Limitations of linear GHG Protocol carbon reporting in achieving circular progress

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Abstract. Net Zero plans are coming with increasing urgency from governments and the corporate sector around the world. Circular Economy is recognized as an essential pathway towards Net Zero in the reduction of supply chain emissions and governments around the world are introducing legislation and policy to support it. However, the globally recognized carbon reporting standard from the GHG Protocol make no distinction between the traditional take-make-waste supply chains and circular economy alternatives. As a result, there is a potential disincentive for companies operating in the circular economy space or incorporating circular economy into their procurement practices. Given the pressing need to both decarbonize the global economy and reduce waste streams, it is imperative that society addresses this issue with an intellectually robust standardized approach to circular economy carbon and environmental reporting.

1 Introduction

There is widespread agreement that the world needs to limit global average temperature rises to well below 2°C (or 1.5°C according to the latest science (IPCC, 2022)) by the end of the century compared to pre-industrial levels to avoid the most catastrophic effects of anthropogenic climate change. This means that the planet needs to see greenhouse gas (GHG) emissions peak by 2025 and then reduce drastically from then onwards to net zero by 2050. The circular economy – an economic system that is regenerative by design – is seen as a key element of our pathway towards net zero. Product strategies, including circular economy measures are needed to address the 45% of emissions remaining after switching to renewable energy supply and implementing energy efficiency measures identified by the Ellen McArthur Foundation and Material Economics (2021).

There is a strong basis of science-based methodologies to demonstrate carbon cost and reduction through the Greenhouse Gas Protocol (GHG Protocol), and this is being adopted by legislators mandating company reporting of their carbon footprints. There is currently no equivalent global circular economy metric, despite circular economy action plans also being

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adopted by governments worldwide. With company carbon accounting presenting no difference between new products (part of the linear, take-make-waste system) and a circular approach (product life extension, reuse and refurbishment/remanufacture), there is no established, universal carbon benefit for companies involved in circular economy practice. With no equal and opposite force in the form of verifiable circular accounting, societal shift towards circular economy as a means to carbon reduction is not supported (and may even be disincentivized) at company reporting level.

This paper aims to identify how and why this is the case and suggest alternative methods for incorporating product life extension and embodied carbon calculations into company reports.

2 Policy Guidelines Options and Implications

2.1 Circular Economy Policy Actions

National circular economy plans are increasingly common and often interwoven with carbon reduction and net zero / carbon neutrality commitments.

In the EU, the Circular Economy Action Plan (European Commission, 2020) forms part of the European Green Deal (European Commission, 2019a) – the EU's agenda for sustainable growth – and has a particular focus on resource-demanding sectors like ICT. Circularity is highlighted as a prerequisite to achieve the bloc's 2050 Climate Neutrality target, forming a key strand of the long-term delivery strategy (European Commission, 2018a).

The UK's Circular Economy Package (UK Government, 2020) is based on the EU Plan. It introduces revised legislation and identifies steps to reduce waste and establish long-term plans for waste management. Circularity has been covered extensively across the UK already through initiatives like Wales's Beyond Recycling (Welsh Government, 2021), Scotland's Making Things Last circular economy strategy (Scottish Government, 2016), and the draft Environment Strategy for Northern Ireland (DAERA, 2021). The UK views these and other resource efficiency strategies as important policy pathways to help realize its Net Zero target. The Net Zero Strategy Document (BEIS, 2021, p.172) says that, by 2050, "[a] circular economy will be part of everyday life: reusing, repairing, and remanufacturing goods will be standard practice."

In the USA, there is no standalone policy; however, overall circularity is covered by the National Recycling Strategy (EPA, 2020), a 10-year vision to promote sustainable materials management and address climate change. The country is committed to achieve Net Zero emissions by 2050, and material efficiency – specifically "recycling, reuse, material substitution, and demand reduction" – is briefly outlined as an industry strategy to achieve it (US Department of State, 2021, p.34).

2.2 Circular Economy Reporting

As summarized by Business in the Community (BITC) following its review of circular economy indicators, "there is not yet a clear approach for businesses to report on resource use or progress in the transition to a circular economy" (2022, p.2). BITC's review compared various metrics currently in use and highlighted shortfalls like focusing on waste created and recycled (which incentivizes recycling over reuse) and ignoring the production of single-use products that do not count as waste because they are sold as products.

