# Data exchange of GHG Logistics Emissions

Guidance

January 2023

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This report was written by Violetta Matzoros and Gabriela Rubio Domingo of Smart Freight Centre.

### About Smart Freight Centre

Smart Freight Centre (SFC) is a global non-profit organization dedicated to an efficient and zero emission freight sector. We cover all freight and only freight. SFC works with the Global Logistics Emissions Council (GLEC) and other stakeholders to drive transparency and industry action – contributing to Paris Climate Agreement targets and Sustainable Development Goals.
Our role is to guide companies on their journey to zero emission logistics, advocate for supportive policy and programs, and raise awareness. Our goal is that 100+ multinationals reduce at least 30% of their logistics emissions by 2030 compared to 2015 and reach net-zero emissions by 2050.

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# Executive Summary

Over 150 multinationals are now using the Global Logistics Emissions Council (GLEC) Framework (Smart Freight Centre, 2022) to calculate and report logistics emissions across the multi-modal supply chain. However, only 23% of these companies were reporting their logistics emissions publicly in 2021. A key reason is that many shippers and LSPs have difficulties getting access to reliable data from their suppliers (carriers). Whilst at the same time, securing access to reliable data that is directly associated with a specific transport operation is increasingly becoming more important to enable more granular reporting of GHG emissions and implementing GHG emission reduction strategies.

These guidelines provide an introduction on how to overcome the barriers to exchanging GHG related information across a supply chain and describe a parameter overview and associated data model for the automated exchange of GHG emissions for a Transport Chain Element.

They have been developed in collaboration with GLEC partners and other selected partners and build upon the results of the first phase, which identified the main barriers to exchange of GHG information across a supply chain (Smart Freight Centre, 2019), and the second phase, which provided a first version of the data model and guidelines. The third phase of this project consisted in the implementation of these guidelines in practice and improvement of the proposed data model.

The Data Access for Logistics Emissions Accounting and Reporting ("Data Access") project aims to support shippers, LSPs, and carriers by improving data access, exchange, and IT integration. By harmonizing the IT semantics and providing suggestions on how to overcome the barriers, we seek to increase joint action and momentum across the industry to improve the ability to take decisions to reduce logistics emissions. The project started in January 2021 and ran until December 2022 and is carried out as a project under the Global Logistics Emissions Council (GLEC) that is managed by Smart Freight Centre.

## Understanding how to exchange GHG emission data within a supply chain

Having observed the different purposes GHG emission data are used for, there are 3 recognized use cases identified:

- **Reporting of logistics GHG emissions,** this is currently the most common use case, in which an organization is reporting its total emissions for a selected period, over the whole organization or for parts of the supply chain. Aggregated input data and emission factors can suffice, although more granular data will increase the level of detail and precision.
- **Decision making,** backward looking to track performance of the supply chain or a supplier, identify outliers or see progression in carbon reduction strategies. This requires granular input data and the use of disaggregated emission intensity data.
- **Granular optimization**, forward looking at projected GHG emissions based on historical data. Requires a form of algorithmic analysis and requires more granular input data to ensure correct decisions are made based on the desired optimal state of the supply chain.

Considering the above-mentioned use cases, there are three main types of exchange: (i) exchange of GHG emissions, i.e. after the GHG calculation is made, (ii) exchange of energy consumed, i.e. supplier provides the amount and type of energy consumed for the shipment or (part of the) supply chain considered, alongside transport activity data and the calculation is made thereafter, (iii) the pure exchange of transport activity data, i.e. the supplier provides transport activity related information concerning the shipment or part of the supply chain to facilitate the calculation, without GHG emission or energy consumption data.

In each of these types of exchange the calculation can be outsourced to a third party. The input data used for the GHG emission calculation can be derived from different sources and can have varying accuracy levels. Understanding what input data type is used and how the emission intensity value is derived determines the relative level of accuracy. A further understanding of the quality of the data is important for all stakeholders to be able to judge the context of the final amount of GHG emissions reported. Therefore, a practical approach is proposed by:

1. Collect, at least, the mandatory variables as proposed in the data model. The exchange of the optional variables is highly recommended. In case of outsourcing the emissions calculation to a tool provider, ensure the output collection's conformity with advised units.
2. Classify these by transport operation category (specific round trip, vehicle class, or schedule average) and data type (primary, modelled and default), and
3. Exchange the selected variables with the interested stakeholders.

The responsibility for gathering and reporting the data is distributed across the shipper/freight buyers and the carrier/service provider. A general principle is that the consignment/shipment information is the responsibility of the freight buyer, whilst routing, transport asset information and energy consumed are the responsibility of the service provider. Although in practice, in many complex supply chains, these responsibilities are transferred or even shared.

In these guidelines, suggestions are made to overcome trust and assurance issues at each of the stages of exchange. This can be achieved by considering the use of an independent third party or through exchange of high aggregation, anonymized emission data. Lastly, audited data and the use of accredited tool providers can help increase trust and confidence in this process.

To increase awareness and action in supply chains, freight buyers will need to support their service providers in calculating and exchanging GHG emissions. This can be done by covering the cost for calculation, offering educational and technical support, sharing insights gained from the data retrieved and finally incentivizing suppliers through contractual agreements and procurement. In the long term, it is anticipated that regulations will require each organization to report their GHG emissions.

## Data model

For the exchange of data across a logistics supply chain, a set of parameters, considering the previously mentioned types of exchange (exchange of GHG emissions, energy consumption or transport activity based) is needed. To fulfil this need, a data model is created and proposed for exchange at the Transport Chain Element level. It aligns with the GLEC Framework Declaration and covers the relevant parameters including the related freight information, energy consumption, transport chain element routing and vehicle information. It provides definitions for the parameters, advised units and other value constraints and it designates which fields are considered mandatory or optional – supporting companies in selecting the suitable parameters for their analyses.

## Next steps

We envision that the proposed guidance and data model are adopted by more companies, shippers, LSPs, carrier or tool providers. Using the same semantics can facilitate the tasks around manipulation and exchange of data, internally or between parties by reducing the time of manual adjustments prior to analysis. Reducing the siloed approaches to data by standardizing the models used, will accelerate the data-driven decision-making efforts of companies. In that regard, Smart Freight Centre is working towards implementing a corresponding technical specification of the Guidance to enable interoperable data exchange between all relevant stakeholders with WBCSD PACT Initiative and its Pathfinder Network (WBCSD, 2021). The goal of this future work stream is to work towards one global network of emission data exchange based on interoperability through open standards.

# 1 Useful terminology

GHG emission accounting and reporting between a transport service operator (carrier) and the transport service organizer or user (shipper or LSP), are described in the GLEC Framework. They are focused on an aggregated perspective and two reporting levels: the company level and the transport operation category level. However, in practice, the calculation and exchange of GHG emission data or exchange of transport activity data is often performed on a shipment or consignment level, despite being possibly derived from transport operation category or company level inputs.

**Definition and understanding of a shipment, consignment & transport chain element [ISO 14083 – in final draft at time of finalizing this report]**

| | |
|---|---|
| A **shipment** is an identifiable collection of one or more freight items (available to be) transported together from the original shipper to the ultimate consignee<br>• A shipment may be transported in one or a multiple number of consignments.<br>• A shipment can be aggregated or disaggregated to different consignments according to the requirements of the means of transportation on any one element of the transport chain, e.g., single bulk units and packages can be aggregated on a pallet and such pallet can be handed over as a unit for aggregation in a container, which in turn is treated as a consignment in a vehicle. | A **consignment** separately identifiable amount of freight transported from one consignor to one consignee via one or more modes of transport.<br><br>A **transport chain element (TCE)** is a section of a transport chain within which the freight is carried by a single vehicle or transits through a single hub.<br><br>A **transport operation category (TOC)** is a group of transport operations that share similar characteristics<br><br>A **hub operation category (HOC)** is a group of hub operations that share similar characteristics |

Note: Although **consignment** and **shipment** are common terms often considered as synonyms, in this document and other technical publications, a consignment is differentiated to a shipment. A shipment refers to a grouping of freight corresponding to the shipper needs, whereas a consignment refers a grouping of freight according to a carrier or freight forwarder's transport solutions.

Typically, it is expected that the data transfer happens on a consignment level for a transport chain element, and on a shipment level for a transport chain. Therefore, the shipment level will contain aggregated information from the possible multiple consignments and individual transport chain elements. In practice, it will depend on how the information is formatted and stored in the respective systems, the transport operation category and mode, and the role of the reporting company.

For example, an LSP might report the emissions of a specific, multimodal shipment to the customer, at the shipment level, but will receive the information from different carriers individually, on consignment level. Figure 1 shows for different examples how a shipment is aggregated or disaggregated, and it also gives an indication of the aggregation levels of the related data.

