A Landscape of Sustainability Attributes Considered by Companies During Chemical and Material Selection

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Acknowledgement

This report was prepared under the framework of the OECD’s Working Party on Risk Management. The draft was developed by the Sustainable Chemistry Catalyst, a research institute at the University of Massachusetts Lowell, with input from the Working Party on Risk Management. The study utilised background research, a survey and follow-up interviews with participating companies, along with outputs from discussions during in-person events in 2023 hosted by a whole value chain sustainable chemistry business association. The report was reviewed and endorsed by the Working Party on Risk Management and is published under the responsibility of the OECD Chemicals and Biotechnology Committee.

Summary

Building on the OECD Guidance on *Key Considerations for the Identification and Selection of Safer Chemical Alternatives,* this report describes the results of a landscape study of sustainability attributes used to guide chemical and material selection decisions. Results outline the range of sustainability attributes being considered, factors guiding the choice of standards and metrics used, as well as lessons learned in terms of challenges, needs and opportunities in the use and interpretation of a range of sustainability impacts to support chemical/material selection decisions. Companies are at various stages, given their value chain position and individual circumstances, in considering sustainability attributes in their chemical and material selection decisions, whether for the design of new chemistries, industrial processes or industrial/consumer products. Companies noted that sustainability attributes were not often considered in chemical substitution efforts given that regulatory and market-based chemical restrictions are primary risk-driven (human/environmental hazards and related exposure concerns). The most commonly considered attributes included the generation of waste and social impacts. Firms rely on a broad range of standards (including industry standards, certifications and eco-labels). This is consistent with existing knowledge about the sheer number of standards and metrics in current use for sustainability assessment that are often specific to product/industry sectors. Use of Ecovadis and Life Cycle Assessment (LCA) were the most commonly mentioned measurement approaches by survey respondents. Future guidance development to establish a minimum and recommended set of sustainable attributes should be flexible to the company/sector/product context as well as specific standards or metrics that could be used to evaluate them. Guidance should also be supportive of chemical-level innovation and selection decisions and aligned with forthcoming mandatory sustainability reporting requirements.

List of Acronyms

CSR	Corporate Social Responsibility
EU CSRD	European Union Corporate Sustainability Reporting Directive
ESG	Environmental, Social and Corporate Governance
EU	European Union
GAO	Government Accounting Office
GHG	Greenhouse Gas
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GRI	Global Reporting Initiative
ISIC	International Standard Industrial Classification of All Economic Activities
ISO	International Standards Organization
LCA	Life cycle assessment
MRSL	Manufacturing Restricted Substance List
OECD	Organisation for Economic Cooperation and Development
PEF	Product Environmental Footprint
RCS	Recycled Claim Standard
RSPO	Roundtable on Sustainable Palm Oil
SBTi	Science Based Targets Initiative
SDG	UN Sustainable Development Goals
SLCP	Social and Labor Convergence Program
SME	Small and Medium Sized Enterprises
SSbd	Safe and Sustainable by Design
SVHC	Substances of Very High Concern
TfS	Together for Sustainability
UN	United Nations

US	United States
VOC	Volatile Organic Compounds
WBCSD	World Business Council for Sustainable Development
ZDHC	Zero Discharge of Hazardous Chemicals

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Executive Summary

Sustainable chemistry provides a proactive strategy for preventive chemicals risk management that considers the safety of chemicals as well as their environmental impact and efficiency.[1] The Organisation for Economic Cooperation and Development (OECD) published in 2021 Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives[2], which succinctly defined minimum criteria for determining whether alternatives are safer. Moving beyond safer, the consideration of a range of sustainability attributes can further improve chemical and material selection decisions and minimise risk. Recently, the European Commission's work to advance Safe and Sustainable by Design (SSbD) innovation for chemicals and materials is gaining momentum to help fill this gap in using both safety and sustainability considerations to minimise overall impacts to human health and ecosystems more broadly.

As such, a preliminary step towards supporting efforts within the OECD to advance chemicals and materials that are both safer *and more sustainable* is to better understand the landscape of sustainability attributes currently being used to support chemical and material selection decisions across a range of firms. Using background research, an industry survey, follow-up interviews with survey respondents, and discussions during forums hosted by a multi-sectoral business association inclusive of companies across the value chain that focuses on advancing sustainable chemistry, this study sought to understand which sustainability attributes and related standards and measurement techniques are being used in chemical and material selection decisions. A primary objective of the study was to identify whether there are specific attributes that are more frequently considered and whether there are commonalities regarding the standards/measurement approaches used. Companies from a range of sectors, position in the value chain, and company sizes were consulted during the survey.

The survey asked companies to identify which sustainability attributes were considered during chemical and material selection and whether such impacts were "sometimes" or "always" considered. Respondents overwhelmingly indicated that a range of sustainability attributes were being considered, most commonly the generation of waste and social impacts. In contrast to other attributes, biodiversity and circularity were mostly considered "sometimes" rather than "always".

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[1] OECD definition for sustainable chemistry: Sustainable chemistry is a scientific concept that seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services. Sustainable chemistry encompasses the design, manufacture and use of efficient, effective, safe and more environmentally benign chemical products and processes.

Sustainable chemistry is also a process that stimulates innovation across all sectors to design and discover new chemicals, production processes, and product stewardship practices that will provide increased performance and increased value while meeting the goals of protecting and enhancing human health and the environment.

[2] Organisation for Economic Cooperation and Development (2021). Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives. Series on Risk Management No. 60. https://www.oecd.org/en/publications/guidance-on-key-considerations-for-the-identification-and-selection-of-safer-chemical-alternatives_a1309425-en.html

Those survey respondents agreeing to follow-up interviews and discussions at forums hosted by the sustainable chemistry business association added more nuanced understanding of the survey findings. Interviewees and forum participants identified a number of challenges and needs/opportunities in the use of existing sustainability attributes to inform chemical innovation and selection.

Notable challenges identified include:

- **The lack of regulatory drivers for considering sustainability attributes as part of chemical restrictions limits their use in substitution-related decisions**. Companies interviewed are mainly using hazard and exposure data in addition to cost and performance information when making specific substitution decisions, not sustainability attributes. Companies noted the lack of regulatory requirements for consideration of sustainability attributes as part of chemical restrictions as a reason for limited use in substitution decisions. Although interviewees noted the growing importance of considering sustainability when making substitution decisions, comprehensive sustainability assessments of alternatives are often not pursued because of tight regulatory timelines associated with chemical restrictions, limited resources, and given that regulatory determinations are based on risk or (less commonly) hazard, not sustainability.

- **The vast array of sustainability reporting instruments complicates harmonisation and alignment**. The proliferation of sustainability reporting instruments can be seen in survey responses regarding measurement approaches commonly used. In addition, the study was unable to develop a clear understanding of which standard and/or metric companies use most for a given sustainability impact category as: (a) the majority of respondents did not provide detailed responses on the standards and metrics being used; (b) some companies use their own unique standards and related metrics to enhance their "fit for purpose" for the specific needs of their given company; and (c) some standards are unique to specific industry sectors. This finding is not unexpected as other research efforts and initiatives have noted that the rapid proliferation of sustainability reporting instruments over the last decade has created a complex and fragmented landscape. Although aligning sustainability measurement approaches seems desirable, some companies interviewed warned that too much standardisation, especially if the primary focus is for financial reporting, will risk losing their utility for chemical and material selection.

- **Sustainability attributes being considered for chemical and material selection are being measured at the chemical-, product-, process- and facility level**. Although the survey specifically asked about sustainability attributes and associated standards/certifications used to support chemical and material selection decisions, the level of assessment varies for specific attributes as well as the position of a company within the supply chain. For example, the assessment of greenhouse gas emissions varies highly based on a company's position in the supply chain. Chemical manufacturers are beginning to make available the carbon footprints of their products, inclusive of scope 1, 2, and 3 emissions. Thus, for some chemical and material selection decisions, there are greenhouse gas data available at the chemical-level. However, product manufacturers noted during interviews that their consideration of greenhouse gas emissions tend to be at the product- or facility- level, given the lack of data currently available at the chemical-level for products being designed or formulated. Product manufacturers also noted considering attributes such as waste generation, water or energy use at the product-level, which is consistent with the primary unity of analysis computed by life cycle assessment (LCA) methodologies. Regarding social impacts, most are assessed at the facility-level and are highly geographically oriented. When interviewees were asked whether standards created for assessment at the product-, process- or facility-level were applicable and relevant for chemical-level decisions, many responded that dimensions of sustainability are not easily contained to just the chemical-level and that it is also important to keep in mind the current primary use of sustainability assessments by companies – for their annual sustainability reports. These reports inform stakeholders of company's overall performance against key sustainability indicators. Thus, decisions at the chemical-level are based in large measure on whether there are notable improvements or declines in a company's sustainability performance.

- **Opinions differ on the value of specific methods and tools to estimate input data for sustainability attributes**. For some, especially smaller companies, use of third-party standards and associated tools creates efficiency and transparency. For others, assessment approaches, such as LCA that rely on the use of estimated and averaged generalised data are not considered stringent enough and some questioned widely differing results from suppliers of the same materials/chemistries leading to mistrust in the use of LCA. Caution was voiced about creating more tools despite challenge with those in current use. Many companies have developed their own sustainability reporting tools creating challenges for suppliers who have numerous customers and therefore numerous tools requiring different data and formats that they are expected to use.

- **Challenges exist with the use of existing metrics, especially for circularity.** Circularity has high-level principles defined by organisations such as the Ellen MacArthur Foundation,[3] and recent efforts have begun to develop circularity metrics, such as the World Business Council for Sustainable Development (WBCSD) Circularity Transition indicators[4] and forthcoming metrics by the International Standards Organisation (ISO FIS 59010 on the Circular Economy). However, challenges exist as existing metrics do not capture internal conflicts that can arise across circularity dimensions (e.g., designing for durability and disassembly, or use of recycled content given problems of residual toxic chemicals in the material).

- **Data availability and sustainability measurement interpretation remains a challenge.** Interviews with chemical manufacturers revealed that the consideration of sustainability attributes is more difficult for new chemistries given lack of knowledge and data about downstream uses. For established companies, companies reported four main challenges with gathering and interpretating data from their supply chain including: (1) lack of relationships and access to Tier 2 and Tier 3 suppliers, particularly for smaller companies; (2) suppliers' lack of resources to gather sustainability data, especially when the data formats/needs differ given the lack of standardisation of reporting needs of product manufacturers and brands; (3) the inability of some companies to verify the accuracy of information provided to them and (4) difficulty in timing and aligning reporting data, especially when needed for short-term decision making such as for chemical selections.

  Metrics are often hard to relate to the broader sustainability journey of a company and in supporting decisions within different departments in a company and across the value chain. The more diverse a company's product portfolio, the more business units are involved (each with different needs and expertise in sustainability assessments), the more complicated internal communication challenge is when using sustainability metrics broadly. A key example of this expressed by multiple

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[3] Ellen MacArthur Foundation. Circular Economy Introduction. https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview#:~:text=The%20circular%20economy%20is%20based,Regenerate%20nature Accessed 1/4/2024.

[4] World Business Council for Sustainable Development. (2023). Circular Transition Indicators Project. Circular Transitions Indicators V. 4.0. https://www.wbcsd.org/Programs/Circular-Economy/Metrics-Measurement/Resources/Circular-Transition-Indicators-v4.0-Metrics-for-business-by-business (accessed January 4, 2024).

interviewees was the use of LCA, the results of which are often difficult to interpret by non-LCA practitioners. Although this may reflect a need for broader education about this assessment approach, it is also a reason explained by interviewees for why companies have developed their own sustainability measurement strategies to more simply communicate results to key users of the information. No one sustainability impact was mentioned as specifically problematic with regards to internal and value chain communications. However, most interviewees stated that the use of standards and approaches to measure sustainability need to reflect the audiences that need to use them.

Notable needs/opportunities identified include:

- **An evolving focus on prioritising measurement of sustainability attributes where businesses can have the greatest positive impact.** Companies noted that there is an ever-increasing array of sustainability attributes of interest to stakeholders but limited internal resources. Consequently, there is a growing focus on prioritising “having an impact” and narrowing-in on areas where there may be impacts of concern to focus improvement efforts versus just tracking a given sustainability attribute because it is considered part of sustainability reporting process. Methods such as mapping UN SDG into quadrants to support prioritisation was one method being used by companies interviewed. Lessons learned in the use of such approaches can help companies narrow-in and prioritise the measurement of sustainability attributes that are most impactful for their chemical and material selection purposes.

- **Increasing use and availability of data sharing platforms and certifications to simplify impact measurement and communication.** Factors affecting the sustainability of a given company’s product or process extends beyond the boundaries of any one firm. Companies noted that organisations that helped suppliers to standardise their sustainability impact measurement and reporting were valuable to enhancing trust and communication across the supply chain. Companies interviewed voiced the need for increased collaboration within industry sectors in order to create efficiencies, to improve data quality, and to reduce the auditing/certification requirements such that suppliers did not have to certify with many different organisations with slightly overlapping data requests/needs.

- **Standards developed over the last decade are benefitting companies newer to the consideration of sustainability.** Interviews consistently noted that companies which started considering sustainability impacts 15-20 years ago typically developed their own standards due to a lack of available industry consensus standards. Although these companies still utilise their own standards, companies that are newer to the consideration of sustainability impacts reported that they had the ability to quickly advance in their journey by leveraging industry-based standards and tools previously developed with the input from and used by other companies.

- **Growth of approaches to consider multiple sustainability attributes to support comparison, prioritisation and deselection of chemicals and products.** Companies interviewed provided examples of approaches being used to target more sustainable product portfolios in their innovation process by screening out products that had high sustainability risks during their design stage. Some companies have developed their own multi-stage multi-factorial eco-design approaches for vetting sustainability risks or benefits to their portfolios, while others mentioned decision support frameworks such as the WBCSD Portfolio Assessment[5] and a range of others that are also available. Interviewees also voiced a need for new approaches to help standardise comparisons within and amongst sustainability attributes, similar to how chemical hazard classifications using the Globally Harmonised System of Classification and Labelling of Chemicals (GHS[6]) are used in hazard assessment processes to translate standardised categories into "high to low" comparison approaches.

Based on the results from this study, a company's value chain position and individual circumstances play a critical role in their approaches to sustainability and which attributes and related metrics/standards are most critical to them and their customers. There is no "one size fits all" approach. At this point, the addition of specific sustainability attributes to consider for a "safer and sustainable" chemical is complicated by lack of consistency, ease of application, and information gaps along the value chain. Although standardisation and harmonisation of existing sustainability standards are a current focus among many initiatives, including the forthcoming Corporate Sustainability Reporting Directive[7] in the EU, a deeper assessment is needed to better understand and evolve existing sustainability assessment processes to ensure they are suitable for the task of driving sustainable chemistry forward.

Companies should continue utilising the best available sustainability information to the extent possible to support the selection of the most sustainable chemicals in the design of new products and processes. Sustainability considerations are also important for companies to consider as part of substitution initiatives and more work is needed within global efforts guiding substitution planning and the use of alternatives assessment practices to build out the use of such attributes more robustly. At a minimum companies should ask basic questions about relevant sustainability impacts and their trade-offs in chemical selection decisions, leveraging tools such as the Change Chemistry Holistic Product Considerations framework[8], and other decision support frameworks, such as the WBCSD Portfolio Assessment as mentioned above. Additional educational efforts are also needed on the use of existing tools, such as the use and application of LCA, given concerns raised regarding the validity of results and an inability to understand assessment outputs across business units. Future guidance development to establish a minimum and recommended set of sustainable attributes should be flexible to the company/sector/product context as well as specific standards or metrics that could be used to evaluate them, supportive of chemical-level selection decisions and aligned with forthcoming mandatory sustainability reporting requirements.

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[5] World Business Council for Sustainable Development. (2023). Portfolio Sustainability Assessment v. 2.0. September 23. https://www.wbcsd.org/Programs/Circular-Economy/Resources/Portfolio-Sustainability-Assessment-v2.0 (accessed January 4, 2024).

[6] United Nations. Globally Harmonized System of Classification and Labelling of Chemicals (GHS) Tenth revised edition. 2023. https://unece.org/sites/default/files/2023-07/GHS%20Rev10e.pdf (accessed January 4, 2024)

[7] European Commission. Corporate Sustainability Reporting. https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en (accessed January 4, 2024).

[8] Change Chemistry. (2023). Holistic Product Considerations for Alternatives Assessment. https://assets-002.noviams.com/novi-file-uploads/gc3/pdfs-and-documents/RLC/Holistic-Product-Consioderations-for-Alternatives-Assessment-December-2023.pdf (accessed January 12, 2024)

1 Introduction

Sustainable chemistry offers a proactive strategy to support the preventive risk management of chemicals from the ground up. As defined by the Organisation for Economic Cooperation and Development (OECD), sustainable chemistry, "Encompasses the design, manufacture and use of efficient, effective, safe and more environmentally benign chemicals products and processes."[9] The United Nations Environment Programme developed a framework to advance opportunities to scale sustainable chemistry, emphasising the potential of chemistry to become fully compatible with the 2030 Agenda for Sustainable Development[10]. Within the last few years, a number of efforts have helped to define sustainable chemistry and related principles and criteria to accelerate innovation and adoption of chemicals that are safer and more sustainable, such as the Expert Committee on Sustainable Chemistry[11], the United States (US) White House Office of Technology and Policy[12], the International Sustainable Chemistry Collaborative Centre (ISC3)[13] and the American Chemistry Council (ACC)[14] among others. Interest in sustainable chemistry has increased with the European Union's Safe and Sustainable by Design (SSbD) efforts.[15] SSbD is a non-regulatory approach envisioned to support the design, development, production and use of chemicals and materials that provide a desired function while avoiding or minimising negative impacts to human health and the environment across all stages of a chemical's life cycle.