Figure 1 below shows the six frameworks BITC analyzed, highlighting the absolute lack of a comprehensive metric that covers all key areas and the relative lack of individual metrics that consider the carbon impact of circularity (see Appendix 1 for a summary of each framework). Consequently, companies may struggle to accurately measure, benchmark, and compare their transitions towards circularity.

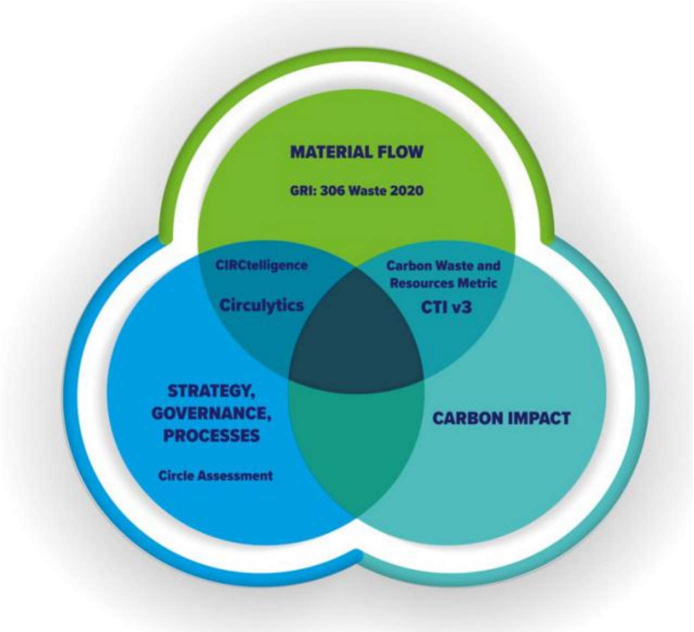

Fig. 1. Venn diagram comparison of circular economy benchmarks (BITC, 2022, p.8).

2.3 Carbon Policy and Actions

Following the breakthroughs at the United Nations (UN) Conference of the Parties (COP) in recent years, over 30 countries have now set net zero or carbon neutral targets (Climate Action Tracker, 2022), most of which are (or claim to be) in line with the latest UN IPCC findings.

The UK was the first major economy to set such a commitment. Its Net Zero Strategy (BEIS, 2021) covers eight key areas, including power, fuel, buildings, industry, resource management, and transport. The circular economy is referenced throughout the report as a mechanism to achieve net zero along with several other landmark policies such as banning new petrol and diesel cars from 2030, creating an entirely clean power grid by 2035, and investing at least £1.5 billion in net zero innovation projects.

In line with this, the UK Government has amended its own procurement policies to drive change. Its Greening government: ICT and digital services strategy 2020-2025 (DEFRA, 2020) guidance requires all government suppliers to commit to science-based net zero targets and states that, by 2025, the government will have yearly increases in the amount of refurbished ICT kit it purchases or leases.

UK businesses are also subject to increasingly strict reporting requirements from government. Under the Streamlined Energy and Carbon Reporting (SECR) regulations (UK Government, 2019), large organisations must include their carbon footprint and energy use as part of their company reports. The Energy Savings and Opportunities Scheme (ESOS) complements this by mandating large businesses to report energy usage and reductions over time (BEIS, 2014).

Additionally, disclosing climate-related risks to stakeholders using Task Force for Climate-Related Disclosures (TCFD) is required of publicly traded large companies in the UK (FSB, 2017). Whilst TCFD reporting is not mandatory in other G20 jurisdictions, companies with public debt or equity are legally obligated to include material climate-related information in their financial filings. For this reason, much of the demand for energy efficiency measurements and strategies is coming from the financial sector.

The EU's Clean Planet for All vision for climate neutrality (part of the European Green Deal) focuses on many of the same key areas as the UK's Strategy (European Commission, 2018a). The Bloc built on this with the introduction of European Climate Law (European Commission, 2021a), which commits into law the Green Deal, the 2050 climate neutral goal, and an intermediate goal of reducing net GHG emissions by 55% by 2030 vs 1990.

