG accounting and improving its accuracy and coverage. These partners include accountancy platforms that are working to incorporate GHG assessment tools as part of their financial reporting packages, a trade association that represents GHG accounting practitioners, and the UK Government which is coordinating activities to streamline carbon reporting by SMEs.

- SWC is working with **Sage Group** to develop a hybridised GHG accounting approach that combines spend-based and activity-based methodologies, enhancing accuracy for SMEs.[15] Leveraging SWC's expertise in carbon emissions factors and Sage's financial data integration capabilities, the collaboration aims to simplify emissions tracking by aligning transaction-level accounting data (e.g. procurement, travel, energy) with sector-specific emissions factors. Integrated into Sage's carbon accounting tools, the solution supports compliance with frameworks like the GHG Protocol while reducing manual effort, aligning with Sage's broader strategy to empower SMBs in achieving net zero targets.
- SWC and Sage Group are founding members of the **Carbon Accounting Alliance (CAA)**. Founded in 2023, the CAA is a global coalition of over 750 organisations – including consultancies, software firms, auditors, and sustainability professionals – dedicated to standardising carbon accounting practices and advancing robust emissions measurement frameworks.[16] Focused on collaboration, the CAA addresses industry fragmentation by sharing best practice, developing technical guidance, and advocating for policy changes. Its members collectively measure emissions for over 160,000 organisations.
- SWC and Sage Group are active members of the **B4NZ SME Sustainability Data Taskforce,** a UK government initiative led by Bankers for Net Zero (B4NZ) to streamline carbon reporting for SMEs and micro-enterprises (representing 95% of UK businesses).[17] The Taskforce aims to encourage SMEs to increase engagement with sustainability issues and carbon reporting, the latter through improved online reporting tools which the Taskforce is developing in consultation with industry as one of its objectives to establish a proportionate, standardised framework for GHG emissions and sustainability reporting. It is hoped that this will address fragmentation caused by over 270 competing carbon accounting tools, which leads to inconsistent data requests from corporates and financial institutions.

[15] https://www.sage.com/en-gb/net-zero/

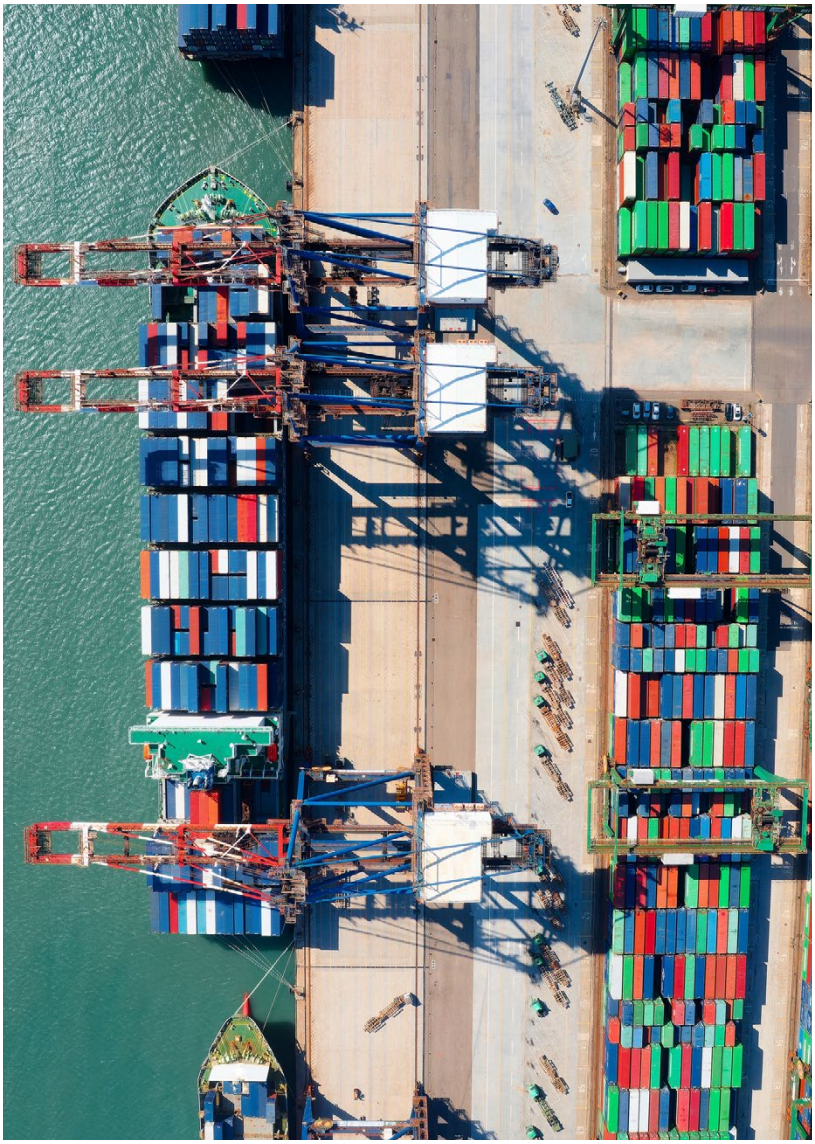
[16] https://www.carbonaccountingalliance.com

[17] https://www.bankersfornetzero.co.uk/workstreams/decarbonising-smes/

Carbon Commons: Next Steps

Carbon Commons will be launched during London Climate Action Week 2025. An initial dataset will form part of the future Sage Earth product that will streamline GHG accounting tools. Once published, SWC will consult with users and industry in parallel with the development of a larger dataset for launch later in 2025/26.