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[9] Organisation for Economic Cooperation and Development. Sustainable Chemistry. https://www.oecd.org/en/topics/risk-management-risk-reduction-and-sustainable-chemistry.html and OECD (2002) Need for Research and Development Programmes in Sustainable Chemistry https://one.oecd.org/document/env/jm/mono(2002)12/en/pdf

[10] United Nations Environment Programme. 2020. Green and Sustainable Chemistry: Framework Manual. https://www.unep.org/resources/toolkits-manuals-and-guides/green-and-sustainable-chemistry-framework-manual

[11] Cannon A, Edwards S, Jacobs M, Moir JW, Roy MA, Tickner JA. 2023. An actionable definition and criteria for "sustainable chemistry" based on literature review and a global multisectoral stakeholder working group. RSC Sustainability.1(8): 2092-2106. https://doi.org/10.1039/D3SU00217A

[12] National Science and Technology Council. (2023). Sustainable Chemistry Report – Framing the Federal Landscape. August. https://www.whitehouse.gov/wp-content/uploads/2023/08/NSTC-JCEIPH-SCST-Sustainable-Chemistry-Federal-Landscape-Report-to-Congress.pdf. (accessed April 15, 2024)

[13] Kümmerer K, Amsel A-K, Bartkowiak A, Bazzanella C, Blum C. (2021). Key Characteristics of Sustainable Chemistry. International Sustainable Chemistry Collaborative Centre. https://www.isc3.org/cms/wp-content/uploads/2022/06/ISC3_Sustainable_Chemistry_key_characteristics_20210113.pdf (accessed April 15, 2024)

[14] American Chemistry Council. ACC Issues Set of Principles to Support Sustainability Initiatives, Policy, Advocacy and Communication Efforts. https://www.americanchemistry.com/chemistry-in-america/news-trends/blog-post/2023/acc-issues-set-of-principles-to-support-sustainability-initiatives-policy-advocacy-and-communications-efforts (accessed April 15, 2024)

[15] Caldeira C, Farcal R, Garmendia Aguirre I, Mancini L, Tosches D, et al. (2022). Safe and sustainable by design chemicals and materials - Framework for the definition of criteria and evaluation procedure for chemicals and materials. Joint Research Council. Doi: 10.2760/487955

Although the focus of SSbD is on “design” of chemicals, the approach is inclusive of innovations to “support the substitution or minimisation of the production and use of substances of concern.” Within the SSbD approach, both the safety/hazard and sustainability dimensions of chemicals are considered. Although hazard criteria (e.g., hazard traits such as carcinogenicity, reproductive toxicity, aquatic toxicity, etc.) and the consideration of intrinsic exposure potential have been a cornerstone in methods and approaches supporting selection of alternatives to substances of concern in a substitution context, use of sustainability attributes to support such assessments and decisions is less established. For example, the OECD’s *Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives*[16] outlined a set of hazard and exposure criteria necessary for making a “safer” determination but did not include a set of sustainability criteria, including only a mention that such criteria are important to consider.

In addition, companies are increasingly considering a broader range of sustainability considerations in their product development, manufacturing, and sourcing decisions to better align with the United Nations Sustainable Development Goals (SDGs)[17]. Companies are also making commitments to address key impacts, such as Scope 3 emissions (those emissions resulting from activities not owned or controlled by the reporting company/those it indirectly affects in its value chain). Corporate social responsibility (CSR), environmental, social and corporate governance (ESG), and similar reporting initiatives required by investors and governments are including a broader range of sustainability attributes such as greenhouse gas emissions, energy use, resource use, biodiversity, waste generation. For example, as companies anticipate reporting mandates for greenhouse gas emissions associated with the EU’s Corporate Sustainability Reporting Directive (CSRD) among other potential forthcoming reporting mandates, greater attention is being focused on full emissions accounting processes inclusive of Scope 3 emissions.

An assessment of sustainability attributes will thus be increasingly considered more integral and fundamental to *chemical and materials selection* decisions, whether to support research and development (R&D), innovation directed at substitution-related needs, or as part of continuous improvement/optimisation practices for products and industrial processes. The purpose of this study was to better understand which sustainability attributes and related standards and measurement techniques are being used by a range of companies across sectors and the value chain to guide chemical and material selection decisions. Such an understanding will help support ongoing efforts within OECD countries to advance the evaluation and adoption of chemicals and materials that are both safer *and* more sustainable. A primary objective of the study was to identify whether there are attributes that are more frequently considered for chemical and material selection decisions and whether there are commonalities in the standards/measurement approaches being used. Although issues of cost and performance are critical to chemical and material decisions, these elements were not addressed in this study as the focus was a landscape of which sustainability attributes are being considered.

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[16] Organisation for Economic Cooperation and Development. 2021. Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives. Series on Risk Management No. 60. https://www.oecd.org/en/publications/guidance-on-key-considerations-for-the-identification-and-selection-of-safer-chemical-alternatives_a1309425-en.html (accessed January 4, 2024).

[17] United Nations Sustainable Development Goals. https://sdgs.un.org/goals (accessed January 4, 2024).

2 Approach

The landscape study involved the use of (a) an industry survey, (b) follow-up interviews with survey respondents where possible, and (c) sessions at two sustainable chemistry business association in-person events, as well as background research.

Survey

The survey was designed to collect the following:

Industry demographics. Initial questions included: company size; industry sector (based on the International Standard Industrial Classification of All Economic Activities (ISIC) Revision 4); and position in the value chain. This survey aimed to capture a diverse range of industries and company sizes.

Use of sustainability attribute categories for chemical design and material decisions. The survey sought to capture the most commonly addressed sustainability attribute categories (see Box 1), which were derived based on a review of the following sources:

- Commonly used sources for compliance with the EU Non-Financial Reporting Directive, including, Global Reporting Initiative, the UN Global Compact and the UN Sustainable Development Goals.[18]
- Life cycle assessment methodologies.[19]
- Reviews of the literature as summarised in government documents, such as the Joint Research Centre's (JRC) guidance on safe and sustainable by design (SSbD).[20]
- Sustainable procurement guidelines for the US, EU, and UN.[21]

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[18] UN Global Compact https://unglobalcompact.org/ (accessed January 4, 2024). EU Non-Financial Reporting Directive https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0095 (accessed January 4, 2024). GRI Standards https://www.globalreporting.org/standards/standards-development/ (accessed January 4, 2024). UN SDGs https://sdgs.un.org/goals (accessed January 4, 2024).

[19] Caldeira C., Farcal R., Moretti C., Mancini L., Rasmussen K., Rauscher H., Riego Sintes J., Sala S. Safe and Sustainable by Design chemicals and materials - Review of safety and sustainability dimensions, aspects, methods, indicators, and tools. EUR 30991 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-47560-6, doi:10.2760/879069, JRC127109

[20] Caldeira C., Farcal R., Garmendia Aguirre, I., Mancini, L., Tosches, D., Amelio, A., Rasmussen, K., Rauscher, H., Riego Sintes J., Sala S. Safe and Sustainable by Design chemicals and materials - Framework for the definition of criteria and evaluation procedure for chemicals and materials. EUR 31100 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-53264-4, doi:10.2760/487955, JRC128591

[21] US Environmental Protection Agency. Greening Government Procurement https://www.epa.gov/contracts/greening-government-procurement (accessed January 4, 2024). EU Green Public Procurement https://green-business.ec.europa.eu/green-public-procurement_en (accessed January 4, 2024). UN's Sustainable Procurement Indicators, https://www.ungm.org/Shared/KnowledgeCenter/Pages/SustProcIndicators (accessed January 4, 2024).

- General categories of product certification schemes with a sustainability focus, such as the EU Ecolabel certification and the Cradle-to-Cradle certification.[22]

Box 1 and Box 2 outline the list of attributes used, which reflects a synthesis of these sources rather than adopting those used by a single source.

For this report, the term "attributes" is used to indicate impacts on different aspects of sustainability, ranging from biodiversity to climate to circularity. Human health and aquatic toxicity considerations were excluded from the survey as these are already addressed in the OECD *Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives*[23].

Box 1. Primary Sustainability Attribute Categories Addressed in the Survey

- Greenhouse gas emissions
- Other air emissions
- Biodiversity impacts (including land use)
- Energy consumption
- Resource use
- Generation of waste
- Circularity
- Social impacts

Questions were designed to collect information on sustainability attributes and associated measurement approaches using a tiered structure. Questions first asked whether any of the eight broad sustainability attribute categories were considered (Box 1). Only if a given attribute category was considered were respondents asked for more detailed information about more discrete categories as well as standards and metrics used (Box 2). This survey structure was chosen to streamline questions for respondents and inquire further only if a given broad-level sustainability impact category was at least sometimes considered.

Although the sustainability attributes queried in the survey were derived from the sources noted above, no definitions (i.e., a definition for waste) were outlined during the survey or interview process. Since the goal of the study was to understand the landscape of attributes and metrics and related standards used by companies, investigators adopted generic, higher-level sustainability impact categories that were relatively self-explanatory. These categories are widely used and accepted by staff working in companies to monitor and report on sustainability outcomes. Definitions of such sustainability attributes are strongly related to how they are measured, and this often varies based on standard-setting organisations. Despite not providing definitions, survey and interview responses provided no indication of a lack of general understanding of the use of general sustainability impact categories.

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[22] EU Ecolabel https://environment.ec.europa.eu/topics/circular-economy/eu-ecolabel-home_en (accessed January 4, 2024). Cradle to Cradle Certified Version 4.0 Product Standard https://api.c2ccertified.org/assets/cradle-to-cradle-certified-product-standard-version-4.0---cradle-to-cradle-products-innovation-institute.pdf (accessed January 4, 2024).

[23] Organisation for Economic Cooperation and Development. (2021). Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives. Series on Risk Management No. 60. https://www.oecd.org/en/publications/guidance-on-key-considerations-for-the-identification-and-selection-of-safer-chemical-alternatives_a1309425-en.html (accessed January 4, 2024).

Box 2. Specific Sustainability Attribute Categories Addressed in the Survey

Primary sustainability impact category	If a respondent indicated that they sometimes/always consider the primary attribute category, a respondent was asked about more discrete attributes:
Greenhouse gas emissions	N/A
Other air emissions	• Ozone-depleting substances (e.g., hydrochlorofluorocarbons HCFCs) • Particulate matter (PM2.5, PM10) • Volatile organic carbon (VOCs) • Nitrous oxides (NOx) • Sulfur oxides (SOx) • Photochemical ozone formation (combination of VOCs and NOx)
Generation of waste	• Hazardous waste amount • Solid waste amount • Water pollution amount • Specific impacts of water pollution, as categorised by LCA (Ecotoxicity, Acidification, Eutrophication, etc.) • Water pollution from hazardous chemicals release
Circularity	• Feedstock of chemical/material (e.g., biobased, recycled, or fossil) • Durability of chemical/material (i.e., the chemical/material lifetime is appropriate to its use in a product) • Ability of chemical/material to be reused, recycled, used in remanufacturing
Energy consumption	• Renewable and non-renewable energy consumption and ratio • Type of energy consumption (e.g., electricity, heating, cooling)
Biodiversity impacts (including land use)	• Proximity of chemical/material production infrastructure to protected areas and areas of high biodiversity value (which may be outside of protected areas) • Land use for facilities and feedstocks involved in chemical/material production. • Terrestrial eutrophication • Ecosystem restoration efforts or efforts to preserve existing ecosystems. • Introduction of invasive species and/or reduction of native species
Resource use	• Water use • Fossil fuel use • Mineral resource use • Metal resource use • Critical/rare metal/material resource use • Recycled material use • Reclaimed material use (no need for mechanical or physical recycling)
Social impacts	• Absence from areas with known lax environmental laws and corruption • Absence of forced labour

	• Absence of child labour • Absence of discrimination (based on race, gender, etc.) • Ability of workers to organise • Implementation of occupational health system • Avoidance of facilities with poor occupational health records • Diversity of governance body and employees • Implementation of anticorruption measures and grievance mechanism

Because of the large number of standards, certifications, and metrics (Box 3) being used to assess sustainability attributes across industries, the survey was designed to collect the primary source/type of standard being used based on discrete categories of standards: (a) internal company standards; (b) industry standards; (c) financial reporting standards (d) government standard (EU/national standards) or (e) other. Given the breadth of metrics used by companies across sectors, a write-in response was used.

Box 3. Explanation of terms used in this report

Standard: A rule or norm related to the measure of value/quality/performance of something established by authority.

- Examples: industry standards such as ISO14067 (related to greenhouse gases/carbon footprint), Zero Discharge of Hazardous Chemicals (ZDHC) or Roundtable on Sustainable Palm Oil; government standards such as air quality standards; financial reporting standards such as those of the Global Reporting Initiative (GRI).

Certification: Based on the use of specific standards to "certify" compliance against that standard. Ecolabels are also a type of certification used for the labelling of products achieving specific sustainability certifications.

- Examples: Cradle to Cradle Certified; blueSign Certified; Ecologo certified; Oeko-Tex Standard 100

Metric: As defined by Ahi and Searcy (2015)*, metrics typically focus on quantitative measurement for tracking performance of a given sustainability impact/attribute.

- Examples: µg air pollutant/m^3 [air pollutant emissions]; mj energy/kg material produced [energy consumption])

Measurement approaches: Measurement approaches is a generic term used in this report to more broadly capture approaches, including established methodologies to calculate/estimate metrics for sustainability reporting.

- Examples: Life cycle assessment, use of emission factors to calculate air emissions

** Ahi P and Searcy C. 2015. An analysis of metrics used to measure performance in green and sustainable supply chains. Journal of Cleaner Production. 86:360-377*

Survey distribution was dependent on the use of third parties to distribute and encourage participation, including industry associations affiliated with the OECD Working Party on Risk Management. Industry representatives of the OECD Working Party on Risk Management that distributed the survey to their members or associates were from the US, EU, Japan and Australia. The survey was also distributed through a sustainable chemistry business association whose members are primarily in the US and EU.

Email solicitations were sent to organisational representatives with email templates to circulate the survey. Survey questions (5Annex A) were shared as an attachment to support review in advance of responding and to help ensure that the appropriate company representative responded. Three attempts over the course of six weeks were made for each contact to ask and then remind them to circulate the survey. This was supplemented with direct emails to industry contacts (where the survey implementors had direct relationships/contacts) in the later stages of the survey administration to ensure that a range of industry sectors were represented in the survey results. Because of this administration strategy, it is not possible to calculate a response rate as the denominator/underlying population receiving the survey is unknown.

The survey results were analysed by calculation of simple frequencies, as the primary purpose was to reveal the extent to which specific sustainability attributes are being used to support chemical and material selection decisions. Stratified analyses were used when supported by the data (i.e., having enough responses to support stratification).

Follow-up Interviews

The survey asked participants if they would be willing to further discuss their results in a confidential interview. The interviews sought to gain greater insight on the drivers, challenges and opportunities of measuring sustainability attributes to support chemical and material selection decisions as well as ask clarifying questions related to specific responses in the survey (see 5Annex B for interview guide). A structured guide designed for a 1-hour discussion and tailored for interviewee based on responses in the survey was used. Twenty survey respondents who indicated their willingness to interview were contacted. If no response from a contact was received after three attempts, they were considered “loss to follow-up”. Interviews were reviewed and synthesised for themes and reported in aggregate.

Forums at a Sustainable Chemistry Business Association

In addition to helping to distribute the survey, discussions undertaken as part of two in-person events hosted by a sustainable chemistry business association were used for this study. During one event in June 2023, break-out session discussions were used to help design the survey by better understanding the primary sustainability attributes participants used to inform chemical and material selection and complexities surrounding the types of standards and metrics used for each. A second event in November 2023 used another plenary session to help interpret findings from the survey by capturing key themes surrounding opportunities and challenges in the use of sustainability attributes to support chemical and material selection decisions. Roughly 60 attendees were present at each session. Participants were generally representative of the entire value chain and not dominated by one sector.

3 Results

The survey was completed by 59 respondents, and ten follow-up interviews were conducted (50% of the 20 invitations sent).

Demographics of Respondents

Survey respondents were more representative of larger firms; 68% of respondents were from companies that employed over 1,000 people (Figure 1). However, very small enterprises were also represented; 18% of respondents were from companies employing less than 50 employees. Survey respondents reflected a range of industry sectors and participation was highest among companies that produce chemicals and chemical products (35%) (Table 1). Respondents included those from different stages of the value chain, including raw materials suppliers (12%), manufacturers of semi-finished goods (17%) and finished goods (23%) as well as also wholesalers (8%, see 5Annex C). In general, interviews reflected survey respondents in terms of company size and industry sectors (Figure 1, Table 1).

The survey did not enquire about the geographic location of the company. However, based on the demographics of interviewees, companies were from the EU and the US. Demographic information was not collected during the sustainable chemistry business association in-person events, but meeting attendees generally represent a broad range of industry sectors and stages of the value chain and based in the EU or US.

Figure 1. Company size of the companies interviewed and surveyed.

