VDA and ECG Recommendation

Emissions calculation and reporting guideline for automotive supply chains

November 2025

About VDA
The German Association of the Automotive Industry (VDA) consolidates about 650 manufacturers and suppliers under one roof. The members develop and produce cars and trucks, software, trailers, superstructures, buses, parts and accessories as well as new mobility offers. We represent the interests of the automotive industry and stand for modern, future-oriented multimodal mobility on the way to climate neutrality. The VDA represents the interests of its members in politics, the media, and social groups. We work for electric mobility, climate-neutral drives, the implementation of climate targets, securing raw materials, digitization and networking as well as German engineering. We are committed to a competitive business and innovation location. Our industry ensures prosperity in Germany: More than 780,000 people are directly employed in the German automotive industry. The VDA is the organizer of the largest international mobility platform IAA MOBILITY and of IAA TRANSPORTATION, the world's most important platform for the future of the commercial vehicle industry.

About ECG
ECG – the Association of European Vehicle Logistics is the established European platform for the outbound automotive logistics sector bringing together logistics service providers and suppliers to the sector. ECG aims to facilitate non commercial collaboration between member companies and assist them in sharing best practices in many operational areas, especially the harmonisation of operational standards.

Content

List of abbreviations

ADD	Actual driven distance
BEV	Battery electric vehicle
CEU	Cargo equivalent units
CNG	Compressed natural gas
CO_2e	CO_2 equivalent
Con-Ro	Container/ Ro-Ro Cargo Ship
DEFRA	Department for Environment, Food & Rural Affairs
DAF	Distance adjustment factor
DIUM	Distancier international uniforme marchandises
DUNS	Data Universal Numbering System
ECF	Energy consumption factor
ECG	Association of European Vehicle Logistics
EIID	Emission Intensity ID
EMS	European Modular System
EV	Electric Vehicle
FTL	Full truck load
FV	Finished vehicle
FVL	Finished vehicle logistics
GCD	Great circle distance
GHG	Greenhouse gas
GLEC	Global logistics emission council
GVW	Gross vehicle weight
HVO	Hydrotreated Vegetable Oil
ICE	Internal combustion engine
ICT	Information and communications technology
IEA	International Energy Agency
JIS	Just-in-sequence
JIT	Just-in-time
LDL	Lower deck load
LNG	Liquefied natural gas
LPG	Propane
LSP	Logistics service provider
LTL	Less than truck load
MoT	Mode of transport
OEM	Original equipment manufacturer
PCC	Pure car carrier
PCTC	Pure car truck carrier
PHEV	Plug-in hybrid electric vehicle
PTS	Points
Ro-pax Ship	Roll-on/ Roll-off passenger ship
RoRo	Roll-on/ Roll-off
RNE	RailNetEurope
RWU	Railway undertaking
SFD	Shortest feasible distance
TCE	Transport chain elements
TEU	Twenty-foot equivalent unit
TMS	Transport management system
TOC	Transport operating categories
TKM	Tonne-Km
TTW	Tank-to-Wheel
UIC	Union international des chemins de fer
VDA	Verband der Automobilindustrie
WTW	Well-to-Wheel

1. Introduction

The urgency for more sustainable and environmentally conscious automotive logistics practices has led to an initiative backed by leading players in the European automotive industry. This collaborative project engages stakeholders from all facets of the industry – Original Equipment Manufacturers (OEMs), suppliers, and Logistics Service Providers (LSPs).

Together, under the umbrella of the Verband der Automobilindustrie (VDA) and the Association of European Vehicle Logistics (ECG), this consortium has developed a guideline, framing the application of ISO 14083, to standardize transport greenhouse gas (GHG) emissions reporting within the automotive supply chain. The current focus of the guideline is GHG emissions measured as CO_2 equivalents (CO_2e), while all data exchange procedures are also capable of including additional air pollution emissions.

This widespread participation by industry leaders represents a collective commitment to mitigating the environmental impact of logistics processes in the automotive industry.

The guideline's principal aim is to provide a clear framework for the application of ISO 14083 in the automotive industry by tailoring industry-specific requirements. The objective is to harmonize the interface between OEMs, suppliers, and LSPs, delineating defined responsibilities and standard reporting procedures.

The guideline lays down minimum requirements for data accuracy and transparency and aspires to continuously elevate the ambition level within the industry.

To facilitate this transition, the guideline introduces a standard scheme for reporting the emission intensity of different transport operating categories (TOC) and consignment GHG emissions to customers. A transparent and comprehensive approach promotes comparability and comprehension across all involved parties.

The guideline specifically provides a detailed calculation guide for initially focused transport modes, namely road and rail transportation. This precise approach ensures the reliability of emissions data, thereby enhancing the credibility of reported information and confidence in the industry's sustainability measures.

As a guideline, it serves as a recommendation rather than a mandatory standard. However, companies are highly encouraged to adopt it as a means to standardize their interactions and procedures concerning GHG emissions reporting. Since this is the first version of the guideline, companies that implement their GHG reporting based on this guideline are asked to provide feedback to the VDA and ECG regarding their initial application experiences and identified needs for further development.

The guideline is designed to integrate seamlessly into the existing normative standardization schemes. It focuses on the movement of freight necessary to support the automotive industry, specifically from the perspective of suppliers and automotive manufacturers. Examples primarily target finished vehicles, production materials and service parts, but the same principles apply throughout the complete supply chain.

In conclusion, the guideline offers an industry-approved roadmap for tackling GHG emissions, fostering a shared sense of responsibility, and promoting best practices throughout the automotive supply chain. By using this guide as a starting point, companies of the automotive industry can make significant strides towards a more accurate and standardized transport emission calculation and reporting.

2. Automotive industry specifics

This section delves into special aspects of transport and logistics operations within the automotive industry, which aren't exhaustively detailed in the existing standards such as ISO 14083, GLEC Framework or Greenhouse Gas Protocol. The foundational methodology stays unchanged: it necessitates identifying all the transport chain's individual components, encompassing potential unladen journeys, and subsequently collating the required data for calculating emissions.

These unique aspects, however, influence how transport operation classifications are established for application in automotive logistics. As a result, a more nuanced and tailored set of transport categories is generated.

2.1. Strategic automotive characteristics

The automotive industry employs a hybrid procurement strategy for logistics services, combining end-to-end door-to-door transports and granular-level procurement. Transport chains include multiple legs and modes of transportation, optimizing logistics and coordination throughout. Clear logical links between Transport Chain Elements (TCEs) are therefore needed.

The Automotive Industry generally already has a high maturity level in standardized digital ordering, labeling, packaging, and delivery communication. The objective of transport GHG emission reporting is therefore to use these frameworks as much as possible and understand GHG emission reports and one additional data exchange communication during a transport.

Despite the automotive industry's stringent auditing standards for emission reporting, it's notable that there is no official auditing mode for submitted transport GHG emissions in the automotive logistics sector. This lack of certification requires industry customers and their auditors to validate the emission data from LSPs independently.

To address this, the industry uses a hybrid approach, where emission data must include a standardized data source indicator and an ISO verification indicator. This enables parties to effectively evaluate and validate information. Furthermore, LSPs are tasked with ensuring ISO-compliant validation of their data and calculation methods.

The Automotive Industry has a high general market influence and ambition level for net zero impact operations. Therefore, a clear development path of emission reporting will be defined in this guideline, reflecting both the current level of capabilities in the LSP market as well as the future industry ambitions.

A standardized emission reporting is understood as a partnership approach between OEMs/suppliers and LSPs to achieve mutual benefits in the efficiency and accuracy of the reporting process. This includes OEMs/suppliers to be responsible for appropriate input data quality e.g., in terms of consignment mass, vehicle master data etc.

2.2. Nature of the cargo transported

The Automotive Industry does rely on dedicated automotive networks (especially in finished vehicle logistics (FVL) and parts of the material logistics process) but is also a customer industry of general cargo networks such as container sea freight or road transportation groupage networks.

2.2.1. Finished Vehicles
Transporting finished vehicles in the automotive industry is a distinct logistical task, given its specific needs. It involves handling a range of vehicles with varying dimensions and mass, requiring diverse transport methods, from specialized car carriers to railway wagons. Automotive logistics also accommodates a substantial volume of used cars, adding complexity in terms of vehicle condition, value, and care during transport. As a result, transporting both new and used vehicles forms a complex yet essential part of automotive logistics.

Therefore, the guideline gives specific recommendations for finished vehicle transports regarding the allocation of transport GHG emissions to each vehicle as well as tailored default values.

2.2.2. General Cargo
In the automobile industry, general cargo typically refers to vehicle parts, components, or materials used in the manufacturing process. These items can vary significantly in size, mass, and shape, and they differ from bulk cargo. They can range from small items like nuts and bolts to larger assemblies such as engines, battery modules, pressed parts and car shells.

Despite the wide diversity of these items, their packaging, and the requirements for their transportation, the guideline offers a comprehensive framework. This framework addresses transportation types and associated calculation parameters for determining transport GHG emissions. The goal is to make the reporting of general cargo emissions in the automobile industry as standardized and comparable as possible.

2.2.3. Other materials
Beyond the aforementioned transports, the automotive industry also relies on several other specialized transport types. These may encompass raw and bulk materials as well as specific general cargo items like battery cells and modules.

The guideline does not intend to encompass all potentially transported items within the automotive supply chain. It's presumed that the GHG emission calculations for transported goods, where the automotive industry isn't the primary user, are handled by relevant initiatives from other industries (e.g., tailored GHG transport emission calculation recommendations from the chemical industry).

Specialized assets vital to the automotive industry are addressed within the guideline based on their predominant mode of transport. For rail and road transports, there will be custom recommendations specifically for battery consignments. Additionally, steel transports will be covered for rail transportation.

2.3. Transport mode specifics of the automotive industry

2.3.1. Modal split Automotive
The modal split refers to the distribution of freight transport across different modes of transport like road, rail, and inland waterways. The European automotive industry has based on Eurostat data an average modal split for intra-European inland-transports in terms of transport activity of 88 % by road, 11 % by rail, and a mere 1 % by inland waterways.

These figures reflect the specific requirements of the automotive industry. Based on this as-is situation it has been decided to initially focus on the dominating transport modes of road and rail.

2.3.2. Transport Operating Models

The transport setup in the automotive industry incorporates several unique features to ensure efficient and timely delivery of components, parts, and vehicles. Beside regular point-to-point/FTL transport, automotive transport operating modes include Just-in-Sequence (JIS) and Just-in-Time (JIT) transport, dedicated Milkrun transport in several formats (e.g., collection rounds in supplier regions or finished vehicle distribution to the dealer network). Tailored transport vehicles (especially in Finished Vehicle Logistics), dedicated loading equipment and intermodal transport setups also in needed reflected in an industry tailored GHG emission calculation approach.

2.3.3. Specialized Transport vehicles

The automotive industry employs specialized transport vehicles to meet its unique logistical needs. Car Carriers or Vehicle Transporters transport completed cars, featuring multiple levels and securing mechanisms to prevent damage during transit.

For larger vehicles like trucks or buses, Flatbed Trucks with open, level beds are used, while Vehicle Transport Trains transport finished vehicles in bulk over long distances.

Specialized Containers with advanced features like temperature control or shock resistance are employed for sensitive components like engines or batteries.

Differentiating those types of transport equipment will be a key aspect of tailored automotive specific TOCs.

2.4. Automotive-specific processes

2.4.1. Freight payer

In automotive logistics, the ‘freight payer’ is the customer primarily responsible for paying the line-haul freight charges for transportation provided by the logistic provider or the company running the owned/operated vehicles. It is essential to note that the shipper is not always the freight payer of a transport. This variability in arrangements significantly impacts emissions calculations and data transparency, necessitating information exchange among all involved parties. Thus, the concept of the ‘freight payer’ underscores the need for effective coordination within automotive logistics for accurate emissions calculations.

2.4.2. End customer

In automotive logistics, the ‘end-customer’ represents the final point in the chain where the product or component is either incorporated into the next assembly (which may not necessarily be a vehicle) or arrives at a retailer transferring ownership to a private or commercial user. For an automotive supplier, this point is crucial for calculating emissions and transparency in data sharing. For an Automotive OEM, the end-customer may be a retailer who transfers the vehicle’s ownership to a private or commercial user, i.e., those who will ultimately drive the vehicle. Alternatively, it could be an independent vehicle conversion company who significantly converts the vehicle before resale. These varied scenarios require effective coordination and communication for accurate emissions calculations.

2.4.3. Value-added services

In the automotive industry, value-added services like pre-assembly in the supply chain are common. Parts may pass through an intermediary for enhancements before reaching the manufacturer. This process, which can include component assembly, quality checks, or customization, streamlines manufacturing and simplifies supply chain management. The influence of these third parties within the end-to-end supply chain needs special consideration when defining the reporting scope of GHG transport emissions.

3. Objectives and ambitions of the automotive industry

The companies that have contributed to this guideline understand that the foundation must be inclusive, accommodating all industry players irrespective of their current level of maturity in processes and systems relevant to transport emissions calculation and reporting.

The customer side acknowledges the target scenario of ISO 14083, where emissions should be calculated based on primary data wherever possible and reported by the party responsible for transport operations. Appropriate data science approaches can be used for extrapolation of missing data and data validation.

Therefore, the guideline describes an agreed roadmap that serves as a guide for all industry players regarding the ambition level and the increase of the minimum requirements to meet these ambitions over time.

Standardized emission reporting for the automotive industry is perceived as a partnership approach between OEMs/suppliers and LSPs to achieve mutual benefits in the efficiency and accuracy of the reporting process. Thus, the roadmap deals with not only the reporting responsibilities of the LSPs but also the required input from the customer side to meet these requirements. This specifically includes the provision of accurate mass information and order reference data (including the mass and dimension master data of vehicles in FVL) provided by the industry side in their order data.

The roadmap consists of three phases:

1. **Startup phase:** Establishes the basic responsibility setup related to ISO, regarding the emission calculation responsibility on the LSP side and the emission reporting to the customers.
2. **Improvement phase:** Aims at the step-by-step improvement of the emission calculation methodology and accuracy.
3. **Maturity phase:** Targets the state of primary data-based emission calculation and reporting.

Each roadmap phase defines the minimum requirements regarding the emission calculation approach, the frequency of updating or transferring data, and additional special considerations on the TOC and TCE levels. If the application of this guideline is agreed between a LSP and a customer the minimum reporting standard a LSP must meet is defined by the respective roadmap phase. Below is a detailed outline of the three phases:

Major emission regulation standards in the EU, especially those impacting industry and transportation, are currently under review and several have been postponed. For example, the introduction of new Euro 7/VII vehicle pollution emission standards for cars, vans, and heavy-duty vehicles has been delayed again, and will now only come into force gradually from 2026. Additionally, the compliance deadline for CO_2 emission targets for car manufacturers has been extended from 2025 to 2027, allowing manufacturers to average their emission values over this period rather than meeting annual targets, which effectively relaxes short-term obligations.

These regulatory delays and proposals like the Omnibus 1 package from the European Commission particularly affect reporting obligations for small and medium-sized enterprises (SMEs), as it allows them a much-needed breathing space for adapting without undue pressure and to focus their investments in decarbonizing their operations. In contrast, large corporates continue to bear the main responsibilities and must adhere to stricter reporting and verification standards.

As a result, this guideline does not give uniform guidance on the maturity level required for transport emission calculation and reporting, as obligations differ depending on company size and regulatory postponements.

Nevertheless, customers remain a key driver in setting reporting expectations, as they may demand specific emissions data from their suppliers regardless of regulatory requirements. Therefore, the pace and depth of emissions reporting for any company are often determined by joint agreements with customers, aligning with their expectations and supply chain requirements. It is recommended to refer those agreements to the different guideline implementation phases, allowing a transparent and consistent definition of roles and responsibilities. Below is a detailed outline of these three phases:

Startup phase

Minimum Standard for TOC calculation and reporting	Minimum Standard for TCE calculation and reporting	Other aspects of data exchange
Applying at least the automotive specific default values where available and GLEC default values for all other transport modes Providing at least yearly updates for the emission intensity of each TOC	Applying the recommended distance modelling approach (SFD including overall route information for RoRo shipping, SFD/GCD for all other transport modes) Using actual mass information (or actual number of loading units if applicable) on the individual consignment level Applying the adjusted mass calculation for vehicle road and finished RoRo transports Reporting the GHG emission calculation results for each consignment in synchronization with the agreed payment schedule	Relevant transports according to Chapter 4 -Application scope and system boundaries of the guideline where the reporting company is not the freight payer need to be reported based on modelled information (no cross-industry data exchange)

Table 1: Roadmap for the minimum Standard for TOC and TCE calculation and reporting: Startup phase

Improvement phase

Minimum Standard for TOC calculation an	Minimum Standard for TCE calculation and reporting	Other aspects of data exchange
At least applying a detailed modelled emission calcula-tion approach fully specifying all recom-mended TOC param-eters/characteristics Providing quarterly updates for the emis-sion intensity of each TOC	Applying the recommended distance model-ling approach (SFD including overall route information for RoRo shipping, SFD/GCD for all other transport modes) Using actual mass information (or actual num-ber of loading units if applicable) on the indi-vidual consignment level Applying the adjusted mass calculation for fin-ished vehicle road and RoRo transports Reporting the GHG emission calculation re-sults for each consignment in synchroni-zation with the agreed payment schedule	Relevant transports according to Chap-ter 4 of the guideline where the reporting company is not the freight payer need to be reported based on modelled information (no cross-industry data exchange)

Table 2: Roadmap for the minimum Standard for TOC and TCE calculation and reporting: Improvement phase

Maturity phase

Minimum Standard for TOC calculation and reporting	Minimum Standard for TCE calculation and reporting	Other aspects of data exchange
A primary data-based emission intensity calculation should be applied under consideration of the recommended rules and methods of the guideline Providing quarterly updates for the emis-sion intensity of each TOC	Applying the recommended distance model-ling approach (SFD including overall route information for RoRo shipping, SFD/GCD for all other transport modes) Using actual mass information (or actual num-ber of loading units if applicable) on the indi-vidual consignment level Applying the adjusted mass calcula-tion for fin-ished vehicle road and RoRo transports Reporting the GHG emission calcula-tion re-sults for each consignment in synchronization with the agreed pay-ment schedule	A data exchange interface between the freight paying company and other reporting com panies is used (freight payer takes responsibility in sharing emission information with the customer/supplier)

Table 3: Roadmap for the minimum Standard for TOC and TCE calculation and regulation: Maturity phase

This roadmap reflects the collective ambition of the industry players to improve the accuracy of emission calculations, standardize the reporting process, and enhance the overall effi-ciency of the system. it underscores the shared responsibility of all stakeholders in achieving a greener and more sustainable automotive industry.

