



# SEEBEYOND

Standardising environmental metrics in the food and drink sector: an incentive-based regulatory approach

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# Preface

The University of Cambridge was commissioned by the Environment Agency (EA) to conduct research on ‘Standardising environmental metrics for food businesses going beyond legal compliance’ (project code: G113238). This project, known as SEEBEYOND, has been made possible by a grant from the £3.7 million Regulators’ Pioneer Fund launched by the Department for Business, Energy and Industrial Strategy (BEIS). The fund enables UK regulators and local authorities to help create a UK regulatory environment that unleashes innovation and makes the UK the best place to start and grow a business. This report presents the key findings and outcomes of the project. The views expressed herein are not necessarily those of the EA. The University of Cambridge warrants that all reasonable skill and care has been used in preparing this report. The research team at the University of Cambridge was led by Dr Lili Jia and the other members included Prof Steve Evans, Mr Ian Bamford, Ms Frances Bycroft, Ms Emily Garverick and Ms Kim Rune.

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# Glossary

## **Agent**

This term refers to a person or thing that does an action.

## **Behavioural incentive**

In this report, the term refers to any incentive that motivates behaviour changes in an individual or organisation toward desirable outcomes. For example, an employee of a food business has a behavioural incentive to minimise operational errors in production to demonstrate a good performance; and a food business has behavioural incentive to improve environmental management to increase their brand value.

## **Beyond legal (environmental) compliance**

By ‘beyond legal compliance’ we refer to the situation in which organisations who are going beyond legal environmental standards, reducing negative social, environmental and economic impacts, seeking opportunities to optimise positive impacts by embracing sustainability in their own value chain, and collaborating with others and advocating public policy/sector guidance changes to create sustainable development.

## **Environment Agencies**

In the context of this project, 'Environment Agencies' refers to specific organisations in the UK including the Environment Agency (EA) in England, Northern Ireland Environment Agency (NIEA), Scottish Environment Protection Agency (SEPA) and Natural Resources Wales (NRW).

## **Formal standards**

'Formal standards' refers to the standards published by National Standards Bodies (NSBs) and Standards Development Organizations (SDOs).

## **Informal standards**

'Informal standards' refers to the standards published by industry bodies or businesses, including standards, guidance documents and/or codes of practice, initiatives or certification schemes to support businesses and industries. Some informal standards may have an established history of publishing standards or are included in a bibliographic database (with necessary accompanying metadata).

## **Legislation**

'Legislation' here refers to a law or a set of laws passed by a parliament. Environmental legislation in this report refers to legislative laws with which it is mandatory for businesses to comply.

## **Regulation**

'Regulation' here refers to an official rule made by a government or some other authority. The approaches recommended in this report provide guidance and support for businesses going beyond legal compliance. It is not mandatory.

## **Science based targets (SBTs) scope 1, 2 and 3**

[SBTs](#) were proposed by SBTi which is a partnership between CDP, the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF). "Targets are considered 'science-based' if they are in line with what the latest climate science deems necessary to meet the goals of the Paris Agreement – limiting global warming to well-below 2°C above pre-industrial levels and pursuing efforts to limit warming to 1.5°C."

"The SBTi currently validates scope 1 and 2 SBTs that are in alignment with limiting global warming to well-below 2°C as a minimum level of ambition. However, in response to the urgency and scale of the climate emergency, the SBTi is ratcheting up its expectations for businesses by ensuring all targets align with a 1.5°C future."

Its calculation methodology of greenhouse gas (GHG) emissions is specified in the GHG protocol. The SBTs scope 1 refers to GHG emissions from sources that are owned or controlled by the company, such as GHG emissions from broilers, vehicles and production processes. The SBTs scope 2 refers to GHG emissions from the generation of purchased electricity consumed by the company. The SBTs scope 3 refers to other indirect GHG emissions resulting from the activities of the company and the sources of emissions are not owned or controlled by the company, such as purchased materials and use of sold services.

## Executive summary

With the increasing demand for reporting environmental performance, businesses encounter a big challenge in collecting and verifying environmental data. This project develops standardised environmental metrics employing an incentive-based approach to help the food and drink sector address this challenge. These standardised environmental metrics provide a data infrastructure for automating data exchange, which could reduce the time and cost to report and communicate environmental performance more effectively.

Our key findings are as follows:

- 79% of 101 surveyed food businesses indicate that data challenge is the biggest barrier to measuring their environmental performance for businesses of all sizes.
- Food businesses indicate that it is highly feasible to report their environmental performance, beyond legal compliance, relating to greenhouse gas (GHG) emissions and air pollutants, water, materials and wastes.
- Reporting the Science-based Targets (SBTs) scope 3 GHG emissions is less feasible for small- and medium-sized enterprises (SMEs) than for large companies in the food and drink sector. There is a great potential for all the food businesses to address SBTs scope 3 GHG emissions through improving material efficiency and reducing waste.

The key outcomes of the project are as follows:

1. Development of an incentive-based regulatory approach
2. Identification of assumptions for standardising environmental metrics
3. Articulation of principles for standardising environmental metrics
4. A systems learning framework for food companies to harness business value from improving environmental performance iteratively
5. A set of standardised environmental metrics for the food and drink sector

Recommendations:

1. The standardised environmental metrics need to be tested with food businesses at both company and site levels.
2. Standardised environmental metrics should be integrated into the digital platforms of Environment Agencies to help food businesses reduce the burden of environmental reporting.
3. Semantic web standards (such as Web Ontology Language (OWL)) should be developed to help food businesses automate the exchange of environmental performance data.
4. Standardised environmental metrics should be integrated into global standards, such as GS1 EPCIS 2.0, to enable data interoperability between food businesses along the global supply chain.
5. Explainable (that is, 'clear-box'), rather than unexplainable ('black-box'), artificial intelligence (AI) algorithms should be used to support the systems learning of food companies to harness business value from improving environmental performance.
6. The incentive-based regulatory approach is transferable to other sectors. Environmental policies that aim to mitigate climate change and reduce waste should apply this approach to motivate the improvement of environmental performance beyond legal compliance.

## 1.0 Introduction

With the increasing awareness of environmental sustainability, businesses have a growing need to demonstrate a strong environmental performance to their stakeholders, such as customers and investors.

Despite the availability of various environmental metrics, it is difficult for businesses to distinguish their genuine improvement of performance from 'greenwashing' activities. One big question for businesses is: what metrics can rigorously benchmark environmental performance beyond legal compliance?

When a business reports environmental performance, it often requires businesses to share environmental performance data with each other via emails. This has created a significant burden on businesses because the process is time-consuming and costly. How can businesses reduce their time and cost involved in exchanging environmental performance data? Most importantly, how can industries harness business value from continuous improvement of environmental performance?

The Regulatory Future Review (Cabinet Office, 2017) pointed out that regulations should ensure not only compliance but also 'steady reduction in the risk of harm and/or improvement in the quality of services'. The Environment Agency (EA) is seeking to help 'the UK economy find the way to Net Zero by 2050' (EA, 2022).

So far, the EA's approach to regulation is divided into six types, namely engagement, regulating to support innovation, digital services and technology, permitting, permit compliance and operator performance and enforcement action (EA, 2021).

The primary focus of these approaches is environmental compliance. In England, 97% of businesses (EA, 2021) have reached environmental compliance (above band C). It is hence imperative to have a new approach in order to motivate environmental performance beyond legal compliance to achieve more ambitious environmental goals, such as Net Zero by 2050, the 25 Year Environment Plan and United Nations Sustainable Development Goals (UN SDG).

This project seeks to adopt an incentive-based approach in order to tackle the challenges mentioned above. The incentive-based approach will lend support to the existing approaches through enhancing engagement with industries, enabling the innovation of environmental traceability and adopting digital services and advanced technology.

We test the feasibility of an incentive-based approach within the food and drink sector in this the project. Such an approach, however, is not limited to the food and drink sector and can be transferred to the other sectors with certain adjustments.

## 2.0 Scope

This project sheds light on environmental performance beyond legal compliance. Any business that fails to meet the requirements of environmental permit lies outside of the project scope.

The project seeks to complement rather than replace any existing policies, legislations, or formal and informal standards. It can complement the existing regulations by providing a voluntary scheme to motivate the improvement of environmental performance beyond legal compliance. It will support the existing formal and informal standards by providing shared understanding of food business behaviours and a roadmap for deriving business value from improving environmental performance.

The project focuses on micro- rather than macro- or technical-level metrics to evaluate environmental performance of food businesses. The metrics for comparing environmental impacts at regional, national and global levels fall outside the scope of this project.

According to the subsector categorisation of the Environment Agencies in England and Scotland, the food and drink sector here includes the following: food manufacturing of animal feed; brewing, dairy; grain milling; red meat abattoir; poultry processing; soft drinks; vegetable processing; meat processing; ready meals; pet food; vegetable oils; sugar; malt manufacturing; other alcoholic drink; rendering; finfish; and shellfish. Agricultural production and farming are not in the project scope.

## 3.0 Methodologies

### 3.1 Incentive-based approach

There is an increasing appreciation that behavioural incentive plays a critical role in motivating environmental performance (Jia et al., 2019; Bansal and Roth, 2000). For example, two surveys by the EA (Jia et al., 2020) indicated that 74% (of 116) businesses and 62% (of 158) regulators expressed the need for stronger incentives to better motivate businesses to go beyond compliance.

This project adopts an incentive-based approach proposed by Jia and Evans (2021) to consider the role of behavioural incentives in the design of standardised environmental metrics beyond legal compliance.