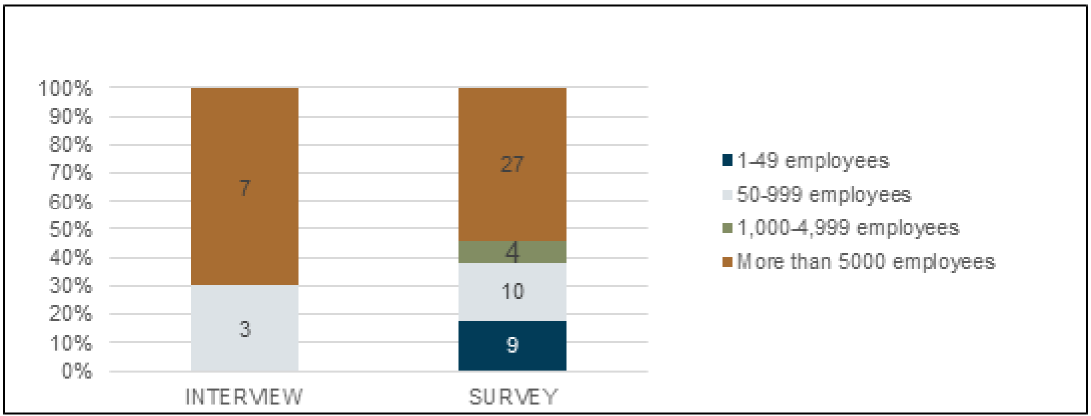


Table 1. Sectors represented in the interviews and survey responses.

Darker cell colours represent relatively larger representation of sectors in either interviews (brown) or surveys (blue).

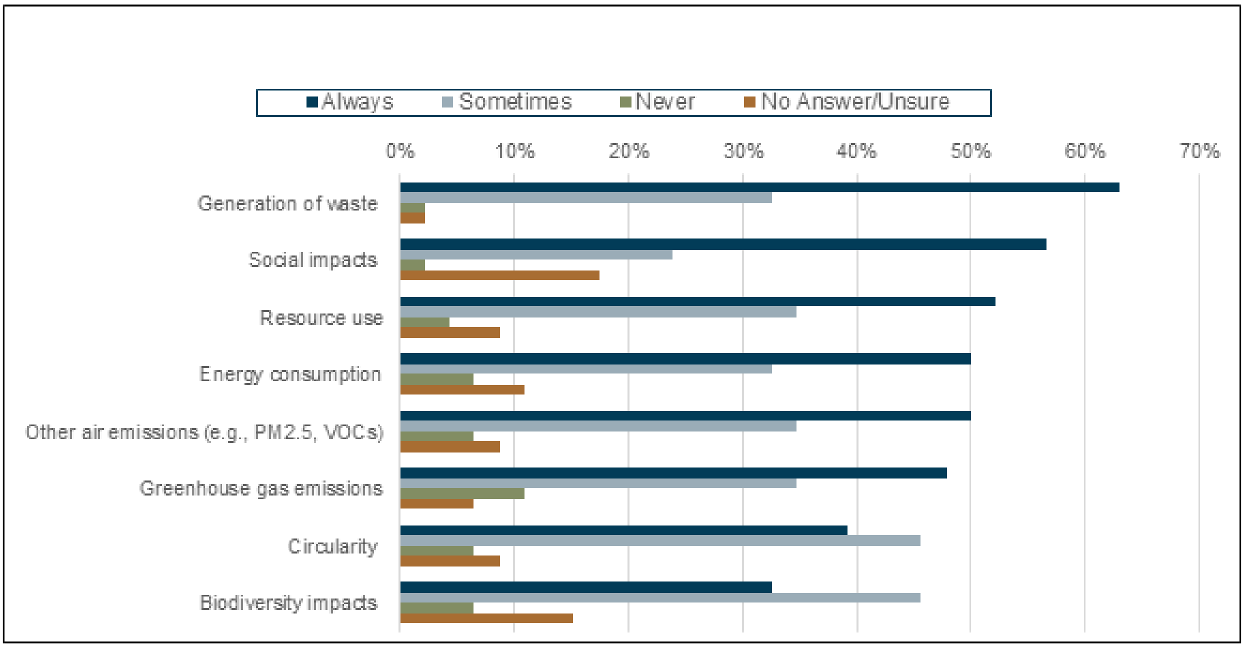
Sector	Interview	Survey responses	Sector	Interview	Survey responses
apparel (ready-to-wear clothing and accessories)	3	7	tobacco products	0	2
basic metals (iron, steel, precious metals)	0	3	motor vehicles, trailers, and semi-trailers	0	0
basic pharmaceutical products and pharmaceutical preparations	1	4	textiles (spinning, weaving, finishing of cloth, as an input to apparel or textile articles)	0	2
beverages	1	3	textile articles (non-apparel, such as blankets, rugs, rope, netting)	2	5
chemicals and chemical products	2	34	other electrical equipment (batteries, lighting, domestic appliances, excluding computer, electronic, and optical products)	2	6
coke and refined petroleum products	0	1	other miscellaneous items (toys, games, sports goods like ice skates, jewellery, musical instruments, candles)	1	4
computer, electronic and optical products	0	8	other non-metallic mineral products (glass, ceramic, concrete)	1	3
fabricated metal products (reservoirs/tanks, cutlery, ammunition, excludes machinery and equipment)	0	1	other transport equipment (boats, aircraft, excluding motor vehicles)	0	2
food products	2	4	paper and paper products	1	4
footwear (shoes, boots, excluding shoes meant for specific sports like ice skates)	1	4	rubber and plastics products	2	10
furniture	2	7	products of wood and cork	2	3
leather and its related products (leather luggage, handbags, harnesses)	0	2	Other	5	18
machinery and equipment (ovens, pumps, power-driven tools, excluding motor vehicles)	0	2			

Sustainability Attributes Considered

The majority (96%) of survey respondents indicated that they considered sustainability attributes to support chemical and material selection decisions. Follow up interviews identified a series of motivations driving such considerations including: (a) long standing corporate commitments to advance sustainability; (b) customer, client and/or purchaser expectations and (c) increasing reputational risk concerns by not considering sustainability concerns.

Among survey respondents, no single sustainability attribute is “always” being considered to support chemical/material selection (Figure 2; see Annex C, Table A C.1. for all survey responses for more discrete results).

Figure 2. Sustainability attribute categories considered when making chemical/material innovation and selection decision (n=46)



Waste generation was the sustainability attribute category most frequently reported as at least "sometimes" considered (96%, Figure 2). Similar frequencies for the consideration of specific attributes such as hazardous waste, solid waste, and amount of water pollution were reported by survey respondents (55%-65%, see Annex C, Table A C.1).

For attributes "sometimes" or "always" considered, smaller enterprises (<50 employees) considered an average of 6 sustainability attributes, while larger companies considered 7-8 sustainability attributes (see Annex C, Table A C.4). Smaller companies were less likely than larger companies (>50 employees) to consider greenhouse gas emissions, biodiversity, energy use, and social impacts. This observation is similar to work by Thammaraska et al.[24], which found that "16% of SMEs (small and medium size enterprises) report on SDGs, while larger companies report at a rate of 45%".

In general, companies that produced raw materials, semi-finished goods, and finished goods "always" considered sustainability impacts at similar frequencies (see Annex C, Table A C.2). Companies further down the supply chain (wholesale, retail) "always" considered sustainability impacts at a relatively lower frequency. For example, 38%-58% of companies that produced goods "always" considered greenhouse gas emissions, while the same is true for only 25% of wholesale/retail companies.

The percentage of respondents by sector who "always" consider sustainability impacts shows variations (see Annex C, Table A C.3). This analysis is based on examining responses across 8 industry sectors. Responses from other sectors are simply too limited to highlight. Consistent with the finding above, the consideration of waste generation across industry sectors is the attribute most frequently "always" considered. However, only 43% of respondents in the paper and wood industry stated that this attribute is "always" considered. Eighty percent of respondents from the electronic equipment and metal and minerals

24 Thammaraksa C, Gebara CH, Hauschild MZ, Pontoppidan CA, Laurent A. (2024). Business reporting of Sustainable Development Goals: Global trends and implications. Business Strategy and the Environment. https://doi.org/10.1002/bse.3760

sectors noted “always” considering social impacts. Biodiversity is among the least frequent attribute that is “always” considered, although it is considered more frequently by the paper and wood sector as well as the metal and minerals sector. Circularity is also an attribute least frequently “always” considered across industry sectors.

The scientific literature that compares the sustainability attributes considered across different sectors and the value chain is limited. Although the widespread use of LCA in chemical selection as part of the sustainability reporting has not been established in the literature, Stewart et al.[25] examined the use of LCA in corporate sustainability reports and found that the sectors most likely to use the methodology were containers and packaging as well as personal and household goods. Other notable sectors included raw materials such as metals, chemicals, and forestry/papers.

During interviews, companies were asked why they consider certain sustainability attributes “sometimes”, “always”, or “never”. Regardless of sector or company size, responses generally centred on two main themes: data availability and priorities given a company’s sector and products. Interviewees noted that they were not always able to obtain the necessary data from their supply chain to track specific sustainability considerations. Data access and availability was not unique to a specific set of sustainability attributes but rather an issue across all. Interviewees noted that they prioritise specific sustainability attributes that have the greatest relevance to and impact on their business; this statement is consistent with other research studies finding that companies report on some but not all SDGs[26]. For example, one interviewee from the building products/construction sector mentioned that their products are mostly based on petrochemicals and recycled materials, and as such, their impact on biodiversity was considered low and thus not generally considered. However, this company “always” considered whether their products could be recycled (i.e., circularity impacts).

When asked why certain sustainability attributes were only considered “sometimes”, interviewees indicated that different impacts are considered at different points in the product design, scaling, and ongoing procurement processes. For example, a company may consider projected greenhouse gas emissions during their eco-design process but may not monitor the greenhouse gas impacts of their existing products. Another company only considered circularity in two of its high-margin brands that are marketed towards sustainability-conscious consumers. This allows for ‘testing’ of sustainability impact measurement on a small scale before scaling to other lower-margin product lines. Another company decided to address the impact of water pollution on their Tier 1 suppliers because the company was responsible for providing the suppliers with low-water process specifications. However, the company could not measure and track the water impacts earlier in their supply chain (Tier 2 and higher suppliers). In short, companies are generally considering specific sustainability impacts in specific products or stages in the supply chain where they have the most control or may benefit most from sustainability assessment.

Biodiversity and circularity were two attributes most frequently considered “sometimes” as opposed to “always” (Figure 2). Interviewees indicated that these attributes were both relatively new impact categories in comparison to others. Some companies were in the process of establishing internal standards to support their biodiversity and circularity efforts. One company mentioned that they were undergoing a biodiversity audit to determine hotspots in their production processes across many different biodiversity impacts (land use, proximity to areas of high biodiversity value, etc.). This audit would then inform their internal strategy.

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[25] Stewart, Raphaëlle, Fantke P, Bjørn A, Owsianiak M, Molin C, Zwicky Hauschild M, et al. (2018). Life cycle assessment in corporate sustainability reporting: Global, regional, sectoral, and company-level trends. Business Strategy and the Environment. 27(8):1751-1764. https://doi.org/10.1002/bse.2241

[26] Thammaraksa C, Gebara CH, Hauschild MZ, Pontoppidan CA, Laurent A. (2024). Business reporting of Sustainable Development Goals: Global trends and implications. Business Strategy and the Environment. (early view) https://doi.org/10.1002/bse.3760

Another company mentioned the growing focus on use of regenerative agriculture but that there is no accepted industry standard. Another company was grappling with circularity and whether to prioritise recyclability, durability, or use of recycled content.

Companies interviewed also mentioned that they "sometimes" considered biodiversity or circularity because of a lack of industry standards that encompass their product lines. For example, the Roundtable on Sustainable Palm Oil (RSPO)[27] certifies palm oil and minimises impacts on biodiversity. Companies have used RSPO-certified palm oil, but no such equivalent exists for other natural materials. The same concept applies for circularity; companies often cited recycling standards for plastics but noted that such circularity standards were not present for other products.

The consideration of greenhouse gases was not a primary sustainability attribute considered based on survey responses. However, interviews suggested that this is an area of significant activity and alignment across industry sectors driven by the dramatic growth in companies establishing decarbonisation and net-zero carbon emissions goals. One chemical manufacturer noted that just a few years ago when they mentioned to customers the ability to reduce 40-60% of the carbon footprint of a given product by helping them make specific reformulation changes, there was no interest. That is not the case today. However, companies, including chemical manufacturers, are challenged by the need to quantify their Scope 3 greenhouse gas emissions, which are needed to comprehensively capture the embedded carbon of a particular chemical product. Despite this challenge, interviewees stated that based on qualitative assessments that have identified high impact areas of the lifecycle, they are taking actions to reduce levels of concern. Interviewees also stated that the focus on decarbonisation is creating tighter alignments with sustainable chemistry in general, given shared goals.

Standards and Metrics Used

For those sustainability attributes considered for chemical and material selection decisions, survey respondents outlined various standards and other measurement tools used. The category of standard being used varied depending on the specific sustainability attribute being addressed. When asked about specific standards and metrics being used, the majority of respondents did not complete this write-in question (only 28% of respondents indicated a specific standard, metric or measurement approach).

For energy consumption, biodiversity, and resource use, no single type of standard dominated impact measurement among survey respondents (see 5Annex C). Companies reported relatively even use of industry specific-standards, internal standards, and government standards.

Industry-specific standards and related certifications are most often used for the measurement of greenhouse gas and other air emissions (Table 2). For greenhouse gases, the specific standards mentioned were International Standardization Organization (ISO) 14067 as well as the Greenhouse Gas (GHG) Protocol (Table 4).[28] In addition, some respondents noted certifying their targets with the Science

[27] RSPO standards. https://rspo.org/as-an-organisation/our-standards/ (accessed January 4, 2024)

[28] ISO 14067 https://www.iso.org/standard/71206.html (accessed January 4, 2024). GHG Protocol https://ghgprotocol.org/corporate-standard (accessed January 4, 2024).

Based Targets Initiative (SBTi).[29] However, scope 3 emissions remain a challenge for companies to assess and then address.[30]

Table 2. Use of industry-specific standards for greenhouse gas emissions and air emissions dominates standard use.

Sustainability Impact		Internal company standards	Industry-specific standards and certifications	Financial Reporting Standards	National or EU emissions standards	No answer or unsure
Greenhouse gas emissions		3	16	6	2	11
Other air emissions (e.g., PM2.5, VOCs)	Ozone-depleting substances (e.g., hydrochlorofluorocarbons HCFCs)	4	11	1	5	3
	Particulate matter ($PM_{2.5}$, PM_{10})	3	9	0	1	4
	Volatile organic carbon (VOCs)	5	14	0	4	6
	Nitrous oxides (NOx)	2	9	0	1	6
	Sulfur oxides (SOx)	1	10	0	1	6
	Photochemical ozone formation (combination of VOCs and NOx)	2	11	0	2	5

Consideration of air emissions was supported overwhelmingly by third party standards (Table 2), but few specific standards were mentioned by survey respondents. When asked specifically which standards were used, respondents indicated the Zero Discharge of Hazardous Chemicals (ZDHC) as well as a few regulatory standards (such as the California Air Resources Board for VOCs[31]). ZDHC is an initiative of the textile industry focused on reduction of hazardous chemicals from manufacturing that is expected to release air emissions guidelines in 2023.[32] One interviewee from a cleaning products company indicated that their priorities regarding air emissions were about limiting product emissions during use, for example, limiting VOC emissions from their cleaning products during use, rather than limiting the VOC emissions generated during production.

Across attributes, two other trends were identified with regards to industry standards. First, the survey and interviews identified standards that are focused on specific ingredients or chemicals. For example, the Roundtable on Sustainable Palm Oil (RSPO) was mentioned as a standard supporting biodiversity considerations. The Responsible Down Standard is used to track the supply of down in the textile industry. This standard is related to animal welfare, which was not a specific sustainability category outlined in the

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[29] SBTi https://ghgprotocol.org/corporate-standard (accessed January 4, 2024)

[30] Only 36% of corporate emissions reductions targets include Scope 3 emissions in 2022. OECD Guidance on Transition Finance https://www.oecd-ilibrary.org/environment/oecd-guidance-on-transition-finance_7c68a1ee-en (accessed January 4, 2024).

[31] California Air Resources Board Regulations https://ww2.arb.ca.gov/our-work/programs/consumer-products-program/current-regulations (accessed January 4, 2024).

[32] 2022 ZDHC Impact Report. https://www.roadmaptozero.com/impact-report-2022 (accessed January 4, 2024).

survey[33]. Second, there are multiple standards in some sectors, for example in the textile sector. The Higg Index, bluesign, Zero Discharge of Hazardous Chemicals (ZDHC), the Social and Labor Convergence Program (SCLP) as well as the Recycled Claim Standard (RCS) were mentioned as supporting sustainability impact measurement and verification in the sector.[34] Interestingly, these third parties overlapped in certain sustainability impact measurements, such as wastewater, hazardous chemical use, and social impacts, while also delivering unique information (e.g., the Higg Index has a repository of life cycle assessments that certain companies use for greenhouse gas emissions estimates). These organisations hosting such standards work together at times to simplify assessments in the industry, such as the possibility for bluesign to certify the ZDHC Manufacturing Restricted Substance List (MRSL) and Higg calculations.[35] The Sustainable Apparel Coalition, which manages the HIGG index, accepts SCLP data.[36]

Industry standards were frequently specific to different industries and as such, generally not noted by other sectors. For example, the textile industry, electronics industry, and the chemical industry each reported different standards to assess social impacts in their supply chains (see Annex C Table A C.7. Standards, related metrics and other measurement approaches reported by survey respondents in 3 industry sectors). The exception to this rule was the measurement of greenhouse gas emissions, which were commonly measured across sectors by the GHG Protocol and GRI[37]. These two GHG standards take two different approaches to sector differences, the former being agnostic to different sectors, while the latter published sector-specific guidelines.