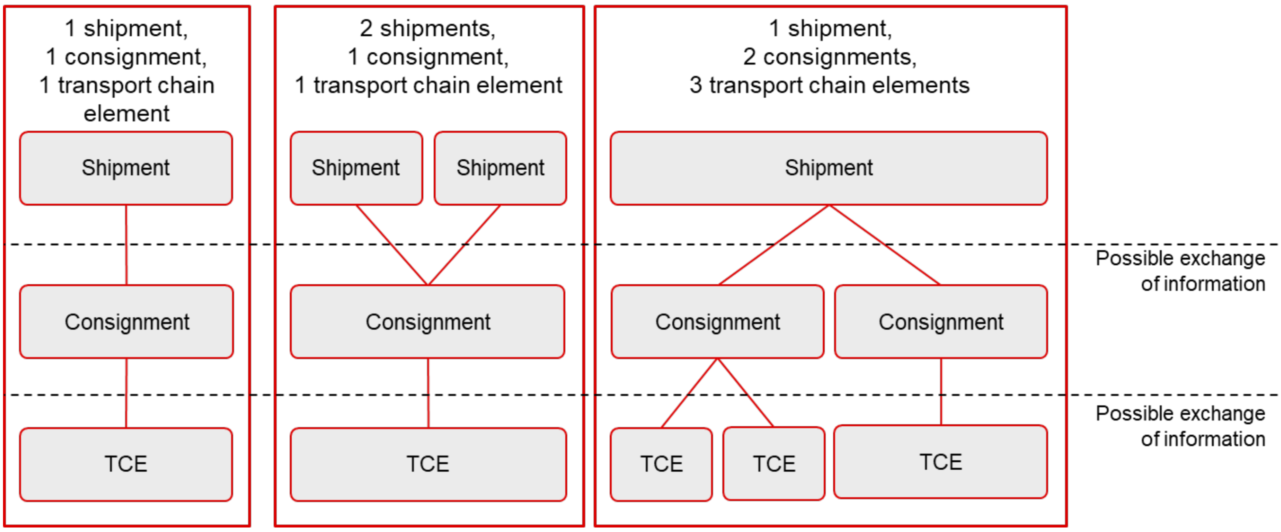



**Figure 1: Examples of Shipment – Consignment – Transport Chain Element relationship**

Each transport chain element belongs in a transport operation category (TOC). To explain this in a visual way, Figure 2 shows an example of a transport chain with 11 transport chain elements. When deciding upon the emission intensity of each of these TCEs, one should think of the characteristics of that group of transport operations the TCE belongs in. Examples are: the route, the amount of vehicle or the type of the vehicle. As it is shown on the last level of the figure, TCE1 can belong in a TOC of a group of vehicles in a single route, shown on the left or in a network, shown on the right side.

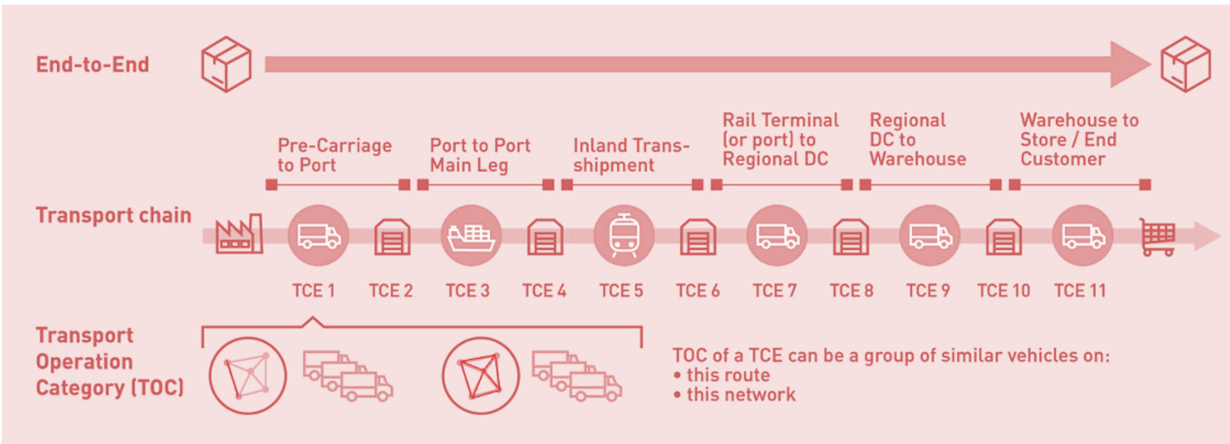



**Figure 2: Schematic representation of a TOC**

# 2 Introduction

The Guidelines provide recommendations on how to exchange GHG related information across the supply chain and a data model for the exchange of GHG emissions of a Transport Chain Element. They seek to address the challenges and barriers identified in the first phase of the project and published under the Insights Paper (Smart Freight Centre, 2019).

With these Guidelines the third phase of the Data Access for Logistics Emissions Accounting and Reporting project ('Data Access project') is concluded. The Data Access project is carried out by Smart Freight Centre in consultation with GLEC Members and Partners.

## 2.1 Background

Over 150 multinationals, including shippers, carriers and logistics service providers (LSPs) are now using the Global Logistics Emissions Council (GLEC) Framework (Smart Freight Centre, 2022) to calculate and report logistics emissions across their multi-modal supply chains. However, only 23% of these companies were reporting their logistics emissions publicly in 2021. A key reason for this is that many shippers and LSPs have difficulties getting access to reliable data from their carriers.

Many carriers do not collect the required data, often because they do not know what variables to collect from fuel and transport management systems or because these systems are not well interconnected (LEARN European Project, 2020). Sometimes, even if the data is available, there is an unwillingness to share due to trust issues, i.e. related to uncertainty about use of commercially sensitive data, lack of third party verification. On the other end, shippers and LSPs face the challenge to integrate and verify the data from multiple stakeholders. As a result, any data that is obtained, for instance from a carrier, may be inadequate or untrustworthy for emissions calculation. These challenges were identified early on by the LEARN initiative as a key barrier for businesses to implement the GLEC Framework.

Other initiatives, such as the EU CEF project FEDeRATED have addressed the problem of interoperability and data exchange by providing an ontology and suggesting a federated IT data architecture. However, their work is more general and encompasses emissions exchange on a general level and does not provide details on suggested data types and units (EU CEF Project FEDeRATED, 2022). Hence, the challenge of exchanging data between external parties stems from a lack of a common data model and a lack of industry-accepted guidelines on data quality.

## 2.2 Objectives

The objective of this Guidance is to help organizations improve their reporting of logistics GHG emissions by facilitating data access and exchange of GHG related information throughout the supply chain.

This Guidance covers:

1. Practical matters to consider when designing IT systems to better capture and exchange logistics emission related data across the supply chain
2. Technical description of the parameters, the attributes and associated data model for the exchange of data

In the context of these guidelines, the data model refers to the set of data variables IT systems shall capture to track and be able to calculate logistics emissions. It defines parameters, constraints, units, etc. (see Section 4.2). It shall not to be confused with emission modelling. The purpose of the data model is by no means to define the way calculations shall be made, but to support the harmonized exchange of variables that are relevant for emissions calculation and reporting.

## 2.3 Approach

The guidance and model were developed in consultation with all stakeholder groups in the logistics industry, namely: shippers, logistics service providers (LSPs), carriers and tool providers, including experts from these organizations. The project involved a combination of semi-structured workshops, interviews and case studies in the course of two years. During the first year, 9 semi-structured workshops took place to identify the challenges inhibiting data exchange between parties and scope a first version of a data model capturing emissions-related variables for logistics.

During the second year, the data model was applied and assessed with real-life use cases. Specifically, it was tested by the teams of EVE Platform, Greenrouter, shipzero and Transporeon Carbon Visibility Platform. 18 interviews were conducted with their teams to assess critically the application of the data model and its limitations. Their input was collected to consider content improvements to support varying operational needs. Also, 4 plenary meetings took place to communicate the work and results to a broader audience. During the plenary meetings, additional expert feedback was collected from a broader stakeholder group. Finally, the results of the case studies were evaluated with respect to a framework of six dimensions: accuracy, completeness, consistency, timeliness, validity and uniqueness.

*Limitations of the testing*

Certain aspects of the data model were missed out during the testing phase, such as multimodal transport chains, multi-TCE, and multiple feedstocks, due to the availability of suitable case studies. The case studies were focused on road transport, although expert feedback was collected and considered to improve the data variables capturing information for other modalities. The usability of shipment, consignment and TCE IDs, which are essential for aggregation, were not sufficiently tested in the case studies. Currently, the data model supports the most common units for some variables, like energy consumption. More testing in the future could reduce the acceptable units to a shorter list.

## 2.4 Preparing for the future

The Data Access project aims to fill the gap in the logistics data exchange by providing guidance document along with a data model. The guidance addresses the different use cases in the data exchange, the topic of responsibilities and trust between the stakeholders of the logistics value chain and lastly some recommendations on incentives for collaboration. The data model presented, can be used by all different logistics stakeholders that wish to capture, calculate and exchange emissions related data. The model is aligned with the GLEC Declaration requirements and conceptually also with the principles of the PACT Framework (WBCSD, 2021). This is chosen as it is important for all logistics stakeholders to facilitate shippers and help them identify the total carbon footprint of their products. Logistics is a significant part of the total emissions of a product thus, there is a need to confidently state what percent of the total emissions logistics is responsible for.

We envision that the proposed guidance and data model are adopted by more companies, shippers, LSPs, carrier or tool providers. Using the same semantics can facilitate the tasks around manipulation and exchange of data, internally or between parties by reducing the time of manual adjustments prior to analysis. Reducing the siloed approaches to data by standardizing the models used, accelerate the data-driven decision-making efforts of companies. This idea is also supported by The International Transport Forum (ITF) which stated in their latest report on data sharing that digitalization in logistics will not scale without the use of open freight data exchange standards (International Transport Forum, 2022). Lastly, an increase of the interoperability of software used in the industry can be expected, supporting the emissions calculations and reporting in the logistics supply chain but also other activities in need of data for optimised decisions making.