4. Application scope and system boundaries

This Chapter delves into the intricate realm of GHG emission reporting in the automotive industry, specifically focusing on its application scope and system boundaries. Given the industry's complex structure – ranging from a multi-tiered supply chain to diverse end customers and varied distribution channels – it is crucial to accurately define these aspects.

First, a process map that delineates the intricate structure of the automotive industry is introduced. This map provides a comprehensive overview of the journey of materials through the supply chain, as well as the array of end customers and distribution paths. This wide-ranging view serves as the foundation for a concrete definition of the application scope and system boundaries.

Common scenarios within the automotive industry are then drawn building on this foundation. These illustrations shed light on who holds the responsibility for reporting Scope 3 emissions within the diverse constellations comprising the industry's process landscape. These case studies encompass different phases of the supply chain – pre-inbound, inbound, pre-outbound, and outbound – as well as intracompany business.

The ultimate goal is to foster a profound understanding of the unique challenges and requirements concerning GHG emission reporting in the automotive industry. With this Chapter, we aim to provide clear and practical guidelines for the application scope and definition of system boundaries within this context.

4.1. Process Landscape

The process landscape of the automotive industry is vast and interconnected. it begins with the procurement of raw materials from various sources and extends to the production of vehicles and their delivery to end customers.

4.1.1. Raw Material Acquisition and Initial Processing

The initial phase of the process landscape includes the acquisition of raw materials and their initial processing. Suppliers at this level provide a variety of materials, from steel and aluminium for the vehicle's frame to plastics and textiles for the interior.

4.1.2. Component Manufacturing

Once raw materials have been processed, they are used in the production of components. This includes everything from engine parts and body panels to electronic systems and interior fittings. These components are produced by a range of suppliers, often known as Tier 1, Tier 2, and Tier 3 etc. suppliers, depending on their place in the supply chain.

4.1.3. Vehicle Assembly and Manufacturing

Vehicle manufacturing in the automotive industry is not a simple, linear process. The automakers operate through intricate internal processes that involve various stages of assembly and manufacturing, often occurring at different sites. These multi-tiered procedures within the manufacturers resemble the layered structure of the supply chain, adding another level of complexity to the process landscape.

4.1.4. Distribution and Sales

Once vehicles have been manufactured, they are transported to dealerships or directly to customers. This phase includes not only local deliveries but also international shipping, requiring a complex logistics network.

4.1.5. Service Parts and Accessories

In addition to the manufacture of complete vehicles, components and accessories are also part of the automotive supply chain – providing items to customers and service centres for the maintenance and repair of vehicles

4.1.6. End Customer

Finally, the vehicles reach their end customers. These could be individual consumers, businesses, leasing companies, rental car agencies, or government organizations. Each of these customer types represents different distribution channels and requires GHG reporting.

Understanding this process landscape is crucial for determining who is responsible for calculating and reporting emissions in various scenarios within the automotive industry's process landscape.

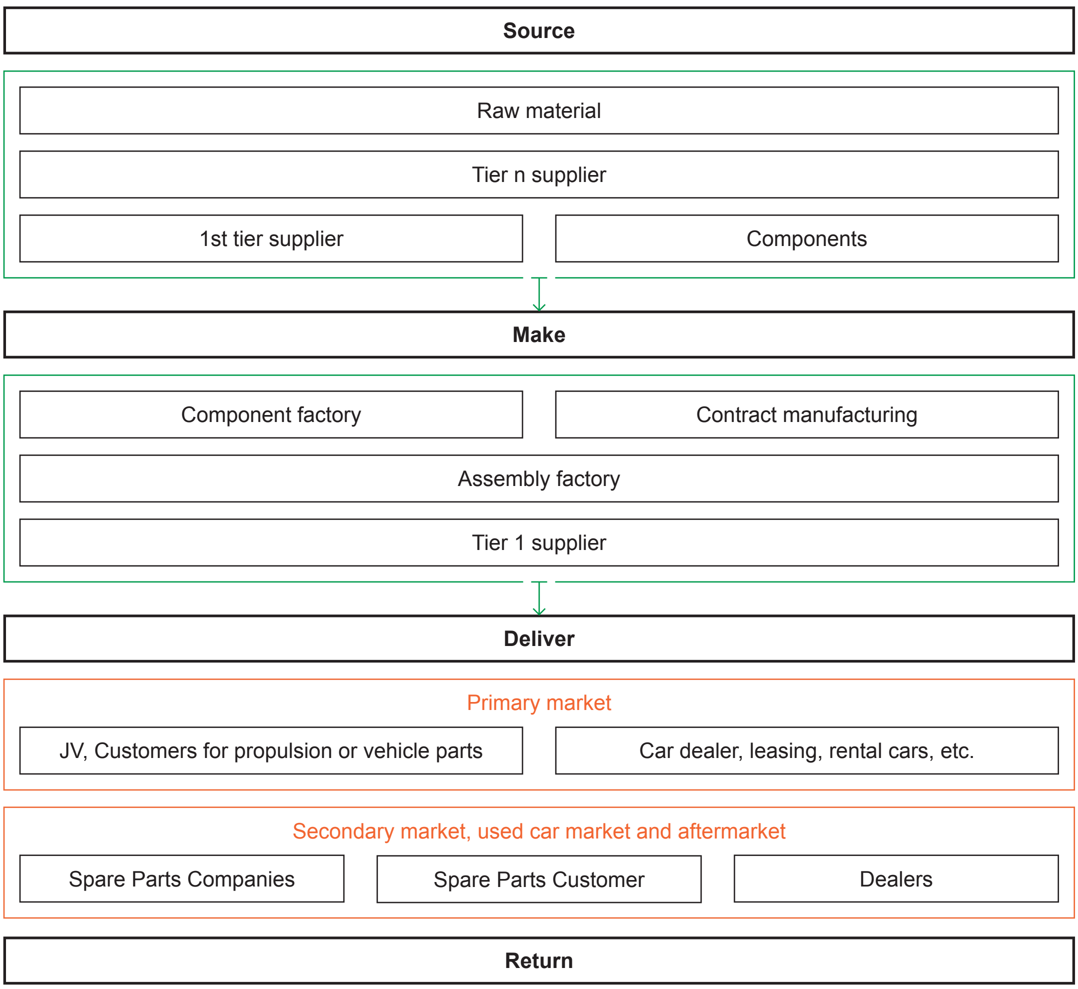

Figure 1: Process landscape of the automotive industry

4.1.7. Freight payment

Unraveling the task of assigning responsibility for reporting and controlling greenhouse gas emissions linked to transportation and distribution proves challenging within the convoluted structure of the automotive industry. The key to deciphering this responsibility often lies in who pays for the freight. Essentially, the responsibility for identifying/calculating emissions from transportation and distribution lies with the company responsible for freight payment. This is because the freight-paying company usually has contractual control over the choice of transportation and can access the emissions data from the freight transport operator.

4.2. Reporting Scopes of automotive transport

In the context of the automotive industry's supply chain from the perspective of an OEM, there is a distinction between 1st tier and N-tier (all suppliers below 1st tier) suppliers when it comes to categorizing Scope 3 emissions. Emissions related to movements between N-tier and 1st tier suppliers typically fall into category 1 (Purchased Goods and Services) of Scope 3 emissions, as the transportation and distribution are an integral part of the provided goods and services.

Freight transportation related emissions can be classified as Scope 1, Scope 2, or Scope 3 (Categories 4 and 9) within the Greenhouse Gas Protocol. All emissions starting from tier 1 to the end customer of a reporting company must be included. The Scope that the freight movements should be recorded against relates purely to the ownership or who the freight payer is for the transport being used. Scope 1 and Scope 2 relate to emissions from owned and operated vehicles, including electrically powered ones charged with imported/purchased electricity. Scope 3, however, covers transportation not reported in Scope 1 or 2, i. e., non-owned/operated transport.

As all entities within the supply chain are obligated to report their upstream transport from their tier 1 suppliers, as well as the downstream transportation to their end customers, it's imperative to establish a robust communication method for sharing the emissions data. The company responsible for the transportation (either as owner-operator or person paying for the service) should also be responsible for communicating the level of CO_2e (CO_2 equivalent) applicable from the share of the freight movement to the other interested parties.

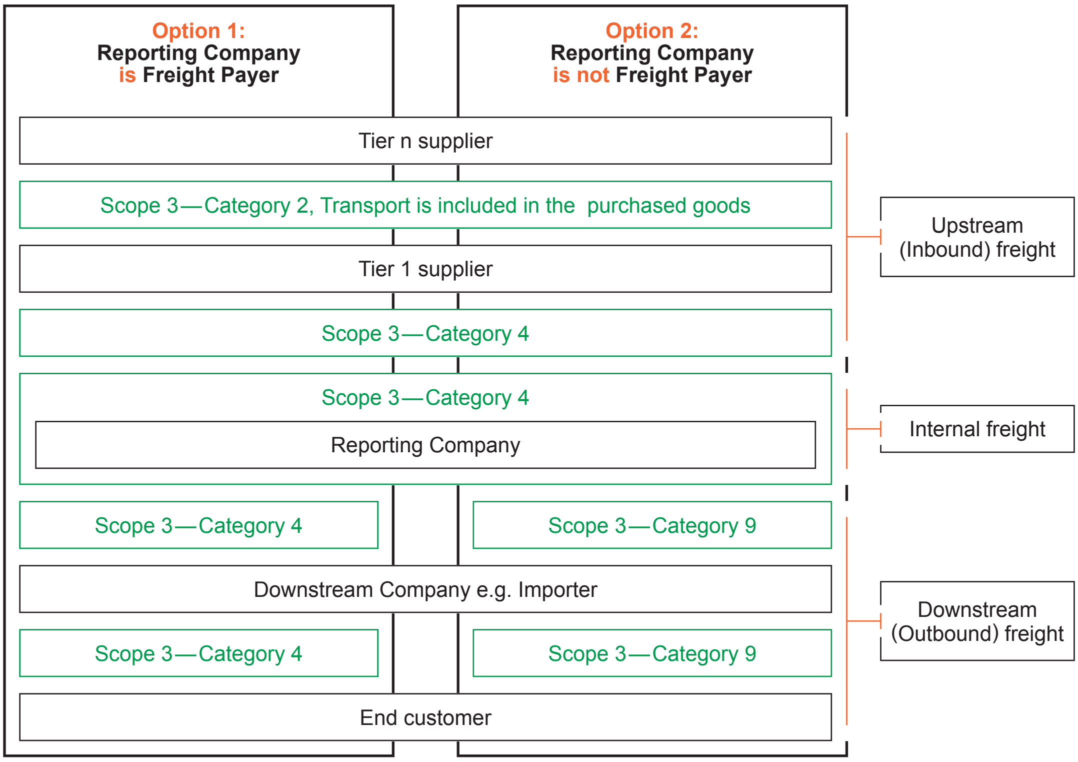

Figure 2: Non owned/operated transport emission categories from the perspective of the "Reporting Company"

To ensure comprehensive and accurate tracking and management of GHG emissions, the following checklist is designed to cover all relevant supply chain processes for an OEM or supplier.

These sections include inbound, intracompany, Outbound, Aftermarket, Retail transports, and the flow of empty packaging materials. The objective of this checklist is to confirm that all emissions, including those generated during the transportation and handling of empty packaging materials, are effectively measured, monitored, and managed in accordance with applicable regulations and industry best practices.

Each section refers to a dedicated example in the annex of the guideline for further details and explanations.

Supply Chain step	Description	Reference
Inbound	inbound transports coming from suppliers to production or component plants as well as deliveries to consolidation and distribution centres are covered for all freight payment situations.	Annex 8.1.1
Intracompany	All transports between the various business units. This includes the transportation of raw materials, components, semi-finished goods, finished goods between different production sites, warehouses	Annex 8.1.3

Supply Chain step	Description	Reference
Outbound	Consignments of finished vehicles or products (from suppliers) are covered from the production plant down the retail chain as far as possible (ideally until the end customer), also if the legal entity structure changes.	Annex 8.1.4
Aftermarket	OEMs and suppliers must consider all transportation related to the distribution of spare parts, accessories, and other products sold after the original sale of the primary product. This includes transport to various distribution centres, retailers, or directly to the customer.	Annex 8.1.5
Mate-rial flows of empty packs	All transportation associated with the return of empty production packaging materials back to the supplier. This includes transport from the place of origin to the production sites, intracompany transports, and return transports once the materials have been used.	Annex 8.1.5
Returns	All transport related to the return of goods. This encompasses not only customer returns but also intra-company returns of un-sold or defective products, and reverse logistics necessary for their management. it may include the transport of these goods back to distribution centres, warehouses, or manufacturing sites, and potentially onwards to recycling or disposal facilities.	Annex 8.1.5

Table 4: Automotive Industry transport scenarios

5. Roles and responsibilities in automotive transport emissions calculation and reporting

The logistics and transportation sector is at the heart of global commerce, fueling economic development and facilitating a connected world. However, this crucial industry is also responsible for a substantial portion of worldwide GHG emissions, demanding significant attention towards environmental sustainability. in this context, the role of Transport Operators emerges as pivotal.

5.1. Logistics Service Providers

Logistics Service Providers carry a profound responsibility for adopting sustainable practices, reducing the carbon footprint of their operations, and contributing to a sustainable logistics and transportation industry. From selecting the appropriate modes of transportation to optimizing routes for fuel efficiency, their actions have a direct impact on the GHG emissions associated with each transport. Thus, LSPs are not just service providers; they are the torchbearers of sustainability in the industry.

5.1.1. Creating the Right Environment for Responsibility

For LSPs to effectively shoulder this responsibility, they require supportive conditions and active cooperation from their customers. Customers need to recognize their role in fostering a green supply chain and work collaboratively with their LSP. This collaboration can manifest in various forms, such as providing accurate and timely data, being flexible with transport modes and schedules, and acknowledging the efforts made towards environmental sustainability.

5.1.2. Meeting Customers' Reporting Obligations

Despite the onus being on the LSP to reduce emissions, customers have their own reporting obligations as well as strategic ambitions and objectives in GHG emission reduction. Customers therefore need detailed data to fulfil their responsibilities, demonstrate their commitment to environmental sustainability, and provide auditable proof of their efforts. it's thus imperative that customers receive comprehensive and accurate reports from their LSP. These reports should provide granular insights into the GHG emissions associated with their transports, empowering them to not only meet their reporting obligations but also devise effective strategies for further emission reductions.

This foundation of an effective GHG emission reporting structure lies in clearly defined roles and shared responsibilities. All key stakeholders – the ECG, VDA, OEM, Suppliers, and LSP must contribute to achieving accurate and comprehensive emission calculations and reporting.

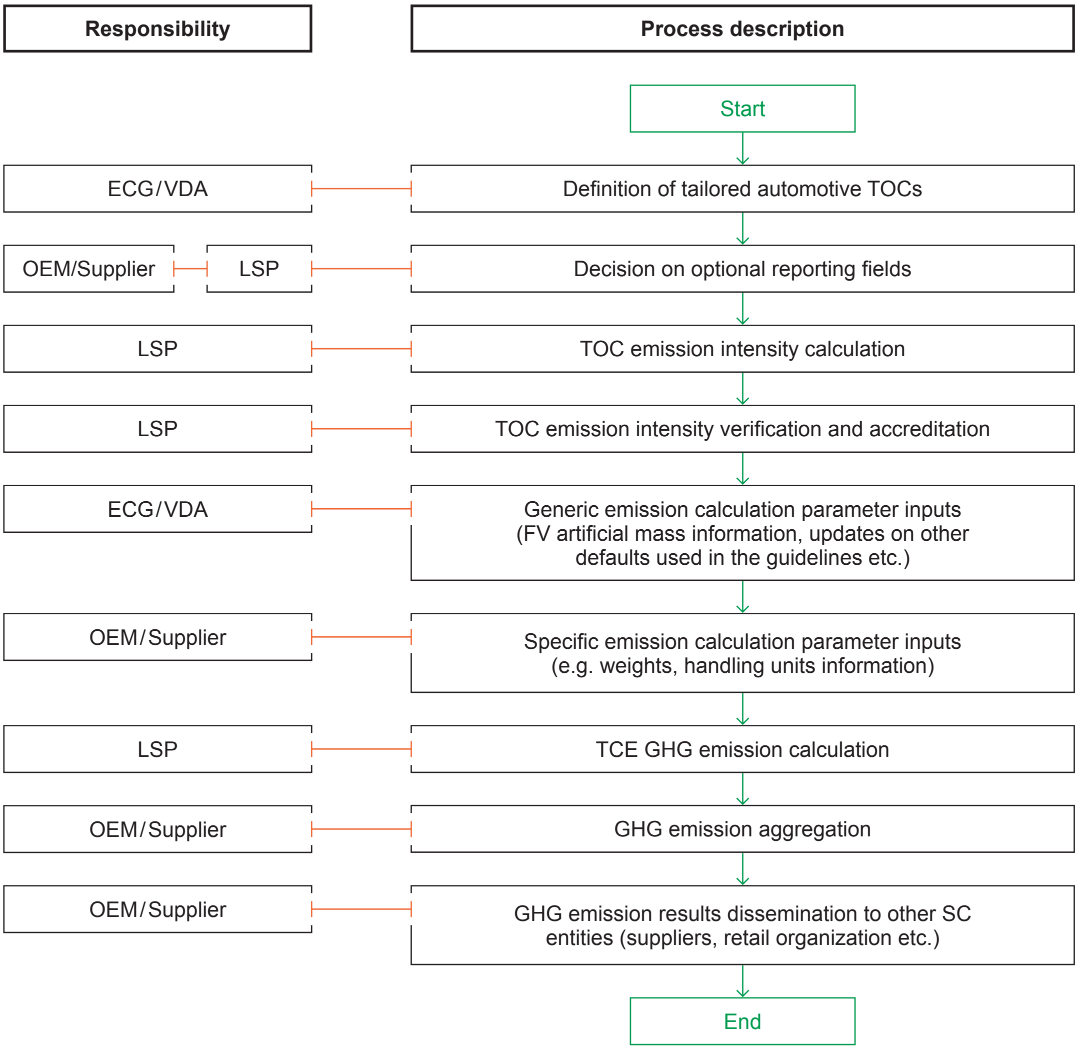

Figure 3: Roles and Responsibility in automotive transport emission calculation and reporting

This model of shared responsibility not only streamlines the emission calculation and reporting process but also fosters a culture of transparency, accountability, and collaboration among all stakeholders.