Companies reported using internal standards for newer attributes or those that companies felt were underserved by other standards. For example, one interviewee from the electronic sector noted that existing standards on social impacts were not robust enough to protect the workers in their supply chains. As a result, that company implemented a code of conduct for suppliers. Often the use of internal company standards required expertise, time, and resources to implement within the supply chain. At times, internal company standard development simply predated third party sector sustainability standard development.

When asked about circularity, respondents most often responded with either no answer (14/27 responses) or internal standards (6/27 responses, see 5Annex C). Interviewees indicated that circularity attributes are relatively newer considerations and that their company would need to develop metrics for sustainability that were “fit for purpose” to their company. For example, one company was deciding how to balance recyclability and durability in the context of circularity for their specific products.

Use of government standards was most significant for the tracking of waste generation attributes, especially for water pollution and hazardous waste quantities (see Table 3). However, no specific

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[33] Although animal welfare is linked to SDGs that protect life below water and on land (14, 15), animal welfare was not highlighted as a sustainability standard in the industry-wide sources reviewed (see methods section). However, animal welfare may be relevant to specific industries.

[34] SCLP https://slconvergence.org/ (accessed January 4th 2024). Higg Index https://apparelcoalition.org/tools-programs/higg-index-tools/ (accessed January 4th 2024). Bluesign https://www.bluesign.com/en/ (accessed January 4th 2024). RCS https://textileexchange.org/recycled-claim-global-recycled-standard/ (accessed January 4th 2024).

[35] Bluesign and ZDHC collaboration https://www.roadmaptozero.com/post/zdhc-and-bluesign-r-collaboration (accessed January 4th 2024).

[36] SCLP data acceptance https://slconvergence.org/slcp-data-acceptance (accessed January 4th 2024).

[37] GHG Protocol https://ghgprotocol.org/about-us (accessed April 19th 2024). GRI standards https://www.globalreporting.org/how-to-use-the-gri-standards/gri-standards-english-language/ (accessed April 19 2024).

standards were mentioned by survey respondents. Interviewees referred to water emissions and waste management standards of the countries in which their manufacturing sites were operating. These companies also mentioned that the global nature of their operations meant that one nation's standards were not applicable in other areas for other suppliers. Instead, third party standards were more robust in their geographic coverage. However, certain laws that reach beyond borders were mentioned as driving sustainability impact measurement. For example, the EU's upcoming Corporate Sustainability Reporting Directive (CSRD) is driving reporting of a variety of sustainability attributes, which will need to be in accordance with European Sustainability Reporting Standards that are still under development (in draft form as of this writing). Third party industry standards, such as the SCLP, tout their applicability to fulfilling multiple regulations.[38]

Table 3. Use of national or EU emissions standards for waste are important for hazardous waste and water pollution. No respondents indicated that financial reporting standards were used to support waste measurement, therefore this column is not shown here.

Sustainability Impact		Internal company standards	Industry-specific standards and certifications	National or EU emissions standards	No answer or unsure
Generation of waste (e.g., hazardous waste, water pollution, solid waste)	Hazardous waste amount	5	8	11	5
	Solid waste amount	8	5	8	6
	Water pollution amount	3	6	13	4
	Specific impacts of water pollution, as categorised by LCA (Ecotoxicity, Acidification, Eutrophication, etc.)	8	8	5	3
	Water pollution from hazardous chemicals release	4	6	9	7

Although financial reporting standards are being used, they are not dominant for any sustainability attribute category supporting chemical and material selection decisions (see 5Annex C). Companies mentioned that these standards were often used in reporting rather than for future decisions on new innovations and sourcing. In addition, these financial reporting standards were not designed at the chemical level, and instead reflect actions of the entire company.

Table 4 summarises the specific standards, metrics or other measurement approaches being used by companies to measure specific sustainability attributes based on the survey and interviews. It is important to note that companies reported using a broad range of measurement approaches, including use of specific standards, methodologies, data sources (such as emission factors/inventories) and use of third- party assessors that utilise either their own standards (e.g., Cradle to Cradle), or industry accepted standards (e.g., Ecovadis). 5Annex D provides a brief description of approaches used.

The most commonly reported measurement approach used by survey respondents was Ecovadis (which encompasses Together for Sustainability, a chemical-sector specific Ecovadis standards initiative). Ecovadis is a subscription based third-party provider of sector-specific sustainability assessments for companies outlining a scorecard and actionable areas for improvements.[39] The assessment platform used

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[38] SCLP Human Right due Diligence Toolkit. 2023. https://static1.squarespace.com/static/5f5bffb630536e3e5586bb4a/t/64521cda867bb93ba1bc2d2f/1683102948237/SLCP+Human+Rights+Due+Diligence+Toolkit.pdf

[39] Ecovadis. EcoVadis Ratings Methodology Overview and Principles. https://resources.ecovadis.com/ecovadis-solution-materials/ecovadis-ratings-methodology-overview-and-principles-2022-neutral (accessed April 7, 2024).

by Ecovadis is based on examining the performance of specific sustainability attributes against established standards and related metrics, such as ISO and the Global Reporting Index (GRI) as well as dimensions of the United Nation's Global Compact, which is based on principles to help operationalise actions on the UN SDGs.

Use of Life Cycle Assessment (LCA) was commonly reported by companies as the methodology used for estimating greenhouse gas emissions, energy use, resource use, and waste. Some respondents also noted specific ISO standards utilising LCA, such as greenhouse gas emissions. However, interviewees expressed various levels of trust in LCA methods and data quality. Indeed, the complexity and challenges of transparency of chemical production and use throughout the supply chain remains a persistent challenge in the sustainability assessment of chemicals[40]. Companies reported that developing an LCA for a product required significant time, resources, and expertise. For some, the timeline for the development of an LCA is too long to inform product development. Other raw material suppliers reported that sharing raw data on their production with customers was more efficient and trusted than sharing a full LCA. Certain companies are leveraging databases such as the Higg Index (textiles) and EcoInvent (general LCA software) to understand potential hotspots in their process. Others were gathering data from their suppliers.

Table 4. Sustainability standards and other measurement approaches used for chemical innovation and selection decisions noted by survey respondents and interviewees

Sustainability Attribute		**Standards, related metrics and other measurement approaches reported by survey respondents***
Greenhouse gas emissions		CSRD (forthcoming), GHG Protocol, GRI, Ecovadis/TsF, EU Taxonomy, Higg, ISO14067, LCA (some respondents specifically mentioned ISO140140/140444), TCFD, SASB, UNGC
Other air emissions (e.g., PM2.5, VOCs)	Ozone-depleting substances (e.g., hydrochlorofluorocarbons HCFCs)	Higg/Wordly MSI, LCA, UNGC, ZDHC
	Particulate matter (PM2.5, PM10)	EPA AP-42, LCA Title V Permit, ZDHC
	Volatile organic carbon (VOCs)	California Air Resources Board list of VOCs in final products, Higg/Wordly MSI, LCA, ZDHC
	Nitrous oxides (NOx)	LCA, ZDHC
	Sulfur oxides (SOx)	EPA AP-42, LCA, ZDHC
	Photochemical ozone formation (combination of VOCs and NOx)	LCA, ZDHC
Biodiversity impacts (including land use)	Proximity of chemical/material production infrastructure to protected areas and areas of high biodiversity value (which may be outside of protected areas)	Ecovadis/TfS, Nagoya compliance

40 Fantke P, Cinquemani C, Yaseneva P, De Mello J, Schwabe H, Bjoern E, et al. (2021). Transition to sustainable chemistry through digitalization. Chem. 7(11): 2866-2882. https://doi.org/10.1016/j.chempr.2021.09.012

	Land use for facilities and feedstocks involved in chemical/material production.	LCA, Ecovadis/TfS, Nagoya compliance, RSPO, SAI, UEBT membership
	Terrestrial eutrophication	Ecovadis/TfS, Higg/Worldly MSI, LCA,
	Ecosystem restoration efforts or efforts to preserve existing ecosystems.	Cradle to Cradle, Ecovadis/TfS, RSPO, Nagoya compliance, UEBT,
	Introduction of invasive species and/or reduction of native species	Ecovadis/TfS, Nagoya compliance
Energy consumption	Renewable and non-renewable energy consumption and ratio	Ecovadis/TfS, use of emissions factors, LCA
	Type of energy consumption (e.g., electricity, heating, cooling)	LCA
Resource use (e.g., water, mineral, metal)	Water use	Cradle to Cradle, Ecovadis/TfS, Higg/Worldly MSI, LCA
	Fossil fuel use	Higg/Worldly MSI, LCA
	Mineral resource use	Ecovadis/TfS, LCA
	Metal resource use	Ecovadis/TfS, LCA
	Critical/rare metal/material	Ecovadis/TfS
	Recycled material use	RCS
	Reclaimed material use (no need for mechanical or physical recycling)	RCS
Generation of waste (e.g., hazardous waste, water pollution, solid waste)	Hazardous waste amount	LCA, bluesign, ZDHC
	Solid waste amount	LCA bluesign
	Water pollution amount	LCA, bluesign, Ecovadis/TfS, ZDHC
	Specific impacts of water pollution, as categorised by LCA (Ecotoxicity, Acidification, Eutrophication, etc.)	LCA, no other specific standards listed.
	Water pollution from hazardous chemicals release	LCA, bluesign, ZDHC
Circularity (e.g., renewable feedstock, durability,	Feedstock of chemical/material (e.g., biobased, recycled, or fossil)	PCR content: biobased content (RCI), ISO16128, bio-based content based on C14 method, ISO certifications, RCS
	Durability of chemical/material (i.e., the chemical/material lifetime is appropriate to its use in a product)	No specific standards listed.
	Ability of chemical/material to be reused, recycled, used in remanufacturing	Association of Plastic Recyclers PCR Certification and Sustainable Packaging Coalition CleanPackage
Social impacts (e.g., worker	Absence from areas with known lax environmental laws and corruption	Ecovadis/TfS, RBA Code of Conduct

rights and conditions)	Absence of forced labour	Ecovadis/TfS, SLCP, RBA Code of Conduct
	Absence of child labour	Ecovadis/TfS, SLCP, RBA Code of Conduct
	Absence of discrimination (based on race, gender, etc.)	Ecovadis/TfS, SLCP, RBA Code of Conduct
	Ability of workers to organise	Ecovadis/TfS, SLCP, RBA Code of Conduct
	Implementation of occupational health system	Ecovadis/TfS, RBA Code of Conduct
	Avoidance of facilities with poor occupational health records	Ecovadis/TfS, SLCP, RBA Code of Conduct
	Diversity of governance body and employees	Ecovadis/TfS, SLCP, RBA Code of Conduct
	Implementation of anticorruption measures and grievance mechanism	Ecovadis/TfS, SLCP, RBA Code of Conduct

**** See 5Annex D for brief description***

4 Lessons Learned: Key Challenges, Opportunities to Evolve Sustainability Impact Measurement for Use in Chemical and Material Selection Decisions

This study uncovered lessons learned regarding the experience of companies in the use of specific sustainability attributes to support chemical and material selection decisions, including specific challenges, needs and opportunities.

Challenges

1. **The lack of regulatory drivers for considering sustainability attributes as part of chemical restrictions limits their use in substitution-related decisions.** Interviewees were asked whether their answers about which sustainability attributes were considered when selecting specific chemistries apply to substitution decisions. The answer was most often, "No." Hazard and exposure related risk considerations, not sustainability, are the primary basis for regulatory and market chemical restrictions. As such, companies mainly use hazard and exposure data in addition to cost and performance information when making specific substitution decisions. There are examples of regulatory chemical restrictions based primarily on sustainability impacts, such as those related to ozone depletion governed under the Montreal Protocol,[41]. However, companies noted the general lack of sustainability impacts as a focus of regulatory as well as market-driven chemicals management decisions in addition to a general lack of regulatory drivers connecting sustainability reporting and chemicals management as a reason for their limited use in substitution decisions. Interviewees noted the growing importance of considering sustainability when making substitution decisions, but comprehensive sustainability assessments of alternatives are often not pursued because of tight regulatory timelines associated with chemical restrictions.

[41] UN Environment Programme. Montréal Protocol. https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol. (accessed April 14, 2024).

2. **The vast array of sustainability reporting instruments complicates harmonisation and alignment efforts.** The survey and interviews found a broad array of often duplicative sustainability reporting instruments. Based on the study results, it was difficult to develop a clear understanding of which standards and metrics companies use most for a given sustainability impact category as: (a) many respondents did not provide detailed responses on the standards and metrics being used; (b) some companies use their own unique standards and related metrics to enhance their "fit for purpose" for the specific needs of their given company; and (c) some standards are unique to specific industry sectors. This finding is not unexpected as others have noted that the rapid proliferation of sustainability reporting instruments over the last decade has created a complex and fragmented landscape.[42] The International Institute for Sustainable Development reports over 400 sustainability standards,[43] and one study found more than 2,500 unique metrics available for supply chain reporting on sustainability factors.[44] In addition, the Ecolabel Index provides a global directory of more than 456 ecolabels across 25 industry sectors and is a recommended resource used for those using the WBCSD's Portfolio Sustainability Assessment framework.[45] In 2018, the US Government Accountability Office (GAO) concluded that there was significant variation in how companies assess the sustainability of their chemical products and processes. The GAO study found similar results as this study in terms of the types of measurement approaches being used, including company-designed standards and tools, industry standards, certifications and commonly used metrics.[46] In, the addition GAO study also observed use of chemical selection guides, such as those developed by the Pharmaceutical Roundtable to support selection of more sustainable solvents.

   Some companies interviewed warned that too much standardisation runs the risk of losing the utility of such sustainability indicators for companies making chemical and material selection decisions given that standards are designed with specific questions and audiences in mind. The survey revealed that sustainability standards designed to support an assessment of financial risks and opportunities are the least used or suitable standards because they were designed for a different purpose. Interviewees mentioned that the forthcoming mandatory CSRD [47] in the EU will continue to drive standardisation and required reporting, but voiced concern about the utility of such standards to support chemical and material selection decisions when their primary purpose is "to ensure that investors and other stakeholder have access to the information they need to assess the impact of companies on people and the environment and for investors to assess financial risks and opportunities arising from climate change and other sustainability issues."[48] To ensure credibility, and to avoid concerns regarding

[42] KPMG International (2022). Big Shifts, Small Steps. Survey of Sustainability Reporting 2022. https://assets.kpmg.com/content/dam/kpmg/xx/pdf/2022/10/ssr-small-steps-big-shifts.pdf (accessed January 4, 2024).

[43] International Institute for Sustainable Development. State of Sustainability Initiatives. Market Coverage https://www.iisd.org/ssi/market-coverage/ (accessed January 4, 2024).

[44] Ahi P and Searcy C. 2015. An analysis of metrics used to measure performance in green and sustainable supply chains. Journal of Cleaner Production. 86:360-377.

[45] Ecolabel Index. https://www.ecolabelindex.com/ (accessed January 4, 2024).

[46] Government Accountability Office. 2018. Technology Assessment - Chemical Innovation Technologies to Make Processes and Products More Sustainable (GAO-18-307). February.

[47] Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting (Text with EEA relevance).

[48] European Commission. Corporate Sustainability Reporting.https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en. Accessed 1/4/2024.

"greenwashing," such standardisation efforts to improve transparency are important. However, additional assessment is needed to ensure that CSRD and other mandatory reporting initiatives are useful and appropriate for internal decision making to support innovation, as it is unlikely that companies would pursue a separate set of standards for chemical and material selection purposes.

3. **Sustainability attributes being considered for chemical and material selection are being measured at the chemical-, product-, process- and facility level**. Although the survey specifically asked about sustainability attributes used to support chemical and material selection decisions, the level of assessment varies for specific impacts as well as the position of a company within the supply chain. Some sustainability attributes, similar to chemical hazards, are intrinsic to the chemical level given that they are highly associated with specific physicochemical properties of the chemical (e.g., boiling point or vapour pressure for VOC emissions) or inherent to the chemical itself (e.g., resource use associated with critical/rare minerals).

   Regarding greenhouse gas emissions, the level of assessment strongly varies based on a company's position in the supply chain. Chemical manufacturers are beginning to make available the carbon footprints of their chemical products, inclusive of scope 1, 2, and 3 emissions. Thus, for some chemical and material selection decisions, there are greenhouse gas data available at the chemical-level. However, some product manufacturers noted during interviews that their consideration of greenhouse gas emissions tends to be at the product- or facility level given the lack of data currently available at the chemical level for specific products being designed or reformulated. Product manufacturers also noted considering attributes such as waste generation, water or energy use at the product-level, which is consistent with the primary unit of analysis computed by LCA. Regarding social impacts, most are assessed at the facility-level and are highly geographically oriented.