# 3 Exchanging logistics GHG emissions data

This section covers the following: (i) definition of use cases, (ii) description of exchange options, (iii) responsibilities for retrieval of the data, (iv) trust and assurance, (v) recommendations on incentives for collaboration, and (vi) assessment of data quality.

## 3.1 Use cases

There are three recognized use cases identified to why an organization is calculating the GHG emissions of logistics. In each use case, the perspective (forward or backward-looking), frequency of calculating, input type, aggregation level of input data and of the emission intensity, as well as the level of data aggregation differ. Recognizing these differences when setting up the exchange, will help to understand what level of granularity and information which is required and how to process the required data.

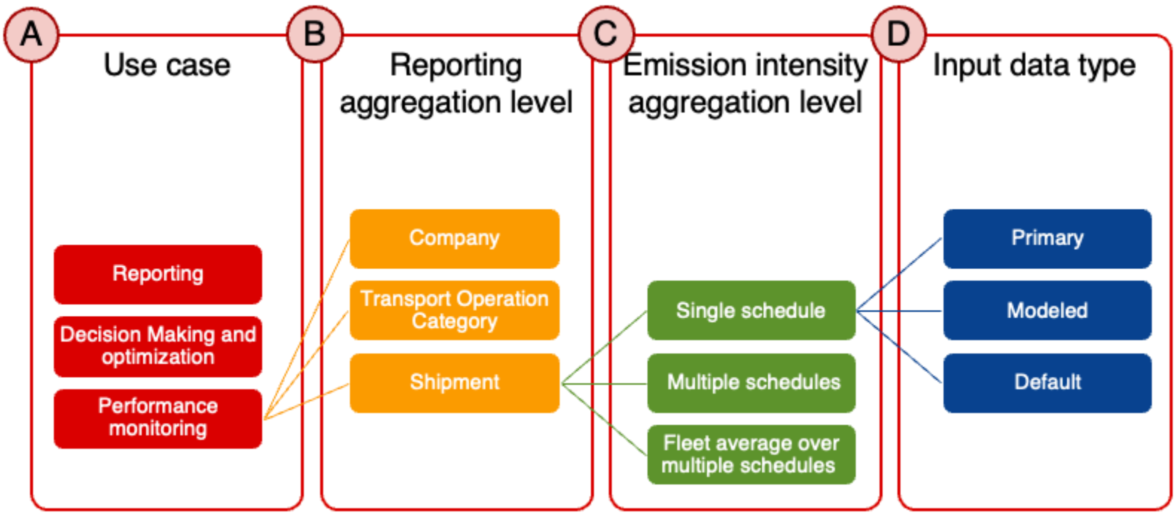



**Figure 3: Potential combination of exchange of information**

The use cases (Figure 3, A) are described as:

- **Reporting of logistics GHG emissions,** this is currently the most common use case, in which an organization is reporting its total GHG emissions for a selected period, over the whole organization or for parts of the supply chain. Aggregated input data and emission factors in line with the GLEC Declaration can suffice, although more granular data will increase the level of detail and precision.
- **Decision making and optimization,** backward-looking to track performance of the supply chain or a supplier, identify outliers or see progression in carbon reduction strategies. This requires granular input data and the use of disaggregated emission intensity data. Depending on the purpose, the respective granularity of the input data level and the use of aggregated or disaggregated emission intensity data are to be considered. Examples are, the quantification of the impact of using different fuels, assessing carrier performance etc.
- **Granular optimization**, forward looking at projected GHG emissions on the basis of historical data. Requires a form of modelling and requires more granular input data, preferable primary data, to ensure correct decisions are made. The ideal data granularity and accuracy will be depending on the type (strategic, tactical, or operational) and scope (e.g. network planning, tendering, vehicle procurement, alternative fuel usage) of the decision.

See Table 1, for more details.

**Table 1: Use Cases for GHG emissions data exchange**

| Use case | Reporting (Public, Government) | Business Decision Making | Granular optimization |
|---|---|---|---|
| Perspective | Backward-looking | Backward-looking | Forward-looking |
| Indicative frequency | Monthly, quarterly or annually | Weekly, Monthly, quarterly, or annually | As per the decision |
| Input data type | Modelled and default data provide a good indication; primary input data is preferred | Primary input data is preferred for a more accurate quantification of the use cases which fall under these categories. | |
| Input data - emission intensity aggregation level | Aggregated emission intensity from fleet averages | Emission intensity should ideally be matched to the required reporting level and purpose. Aggregated emission intensity is commonly used for transport operation categories such as trade lanes (to avoid outliers and allow benchmarking). Emission intensity specific to the shipment/ consignment is preferred when using granular input data levels. | |
| Output data (reporting aggregation level) | • Company<br>• Transport operation category<br>• Shipment | • Company<br>• Transport operation category<br>• Shipment | • Transport operation category<br>• Shipment |
| Exchange of data required | Minimum is GLEC Declaration. Additional variables can be added as per use case. | It is advised to exchange all mandatory and as many optional variables as deemed applicable. | |

Secondly, the received information can be reported at various aggregation levels (Figure 3, B). It should be recognized that the more aggregated the information, the less detail is visible or retained. Several aggregation levels, subject to varying time periods, can be considered:

- Company: total GHG emissions produced by the supplier for the client. This would be in line with the requirements of the GLEC Declaration.
- Transport operation category: GHG emissions per transport service based on mode, journey, freight, trade lane or contract type
- Shipment: GHG emissions per shipment from origin to destination

Thirdly, it is important to recognize how, besides the activity data, the emission intensity is derived (Figure 3, C). This value can be determined in various ways, based on the categorization of the transport operation categories (TOCs). Examples can be:

- a specific vehicle type in a single schedule or
- based on a specific group of vehicles in multiple schedules or
- fleet average over multiple schedules

Understanding these variations will help to interpret the data received and its' suitability for the proposed use case.

Finally, the input data type (Figure 3, D) can be classified in:

- **Primary Data**: Actual carrier information, such as from fuel receipts and telematics systems as well as aggregated values that reflect fuel or emission intensity for a period of time.
- **Detailed Modelling**: Emission-relevant parameters to model fuel use and emissions. There are two modelling approaches: energy-based and activity-based.
- **Default Data**: Values drawn from published, acknowledged sources.

Together, these four considerations help to determine the level of granularity and information required for any data exchange of logistics emissions. Each combination can be "mixed and matched"; however, it should be recognized that certain combinations are more useful (e.g. using primary data for transport chain element calculations) than others depending on the business needs (e.g. using default data for performance monitoring of a trade lane). Figure 4, shows the diverse reporting levels which can be used and how to aggregate and report depending on the desired scope.

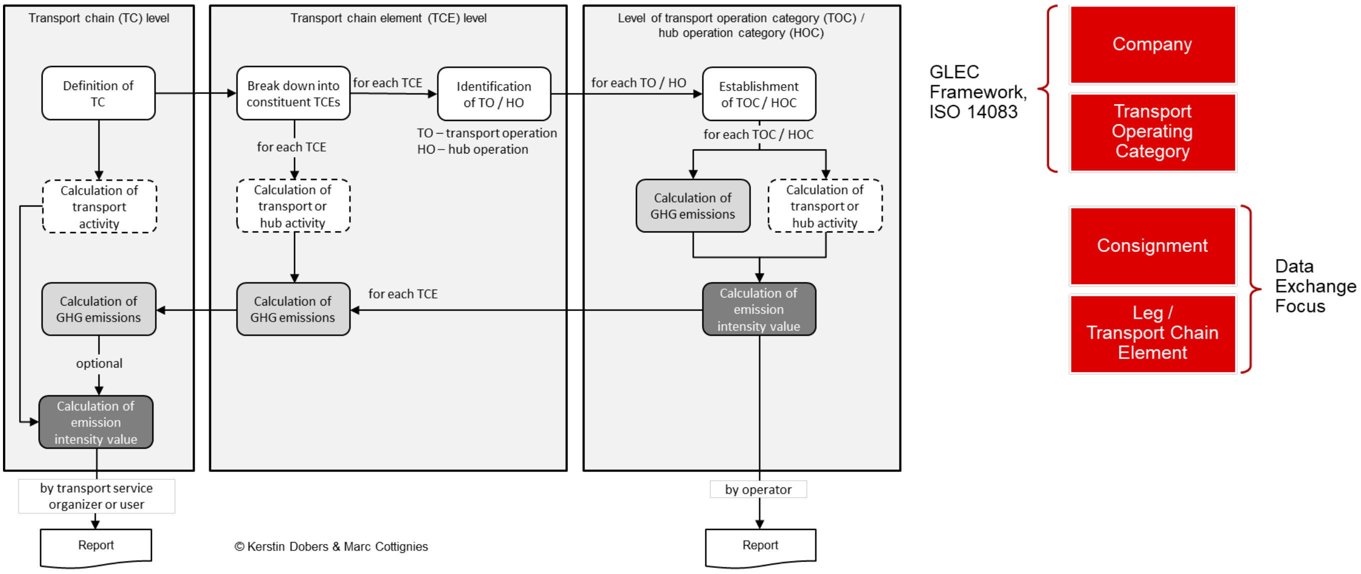



**Figure 4: Reporting levels and Data Exchange focus**

## 3.2 Exchange options

In each of the use cases it is important to identify who makes the calculations and what information should be exchanged. The calculations can be outsourced to a third-party or made by either the service supplier or freight buyer. In general, information is exchanged in a given constellation of the main stakeholders, depending on the transport chain and use case:

- Carrier → Shipper
- Carrier → LSP
- LSP → Shipper
- Carrier/LSP/Shipper → 3rd party (possibly a solution or assurance provider)

Depending on the situation, the required information changes. Figure 5 contains the main five exchange options for data exchange, depending on what party conducts the calculations. What is important to notice, is the different flows of information (shown with red and green) and who is the party that calculates the logistics emissions shown with a small calculator icon.