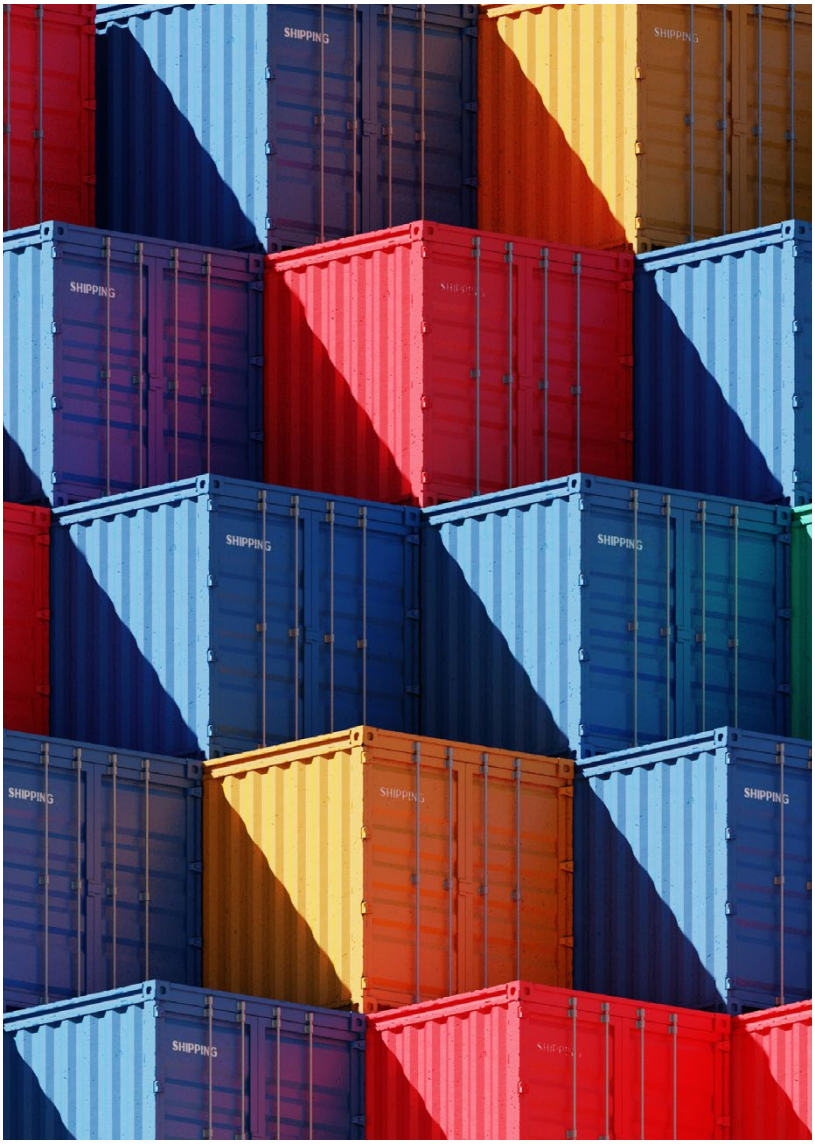
In addition to the core database, documentation and guides, Carbon Commons will establish effective governance mechanisms to ensure impartial oversight and industry relevance. This includes a **Carbon Commons Steering Group** and an **Expert Advisory Board** to guide the development of the database and provide strategic direction to the project which will have open-source and commercial elements. Central to the project is the provision of hybridised data at low cost (according to ability to pay) to all users via an open-source platform. Feedback mechanisms will be designed to safeguard against influence from vested interests.



Funders and Partners

To secure the long-term viability of the project, and to support its vision, Carbon Commons welcomes the involvement of all organisations and stakeholders that are aligned with its key objectives and values, whether they be from the private or public sectors, academic bodies or NGOs.

Building on the initial funding provided by Sage Group, **the project is seeking forward-thinking funders to support its ambitious vision** by contributing to the ongoing validation of our innovative hybridising methodology, the development of the open-source database, and the promotion of its adoption globally. Early supporters will gain a unique opportunity to demonstrate climate leadership, elevate their brand visibility, and shape the future of sustainable business practices globally.



About Small World Consulting

We are a world-leading consultancy with expertise in measuring the carbon and climate impact of full supply chains and operations. Our mission is to help organisations understand their true impact on people and the planet and inspire them to think and act differently to become truly sustainable. Building on 20 years of experience leading in the field, we have developed the Carbon Commons database drawing upon our in-house MRIO model, a wealth of academic literature in the field of LCAs, as well as the findings of a major UK government report which assessed the standard GHG assessment methodologies.

To become an active participant/supporter of the Carbon Commons project, or for more information, please contact: **carboncommons@sw-consulting.co.uk.**

This white paper was authored by Small World Consulting with key contributions by:

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- **Alex Boyd, SWC Consultant**
  An expert in carbon accounting and IO methodologies, Alex completed a PhD while at the consultancy for which he applied the global MRIO model that underpins the hybridised Carbon Commons methodology.
- **Victoria Harvey, SWC Consultant**
  With 17 years' experience in GHG accounting, Victoria has played a key role in establishing accountability for emissions related to advertising and digital storage and has developed industry-standard carbon calculators used in the UK/US.
- **Ben Lane, SWC Senior Consultant**
  Following two decades in the electric vehicle (EV) sector, Ben has extensive experience in conducting road transport LCAs and is active in assessing GHG removal pathways and climate interventions.
- **With additional contributions and comments from:** George Sandilands (VP Sage Earth), Henrik Micski (Principal Climate Scientist), Duncan Oswald (Climate Science Lead), and David Harrop (Climate Change and Environment Director) at Sage Group PLC.

CARBON COMMONS

Sage

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