   Despite these varying levels of analysis, there is consistency in the primary lens/question companies are viewing beyond regulatory requirements when making chemical and material selection decisions: *How does a given impact affect the overall sustainability footprint of the company.* When interviewees were asked whether standards created for assessment at the product, process or facility level were applicable and relevant for chemical-level decisions, many responded that dimensions of sustainability are not easily contained to just the chemical level and that it is important to keep in mind the primary use of sustainability assessments by companies – for their annual sustainability reports. these reports inform stakeholders of company's overall performance against key sustainability indicators. Thus, decisions at the chemical-level are based in large measure on whether there are notable improvements or declines in a company's overall sustainability performance.

   Interviews offered examples of how sustainability standards were used to support their chemical decision processes. One household cleaning products company provided clear examples indicating how sustainability standards were used in their chemical decisions processes. Using a combination of data from their supply chain and from industry averages, the company was able to decide which chemicals to use based on their sustainability profile (in addition to other considerations, such as inherent hazard). A chemical formulator that supplies to a broad range of markets noted how they have operationalised their own measurement approach to ensure the eco-design of their formulations, including the importance of using certifications from their upstream raw material suppliers as well as operationalising the 12 principles of green chemistry[49] and considering impacts on waste, energy and water during their production processes.

[49] Anastas PT and Warner JC. (1998). Green Chemistry Theory and Practice. Oxford University Press, Oxford.

4. **Opinions differ as to the value of specific methods and tools to estimate input data for sustainability attributes.** During the sustainable chemistry business association events, participants remarked on the need to "make things simpler to use" as it requires significant expertise and resources to incorporate the consideration of sustainability attributes given the nuanced and sophisticated science and measurement needed. Suppliers, in particular, noted the need to be a part of the conversation to develop such tools if they are expected to use them. Interviewees also noted that tools which rely on the use of estimated and averaged generalised data are not considered stringent enough due to the estimate's lack of consideration of the variation in production practices. This can lead to a mistrust of certain sustainability impact results. In addition, some of the sustainable chemistry business association event participants cautioned about the need for more tools; many companies have developed their own sustainability reporting tools creating challenges for suppliers who have numerous clients and therefore numerous tools requiring different data and formats that they are expected to use.
5. **Challenges with the use of existing metrics, especially for circularity.** There are high level principles for circularity defined by organisations such as the Ellen MacArthur Foundation[50]. More recently, metrics for circularity are being developed such as the WBCSD's Circular Transitions Indicators[51] and forthcoming metrics by the International Standards Organisation (ISO) (e.g., ISO FIS 59010 on the Circular Economy). Yet challenges exist with existing metrics. Existing metrics do not always capture the reality of products and the internal conflict that arises across a set of circularity dimensions. For example, a shoe can be designed to be durable to have a longer lifetime. A shoe can also be designed for disassembly and the use of recyclable materials. These circularity dimensions may conflict with one another because a shoe made for disassembly may compromise its lifetime and vice versa. Participants at the sustainable chemistry business association events highlighted the unique challenge of measuring recycled content, as the metric alone (e.g., % recycled content), does not provide the nuance and assurances of safety needed. Meeting participants also expressed the current need to use virgin materials because levels of substances of very high concern (SVHC) are still too high to use in recycled content and there remains a lack of supplier declarations necessary for assurances regarding contaminant levels.
6. **Data availability and sustainability measurement interpretation remains a challenge.** For chemical manufacturers that are innovating new chemistries, interviews revealed that the consideration of sustainability attributes is difficult. Lack of knowledge about how the chemistry will be used by downstream users and related lack of data make the use of LCA on newer chemistries inherently challenging. The LCA community is beginning to respond to this need by exploring more predictive LCA approaches to better support early-stage chemical innovations[52]. For established chemistries, companies reported four main challenges with gathering and interpreting data from their supply chain. First, interviewees reported that they may not always have relationships or access to their Tier 2 and Tier 3 suppliers, which are not considered direct suppliers (Tier 1), but rather those further upstream in the supply chain. This challenge was particularly a concern for smaller companies. Second, suppliers' lack of resources in gathering sustainability data, especially when the data formats/needs

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[50] Ellen MacArthur Foundation. Circular Economy Introduction. https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview#:~:text=The%20circular%20economy%20is%20based,Regenerate%20nature Accessed 1/4/2024.

[51] World Business Council for Sustainable Development. (2023). Circular Transitions Indicators V.4.0. May. https://www.wbcsd.org/Programs/Circular-Economy/Metrics-Measurement/Resources/Circular-Transition-Indicators-v4.0-Metrics-for-business-by-business(accessed January 4, 2024).

[52] Kleinekorte J, Kleppich J, Fleitmann L, Beckert V, Blodau L, Bardow A. (2023). APPROPRIATE life cycle assessment: a PROcess-specific, PRedictive Impact AssessmenT method for emerging chemical processes. ACS Sustainable Chemistry & Engineering. Jun 9;11(25):9303-19.

either differ as the reporting needs of the product manufacturers and brands are not standardised. This results in outcomes including significant delays, inability to interpret the data received, or not receiving the data at all. Interviewees stated that their suppliers view responding to sustainability impact data requests as additional work demands outside their normal operations without additional benefits or technical support. The third challenge noted was the inability of some companies to verify accuracy of information provided to them. For example, one company reported over 3000 direct suppliers (Tier 1) and that auditing all these direct suppliers was time and labour intensive and not practical. Lastly, companies expressed difficulty in timing and aligning reporting data. For example, some suppliers report data with a two-year lag or only report data every two years, which is not suitable for companies needed to file annual reports, or to use such data for more short-term decision making for chemical and material selections.

Metrics are often hard to relate to the broader sustainability journey of a company and in supporting decisions within different departments in a company and across the value chain. Interviewees noted that certain standards are at the facility level, others are at the product level, and only a few are at chemical or material input level. Metrics at the ‘per product’ level can be misinterpreted by others in the supply chain. The more diverse a company’s product portfolio, the more business units are involved, each with different needs and expertise in sustainability assessments, the more complicated the internal communication challenge is when using sustainability metrics broadly. No one impact was mentioned as specifically problematic regarding internal and value chain communications. However, companies stated that the use of standards and approaches need to reflect the audience that needs to use them. Some interviewees mentioned this communication need as part of the reasoning for developing their own internal sustainability assessment approaches while others voiced this a continual challenge with using existing standards.

As seen in the survey results, LCA is broadly considered useful and popular for the measurement of greenhouse gas emissions, resource use and waste and supported through the use of ISO standards. However, some interviewees expressed distrust in the results of LCA given observed problems in the choice of data, boundary conditions, and models that could be employed. The expertise needed to interpret LCA's was also seen as a barrier to the use of this methodology for communication with different departments in companies and across the value chain. Although this may reflect a need for broader education about LCA given that sustainability standards that are aligning on use of this methodology, it was voiced by interviewees as a reason why companies have developed their own sustainability measurement approaches to better communicate results to key users of the information.

Needs and opportunities

Given the increased focus on both safer and sustainable chemicals, materials, and products, there is a need for more specific and easily applicable sustainability standards and metrics that can help inform chemical and material selection decisions. The research identified four high-level opportunities to further evolve the use sustainability attributes to inform and communicate about chemical and material selection decisions:

1. **An evolving focus on prioritising measurement of sustainability attributes where businesses can have the greatest positive impact**. Companies noted that there is an ever-increasing array of sustainability attributes of interest to stakeholders, but limited resources dedicated to tracking and using sustainability data. Moreover, reporting has become highly process-based, especially in reference to financial reporting purposes, and devoid of deeper assessments of the data to prioritise consideration of specific attributes of importance to the company or product or application.

   Consequently, there is a growing focus on prioritizing “having an impact” and narrowing-in on areas of potential risk over just tracking a given impact category because it is considered part of sustainability reporting process. For example, some companies interviewed reported using a Trucost ESG Analysis to map the UN SDGs into four quadrants.[53] Each quadrant called for different actions from the company, either “monitor”, “maintain”, “address” or “enhance”. Companies then reported that they decided to prioritise the measurement of sustainability attributes that aligned with the “address” and “enhance” quadrants. In another example, a company realised that their participation in a sector’s standards setting effort around the sustainability impacts of a mineral was not needed because of their limited use of that mineral. Such investigations into sustainability attributes that matter most to companies can also start in a qualitative manner, as recently outlined in Change Chemistry’s Holistic Product Considerations Framework.[54] A toolbox of more quantitative data resources to support the consideration of sustainability attributes in the evaluation of chemicals and materials as part of the EU’s Safe and Sustainable by Design initiative is being developed through the Partnership for Assessment of Risks from Chemicals (PARC) and other initiatives.[55]

Efforts to support such prioritisation processes will allow companies to narrow-in on those sustainability attributes where their company’s focus is needed most. Lessons learned in the use of such approaches should be shared more broadly and may support narrowing-in on those attributes most impactful for chemical and material selection purposes, whether for innovation or substitution related purposes.

2. **Increasing use and availability of data sharing platforms and certifications to simplify impact measurement and communication**. Factors affecting the sustainability of a given company’s product or process extends beyond the boundaries of any one firm. As noted above, getting access to desired data on a given sustainability impact upstream in the supply chain (Tier 2 and 3 suppliers) is incredibly challenging. However, companies noted that organisations that helped suppliers to standardise their sustainability impact measurement and reporting were valuable to enhancing trust and communication across the supply chain. Greater alignment across supply chains is being experienced in some sectors over others. For example, interviews revealed that companies involved in textiles and apparel are highly aligned in the use of sustainability standards outlined through Higg and ZDHC. Sustainability assessment platforms such as those offered by Ecovadis (see 5Annex D for additional description) were mentioned as assets for helping to improve efficiencies in the assessment process and for standardising data that can be shared across the supply chain. Companies interviewed voiced the need for increased collaboration within industry sectors in order to create efficiencies, to improve data quality and to reduce the auditing/certification requirements such that suppliers did not have to certify with many different organisations with slightly overlapping data requests/needs.
3. **Standards developed over the last decade are benefitting companies newer to the consideration of sustainability.** Interviews consistently revealed that companies that started considering sustainability impacts 15-20 years ago typically developed their own standards due to a lack of available industry standards. Although some companies still rely on their own standards, companies that are newer to sustainability considerations reported that they had the ability to quickly advance in their journey by leveraging industry standards and tools previously developed with the input from and used by other companies.

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[53] Trucost (2018). Discovering Business Value in the United Nations Sustainable Development Goals (SDGs). April. https://www.spglobal.com/marketintelligence/en/documents/discovering-business-value-in-the-sdgs-12.11.18.pdf (accessed January 4, 2024)

[54] Change Chemistry. (2023). Holistic Product Considerations for Alternatives Assessment. https://assets-002.noviams.com/novi-file-uploads/gc3/pdfs-and-documents/RLC/Holistic-Product-Consioderations-for-Alternatives-Assessment-December-2023.pdf (accessed January 12, 2024)

[55] Partnership for Assessment of Risks from Chemicals (PARC). Thematic Areas. https://www.eu-parc.eu/#thematic-areas. (accessed April 15, 2024).

4. **Growth of approaches to consider multiple sustainability attributes to support comparison, prioritisation and deselection of chemicals and products**. Companies interviewed mentioned that they were targeting more sustainable product portfolios in their innovation process by screening out products that had high sustainability risks during the design stage. Companies often mentioned that they had developed their own internal multi-stage, multi-factorial eco-design approaches for vetting sustainability risks or benefits to their portfolios. One company's approach includes factors associated with ingredient/material sources, operations (e.g., energy consumption, waste), customer needs (e.g., transportation, use conditions), and end-of-life and creates an overall score to support decisions. Although LCA also can be considered such an approach, companies were creating such systems based on their unique set of priorities for sustainability considerations and internal information and decision flows.

   Other interviewees mentioned the use of decision support frameworks such as the WBCSD Portfolio Assessment[56]. A range of such support frameworks are available, examples of which are described below and outlined in Table 5. Such frameworks provide methods to compare different impacts to one another to support decisions.

   Interviewees consistently voiced a need for new approaches and tools to standardise comparisons between sustainability attributes to support chemical and material selection. Chemical hazard classifications benefit from the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)[57] which utilises a categorical ranking scheme to translate toxicological data into a simplified scheme of very high/high to very low/low and is used to support comparison of hazard endpoints. There is no such system for sustainability attributes that easily communicates (such as through the use of stop light matrices - red, yellow, green categories of concern) the level of impact/acceptability of a given sustainability attribute to support internal discussions and decision making. Although inconsistencies in hazard classification still exist even with a system such as GHS, having a globally accepted standardised framework for sustainability attributes that better supports comparisons and communicates levels of concern would be a step forward to addressing the need identified.

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[56] World Business Council for Sustainable Development. 2023. Portfolio Sustainability Assessment v. 2.0. September 23. https://www.wbcsd.org/Programs/Circular-Economy/Resources/Portfolio-Sustainability-Assessment-v2.0 (accessed January 12, 2024)

[57] United Nations. (2023). Globally Harmonized System of Classification and Labelling of Chemicals (GHS) tenth revised edition. https://unece.org/sites/default/files/2023-07/GHS%20Rev10e.pdf (accessed January 4, 2024).

Table 5. Moving beyond individual sustainability attributes and towards frameworks/methods that compile multiple attributes for chemical and material selection. Examples of frameworks.

Framework or Method	Audience / Sector	Short description of framework
Change Chemistry Holistic Product Considerations Framework[58]	Retailers and brand managers choosing chemicals	Many questions related to sustainability attributes are presented as a foundation for companies to inquire about sustainability information from their suppliers. The framework prompts companies to prioritise/compare different sustainability attribute information from suppliers.
Life Cycle Assessment (LCA)[59]	Developed for use in many sectors	Many methods exist in LCA that combine different impacts into simpler scores, such as ReCiPe 2016.[60] For example, IMPACT World+ combines 16 midpoint categories (e.g., attributes such as greenhouse gas emissions) into two different endpoint damage indicators damage to human health, and ecosystem quality.[61]
WBCSD Portfolio Sustainability Assessment (PSA) Framework[62]	Chemical industry and their value chain	PSA assigns scores from C-- to A++ to different signal categories (which may include sustainability attributes) that are then combined into a single score. Companies use this single score to categorise the sustainability of their product portfolio to determine whether new products pose a potential risk to their business or are a potential sustainability solution that outperforms the market.
Product Environmental Footprint (PEF)[63]	Developed to assess products from many different sectors	Researchers at JRC have proposed a weighting method that incorporates both surveys of relative impact importance (with both LCA experts and lay people consulted) and impact measurement robustness. This allows for all impact categories to be combined into a single score, which could then be compared to the single score of a similar product.
Safe and Sustainable by Design (SSbD)[64]	Newly designed or existing chemicals and materials	SSbD relies on the Product Environmental Footprint (PEF) for impact category definitions (i.e., greenhouse gas emissions). SSbD defines that for each impact category a criterion should be defined as a reduction of the impact category value of X% (target) relative to a reference value. Although the target is left to the individual assessor as is the sustainability standards used, this allows for the ranking of sustainability impacts relative to the reference value.

[58] Change Chemistry. (2023). Holistic Product Considerations for Alternatives Assessment. https://assets-002.noviams.com/novi-file-uploads/gc3/pdfs-and-documents/RLC/Holistic-Product-Consioderations-for-Alternatives-Assessment-December-2023.pdf (accessed April 18, 2024).

[59] Rosenbaum, RK, et al. Life cycle impact assessment. In: Hauschild, Rosenbaum RK and Olsen SI. Life cycle Assessment: Theory and Practice 1st Edition. Cham, Switzerland: Springer; 2018. 167-270.

[60] Huijbregts MAJ, Steinmann ZJN, Elshout PMF *et al.* (2017). ReCiPe2016: a harmonised life cycle impact assessment method at midpoint and endpoint level. International Journal of Life *Cycle Assessment.* **22**:138–147 https://doi.org/10.1007/s11367-016-1246-y.

[61] Bulle C, Margni M, Patouillard L, Boulay A-M, Bourgault G, De Bruille V, et al. (2019). IMPACT World+: a globally regionalized life cycle impact assessment method. International Journal of Life Cycle Assessment 24(9):1653–74. https://doi.org/10.1007/s11367-019-01583-0

[62] World Business Council for Sustainable Development. (2023). Portfolio Sustainability Assessment v. 2.0. September 23.https://www.wbcsd.org/Programs/Circular-Economy/Resources/Portfolio-Sustainability-Assessment-v2.0 (accessed January 12, 2024).

[63] Sala S, Cerutti AK, Pant R. (2018). Development of a weighting approach for the Environmental Footprint. https://doi.org/10.2760/945290

[64] Caldeira C, Farcal R, Garmendia Aguirre, I, Mancini L, et al. (2022). Safe and Sustainable by Design chemicals and materials - Framework for the definition of criteria and evaluation procedure for chemicals and materials. https://doi.org/10.2760/487955

5 Conclusion

Given increasing market and regulatory pressures to substitute chemicals of concern in products and products, OECD developed a *Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives*[65] to provide a relatively simple and consistent minimum and recommended approach for selecting a "safer" chemical. In developing the guidance, the ad-hoc working group considered that broader sustainability impacts also impact selection of alternatives but did not include them in the guidance at the time. Increasing global pressures for firms to address a broad set of sustainability criteria – such as climate impact, biodiversity, and circularity – as part of chemical and product innovation and selection processes have only increased since the publication of the guidance. Examples include a range of existing and proposed policies in Europe dictating the need for sustainable sourcing and selection of chemicals and materials, such as the revised Batteries Directive[66] as well as the Ecodesign for Sustainable Products Regulation[67]. At the same time, discussions on SSbD – a centrepiece of the European Commission's Chemical Strategy for Sustainability – have rapidly multiplied with numerous workshops and funded projects. However, there are concerns that application of the SSbD framework has a number of practical challenges[68] and is overly complex. Although the consideration of a range of sustainability attributes can improve chemical and material selection decisions and minimise risk beyond toxicity-related hazard alone, there is a need for simple and consistent assessment approaches for sustainability attributes. This research examined to what extent and how companies across sectors and the value chain are currently evaluating sustainability attributes as part of their chemical innovation and selection decisions.