According to the behavioural cost-benefit model (Jia et al., 2019), the behavioural incentive of business is jointly shaped by its behavioural benefits and costs. Behavioural benefits of business concern the gains of social, environmental and economic values; and its behavioural costs concern the expenditure of social,

environmental and economic values. In this manner, the behavioural incentive of businesses to reduce negative impacts to society and the natural environment is dynamic rather than static (Jia and Evans, 2021; Bandura, 1989).

The behavioural incentive of business to improve environmental performance can be optimised by raising its behavioural benefits (such as attracting investors and customers) and reducing behavioural costs (such as production cost reduction and lower collaboration cost) in improving environmental performance.

This project especially designed environmental metrics to capture the dynamics of behavioural incentive. These metrics will inform the continuous improvement of standardised environmental metrics and motivate food businesses to go beyond legal compliance.

### **3.2 Co-creation**

This project adopts a co-creative approach to ensuring the engagement of all the relevant stakeholders throughout the design of regulation. This approach allows us to identify and address the most urgent needs shared by all the stakeholders and design the solutions with them collaboratively (Bocken et al., 2013).

We have worked closely with businesses, regulators and NGOs through six online workshops and one online survey (with 101 responses) to identify the needs of standardised environmental metrics. Both workshop and survey results evidenced that data challenge is the biggest barrier to measuring environmental performance in the food and drink sector. This confirms the need from all the stakeholders.

The standardised environmental metrics together with assumptions and principles were sent to all the stakeholders for comments. We also held two workshops with environmental regulators in England, Scotland, Northern Ireland and Wales and three workshops with food businesses and NGOs. The comments and feedbacks from these events informed the revision of standardised environmental metrics.

### **3.3 Transparent behavioural assumptions**

As behaviours of businesses are complex, it is impossible to consider all the aspects of the real world in the design of standardised environmental metrics. When assumptions are not indicated explicitly, misunderstandings may arise between different agents. To avoid any potential misunderstandings, assumptions should be disclosed to clarify what characteristics are captured in the design of standardised environmental metrics. This also clarifies the boundaries for application of the designed metrics.

As different scientific disciplines may make different assumptions regarding the same behaviour, it is critical to ensure that assumptions are consistent with the real-

world behaviours and robust across disciplines. For example, it is commonly assumed that businesses seek to optimise their economic profit (Aidt et al., 2017; Dasgupta, 2021). Such an assumption does not hold because much evidence indicates that businesses do consider social and environmental values in operations (Basal and Roth, 2000; Bocken et al., 2014). Therefore, the profit maximising goal should not be taken as the default assumption.

Drawing on both the relevant previous studies and data evidence from our survey, we established seven assumptions for standardising environmental metrics. The assumptions are presented in section 5.0.

### **3.4 Specific principles**

Interests, relating to various principles (TCFD, 2017; GRI, 2021; FSC, 2015; SBTs, 2021), differ between stakeholders. For this reason, it is critical to clarify principles in the design of standardised environmental metrics. Making these principles transparent will ensure that all the stakeholders are informed about the shared interests and can facilitate collaboration between all the relevant stakeholders.

We collected 77 principles from existing policy guidance and informal standards. In addition, we identified three principles with environmental regulators through two workshops. Following a semantic analysis, these principles have been clustered into four groups comprising measurement of environmental performance, behavioural incentive, environmental traceability and environmental management. Overall, 15 principles are identified in four clusters as reported in [appendix 1](#).

### **3.5 Environmental traceability**

The emerging technologies, such as digital traceability (Badia-Melis et al., 2015; Ringsberg, 2014), have produced an opportunity for environmental regulation to harmonise the environment, people and growth in the long-term. Standardising environmental metrics can provide a shared data infrastructure to enable businesses to automate data exchange across different computer systems. This will enable the adoption of data interoperability technologies, such as ontology and Extensible Markup Language (XML), to reduce the burden of reporting environmental performance for businesses and improve data management efficiency (Ringsberg, 2014).

In the design of standardised environmental metrics, we considered the future development of data interoperability. For example, we adopted the GS1 Global Product Classification (GPC) to categorise product groups so that the standardised environmental metrics can be directly integrated into global standards (GS1, 2022).

### 3.6 Systems learning framework

Harnessing business value from improving environmental performance is a complex process that involves multiple stakeholders, including but not limited to food businesses, employees of businesses, customers/consumers, auditors, regulators, data, operations, and technology. To capture all the relevant stakeholders, we should adopt a systems approach (Arnold and Wade, 2015) which considers different stakeholders and their interactions.

According to theories of social learning (Bandura, 1977), social cognition (Bandura, 1989) and organisational learning (Nonaka, 2000), all the stakeholders are learning agents and they can collaborate with each other to facilitate systems learning towards environmental sustainability (Loeber et al., 2007). The implication here is that our systems approach needs to go beyond systems thinking – it is a systems learning approach that is required.

The project constructed a systems learning framework for food businesses to develop standardised environmental metrics, shown in section 6. The framework depicts an iterative process of systems learning for food companies to harness business value from improving environmental performance. The systems learning framework is not static. It can be tested with the data collected through standardised environmental metrics and improved with Artificial Intelligence (AI) iteratively.

In systems learning, human and artificial agents are not independent from each other and they can support each other to learn iteratively. Human agents can provide data to artificial agents and artificial agents can support the decision-making of human agents with prediction tools (Agrawal et al., 2018; Jia and Evans, 2021; Jia and Evans, 2022). In other words, artificial agents provide insights to human agents in decision-making rather than make decisions for human agents.

There are two types of AI: explainable ('clear-box') and unexplainable ('black-box'). The explainable AI is more suitable for systems learning because it can help human agents understand and interpret predictions.

## 4.0 Review of environmental metrics

### 4.1 Policies and guidance

There are three policies and forms of guidance associated with moving beyond legal compliance. The first one is the '[Environmental Reporting Guidelines: Including streamlined energy and carbon reporting guidance](#)' published by HM Government in 2019. It establishes the principles and the guidelines to report environmental impacts.

The [Sustainable Green Growth Agreements \(SGAs\)](#) was developed by SEPA: “SGAs are voluntary formal agreements between an organisation (or organisations) and SEPA that focus on practical action to deliver environmental outcomes and help achieve One Planet Prosperity”. The [Prosperity Agreement](#) was developed by NIEA: “Prosperity Agreements were initiated as a means of working in partnership with regulated businesses, in an innovative way to find opportunities for step change in environmental performance and to secure positive business growth and development”.

## 4.2 Formal standards

The formal standards beyond legal compliance reviewed are derived from the [British Standards Institution \(BSI\) database](#). Initially, 402 formal standards were found, 86 of which were duplicates (50 duplicates with formal standards and 36 duplicates with informal standards). Furthermore, four standards included by BSI have been withdrawn by the International Organization for Standardization (ISO). For the sake of consistency, we excluded these as well as the duplicates. Thus we were left with a total of 312 standards.

Following a screening of title and full-text review, we identified 22 formal standards for the development of standardised environmental metrics.

Our survey of 101 food businesses did not identify any further formal standards for consideration. The survey identified seven standards used by food businesses, namely ISO14001, ISO 9001, ISO 50001, ISO 14002, ISO 14064, PAS 110 and PAS 2060. Among these, ISO 9001 is for quality management not directly linked to environmental management and PAS 110 is a technical standard focusing on whole digestate, separated liquor and separated fibre derived from the anaerobic digestion of source-segregated biodegradable materials. The other five formal standards reported by the survey were identified previously.

## 4.3 Informal standards

Food businesses may use different informal standards to demonstrate their environmental performance beyond legal compliance. It is impossible to produce an exhaustive list. During the project, we sought to identify the major informal standards used by the food and drink sector. Following four workshops and the online survey with 101 food businesses, we collected 39 informal standards. These are displayed in figure 1. Furthermore, we identified 2 additional standards from workshops with food businesses. Among them, 16 standards were excluded due to lacking sufficient information or information not publicly assessable. Finally, we obtained 25 standards for full-text review.



**Figure 1: Informal standards used in the food and drink sector by environmental area.**

Note: More information about the informal standards can be found here: [CDP](#), [Food and Drink Federation \(FDF\)](#), [Global Reporting \(GRI\)](#), [WRAP](#), [Taskforce on Nature-related Financial Disclosure \(TNFD\)](#), [Task Force on Climate-related Financial Disclosure \(TCFD\)](#), [SASB](#), [Marine Stewardship Council \(MSC\)](#), [Global GAP](#), [IIRC](#), [LEAF](#), [WWF](#), [SMETA](#), [Roundtable on Sustainable Palm Oil \(RSPO\)](#), [Sedex](#), [Business Benchmark on Farm Animal Welfare \(BBAFW\)](#), [British Egg Industry Council \(BEIC\)](#), [OF&G](#) and [SWA Environmental Strategy reporting](#).

#### 4.4 Scoping literature review

The scoping literature review focused on four databases, comprising ProQuest, JSTOR, Science Direct and Scopus. The search key words were ‘(company OR corporate OR business) AND (responsibility OR sustainability) AND (measure OR metric OR indicator OR index) AND food’ between 1<sup>st</sup> January 2016 and 26<sup>th</sup> September 2021.

In that period of time, a number of review articles on environmental metrics have been published. Not all such articles comprehensively cover all the environmental metrics. Hence, this project conducted a scoping literature review to review the review articles. It took a snowballing approach to identify environmental metrics from the references of review articles.

Initially, we found 101,863 citations and 2,051 of them were duplicates. After removing the duplicates, we screened titles and abstracts and established a list of 78 review articles. Then, we conducted a full-text screening and obtained 30 such

articles. The articles that don't contain any micro-level environmental metrics were excluded. Then we sought the references of the 30 review articles to extract environmental metrics. Eventually, we obtained 380 metrics from 143 citations.

## 5.0 Assumptions

Assumptions are essential to lay out a shared understanding of key issues among different stakeholders in standardising environmental metrics.