From a business perspective, similar reporting requirements to the UK's ESOS are imposed on EU companies under the Energy Efficiency Directive, which requires companies to report energy and carbon use as well as plans for and evidence of reductions over time (European Commission, 2018b). Additionally, businesses will soon be subject to the Corporate Sustainability Reporting Directive (CSRD), which is set to be adopted in late 2022 and enforced from 2024 (European Parliament, 2022a). Designed to support the Green Deal as part of a Sustainable Finance Package (European Commission, 2021b) that channels investment into a carbon-neutral economy, CSRD will require large EU companies to follow a new set of sustainability reporting standards covering environmental risks, opportunities, and impacts.

The US' Long-Term Strategy to achieve net zero emissions by 2050 primarily focuses on power, energy efficiency, and GHG removals. US companies are not currently required to report their emissions; however, the SEC is proposing a change that would mandate reporting of climate-related risks, including emissions (SEC, 2022).

2.4 Carbon reporting

The globally accepted methodology for carbon accounting comes from the Greenhouse Gas Protocol (GHG Protocol), whose guidance on upstream and downstream emissions is intended "to support consistent and transparent public reporting of corporate value chain emissions according to a standardized set of reporting requirements" (GHG Protocol, 2011a, p.4). A standardized methodology for organisations worldwide, it defines three scopes of carbon reporting: scope 1 relates direct emissions (for example from boilers or company vehicles), scope 2 relates to emissions related to electricity used by the organisations, and scope 3 relates to supply chain emissions within the organization's control.

The full overview of scope 1, 2 and 3 emissions is set out in the Figure 2 below and published in the GHG Protocol reporting guidance documentation.

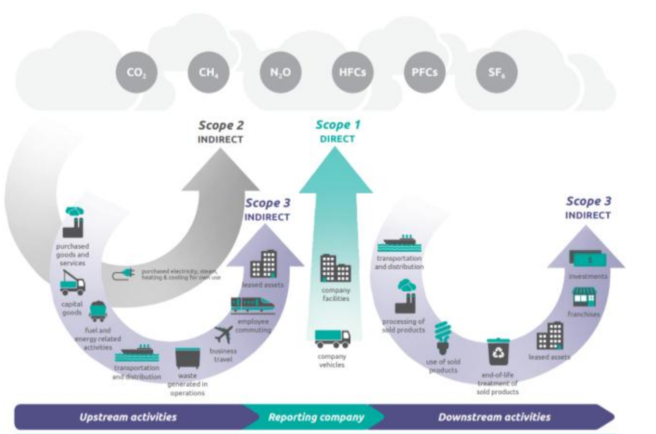

Fig. 2. GHG emission scopes (GHG Protocol, 2011a, p.5).

2.4.1 Carbon Reporting for companies

Depending on location and size, some companies will have to report against multiple carbon frameworks at the same time. Some of these (e.g., SECR) will only request the carbon footprint year on year. Others (e.g., ESOS) will request plans and evidence of energy and carbon reduction. All company reporting relies on similar metrics: direct emissions (scope 1) of greenhouse gasses expressed as CO2e in kg or tonnes as well as those associated with energy usage (scope 2). Reporting on upstream and supply chain emissions (scope 3) is encouraged, beginning with the items that have the biggest impact. Given the growing awareness of the importance of scope 3 reporting, it is expected this will be increasingly mainstream over time.

2.4.2 The Rationale behind Scope 3 Reporting

Reporting scope 3 emissions forces carbon accountability down through the supply chain. Smaller suppliers will not need to report directly but knowing their carbon footprint potentially influences customers' buying decisions, which will encourage them to take steps to reduce this. The same is true for suppliers who do not need to report in their own country but sell to a country where carbon accounting is required.

Scope 3 also captures global shipping, a glaring hole in the UN Emissions Gap (UNEP, 2021) report. Assessing and reporting on the embodied carbon impact of purchased goods and services (all the carbon it took to deliver them to first use) means, in theory, that companies will reduce the amount they ship from one side of the world to the other.

This is particularly true of IT hardware manufacture, where raw materials are mined all over the world, components are manufactured in the Far East, assembly takes place in Europe and America and the end product is delivered worldwide.

Finally, scope 3 addresses society's carbon footprint. Citizens do not have to report to government on how much emissions shipping their purchased goods and services are responsible for. However, companies selling to them do have to. Similarly, citizens cannot directly control the design or energy efficiency of their products, but the manufacturers can. Many emissions would not be there without the financial incentive to create them. Scope 3 reporting is a way of redressing that balance.