The most important conclusion from this study is that *it depends*. Companies are at various stages in considering sustainability attributes in their chemical and material selection decisions, whether for the design of new chemistries, or in industrial processes or industrial/consumer products. A company's value chain position and individual circumstances play a critical role in their approach to sustainability and which attributes and related metrics/standards are most critical to them and their customers. There is no 'one size fit all" approach. There is inconsistency in the attributes measured and how they are measured with

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[65] Organisation for Economic Cooperation and Development. 2021. Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives. Series on Risk Management No. 60. https://www.oecd.org/en/publications/guidance-on-key-considerations-for-the-identification-and-selection-of-safer-chemical-alternatives_a1309425-en.html (accessed January 4, 2024).

[66] Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC.

[67] European Commission. Ecodesign for Sustainable Products Regulation. https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/sustainable-products/ecodesign-sustainable-products-regulation_en. Accessed January 14, 2024.

[68] Stringer, L. (2023). *BASF, Clariant, Novozymes share challenges of applying EU SSbD framework*. Chemical Watch. https://chemicalwatch.com/679326/basf-clariant-novozymes-share-challenges-of-applying-eu-ssbd-framework.

the most commonly considered attributes being the generation of waste and social impacts. Companies rely on a broad range of standards (including industry standards, certifications and eco-labels), consistent with existing knowledge about the sheer number of standards and metrics in current use for sustainability assessments that are often specific to product/industry sectors. Moreover, existing standards are often not considered relevant or useful for the types of sustainability considerations and assessments needed by companies in some sectors to support their chemical and material selection decisions, requiring those companies to develop approaches that are more "fit for purpose". Although the majority of survey respondents did not provide details on the specific metrics/measurement approaches used, the most frequently reported response was the use of Ecovadis/TfS and LCA. Future research efforts are needed to further capture metrics/measurement approaches being actively used. Based on experience in this study, use of surveys is often not a good research tool to capture such understandings as respondents did not in most cases complete open-ended response options.

The study raises questions about the suitability of existing standards to support chemical-level selection decisions given challenges identified, including that the majority of standards were developed for different purposes and audiences. Although such standards were considered useful for monitoring and steering the direction of a company's overall sustainability footprint, there remains questions regarding the utility and relevance of existing standards for specific chemical-level selection questions. The study also makes clear that a range of expertise is needed to answer this question. Existing standards and assessment approaches are not being used by some companies because their results are too complicated and nuanced to communicate to the range of professionals involved in product design/redesign and process engineering. Although standardisation and harmonisation of existing sustainability standards are a current focus among many initiatives, including the forthcoming CSRD in the EU, a deeper assessment is needed to better understand and evolve existing sustainability assessment processes to ensure they are suitable for the task of driving sustainable chemistry forward.

At this point, the addition of specific sustainability attributes to consider for a "safer and sustainable" chemical is complicated by lack of consistency, ease of application, and information gaps along the value chain. In the meantime, companies should continue utilising the best available sustainability information to the extent possible to support the chemical and material selection process. At a minimum companies should ask basic questions about relevant sustainability impacts and their trade-offs in chemical and material selection decisions, including in substitution efforts, leveraging the range of decision support tools outlined in Table 3 above. In addition, more quantitative assessment tools and data resources are on the horizon, such as those currently under development by the Partnership for the Assessment of Risks from Chemicals (PARC) to support the EU's Safe and Sustainable by Design initiative[69].

Future needs include:

- **Supporting flexibility in which set of sustainability attributes are supportive of making a "sustainable" or "more sustainable" chemical determination**. Development of a minimum and recommended set of sustainability attributes to evaluate and support determinations of a "sustainable" or "more sustainable" chemical/material should be flexible to the company/sector/product context as well as specific standards or metrics that could be used to evaluate them. This is consistent with newer decision support approaches such as the WBCSD's Portfolio Sustainability Assessment, which outlines use of "recognised ecolabels, sustainability

[69] Partnership for the Assessment of Risks from Chemicals (PARC). Thematic Areas. https://www.eu-parc.eu/#thematic-areas. (accessed April 15, 2024).

related certification and standards" but does not dictate which to use in a given product or industry sector.[70]

- **Assessing forthcoming mandatory sustainability reporting requirements regarding how they can be utilised to support chemical-level decisions**. Companies are currently substituting chemicals because of market forces and chemical regulation driven by hazard/exposure concerns. In addition to this, companies will soon be required to adapt their existing sustainability assessment approaches to comply with mandatory reporting requirements to be issued through the CSRD in the EU and the SEC in the US. To the extent possible, future initiatives supporting the consideration of sustainability attributes for chemical and material selection decisions should align with these mandatory reporting requirements while still aligning with existing regulations. Given that the primary sustainability reporting focus is the company-level, a critical assessment will be needed as to how metrics and assessment approaches required by these mandates can be leveraged for chemical-level selection decisions.
- **Encouraging broader education on the use of well-established sustainability assessment tools, such as LCA.** Given expressions of concern regarding the validity of assumptions and data used in some LCA and the lack of understanding on how to interpret outputs from such assessments across business units, additional educational and outreach efforts to support more effective and trusted use of LCA as needed. This is especially important given that implementation of the JRC's SSbD framework is highly based on the use of LCA methods. Educational resources exist, such as those created by the American Center for Lifecycle Assessment[71] which is working to support and enhance knowledge growth in the field of LCA.
- **Developing a better understanding of whether criteria to support a "sustainable" or "more sustainable" chemical determination can be derived from existing standards**. Although less waste, less emissions to water, less greenhouse gas emissions is always better than more, such comparisons using continuous data do not have cut point parameters or benchmarks to support judging levels of acceptability (e.g., excellent to very bad) or easily comparing trade-offs. Such cut-point decisions are commonly a combination of objective and subjective assessments and should be established by consensus standards. As the report acknowledges, there is no analogous GHS categorical ranking scheme for a chemical or material's sustainability attributes to ease comparisons. As such, it would be useful to review existing standards, ecolabels and product certification to discern whether cut-point thresholds exist and are generally aligned for establishing minimum requirements for supporting a "sustainable" "more sustainable" chemical determination.

[70] World Business Council for Sustainable Development. 2023. Portfolio Sustainability Assessment v. 2.0. September 23. https://www.wbcsd.org/Programs/Circular-Economy/Resources/Portfolio-Sustainability-Assessment-v2.0 Accessed January 12, 2024.

[71] American Center for Life Cycle Assessment. https://aclca.org/ (accessed April 15, 2024).

Annex A. Survey Questions

[Format is the version shared with companies in advance to show the types of questions asked]

Survey Questions

The survey is divided into three sections: demographic information, general sustainability impacts, and follow-up questions on sustainability impacts. The survey should take no more than 15 minutes to complete.

The survey will only ask for contact information if the participant is willing to do a follow-up interview. **No identifying information will be published in any publication (presentation/report) resulting from this survey or interviews.**

Demographic Information:

What sector best defines your company's products? Please select all that apply.

- apparel (ready-to-wear clothing and accessories)
- basic metals (iron, steel, precious metals)
- basic pharmaceutical products and pharmaceutical preparations beverages
- chemicals and chemical products
- coke and refined petroleum products
- computer, electronic and optical products
- fabricated metal products (reservoirs/tanks, cutlery, ammunition, except machinery and equipment)
- food products
- Footwear (shoes, boots, excluding shoes meant for specific sports like ice skates)
- furniture
- leather and related products (leather luggage, handbags, harnesses)
- machinery and equipment (oven, pumps, power-driven tools, excluding motor vehicles)
- tobacco products
- motor vehicles, trailers, and semi-trailers
- textiles (spinning, weaving, finishing of cloth, as input to apparel and textile articles)
- textile articles (non-apparel, such as blankets, rugs, rope, and netting) other electrical equipment (batteries, lighting, domestic appliances, excluding computer, electronics, and optical products)
- other miscellaneous items (toys, games, sports goods like ice skates, jewellery, musical instruments, candles)
- other non-metallic mineral products (glass, ceramic, concrete)
- other transport equipment (boats, aircraft, excluding motor vehicles) paper and paper products
- rubber and plastics products
- wood and of products of wood and cork, except furniture
- Other(write-in)____

General Sustainability Impacts Considered During Chemical/Material Selection

Specific survey questions designed to be displayed when sustainability impacts are selected; these conditions will be displayed in the following format:

If [condition is met], then the following question is displayed:

For the next set of questions, please consider sustainability impacts that are relevant to your company's chemical and material selection decisions.

Sustainability impacts: This survey is designed to capture environmental and social dimensions of sustainability that businesses consider when selecting specific chemistries/materials for use in their industrial processes and products. These include attributes such as climate change impacts, water impacts, biodiversity impacts, etc. This survey is not focused on toxicity attributes that would be included a safety data sheet (SDS), such as human health hazards (e.g., carcinogenicity, reproductive toxicity, etc.) and environmental hazards (e.g., persistence, aquatic toxicity, etc.).

Your companies' chemical/material selection decisions: For this survey, the OECD has taken a broad view on chemical/materials selection decisions in companies. This view encompasses everything from early to late R&D and sourcing/procurement considerations in the process of bringing a new or redesigned product to market or designing/implementing a new industrial process.

Does your company consider any aspect of sustainability of specific chemicals or materials when deciding which to use in your processes or products?

- Yes
- No

If your company considers any aspect of sustainability of specific chemicals or materials when deciding which to use in your processes or products, then the following question is displayed:

Does your company consider the following sustainability attributes when making decisions regarding chemical/material innovation and selection? Please select whether the attribute is never, sometimes, or always considered.

	Never	Sometimes	Always	Unsure
Greenhouse gas emissions (i.e., climate change impacts)	○	○	○	○
Other air emissions (e.g., PM2.5, VOCs)	○	○	○	○
Biodiversity impacts (including land use)	○	○	○	○
Energy consumption and energy type (renewable or non-renewable)	○	○	○	○

Resource use (e.g., water, mineral, metal)	○	○	○	○
Generation of waste (e.g., hazardous waste, water pollution, solid waste)	○	○	○	○
Circularity (e.g., renewable feedstock, durability, ability to recycle chemical/material)	○	○	○	○
Transparency of chemical/material ingredients and/or adherence to company restricted substances lists	○	○	○	○
Social impacts (e.g., worker rights and conditions)	○	○	○	○
Other (write-in)	○	○	○	○

If “other” impact was considered “sometimes” or “always”, then the following question will appear:

Please briefly outline the "other" impact and the metrics that support it below:

____

Request for Follow-up

The project team will be following up with willing survey respondents to dive deeper into how companies are considering sustainability impacts during chemical/material selection. Information associated with interviews will be published in the OECD report WITHOUT individual/company names identified.

Are you willing to be interviewed regarding sustainability impacts considered during chemical/material selection?

- ☐ Yes
- ☐ Maybe. I would like more information before deciding.
- ☐ No

If yes or maybe, then the following question is displayed:

Thank you for your interest! Please indicate your email below. Your email will only be used for follow-up regarding the interview.

____

Specific Sustainability Impacts Considered During Chemical/Material Selection

Specific survey questions designed to be displayed when sustainability impacts are selected as “always” or “sometimes” considered:

<table>
<tr><th>Condition</th><th>Question if condition is met</th></tr>
<tr><td>If ‘Greenhouse gas emissions (e.g., climate change impacts)’

are considered sometimes or always, then the following question will appear:</td><td>When considering greenhouse gas emissions in chemical/material selection, which of the following types of metrics and specific metrics are used?
<table>
<tr><th></th><th>Which type of metric is used to evaluate/quantify the impact?</th><th>Please elaborate on the metrics used</th></tr>
<tr><td>Greenhouse Gas Emissions (GHG, climate change)</td><td>Drop down list for each impact includes the following choices:
☐ Company financial reporting metrics (e.g., GRI)
☐ National or EU standards
☐ Industry-specific standards or certifications
☐ Internal company standards
☐ Other
☐ I don’t know</td><td>Write-in response option available for each impact.</td></tr>
</table>
</td></tr>
</table>

If ‘***Other air emissions (e.g., PM2.5, VOCs)’***

are considered ***sometimes or always,*** then the following questions will appear:

When selecting chemicals/materials, which of the following **air emissions** does your company evaluate?

	How often is the impact considered?
Ozone-depleting substances (e.g., hydrochlorofluorocarbons HCFCs)	One of the following options can be chosen for each impact: ○ Never ○ Sometimes ○ Always ○ Unsure
Particulate matter (PM2.5, PM10)	
Volatile organic carbon (VOCs)	
Nitrous oxides (NOx)	
Sulfur oxides (SOx)	
Photochemical ozone formation (combination of VOCs and NOx)	
Other, if applicable (write in below)	

If an above sustainability impact above is considered sometimes or always, the following question will appear to probe specific metrics:

	Which type of metric is used to evaluate/quantify the impact?	Please elaborate on the metrics used
Sustainability impacts that are sometimes or always considered	Drop down list for each impact includes the following choices: ☐ Company financial reporting metrics (e.g., GRI) ☐ National or EU emission standards ☐ Industry-specific standards or certifications ☐ Internal company standards ☐ Other ☐ I don’t know	Write-in response option available for each impact.

If **Biodiversity impacts (including land use)**

is considered ***sometimes or always,*** then the following question will appear:

When analysing **biodiversity** impacts during chemical/material selection, which of the following impacts does your company consider?

	How often is the impact considered?
Proximity of chemical/material production infrastructure to protected areas and areas of high biodiversity value (which may be outside of protected areas)	One of the following options can be chosen for each impact: ○ Never ○ Sometimes ○ Always ○ Unsure
Land use for facilities and feedstocks involved in chemical/material production.	
Terrestrial eutrophication	
Ecosystem restoration efforts or efforts to preserve existing ecosystems.	
Introduction of invasive species and/or reduction of native species	
Other, if applicable (write in below)	

If an above sustainability impact above is considered sometimes or always, the following question will appear to probe specific metrics:

	Which type of metric is used to evaluate/quantify the impact?	Please elaborate on the metrics used
Sustainability impacts that are sometimes or always considered	Drop down list for each impact includes the following choices: ☐ Company Financial reporting metrics (e.g., GRI) ☐ National or EU biodiversity standards ☐ Industry-specific standards or certifications ☐ Internal company standards ☐ Other ☐ I don’t know	Write-in response option available for each impact.

If **Energy consumption and energy type (renewable or non-renewable)**

is considered ***sometimes or always,*** then the following question will appear:

When considering **energy use** during chemical/material selection, which types of resources does your company consider?

	How often is the impact considered?
Renewable and non-renewable energy consumption and ratio	One of the following options can be chosen for each impact: ○ Never ○ Sometimes ○ Always ○ Unsure
Type of energy consumption (e.g., electricity, heating, cooling)	
Other, if applicable (write in below)	

If an above sustainability impact above is considered sometimes or always, the following question will appear to probe specific metrics:

	Which type of metric is used to evaluate/quantify the impact?	Please elaborate on the metrics used
Sustainability impacts that are sometimes or always considered	Drop down list for each impact includes the following choices: ☐ Company Financial reporting metrics (e.g., GRI) ☐ National or EU standards ☐ Industry-specific standards or certifications ☐ Internal company standards ☐ Other ☐ I don't know	Write-in response option available for each impact.

If **Resource Use (e.g., water, metal, mineral)** is considered ***sometimes or always,*** then the following question will appear:	When considering **resource use** during chemical/material selection, which types of resources does your company consider?

	How often is the impact considered?
Water use	One of the following options can be chosen for each impact: ○ Never ○ Sometimes ○ Always ○ Unsure
Fossil fuel use	
Mineral resource use	
Metal resource use	
Critical/rare metal/material resource use	
Recycled material use	
Reclaimed material use (no need for mechanical or physical recycling)	
Other, if applicable (write in below)	

If an above sustainability impact above is considered sometimes or always, the following question will appear to probe specific metrics:

	Which type of metric is used to evaluate/quantify the impact?	Please elaborate on the metrics used
Sustainability impacts that are sometimes or always considered	Drop down list for each impact includes the following choices: ☐ Company Financial reporting metrics (e.g., GRI) ☐ National or EU resource permits and standards ☐ Industry-specific standards or certifications ☐ Internal company standards ☐ Other ☐ I don't know	Write-in response option available for each impact.

If **Generation of waste (e.g., hazardous waste, water pollution, solid waste)** is considered ***sometimes or always,*** then the following question will appear:

During chemicals/materials selection, does your company consider the following types of **wastes** that are produced during chemical/material production?