The following Chapters delve into the specifics of the reports, namely the TOCs Report, TOC Emission Intensities Report, and TCE Report. These reports underscore the concerted efforts of all parties and form the foundation of a robust and credible sustainability reporting structure in the automotive transport industry.

6. General guideline for transport emissions reporting

6.1. Master Data Report

The process of creating an accurate emissions report begins by attributing all transports or hub activities, regardless of the client, to a corresponding TOC or HOC. For better readability, only "TOC" is mentioned in the following text, but HOC are formed in the same way, with the same characteristics. A TOC is a categorization framework that helps organize transport operations based on their shared attributes, serving as the basis for all subsequent analysis.

The TOC Master Data Report is a comprehensive dataset for each TOC. It includes an identification code, the name, and further specific parameters such as the Mode of Transport (MoT), Asset type, Propulsion type, and more, depending on the mode of transport. These parameters are critical in accurately grouping each transport operation under the appropriate TOC and serve as key variables in the ensuing emissions calculations.

XML files for all the reports described below (Master Data Report, Emission Intensity Report, Transport TCE GHG Emission Report and Hub TCE GHG Emission Report) can be downloaded online at the following link: https://www.odette.org/repository/VDA_ECG_ODETTE_CO_2_Reporting_V1R1.zip

6.1.1. TOC Identification Code

Each TOC is represented by a specific seven-digit serial number. Each position of this number corresponds to a particular parameter in the context of the chosen mode of transport, and the number at that position provides information about the specific manifestation of that parameter.

As an example for the rail mode of transport, let's consider the serial number '1135101'. The significance of each number in this serial number is as follows (Annex 8.4.1):

Number	Parameter	Value
1	Asset	Finished Vehicle
1	Transport concept	Single Wagon
3	Train configuration	< 700 m length
5	Wagon type	Flat Wagon
1	Operating mode	Shuttle full-full
01	Propulsion type + Source of electric energy	Electric powered – energy mix

Table 5: TOC identification example

It's essential to note that in the serial number "0" stands for "empty." This means that the specific parameter has no significance for the particular mode of transport.

Detailed definitions for the individual numbers and positions of the serial number related to different modes of transport – Road, Rail, and RoRo – can be found in the respective sub-Chapters of this guideline.

To ensure the correct identification of the associated mode of transport, this will be guaranteed by a separate column in the 'TOC Master Data Report'. Through this system, companies can categorize their transport activities accurately and ensure consistent GHG reporting.

6.1.2. Master Data Report Parameters

The TOC Master Data Report is delivered initially and only updated when there's a change in any of the relevant parameters. This approach ensures that any changes in the operation characteristics are accurately captured and reflected in the emissions data, promoting accurate and up-to-date reporting. This foundational step is critical to understanding the complex relationship between different transport types and their corresponding greenhouse gas emissions, enabling us to create more targeted strategies for emissions reduction.

Parameter	Definition	Requirement
ID	See 8.2.1	mandatory
Name	See 8.2.1	Optional
BusinessEntityID	See 8.2.1	Mandatory
AutomotiveIndicator	See 8.2.1	Mandatory
AssetType	See 8.2.1,7.2.2.1 (road), 7.3.2.1 (rail), 7.4.2.1 (sea), 7.6.2.1 (hub)	Mandatory
AssetType starts with 'road'		
JourneyType	General Cargo: 'FTL'. 'LTL' Finished Vehicle Transports: 'FV Point-to-Point', 'FV Multi-stop' See 7.2.2.2	Mandatory
DistanceClass	'Long haul', 'Short haul' See 7.2.2.3	Mandatory
VehicleType	'>3.5–7.5 t', '>7.5–12 t', '>12–20 t', '>20–26 t', '>26–40 t', '>40 t Truck' See 7.2.2.4	Mandatory
PropulsionType	'ICE ', 'BEV', 'PHEV', 'LNG', 'Hydrogen fuel cells', 'Dual fuel' See 7.2.2.5	Mandatory
FuelType	'Diesel', 'Gasoline', 'Electricity', 'CNG', 'LNG', 'Hydrogen', 'LPG', 'Biodiesel', 'HVO', 'Ethanol', 'Hybrid Fuels' See 7.2.2.5	Mandatory

Parameter	Definition	Requirement
AssetType starts with ‘rail’		
TransportConcept	‘Single wagon’, ‘Block train’ See 7.3.2.2	Mandatory
TrainConfiguration	‘<500 m’, ‘<600 m’, ‘<700 m’, ‘>=700 m’ See 7.3.2.3	Mandatory
WagonType	Finished Vehicle: ‘Double deck’, ‘Flat Wagon’ Components: ‘Regular’, ‘Multimodal wagon’, ‘Steel transporting wagon’ See 7.3.2.4	Mandatory
OperatingMode	‘Shuttle full-full’, ‘Shuttle full-empty’, ‘Triangle’, ‘Network’ See 7.3.2.5	Mandatory
PropulsionType	‘Electric-powered’, ‘Diesel-powered’ See 7.3.2.6	Mandatory
ElectricEnergySource	‘Energy mix’, ‘100 % renewable’ See 7.3.2.6	Mandatory
AssetType starts with ‘sea’		
TransportConcept	‘Deep Sea’, Short Sea’, ‘inland waterway’ See 7.4.2.2	Mandatory
ShipType	Finished vehicle: ‘Vehicle Carrier (PCC+PCTC)’, ‘ConRo’, ‘RoRo’, ‘RoPax’ General Cargo: ‘Container ship’ See 7.4.2.3	Mandatory
AssetType starts with ‘hub’		
CompoundType	‘InlandCompound’, ‘PortTerminal’ See 7.6.2.2	Mandatory

Parameter	Definition	Requirement
ConnectionType	'Road', 'Rail', 'Road_Rail', 'Road_Port', 'Road_InlandWaterway', 'Rail_Port', 'Rail_InlandWaterway', 'Port_InlandWaterway', 'Road_Rail_Port', 'Road_Rail_InlandWaterway', 'Road_Port_InlandWaterway', 'Rail_Port_InlandWaterway', 'Road_Rail_Port_InlandWaterway' See 7.6.2.3	Mandatory
ServiceSpectrum	'Handling', 'LowImpact', 'HighImpact' See 7.6.2.4	Mandatory
CompoundSize	'Small', 'Medium', 'Large' See 7.6.2.5	Mandatory
CompoundArea	'North', 'Middle', 'South' See 7.6.2.6	Mandatory
For all mode of transports or asset types not covered by this guideline		
TOC characteristics individually defined by the transport operator according to ISO 14083 or other industry specific recommendations		

Table 6: TOC Master Data Report Parameters

6.2. Emission Intensity Report

The second crucial report in the system is the TOC Emissions Intensity Report. This report contains information regarding the specific emission intensity for each TOC. The emission intensities are calculated by dividing the total emissions of a TOC by its transport activity. Thus, this report provides a detailed snapshot of the environmental footprint of each TOC, quantifying the amount of GHG emissions produced per unit of transport service in a defined time period. Note that there is no prescribed procedure for the allocation of shipments that take place in two reporting periods, i. e. start of shipment in one period and end of shipment in another. It is only important to choose a procedure and to perform it consistently. E. g. allocating the transport to the period in which the transport is completed.

The report has a direct link to the TOC Master Data Report. The Emission Intensity ID (EIID) and the Business Entity ID number ensure this connection. The EIID serves as a unique identifier of a particular emission intensity data set. This unique ID allows each TOC to be distinctly associated with its emission intensity. Thus, the EIID provides a direct link between the TOC Master Data Report (which houses all the necessary characteristics of a TOC) and the TOC Transactional Data (which contains the emission intensity of the TOC). The TOC_ID in both reports ensures that the emission intensity data can be directly tied back to the specific TOC it pertains to, enabling accurate tracking and reporting of the emissions associated with each TOC.

In addition to the EIID, the business entity ID further enhances the connectivity between the TOC Master Data Report and the TOC Transactional Data. The BusinessEntityID can be defined as the unique nine-digit DUNS (Data Universal Numbering System) identifier or the business ID according to ISO 15459.

This report not only indicates the emission intensities for different types of transport but also provides critical inputs to the third and final report, which applies these emission intensities to specific consignments.

Parameter	**Definition**	**Requirement**
EmissionIntensityID (TOC/HOC_EIID)	See 8.2.2	Mandatory
BusinessEntityID	See 8.2.2	Mandatory
InsettingType	See 8.2.2	Mandatory
ValidityFromDate	See 8.2.2	Mandatory
ValidityToDate	See 8.2.2	Mandatory
ID	See 8.2.2	Mandatory
DataSource	'primary', 'secondary' See 8.2.2	Mandatory
SampleSize	See 8.2.2	Mandatory (if DataSource = primary)
SampleSpecificity	'customer specific', 'not customer specific' See 8.2.2	Optional (if DataSource = primary or modelled)
VerificationIndicator	'true', 'false' See 8.2.2	Mandatory
AccreditationIndicator	'true', 'false' See 8.2.2	Mandatory
WTWEmissionFactor	See 8.2.2	Mandatory
WTWEmissionIntensity	See 8.2.2	Mandatory
WTWEmissionIntensity2	See 8.2.2	Optional

Table 7: TOC Transactional Data Parameters

6.3. Transport Chain Element (TCE) GHG Emission Report

The final piece of our comprehensive emission tracking system is the TCE GHG Emission Report. The TCE GHG Emission Report applies the TOC or HOC specific emission intensity, as calculated and provided in the Emission Intensity Report, to individual transports or consignments. Thus, the TCE GHG Emission Report forms the endpoint of our approach, linking the data from the previous two reports to actual transportation activities. As the information required in TCE GHG Emission Reports differs for transport sections and processing in hubs and compounds, there are different templates for each (Transport TCE GHG Emission Report, Hub TCE GHG Emission Report).

Once the specific emission intensity is assigned to a consignment, it is then multiplied by the transport activity of that consignment to calculate the total emissions generated by that particular consignment. This critical calculation translates the previously abstract TOC/HOC specific emission intensity into a tangible figure of greenhouse gas emissions for each consignment, facilitating a more transparent and comprehensive understanding of the environmental impact associated with a company's shipping activities.

The TCE GHG Emission Report includes several crucial parameters. These include identifiers like the consignment ID, consignment reference number, and transport order number, which provide information about the consignment. The Emission Intensity ID (EIID) links the consignment back to the TOC/HOC and its associated emission intensity. Key data points such as the arrival date of transport, the place of arrival, the source of distance and mass data, and the distance and mass used for the calculation provide context and input for the calculation. The report then presents the calculated emissions in terms of both Well-To-Wheel (WTW) and Tank-To-Wheel (TTW) GHG emissions.

To summarize, the TCE GHG Emission Report effectively applies the data compiled and calculated in the Master Data Report and the Emission Intensity Report to real consignments. It allows us to quantify the emissions generated by each consignment in a standardized and comparable way. This report, therefore, forms the core of our emission tracking and reporting process, providing companies with the vital data they need to track, reduce, and offset their consignment-related emissions.

Transport TCE GHG Emission Report:

Parameter	Definition	Requirement
Primary identifiers according to the defined reporting level of the consignment		
ConsignmentID	See 8.2.3	Mandatory
OtherReference	See 8.2.3	Optional
Additional identifiers for reference		
TransportOrder	See 8.2.3	Optional
TransportID	See 8.2.3	Optional
TransportIDLSP	See 8.2.3	Optional

Parameter	Definition	Requirement
TransportChainReference	See 8.2.3	Optional
TOCEmissionIntensityID	See 8.2.3	Mandatory
BusinessEntityID	See 8.2.3	Mandatory
ArrivalDate	See 8.2.3	Mandatory
ShippingLocation	See 8.2.3	Mandatory
PlaceofArrival	See 8.2.3	Mandatory
DistanceDataSource	‘default’, ‘secondary’ See 8.2.3	Mandatory
MassDataSource	‘default’, ‘secondary’, ‘primary’ See 8.2.3	Mandatory
AccreditationIndicator	See 8.2.3	Mandatory
Distance	See 8.2.3	Mandatory
OriginalMass	See 8.2.3	Mandatory
AdjustedMass	See 8.2.3	Mandatory
WTWCO_2e	See 8.2.3	Mandatory
TTWCO_2e	See 8.2.3	Mandatory

Table 8: Transport TCE GHG Emission Report

Hub TCE GHG Emission Report:

Parameter	Definition	Requirement
Primary identifiers according to the defined reporting level of the consignment		
ConsignmentID	See 8.2.4	Mandatory
OtherReference	See 8.2.4	Optional
Additional identifiers for reference		
TransportOrder	See 8.2.4	Optional
TransportID	See 8.2.4	Optional
TransportIDLSP	See 8.2.4	Optional

Parameter	Definition	Requirement
TransportChainReference	See 8.2.4	Optional
HOCEmissionIntensityID	See 8.2.4	Mandatory
BusinessEntityID	See 8.2.4	Mandatory
ArrivalDate	See 8.2.4	Mandatory
DispatchDate	See 8.2.4	Mandatory
MassDataSource	'default', 'secondary', 'primary' See 8.2.4	Mandatory
AccreditationIndicator	See 8.2.4	Mandatory
OriginalMass	See 8.2.4	Mandatory
WTWCO$_2$e	See 8.2.4	Mandatory
TTWCO$_2$e	See 8.2.4	Mandatory

Table 9: Hub TCE GHG Emission Report

6.4. Application Examples

6.4.1. Logistics Service provider reporting example

A LSP runs two different transport chains for a customer (K).
In national Groupage transport, he transports goods from K as an area forwarder from the northwest of Germany to the south of the country to Munich. The main part of transport chain is conducted by train with electric propulsion. The preand post-carriage is operated by truck.

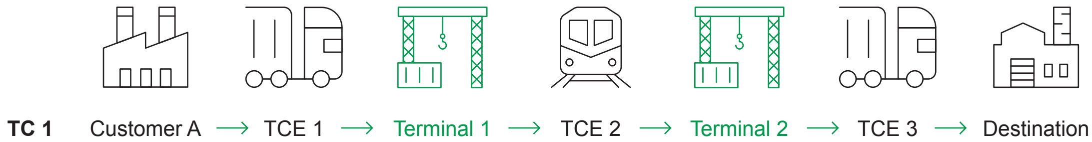

Figure 4: First transport chain for customer (K)

In the second transport chain, air freight consignments are transported from Germany to a warehouse in the USA in Houston, Texas. In this chain preand post-carriage are also carried out by truck.

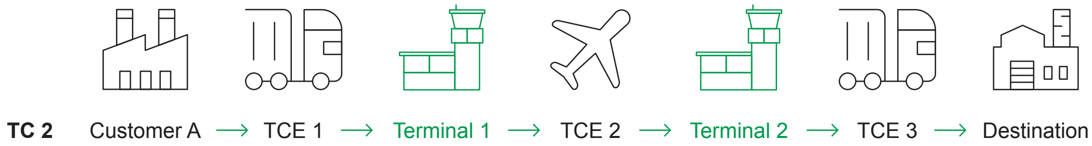

Figure 5: Second transport chain for customer (K)

Customer K expects information on what TOCs are operated and a quarterly update of the respective emission intensity information for each TOC. The individual elements of the transport chain are shown and given in “g CO_2e per tonne-kilometre (tkm)”. The reporting also correctly monitors the proportion of primary and secondary data used according to the automotive guideline. Apart from that Customer K requests information of compliance with ISO 14083. The TOC information the LSP provides to customer K include:

TOC_ EIID	TOC_ DUNS	TOC_ start_date	TOC_ end_date	TOC_ ID	TOC_Data-Source	Data_Sample_ Source	TOC_Veri-fication	TOC_Emission_ Intensity
000-TC1	315954487	20230801	20230831	TC1_ TCE1	Primary	70 %	TRUE	82.3 gCO_2e/tkm
000-TC1	315954487	20230801	20230831	TC1_ TCE2	Secondary		TRUE	15.2 gCO_2e/tkm
000-TC1	315954487	20230801	20230831	TC1_ TCE3	Primary	20 %	TRUE	72.7 gCO_2e/tkm
000-TC2	315954487	20230801	20230831	TC2_ TCE1	Primary	40 %	TRUE	67.3 gCO_2e/tkm
000-TC2	315954487	20230801	20230831	TC2_ TCE2	Secondary		TRUE	808.2 gCO_2e/tkm
000-TC2	315954487	20230801	20230831	TC2_ TCE3	Secondary		TRUE	128.1 gCO_2e/tkm

Table 10: Logistics Service provider reporting example

6.4.2. Example of customer usage of reporting information

This example outlines the practical application of GHG reporting information received from LSPs and the actions most customers will undertake in using this data across various application dimensions.