2.4.3 Company reporting on Supply Chain Emissions (scope 3) according the GHG Protocol

The GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (2011a) outlines the methodology for reporting supply chain emissions. The reporting on scope 3 (supply chain emissions) is "intended to be tailored to business realities and to serve multiple business objectives" (2011a, p.4) and is designed to report a company carbon footprint. It has 15 categories in total. Category 1 is purchased goods and services, which is where a product's embodied carbon naturally sits. Emissions calculations are described as cradle-to-gate. Category 12 deals with emissions at the end of life that are associated with the destruction or recycling process, so also touch on product carbon footprint at gate-to-grave.

There is no mention or provision for the purchase of reuse, remanufactured or refurbished hardware or for sale to a secondary user. The assumption is that all companies buy new and then destroy after first use – in other words that they operate on a take-make-waste model. There is no provision for a circular system, in which multiple gate-to-gate transactions are completed between companies as product lives are extended. In the letter of the guidance, companies buying refurbished equipment must record the entire pre-use (embodied) carbon footprint of the product whether this is at first or second use. They must also record the entire end-of-life carbon footprint, regardless of whether it is sold after first, second or third use. Moreover, they must also add on emissions from the refurbishment process, which could perversely make a new product have a lower carbon footprint than a refurbished alternative, thus disincentivizing the circular economy from a scope 3 perspective.

GHG Protocol advice on company scope 3 emissions advises that organisations set boundaries according to the emissions that are within either their financial or operational control. This means that many organisations do not report against all 15 categories of scope 3 either because they are not part of their operations or financial control or because the effect is negligeable. As long as this is justified within the reporting process, this still qualifies as being in line with the guidance; however, none of these documents are currently audited by an outside body.

This approach means that there is also scope for companies to discount the embodied carbon of purchased products that are second hand or have had their product licenses extended. However, there is no overt process for articulating carbon savings as a result. It is left to individual companies and the consultancies supporting them in carbon reporting to decide and justify what they have decided to include and exclude.

2.4.4 Variance in company carbon reporting

Organisations practicing circular economy, whose upstream and downstream products are gate-to-gate, are potentially at a disadvantage unless they reinterpret the guidance. There is scope for taking exactly this approach. However, as discussed above, the results are not verified through an audit nor one approach compared against another. There is no template for this approach within the wording of the GHG Scope 3 guidance so no parity to be achieved with this method.

Many customers of the above companies, notably financial institutions, follow the letter of the guidance for their own carbon reporting, and will not accept carbon reductions for refurbished or remanufactured equipment. A life cycle approach to reporting would be able to articulate value, but there is no obvious space to integrate this into GHG reporting.

2.4.5 Carbon reporting on products

The GHG Protocol Product Life Cycle Accounting and Reporting Standard (GHG Protocol, 2011b) is designed to build on ISO 14044:2006 (ISO, 2006). It presents guidance for companies and other organisations attempting to account for life cycle emissions and removals at a product level via Life Cycle Assessments (LCAs).

The GHG Protocol Standard focuses largely on products developed via a linear process, but it does recognize that circular economy approaches can cut GHG emissions at various stages: “Reducing the amount of waste entering waste treatment reduces the GHG emissions from waste treatment in the end-of-life stage. Reducing upstream virgin material acquisition reduces the GHG emissions and removals from material acquisition if the recycling processes are less GHG intensive than virgin extraction” (2011b, p.73).

As a result, the GHG Protocol Standard includes dispensation for circular economy through a process of allocation. It is worth noting that, while ISO 14044 makes provision for allocation of reuse and recycling, “reuse” appears to be omitted from the GHG Protocol Standard version, which instead focuses solely on recycling.

The GHG Protocol Standard proposes two methodologies for allocation, namely Closed-Loop Approximation and the Recycled Content Method. The former accounts for the impact of end-of-life recycling by considering the effect on net virgin acquisition of a material, based on the assumption that “the creation of recyclable material results in the displacement of virgin material and the emissions and removals associated with its creation" (2011b, p.72) The latter, meanwhile, deals with downstream recycling by allocating the emissions and removals from the recycling process to the product life cycle that uses the recycled material. This is a crucial step, as "correctly allocating removals is important to avoid double counting among different products" (2011b, p.70).