	How often is the impact considered?
Hazardous waste amount	One of the following options can be chosen for each impact: ○ Never ○ Sometimes ○ Always ○ Unsure
Solid waste amount	
Water pollution amount	
Specific impacts of water pollution, as categorised by LCA (Ecotoxicity, Acidification, Eutrophication, etc.)	
Water pollution from hazardous chemicals release	
Other, if applicable (write in below)	

If an above sustainability impact above is considered sometimes or always, the following question will appear to probe specific metrics:

	Which type of metric is used to evaluate/quantify the impact?	Please elaborate on the metrics used
Sustainability impacts that are sometimes or always considered	Drop down list for each impact includes the following choices: ☐ Company Financial reporting metrics (e.g., GRI) ☐ National or EU waste permits and regulations ☐ Industry-specific standards or certifications ☐ Internal company standards ☐ Other ☐ I don’t know	Write-in response option available for each impact.

If ***Circularity (e.g., renewable feedstock, durability, ability to recycle chemical/ material)***

are considered ***sometimes or always,*** then the following question will appear:

When selecting chemicals/materials, which of the following **circularity** impacts is your company evaluating?

	How often is the impact considered?
Feedstock of chemical/material (e.g., biobased, recycled, or fossil)	One of the following options can be chosen for each impact: ○ Never ○ Sometimes ○ Always ○ Unsure
Durability of chemical/material (i.e., the chemical/material lifetime is appropriate to its use in a product)	
Ability of chemical/material to be reused, recycled, used in remanufacturing	
Other, if applicable (write in below)	

If an above sustainability impact above is considered sometimes or always, the following question will appear to probe specific metrics:

	Which type of metric is used to evaluate/quantify the impact?	Please elaborate on the metrics used
Sustainability impacts that are sometimes or always considered	Drop down list for each impact includes the following choices: ☐ Company Financial reporting metrics (e.g., GRI) ☐ National or EU standards and regulations ☐ Industry-specific standards or certifications ☐ Internal company standards ☐ Other ☐ I don't know	Write-in response option available for each impact.

If **Transparency of chemical/ material ingredients and/or adherence to company restricted substances lists** is considered ***sometimes or always,*** then the following question will appear:	When considering **transparency** during chemical/material selection, which factors does your company consider? ☐ Business-to-business (B2B) reporting on chemical/material ingredients in chemical/material. ☐ B2B reporting on avoidance of use of chemicals/materials that are on my company's restricted substances list. ☐ Certification through a trusted third-party (e.g., Material Health Certificate from Cradle-to-Cradle Product Innovation Institute) (write in option available) ☐ Public disclosure of chemical ingredients in products. ☐ Other (write-in) ☐ I don’t know

If **Social impacts, in chemical/material production and/or processing facilities**

is considered ***sometimes or always,*** then the following question will appear:

Which of the following **social impacts** are considered in chemical/material selection?

	How often is the impact considered?
Absence from areas with known lax environmental laws and corruption	One of the following options can be chosen for each impact: ○ Never ○ Sometimes ○ Always ○ Unsure
Absence of forced labour	
Absence of child labour	
Absence of discrimination (based on race, gender, etc.)	
Ability of workers to organise	
Implementation of occupational health system	
Avoidance of facilities with poor occupational health records	
Diversity of governance body and employees	
Implementation of anticorruption measures and grievance mechanism	
Other, if applicable (write in below)	

If an above sustainability impact above is considered sometimes or always, the following question will appear to probe specific metrics:

	Which type of metric is used to evaluate/quantify the impact?	Please elaborate on the metrics used
Sustainability impacts that are sometimes or always considered	Drop down list for each impact includes the following choices: ☐ Company Financial reporting metrics (e.g., GRI) ☐ National or EU worker regulations and standards ☐ Industry-specific standards or certifications ☐ Internal company standards ☐ International certifications such as SA8000, Fair Trade, B-Corp, etc. ☐ Other ☐ I don't know	Write-in response option available for each impact.

Annex B. Sample interview guide

The following interview guide was adapted to each participant to further inquire about sustainability impacts and standards mentioned in their survey.

Introduction:
Thank you for agreeing to be interviewed for this OECD effort. Our goal today is to dig in a bit further on responses in your survey to gain a better understanding of drivers, priorities, and challenges/benefits in the use of sustainability attributes to inform chemical/material selection decisions. As you recall, the OECD has taken a broad view on chemical/materials selection decisions in companies. This view encompasses everything from early to late R&D/innovation activities, sourcing/procurement considerations in the process of bringing a new or redesigned product to market, designing/implementing a new industrial process or substitution efforts.

As we've mentioned in prior communications, information collected in the survey as well as this interview will inform a report describing the landscape of sustainability impacts considered for chemical/material selection, which will be published by the OECD Working Party on Risk Management early next year.

A couple disclaimers and requests before we begin:

- NO identifying information –personnel and company names – will be included in any publication (presentation/report) resulting from this survey or interviews. We will report our findings only in association with industry/product sector and geography. Our focus is to describe overarching themes and trends rather findings from any one company.
- Please pull up your survey responses that we sent to you as it may be easiest to refer to them as we ask you a couple of our questions.

Contact Person:

- Could you let us know a little bit more about your role(s) within your company? Please include your title and a short description of your role.

Drivers/Motivations

- What are the key drivers motivating your company to consider sustainability impacts in chemical sourcing or design decisions in general? [Probe using examples if needed: sustainability goals/brand image of your company? Corporate Social Responsibility reporting/investor concerns? Policy/regulatory drivers? Customer priorities?]
- Who in the company was instrumental in driving the use of these considerations? [Probe as needed: C-suite; research and development; sustainability; regulatory affairs, etc.]
- In your survey, you mentioned that your company considered X, Y, Z sustainability impacts. Are these drivers/motivations for considering these specific sustainability impacts similar or are there additional reasons?

Understanding Sustainability Impacts Used
We'd like to better understand nuances related to each of these sustainability attributes used to support chemical and material selection decisions.

    - You mentioned that impact X is an attribute used [sometimes or always considered]. Can you say more as to why? If always, why is this impact a priority? If sometimes, why is the measurement of this impact situation dependent?

- Can you elaborate on the level of analysis (e.g., chemical-level, product-level, process, level, facility level) and the appropriateness of supporting chemical-specific decisions?
- Do you see alignment throughout your value chain that the sustainability impact is a priority?
- We organised this survey to ask about chemical and material selection in general. However, OECD is interested in substitution decisions more specifically as well. Do you know if this impact is also used when evaluating substitution options? What type of specific challenges, if any, has the company encountered when using this sustainability impact to inform such decisions?
- What tools do you use to measure the sustainability impact? What is your perspective on the sufficiency or existing tools to support considering sustainability attributes for chemical and material selection?
- What type of challenges if any have you encountered when measuring this sustainability attribute?

Last Questions:

- We don't have time to go into every other sustainability attribute that we asked about and which you noted wasn't considered. However, OECD is interested in learning about what is not being used to inform chemical design/selection decisions just as much as what is. Can you give any insights as to why these other attributes aren't being used?
- Anything else to add that you think is useful for this landscape study? Are there additional lessons learned or other factors you think useful in understanding the landscape of sustainability attributes being used to support chemical design and selection decisions?

Annex C. Additional Survey Results

Figure A C.1. Survey and interviewee's role in the supply chain

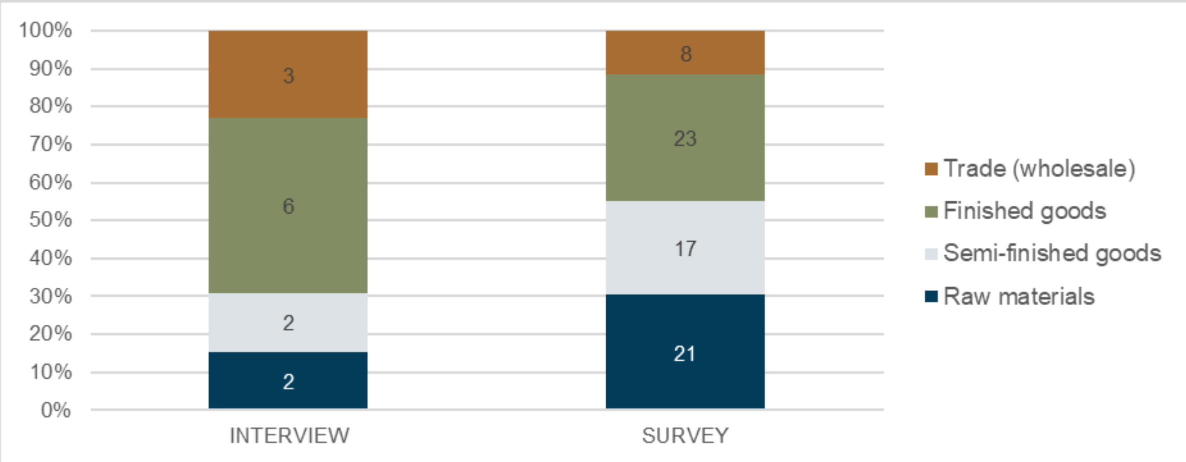

Figure A C.2. Companies do not consider the same impact for generation of waste

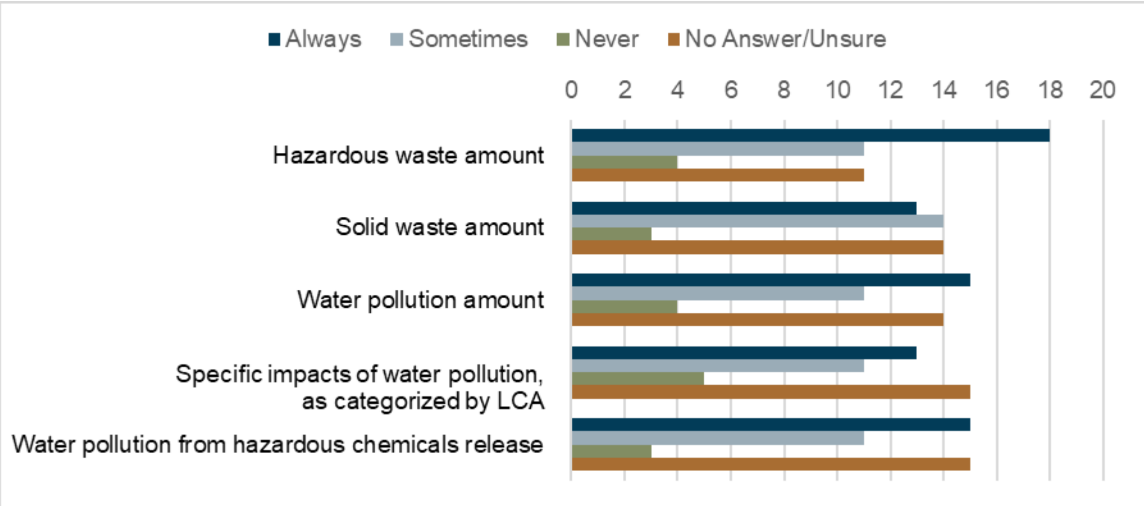

Figure A C.3. Average # of sustainability impact categories "sometimes" or "always" considered by company size.

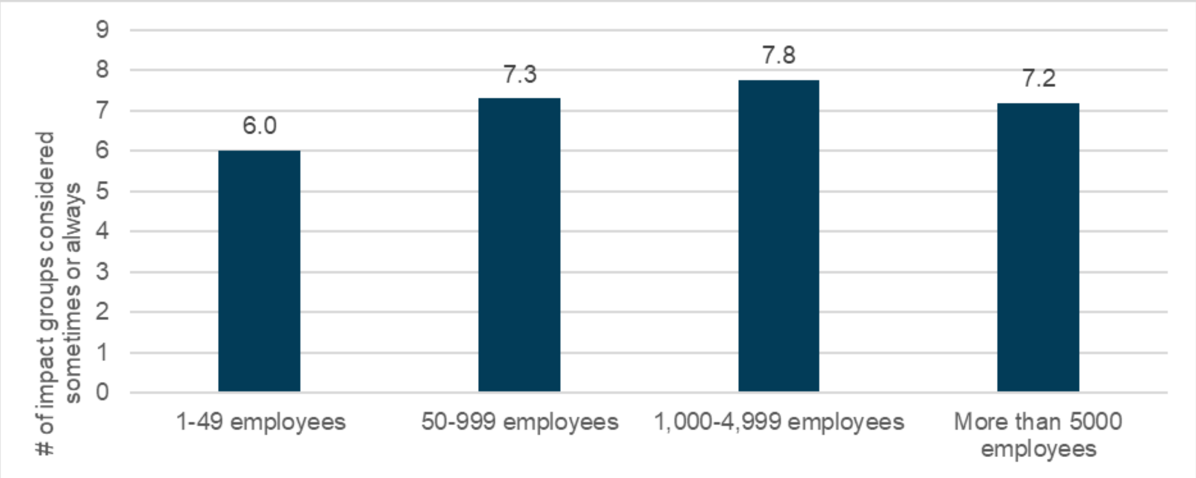

Table A C.1. Responses in survey as to whether companies considered sustainability impacts “always,” “sometimes,” “never,” or were unsure.

Note: Outlined cells represent the primary sustainability categories. If the survey respondent answered sometimes or always to the primary attribute category, they were asked a follow-up question to inquire about specific sustainability attributes within that category.

Sustainability Attribute	Always	Sometimes	Never	No Answer/Unsure
Greenhouse gas emissions	**22**	**16**	**5**	**3**
Other air emissions (e.g., PM2.5, VOCs)	**23**	**16**	**3**	**4**
Ozone-depleting substances (e.g., hydrochlorofluorocarbons HCFCs)	18	6	6	9
Particulate matter (PM2.5, PM10)	11	6	7	15
Volatile organic carbon (VOCs)	20	9	1	9
Nitrous oxides (NOx)	12	6	9	12
Sulfur oxides (SOx)	12	6	10	11
Photochemical ozone formation (combination of VOCs and NOx)	11	9	8	11
Biodiversity impacts (including land use)	**15**	**21**	**3**	**7**
Proximity of chemical/material production infrastructure to protected areas and areas of high biodiversity value (which may be outside of protected areas)	9	6	10	11
Land use for facilities and feedstocks involved in chemical/material production.	12	8	4	12
Terrestrial eutrophication	8	6	8	14
Ecosystem restoration efforts or efforts to preserve existing ecosystems.	7	10	5	14
Introduction of invasive species and/or reduction of native species	6	4	10	16
Energy consumption	23	15	3	5
Renewable and non-renewable energy consumption and ratio	16	12	0	10
Type of energy consumption (e.g., electricity, heating, cooling)	12	12	3	11
Resource use (e.g., water, mineral, metal)	24	16	2	4
Water use	15	14	2	9
Fossil fuel use	14	12	4	10
Mineral resource use	10	10	5	15
Metal resource use	6	9	7	18
Critical/rare metal/material	7	6	8	19
Recycled material use	15	15	0	10
Reclaimed material use (no need for mechanical or physical recycling)	10	11	4	15
Generation of waste (e.g., hazardous waste, water pollution, solid waste)	29	15	1	1
Hazardous waste amount	18	11	4	11
Solid waste amount	13	14	3	14
Water pollution amount	15	11	4	14
Specific impacts of water pollution, as categorised by LCA (Ecotoxicity, Acidification, Eutrophication, etc.)	13	11	5	15
Water pollution from hazardous chemicals release	15	11	3	15
Circularity (e.g., renewable feedstock, durability,	18	21	3	4
Feedstock of chemical/material (e.g., biobased, recycled, or fossil)	15	12	1	11
Durability of chemical/material (i.e., the chemical/material lifetime is appropriate to its use in a product)	13	12	3	11

Table A1 [continued]

Sustainability Attribute	Always	Sometimes	Never	No Answer/Unsure
Ability of chemical/material to be reused, recycled, used in remanufacturing	11	14	2	12
Transparency of chemical/material ingredients	29	12	0	5
Social impacts (e.g., worker rights and conditions)	26	11	1	8
Absence from areas with known lax environmental laws and corruption	13	4	2	18
Absence of forced labour	22	2	1	12
Absence of child labour	22	1	1	13
Absence of discrimination (based on race, gender, etc.)	21	2	1	13
Ability of workers to organise	15	5	2	15
Implementation of occupational health system	18	4	0	15
Avoidance of facilities with poor occupational health records	17	5	0	15
Diversity of governance body and employees	14	3	4	16
Implementation of anticorruption measures and grievance mechanism	18	4	0	15

Table A C.2. Percentage of respondents who "always" consider sustainability impacts, by position in the supply chain

Note: respondents could indicate more than one position in the supply chain

	Raw materials/ Chemicals* (N=21)	Manufacturer of semi-finished/ intermediate goods** (N=17)	Manufacturers of finished goods*** (N=23)	Trade (wholesale, retail) (N=8)
Greenhouse gas emissions	38%	53%	48%	25%
Other air emissions (e.g., PM2.5, VOCs)	43%	41%	52%	38%
Biodiversity impacts (including land use)	33%	29%	30%	13%
Energy consumption	33%	47%	48%	25%
Resource use (e.g., water, mineral, metal)	48%	47%	43%	25%
Generation of waste (e.g., hazardous waste, water pollution, solid waste)	57%	59%	48%	50%
Circularity (e.g., renewable feedstock, durability,	29%	41%	43%	25%
Social impacts (e.g., worker rights and conditions)	57%	53%	48%	38%

Table A C.3. Percentage of respondents who "always" consider sustainability impacts by sector