### 5.1 Strategies to motivate environmental management are not limited to legislative and financial incentives

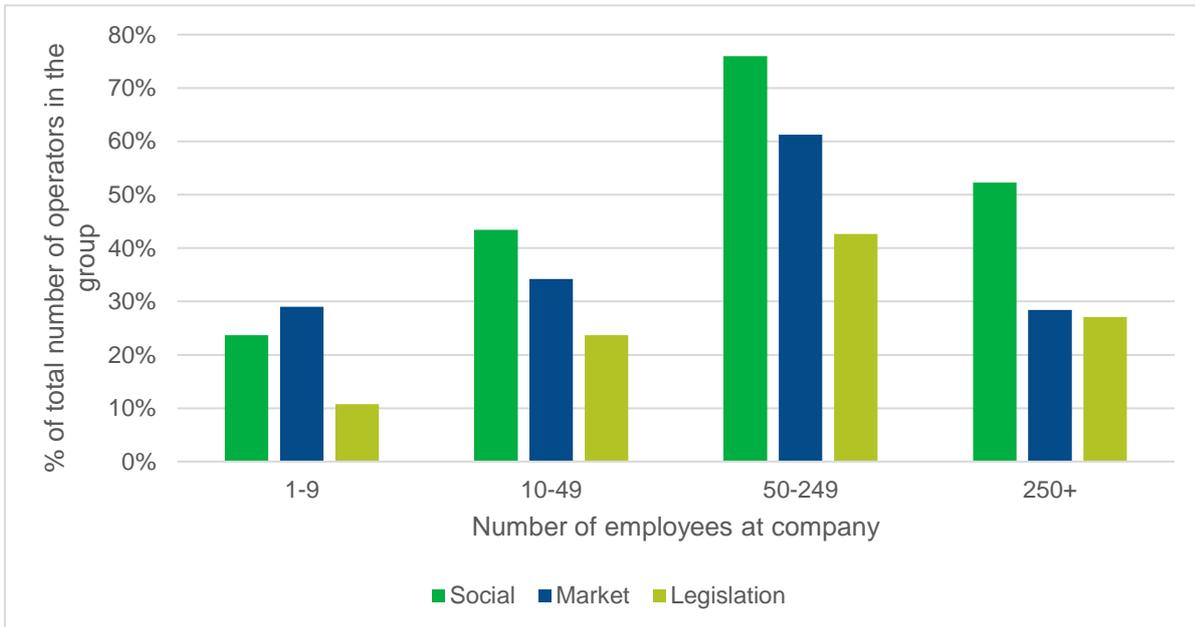
Legislative and financial incentives are the most commonly used strategies in environmental regulation. Legislation (such as [the Environmental Permitting \(England and Wales\) Regulations 2016 \(SI 2016 No 1154\)](#)) enacts the minimum standard for environmental performance, which are mandatory for companies. Financial incentives (such as carbon tax and environmental permit charge discount on high performance operators) can also motivate environmental performance by manipulating its economic cost and benefit.

Strategies to motivate environmental management, however, go beyond legislative and financial incentives. This is because companies are concerned with business value rather than solely economic profit within legal compliance (Barnal and Roth, 2000). It has been evidenced that environmental value aligns with business value in multiple dimensions (Jia and Evans, 2021; Jia et al., 2019; Bocken et al., 2014), such as improving material efficiency, increasing brand value and attracting employees.

The EA conducted a survey with 505 business sites (Jia et al., 2020) regarding the drivers of environmental management. It reveals that social, market and legislative incentives jointly drive voluntary adoption of environmental management system, as shown in figure 2 below. Whilst legislation (such as setting permit conditions) provides a minimum standards and basic incentive to achieve environmental compliance, social and market incentives are stronger drivers for voluntary adoption of environmental management system. Market incentive here includes not only financial income but also other market benefits, such as attracting new customers, leading technological innovation, and increasing brand value.

This, however, does not mean that legislative incentives (such as Environmental Permitting Scheme) can be wholly replaced by social (such as better neighbour and increasing team morale) and economic (such as attracting investors and green customers) incentives. Instead, it indicates that the three incentives are complementary. If environmental regulators are able to harness both social and economic incentives to influence those they regulate, it is more likely to achieve a

progressive improvement in environmental performance at a faster pace than legislative incentive alone. Using a mix of incentives, including those which require fewer resources and incur lower costs, would offer a cost-effective mechanism to deliver enhanced environmental performance.



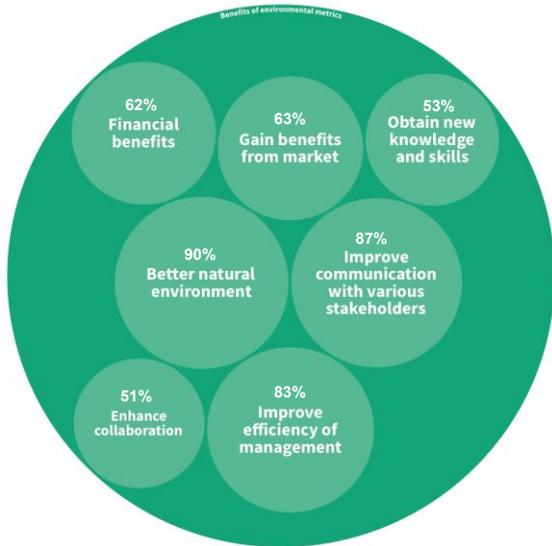
**Figure 2: Drivers of voluntary adoption of environmental management system**

## 5.2 Food businesses perceive environmental, social and economic benefits of measuring environmental performance

Measuring environmental performance could produce multiple types of business value for companies in the food and drink sector including environmental, social and economic benefits.

The SEEBEYOND project conducted a survey with 101 food businesses in 2021 including 61% large, 14% medium, 7% small and 18% micro companies. The survey is skewed toward large companies. This is probably because they are generally more active in going beyond legal compliance and willing or have greater capacity to participate in the survey.

The survey results presented in figure 3 shows that food businesses perceive multiple behavioural benefits from improving environmental performance, such as generating positive impacts on the natural environment, improving communication with stakeholders, improving efficiency of management and financial benefits. The size of bubble indicates the percentage of benefits perceived by food businesses. For example, 87% of food businesses perceive that measuring environmental performance can improve their communication with various stakeholders, such as investors, employees and consumers.

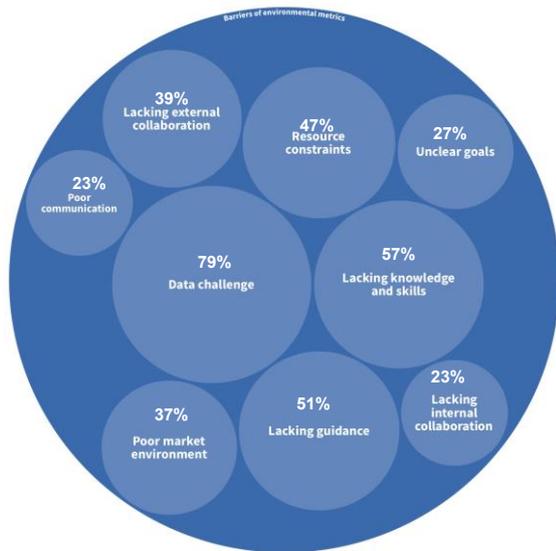


**Figure 3: Behavioural benefits of measuring environmental performance perceived by food businesses**

### **5.3 Food businesses face various barriers when measuring environmental performance**

The perception of business value in measuring environmental performance does not always trigger the actions of food businesses required to measure and improve environmental management. The various barriers that prevent food businesses from taking the required actions should not be ignored.

The survey findings presented in figure 4 reveal that food businesses perceive various barriers to improving environmental performance, such as the data challenge, lacking knowledge and skills, resource constraints, lacking guidance and unclear goals. Among them, 79% of food businesses indicate that the data challenge forms the biggest barrier to measure their environmental performance. The data challenge includes the lack of accurate data for measuring environmental performance, time-consuming process of collecting data to track environmental performance, and costliness of collecting data to report environmental performance.



**Figure 4: Behavioural barriers of measuring environmental performance perceived by food businesses**

### **5.4 The level of achievement rather than the number of environmental goals distinguishes better environmental performance**

There is a gap between intention to change behaviour and taking action to do so (Ajzen, 1990). It is important for environmental strategies to focus on the action rather than intention of environmental performance. The project survey displayed figure 5 shows that the number of environmental goals is generally high across various sizes of company and 75% of them have seven or more environmental goals. This indicates that the number of environmental goals is not sufficient to distinguish truly high environmental performance.

If insufficient resources are allocated to improving environmental performance, a high number of environmental goals may create challenges in prioritising resources. In this way, the high number of environmental goals here may be associated with lacking guidance and clear goals in beyond legal compliance.

In this manner, the project considers the actual performance for each environmental goal rather than the number of environmental goals in the design of standardised environmental metrics.