While these methods can account for the impact of recycled materials, there is still no consideration of product life extension through processes like refurbishment, and, as noted above, "reuse" is not specifically covered in the GHG Protocol Standard's allocation guidelines. While certainly beneficial, amending these allocation procedures to account for product life extension and reuse would not solve the challenge from a scope 3 perspective. Due to configuration variances in many ICT products companies rely on base specification averages for LCAs, making them less relevant to the equipment actually seen in the market.

Moreover, despite the guidance of the GHG Protocol Standard and ISO 14044, there is still significant variation between different LCAs of seemingly comparable products. This is prevalent in enterprise IT, where some server Original Equipment Manufacturers (OEMs) are changing the configurations of the devices in their studies by reducing the included number of carbon intensive components like Central Processing Units (CPUs), Random Access Memory (RAM) and Hard Disk Drives (HDDs). This results in a lower LCA for the manufacturer but makes is a less representative configuration than is commonly seen in the market. The resulting LCAs are up to 300% lower than comparable products from other manufacturers. This provides a scope 3 incentive for companies to buy these products, which could encourage other server OEMs to adopt the same practices unless we have increased consistency within industries.

2.5 Variance between societal impact and company impact

LCAs are intended to articulate the environmental and potentially social impact of a product over the course of its lifetime. Academics working in the field of lifecycle management often include a much wider range of impacts than carbon. On the environmental side, data on eutrophication, water usage, pollution and others would be factored into an impact assessment. For a social impact assessment, metrics such as on child labor and freedom of association would be factored for all elements of the supply chain. Full LCA analysis often attributes a greater proportion of impacts to the production of goods than their use phase than a carbon LCA would reveal.

GHG company reporting is a laser focus on carbon within the boundaries of company responsibility (i.e., limited). Allowances are made for companies to provide additional evidence with their report in order to avoid double counting. However, there is no guarantee that these individual company reports cover the entire scope of a product life cycle because there is no transparent parity between company reporting (as explored above) and because it only deals with carbon rather than environmental, or environmental and social, impact.

The GHG Protocol Product Standard highlights this very issue when discussing an example where a recycling process is more GHG intensive than virgin material processing. The guidance suggests that, while virgin materials would reduce inventory emissions in this instance, this is "an example of when focusing on one impact category may drive companies to make product decisions that are desirable for one impact (e.g., GHG emissions) but unfavorable to another (e.g., material depletion)" (2011b, p.73).

This lack of transparency introduces an element of risk to reporting at all. Some companies are reluctant to take a rebate on the scope 3 product carbon, while other companies are taking that risk and supplying supplementary information to justify their stance. The variance ultimately reduces trust in the system of measuring and articulating embodied carbon reductions, which means that the circular economy is potentially not properly represented in carbon reporting.

Even if carbon accounting did take circular economy into account in a standardized way, we would still miss other environmental impact reduction measurements attributable to circular economy. Rockström et al. (2009) identified 9 planetary boundaries, within which humanity can continue to develop and thrive in years to come, which is summarized in Figure 3 below. Climate Change is one of the six of these boundaries we are currently exceeding. The others – novel entities (e.g., plastics), biosphere integrity, land-system change, and biogeochemical flows, and fresh water (specifically, green-water) – are all at least partially attributable to mining and manufacture. A full environmental LCA calculates this at product level, whereas a carbon LCA fails to capture all impacts.

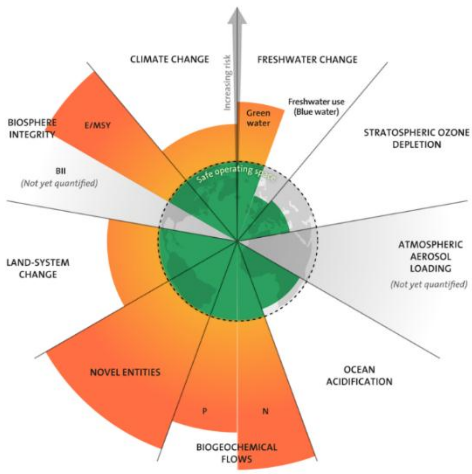

Fig. 3. The Planetary Boundaries Framework (CEEweb, 2022).