Upon receiving TCE data, the first step for a company is to integrate this information into a central data cube. This repository ensures consistency, accessibility, and the possibility for advanced analytics across the entire organization.

OEMs and suppliers are typically required to disclose environmental impact in their annual sustainability reports. The GHG emissions per consignment from LSPs feed directly into these reports, providing quantifiable and verifiable metrics on logistics emissions. The data will be aggregated to reflect total emissions associated with logistics and compared against previous periods to track performance and set future targets.

Beside annual sustainability reporting, OEMs and suppliers typically measure the environmental impact associated with individual products throughout their life cycles. The granular GHG emission data per consignment support those life cycle analyses as the accurate allocation to specific products is simplified.

Additionally, OEMs and suppliers have their own internal KPI systems for sustainability performance within logistics operations. Holding granular GHG emission information per consignment allows for different information aggregations and analyses. This includes the calculation of transport GHG emissions per plant, region, logistics process type, mode of transport and LSP, enabling OEMs and suppliers in identifying inefficiencies, setting reduction goals, and benchmarking against industry standards.

LSP-provided emission intensities per TO C also serve as an input for logistics planners. By standardizing values related to emissions, planners can integrate sustainability considerations into routing, mode selection, and carrier choice.

7. Guidelines for transport emission calculation per mode of transport

7.1. Emissions Assignment in FVL transport

This Chapter outlines how to assign GHG emissions to consignments in FVL. In general, mass is used as the basis of assigning emissions to general cargo and mass, or Cargo Equivalent Units (CEU), is used to assign emissions to car transports.

For most general cargo, mass is the key unit for assigning emissions. E.g., emissions for a transport would be calculated using the direct distance, emissions factor and mass of the package.

7.1.1. Defining a conversion system for assigning emissions for FVL

In the context of assigning emissions to cargo, the ISO14083 standard typically utilizes mass as the default unit, a practice that presents unique challenges and complexities, especially when dealing with car transporter capacity. Since mass is not a sufficient measure for car transporter capacity, conversion systems have been developed as a standard metric for car transport. The system acknowledges that capacity usage varies across modes: surface area matters for ships, space and mass for trucks, and dimensions more than mass for trains.

Different conversion models are needed for each transportation mode. For road and RoRo FVL transportation, these are particularly crucial due to dimensional limitations and capacity considerations, especially with varied cargo like conventional cars, light trucks, and modern electric cars. In the case of rail transport, detailed modelling of volumetric load restrictions is more difficult and less common.

For RoRo transportation, the main concern is floor space usage, and existing RoPax models that factor in volume and mass have been deemed suitable. This alternative to mass is referenced in ISO 14083 as passenger equivalent unit (PEU) and was renamed to CEU for the RoRo method standard. The CEU is intended to satisfy the need for a complementary value that does not rely exclusively on mass but also takes into account length, width and height which reflects the space that cargo occupies on a Ro-Ro vessel.

7.1.2. Conversion calculation model for road FVL Transport

The CEU-Road value is based on mass, height, length, and width. Units are mm for measurements and kg for mass.

For each dimension, a base value is defined:

base_mass = 1400
base_height = 1500
base_length = 4000
base_width = 1900

For each dimension, if the value exceeds the base value, the excess is calculated:

If mass < base_mass Then extra_mass = 0 Else extra_mass = mass – base_mass
If height < base_height Then extra_height = 0 Else extra_height = height – base_height
If length < base_length Then extra_length = 0 Else extra_length = length – base_length

For width it is assumed that any extra width of a car does not influence the load factor of a FVL transport as long as the width does not exceed the allowed maximum of a car transporter. Therefore, no additional manipulation of the base value is needed for the width.

A base value of 10 CEU-Road is assigned to every car as a starting point, regardless of size. Therefore, the minimum CEU-Road a car model is evaluated with is 10 CEU-Road:

res = 10' Base CEU-Road

Additional CEU-Road are then added based on how much a car exceeds the base value in the measures as follows:

res = res + extra_mass/250 + (extra_length/500) * (extra_height/300)

E.g., this means that mass adds an extra CEU-Road for every 250 kg over the base mass and that excess length is multiplied by excess height, each divided by different factors before being multiplied.

The result is lastly rounded to whole figures, for practical reasons. The idea is that to standardise for example a VW Golf as a 10 CEU-Road car and a Tesla as a 13 CEU-Road car, rounded.

Pts = Round (res, 0)

7.1.3. Conversion from CEU-Road to adjusted tonnes for road FVL Transport

This initial assumption is that a standard transporter can load a maximum of 18 tonnes, and a maximum of 100 CEU-Road.

Under this assumption, adjusted tonnes can then be calculated as 0,18*pts and must always be used for the conversion from CEU-Road to adjusted tonnes. E.g., for a 10 CEU-Road car that means 10 * 0,18 = 1.8 tonnes.

This means that light cars will be adjusted upwards, while heavy, normal size cars will be close to their real mass.

An Audi A1 for instance, in reality only weighs 1.269 kg. The mass of 10 Audi A1s is 12,69 tonnes, but since 10 Audi A1s is a full load of a standard Car Transporter, the adjusted mass should be 18 tonnes to illustrate that the truck is full.

A Tesla S weighs 2.162 kg, so a full load of 8 Teslas weighs 17,296 tonnes. The Tesla S is 13 CEU-Road, so the adjusted mass is 0,18*13 = 2,34 tonnes.

A Ford Transit ELWB is a 35 CEU-Road vehicle, so it's adjusted mass is 35 × 0,18 = 6,3 tonnes.

7.1.4. Conversion calculation model for RoRo FVL Transports

The CEU-RoRo value is based on mass, height, length, and width of the vehicle. Units are mm for measurements and kg for mass.

The calculation formula is as follows:

Pts = 0,00041 x mass (kg) + 0,019756 x volume (m^3)

The volume is defined as the vehicle width * vehicle height * vehicle length, measured at the widest, highest, and longest points of the vehicle (volumetric principle).

The formula consists of the two variables, mass and volume, and the fixed coefficients.

The CEU-RoRo value in RoRo FVL Transports is used by allocating total emissions according to share of CEU-RoRo-based transport activity, divided by the transport activity based on the actual mass.

7.2. Road Transport

7.2.1. Introduction

This Chapter provides a structured overview of the recommended way to calculate GHG emissions for road transport operations within the automotive industry. Beginning with a detailed exploration of Road TOC, the Chapter delves into the specifics of assets, journey types, distance classes, and vehicle-related classifications. It then covers data collection methodologies, emphasizing system boundaries and the distinction between primary and secondary methods. Finally, the guide offers insight into the precise calculations for emissions and their intensities. The calculations in this example are based on FVL and therefore the related conversion system for assigning emissions for FVL. For other general cargo such as components and materials the calculations are based on the mass of the packages.

7.2.2. Road TOC Definitions

One of the primary tools in achieving clarity for emissions calculations in automotive logistics is through the definition of TOCs. Each TOC is tailored to encapsulate the diverse operations, transport modes, and nuances inherent in the industry.

As described in Chapter 6, each TOC is assigned a 7-digit number. For road transport, the positions are associated with the TOC parameters and their potential values. An overview table can be found below in annex 8.3.1.

7.2.2.1. Asset Type

For the definition of TOC, the asset type is key as the mass-to-volume ratio of transported goods can vary significantly. We therefore recommend using just three principal asset types:

- Finished Vehicles
- Electric Vehicle Batteries
- General Cargo

7.2.2.2. Journey Type

The “Journey Type” is crucial in describing a transport’s operating mode. It is directly related to transport efficiency, allowing for FTL and LTL, direct transports (point-to-point) and multi stops. Because of its influence on emission intensity, it’s recommended to consider the Journey Type when defining TOC. In order to define the appropriate Journey Types, a distinction must also be made between either General Cargo / Electric Vehicle Battery transport or Finished Vehicle transport.

For **General Cargo / Electric Vehicle Battery Transport,** there are two recommended distinctions:

- **A FTL** (Full Truck Load) transport in road transportation refers to dedicated consignments where the cargo is transported directly to the destination without sharing the space with other cargo owners. In the automotive industry this is often related to high volume transports where the truck transports parts with a stable delivery frequency.
- **A LTL** (Less than Truck Load) transport involves consolidating multiple consignments from different sources into a single truckload for cost-effective and efficient delivery to various destinations.

For **Finished Vehicle Transport,** the distinctions are:

- **Point-to-point** transport entails the exclusive use of a truck that is fully loaded with vehicles from a single source or for a specific destination. The truck is dedicated solely to the consignment of finished vehicles, ensuring that the entire truck capacity is utilized for the transportation of the designated quantity of vehicles.
- **Multi-stop** is a method of shipping where multiple cargo from different sources or destinations are consolidated onto a single truck for transportation. In logistics, multi-stop transport is commonly used when there is a need to transport smaller quantities than full truck loads. Multi-stop transport allows for the efficient use of truck space by combining multiple smaller consignments into a single load.

7.2.2.3. Distance Class

Distance Classes represent a crucial characteristic in defining TOC in road transportation. The distance a transport covers is not merely about how far a vehicle travels; it's closely related to various operational factors influencing transport efficiency, such as the mix of stop-and-go driving and average driving speeds. Given the significance of these correlations to the emission intensity, it's imperative to employ a clear classification. In this context, we will introduce a simplified distance class classification for integration into the TOC definition.

In transport logistics, **long haul transport** is used to describe the transportation of cargo where the average shortest feasible distance for each leg is 50 km or more. This typically involves intercity, interstate, or even international routes. It covers the movement of finished vehicles or material components from sources such as manufacturing plants, distribution centres, ports, or rail yards to distant destinations. Given the significant distances involved, specialized logistics and transportation modes are often required for efficiency.

Conversely, short haul transport pertains to the transportation of goods where the average shortest feasible distance per leg is less than 50 km, generally occurring within a local or regional scope. This category deals with the movement of finished vehicles from manufacturing plants, distribution centres, ports, or rail yards to closer destinations like dealerships, car rental agencies, or other specified sites. It can also involve pick-up trips from material suppliers within a confined region to a consolidation centre or cross-dock.

A leg is understood as a segment of a journey with a consistent payload. Any (partial) loading or unloading initiates a new leg within that journey. ISO 14083 uses TCEs to describe legs. TCE is a section of a transport chain within which the freight is carried by a single vehicle.

To determine the average shortest feasible distance per leg within a transport, one divides the shortest possible distance of the entire journey by the number of legs. For instance, a trip spanning a shortest feasible distance of 120 km, divided into 3 legs, would result in an average distance of 40 km per leg. Consequently, this journey would be classified as short haul transport.

7.2.2.4. Vehicle Type

Vehicle Types serve as a familiar and essential differentiation criterion, one that is highly recommended when defining TOC. Rooted in the generic classification of commercial vehicles (known as EU Vehicle Groups), the automotive industry finds a need to further streamline the number of distinguishable vehicle classes. This need arises due to the relatively limited and standardized profile prevalent in both General Cargo / Electric Vehicle Battery Transports and Finished Vehicle Transports.

For **General Cargo / Electric Vehicle Battery Transports,** the following vehicle types are differentiated:

- **Vans:** Within logistics, a van denotes a commercial vehicle chiefly intended for the carriage of smaller quantities of goods. Such vans are frequently employed in diverse automotive logistics operations, such as emergency transport of missing production materials or the last-mile distribution tasks in after-sales logistics.
- **Up to 18 t GVW truck:** Two-axle motor vehicles with a gross vehicle weight up to 18 tonnes. These trucks are compact and manoeuvrable and therefore ideal for regional inbound flows with moderate cargo volumes.
- **Up to 24 t GVW truck:** Three-axle motor vehicles with up to 24 tonnes GVW. Offer higher payload and increased stability for heavier inbound shipments on regional routes.
- **Up to 40 / 44 t GVW truck:** Vehicle and trailer combinations with four to six axles and up to 18.75 m length. Standard class for long-haul inbound logistics, maximizing transport efficiency within legal weight limits.
- **Over 40 / 44 t GVW truck:** Used under permit or in closed systems, these vehicle combinations exceed standard GVW limits and enable high-volume or heavy-load inbound transport beyond public road restrictions. This includes EMS (European Modular System) trucks (up to 25.25 m length), which offer additional loading space for consolidated shipments in structured inbound flows.

For **Finished Vehicle Transports,** differentiation is done for the following vehicle types:

In the realm of finished vehicle logistics, each vehicle category bifurcates further into two nuanced sub-types: open and covered.

- **Up to 18 t GVW Small Car Carrier:** Within automotive logistics, this vehicle is used for transporting small quantities of 1 to 4 vehicles. Typical scenarios include the repositioning of pre-owned vehicles or the dispatch of finished vehicles to urban retail outlets with constrained storage.
- **Up to 40 t GVW Car Carrier:** Within the confines of finished vehicle logistics, a car carrier is a transport vehicle, tailor-made for the proficient, secure transport of a plethora of finished vehicles, ranging from compact cars to SUVs and trucks.
- **EMS Car Carrier:** Distinguished from the standard car carrier, this elongated version is adept at accommodating and ferrying a more substantial volume of vehicles across extended distances. Its design fosters operational efficiency. EMS car carriers of 25.25 metres in length are typically used in countries with low population density, such as Scandinavia, where the infrastructure allows this.

For an in-depth understanding of the default gross and net mass parameters associated with each vehicle type, please refer to annex 8.3.2.

7.2.2.5. Propulsion and fuel types

The propulsion and fuel type of a truck are critical determinants of its emission factor and subsequent emission intensity in transport operations. Within the automotive domain, specific procurement agreements often exist between customers and transport operators concerning the usage of certain truck types. Consequently, it's prudent to embed the differentiation of propulsion and fuel types into the TOC definition. Instead of relying on an average mix of the transport operator's fleet, direct specification of propulsion ensures more accurate emission intensity calculations.

In a standardized automotive TOC definition, using the following propulsion types is recommended:

- **Internal Combustion Engine (ICE) Propulsion:** with Diesel predominantly found in most trucks. In some cases, petrol is used in lighter trucks.
- **Battery Electric Vehicles (BEV):** Powered solely by batteries, with no combustion engine.
- **Plug-in Hybrid Electric Vehicles (PHEV):** A fusion of battery power and an internal combustion engine.
- **Hydrogen Fuel Cells:** Uses hydrogen to produce electricity.
- **Dual Fuel:** Involves the simultaneous use of diesel and another fuel variant, such as natural gas or propane.

Additionally, the following general fuel types should be differentiated:

- **Diesel:** The mainstay fuel for the majority of heavy-duty trucks.
- **Gasoline:** Opted for in several lighter truck variants.
- **Electricity:** The power source for electric and plug-in hybrid trucks.
- **Compressed Natural Gas (CNG):** Customary for medium to heavy-duty trucks.
- **Liquefied Natural Gas (LNG):** An alternative in long-distance trucking scenarios.
- **Hydrogen:** The fuel for hydrogen fuel cell-equipped and some ICE trucks.
- **Propane (LPG):** Some trucks are designed to function on propane.
- **Biodiesel:** Blendable with, or usable as a direct replacement for, conventional diesel.
- **HVO (Hydrotreated Vegetable Oil):** Derived from sustainably sourced renewable materials. Can be used in pure form or blended with diesel.
- **Ethanol:** Typically added in certain quantities to petrol fuels.
- **Hybrid Fuels:** A mix of multiple fuels in hybrid systems.

Annex 8.3.1 provides the detailed overview regarding which propulsion types and fuel type combinations are predominant in the automotive industry and should therefore be used in the TOC definition.

7.2.2.6. Trailer technologies

For the sake of completeness, new technologies for trailers that contribute to the reduction of emissions are presented below. However, these have no influence on the formation of TOC.

Especially in the EU, the CO_2e emission regulation for heavy-duty vehicles ("Verordnung (EU) Nr. 1242/2019") sets specific emission reduction targets for trailers from 2030 onwards, which means that there's a need for action for parts logistics and vehicle distribution.

There are two main trailer technologies for this purpose, that can be used to reduce CO_2e emissions, depending on the intended use: electric trailers and aerodynamic kits.

E-trailers can be used without adapting the tractor truck and feature an electrically driven axle, which is supplied with energy from a trailer battery. If E-trailers are used for shorter distances, a system in which the battery is charged via recuperation is recommended. For longer distances, E-trailers with plug-in chargeable batteries are recommended. That means the batteries can be charged via an external power supply. In general, attention must be paid to an appropriate axle load distribution of the E-trailer to ensure that transport capacities are not disproportionately limited compared to conventional trailers. In automotive logistics, the use of so-called Mega trailers is recommended. Pilot projects with E-Trailers in parts logistics showed savings of more than 40 % of diesel fuel.

Another possibility to reduce CO_2e emissions are aerodynamic kits for trailers. In particular, side panels (so-called “skirts”), which largely cover the area between trailer and road, need to be mentioned. Aerodynamic kits are, however, not a useful option for vehicle distribution, where open trailers are predominantly used. To achieve an appropriate effect on CO_2e reduction, large areas would have to be covered.

Trailers with solar panels can be mentioned as a third technical option. However, this is more of a useful option for refrigerated trailers and unlikely to be used for automotive logistics.