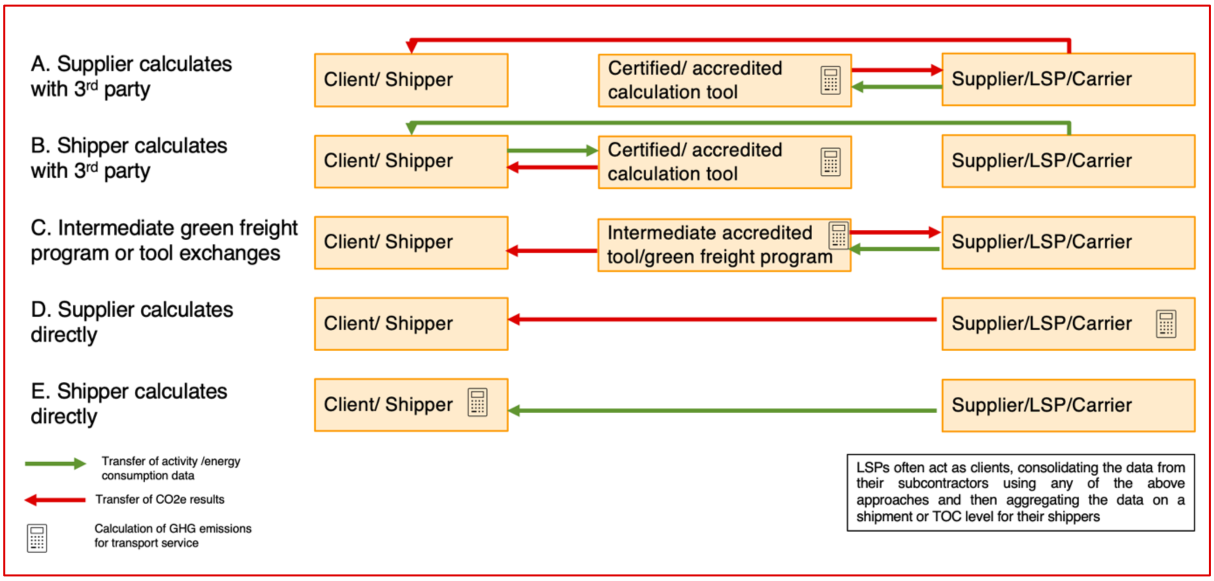
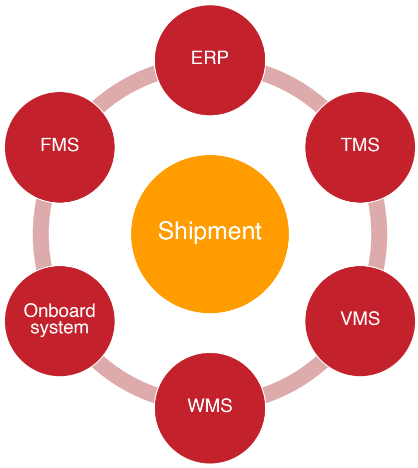



**Figure 5: Exchange options**

- In situation A. the supplier exchanges the activity data to a certified calculation tool for calculating the GHG emissions and reports the GHG emissions to the client.
- In situation B. the supplier exchanges the activity data to the client and the client will exchange this information with a certified calculation tool for determining the GHG emissions.
- In situation C. the supplier exchanges activity data to an intermediate platform, which calculates the GHG emissions and provide the results to both the supplier and the client.
- In situation D. the supplier calculates the GHG emissions and exchanges this directly to the client.
- In situation E. The supplier exchanges the activity data with the client directly and the client makes the calculation.

Lastly, depending on the exchange options and stakeholders, various IT systems are involved, as can be seen in Figure 6. These have been described in detail within the Insights paper (Smart Freight Centre, 2019). The different systems need to capture and exchange specific data parameters depending on the calculation approach, use case and stakeholder. In Section 4, the information which is required for the calculation and reporting will be defined as part of the data model.




- Transport Management System (TMS)
- Warehouse Management System (WMS)
- Vendor Management System (VMS)
- Enterprise Resource Planning (ERP)
- Onboard & Telematic Systems
- Fleet Management Software
- Calculation tools (internal & external)

**Figure 6: Landscape of logistics related systems**

This figure is meant to be used as a guide to think where data comes from and if all available systems have been exhaustively utilized in the data collection process. Section 4 of this guidance aims to provide a revised data model to act as a starting point for organisations wishing to standardize the naming and units of the parameters captured in their IT systems and their data specifications so that interoperability between them is increased.

## 3.3 Responsibilities

The responsibility for gathering and reporting emission data is distributed across the logistics value chain. In general, the freight buyer is responsible for retrieving general freight information, like freight mass, whilst routing, transport asset information and energy consumption information are managed by the service provider. A crucial role is also assigned to calculation tool providers that are supporting the emissions calculation with the use of activity or energy data shared by different stakeholders in the supply chain. In practice, in many complex supply chains, these responsibilities are not strictly defined and are usually transferable or shared. In Figure 7 most common distribution of responsibilities is shown. Partial responsibility means that the stakeholder is highly likely to be able to retrieve and provide this information to the other parties. For a fuller explanation on how the responsibilities are linked to IT systems used by the different stakeholders, please refer to section 1.5 of the Data Access Insights Paper (Smart Freight Centre, 2019).

The following general principles have been defined:

1. Responsibilities are determined based on the decision-making type (planning or execution). A shipper determines the consignor and consignee addresses and an LSP might decide on the planned route of shipment (planning capacity). However, the actual routing and possible

intermediate stops are decided by the executing party, the carrier, that is subsequently responsible to provide transparency on it.

2. Responsibilities are determined based on the scope. Example: While a carrier will be responsible for specific multi-modal transport chain elements of a shipment, the LSP, will be managing the entire transport chain and will be responsible for providing the full set of information to the shipper.

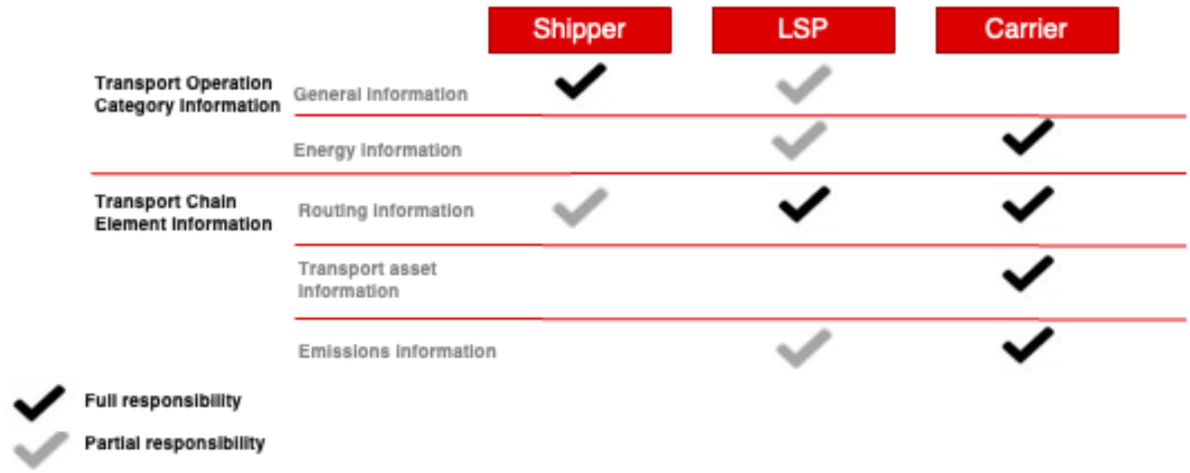



**Figure 7: Different responsibilities for information retrieval**

Note: Additionally, if a company chooses to outsource the emissions calculation to a tool provider, then the tool provider would be responsible for circulating back the calculated values; the total emissions and the emission intensity value.

## 3.4 Trust & Assurance

In the Insights Paper (Smart Freight Centre, 2019), trust and assurance were referenced as a critical challenge to the exchange of GHG emissions and the multi-facetted nature of this challenge were first laid out. Main trust and assurance issues include: reluctance to share information, unreliability of the data retrieved, missing or inaccurate data and wrong implementation of calculation methodology. Each of these challenges can be overcome through different solutions, such as:

- The use of an independent third-party that ensures the correctness of emissions methodology, for instance, an accredited organization (e.g. a SFC Accredited tool provider) or an external independent auditor.
- Ensure anonymization of data, e.g. non-traceable to a specific supplier. This could increase the willingness to share
- Exchange of GHG emissions instead of activity or energy related data. This avoids sharing any commercially sensitive information, such as fuel consumption.
- The reliability of the exchange can be improved through the automatization of the exchange, with respect to manual exchange.