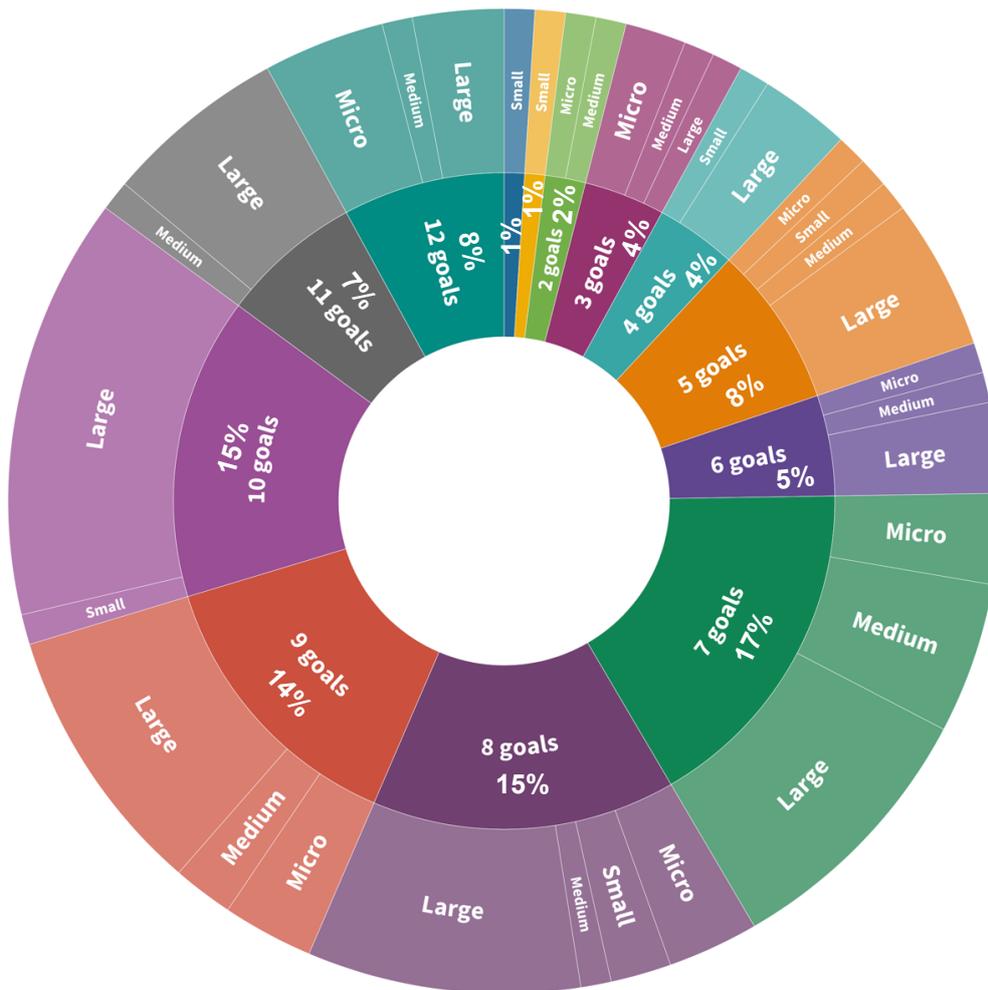


Figure 5: Number of environmental goals by company size

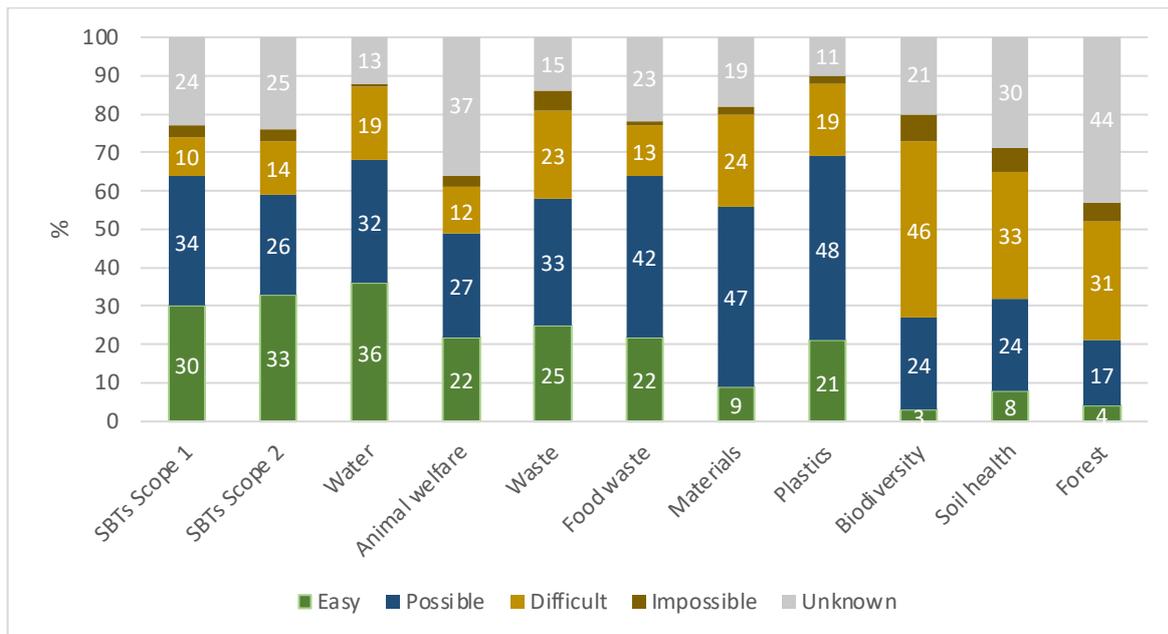
## 5.5 Environmental metrics should be chosen from high to low feasibility of implementation

Food businesses have various levels of readiness to measure and report their environmental performance. Hence, it is important to consider feasibility of implementation in the design of environmental strategies. Doing so will help to ensure that standardised environmental metrics could optimise environmental performance for all food businesses at large scale rather than for only a few leading businesses.

Our survey shows that greenhouse gas (GHG) emissions, water, waste (including food waste) and materials (including plastics) have higher feasibility than the other environmental areas to measure environmental performance. The survey also shows (in Box 4.6) that it is generally difficult for food businesses to report environmental performance according to science-based targets (SBTs) scope 3 (SBTs, 2021), especially for small and medium-sized enterprises (SMEs).

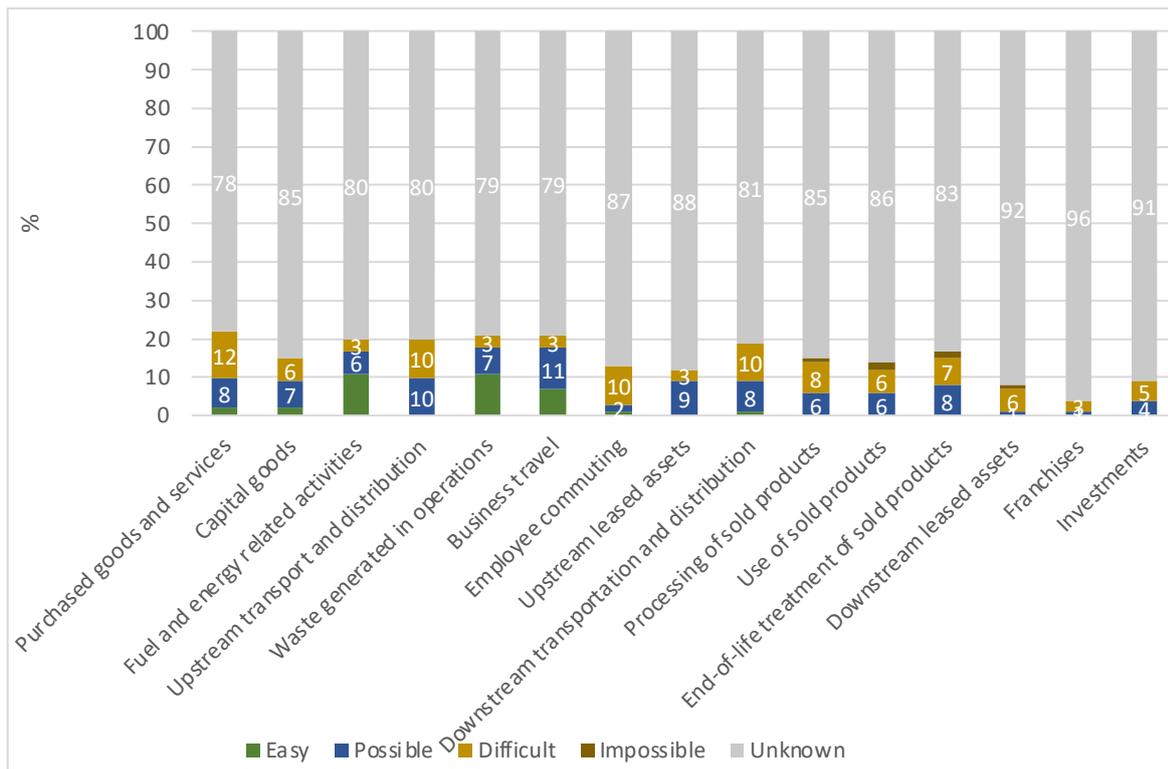
As stated in the Principle 4.2 in [Appendix 1](#), this project aims to provide equal opportunities across different sizes of food businesses. It hence will mainly focus on the following four areas where the majority of food businesses have an opportunity to participate.

According to the SEEBEYOND project survey, more than 50% of food businesses indicated that SBTs scope 1 and 2, water, waste (including food waste) and materials (including plastics) are easy or possible to measure, as shown in figure 6 below.



**Figure 6: Feasibility of measuring environmental performance by environmental goals**

In our survey, only 27 companies reported the adoption of SBTs scope 3. Among them, only two companies are medium-sized enterprises and the remaining 25 companies are large ones. It is reported by food businesses that SBTs scope 3 are generally difficult to measure for all the subcategories, as shown in figure 7 below.



**Figure 7: Feasibility of measuring environmental performance by SBTs scope 3 goals**

Our workshops with food businesses revealed that there were mainly two factors influencing the feasibility of adopting certain environmental metrics: quantification of environmental performance and data availability. For example, it is easier for companies to measure the environmental performance of SBTs scope 1 and 2 GHG emissions than soil health and biodiversity. Food businesses could calculate direct GHG emissions and those from their energy use with their existing knowledge, skills and data. It is, however, more complex to quantify environmental performance in soil health and biodiversity and food businesses generally lack the required knowledge, skills and data.