7.2.3. Data Collection

7.2.3.1. System boundaries

System boundaries in transport GHG emission reporting for the automotive industry define the scope of data collection, specifying the processes and activities that are included or excluded in the assessment. They are critical in ensuring a consistent and transparent evaluation of emissions, aligning with specific guidelines and standards. The following sections detail the included and excluded processes within these boundaries.

Processes included:

The following processes are considered in the calculation of CO_2e emissions related to transportation in the automotive industry:

- **Vehicle Operational Processes:** This encompasses all activities directly related to the operation of the vehicle.
- **Vehicle Energy Provision Processes:** This refers to the provision of energy required to power the vehicle, including all associated emissions.
- **Loaded and Empty Trips Made by Vehicle:** All trips, whether loaded or empty, related to a transport order
- **Combustion of Energy Carriers at Vehicle level:** This includes emissions resulting from the combustion of energy carriers used in the vehicle.

Processes excluded:

The following processes are excluded from the calculation:

- **Processes at the Administrative (Overhead) Level of the Organizations Involved in the Transport Services:** All higher-level administrative processes of the transport service providers are excluded.
- **Processes for the Construction (e. g., Embedded GHG Emissions Associated with Vehicle Production), Maintenance, and Scrapping of Vehicles or Transhipment and (De) Boarding Equipment:** All emissions related to the manufacturing, maintenance, and scrapping of vehicles and related equipment are excluded.

- **Processes of Construction, Service, Maintenance, and Dismantling of Transport Infrastructures Used by Vehicles:** This excludes emissions related to roads, inland waterways, rail infrastructure, or transhipment and (de) boarding infrastructure.
- **Examples of additional Trips Besides a Transport Order:**

  - Internal Transport Activities
  - Drive to Gas Station: Specially started trips towards a gas station outside of a transport order are not taken into account. Additional mileage due to refuelling operations during a transport order is already compensated with the distance adjustment factor (DAF).
  - Drive to Maintenance: Specially started trips towards a repair shop outside of a transport order are not taken into account. Additional mileage due to maintenance activities during a transport order is already compensated with the DAF.
  - Journeys of External Companies or Independent Drivers to the Starting Point

- **Use of Information and Communications Technology (ICT) Equipment and Data Servers Related to Transport and / or Hub Operations**
- **Leakage of Energy Carriers at Vehicle level:** This includes emissions resulting from the leakage of energy carriers used in the vehicle. As there is currently no standardised calculation method, these leakages are not yet taken into account.
- **Black Carbon Emissions**

7.2.3.2. Primary Data collection for a consumption-based calculation

This method employs specific measurement devices and instruments to directly measure emissions at their sources. By installing emission monitoring systems on vehicles or other emission sources, accurate and immediate measurements are obtained. The foundation for emission calculations is built on this measured data, which we classify as 'primary data. ' Primary data, by definition, is data that originates directly from the source in this context, data procured via an information or telematics system. The distinguishing factor between primary data and modelled data lies in the origin of the information. For primary data, the original source is decisive. Furthermore, a crucial connection exists between emission data and order management, ensuring a cohesive and comprehensive assessment of emissions based on real-time activities and operations.

Primary Data Parameter:

In order to be able to calculate emissions from road transport on the basis of primary data three things are required: information on the mileage performed (loaded and empty), information on the mass transported, and information on the actual fuel consumption.

Energy Consumption:

Currently there are 3 main technological approaches available for energy consumption measurement in road transportation. First, telematic systems in trucks capture energy consumption data essential for consumption-based emission calculations. The fuel consumption is typically calculated via the injection quantity determined by the engine control unit. Flow meters are an alternative way to measure fuel consumption in a direct way (fuel consumption is determined directly with the flow meter). An alternative to energy consumption measurements are emission measuring devices, which means that the resulting emissions are measured directly and not calculated based on fuel consumption data.

While direct energy consumption or emission measurements are ideal, implementing this strategy is not always feasible for all LSPs. An alternate method to gather primary data is a consumption-based calculation using average vehicle fuel consumption data. Instead of collecting consumption data on a trip-by-trip basis, it is proposed to aggregate the data over specific intervals. This method can be a temporary solution, but the defined level of ambition remains: to achieve trip-specific consumption data. If a truck's journeys consistently fall within the same TOC, collecting and analysing aggregated data at the vehicle level is a valid approach.

Mass and information for adjusted mass calculation of finished vehicles:
A primary data- approach based on mass is defined as consignment gross mass information originating directly from the customers transport order message. In FVL the same logic applies for the additional information needed for the adjusted mass calculation of a specific vehicle (car model and/or dimensions of the vehicle). Mass calculations by the transport operator based on historical data and other own calculation approaches do not meet the standard of a primary data-based mass information.

Distance:
Distance information always needs to be calculated as shortest feasible distance (SFD). Actual driven distances (ADD) should not be used to calculate GHG emission intensities, because only the LSP knows the ADD. Therefore, the customer is not able to validate or plan the TOC CO_2e with the ADD and must use the SFD to do so. A shortest feasible distance meeting the standards of being primary data based must be calculated based on the real geocoordinates of the point of origin and the point of destination of the transport. The extrapolation of this geographical information or a calculation based on aggregated geographical regions (e.g. postal code areas) do not meet the primary data standard. A well-established route calculation service with good accuracy of the underlying route network data (including specific heavy trucking restrictions) should be used for this calculation. The preferred data source of these distance calculation results is the internal transport management system of the transport operator to ensure a high level of process robustness and auditability of the calculation. Distance calculations in manual processes (e.g. excel based calculations) should be avoided.

7.2.3.3. Secondary Data collection for a transport activity-based calculation
Within GHG transport emissions reporting in the automotive sector, primary data might be hard to obtain. When faced with such gaps, the transport-based calculation, fortified by secondary data sources, offers a dependable recourse. This methodology emphasizes transportation specifics over direct consumption metrics. By assessing intrinsic transportation factors such as distance, vehicle type and load mass, the transport-based calculation constructs a credible emissions estimate. It's crucial to note that companies using this guideline, who find it challenging to source specific data for the mentioned parameters, have the option to rely on default values. However, these default values, being of the highest level of aggregation, might lead to less precise emission calculations. Nevertheless, this method serves as a valid strategy, especially for stakeholders operating within data constraints, ensuring that the automotive industry can maintain both accuracy and transparency in its emissions reporting even when primary data is elusive.

In order to be able to calculate emissions from road transport based on secondary data, information is required on the following parameters:

- **Distance travelled:** The span covered during the transportation of automotive components or finished vehicles, usually measured in kilometres or miles. To model the distance, the point of origin and the point of destination are necessary, as well as the route for ADD and SFD. EcoTransIT (or similar sources) can be used to gather this information.

- **Vehicle Type:** Pertains to the specific classification of the truck, factoring in its design, size, and intended use. Different trucks (e.g. heavy-duty vs. light-duty) have varied emission profiles based on their efficiency and build.
- **Mass:** Represents the gross mass of the automotive parts or finished vehicles being transported. The gross mass of automotive parts includes the mass of any container, packaging, pallet etc. The mass directly influences the fuel efficiency of the truck and consequently, its emissions.
- **Empty Trip Factor:** Indicates the proportion of a truck's journey where it travels without carrying automotive parts or vehicles. During such trips, the truck's emission dynamics differ due to the absence of cargo mass.
- **Utilization Rate:** Describes the degree to which a truck's cargo space is occupied by automotive parts or vehicles. It provides insight into the efficiency of capacity utilization and its potential impact on emissions.
- **Emission Factor:** Emission factors provide a consistent metric to convert the fuel and energy used in freight transport into CO_2e emission values. It is usually specified in the unit 'grammes of CO_2 equivalent per megajoule' (g CO_2e/MJ) or 'kilogrammes of CO_2 equivalent per kilogramme' (kg CO_2e/kg).
- **Emission Intensity:** A value denoting the amount of CO_2e emissions produced by trucks per unit of activity, specific to the automotive transport context. This factor helps in converting distance travelled, mass carried, and other activity metrics into tangible CO_2e emission values. A possible way of specifying the value is in the unit 'grammes of CO_2 equivalent per tonne-kilometres' (g CO_2e/t-km).

In case of unavailability of secondary data for modelling, it is valid to resort to default values. In 8.3.3 and 8.3.4, you will find a comprehensive table that includes default values. Additionally, we have provided a ranking that dictates the order in which these default values should be referred to.

Fuel/Energy Economy: it's advised to utilize the recommended emission factor data sources specific to each country. If such specific data sources are not available, one can turn to the default values provided by GLEC. However, in using GLEC's default values, it's crucial to adapt the Empty Trip Factor and Loading Factor to best suit the specific use case.

The CO_2e-Emissions for battery electric vehicles (BEV trucks) is depending on the energy used, which varies a lot between countries and the consumed energy source for recharging of the truck. Emissions from BEV trucks can be calculated based on the following two approaches:

- Location-based approach
- Market-based approach

The difference between these two approaches lies in the source of the emission factors. In the location-based approach, the emission factor based on the regional or national electricity mix is used. The emission factor is derived from the average CO_2 emissions of electricity production for the region/country in which the BEV is operated. This value is independent of the source of the electricity actually purchased. On an annual basis this average energy mix is provided by national authorities such as the German Environment Agency.

The market-based approach provides more accurate results but requires detailed information about the electricity source underlying the BEV. The approach makes it possible to calculate the specific emission factor of the electricity purchased, taking into account green electricity certificates or emission certificates that prove that the electricity comes from renewable sources. This takes into account the electricity mix of the actual electricity supplier used by the company.

In summary, it should be noted that the location-based approach leads to broader applicability, while the market-based approach increases accuracy. The location-based approach ensures greater comparability and data consistency. In order to be able to report emissions as accurately as possible, the market-based approach is preferred, while the location-based approach is recommended if there is a lack of data.

Distance Travelled: No specific preference is indicated here. The main distinction to make is between data sourced from public repositories and those obtained from internal records or analytics.

Mass Carried: When considering the mass being transported, the primary data source should be the mass of parts or vehicles as provided by the customer, as described in the requirements developed by the ECG for the "Information shared on transported vehicles".

Any other sources of mass data should be considered secondary and used only when the primary source isn't available.

7.2.3.4. Calculation Approach for Emission Factors for Alternative Fuels from various suppliers

The term "Proof of Sustainability"(PoS) in transport logistics refers to the documentation and verification of a company's measures and performance in the field of sustainable logistics. This includes reducing greenhouse gas emissions, improving energy efficiency, minimizing environmental impacts, and promoting social responsibility.
A PoS is usually provided by an external, independent body to ensure objectivity and credibility. These bodies can be:

- certification companies (e. g. TÜV, SGS etc.)
- environmental organizations
- governmental bodies (e. g. Federal Environment Agency; Umweltbundesamt etc.)
- industry associations (e. g. Red-Cert EU; ISCC-EU; Global Reporting Initiative; Carbon Disclosure Project etc.)
- infrastructure or energy provider (e. g. petroleum company; fuel producer / supplier; electricity producer / suppliers etc.)
- independent consultants.

PoS is crucial for companies aiming to demonstrate their environmental responsibility and commitment to sustainable practices. Information provided within a POS can be considered within the modelled data-based TOC emission intensity calculation (chapter 7.2.4.2).

As an example a Transport Service Provider receives one PoS from a fuel producer or fuel supplier for each delivery of fuel to its own depot fuelling station.

In context of transport logistics a PoS for biofuels & synthetic fuels should at least include the following information categories to enable the possibility to consider the information within CO_2 emission factor modelling (chapter 7.2.4.2) for a specific period of time:

- Fuel type (e. g. Hydrotreated Vegetable Oil [HVO-100])
- Proportion of Biomass (%): e. g. 100 %

- Delivered amount / quantity of product e.g. 123.456 MJ / kilogramme / litre / m³
- Issue date (and expiry date if applicable)
- GHG emission information for product / fuel / energy in gram CO_2e / Megajoule:
  - Well-to-Wheel gCO_2e / MJ
- Emission reduction in relation to the GLEC emission values of the fossil comparator used
- Standard on which the certificate is based (e.g. RED)
- Other qualitative characteristics
  - Country of origin
  - Land-use-change
  - Feedstock information

The information required for the emission factor calculation must be obtained from the available PoS for the period to be calculated. The information can either be taken directly from a single document (example no. 1) or calculated as a weighted average of several documents (example no. 2) if several purchases of the fuel were made.

In context of transport logistics a PoS for electric energy for BEV trucks should at least include the following information categories to enable the possibility to consider the information within CO_2 emission factor modelling (chapter 7.2.4.2) for a specific period of time:

- Energy Source (e.g. Energy Mix; 100 % Renewable energy)
- Energy / Electricity Provider information
- Total quantity (MJ)
- Charging Station (e.g. Private depot Charging; Public Charging; Both …etc.)
- Issue date (and expiry date if applicable)
- GHG emission information for energy in gramme CO_2e / kWh:
  - Well-to-Wheel gCO_2e / kWh
- Emission reduction in relation to the GLEC emission values of the fossil comparator used
- Standard on which the certificate is based (e.g. RED)
- Other qualitative characteristics
  - Country of origin
  - Land-use-change
  - Feedstock information

Example no. 1: One document "Proof of Sustainability"

	PoS 1, HVO-100, 01.01.2024–31.12.2024
Quantity:	10,000 litre
TTW:	1.2 gCO2e/MJ
WTW:	12 gCO2e/MJ

Table 11: One document "Proof of Sustainability"

Parameter	Value	Unit	Source
Load Factor	60	%	GLEC Framework V3.1 2024
Empty Factor	17	%	GLEC Framework V3.1 2024
Fuel intensity factor	0.024	kg/tkm	GLEC Framework V3.1 2024
Lower Heating Value (HVO-100)	44.0	MJ/kg	GLEC Framework V3.1 2024
TTW-GHG Emission intensity	1.2	gCO_2e/MJ	Proof of Sustainability (PoS 1)
WTW-GHG Emission intensity	12	gCO_2e/MJ	Proof of Sustainability (PoS 1)
Energy Consumption Truck Modelled	1.056	MJ/tkm	Calculated acc. ISO 14083/GLEC V3.1 2024
TTW-GHG Factor Modelled (HVO-100)	1.27	gCO_2e/tkm	Calculated acc. ISO 14083/GLEC V3.1 2024
WTW-GHG Factor Modelled (HVO-100)	12.67	gCO_2e/tkm	Calculated acc. ISO 14083/GLEC V3.1 2024

Table 12: One document “Proof of Sustainability”

Example no. 2: Various number of documents “Proof of Sustainability”

	PoS 1, HVO-100	PoS 2, HVO-100	PoS 3, HVO-100	PoS 4, HVO-100
	Q1/2024	Q2/2024	Q3/2024	Q4/2024
Quantity:	10,000 litre	20,000 litre	10,000 litre	20,000 litre
TTW:	1.5 gCO2e/MJ	1.1 gCO2e/MJ	0.9 gCO2e/MJ	1.3 gCO2e/MJ
WTW:	7.5 gCO2e/MJ	6.0 gCO2e/MJ	4.5 gCO2e/MJ	10 gCO2e/MJ

Table 13: Various number of documents “Proof of Sustainability”

HVO-100 WTW Ø (Q1-Q4 2024):

$$\frac{10{,}000}{60{,}000} \times 7.5 + \frac{20{,}000}{60{,}000} \times 6.0 + \frac{10{,}000}{60{,}000} \times 4.5 + \frac{20{,}000}{60{,}000} \times 10.0 = 7.33 \frac{gCO_2e}{MJ}$$

Depending on the CO_2e emission factor modelling and the modelling period, it is recommended to calculate an average value from the individual PoS documents.

Parameter	Value	Unit	Source
Load Factor	60	%	GLEC Framework V3.1
Empty Factor	17	%	GLEC Framework V3.1 2024
Fuel intensity factor (Diesel)	0.024	kg/tkm	GLEC Framework V3.1 2024
Lower Heating Value (HVO-100)	44.0	MJ/kg	GLEC Framework V3.1 2024
TTW-GHG Emission intensity	1.2	gCO_2e/MJ	Ø Proof of Sustainability documents
WTW-GHG Emission intensity	7.33	gCO_2e/MJ	Ø Proof of Sustainability documents
Energy Consumption Truck Modelled	1.056	MJ/tkm	Calculated acc. ISO 14083/GLEC V3.1 2024
TTW-GHG Factor Modelled (HVO-100)	1.27	gCO_2e/tkm	Calculated acc. ISO 14083/GLEC V3.1 2024
WTW-GHG Factor Modelled (HVO-100)	7.74	gCO_2e/tkm	Calculated acc. ISO 14083/GLEC V3.1 2024

Table 14: Various number of documents "Proof of Sustainability"

7.2.4. TOC emission intensity calculation

The emission intensity of every applicable TOC should be calculated based on primary data wherever possible. This approach promises the highest data quality and is most likely to allow conclusions to be drawn about the emissions that actually occur. For those transports where a calculation based on primary data is not possible, the emission value can be modelled, or default values can be used.

If the transports with available primary data within a TOC are representative for all transports within the same TOC, the emission value collected on the basis of primary data can be allocated for the entire TOC. Transports are representative if they are a realistic representation of the general transport operations profile, such as the technical equipment used, the geographical conditions, customer service level requirements and logistics operating model.

In the following, both calculation approaches are explained by way of example.

7.2.4.1. Primary data-based TOC emission intensity calculation

In the following, the emission intensity for one finished vehicle transportation TOC is determined as an example (the example is also a reference for material logistics transports).