A formal assurance guidance, covering further details to provide the assurance of the input data and the methodology is presented in the final Guidance published as part of the End-to-End project (Smart Freight Centre, 2023).

## 3.5 Incentives and collaboration

To increase willingness in exchanging GHG emissions, freight buyers will be required to support, particularly, small and medium-sized carriers in calculating and exchanging GHG emissions (Smart Freight Centre, 2021). This can take place through collaboration and therefore working closely with suppliers to improve the calculations and the associated GHG emission footprint or through a formal enforcement mechanism such as contractual and tendering procedures.

Through discussion, the following suggestions are provided for freight buyers:

- Financially support the use of third party calculation tool,
- Offer educational and technical support (e.g. help what information is required and why)
- Share insights gained from the data retrieved to support operations
- Incentivize carriers through contractual agreements and procurement practices
  - Preferred carrier approach in procurement. For example, rewarding business based on an evaluation of a supplier on their ability to calculate the GHG emissions and their GHG performance
  - Mandatory requirements. For example, requiring specific information and working collaboratively to address those needs with a structured approach.

In the long term, it is anticipated that regulations will require each organization to report their GHG emissions and potentially have also a formal assurance statement.

## 3.6 Assessing Data Quality and Data Quality Ranking

There are many existing methods to evaluate data quality for input data used in emissions calculations. The EN16258 standard, requires reporting a data quality level for each input variable (default, carrier's average, carriers' specific value or actual transport operation value), whilst the GLEC Framework requires a breakdown of the type of used data (default data, modelled data, program data or primary data). The GLEC Framework only requires determining the percentage of each data type for the overall calculation. The AFNOR SPEC X43-072 (AFNOR, 2021) provides a ranking mechanism based on the source and aggregation level of the utilized fill rate, the empty run rate, and the energy consumption to derive an accuracy index and associated label.

Quality rankings provide a confidence level for the elements of supply chains regarding the quality of the exchanged data and therefore the quality of the calculated GHG emissions. A quality ranking can also act as an incentive to increase the precision of the calculated emissions and can enable benchmarking. However, the quality of the data does not necessarily correlate with good GHG emission performance, and therefore focusing on high data quality can provide a false sense of efficiency. Moreover, during this project, it has been highlighted that in many cases there are significant data gaps in logistics IT systems. A data quality ranking cannot address those and thus, it is not considered in the current Guidance.

As part of the End-to-End project (Smart Freight Centre, 2023), a Data Quality Index was defined. The principles behind this index build upon the main variables which mostly affect the calculated result of the logistics GHG emissions. These are variables like: empty distance, load factors, energy consumption etc. Thus, companies can estimate data quality on a TOC level and then share these outcomes with the rest of the stakeholders in the supply chain. TCEs will inherit the data quality index value based on which TOC they belong in. Then, TCE information is factored in on distance and mass, shaping the final data quality index. For a step-by-step guide on how to calculate the data quality for a TOC and a TCE the reader is prompted to look at section 3.2 of the End-to-End Guidance.

# 4 Data model overview

This section presents (i) how the data model adds value with respect to the existing GLEC Declaration (ii) a data model for the standardization of parameters to be accessed and exchanged to support sharing of GHG emissions data between stakeholders in the logistics supply chain.

## 4.1 Added value of the data model with respect to the GLEC Declaration

The existing GLEC Declaration offers a standardized format for reporting of emissions in accordance with the GLEC Framework. It is mainly scope, input data type, data verification statement. Coverage of reporting is not directly included in the data model when it is underlined as an important parameter to be declared when reporting emission data. It can be extrapolated by the datetime variables of the transported freight which are part of the data model.

The current data model builds upon the GLEC Declaration, as it contains all basic parameters of the GLEC Declaration, while offering a further level of detail to support use cases beyond reporting. Specifically, performance monitoring and optimization are supported thanks to the inclusion of specific parameters related to operational performance (e.g. empty mileage, load factor), energy carriers and a more exhaustive analysis at the TCE/consignment level.

The list of proposed parameters is meant to be included in databases of companies that wish to register and store data on a TCE level. By storing low-level information, all aggregation activities can be facilitated, for example aggregated upwards to shipment or business unit level of emissions. Additionally, two requirement levels have been specified: mandatory and optional, to guide the companies wishing to implement the data model. We suggest the mandatory ones as a first step in storing and using data. However, the ideal approach is to implement in a database all variables even if currently no data is available. In that way, companies can increase their IT readiness to support more granular information of their operations; either when it becomes available or to accommodate the collection of data from other parties through exchange.

## 4.2 Data model

To standardize the exchange of emission related information, a data model which supports the exchange of GHG emissions, energy consumption and transport activity data is presented in Table 2. The data model was developed in close alignment with the previous work done in the DIN SPEC 91224:2017-03 (DIN, 2017).

It is meant to cover the most relevant parameters needed for calculating and reporting GHG emissions, defined as mandatory parameters, as well as optional parameters which can complement this information.

- **Mandatory**: Requirement for GLEC Framework compliance. Mandatory to be accessed and exchanged with relevant parties.
- **Optional**: Identified as beneficial for additional insights and more precise calculations in case of modelling and use of defaults. The exchange of optional variables is not prescribed, although it is acknowledged that for certain use cases, calculation approaches and decision-making processes, these might be crucial, and users have the freedom to include them or not in their reports.

At this moment there is no classification which of the identified IT systems should capture, send and receive the parameters as this depends on the IT environment of a given company and requires further analysis. Standardized parameters should ideally be implemented in all systems involved to ensure alignment.

To support the adoption of the data model for different flow of information options, two levels of requirements are defined: “TCE Calculation Requirement” and “TCE Reporting Requirement”. Depending on the case, the user of the model will report the necessary information for the intermediate partner or final client to make the calculations, they will make the calculations and report the final emissions, or even do both. The recommended practice is to implement the full data model in an IT system, even if there are still empty values.

The data model is designed from the perspective of a consignment which is transported via one or more than one transport chain elements, which is the lowest possible aggregation level for transport operations. Each transport chain element is defined by both specific TCE parameters, as well as parameters related to the TOC. This categorisation is chosen to clarify which features relate to the operation of a fleet and which are consignment/TCE specific. Figure 8 clarifies the relationships between the elements of the transport chain. A transport chain is composed of multiple TCEs and each of the TCEs belongs in one operation category. In addition, suggested units of measurement, constraints and data types are presented in the full description of the data model in Table 2. The units of measurement are important to be used as proposed in the model, as they are directly related to the emissions calculation. By following the suggested units, the time spent in manipulation and data processing can be significantly reduced.

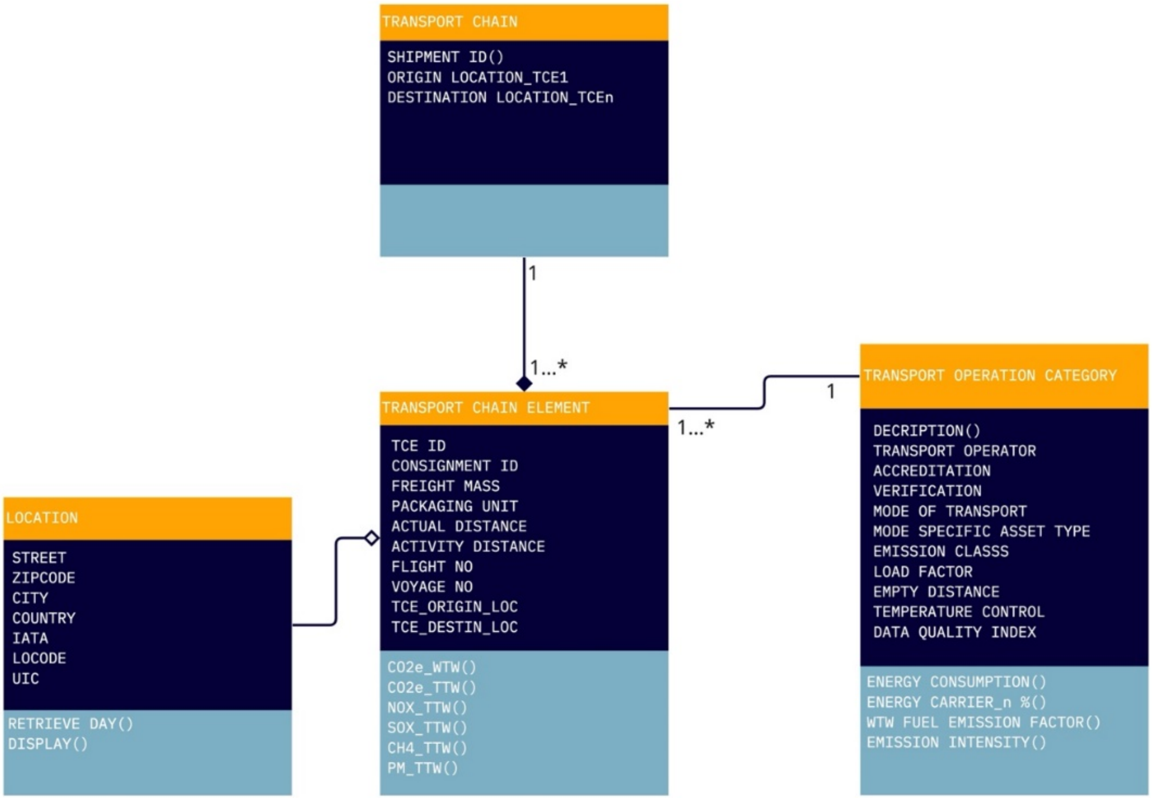



**Figure 8: Data model for exchange of logistics GHG information**

The model is intended to facilitate reporting at any level with the appropriate use of the ID variables, specifically TCE ID, consignment ID and shipment ID to support aggregation. If a company aims to report on business unit level, company level, customer service, or any more aggregated category, it is highly advisable to look at the GLEC Declaration from the GLEC Framework. Designing the data model around the smallest possible exchange unit allows for any upward aggregation of reporting of emissions for transport operation.