The calculation of SBTs scope 3 GHG emissions requires detailed data to estimate indirect GHG emissions from various sources, such as purchased goods and services and investments, and majority of food businesses do not have the data. Some large food businesses may have more resource and capacity to collect data, especially from the suppliers, to calculate SBTs scope 3 GHG emissions, while the SMEs generally have less resource to collect environmental data and lack support from their suppliers.

## 5.6 Every business is a learning organisation and can improve its environmental performance iteratively

Nonaka (2000) has pointed out that the knowledge of a business is dynamic: it changes over time. A food business, as a learning organisation, can create and/or

learn new knowledge in the process of improving environmental management. Although food businesses may have varying abilities to create environmental knowledge, we assume that they all can learn progressively and increase their abilities to harness business value from improving their environmental performance.

This project aims to help food companies harness business value from improving environmental performance continuously. This assumption helps to establish a coherent rationale for developing standardised environmental metrics towards this goal.

## **5.7 Knowledge boundary is open to changes**

As knowledge is dynamic rather than static, the information that we don't know changes over time. In computer science, there are two assumptions about the information that we don't know: one is an open-world assumption and the other is a closed-world assumption. According to the open-world assumption, the information that we don't know could be true or false (Russell and Norvig, 2003, p. 355); according to the closed-world assumption, the information that we don't know is false (Russell and Norvig, 2003, p. 354).

This project takes the 'open-world' assumption and acknowledges the existence of unknown information. For example, we chose GHG emissions and air pollutants, water, materials and waste as targeted environmental areas in the development of standardised environmental metrics because in these areas there are more rigorous metrics to measure environmental performance. This does not mean, however, that we ignore the other environmental areas where environmental performance is more difficult to measure, such as soil health and biodiversity. We intend to expand to these areas once the environmental metrics in those areas become more rigorous.

The adoption of the 'open-world' assumption allows us to reduce the burden of data collection at the initial stage, especially for the SMEs that have not adopted any strategies beyond legal compliance. In the development of standardised environmental metrics, we selected the most essential metrics. Under the 'open-world' assumption, more standardised environmental metrics can be added in the future if necessary.

The 'open-world' assumption provides guidance for choosing suitable AI algorithms. This means that only the AI algorithms aligned with the 'open-world' assumption can be used for supporting the future development of standardised environmental metrics.

All the assumptions established on this project could support a shared understanding of the real world in the development of standardised environmental metrics for the food and drink sector. Following the 'open-world' assumption, these assumptions (in

sections 5.1-5.6) are not fixed and can be changed when the necessity is justified in the future.

## 6.0 Framework

The systems learning of harnessing business value from continuously improving environmental performance is an extremely complex process.

To illustrate this complex process more clearly, we have developed a systems learning framework to map out the route for food companies to harness business value from improving environmental performance continuously. This is presented in figure 8. Rooted in the integrated human-machine learning framework proposed by Jia and Evans (2021), it considered value exchanges among different stakeholders (Bocken et al., 2013) and the key processes of environmental management in formal and informal standards.

The framework is comprised of multiple stakeholders: the food company and its key stakeholders for improving environmental performance including an environment agency (which could be the EA, SEPA, NRW or NIEA depending on the location of the food company), its products and services supplier(s), consulting companies, universities, research institutes, other certification bodies (such as BSI, CDP and TCFD) and other stakeholders (such as other government organisations, trade associations, customers, investors and the public).

The systems learning in figure 8 considers two boundaries for the food company and external environment. The external environment includes the regulatory, political, technological, environmental, social and economic contexts where the food company and the other stakeholders are sharing. Within the food business boundary, an iteration of improving environmental performance generally follows the key steps below:

- identify its behavioural incentives for improving environmental performance
- set environmental goals beyond legal compliance
- develop environmental strategies
- implement environmental strategies in collaboration with its suppliers
- measure its performance with standardised environmental metrics
- report environmental performance to environment agency and other certification bodies to obtain certificates and receive guidance and advice for further improvements
- collect and store data
- obtain data insights which could come from in-house analysts and/or consulting companies, universities, and research institutes
- communicate and collaborate with both internal and other external stakeholders to generate new knowledge and learning

- the new knowledge and learning can also help the food company improve its environmental goals, strategies, implementation of strategies and measure of environmental performance
- the food company can harness business value through both internal and external channels
- an increase of business value will provide further behavioural incentive for the food company to set higher environmental goals and iterate this process

In this manner, the food company will be able to harness business value from improving environmental performance continuously within the learning systems.

The standardised environmental metrics are designed according to the key steps here, which could help the food business not only measure but also learn how to improve environmental performance. These metrics are outlined in [appendix 2](#). The data collected through the standardised environmental metrics, in turn, can be used to test and support the improvement of the systems learning progressively.

It is acknowledged that every stakeholder has its own framework of systems learning. This project focuses on systems learning only for food businesses and the frameworks for the other stakeholders are left for future research.

## 7.0 Recommendations

Drawing on the project findings and the feedback from the relevant stakeholders, we have formulated six recommendations for the environment agencies, as follows:

- Environmental policies that aim to mitigate climate change and reduce waste should adopt an incentive-based approach to motivate the improvement of environmental performance beyond legal compliance.
- The standardised environmental metrics need to be tested with food businesses at both company and site levels.
- Standardised environmental metrics should be integrated into the digital platforms of the environment agencies in order to reduce the burden of environmental reporting on food businesses.
- Semantic web standards (such as Web Ontology Language (OWL)) should be developed to help food businesses automate the exchange of environmental performance data.
- Data interoperability between food businesses along the global supply chain should be achieved by means of integration of standardised environmental metrics into global standards, such as GS1 EPCIS 2.0.
- Explainable (that is, 'clear-box'), rather than unexplainable ('black-box'), Artificial Intelligence (AI) algorithms should be used to support the use of systems learning of food businesses for harnessing business value from improving environmental performance continuously.

## 8.0 Conclusions

The project seeks to test the feasibility of an incentive-based approach for developing standardised environmental metrics for beyond legal compliance. Using an incentive-based regulatory approach, we have developed assumptions, principles, a systems learning framework and standardised environmental metrics.

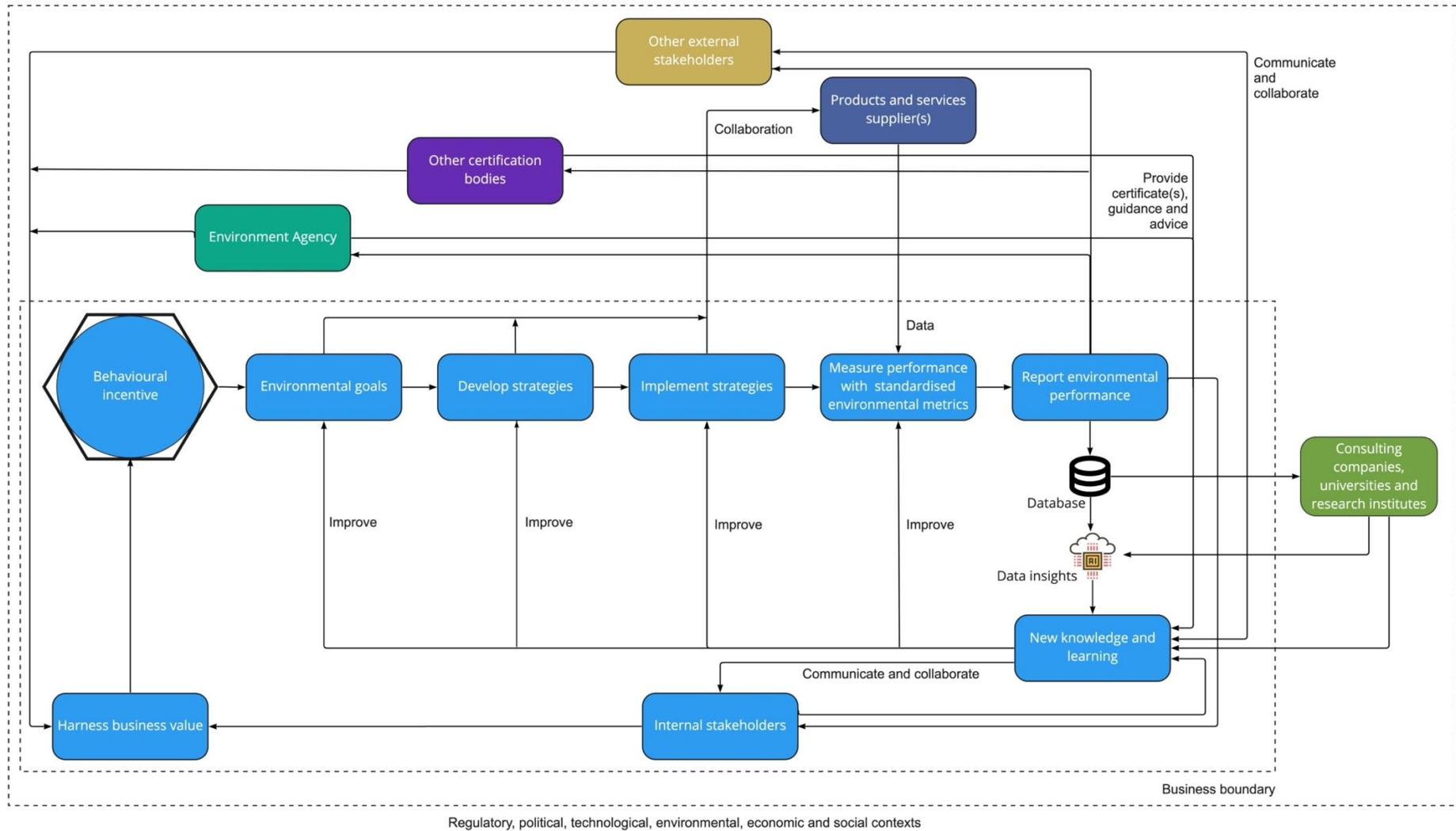
The feedback from all the relevant stakeholders is positive overall. Some food businesses from agricultural production and farming, however, would like to include more environmental areas, such as soil health and biodiversity. Since agricultural production and farming fall outside the scope of the project, we will consider this request when we develop standardised environmental metrics in the future.