3 Implications for high environmental impact sector (Technology)

The tech sector is one of the high impact areas ear-marked for special interest by policy makers, notably the Circular Economy Action Plan from the EU (European Commission, 2020). Part of the reason for this is its use of a significant number of rare earths, precious metals, and roughly 23 of the items on the EU Critical Raw Materials list. Another part of the reason is the high GHG emissions associated with the sector.

In September 2022, the European Parliament published an update on its Circular Electronics Initiative, which included plans for the implementation of the 'right to repair' along with regulatory measures for mobile phone chargers and similar devices, intended to promote longer product lifetimes (European Parliament, 2022b). The focus has initially been consumer devices. However, non-consumer (public and private) sector also have a significant effect.

Currently, many companies buy new IT hardware every 3 years. Reliable data on what happens to retired equipment is not easy to come by, but the EU Commission has estimated that 1/3 of goods arriving at recycling centers are re-usable and could be sold second hand (European Commission, 2019b). Deloitte (2019) assessments suggest that ICT aftermarkets were, at least, worth $46 billion in Europe and employed more than 220,000 people in 2015.

3.1 Circular Economy viewpoint

Even when considering the high energy usage attributable to the use phase of always-on technology (notably servers), the embodied environmental impact is significant in the manufacture of electronics. Collectively, the sector manufactures equipment that includes almost every element of the periodic table. In 2021, the British Geological Survey (2022) published a UK Criticality assessment for technology critical materials. Table 1 below is taken from that report, showing that all 26 materials investigated were at either medium or high risk because of their production concentration, the need to extract from other metal processing (column three) and their recycling rate.

Table 1. Global supply risk (S) indicator scores for 26 materials (British Geological Survey, 2022, p.9).

	Global supply risk(s) indicator scores			Global supply risk(s)	Weighted PC (70%)	Weighted CMF (20%)	Weighted RR (10%)	**Sum of weighted S indicators**
Candidate material	Production concentration (PC)	Companion metal fraction (CMF)	Recycling rate (RR)					
Antimony	3	3	2	8	2.1	0.6	0.2	2.9
Beryllium	1	1	3	5	0.7	0.2	0.3	1.2
Bismuth	2	3	3	8	1.4	0.6	0.3	2.3
Cobalt	2	3	2	7	1.4	0.6	0.2	2.2
Gallium	3	3	3	9	2.1	0.6	0.3	3
Germanium	3	3	3	9	2.1	0.6	0.3	3
Graphite	3	1	3	7	2.1	0.2	0.3	2.6
Indium	2	3	3	8	1.4	0.6	0.3	2.3
Lithium	1	2	3	6	0.7	0.4	0.3	1.4
Magnesium	3	1	2	6	2.1	0.2	0.2	2.5
Manganese	1	1	3	5	0.7	0.2	0.3	1.2
Molybdenum	1	2	1	4	0.7	0.4	0.1	1.2
Nickel	1	1	2	4	0.7	0.2	0.2	1.1
Niobium	3	1	3	7	2.1	0.2	0.3	2.6
Palladium	2	3	2	7	1.4	0.6	0.2	2.2
Platinum	3	1	2	6	2.1	0.2	0.2	2.5
Rare earth elements	3	3	3	9	2.1	0.6	0.3	3
Rhenium	1	3	1	5	0.7	0.6	0.1	1.4
Silicon	3	1	3	7	2.1	0.2	0.3	2.6
Strontium	2	1	3	6	1.4	0.2	0.3	1.9
Tantalum	2	1	3	6	1.4	0.2	0.3	1.9
Tellurium	3	3	3	9	2.1	0.6	0.3	3

Tin	2	1	1	4	1.4	0.2	0.1	1.7
Titanium	1	1	2	4	0.7	0.2	0.2	1.1
Tungsten	3	1	1	5	2.1	0.2	0.1	2.4
Vanadium	2	3	3	8	1.4	0.6	0.3	2.3

Rank	Low	Medium	High

Whilst product life extension is not the only model in circular economy, it is generally accepted to be a higher value proposition than recycling. For the tech sector, this is because a lot of the materials present in the hardware (notably Critical Raw Materials) cannot be recovered at scale with current recycling technologies, which melt down the equipment to recover metals and burn trace elements away in doing so. Alternatives such as bioleaching and pyrolysis are on the horizon but are not yet viable at scale. With no standardized reporting on circular economy performance for companies, there is no way for organisations to articulate the benefit of choosing one over another internally or externally in concrete terms. converted to black and white, and this should be considered when preparing them.