### Table 2: Data model (GHG Related Variables for Collection and Exchange) – Transport Chain Element level

| Category | Parameter | Field | Unit | Constraint | Data type | Calculation Requirement | Reporting Requirement | Description |
|---|---|---|---|---|---|---|---|---|
| TOC | Transport operator Name | transport_operator_name | - | - | string | mandatory | mandatory | Identification name of the organization submitting/reporting |
| TOC | Transport operator ID | id_transport_operator | - | DUNS number | string | mandatory | optional | Identification code/name of the organization submitting/reporting |
| TOC | Verification | verification | - | 'TRUE','FALSE' | boolean | mandatory | mandatory | Statement of external verification of the input data |
| TOC | Accreditation | accreditation | - | 'TRUE','FALSE' | boolean | mandatory | mandatory | Statement of accreditation of the calculation methodology |
| TOC | Transport operation category[1] | TOC | - | - | string | optional | optional | Text description of the applicable TOC. Reflect on mode of transport, contract type, equipment type, vehicle type, freight temperature, LTL/FTL etc |
| TOC | Mode of transport | mode_of_transport | - | 'rail', 'road', 'sea', 'air', inland waterway', 'hub' | string | mandatory | mandatory | Means of transport or type of transport |
| TOC | Mode specific asset type | asset_type | - | - | string | optional | optional | Categories per mode of transport (Specific category of vehicle, such as 40t truck, 3,5t van, or container vessel or bulk vessel) |
| TOC | Emission class (road) [2] | emission_class | - | Euro 1-6, EPA classes | categorical | optional | optional | Identification of the vehicle emission class (Road). Depending on the geography of operations, this can be adapted |
| TOC | Load factor[3] | load_factor | percentage | numeric (0-1] | float | mandatory | mandatory | Ratio of the mass of the actual load to the maximum legally authorized load of a particular vehicle on a TOC level |
| | | load_factor_add_information | - | - | string | optional | optional | Description of derivation of the load factor |
| TOC | Empty distance | empty_distance | percentage | numeric (0-1) | float | mandatory | mandatory | Ratio of the section of the route of a vehicle during which no freight is transported on to the total distance of a vehicle on a TOC level |
| | | empty_distance_add_information | - | - | string | mandatory | optional | Description of derivation of the empty running |
| TOC | Temperature control | temp_control | - | 'frozen', 'refrigerated', 'ambient', 'high temp' | string | mandatory | optional | Status of freight being non-ambient |
| TOC | Energy consumption[4] | energy_consumption_add_information | - | - | string | optional | optional | Description of derivation of the fuel consumption |
| TOC | Energy carrier | energy_carrier_N | - | - | string | mandatory | optional | Category of primary energy carrier, such as Diesel, HVO, petrol, CNG, LNG, LPG, HFO, MGO, Aviation fuel, Hydrogen, Methanol, Electric, etc |
| TOC | Energy consumption_N | energy_consumption_N | l, kg, kWh, MJ per km | numeric >= 0 | float | optional | optional | Amount of energy or fuel consumed per km |
| TOC | Feedstock | Feedstock_N | - | - | string | mandatory | optional | Primary feedstock of energy carrier N (e.g. fossil, natural gas, grid, renewable electricity, waste) |
| TOC | Feedstock share of the blend | energy_carrier_feedstock_N | - | - | string | mandatory | optional | Secondary feedstock of energy carrier N (e.g. bio-waste, soy, legislated biofuel mix, etc) |
| | | energy_carrier_feedstock_N_% | - | numeric [0,1) | float | mandatory | optional | Share of the feedstock N of the energy carrier (0 in case only 1 feedstock is applicable, e.g. 5% to cover a 5% blend) |
| TOC | WTW fuel emission factor (certified) | WTW_fuel_emission_factor | kg CO2e per kg, l, kWh, MJ | numeric | float | optional or mandatory | optional | WTW fuel emission factor (certified) |
| TOC | Emission Intensity | co2e_intensity_wtw | g/t-km, g/teu-km, g/feu-km | numeric >= 0; must equal to 1000 * (co2e_wtw / transport_activity | float | N/A | mandatory | Coefficient relating specified transport activity with GHG emissions |
| TOC | Data quality index | Data_quality_index | - | Level 1 – Level 4 | categorical | N/A | mandatory | TBC (Definition from E2E. Calculated with respect to % of emissions) |
| TCE | Shipment ID | id_shipment | - | - | string | mandatory | mandatory | Identifier of the shipment |
| TCE | Consignment ID | id_consignment | - | - | string | mandatory | optional | Identifier of the consignment |
| TCE | | id_tce | - | | string | mandatory | optional | Identifier of the transport chain element |

| Category | Parameter | Field | Unit | Constraint | Data type | Calculation Requirement | Reporting Requirement | Description |
|---|---|---|---|---|---|---|---|---|
| | Transport chain element ID | id_tce_order | - | - | string | mandatory | optional | Consecutive number of TCE for the consignment, in case of multiple TCEs for one consignment/shipment |
| TCE | Freight Mass | mass | kg | numeric > 0 | float | mandatory | mandatory | Mass of the transported freight (gross mass) |
| TCE | Packaging unit[5] | packaging_unit | - | ‘Euro pallet’, ‘US pallet’, ‘TEU’, ‘Bulk’, ‘N/A’ | string | optional | optional | Category of the packaging of the consignment packaging (e.g. pallet, container, etc.) |
| | | packaging_unit_amount | Packaging unit | numeric > 0 | integer | optional | optional | Number of packaging units |
| TCE | Actual Distance | Distance_actual | km | numeric > 0 | float | optional | optional | Distance between the origin and the destination of a consignment of freight or a vehicle, along a specified route (or from telematics) |
| TCE | Activity Distance[6] | Distance_activity | km | numeric > 0 | float | mandatory | mandatory | Distance between the origin and the destination of a consignment SFD or GCD (found in the past publications as planned distance)1 |
| | | Activity_Distance_type | - | GCD or SFD | categorical | mandatory | mandatory | GCD: transport distance determined as the shortest distance between any two points measured along the surface of a sphere<br>SFD: transport distance determined as the distance achievable by the shortest practical route available according to the infrastructure options for a particular vehicle type |
| TCE | Origin location[7] | loading_street | - | loading_zip OR loading_city NOT NULL | string | optional | optional | Origin street |
| | | loading_zip | - | - | string | optional | optional | Origin zipcode |
| | | loading_city | - | - | string | mandatory | mandatory | Origin city |
| | | loading_country | - | iso2-code | string | mandatory | mandatory | Origin country |
| | | loading_iata | - | IATA code | string | optional | optional | IATA code of origin airport |
| | | loading_locode | - | UN/LOCODE | string | optional | optional | UN/LOCODE of origin |
| | | loading_uic | - | UIC station code | string | optional | optional | UIC station code of origin station |
| | | loading_lat | - | decimal degrees | string | optional | optional | Latitude of origin |
| | | loading_lng | - | decimal degrees | string | optional | optional | Longitude of origin |
| TCE | Destination location | unloading_street | - | loading_zip OR loading_city NOT NULL | string | optional | optional | Destination street |
| | | unloading_zip | - | - | string | optional | optional | Destination zip code |
| | | unloading_city | - | - | string | mandatory | mandatory | Destination city |
| | | unloading_country | - | iso2-code | string | mandatory | mandatory | Destination country |
| | | unloading_iata | - | IATA code | string | optional | optional | IATA code of destination airport |
| | | unloading_locode | - | UN/LOCODE | string | optional | optional | UN/LOCODE of destination |
| | | unloading_uic | - | UIC station code | string | optional | optional | UIC station code of destination station |
| | | unloading_lat | - | decimal degrees | string | optional | optional | Latitude of destination |
| | | unloading_lng | - | decimal degrees | string | optional | optional | Longitude of destination |
| TCE | Transport Activity | transport_activity | t-km, teu-km, feu-km | numeric > =0 | float | mandatory | mandatory | Amount of freight multiplied by the transport activity distance |
| TCE | Departure date | loading_date | - | datetime | datetime | optional | optional | Date of loading |
| TCE | Arrival date | unloading_date | - | datetime | datetime | optional | optional | Date of arrival |
| TCE | Flight No. | flight_no | - | - | string | mandatory | optional | Identification no of the IATA flight number |
| TCE | Voyage number | Voyage_nr | - | - | string | mandatory | optional | Identification no of a specific vessel conducting a specific route |
| TCE | CO2e WTW | co2e_wtw | kg | numeric >= 0 | float | N/A | mandatory | GHG released to atmosphere during the process of producing, storing, processing and distributing an energy carrier for vehicle operation + GHG released to atmosphere as a result of vehicle operation |
| TCE | CO2e TTW | co2e_ttw | kg | numeric >= 0 | float | N/A | mandatory | GHG released to atmosphere as a result of vehicle operation |
| TCE | NOx TTW | Nox_ttw | kg | numeric >= 0 | float | N/A | optional | Nitrogen oxide released to atmosphere as a result of vehicle operation |
| TCE | SOx TTW | Sox_ttw | kg | numeric >= 0 | float | N/A | optional | Sulphur oxide released to atmosphere as a result of vehicle operation |