The reporting of SBTs scope 3 GHG emissions is encouraged rather than mandatory. Some of the SBTs scope 3 GHG emissions are addressed through improving material efficiency and reducing waste. This is because the project aims to motivate all food businesses across a range of sizes to improve environmental performance rather than solely large businesses. The reporting of materials usage and wastes is more feasible than that of the SBTs scope 3 GHG emissions. Following the Assumption 5.5, we didn't mandate the reporting of SBTs scope 3 GHG emissions.

While current environmental regulations rely heavily on legislation and taxonomy to motivate industrial sustainability, this report proposes a promising complementary approach to environmental regulation. This represents the first attempt to embed behavioural incentives into the design of environmental strategy. Such an incentive-based approach is novel for environmental regulators. This incentive-based approach can be transferred to other sectors, such as the textile sector.

The standardised environmental metrics developed here represent the first step towards the automation of environmental data exchange for the food and drink sector. These metrics provide an essential shared data infrastructure to OWL or XML that can enable data automation and help food businesses reduce the cost and time required for data exchange.

It is acknowledged that AI has a great potential to improve regulation. However, the lack of transparency in AI often becomes a barrier to its application. This project tackled this problem by integrating the learnings of human and artificial agents into a systems learning framework. This enables 'clear-box' AI to support all the relevant stakeholders to make better decisions. It offers a vision for an ethical use of AI in future regulation.



**Figure 8: A systems learning framework for food companies to harness business value from continuous improvement of environmental performance**

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# Appendix 1: Principles

Principles provide a value guidance for developing standardised environmental metrics. Drawing on a semantic analysis of 77 principles from 9 informal standards and 2 policies and 3 additional principles proposed by environmental regulators, we establish 15 principles in 4 clusters. The informal standards include Science Based Targets (SBTs), Global Reporting Initiative (GRI), International Integrated Reporting Council (IIRC), Climate Disclosure Boards (CDSB), Task force on Climate related Financial Disclosures (TCFD), Task force for Nature related Financial Disclosures (TNFD), WRAP Courtauld, United Nations World Conservation Monitoring Centre (UNWCWC) and Forest Stewardship Council (FSC). The policies include European Union Emission Trading Scheme (EU ETS) and Streamlined Energy and Carbon Reporting (SECR).

## 1.0 Principles for measuring environmental performance

### 1.1 Clarity

A food business should report environmental performance in a way that is clear and understandable to all the information users. Environmental performance should be reported in a concise and aggregated way without omitting necessary details. Plain language should be used wherever possible. The information should be understood by users who have reasonable knowledge of the organisation and its activities. The report of environmental performance needs to avoid abbreviations, technical terms and jargons that are likely to be unfamiliar to users. Appropriate explanation should be provided for technical terms to ensure that users can understand the information without additional assistance.

### 1.2 Accuracy

A food business should report correct and valid information of its environmental impacts. Both qualitative and quantitative information about its environmental performance should be reported to users. The information should be neutral and free from biases and errors so that it can truly reflect the level of environmental performance.

### 1.3 Robustness

Methods should be robust. By this, we mean that data and information can be verified with evidence. Both quantitative and qualitative information should be used to provide consistent reporting of environmental performance. Information and data

are developed using reproducible methods and indicators. If assumptions have to be used, they should be developed with credible evidence.

## **1.4 Completeness**

All sources of environmental impacts within the reporting boundary should be disclosed and justification should be provided if there are any specific exclusions. The reported information should ensure that it does not overemphasise positive environmental impacts while omitting negative environmental impacts.

## **1.5 Comparability**

The environmental performance of a company should be comparable over time to reflect the trend of changes. Companies should be able to benchmark performance against peers within food and drink sector.

## **1.5 Transparency**

A record of all the assumptions, calculations, methodologies and data should be kept and made available to information users.

# **2.0 Principles for behavioural incentive**

## **2.1 Beyond legal compliance**

'Beyond legal compliance' refers to the situation in which organisations who are going beyond legal environmental standards, reducing negative social, environmental and economic impacts, seeking opportunities to optimise positive impacts by embracing sustainability in their own value chain, and collaborating with others and advocating public policy/sector guidance changes to create sustainable development.

It should ensure that the data collected and reported appropriately reflects the corresponding business' environmental impacts; and serves the decision-making needs of both internal and external information users.

## **2.2 Capture of business value**

The improvement of environmental performance should bring business value for companies. Business value includes environmental, social and economic benefits in short, medium and long terms.

## **2.3 Optimisation of behavioural incentives**

Behavioural incentives of all the stakeholders (such as employees, managers, directors, investors and consumers) involved in improving environmental performance are not static and can be optimised progressively. The optimisation of behavioural incentive should be addressed in the design of environmental regulation.

## **3.0 Principles for environmental traceability**

### **3.1 Interoperability**

The collection of data should enhance the ability of information users to exchange and make use of information across different computer systems. It should optimise the value of data and avoid duplication of effort for all relevant stakeholders through automating data exchange. Data security should be ensured to the owning organisation by providing necessary options to manage and control data distribution.

### **3.2 Timeliness**

The food business should report information on a regular schedule to support the decision making of information users.

## **4.0 Principles for environmental management**

### **4.1 Good practices**

The environmental regulation should guide food businesses to adopt good practices including technological, managerial, and operational aspects. It should acknowledge that using advanced technologies may not guarantee an improvement of environmental performance. A coherent integration of suitable technologies, management and operations is required to achieve higher environmental performance

### **4.2 Equal opportunities**

Food businesses of different sizes located should all have equivalent opportunities to benefit from improving environmental performance. It should consider the accessibility and affordability in developing, emerging and developed countries.

### **4.3 Collaboration**

Collaboration should involve all the relevant stakeholders and facilitate progressive collaboration through better communication and coordination. This means that we should take a systems approach to designing standardised environmental metrics. It will ensure that both internal and external collaborations for food businesses are considered.

### **4.4 Continuous improvement**

The improvement of environmental performance should be continuous over time. It should encourage food businesses to take actions of improving environmental management progressively.

# Appendix 2: Standardised environmental metrics

The standardised environmental metrics are drawn on the systems learning framework in figure 8 to ensure that the evaluation of environmental performance can contribute to systems learning of food businesses.

The metrics can be categorised two levels including company and site levels. Section 1-2 pertain to company level and Section 3-7 pertain to site level. During the project, we have learned that it is hard or impossible for many food businesses to report environmental performance at product level. Hence, standardising environmental metrics at the product level will be left for future research.

It is also possible to develop assessment criteria for the standardised environmental metrics. The development of these metrics, however, is outside the project scope and will be discussed in the future.

## 1.0 General information

### 1.1 Company information

Company information contains company name, company registration number (Companies House), logo, company size (by number of employees) and head office address.

Your company reports on all sources of environmental impact over which it has financial control.

### 1.2 Site information

Site information contains company name, site address, site postcode, contact person, email, and telephone number. If a company has multiple sites, the sections below should be reported separately for each site.

### 1.3 Reporting period

The reporting period is for 12 months corresponding with your financial year. Following the comparability principle (0 Comparability), the adoption of financial year allows to compare a company's environmental performance against financial performance.

## 1.4 Subsector

The subsector is classified as animal feed, brewing, dairy, grain milling, red meat abattoir, poultry processing, soft drinks, vegetable processing, meat processing, ready meals, pet food, vegetable oils, sugar, malt m/f, other alcoholic drink, rendering, finfish, and shellfish. This is based on the EA's and SEPA's existing subsector categories.

## 1.5 Commodities

The category of commodities is based on Global Product Classification. This allows an easier integration of the standardised environmental metrics into GS1 standards.

## 2.0 Environmental sustainability culture

This section (2.1-2.3) is to be completed by your company's Headquarter.

### 2.1 Environmental sustainability leadership

Please indicate the leadership position(s) (NOT names of individuals) of your company involved in improving environmental performance (such as Director of Board, Chief Executive Officer (CEO), Chief Financial Officer (CFO) and Chief Sustainability Officer (CSO)).

If you are involved in improving environmental performance at leadership position, please answer the questions in 2.1.1-2.1.7 below:

#### 2.1.1 Business benefits

In your opinion, what benefits that your company could obtain from improving environmental performance? Business benefits may include but be not limited to attracting new customers, increasing brand value and meeting the expectation of investors etc.

#### 2.1.2 Business risks

Is there any business risk if your company does not improve environmental performance? If yes, please specify.

#### 2.1.3 Business opportunities

What opportunities does your company have in improving environmental performance?

## **2.1.4 Overarching environmental goals**

Please indicate your company's environmental goals (multiple choices): Greenhouse gas (GHG) emissions reduction, water conservation, material efficiency, waste reduction, biodiversity, soil health, animal welfare, forestation and others.

## **2.1.5 Business challenges**

What challenges does your company have to improve environmental performance?

## **2.1.6 Business strategies**

What strategies does your company have to address the challenges and capture business opportunities in improving environmental performance?

## **2.1.7 Resources**

How can your company ensure the resources (such as budget, materials, staff, knowledge and skills etc.) needed for improving environmental performance?

## **2.2 Employee engagement**

Please indicate the non-leadership position(s) (NOT names of individuals) of your company involved in improving environmental performance.