Note: respondents could indicate more than one sector

Sustainability Impact Category	Chemicals and Chemical products (N=34)*		Rubber and Plastics products (N=10)	Textiles (N=10)**	Electronic Equipment (N=10)***	Food, Beverage, and Pharmaceutical products (N=8)^	Paper and Wood (N=7)^^	Metals and Minerals (N=5)^^^	Furniture (N=7)
Greenhouse gas emissions	38%		50%	50%	60%	50%	57%	40%	43%
Other air emissions (e.g., PM2.5, VOCs)	38%		60%	50%	50%	50%	43%	40%	57%
Biodiversity impacts (including land use)	26%		30%	20%	20%	25%	43%	40%	29%
Energy consumption	38%		50%	40%	60%	50%	43%	60%	43%
Resource use (e.g., water, mineral, metal)	41%		50%	40%	50%	50%	29%	60%	43%
Generation of waste (e.g., hazardous waste, water pollution, solid waste)	47%		70%	50%	70%	50%	43%	60%	57%
Circularity (e.g., renewable feedstock, durability)	32%		20%	30%	20%	25%	29%	0%	29%
Social impacts (e.g., worker rights and conditions)	47%		60%	40%	80%	63%	57%	80%	57%

**A number of survey responders indicated that they were a part of the chemical industry but did not complete the sustainability attributes portion of the survey (n=6, or 18% of responses for the sector). Therefore, the percentages listed in the table may be artificially lower than for other sectors.*

*** Textiles sector is a combination of the following three responses for sectors: apparel (ready-to-wear clothing and accessories), textiles (spinning, weaving, finishing of cloth, as an input to apparel or textile articles), textile articles (non-apparel, such as blankets, rugs, rope, netting).*

****Electronic Equipment is a combination of the following two responses for sectors: computer, electronic and optical products, other electrical equipment (batteries, lighting, domestic appliances, excluding computer, electronic, and optical products).*

^This is a combination of the following sectors: beverages, food products, basic pharmaceutical products and pharmaceutical preparations

^^This is a combination of the following sectors: paper and paper products, products of wood and cork

^^^This is a combination of the following sectors: basic metals, fabricated metal products, non-metallic mineral products

Table A C.4. Percentage of respondents who "always" consider sustainability impacts, by company size

	1-49 employees (N=9)	50-999 employees (N=10)	1,000-4,999 employees (N=4)	More than 5000 employees (N=27)
Greenhouse gas emissions	22%	60%	50%	44%
Other air emissions (e.g., PM2.5, VOCs)	44%	50%	25%	48%
Biodiversity impacts (including land use)	11%	40%	25%	33%
Energy consumption	22%	40%	75%	52%
Resource use (e.g., water, mineral, metal)	44%	50%	50%	48%
Generation of waste (e.g., hazardous waste, water pollution, solid waste)	67%	60%	75%	52%
Circularity (e.g., renewable feedstock, durability,	44%	40%	0%	37%
Social impacts (e.g., worker rights and conditions)	22%	30%	75%	67%

Table A C.5. Survey responses for the type of standard used for the measurement of biodiversity, energy use, resource use, and circularity

Sustainability Impact		Internal company standards	Industry-specific standards and certifications	Financial Reporting Standards	National or EU emissions standards	No answer or unsure
Biodiversity impacts (including land use)	Proximity of chemical/material production infrastructure to protected areas and areas of high biodiversity value (which may be outside of protected areas)	2	3	0	3	7
	Land use for facilities and feedstocks involved in chemical/material production.	2	5	1	4	8
	Terrestrial eutrophication	1	5	0	4	4
	Ecosystem restoration efforts or efforts to preserve existing ecosystems.	1	5	0	5	6
	Introduction of invasive species and/or reduction of native species	1	2	0	5	2
Energy consumption	Renewable and non-renewable energy consumption and ratio	5	8	6	4	5
	Type of energy consumption (e.g., electricity, heating, cooling)	8	6	4	4	2
Resource use (e.g., water, mineral, metal)	Water use	8	9	3	4	5
	Fossil fuel use	6	7	3	4	6
	Mineral resource use	7	3	2	3	5
	Metal resource use	4	4	2	2	3
	Critical/rare metal/material	4	3	2	1	3
	Recycled material use	11	6	4	4	5
	Reclaimed material use (no need for mechanical or physical recycling)	7	5	3	3	3
Circularity (e.g., renewable feedstock, durability,	Feedstock of chemical/material (e.g., biobased, recycled, or fossil)	7	4	1	1	14
	Durability of chemical/material (i.e., the chemical/material lifetime is appropriate to its use in a product)	6	4	0	1	14
	Ability of chemical/material to be reused, recycled, used in remanufacturing	6	4	1	0	14

Table A C.6. Survey responses for the type of standard used for the measurement of social impacts

Social Impacts	Internal company standards	Industry-specific standards & certifications	Financial Standards	National or EU standards	International Certifications	Unsure or no answer
Absence from areas with known lax environmental laws and corruption	5	1	1	3	4	3
Absence of forced labour	3	3	1	7	6	4
Absence of child labour	3	3	1	7	6	3
Absence of discrimination (based on race, gender, etc.)	4	3	1	6	4	5
Ability of workers to organise	3	3	1	6	4	3
Implementation of occupational health system	4	2	1	9	3	3
Avoidance of facilities with poor occupational health records	5	3	1	8	1	4
Diversity of governance body and employees	6	2	1	4	1	3
Implementation of anticorruption measures and grievance mechanism	7	2	1	6	4	2

Table A C.7. Standards, related metrics and other measurement approaches reported by survey respondents in 3 industry sectors

Sustainability Attribute		Sector		
		Chemical Industry	**Textile Industry**	**Electronic equipment**
Greenhouse gas emissions		GHG Protocol, Global Reporting Initiative (GRI), LCA	GHG Protocol, Global Reporting Initiative (GRI), Higg, LCA	Corporate Sustainability Reporting Directive forthcoming), GHG Protocol, LCA, SASB
Other air emissions (e.g., PM2.5, VOCs)	Ozone-depleting substances (e.g., hydrochlorofluorocarbons HCFCs)	LCA, UNGC	Higg/Wordly, ZDHC	
	Particulate matter (PM2.5, PM10)	EPA AP-42	ZDHC	EPA AP-42
	Volatile organic carbon (VOCs)	LCA	Higg/Wordly, ZDHC	
	Nitrous oxides (NOx)	LCA	ZDHC	
	Sulfur oxides (SOx)	EPA AP-42, LCA	ZDHC	EPA AP-42
	Photochemical ozone formation (combination of VOCs and NOx)	LCA	ZDHC	
Biodiversity impacts (including land use)	Proximity of chemical/material production infrastructure to protected areas and areas of high biodiversity value (which may be outside of protected areas)	Ecovadis/Together for Sustainability(TfS), Nagoya compliance		
	Land use for facilities and feedstocks involved in chemical/material production.	LCA, Ecovadis/TfS, Nagoya compliance, RSPO, SAI, UEBT membership		
	Terrestrial eutrophication	Ecovadis/TfS, LCA,	Higg/Worldly MSI, LCA,	
	Ecosystem restoration efforts or efforts to preserve existing ecosystems.	Ecovadis/TfS, RSPO, Nagoya compliance, UEBT,	Cradle to Cradle,	
	Introduction of invasive species and/or reduction of native species	Ecovadis/TfS, Nagoya compliance		

Energy consumption	Renewable and non-renewable energy consumption and ratio	Ecovadis/TfS, use of emissions factors, LCA		
	Type of energy consumption (e.g., electricity, heating, cooling)	LCA	LCA	
Resource use (e.g., water, mineral, metal)	Water use	Ecovadis/TfS, LCA	Cradle to Cradle, Higg/Worldly MSI, LCA	
	Fossil fuel use	Ecovadis/TfS, LCA	Higg/Worldly MSI	
	Mineral resource use	Ecovadis/TfS, LCA		
	Metal resource use	Ecovadis/TfS, LCA		
	Critical/rare metal/material	Ecovadis/TfS, LCA		
	Recycled material use		RCS	
	Reclaimed material use (no need for mechanical or physical recycling)		RCS	
Generation of waste (e.g., hazardous waste, water pollution, solid waste)	Hazardous waste amount	LCA	bluesign, ZDHC	
	Solid waste amount	LCA	bluesign	
	Water pollution amount	LCA	bluesign, ZDHC	
	Specific impacts of water pollution, as categorised by LCA (Ecotoxicity, Acidification, Eutrophication, etc.)	LCA	LCA,	
	Water pollution from hazardous chemicals release	LCA	LCA, bluesign, ZDHC	ZDHC
Circularity (e.g., renewable feedstock, durability,	Feedstock of chemical/material (e.g., biobased, recycled, or fossil)	ISO16128, bio-based content based on C14 method	RCS	
	Durability of chemical/material (i.e., the chemical/material lifetime is appropriate to its use in a product)			
	Ability of chemical/material to be reused, recycled, used in remanufacturing			
Social impacts (e.g., worker rights and conditions)	Absence from areas with known lax environmental laws and corruption	Ecovadis/TfS	Ecovadis/TfS	RBA Code of Conduct
	Absence of forced labour	Ecovadis/TfS,	SLCP	RBA Code of Conduct
	Absence of child labour	Ecovadis/TfS,	SLCP	RBA Code of Conduct
	Absence of discrimination (based on race, gender, etc.)	Ecovadis/TfS,	SLCP	RBA Code of Conduct
	Ability of workers to organise	Ecovadis/TfS,	SLCP	RBA Code of Conduct
	Implementation of occupational health system	Ecovadis/TfS,	SLCP	RBA Code of Conduct
	Avoidance of facilities with poor occupational health records	Ecovadis/TfS,	SLCP	RBA Code of Conduct
	Diversity of governance body and employees	Ecovadis/TfS,	SLCP	RBA Code of Conduct
	Implementation of anticorruption measures and grievance mechanism	Ecovadis/TfS,	SLCP	RBA Code of Conduct

Annex D. Sustainability methods, tools, and standards mentioned in survey responses

Sustainability standards mentioned by survey respondents are outlined below in alphabetical order (see Table 2). Additional sustainability standards resources are also provided at the end of this section.

APR PCR Certification acts to certify recycled post-consumer recycled plastics that are chemically and mechanically recycled.

bluesign serves the textile value chain by outlining criteria for specific chemicals in production. It outlines limits for certain chemicals in consumer products (bluesign system substances list) as well as a restricted substances list.

California Air Resources Board Regulations limit the emissions of volatile organic compounds (VOCs) in antiperspirants, deodorants, consumer products, aerosol coating products, and hairspray.

Clean Package is a repository of packaging materials that conform to “ChemFORWARD SAFER, GreenScreen Certified for Food Service Ware (Gold or higher) or Cradle to Cradle Certified or Material Health Certificate (Gold or higher)” managed by the Sustainable Packaging Coalition.

Corporate Sustainability Reporting Directive (CSRD) are the EU rules for companies to disclose information on risks and opportunities related to the company’s social and environmental activities. This directive entered into force in 2023 and the first reports will be published in 2025.

Cradle to Cradle standard and accompanying certification outlines how products can reach different levels (bronze to platinum) after aligning with five sets of requirements: material health, product circularity, clean air & climate protection, water & soil stewardship, and social fairness.

Ecopassport may refer to the PEP Ecopassport program or the Oeko-Tek ecopassport certification.

Ecovadis has set 21 sustainability criteria based on the UNGC, the International Labor Organization (ILO) conventions, the ISO 26000 standard, the CERES Roadmap, and the UN Guiding Principles on Business and Human Rights. Ecovadis rates companies by considering many factors, such as a company’s industry, size, and location as well as a company’s responses to a questionnaire. The final scoring scale, which combines criteria with different weights according to company industry and location, rates companies from best in class to insufficient sustainability.

EPD may have been in reference to Environmental Product Declarations. Various certification bodies provide EPDs, such UL and the International EPD System. In addition, the US EPA is in the process of creating an EPD for the construction sector.

EU Taxonomy outlines what the EU considers to be a sustainable investment because of the economic activities’ alignment with a goal of net-zero carbon emission by 2050 and other broader environmental goals. These economic activities span many sectors.

Global Reporting Initiative (GRI) provides a framework for organisations to disclose their social and environmental impacts. There is a set of universal standards, in addition to many sector-specific standards.

Green Seal certifies cleaning products that “protect human health, preserve the climate, minimise waste, and ensure clean water.” It assesses the whole life cycle of the product as well as product performance.

Greenhouse Gas Protocol (GHG Protocol) published greenhouse gas accounting and reporting frameworks. The frameworks cover scope 1, 2, and 3 and are tailored to different end uses, such as companies or products.

Higg Index measures environmental and social impacts of the footwear, apparel, and textile supply chains. The tool is available for both brands and manufacturers.

ISCC manages a group of certifications related to sourcing sustainable materials. The certifications include those for materials that support the circular economy, the bioeconomy, and sustainable agriculture.

ISO 14067 outlines the “principles, requirements and guidelines” for carbon footprint of products, based on ISO 14040.

ISO14040/14044 outlines how to conduct a life cycle assessment (LCA), from the start of the process (defining a goal and scope) to the final phases (reporting and critical review). In addition, the limitations of LCA as well as the potential conditions of use are outlined.

ISO16128 provides technical definitions and criteria for natural and organic ingredients in the context of the cosmetics industry.

Life Cycle Assessment is a methodology that calculates the environmental impact of a product or process. It is outlined by ISO 14040/14044.

Nagoya Protocol on Access and Benefit-sharing is an international agreement whose goal is to equitably share benefits from the use of genetic biological diversity and genetic resources.

Oeko-Tex manages a group of certifications in the leather and textile sectors. These certifications include criteria such as minimisation of harmful substances, production of organic materials, as well as sustainable supply chains.

RBA Code of Conduct combines social, environmental, and ethical criteria for the electronic industry. Companies can declare their alignment to the Code of Conduct, which is accompanied by “self-assessment, questionnaires, and audits.”

Recycled Claim Standard (RCS) defines and verifies the recycled content in textile products (pre-consumer and post-consumer textiles included) as these textiles move through complex supply chains.

Roundtable on Sustainable Palm Oil (RSPO) certifies sustainable palm oil by considering the economic, social, and environmental impacts associated with its production.

SASB Standards, from the Sustainability Accounting Standards Board, provides standards for integrating relevant environmental, social, and governance (ESG) risks and opportunities into reporting. They cover 79 industries in 11 sectors.

Screened Chemistry, otherwise known as ToxServices’ Ful Material Disclosure (ToxFMD), is in conformance with the ZDHC MRSL. The certification assesses the safe use and communication of chemicals in the textile supply chain, in addition to electronics manufacturing.

The Social and Labor Convergence Program (SLCP) established a converged Assessment Framework, which simplifies the social auditing of textile supply chains. The program involves auditing and a verified data set, but not a scoring system.

Supplier to zero is an initiative of ZDHC which facilitates entry into the ZDHS Chemical Management System to facilitate communication and transparency between suppliers and their customers.

The Task Force on Climate-Related Financial Disclosures (TFCD) outlined recommendations for climate-related financial disclosures in the areas of “governance, strategy, risk management, and metrics and targets.” It was disbanded in 2023.

Title V Permit by the US EPA regulates actions for facilities to control their air pollution. There are additional rules regarding specific pollutants, the amounts released and the sizes of facilities that are subject to this regulation.

Together for Sustainability is an initiative of the chemical industry to assess and audit suppliers to streamline sustainable procurement and CSR. It partners with EcoVadis to assess suppliers in the chemical industry and supports suppliers in the audit process.

TÜV SÜD certifies electrical components. Its criteria include reliability of the component, safety of the components, and inspection of the production line.

UEBT standard outlines how botanicals can be grown and harvested in a way which preserves biodiversity, respects the environment, and the local population. Companies can join this initiative by agreeing to six minimum requirements that centre on continuous improvement, "positive impact for people and biodiversity" as well as transparency and reporting.

UL ECOLOGO certifies products that meet a range of criteria, from materials and energy use, to health, environment and product stewardship. Its product categories include cleaning products, electronics, personal care, building, paper, renewable energy and plastic packaging.

United Nations Global Compact (UNGC) is an initiative that outlines Ten Principles to help companies act more responsibly in the areas of "human rights, environment, labour and anti-corruption" which support broader UN SDGs.

USDA Bio-preferred program established biobased material purchasing requirements for government agencies and manages a labelling initiative for biobased content.

ZDHC facilitates collaboration in the "textile, apparel, leather and footwear value chains" to decrease the impacts of the industry's inputs, processes, and outputs (i.e., waste).

Additional Resources:

The Ecolabel Index provides more than 400 ecolabels used in many sectors.

The EU Ecolabel certifies many different types of products in the EU.

Building on the OECD Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives, this report describes the results of a landscape study of sustainability attributes used by companies to guide chemical and material selection decisions. Results outline the range of sustainability attributes being considered, factors guiding the choice of standards and metrics used, as well as lessons learned in terms of challenges, needs and opportunities in the use and interpretation of a range of sustainability impacts to support chemical/material selection decisions. Companies are at various stages, given their value chain position and individual circumstances, in considering sustainability attributes in their chemical and material selection decisions, whether for the design of new chemistries, industrial processes or industrial/consumer products. Companies noted that sustainability attributes were not often considered in chemical substitution efforts given that regulatory and market-based chemical restrictions are primary risk-driven. Future guidance development to establish a minimum and recommended set of sustainable attributes should be flexible to the company/sector/product context as well as specific standards or metrics that could be used to evaluate them. Guidance should also be supportive of chemical-level innovation and selection decisions and aligned with forthcoming mandatory sustainability reporting requirements.

https://www.oecd.org/en/topics/risk-management-risk-reduction-and-sustainable-chemistry.html