| Category | Parameter | Field | Unit | Constraint | Data type | Calculation Requirement | Reporting Requirement | Description |
|---|---|---|---|---|---|---|---|---|
| TCE | CH4 TTW | CH4_ttw | kg | numeric >= 0 | float | N/A | optional | Methane released to atmosphere as a result of vehicle operation |
| TCE | PM TTW | PM_ttw | kg | numeric >= 0 | float | N/A | optional | Particulate matter (PM10 and PM2.5) released to atmosphere as a result of vehicle operation |

Disclaimer: Smart Freight Centre does not prescribe the exchange of the optional variables, each stakeholder has the freedom to decide which variables will or not be shared with other parties in the value chain

Notes on the scope of the data model:

[1] Definition of the aggregation level of the underlying TOC as well as the respective data input type of this parameter should be supplied either as additional information within the data exchange or in accompanying documentation. See Section 1 of the guidance.

[2] The "Emission class (road)" variable is now scoped for EU operations only.

[3] Even in a calculation based on primary data, where load factor and empty running are not needed to conduct the $CO_2e$ calculation, these variables are still considered mandatory for both requirement levels as they are critical from supporting decarbonisation initiatives and decision making.

[4] Energy consumption parameters will be deemed as mandatory regarding the "TCE calculation requirement" if the emissions calculations are based on primary data.

[5] Packaging unit is kept as an open variable, as there is no consensus in terms of standardized packaging units.

[6] Should be planned distance. For certain calculation approaches using fuel or energy consumption, or bottom-up modelling, actual distances can be used and should be scaled according to the rules set out in the GLEC Framework. It is important to note that when activity distance is not reported, actual distance becomes mandatory. It is mandatory to report at least one of the two.

[7] Zip code is currently an optional variable. In the future it is subject to become mandatory, as it is a requirement for specific countries.

# 5 Data model assessment

This section presents the methodology and results of the data model assessment which was used in the context of the case studies. In addition, the limitations of the conducted use cases are declared.

## 5.1 Methodology to assess data model adoption

As mentioned in Section 2.3, to assess the adoption of the data model and its limitations, a framework of six dimensions was identified. The dimensions are defined in the current scope of the guidance as:

- Accuracy: The information captured is accurate if it represents the reality of operations i.e. if the data reported has a low margin of error.
- Completeness: Data is considered complete when it fulfills expectations of comprehensiveness. Operationally, data would be complete when all variables that are needed to fully describe a concept are included. For example, asset information is complete when the *mode of transport* is known, and, in the case of this being required for the calculations, also the *mode specific asset type* and the *emission class* are reported.
- Consistency: There is consistency if there are not internal conflicts of information. This is particularly relevant as the same piece of information may be stored in more than one place. For example, in the *transport operation category* variable the vehicle types can be described along the mode of transport. The vehicle type information should be then consistently reflected in the variable *mode specific asset type* as well.
- Timeliness: The information is timely if it is accessible and available in the required period of time set by the testing partners.
- Validity: Data is valid if it follows the format defined in the data model. For variables where a format requirement is not in place, common formats or business rules were accepted as valid. For example, if dates are saved separated with "-" or "/".
- Uniqueness: Data uniqueness requirement is fulfilled if no duplicates can be found in the datasets.

## 5.2 Results of the assessment

In phase 3 of the project, the interim data model produced by the second phase of this project was tested and refined with the conduction of four use cases. Particularly, the analysis has focused on the six dimensions of data quality, namely: accuracy, completeness, consistency, timeliness, validity and uniqueness, as described below.

### Accuracy

The main accuracy challenge was the correct identification of variables. Especially hard to identify accurately where load factor, vehicle type and in a few cases the modality. It was found out that even key variables such as weight are subject of significant errors, especially when shippers are responsible for reporting these parameters.

Adding to the performance tracking and optimization use cases, the use of primary data, which is supported by the data exchange data model, improved accuracy with respect to modelled or default data. Primary data also allows for greater granularity, which enables the identification of hot spots, or points of the supply chain with high potential for emission reduction. Also, the level of granularity at the transport chain element level, which is supported by the data model, allows precise performance tracking of measures like round-trip booking, load optimization, low-carbon fuels, carrier efficiency.

### Completeness

In general, the implementation partners have found difficulties including all mandatory variables. In some cases, efforts have been made to expand the variables exchanged to fit the requirements of the data model, but some variables remained difficult to identify, especially empty distance, mode specific vehicle type and in rare cases the mode of transport.

It has been noted that completeness of the data can vary a lot depending on the stakeholder who provides the information. This might relate to different degrees of data availability or willingness to share. One specific issue in terms of this dimension was the clear distinction between Transport Operator Name and IDs (SCAC or DUNS) and how they relate to a unique legal entity. From the implementations, the organisations realised that the Transport Operator Name if is interpreted as company name, is not granular enough to facilitate data exchange and also can contain multiple different legal names referring to one company. This impeded the data aggregation step (prior to the exchange of GHG related information). One of the proposals is to use tax related unique IDs which show clearly the hierarchies of transport operating companies in their different countries of operations.

### Consistency

In some cases, due to inaccuracy or lack of data, the GHG emissions calculated in TMS and the values from different stakeholders present discrepancies. This is a known challenge and lies outside of the scope of this project. In case the reader is interested in understanding the methodology of calculating emissions when using primary data they are prompted to refer to the End – to – End project. To understand more of the overall methodology for calculating emissions the reader is prompted to refer to the GLEC Framework.

### Timeliness

As the data model is not providing a preferential or required exchange period, the different test cases have different exchange periods set depending on the customer or platform request. No challenges have been reported in terms of exchanging the data in the data periods fixed by each case.

### Validity

No challenges in terms of validity of data have been identified in the project.

### Uniqueness

No challenges in terms of uniqueness of data have been identified in the project.

### IT implementation considerations

Apart from the six dimensions of data quality, other key aspects have also been considered, including IT challenges/integration, data availability and level of detail. Regarding IT integration, two of the test cases highlighted the convenience of automatizing the exchange of information, to avoid relying on manual exchange. However, it has also been pointed out that the implementation of such a system can be slow if the company platform is big and requires the integration of reports from different parties. This reinforces the relevance of implementing common semantics through the exchange data model, in a format that is compatible and easily automated to avoid long times invested in systems integration.

Although the level of detail proposed in the data model is at the transport chain element level, not all case studies facilitate this level of exchange of information. This has been considered not a major issue, as it is recognized that some business cases will not require the same level of detail in the exchange of information. It has been pointed out in one of the test cases that there are difficulties identifying separate consignments or transport chain elements, because of lack of more clear identification. The IT systems do not always have a hierarchy to accommodate TCE, consignment and shipment level information, which is a basic requirement for the correct exchange and consequent interpretation of data.

## 5.3 Limitations

The testing of the present data model and guidelines is limited due to the reduced availability of companies to participate with case studies. This can be due to lack of capacity of transport companies, either lacking the IT readiness or also the reduced availability of human resources caused by last years' political instability.

More concretely, relevant aspects of the data model that were missed out in the testing phase include: multimodal transport chains, multi-TCE. Only road was covered as a transport modality, although expert feedback was collected and considered to improve the data variables capturing information for other modalities.

The data model is designed to describe the exchange GHG emissions with additional related transport activity information. It covers energy related information and suggests some variables to describe the consumed energy. As many companies monitor the energy consumed in different units, at the moment the data model supports the most common ones. More testing in the future could potentially help reduce the acceptable units to a shorter list. Additionally, when it comes to capturing primary data specifically around fuel or energy consumption, the data model has not been tested under multiple feedstock scenarios. Thus, as many companies track the fuel or energy consumed in different units, currently the data model can support the most common ones. More testing in the future could potentially help finetune the acceptable units.

It is considered that all "Shipment ID", "Consignment ID" and "Transport chain element ID" are essential for aggregation. However, there has not been enough testing of the usability of different ID numbers at the shipment, consignment and TCE level for more aggregated data exchange. For this reason, and until this is not further tested, the users of the model can use alternative ID numbers that facilitate aggregation at the shipment level and leave unknown ID numbers blank.

Lastly, the produced data model is a first attempt to an open standard for easier access and reporting of emission related data. One aspect in further defining the model will be to produce and maintain a comprehensive list of energy carriers, packaging unit types, asset types (incl. dual fuel), emission classes, and TOC definitions to further classify the constraints for these parameters. It is expected that, as the data model and guidelines are adopted and tested by more organizations, future updates will consider the experience in data exchange for the missing aspects, thus further improving the current guidelines and adapting them to the users' needs.