### **2.2.1 Communication**

Please indicate how your company communicates strategies for improving environmental performance internally, especially communications between different departments and between managers and team members.

### **2.2.2 Collaboration**

Please demonstrate how your company facilitates collaboration internally for capturing opportunities in environmental sustainability, especially collaborations between different departments and between managers and team members.

## **2.3 Key stakeholders**

### **2.3.1 Investors**

Please demonstrate how your company communicates and engages with investors to capture opportunities in environmental sustainability.

## 2.3.2 Suppliers

Please demonstrate how your company communicates and collaborates with suppliers to improve environmental performance.

Please list environmental performance of your suppliers in the UK:

Suppliers	Location	Environmental impacts <sup>a</sup>	Beyond environmental compliance <sup>b</sup>	Justification of environmental performance <sup>c</sup>	Percentage of purchase value <sup>d</sup>

Note: <sup>a</sup> Environmental impacts include GHG emissions and air pollutants, water, wastes, plastics, biodiversity, forestation, soil health, animal welfare, and other impacts (such as social responsibility).

<sup>b</sup> Beyond environmental compliance refers to the situation in which organisations who are going beyond legal environmental standards, reducing negative social, environmental and economic impacts, seeking opportunities to optimise positive impacts by embracing sustainability in their own value-chain; and collaborating with others and advocating public policy/sector guidance changes to create sustainable development.

<sup>c</sup> Justification of environmental performance includes but is not limited to relevant standards and certificates issued by authorised bodies.

<sup>d</sup> *Percentage of purchase value* =  $\frac{\text{Total purchase value from the beyond environmental compliance supplier}}{\text{Total purchase value}} \times 100$ .

## 2.3.3 Customers/Consumers

Please demonstrate how your company communicates and collaborates with customers/consumers to improve environmental performance.

## 2.3.4 Environmental regulators

Please demonstrate how your company communicates and collaborates with regulators to improve environmental performance.

## 2.3.5 Other stakeholders

Please indicate other stakeholders that your company collaborates with to improve environmental performance, such as green initiatives and local communities.

## 3.0 Certificates

What certificates (such as Environmental permit, ISO 14001 and ISO 14064) do you have from approved assessors to demonstrate the environmental performance of your site?

## 4.0 GHG emissions and air pollutants

Emissions to air include Carbon Dioxide (CO<sub>2</sub>), Nitrous Oxide (N<sub>2</sub>O), NO<sub>x</sub>, HFCs, Methane, PM<sub>10</sub>, PM<sub>2.5</sub>, total particulates, Sulphur Dioxide, Carbon Monoxide, Non-methane volatile organic compounds (NMVOCs), hexane and Ammonia. This section (4.1-4.7) is to be completed by environmental managers and/or operators at site. This section links to United Nations Sustainable Development Goals (UN SDGs) Target 13.

### 4.1 Compliance

In this financial year, has your company received any fines, enforcement orders, suspensions, and/or other penalties for breaching GHG or air emission regulations?

### 4.2 Targets

Please indicate your targets of reducing GHG emissions and air pollutants (excluding GHG emission removal) in this financial year by activities:

Activities	GHGs/Air pollutants	Emission amount (tonnes/year)	Intensity (per metric ton of product)

Note: Activities refer to different stages of production and production of different products. Both Science-based Targets (SBTs) scope 1 and scope 2 should be fully reported (SBTs, 2021; GHG Protocol, 2022; ISO 14064). The reporting GHG emissions and air pollutants associated with your activities, such as investment and purchased goods and services, is encouraged.

Please indicate GHG emission removal in this financial year by activities:

Activities	GHGs/Air pollutants	Country/Region	Emission removal amount (tonnes)

### 4.3 Strategies

Please indicate your strategies to achieve the targets identified in section 4.2 by activities.

Activities	Strategies

Note: Please report all the relevant strategies in improving environmental performance. Obtaining certificates on environmental performance, such as ISO 14064, from approved assessors is considered as one of strategies.

### 4.4 Implementation

To your best knowledge, please indicate to which degree that the strategies have been implemented in this financial year.

Activities	Implementation score (0-10, 0 means no implementation and 10 means full implementation and beyond)

### 4.5 Performance

Please indicate your GHG emissions reduction (excluding GHG emission removal) and air pollutants by activities:

Activities	Year	GHGs/Air pollutants	Emission amount (tonnes/year)	Equivalent CO <sub>2</sub> emissions (tonnes/year)	Intensity (tonnes CO <sub>2</sub> emissions per tonne of product)

Note: More than one year should be reported to demonstrate a continuous improvement.

Please indicate your removal of GHG emissions and air pollutants by activities:

Activities	Year	GHGs/Air pollutants	Country/Region	Emission removal amount (tonnes/year)	Calculation method or certificate

Note: More than one year should be reported to demonstrate a continuous improvement.

## 4.6 Lessons learned

What business benefits has your company obtained from reducing GHG emissions in this financial year?

What business risks has your company mitigated through reducing GHG emissions in this financial year?

What new business opportunities does your company have in reducing GHG emissions?

What new challenges does your company have in reducing GHG emissions?

How did you communicate lessons learned from reducing GHG emissions in this financial year? Please specify all the stakeholders involved in communicating lessons learned, such as senior leaders of your company.

## 4.6 Continuous improvement

Drawing on the lessons learned in this financial year, please indicate the strategies to tackle these challenges and improve your performance of GHG emissions reduction continuously:

Activities	Strategies for continuous improvement

Note: Please indicate all the possible strategies, for example some strategies may require better communication and collaboration across teams, departments and companies.

## 5.0 Water

This section (5.1-5.7) is to be completed by environmental managers and/or operators at site. This section links to UN SDGs Target 6.

### 5.1 Compliance

In this financial year, has your company received any fines, enforcement orders, and/or other penalties for breaching regulations in water resource protection?

### 5.2 Targets

Please indicate your targets of water usage in this financial year by activities:

Activities	Total water use (m <sup>3</sup> /year)	Water use per day (m <sup>3</sup> /year)	Intensity (m <sup>3</sup> per metric ton of product)	Percentage of wastewater reuse <sup>a</sup>

Note: Please include all the activities relating to water usage.

$$^a \text{Percentage of waste water reuse} = \frac{\text{Total amount of reused waste water}}{\text{Total amount of water usage}} \times 100.$$

Please indicate your targets of wastewater reduction in this financial year by activities:

Activities	Pollutants	Total wastewater (m <sup>3</sup> /year)	Concentration limits			
			95% percentile	Mean	Maximum	Differential

Note: Please include all the activities relating to water discharge. The pollutants must include but are not limited to chemical oxygen demand, total suspended solids, total Phosphorus and chlorides (where applicable). The reporting of the other pollutants is highly encouraged.

### 5.3 Strategies

Please indicate your strategies to achieve the targets identified in section 5.2 by activities.

Activities	Strategies

### 5.4 Implementation

To your best knowledge, please indicate to which degree that the strategies have been implemented in this financial year.

Activities	Implementation score (0-10, 0 means no implementation and 10 means full implementation and beyond)

### 5.5 Performance

Please indicate your performance of water usage in this financial year by activities:

Activities	Year	Total water use (m <sup>3</sup> /year)	Water use per day (m <sup>3</sup> )	Intensity (m <sup>3</sup> per metric ton of product)

Note: More than one year should be reported to demonstrate the improvement of water usage reduction. The reporting of water protection impact on external stakeholders is encouraged, for example through investment and purchasing goods and services.

Please indicate your targets of wastewater reduction in this financial year by activities:

Activities	Year	Pollutants	Total wastewater (m <sup>3</sup> /year)	Concentration limits			
				95% percentile	Mean	Maximum	Differential

Note: More than one year should be reported to demonstrate the improvement of wastewater reduction. Please include all the activities relating to water discharge. The pollutants must include but are not limited to chemical oxygen demand, total suspended solids, total Phosphorus and chlorides (where applicable). The reporting of the other pollutants is highly encouraged.

### 5.6 Lessons learned

What business benefits has your company obtained from protecting water resource in this financial year?

What business risks has your company mitigated through protecting water resource in this financial year?

What new business opportunities does your company have in protecting water resource?

What new challenges does your company have in protecting water resource?

How did you communicate lessons learned from protecting water resource in this financial year? Please specify all the stakeholders involved in communicating lessons learned, such as Directors of your company.

### 5.7 Continuous improvement

Drawing on the lessons learned in this financial year, please indicate the strategies to tackle these challenges and improve your performance of protecting water resource continuously:

Activities	Strategies for continuous improvement

Note: Please indicate all the possible strategies, for example some strategies may require better communication and collaboration across teams, departments and companies.

## 6.0 Materials

This section (6.1-6.7) is to be completed by environmental managers and/or operators at site. This section links to UN SDGs Target 12.2, 12.6, 12.7 and 12.a.

### 6.1 Compliance

In this financial year, has your company received any fines, enforcement orders, and/or other penalties for breaching regulations relevant to materials use?

### 6.2 Targets

Please indicate your targets of materials use reduction (excluding packaging materials) in this financial year by activities:

Activities	Material type	Renewable or non-renewable	Amount (tonnes/year)	Intensity (tonnes per tonnes of product)	Percentage of material reuse <sup>a</sup>	Data source <sup>b</sup>

Note: Please include all the activities relating to materials use except for packaging materials.

$$^a \text{Percentage of materials reuse} = \frac{\text{Total amount of reused materials}}{\text{Total amount of materials input}} \times 100.$$

<sup>b</sup> Please report the method(s) used if it is an estimation.