Summary of primary data-based emission intensity calculation for one TOC

Parameter	Value	Unit	Source
Total calculated transport distance (SFD)	950	km	TMS
Calculated empty trip factor (SFD)	28,4	%	TMS
Adjusted mass	2	Adjusted tonnes per vehicle	calculated acc. to customer transport orders (Chapter 7.1.3)
Number of cars	38	#	
Total energy consumption (Diesel, B5)	285	l	Telematics system linked to TMS
TtW-GHG emissions factor (Diesel, B5)	2.538	gCO_2e/l	GLEC Framework v3.1 2024
WtW-GHG emissions factor (Diesel, B5)	3.365	gCO_2e/l	GLEC Framework v3.1 2024
TtW-GHG Emission intensity	45,07	$gCO_2e/$ adjusted tonne km	calculated acc. ISO 14083
WtW-GHG Emission intensity	59,75	$gCO_2e/$ adjusted tonne km	calculated acc. ISO 14083

Table 15: Primary data-based TOC emission intensity calculation

First, the total emissions incurred within the scope (usually a specific TOC over one quarter) is calculated. To do this, the actual energy consumption of the vehicles (including empty and loaded runs) is multiplied by the emission factor of the corresponding energy carrier.

When selecting an appropriate emission factor, the minimum requirement is to refer to one of the sources recommended in this guideline. If available, a propulsion type-specific emission factor should always be preferred. This value could be obtained from a certificate on the purchased fuel or from the certified electricity label of the respective energy supplier.

$$Total\ emissions\ [gCO2e] = Energy\ consumption\ [unit] \cdot Emission\ factor \left[\frac{gCO2e}{unit}\right]$$

In the second step, the transport activity is calculated. For this purpose, the mileage under load is multiplied by the transported mass. Preferable is the calculation on a trip by trip level, but it is also possible at an aggregated level and sometimes necessary. The following provides an explanation and a simple example of how to calculate the transport activity on a trip by trip level (1) and on an aggregated level (2).

1. In this calculation method, the sum of products between transported mass (adjusted mass for finished vehicle transports respectively) and kilometres travelled with cargo of all legs is formed for each transport order. The sum of all transport orders thus forms the TOC.

Transport order 1

Leg 1: Point A to Point B; 100 km SFD; 15 adjusted tonnes
Leg 2: Point B to Point C; 50 km SFD; 7 adjusted tonnes
Leg 3: Point C to Point A; 70 km SFD; empty

Transport order 2

Leg 1: Point A to Point B; 200 km SFD; 20 adjusted tonnes
Leg 2: Point B to Point A; 200 km SFD; empty

Transport order 3

Leg 1: Point A to Point B; 300 km SFD; 18 adjusted tonnes
Leg 2: Point B to Point A; 300 km SFD; 16 adjusted tonnes

The total transport activity is hence:

$$\begin{aligned} Transport\ Activity &= (100 * 15 + 50 * 7) + (200 * 20) + (300 * 18 + 300 * 16) \\ &= 16.050\ adjusted\ tonne\ kilometers \end{aligned}$$

2. Another option is to use calculated average values bases in all transports within the TOC. In the example of a finished vehicle transport, the average load factor (information from the TMS) is multiplied by the average adjusted mass of a vehicle (calculated within the TMS in a preparatory step), to determine the transported mass. This is then multiplied by the total mileage and the load mileage percentage.

$$Transport\ performance\ [tkm] =$$

$$Total\ mileage\ [km] \cdot (1 - Empty\ run\ factor\ [\%]) \\ \cdot\ average\ transported\ adjusted\ mass\ [t]$$

In the last step, the total GHG emissions of the TOC are divided by the transport activity in order to determine the final emission intensity factor.

7.2.4.2. Modelled data-based TOC emission intensity calculation

If the calculation of the emission value of a TOC is not possible on the basis of primary data due to insufficient data, the value must be modelled using default values.

This reduces the required parameters to the essentials. In the following, two examples are used for explanation.

Summary of modelled emission intensity calculation for one TOC with default values

Parameter	Value	Unit	Source
Load Factor	60	%	GLEC Framework V3.1 2024
Empty Factor	17	%	GLEC Framework V3.1 2024
Fuel intensity factor (Diesel)	0.021	kg/tkm	GLEC Framework V3.1 2024
Lower Heating Value (Diesel, B0)	42.8	MJ/kg	GLEC Framework V3.1 2024
TTW-GHG emissions factor (Diesel, B0)	75.3	gCO_2e/MJ	GLEC Framework V3.1 2024
WTW-GHG emissions factor (Diesel, B0)	97.8	gCO_2e/MJ	GLEC Framework V3.1 2024
TTW-GHG Emission intensity Diesel EU	67.68	gCO_2e/tkm	Calculated acc. ISO 14083
WTW-GHG Emission intensity Diesel EU	87.90	gCO_2e/tkm	Calculated acc. ISO 14083

Table 16: Modelled data-based TOC emission intensity calculation

The first case describes the application of a default emission factor from the GLEC Framework for transport with a truck with a GVW of 40 t. This case should only be applied if more detailed information about the transport is not available, such as the Load Factor or the Empty Factor.

The GLEC framework offers a certain number of default values. Shown here is the use of an articulated truck up to 40 t GVW, assuming a loading factor of 60 % and an empty run share of 17 % with the corresponding specific fuel consumption [kg/tkm]. For the full list of recommended default values and their sources refer to Annex 8.3.3. In order to convert this value into an appropriate emission intensity, we need the Lower Heating Value of diesel [gCO_2e/MJ] and the emission factor of the fuel [gCO_2e/MJ].

$$Emission\ intensity \left[\frac{gCO_2e}{tkm}\right] = Energy\ consumption\ factor \left[\frac{kg}{tkm}\right] * Lower\ heating\ value \left[\frac{MJ}{kg}\right] * Emission\ factor \left[\frac{gCO_2e}{MJ}\right]$$

This emission intensity represents the simplest way of sourcing a TOC value.

Summary of modelled emission intensity calculation for one TOC with detailed modelling parameters

Parameter	Value	Unit	Source
Empty mass truck	14.00	t	Assumption
Max. total mass of the truck	40.00	t	Assumption
Empty Factor	50 %	Percentage	TMS
Average mass	2.00	t	TMS
ECF full	41.40	l / 100 km	DEFRA, 2024: Articulated Truck (>33 t) 100 % loaded
ECF_empty	24.84	l / 100 km	DEFRA 2024: Articulated Truck (>33 t) 0 % loaded
Payload capacity	26.00	t	Calculation
Capacity utilization	8 %	Percentage	Calculation
ECF actual load	26.16	l / 100 km	Calculation acc. EcoTransIT World—Methodology Report 2023 page 59
WTW-GHG emission factor (Diesel, B5)	3.365	gCO_2e/l	GLEC Framework V3.1 2024
WTW-GHG Emission intensity loaded	0.880	gCO_2e/km	Calculation
WTW-GHG Emission intensity empty	0.836	gCO_2e/km	Calculation
WTW-GHG Emission intensity	85.81	gCO_2e/tkm	Calculation

Table 17: Summary of modelled emission intensity calculation for one TOC

As seen in the previous example, the use of default values can only partially reflect reality due to the limited data complexity. Therefore, wherever possible, additional information should be taken into account during modelling. The following example describes the calculation of a TOC for transports in general cargo logistics with very low utilization of the GVW, making common default values inaccurate and therefore a more detailed modelling approach necessary.

In this example, we assume that the truck used (40 t GVW) has an empty mass of 14 t. As the next step, we need information about the total mileage within the TOC driven, as well as the average percentage of empty trips. This can preferably be extracted from a TMS but, for recurring transports, a fixed tour plan, for example, is an option as well. The same applies to the average mass transported during the loaded segments of the transport.

As we assume that we do not have any information about the actual energy consumption, we need to model the energy consumption factor (ECF) for the actual load. In order to do so, we need an assumption for the energy consumption during empty trips and at 100 % capacity utilization. Various data sources or studies can be used to determine the corresponding consumption values. In the example, a fuel consumption value for an Articulated Truck from DEFRA (Department for Environment, Food & Rural Affairs, United Kingdom) was used.

After calculation of the Payload Capacity (GVW minus empty mass of the truck) and the Capacity Utilization (average transported mass divided by the Payload Capacity) we are able to use the following formula in order to calculate the ECF under actual load.

7.2.5. Consignment GHG emission calculation

Your first step is to identify all consignments within the desired reporting timeframe. Emphasize the significance of a digital system, if possible, which can adeptly track emission metrics for every consignment. Such systems ensure accuracy, speed, and efficiency, eliminating manual errors and saving time.

Upon gathering all the necessary data, the next pivotal task is the categorization of consignments. Each consignment should be associated with its correct TOC. Familiarizing oneself with the array of TOC classifications is essential.

For a more hands-on approach: closely examine each consignment. Factors such as the mode of transportation, fuel type, and chosen route play crucial roles. For instance, was the consignment transported via car carrier or a van? Was diesel or green electricity used as fuel? The answers to these questions will guide you towards the correct TOC.

For clarity and future reference, always document the TOC determinations for each consignment. Such documentation is not merely an administrative formality. It stands as a testament to transparency and can significantly aid in future reporting or referencing.

To show the concept further, let's explore a fictitious calculation. Let's assume five transport groups, each showcasing varied properties, as outlined below:

	Asset Type	Journey Type	Distance Class	Vehicle Type	Propulsion and fuel types
1	Finished vehicle	Point-to-Point	Short haul	Car Carrier	ICE – Diesel, B0
2	Finished vehicle	Point-to-Point	Long haul	Car Carrier	ICE – HVO
3	Finished vehicle	Multi-stop	Short haul	Car Carrier	ICE – Diesel, B100 (100 % Bio-Diesel-share)
4	General Cargo	FTL	Long haul	Drawbar Truck	Hydrogen – green
5	General Cargo	LTL	Short haul	Van	BEV – green

Table 18: TOC examples

Based on these transport properties, it is now possible to obtain the corresponding TOC number for each transport with the help of table in 8.3.1. Based on the own TOC emission calculation, the WTW emission intensity of the specific TOC is to be used.

	TOC	TOC Emission intensity [gCO_2e/tkm]
1	1316001	90
2	1326006	20
3	1416005	100
4	3125018	60
5	3211014	0

Table 19: TOC Emission intensity examples

In the next step, the total transport activity of the respective TOC is determined by multiplying the load kilometres by the transported mass for all transport operations. This transport activity of the TOC is multiplied by the associated emission intensity to finally obtain the emission quantity to be reported.

	Transport activity [tkm]	TOC Emission intensity [gCO_2e/tkm]	Total emission [tCO_2e]
1	1.500.000	90	135,00
2	20.000	20	1,60
3	14.500.000	100	290,00
4	7.500.000	60	450,00
5	6.000.000	0	—

Table 20: Total emissions per TOC example calculation

In order to calculate the emissions of a consignment or vehicle transported, two examples of consignments are presented. The first example is a consignment operating in TOC number 1, the second example is a consignment operating in TOC number 3.

Example 1

The first consignment is a dedicated point-to-point transport for a single customer (VW as an example), transporting seven vehicles in total with a mass of 10,9 t over 40 km, which is illustrated by the figure below.

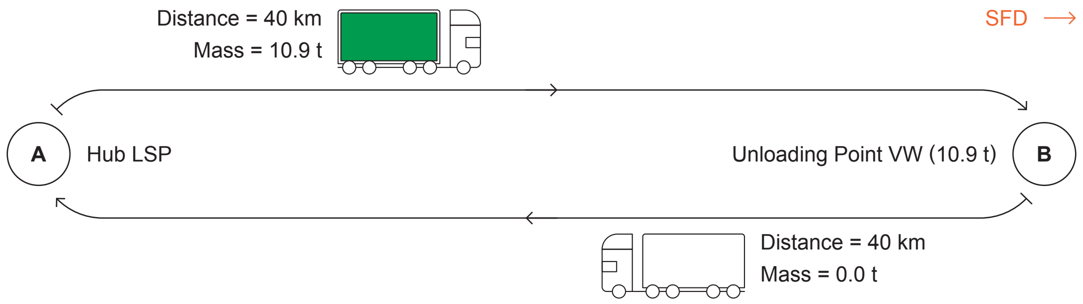

Figure 6: Point-to-point transport for a single customer

The first step is to calculate the total emissions resulting from the transport chain element, using the corresponding TOC emission intensity:

$$Total\ emissions_{Example1}[gCO2e] = 40[km] * 13{,}68[t] * 90[\frac{gCO_2e}{tkm}]$$

By that, it is assumed that the consignment led to total emissions of ~49 kgCO_2e. In the following step every vehicle transported must be listed, including the mass and the CEU-Road of the car model, based on Chapter 7.1.3.

Customer	Model	Mass [kg]	CEU-Road/Car	Adjusted mass [kg]	Vehicles loaded
VW	Golf	1.304	10	1.800	3
VW	Passat TDI	1.703	11	1.980	2
VW	Passat GTE	1.780	12	2.160	2

Table 21: Vehicle specific parameters

Based on this, the total emissions are allocated to the individual vehicle models. This assignment is calculated by dividing the product of the points and the amount of vehicles transported per model by the sum of products of both variables across all models. For example:

$$Assignment_{Golf} = \frac{10 * 3}{10 * 3 + 11 * 2 + 12 * 2} = 39\ \%$$

The emissions generated per vehicle model is then calculated by multiplying the assignment by the total emissions generated during transport. The final result is shown in the table below.

Customer	Model	Assignment [%]	Emissions [kgCO_2e]	Emissions per vehicle [kgCO_2e/car]
VW	Golf	39 %	19,21	6,40
VW	Passat TDI	29 %	14,28	7,14

Customer	Model	Assignment [%]	Emissions [$kgCO_2e$]	Emissions per vehicle [$kgCO_2e$/car]
VW	Passat GTE	32 %	15,76	7,88
			49,25	

Table 22: Emissions per vehicle

Example 2

The second example shows a multi-stop transport for three different customers (VW, Ford and Audi), which is illustrated by the figure below.

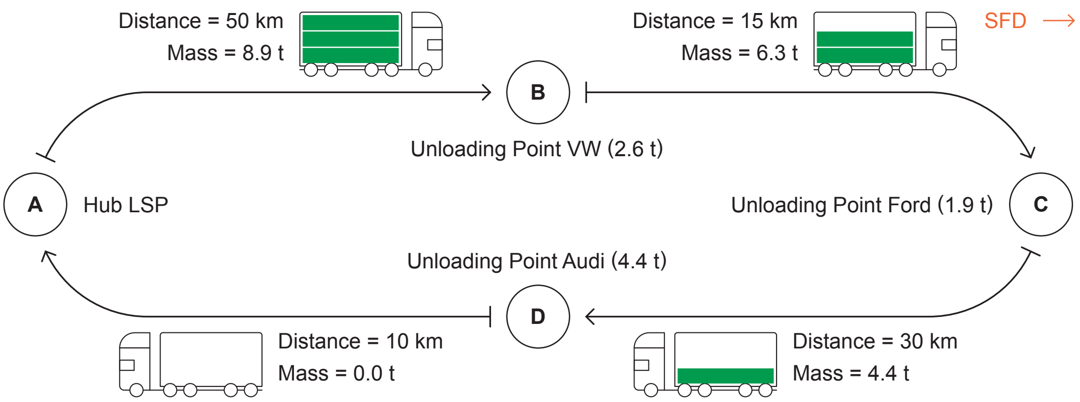

Figure 7: Multi-stop transport for three different customers

Again, the first step is to calculate the total emissions occurred by the transport, using the corresponding TOC emission intensity:

$$Total\ emissions_{Example2}\ [gCO2e] = (50[km] * 14{,}58[t] + 15[km] * 10{,}98[t] + 30[km] * 4{,}68[t]) * 100[\frac{gCO2e}{tkm}]$$

By that, it is assumed that the transport led to total emissions of ~ 103 $kgCO_2e$. In the following step every vehicle transported is listed, including the mass and the CEU-Road of the car model, based on Chapter 7.1.3.

Customer	Model	Mass [kg]	CEU-Road/Car	Adjusted mass [kg]	Vehicles loaded
VW	Golf	1.304	10	1.800	2
Ford	Transit EWLB	1.908	35	6.300	1
Audi	A8	2.220	13	2.340	2

Table 23: Vehicle specific parameters

Based on this, we allocate the total emissions generated to the individual vehicles. This assignment is calculated by dividing the product of the points and the amount of vehicles transported by the sum of products of both variables across all models. The emissions generated per vehicle model is then calculated by multiplying the assignment by the total emissions generated during transport. The final result is shown in the table below.

Customer	Model	Assignment [%]	Emissions [kgCO_2e]	Emissions per vehicle [kgCO_2e/car]
VW	Golf	25 %	25,85	12,925
Ford	Transit EWLB	43 %	44,47	44,47
Audi	A8	32 %	33,09	16,545
			103,41	

Table 24: Emissions per vehicle

The final step is to convert the calculated emissions per vehicle into the reporting form according to Chapter 6.3.

With this comprehensive approach to emission reporting, automotive industry players can ensure that they are not only compliant with regulations but also contributing to a transparent and sustainable future.

7.3. Rail Transport

7.3.1. Introduction

This Chapter presents a structured guide on the recommended methodology for calculating GHG emissions related to rail transportation operations within the automotive industry. It first introduces the Rail TOC and breaks them down into parts like Asset, Transport Concept, Train Configuration, Operating Mode, and vehicle-related classifications. As we progress, attention is turned to the methodologies for data collection, focusing especially on system boundaries and distinguishing between primary and secondary methods. Ultimately, the Chapter explains the exact calculations associated with emissions and their respective intensities.

7.3.2. Rail TOC Definitions

In the world of automotive logistics, it's crucial to have a clear and consistent structure. One main way to achieve this is by defining TOCs. This Chapter is a key guide to the TOCs designed especially for rail transport in automotive logistics. Each TOC captures the different activities, transport methods, and unique aspects of the industry.