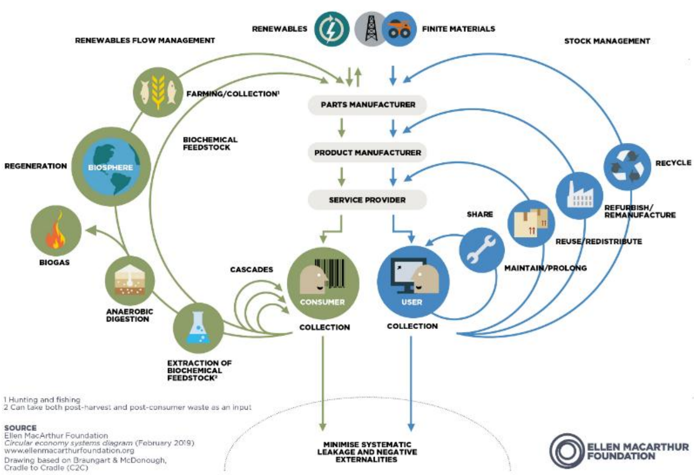

Fig. 4. The circular economy butterfly diagram (Ellen Macarthur Foundation, 2019).

3.2 Carbon Viewpoint

A report from The Shift Project (2019) stated that the direct energy consumption caused by $1 invested in digital technologies increased by 37% between 2010 and 2019, that CO2e emissions of digital technologies increased by about 450 million tonnes between 2013 and 2019, and the share of digital technologies in global GHG emissions increased by 50% in the same period. Authors identified 33% of the energy consumption to be related to production of devices, with the remaining 66% in the use phase.

The high embodied energy impact of manufacture and pre-use is partly due to the technology sector's complex supply chain, which has a large number of international travel miles. In addition, much of the material extraction and component production throughout the supply chains occur in areas of the world that do not have carbon reporting, so reporting it at first use is appropriate.

With this in mind, many organisations in the refurbishment, reuse, repair and remanufacture sector are articulating the value of their products with the use of embodied carbon figures.

Based on the published carbon footprints of manufacturers, these figures are used for customers to assess carbon saved either through extending product life with purchase decisions or facilitating product life extension through sale to the secondary market.
However, with no standardized approach, it is unclear how embodied carbon metrics can be integrated into customer carbon reporting. With no consistent benefit of recording carbon benefits associated with use of refurbished or remanufactured hardware, companies are articulating the rebate but have no transparent methodology to do this.
Allied to this but possibly more impactful is the fact that some large organisations are following the letter of the law when it comes to new and extended lifespan products. If they mandate their supply chain to report in the same way, it puts providers of refurbished and remanufactured equipment at a potential disadvantage when it comes to their own carbon footprint and the footprints of the products they sell. This is because they have to account of the pre-use carbon footprint of a product and then have an additional refurbishment carbon overhead due to processing.

4 Recommendations

The GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (2011a, p.9) suggests that "Sectors should develop guidance through an inclusive multi-stakeholder process to ensure broad acceptance and facilitate increased consistency and credibility". We suggest that this should happen for key sectors in the circular economy such as plastics, electronics and fashion and focus on a standardized methodology for articulating the value of product life extension and refurbishment in carbon terms.

This standardized carbon reporting approach should recognize that passing products to a secondary market (for reuse) is not the same as passing products for end of life (and then incorporate carbon costs associated with this). It should also encourage product life extension instead of other measures lower down the waste hierarchy and have separate methodologies for reuse, refurbishment, and remanufacturing, as the processing carbon costs and associated reporting standards should differ from those for recycling. Finally, it should deliver a standardized way of attributing refurbishment costs by sector.

As a first step, embodied carbon should be attributed to a fixed lifetime of an asset and a proportion written down every successive year within this lifetime. This carbon amortization approach is similar to the economic write down of assets in traditional accounting practices. When products are sold within the write down lifetime, their residual embodied carbon cost should be passed on to the second user. Once the product has passed its write down period, it should be considered to have no embodied carbon cost other than the CO2e associated with the refurbishment or remanufacturing process. This cost should be agreed across industry.

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