# 6 Conclusions

## 6.1 Trust

It has been observed that trust and commitment strongly depend on the contractual situation and attitude towards collaboration. There is a question on how to ensure trust to share data when this is not required by law.

This relates strongly to the willingness to share. In some cases, even if there would be trust in sharing the information, some carries would not have interest or incentives to be transparent about their operations. Ways to incentivize transparency could include moderating carrier success independently or unifying the list of requirements that shippers request from their carriers.

In this sense, the importance of collaborative measures, where shippers would work towards achieving effective reductions, has also been highlighted. If, thanks to more accurate emissions data, shippers can have a better record of their emissions reduction, there would be a stronger willingness to participate in the exchange of information.

## 6.2 Technical conclusions and limitations

To standardize the exchange of data and facilitate the communication between systems that are interoperable, a data model is proposed. The data model defines all parameters required for calculation and reporting of GHG emissions and is meant to support all use cases of data exchange for all stakeholders in the logistics supply chain. Its usability for the exchange of emissions data was proved through the testing in four case studies. However, some aspects of the data model were missed or not sufficiently tested within the case studies. This is due to the challenges in obtaining complete and accurate data from organizations and the lack of multi-modal case studies.

Finally, it is expected that, as the data model and guidelines are adopted by more organizations, more feedback will be collected, helping its further refinement. A wide adoption could help address the low annual emission reporting from logistics operations and increase transparency in the emissions reporting of the industry. Future work will include the creation of a digital version of the data model which would facilitate its adoption and support interoperability among IT systems of all stakeholders in the supply chain.

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# 7 Outlook

## 7.1 Current and future development

This guidance, concluded with a qualitative and a technical deliverable. Both deliverables have been developed by dedicated workstreams within phase 2 and 3 of the project, building on the insights gained in the 1st phase. The overall aim of this project is to harmonize and advocate for an uptake in an open data standard across supply chains for GHG emission reporting and reduction.

In phase 3 of the project, the principles put forward in this Guidance as well as the applicability of the parameter overviews and data model for various use cases were tested and refined. Amongst others, key aspects and research questions answered include:

- Guidance
  - How to think of the different exchange options and information flows?
  - Which parties are responsible for the provision of different parameters?
  - How to approach the issue of trust and assurance in data exchange?
  - How to align between other GLEC projects?
- Data model
  - What parameters are related to the TOC level and which to the TCE level?
  - To what degree can the data model be implemented in existing systems, what adjustments are needed?
  - Which of the recommended variables were difficult to implement?
  - In what way can the data model be aligned with existing exchange data models?

The outcome is a finetuned version of the guidance data model, which is intended to be used as an open industry standard that facilitates data exchange among stakeholders in logistics. The learnings from the individual cases studies, documented in these guidelines, are meant to help other organizations when implementing the data model in their IT systems for the data collection, emissions calculation and results exchange with other stakeholders.

As future development, it is at the moment expected to have more case studies from intermodal chains. In addition, Smart Freight Centre is working towards implementing a corresponding technical specification of the Guidance to enable interoperable data exchange between all relevant stakeholders. This includes the conceptual and technical integration with WBCSD PACT Initiative and its Pathfinder Network (WBCSD, 2021). The goal of this future work stream is to work towards one global network of emission data exchange based on interoperability through open standards. Lastly, this model will be tested in other in-house project where deemed relevant. Smart Freight Centre will maintain this work as up to date as possible by adapting the data model when legitimate improvements are proposed.

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# 9 Appendix

This Appendix contains an overview of the project development, including the results of phases 1 and 2, and an overview of the development of phase 3.

**Table 3: Overview of project phases**

| **Phase 1. Jan-Jun 2021 (completed)**<br>**Status review of systems and exchange of logistics GHG emissions** | **Phase 2. Jul-Dec 2021 (completed)**<br>**Development of data exchange guidance and data exchange data model** | **Phase 3. Jan-Dec 2022 (this report)**<br>**Implement and test Guidance and Data model in different case studies** |
|---|---|---|
| Output:<br>▪ Insight's Paper covering the 5 insights justifying the need for standardization in data exchange (link) | Output:<br>▪ Guidance on data exchange of GHG logistics emissions<br>▪ Data model for exchange of GHG emissions (version 1) | Output:<br>▪ Data model for exchange of GHG emissions (version 2) |

### 9.1.1 Results Phase 1

The main output of Phase 1 is the five insights, which were published in the Insights Paper (Smart Freight Centre, 2019) in July 2021. Through interviews with various stakeholders, insights were identified regarding the status quo of GHG emission calculation. They highlight the necessity for improved data-exchange guidance and standardization. A summary is given below:

1. **Each party calculates and reports GHG emissions, but the exchange of values and the use of any exchanged values is limited.** This results in duplicity of calculations, differences in assumptions and input values used, and differences in reported emissions.
2. **It is not just about the granularity of reporting but about using the right emission intensity granularity.** Everyone is seeking to move beyond annual reporting to enable performance monitoring and facilitate decision making; however, the accuracy of the data is to a large extent determined by the granularity of the emission intensity factor used.
3. **The majority of systems in use by freight buyers use default and modeled data and cannot cope with primary data yet.** Although it is planned by all parties to move towards primary data directly from the supply chain, this is not yet implemented nor does a system exist where companies can reliably exchange these values that can cope with all modes and the sheer number of stakeholders involved in a supply chain.
4. **Clear parameters and guidance are key to standardize any kind of exchange, independent of data type or use case.** Due to the absence of clear guidance, companies are not capturing the necessary information in their systems and subsequently calculate with partial information.
5. **GLEC certified calculations by carriers or audited 3rd party intermediates will be needed to accept primary data.** Primary data poses new challenges towards the verification and validation of the accuracy of the methodology and the input data; third party assurance

will be required for nearly all organizations to accept and start utilizing this informal reporting and decision making.

### 9.1.2 Results Phase 2

The already published guidance has been completed with the formation of an inclusive collaborative project group operating under the Global Logistics Emissions Council. Two workstreams were set, one for the guidance developments and the other for the data model and model development. Both workstreams included a diverse group of members, representing the different stakeholders (Shipper, LSP, Carrier, IT provider), with bi-weekly workstream meetings between September and December.

- The **Guidance Workstream** worked towards an overall guidance document to (i) define the use cases, (ii) set out the responsibilities for the data, (ii) produce recommendations to gain trust & setup assurance process, (iv) produce recommendations on incentives, (v) discuss the merits of ranking data quality and (vi) defining the logic of the data model.
- The **Data Model Workstream** worked towards the development of a data model for the exchange of data, suitable for various data format types, based on DIN SPEC and allowed for three exchange scenarios: 1. emission data is available 2. fuel/energy consumption is available 3. no consumption data is available with the use of the proposed variables.

The developments and results of the workstreams were presented and discussed with the project group for verification in a webinar in October and December 2021. A final review within the project group was conducted in January 2021 which led to a subsequent publication of a draft guidance in February 2022. The outcome contained a first draft of the data model and guidelines which was tested during the rest of 2022 as part of Phase 3.

### 9.1.3 Phase 3

From the previous publication, the Data Model Workstream resulted in publishing the first draft version of the data model to be used in the context of calculating and exchanging logistics GHG emissions. To test its validity, limitations and areas of improvement, organisations that were willing to assess it and to apply it in their IT systems were identified. Thus, in the third phase, the data model was applied and assessed with real-life use cases. Specifically, it was tested by the teams of EVE Platform, Greenrouter, shipzero and Transporeon Carbon Visibility Platform[1]. This phase was completed through an inclusive collaborative project group operating under the Global Logistics Emissions Council and partners, consisting in the following key activities:

- **Official kick-off webinar** with broader group in April 2022. The objectives and approach and the three main case studies supporting Phase 3 were presented. The project partners who contributed with case studies, presented their scope along with initial results, including the presentation of the level of granularity in their IT systems, the approach for emissions data collection and calculation and lastly what the results will be used for.
- **Monitoring of case studies**, consisting of recurrent meetings with the three project partners to check progress and alignment with data model during the months of April-September 2022. SFC monitored the case studies, by discussing about the progress and the issues around data collection. Conclusions were drawn on data quality, practical aspects of data collection,

[1] The results of this case study are published here.

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usability of variables and general use of the data model. To assess its adoption, a framework with specific variables was set up to help track the extent of adoption and the difficulties faced by the organizations who participated in the testing. The main criteria of assessment were: accuracy, completeness, consistency, timeliness, validity and uniqueness. The assessment was qualitative through a series of discussions with the teams implementing the data model.

- **Expert feedback session** in July 2022, presenting updates on case studies and conclusions. Participants were both project and knowledge partners. Feedback on the data model was asked, with a particular focus on: improvement in variable naming, change in categorization and definition of specific parameters and challenges encountered when exchanging data between systems.
- **Revision** of the guidance between September to October. Considering the collected feedback and a subsequent alignment with concepts of the upcoming ISO14083 and the PACT Framework. The results will be presented to the project group in November.
- **Writing** of the guidance. Final stage is the writing of the official guidance which was completed through November - December 2022.

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