As described in Chapter 6.1, each TOC is assigned a 7-digit number. For rail transport, the positions are associated with the TOC parameters and their potential values. An overview table can be found in 8.4.1.

7.3.2.1. Asset Type

In defining TOCs, the type of asset is a key factor for grouping. This is especially true in the automotive industry, where there's a wide range in mass-to-volume ratios of the goods being moved. For clear and accurate TOCs, we need uniform and well-defined categories. For Rail transport five main asset types are differentiated:

1. **Finished Vehicles**
2. **Electric Vehicle Batteries**
3. **Steel**
4. **General Cargo**
5. **Intermodal Transport**

7.3.2.2. Transport Concept

In rail logistics, the 'Transport Concept' delineates how goods and cargo are organized and transported on the rail network. There are two predominant transport concepts.

1. **Single Wagon** refers to an individual railcar that is used for the transportation of goods or cargo. It is a standalone that plays a significant role in rail logistics by providing a flexible and efficient means of transporting goods by rail. Single wagons are used in wagon groups as a common practice in FVL.
2. In rail logistics, a **block train** refers to a type of train consisting of a continuous series of wagons or containers that are dedicated to carrying a single type of cargo or belonging to a single customer. The wagons or containers are coupled together without any intermediate stops or shunting operations along the designated route.

7.3.2.3. Train configuration

Train configurations regarding length refer to the measurement of the overall length of a train from the front of the locomotive or leading unit to the end of the last car or wagon. It is an important aspect of train design and operation, as the length of a train affects various factors such as capacity, manoeuvrability, braking performance, and the ability to negotiate curves and gradients.

The length of a train configuration can vary significantly depending on the specific requirements and constraints of the railway system, including infrastructure limitations, platform lengths, and operational considerations. The recommended length categories for train configurations are as follows:

- **< 500 m length**
- **< 600 m length**
- **< 700 m length**
- **>= 700 m length**

7.3.2.4. Wagon type

In rail logistics for the automotive industry, the "Wagon Type" categorizes railcars based on what they transport and their specific requirements. This choice is crucial for efficient loading, protecting goods and timely delivery. The two main categories in this system are finished vehicles and components.

Finished vehicles

For the transportation of completed vehicles, rail logistics utilizes specific wagon types optimized for the job. Under the category of "Finished Vehicles" there are primarily two specialized wagon designs: Double deck wagons (open or closed) and Flat wagons. These are tailored to ensure the safe and efficient transit of vehicles.

1. **Double deck** wagons in automobile rail logistics refer to specialized railcars designed to transport vehicles on two levels, maximizing the utilization of space on a train.
2. **Flat wagons** in automobile rail logistics, also known as flatcars or car carriers, are specialized railcars designed to transport vehicles in a single layer of vehicles. These wagons have a flat, uninterrupted deck without any sides or walls, providing a large open space to accommodate automobiles of various sizes and configurations.

If adjustable wagons are used in a transport operation, they should be categorized in the TOC with the characteristics they had during the transport. For example, adjustable double-decker wagons that have been set up in a transport so that they have only used one loading level, like a flat wagon, are to be categorized as flat wagons.

Electric Vehicle Batteries, Steel, General Cargo and Intermodal Transport
When it comes to the transportation of automotive components, rail logistics employs a variety of specialized wagons, each designed to cater to specific needs. Within the "Components" category, we primarily discuss three main types of wagons: the Regular Wagon, Multimodal Wagon, and Steel Transporting Wagon. Each of these wagons is meticulously designed, keeping in mind the nature of the components they transport, ensuring safety, efficiency, and compatibility with various rail infrastructures.

1. In the Automotive Logistics industry, a **"regular wagon type"** refers to a standardized rail car used for transporting a variety of automotive components, ranging from smaller parts to larger units like engines or vehicle bodies. These wagons typically have a closed design for protection against external elements,, and incorporate securing mechanisms to prevent load movement during transit. They also adhere to standard dimensions for compatibility with various rail infrastructures. Some may have specialized loading and unloading mechanisms. The specific design varies depending on the transported components and the requirements of the automotive company.
2. A **"Multimodal Wagon"** in automotive rail transport is a versatile rail car designed for intermodal freight transport. It carries containers or units that can easily be transferred between trains, trucks, and ships without unloading the cargo. This category includes trailers with or without trucks that are driven or craned onto the wagon. The exact design can vary based on cargo type and specific requirements.
3. A **"Steel Transporting Wagon"** in automotive rail transport is a robust rail car specifically designed to carry steel in forms like coils, sheets, rods, or slabs. These wagons have high load-bearing capacities and specialized load-securing mechanisms tailored to the mass and shape of the steel products. The wagon can be either open or closed, depending on the type of steel transported and its protection needs. The exact design varies based on the specific steel product and the requirements of the automotive industry.

7.3.2.5. Operating mode
"Operating Mode" in rail logistics provides a structured framework for understanding and categorizing the various ways freight trains conduct their journeys in terms of routing, load-ing strategies, and frequency. This framework is pivotal for ensuring efficient and streamlined operations within the complex realm of rail transportation. By designating specific operating modes, stakeholders in the rail logistics domain can better strategize, optimize costs, and

align their operations with environmental sustainability goals. The four primary operating modes are:

1. **Shuttle full-full:** The term “shuttle transport” typically implies a regular, repeated movement between two fixed points, often following a predefined schedule or route. In this context, the shuttle transport operates with the objective of maximizing efficiency by ensuring that the vehicle is fully utilized both in its outbound and return journeys.
2. **Shuttle full-empty:** in this context, the term “shuttle transport” indicates a regular, repeated movement between two fixed points on a rail network, often following a predetermined schedule or route. However, in this case, the return trip of the shuttle transport is without any payload, resulting in an empty or unladen return journey.
3. **Triangle** transport in rail logistics refers to a transport operation involving three or more distinct locations, creating a triangle-like route. The primary benefit is increased efficiency, as it allows the rail service to carry goods at all stages, thereby reducing the likelihood of making trips with empty loads. This can lead to significant cost savings and environmental benefits.
4. **Network:** In rail logistics for finished vehicles, a transportation network refers to the interconnected system of routes, rail lines, facilities, and operations that facilitate the movement of finished vehicles from manufacturing plants or distribution centres to their final destinations.

7.3.2.6. Propulsion type and source of electric energy

Propulsion Type in rail transport refers to the primary power source utilized by locomotives to move and convey goods or cargo across the railway network. This classification is essential, as it not only dictates the locomotive’s operational capabilities but also impacts environmental considerations and energy consumption. Within the context of rail logistics, two principal propulsion types are predominant.

1. An **electric-powered** locomotive in rail logistics is a type of train vehicle that relies on electricity as its primary power source to propel and transport goods or cargo along the railway network. it uses electric motors or engines to convert electrical energy into mechanical energy, driving the locomotive’s wheels or propulsion system.
2. A **diesel-powered** locomotive in rail transportation is a type of train vehicle equipped with a diesel combustion engine as its primary power source. Diesel locomotives are also known as diesel locomotives or diesel multiple units.

Source of Electric Energy as a TOC in rail transportation refers to the origins of the electrical power used to propel electric-powered locomotives. Recognizing and categorizing this source is crucial for understanding the environmental implications and sustainability of rail operations. Within this context.

1. An **energy mix** refers to the combination of different sources used to generate electric energy for an electric-powered locomotive. instead of relying on a single source, such as fossil fuels or renewable energy, an energy mix incorporates multiple energy sources to meet the electricity demand.
2. **100 % renewable** energy refers to a state where all energy use is sourced from renewable energy resources.

7.3.3. Data Collection

7.3.3.1. System boundaries

For the purpose of streamlining and maintaining clarity in our rail transportation emissions calculations, it’s vital to be explicit about the components considered within our system boundaries. Appropriate sample size to obtain meaningful and reliable emissions data. it is important to carefully justify the chosen sample size and document the underlying assumptions and limitations.

Processes included

The following processes are considered in the calculation of CO_2e emissions related to transportation in the automotive industry:

- **Shunting:** This ensures that all activities, energy consumptions, and resultant emissions related to shunting are accounted for in our evaluations

Processes excluded

The following processes are excluded from the calculation:

- **Hubs:** This includes all handling facilities
- **Specific operational processes:** These are construction, waste management, administration tasks, maintenance and strapping

By excluding these areas, we maintain a focused approach, targeting the most direct and pertinent sources of emissions in rail transportation.

7.3.3.2. Primary Data collection for a consumption-based calculation

This method uses specialized measuring tools to directly capture emissions at their point of origin. By equipping vehicles or other emission points with monitoring systems, we can achieve precise and real-time data collection. This collected information, termed as ‘primary data’, serves as the basis for calculating emissions. Primary data is inherently sourced directly from its origin, typically through an information or telematics system. The key difference between primary and modelled data is the data’s source. For primary data, its direct origin is what matters most. Additionally, there’s a vital link between telematics data and order management, which ensures a thorough evaluation of emissions based on current activities and processes.

To compute emissions from rail transport using primary data, three key pieces of information are essential: details on the distance travelled (both loaded and empty), data on the mass of goods transported, and records of actual fuel consumption.

Mass

In the realm of CO_2e emission calculations for rail transport in the automotive industry, understanding the mass parameter is pivotal, especially when employing the consumption-based calculation method or the primary calculation. Mass, in this context, is split into two main categories:

- **Mass of the Empty Wagon (Equipment):** This represents the mass of the rail wagon when it is unloaded.
- **Mass of the Freight:** An illustrative example here is a loaded finished vehicle.

It’s important to note that the mass details of both the wagon and its load are systematically recorded in the bill of lading, ensuring data accuracy. To determine the overall mass of a train, one must consider the individual mass of each wagon and multiply it by the total number of wagons. However, if for any reason this data isn’t readily accessible from system records, default values can be employed. These default values are predicated upon the type of freight and the transport concept, with examples including finished vehicles and block train transport. This methodological approach ensures that CO_2e emission calculations remain as precise and representative as possible.

Distance

In the process of determining distances for CO_2e emission calculations in rail transport for the automotive industry, the DIUM (Distancier Internationale Uniforme Marchandises) directory by UIC (Union Internationale des Chemins de fer) stands as a principal source. However, not all Rail Undertakings may have access to it, necessitating the use of alternative solutions.

The customer information platform of RailNetEurope (RNE) is recommended as a publicly available alternative source with the limitation of only focusing on major European rail corridors. If additional routes not covered by RNE are needed, commercial tools that provide accurate distance calculation based on DIUM data (e.g., EcoTransIT World) are a commendable substitute.

Energy Consumption

The process for determining carbon emissions in the automotive industry based on the information you provided involves two key steps:

Step 1: Identifying the needed emission factor

First, you need to determine which emission factor should be used for calculating emissions in your specific situation. This can be done on three levels:

1. Market-based approach: The use of a company-specific emission factor that results from the actual energy mix or fuel mix is an option. This method requires certified emission factors and is best if such a factor is available for your specific operation or vehicle model, as it provides the most accurate and relevant data.
2. Using a country-specific emission factor: If no certified emission factor is available, you should resort to country-specific emission factors. These can be provided by various organizations, including the International Energy Agency (IEA) and Eurostat.
3. Using the average power mix as per GLEC Framework: If neither a certified nor a country-specific emission factor is available, you can resort to the average power mix as indicated in the Global Logistics Emission Council (GLEC) Framework.

Step 2: Application of the emission factor

Once you've determined the relevant emission factor, apply it to the specific operational data of your fleet. This could be, for example, the total distance travelled.

7.3.3.3. Secondary Data collection for a transport activity-based calculation

Navigating the challenges of data collection in today's complex organizational setups often leads businesses to seek alternatives. Secondary data stands out as a prominent solution, especially when primary data remains elusive. Predicated largely on transport-based calculations, this type of data offers companies a means to reliably estimate their energy consumption and associated emissions through modelled information.

Modelled data's strength is its adaptability. By leveraging pre-existing datasets and research, or specially designed models, it factors in key parameters like utilization rates and the share of empty runs. Such an approach ensures that even in the absence of direct measurements, companies can maintain an informed perspective on their environmental impact.

In the sections to follow, we delve deeper into the nuances of secondary data, with a special focus on transport-based calculations, emphasizing its vital role in facilitating a comprehensive emissions assessment for businesses.

Modelled or secondary calculation leverages a variety of parameters to construct a representative model of transports and their associated CO_2e emissions. Here's a brief overview of each parameter:

- **Distance:** This parameter denotes the length of the route between the starting point (origin) and the endpoint (destination). Accurate distance measurements are crucial to approximate the emissions generated over a given transport journey.
- **Train type:** The specific category or model of the train used has inherent efficiencies and characteristics that influence emissions. Different train types, such as passenger trains, freight trains, or high-speed trains, have varied emission profiles.
- **Train Mass:** This refers to the total mass of the train, including both the wagons and their cargo. The mass can influence the amount of energy required to move the train, and consequently, its emissions.
- **Utilization Rate:** This parameter indicates the degree to which a train's capacity is utilized. A fully loaded train may emit more in total, but its emissions per unit of cargo could be lower compared to a half-empty train.
- **Proportion of Empty Runs:** This denotes the percentage of trips where the train operates without cargo or passengers. Empty runs, while generating emissions, don't contribute to productive transport, thus affecting the overall emission efficiency.
- **Drive or Propulsion System:** The propulsion system, whether electric, diesel, or a hybrid, plays a pivotal role in determining emission outputs. Electric drives, for example, may have different CO_2e emissions depending on their energy source.
- **Shunting:** This refers to the movements of trains or individual wagons within rail yards or terminals. Shunting operations, though short in distance, can add to the total emissions due to frequent start-stop actions and idling.

By understanding and integrating these parameters, the transport-based calculation method offers a comprehensive approach to estimating CO_2e emissions in rail transport.

In case of unavailability of secondary data for modelling, it is entirely valid to resort to default values. In 8.4.3, you will find a comprehensive table that includes both default values and their sources.

7.3.4. TOC emission intensity calculation

The emission value of a TOC should be calculated based on primary data wherever possible. This approach promises the highest data quality and is most likely to allow conclusions to be drawn about the emissions that occur. For those transports where a calculation based on primary data is not possible, the emission value can be modelled, or default values can be used.

When the transports with existing primary data accurately represent all the transports within a TOC, the emission value derived from primary data can be applied to the entire TOC. A transport is deemed representative when it genuinely mirrors the general transport operations profile, encompassing aspects like utilized technical equipment, geographical conditions, client service requirements, and the logistics operating model. Next, we'll illustrate both calculation methods with examples.

7.3.4.1. Primary Data-based TOC emission intensity Calculation

In the following example the emission intensity for one finished vehicle transportation TOC is determined.

Summary of primary data-based emission intensity calculation for one TOC

Parameter	Value	Unit	Source
Total calculated transport distance	476	km	DIUM
Freight mass	400	t	Railway undertaker (RWU)
Energy consumption	8.000	kwh	RWU
Emission factor	400	gCO_2e/kwh	Sourced Country specific GLEC Framework V2.0 2022
GHG Emission intensity	16,8	gCO_2e/tkm	calculated acc. ISO 14083

Table 25: Primary data-based emission intensity example calculation

First, the total emissions incurred within the scope (usually a specific TOC over one quarter) is calculated. To do this, the actual energy consumption of the train (including empty and loaded runs) is multiplied by the emission factor of the corresponding energy carrier.

The minimum requirement for the emission factor of the propulsion type is an average emission factor from recommended source (see 8.4.2), if available, a specific emission factor for the propulsion type should be used. This value could be obtained from a certificate on the purchased fuel or from the certified electricity label of the respective energy supplier.

$$Total\ emission\ [gCO2e] = Energy\ consumption\ [unit]\ \cdot\ Emission\ factor\ \left[\frac{gCO2e}{unit}\right]$$

In the second step, the transport activity is calculated. For this purpose, the total calculated transport distance is multiplied by the freight mass.

$$Transport\ activity\ [tkm] = Total\ mileage\ [km] \cdot Average\ transported\ mass\ [t]$$

In the last step, the total GHG emissions of the TOC are divided by the transport activity in order to determine the final emission intensity factor.

$$GHG\ Emission\ factor\ \left[\frac{gCO2e}{tkm}\right] = \frac{Total\ emission\ [gCO2e]}{Transport\ performance\ [tkm]}$$

7.3.4.2. Modelled data-based TOC emission intensity Calculation

If the calculation of the emission value of a TOC is not possible based on primary data due to insufficient data, the value must be modelled using default values.

Summary of modelled emission intensity calculation for one TOC with detailed modelling parameters

Parameter	Value	Unit	Source
Train Empty mass	500	t	RWU
Average freight mass	400	t	RWU
max. possible freight mass	700	t	RWU
Total mass (train + freight mass)	900	t	RWU
Empty trip share	96	%	RWU
Energy consumption	0,0157	kWh/gross tkm	EcoTransIT World—Methodology Report 2023 page 73
Energy consumption actual load	0,02826	kWh/net tkm	calculated
Energy consumption empty	0,0216	kWh/gross tkm	EcoTransIT World – Methodology Report 2023 page 73
Energy consumption empty actual load	0,01728	kWh/net tkm	calculated
Emission Factor	0,3962	gCO_2e/Wh	EcoTransIT World—Methodology Report 2023 page 126, emission factor Germany converted from WTT gCO_2e/MJ
Shunting Data			
Shunting	2	hours	RWU
Energy Consumption (Shunting)	18	l/hour or kWh/hour	RWU
Energy (Shunting)	36	l or kWh	RWU
Well-to-Wheel GHG	3.240	gCO_2e/l or gCO_2e/kWh	RWU
Calculated Data			
WTW-GHG Emission factor loaded	11,20	gCO_2e/km	Calculated
WTW-GHG Emission factor empty	6,85	gCO_2e/km	Calculated

Parameter	Value	Unit	Source
GHG intensity (Transport)	9,025	gCO_2e/tkm	Calculated
GHG (Shunting)	0,12	gCO_2e/tkm	Calculated
GHG intensity (Total)	9,145	gCO_2e/tkm	Calculated
Average GHG intensity (Total) per vehicle	16,461	gCO_2e/ vehiclekm	Calculated

Table 26: Modelled data-based TOC emission intensity Calculation

1. Mass Parameters:

Start by understanding the train's empty mass and its mass when loaded with freight. The total mass of the train during its journey (either loaded or empty) plays a crucial role in determining its energy consumption.