Please indicate your targets of packaging materials use reduction in this financial year by activities:

Packaging purpose	Material type	Amount (tonnes/year)	Intensity (tonnes per tonnes of product)	Percentage of reclaimed packaging materials <sup>a</sup>	Data source <sup>b</sup>

Note: Please include all the activities relating to packaging materials use.

$$^a \text{Percentage of reclaimed packaging materials reuse} = \frac{\text{Total amount of reclaimed packaging materials}}{\text{Total amount of packaging materials input}} \times 100.$$

<sup>b</sup> Please report the method(s) used if it is an estimation.

### 6.3 Strategies

Please indicate your strategies to achieve the targets identified in section 6.2 by activities.

Activities	Strategies

### 6.4 Implementation

To your best knowledge, please indicate to which degree that the strategies have been implemented in this financial year.

Activities	Implementation score (0-10, 0 means no implementation and 10 means full implementation and beyond)

### 6.5 Performance

Please indicate your performance of materials use reduction (excluding packaging materials) by activities:

Activities	Year	Material type	Renewable or non-renewable	Amount (tonnes/year)	Intensity (tonnes per tonnes of product)	Percentage of material reuse <sup>a</sup>	Data source <sup>b</sup>

Note: Please include all the activities relating to materials use except for packaging materials. More than one year should be reported to demonstrate the improvement of material efficiency. The reporting of material efficiency on external stakeholders is encouraged, for example through investment and purchasing goods and services.

<sup>a</sup> Percentage of materials reuse =  $\frac{\text{Total amount of reused materials}}{\text{Total amount of materials input}} \times 100$ .

<sup>b</sup> Please report the method(s) used if it is an estimation.

Please indicate your performance of packaging materials use reduction by activities:

Packaging purpose	Year	Material type	Amount (tonnes/year)	Intensity (tonnes per tonnes of product)	Percentage of reclaimed packaging materials <sup>a</sup>	Data source <sup>b</sup>

Note: Please include all the activities relating to packaging materials use. More than one year should be reported to demonstrate the improvement of packaging material efficiency. The reporting of packaging material efficiency on external stakeholders is encouraged, for example through investment and purchasing goods and services.

<sup>a</sup> Percentage of reclaimed packaging materials reuse =  $\frac{\text{Total amount of reclaimed packaging materials}}{\text{Total amount of packaging materials input}} \times 100$ .

<sup>b</sup> Please report the method(s) used if it is an estimation.

## 6.6 Lessons learned

What business benefits has your company obtained from improving material efficiency in this financial year?

What business risks has your company mitigated through improving material (including plastics) efficiency in this financial year?

What new business opportunities does your company have in improving material (including plastics) efficiency?

What new challenges does your company have in improving material (including plastics) efficiency?

How did you communicate lessons learned from improving material (including plastics) efficiency in this financial year? Please specify all the stakeholders involved in communicating lessons learned, such as Directors of your company.

## 6.7 Continuous improvement

Drawing on the lessons learned in this financial year, please indicate the strategies to tackle these challenges and improve your performance of improving material (including plastics) efficiency continuously:

Activities	Strategies for continuous improvement

Note: Please indicate all the possible strategies, for example some strategies may require better communication and collaboration across teams, departments and companies.

## 7.0 Waste

This section (7.1-7.7) is to be completed by environmental managers and/or operators at site. This section links to UN SDGs Target 12.3, 12.4, 12.5, 12.8 and 12.b.

### 7.1 Compliance

In this financial year, has your company received any fines, enforcement orders, and/or other penalties for breaching regulations relevant to waste disposal?

### 7.2 Targets

Please indicate your targets of waste reduction (excluding food waste) in this financial year by activities:

Activities	Material type	Amount (tonnes/year)	Reduction method <sup>a</sup>	Waste intensity (tonnes per tonnes of product)	Percentage of waste recycled <sup>b</sup>	Data source <sup>c</sup>

Note: Please include all the activities relating to materials use except for food.

<sup>a</sup> Reduction method includes but is not limited to remanufacturing, diverting to other purposes, helping suppliers reduce waste, educating consumers and industrial symbiosis (an organisation's waste or by-products becomes inputs for another organisation) etc.

<sup>b</sup>  $Percentage\ of\ waste\ recycled = \frac{Total\ amount\ of\ waste\ diverted\ from\ landfill}{Total\ amount\ of\ waste} \times 100.$

<sup>c</sup> Please report the method(s) used if it is an estimation.

Please indicate your targets of food waste reduction in this financial year by activities:

Food waste type	Solid or liquid	With package or not	Edible or not <sup>a</sup>	Amount (tonnes/year)	Destination <sup>b</sup>	% of food waste reduction <sup>c</sup>	Data source <sup>d</sup>

Note: Please include all the food waste. The scope of food waste reduction includes not only own production but also help suppliers and consumers reduce food waste.

<sup>a</sup> Inedible parts refer to components associated with a food that would never have been intended to be consumed by humans – such as shells, bones, pits/stones. ‘Inedible parts’ do not include packaging, or food that could once have been eaten but has been spoiled or passed its ‘use by’ date (WRAP, 2021).

<sup>b</sup> Destination includes but is not limited to redistribution to human consumption, sent for animal feed, bio-based materials/biochemical processing (including cat. 3 rendering for meat sector), anaerobic digestion/codigestion, composting/aerobic processes, incineration/controlled combustion (including cat. 1 rendering for meat sector), land application, landfill, sewer/wastewater treatment, not harvested/ploughed in, discard/litter (including dumping or unmanaged disposal) and unknown (WRAP, 2021). Please find their definitions in WRAP’s ‘data capture sheet’ in the Supporting Guidance (2021). If one type of food waste has multiple destinations, please indicate separate targets by destinations.

$$^c \text{Percentage of food waste reduction} = \frac{\text{Amount of food waste reduced}}{\text{Total amount of food waste}} \times 100.$$

<sup>d</sup> Please report the method(s) used if it is an estimation. The estimation method may include using mass balance calculation, proxy estimation with inventory data, assessing volume and modelling.

### 7.3 Strategies

Please indicate your strategies to achieve the targets identified in section 7.2 by activities.

Activities	Strategies

Note: Strategies may include but be not limited to remanufacturing, diverting to other purposes, educating consumers and industrial symbiosis (an organisation’s waste or by-products becomes inputs for another organisation).

## 7.4 Implementation

To your best knowledge, please indicate to which degree that the strategies have been implemented in this financial year.

Activities	Implementation score (0-10, 0 means no implementation and 10 means full implementation and beyond)

## 7.5 Performance

Please indicate your performance of waste reduction (excluding food waste) by activities:

Activities	Year	Material type	Amount (tonnes/year)	Reduction method <sup>a</sup>	Waste intensity (tonnes per tonnes of product)	Percentage of waste recycled <sup>b</sup>	Data source <sup>c</sup>

Note: Please include all the activities relating to materials use except for food. More than one year should be reported to demonstrate the improvement of waste reduction (excluding food waste). The reporting of waste reduction impact on external stakeholders is encouraged, for example through investment and purchasing goods and services.

<sup>a</sup> Reduction method includes but is not limited to remanufacturing, diverting to other purposes, educating consumers and industrial symbiosis (an organisation's waste or by-products becomes inputs for another organisation) etc.

<sup>b</sup>  $Percentage\ of\ waste\ recycled = \frac{Total\ amount\ of\ waste\ diverted\ from\ landfill}{Total\ amount\ of\ waste} \times 100.$

<sup>c</sup> Please report the method(s) used if it is an estimation.

Please indicate your targets of food waste reduction by activities:

Food waste type	Year	Solid or liquid	With package or not	Edible or not <sup>a</sup>	Amount (tonnes/year)	Destination <sup>b</sup>	Percentage of food waste reduction <sup>c</sup>	Data source <sup>d</sup>

Note: Please include all the food waste. More than one year should be reported to demonstrate the improvement of food waste reduction. The reporting of food waste reduction impact on external stakeholders is encouraged.

<sup>a</sup> Inedible parts refer to components associated with a food that would never have been intended to be consumed by humans – such as shells, bones, pits/stones. ‘Inedible parts’ do not include packaging, or food that could once have been eaten but has been spoiled or passed its ‘use by’ date (WRAP, 2021).

<sup>b</sup> Destination includes but is not limited to redistribution to human consumption, sent for animal feed, bio-based materials/biochemical processing (including cat. 3 rendering for meat sector), anaerobic digestion/codigestion, composting/aerobic processes, incineration/controlled combustion (including cat. 1 rendering for meat sector), land application, landfill, sewer/wastewater treatment, not harvested/ploughed in, discard/litter (including dumping or unmanaged disposal) and unknown (WRAP, 2021). Please find their definitions in WRAP’s ‘supporting guidance for data capture sheet’. If one type of food waste has multiple destinations, please report separately by destinations.

<sup>c</sup>  $Percentage\ of\ food\ waste\ reduction = \frac{Amount\ of\ food\ waste\ reduced}{Total\ amount\ of\ food\ waste} \times 100.$

<sup>d</sup> Please report the method(s) used if it is an estimation. The estimation method may include using mass balance calculation, proxy estimation with inventory data, assessing volume and modelling.

## 7.6 Lessons learned

What business benefits has your company obtained from reducing waste (including food waste) in this financial year?

What business risks has your company mitigated through reducing waste (including food waste) in this financial year?

What new business opportunities does your company have in reducing waste (including food waste)?

What new challenges does your company have in reducing waste (including food waste)?

How did you communicate lessons learned from reducing waste (including food waste) in this financial year? Please specify all the stakeholders involved in communicating lessons learned, such as Directors of your company.

## 7.7 Continuous improvement

Drawing on the lessons learned in this financial year, please indicate the strategies to tackle these challenges and improve your performance of reducing waste (including food waste) continuously:

Activities	Strategies for continuous improvement

Note: Please indicate all the possible strategies, for example some strategies may require better communication and collaboration across teams, departments and companies.

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