2. Trip Shares:

Establish the proportion of trips the train undertakes when empty versus when it's loaded. This split often varies, and understanding it helps in averaging out emissions for round trips.

3. Energy Consumption Metrics:

For each type of journey (loaded or empty), calculate the energy consumed per tonne-kilometre. The energy consumption typically differs based on the mass of the train and the nature of its journey.

4. Emission Factors:

Once you have the energy consumption data, apply the known emission factor. This factor represents the amount of CO_2e emitted per unit of energy consumed. Multiplying the energy consumed by the emission factor will provide the GHG emissions for each journey type.

Emissions from electrified trains depend on the energy used, which varies greatly from country to country and from energy source to energy source. Emissions from electrified trains can be calculated in two different ways:

- **Location-based approach**
- **Market-based approach**

The difference between these two approaches lies in the calculation method of the emission factors. In the location-based approach, the electricity emission factor is calculated based on the regional or national electricity mix. The emission factor is derived from the average CO_2e emissions of electricity production for the region in which the train is operated. This value is independent of the source of the electricity actually purchased.

The market-based approach provides more accurate results but requires detailed information about the electricity source underlying the train operation. The approach makes it possible to calculate the specific emission factor of the electricity purchased, taking into account green electricity certificates or emission certificates that prove that the electricity comes from renewable and low carbon energy. This takes into account the electricity mix of the actual electricity supplier used by the company.

In summary, it should be noted that the location-based approach leads to broader applicability, while the market-based approach increases accuracy. The location-based approach ensures greater comparability and data consistency. In order to be able to report emissions as accurately as possible the market-based approach should be used, whereas the location-based approach is recommended if there is a lack of data.

5. Shunting Operations:

Besides the primary journey, rail operations often include shunting activities. These have their own energy consumption rates and durations. By understanding how much energy is used during shunting and applying the respective emission factor, you can calculate the GHG emissions specific to shunting.

6. Compiling the Data:

Now, compute the Well-to-Wheel GHG Emission factors for both loaded and empty trips. By averaging these over a round trip, you get the GHG intensity for the transport segment. Adding the emissions from shunting operations will give you the comprehensive GHG intensity for the entire operation.

7.3.5. Consignment GHG emission calculation

Your first step is to identify all consignments within the desired reporting timeframe. Emphasize the significance of a digital system, if possible, which can adeptly track emission metrics for every consignment. Such systems ensure accuracy, speed, and efficiency, eliminating manual errors and saving time.

Upon gathering all the necessary data, the next pivotal task is the categorization of consignment. Each consignment should be associated with its correct TOC. Familiarizing oneself with the array of TOC classifications is essential.

For a more hands-on approach: closely examine each consignment. Factors such as the train configuration and electrical energy used play crucial roles. For instance, was the consignment transported via shuttle or triangular rail transport? Was the standard electric energy mix or 100 % renewable energy used? The answers to these questions will guide you towards the correct TOC.

Individual cases that cannot be categorised in a TOC: If journeys are not carried out as planned, for example because a train provided is not loaded at all, the emissions generated from the outward and return journey should still be allocated to the planned TOC.

For clarity and future reference, always document the TOC determinations for each consignment. Such documentation is not merely an administrative formality. it stands as a testament to transparency and can significantly aid in future reporting or referencing.

To show the concept further, let's explore a fictitious calculation. Assume five transport groups, each showcasing varied properties, as outlined below:

	Asset Type	Transport Concept	Train Config-uration	Wagon type	Oper-ating mode	Propulsion type—source of energy
1	Finished vehicle	Single Wagon	< 500 m	Double deck	Shuttle full-full	Diesel
2	Finished vehicle	Wagon Group	< 600 m	Double deck	Shuttle full-empty	Electric—energy mix
3	Finished vehicle	Block Train	< 700 m	Flat wagon	Shuttle full-full	Electric—energy mix
4	General Cargo	Block Train	≥ 700 m	Regular	Triangle	Electric—100 % renewable
5	General Cargo	Single Wagon	< 500 m	Multimodal	Network	Electric—energy mix

Table 27: TOC Examples

Based on these transport properties, it is now possible to obtain the corresponding TOC number for each transport with the help of table 33 in 8.4.1. Based on the own TOC emission calculation, the emission intensity of the specific TOC is to be used.

	TOC	TOC Emission intensity [gCO_2e/tkm]
1	1111100	90
2	1221201	80
3	1332101	50
4	3343302	10
5	3114401	70

Table 28: TOC emission intensity example

In the next step, the transport activity of each individual consignment to be reported on is collected. One example could be reporting for a block train full-empty shuttle transport from Regensburg to Bremerhaven. It has been identified that this transport is categorized in the TOC 1221201 which has an emission intensity factor of 80 gCO_2e/tkm. The transport distance for this relation according to DIUM is documented as 714 km. For the customer, BMW, now the GHG emissions for each transported vehicle is reported. First, for each of these vehicles the consignment mass is needed.

Customer	Model	Mass [kg]
BMW	1er	1.600

Customer	Model	Mass [kg]
BMW	X1	2.085
BMW	X2	1.805

Table 29: Vehicle specific parameters

Based on this, the GHG emissions for the individual consignment are calculated by multiplying the emission intensity factor with the transport distance and their mass. The final result is shown in the table below.

7.3.6. Allocating emissions from trains with multiple asset types

To determine the allocation of the emissions of a train operation with different loaded asset types, the decisive importance of the total mass of each wagon for the corresponding energy requirement of the operation is taken into account. Therefore, the allocation of emissions should primarily be based on the total mass of the respective asset type in relation to the total mass of the train operation (w/o locomotive). For reasons of simplification for calculating third parties who do not have the operator's data, the emission allocation can be based proportionally on the load mass of the respective asset type in relation to the total load mass of the train operation.

EXAMPLE:

Total Mass* Wagon I Steel a t
+ Total Mass* Wagon II General Cargo b t
+ Total Mass* Wagon III Finished Vehicles c t
= Total Mass* Train (w/o locomotive) a+b+c t

Emissions Train: x t CO_2e

Emissions Wagon I Steel = (a t/(a t + b t + c t)) * x t CO_2e

*'Loaded mass' can be used instead of 'total mass' for simplification if necessary data is not available.

7.3.7. Calculating emissions for intermodal transports

When calculating emissions from an intermodal transport, i.e. a transport in which the lorry trailer or even the tractor unit is transported on the train in addition to the goods, it is important to consider which weights must be used by which actor for the calculation.

For the calculation by the railway undertaking the total mass of transported units must be used, i.e. the weight of the transported goods and the weight of the trailer and the tractor unit. It can report these emissions to the LSP. The LSP must then allocate the emissions it has received from the railway undertaking to the consignments within its lorry before it can report them to its customer.

7.4. Sea Transport

7.4.1. Introduction

This Chapter presents a summary of the standardisation of reporting related to sea transport, especially regarding the use of the standard TOC identifier codes. The recommended methodology for calculating GHG emissions in sea transport itself is provided in the guidelines specialised in the respective transport type:

- **Ro-Ro short sea:** ECG Ro-Ro GHG Emissions Accounting Guidance
- **Ro-Ro deep sea:** Global Ro-Ro Community Emission Accounting Guidance
- **Container deep sea:** Clean Cargo – Ocean Containership Greenhouse Gas Emission Intensity Calculation Methods
- **Inland Barge:** GLEC Framework

All other reporting related recommendations and standards of this guideline for the TOC emission intensity and the Consignment GHG emissions also fully apply for sea transport.

Note that Clean Cargo distinguishes between dry and refrigerated containers for deep sea container transport. At present, this distinction cannot be shown in the TOC table in this guideline. However, it is important not to mix these two container types, as they lead to different emission intensities. The inclusion of reefer containers will be reviewed and included in future versions.

7.4.2. TOC Definitions

As described in Chapter 6.1, each TOC is assigned a 7-digit number. For sea transport, the positions are associated with the TOC parameters and their potential values. An overview table can be found in 8.5.1.

7.4.2.1. Asset type

In defining TOCs, the type of asset being transported is a key factor for grouping. This is especially true in the automotive industry, where there's a wide range in mass-to-volume ratios of the goods being moved. For clear and accurate TOCs, we need uniform and well-defined categories. For Sea transport two main asset types are identified:

- **Finished vehicles**
- **General Cargo**

7.4.2.2. Transport concept

The concepts are short sea shipping and inland waterways barges for regional shipments, as well as deep sea shipping which is principally for intercontinental deliveries. Roll-on/roll-off vessels provide the most efficient way of transporting vehicles but containers can also be used in our sector (e.g. in low volume routes or as a substitute for Ro-Ro when there is insufficient capacity).

- **Deep Sea:** Deep sea transport denotes the long-haul consignment of vehicles and components across oceans using specialized cargo ships. This method ensures global distribution and supply chain fluidity for the automotive industry, catering for intercontinental movements.
- **Short Sea:** Short sea transport refers to the nearby, regional consignment of vehicles and components using coastal and sea routes. This method optimizes supply chains within continents.

- **Inland waterways:** Inland waterways transport involves the movement of vehicles and components via rivers, canals, and other navigable inland waters. This mode of transport could be an alternative to road and rail transport, increasing efficiency while supporting regional and cross-border supply chains.

7.4.2.3. Ship type

Efficient maritime transport relies on specialized vessel types tailored to different cargo requirement. Each vessel type serves a distinct purpose, from dedicated car carriers to versatile container ships, ensuring seamless global and regional supply chain operations.

- **Vehicle Carrier:** A multi-deck roll-on roll-off cargo vessel specially designed for the transport of either passenger cars only (PCC) or passenger cars and trucks (PCTC) in extremely large quantities.
- **Ro-Pax Ship:** A vessel combining passenger and cargo capabilities, designed to accommodate more than 12 passengers and equipped with roll-on/roll-off cargo spaces.
- **Ro-Ro Cargo:** A ship engineered to cater exclusively to the transportation of roll-on/roll-off cargo units or boasting dedicated roll-on/roll-off cargo spaces.
- **Container/Ro-Ro Cargo Ship (Con-Ro):** A unique blend of a traditional container ship and a Ro-Ro cargo ship, it houses independent sections for each.
- **Container Ship:** A vessel specifically designed to transport standardized shipping containers, maximizing efficiency in trade. These ships feature a cellular structure with dedicated slots for containers, allowing for high-capacity, intermodal transport.

7.4.3. Calculating emissions for intermodal transports

When calculating emissions from an intermodal transport, i.e. a transport in which the lorry trailer or even the tractor unit is transported on the ship in addition to the goods, it is important to consider which weights must be used by which actor for the calculation.

For the calculation by the ship operator, the total mass of transported units must be used, i.e. the weight of the transported goods plus the weight of the trailer and, if applicable, the tractor unit. It can report these emissions to the LSP. The LSP must then allocate the emissions it has received from the ship operator to the consignments within its lorry before it can report them to its customer (s).

Data of ship operator			
Parameter	Value	Unit	Source
Total emissions	20	tCO_2e	calculated
Total cargo	2000	t	TMS
Distance	500	km	TMS
Emission intensity	20	gCO_2e/tkm	calculated

Table 30: Data of ship operator

Report from ship operator to LSP “green” (shortened)	
Cargo	25 t
Distance	500 km
Emission intensity	20 gCO_2e/tkm
Emission	250 $kgCO_2e$

Table 31: Report from ship operator to LSP “green” (shortened)

Data of LSP “green”			
Parameter	Value	Unit	Source
Total emissions	250	$kgCO_2e$	reported from ship operator
Total cargo	10	t	TMS
Distance	500	km	reported from ship operator
Emission intensity	50	gCO_2e/tkm	calculated

Table 32: Data of LSP “green”

Report from LSP “green” to customer “blue” (shortened)	
Cargo	10 t
Distance	500 km
Emission intensity	50 gCO_2e/tkm
Emission	250 $kgCO_2e$

Table 33: Report from LSP “green” to customer “blue” (shortened)

7.5. Other Modes of transport

In the second release of this GHG transport emission reporting guideline tailored for automotive industry logistics, the initial focus on road, rail and RoRo transport has been expanded to include container transports, barge transports and hub operations.

Transport modes such as airfreight that are not detailed in this version are still fully covered by the provided standardized reporting scheme. For the detailed emission calculation methodology, the existing generic standards of the GLEC framework and ISO 14083 could be referenced.

7.6. Hubs and Compounds

7.6.1. Introduction

This Chapter presents a summary of the reporting-related standardization of hubs and compounds, especially regarding the use of the standard HOC identifier codes. The recommended methodology for calculating GHG emissions for hubs and compounds itself is provided in the Fraunhofer IML "Guide for Greenhouse Gas Emissions Accounting at Logistics Hubs". All other reporting related recommendations and standards of this guideline for the TOC/HOC emission intensity and the Consignment GHG emissions also fully apply for hubs and compounds.

7.6.2. HOC Definitions

As described in Chapter 6.1 each HOC, similar to a TOC, is assigned a 7-digit number. For hubs and compounds, the positions are associated with the HOC parameters and their potential values, which can be found in the overview table in 8.6.1.

7.6.2.1. Asset type

In defining HOCs, the type of asset is a key factor for grouping. In order to obtain clear and accurate HOCs, three asset types are differentiated for hubs and compounds:

- **Finished vehicles**
- **Finished vehicles + High&Heavy**
- **Material**

The category "Finished vehicles + High&Heavy" includes not only standard passenger vehicles but also oversized or overweight equipment such as agricultural machinery, construction vehicles, and other heavy-duty mobile units. Their larger size and heavier weight require special handling procedures and infrastructure, which leads to different logistical requirements than for conventional finished vehicles.

7.6.2.2. Compound type

Hubs and compounds can be categorized based on their location and function within the supply chain. The distinction between inland compounds and port terminals is relevant, as their operational characteristics and connectivity options differ.

- **Inland compound:** An inland compound is a storage and processing facility located away from coastal or inland waterway ports. These facilities are typically connected by road and rail and serve as consolidation points for vehicle storage, processing, and onward distribution.
- **Port terminal:** A port terminal is a compound located at a seaport or inland waterway port. These facilities handle the transshipment of vehicles between ocean-going vessels, barges, trains, and trucks. Due to their strategic location, port terminals often serve as key gateways for international and intercontinental vehicle logistics.

7.6.2.3. Connection types

Connection types specify which MoTs can be processed on a hub or compound. The possible modes are road by truck, rail by train, maritime by ocean-going vessels and inland waterways by barges. As hubs and compounds might process several of these MoTs, any combination of these four is possible. As maritime and inland waterways always have another connection (road or rail), they are not represented alone in the following list.

- **Road**
- **Rail**
- **Road + Rail**
- **Road + Maritime**
- **Road + Inland waterway**
- **Rail + Maritime**
- **Rail + Inland waterway**
- **Maritime + Inland waterway**
- **Road + Rail + Maritime**
- **Road + Rail + Inland waterway**
- **Road + Maritime + Inland waterway**
- **Rail + Maritime + Inland waterway**
- **Road + Rail + Maritime + Inland waterway**

7.6.2.4. Service spectrum

The services offered by a hub or compound have a direct impact on the emissions generated at this location. For example, the average emissions intensity of a location that offers more emissions-intensive services will inevitably be higher than that of a location that only offers storage and onward transport. To ensure sufficient differentiation, a distinction is made here between hubs and compounds that only offer basic services, those that offer additional services with low emissions and those that offer additional services with high emissions.

- **Handling (Basic):** Basic services are those that only represent the absolute minimum of a hub or compound. These include the unloading and loading as well as the short-term storage of vehicles or material.
- **Additional "low impact" services:** In the context of hubs and compounds, low-impact services are understood to be those services that only cause a low level of emissions. This category includes the storage of vehicles and materials, washing and PDI.
- **Additional "high impact" services:** Consequently, high-impact services are services that cause higher emissions. This category includes paint and body-shop services, as well as charging and fuelling.

7.6.2.5. Size

The size of hubs and compounds is defined on the basis of the available storage places. A distinction is made here between small, medium and large hubs.

- **Small hubs** and **ports** have space for up to 2,000 vehicles.
- **Medium hubs** and **ports** can store between 2,000 and 20,000 vehicles on their premises at the same time.
- **Large hubs** and **ports** are facilities that can store more than 20,000 vehicles on their premises at the same time.

7.6.2.6. Geographical location

The geographical location of a hub or compound has a significant impact on the amount of electricity required for lighting and heating. For this reason, a distinction is made here between northern, central and southern Europe in terms of the operating location.

- **Northern Europe:** Hubs and compounds located in latitudes North of 55 degrees North are classified as being in northern Europe. This includes, for example, Scandinavia and the Baltic states.

- **Middle Europe:** Hubs and compounds located in latitudes between 45 and 55 degrees North are classified as being in Central Europe. This includes Germany, Poland, Austria, France, the Benelux countries and the Czech Republic.
- **Southern Europe:** Hubs and compounds located in latitudes South of 45 degrees North are classified as being in southern Europe. This includes, for example, Spain, Italy, Greece, southern France and the Balkans.

7.6.3. Data collection

7.6.3.1. Scope

The scope of emission calculation in hubs and compounds should as broad as possible. Although ISO14083 classifies a number of services as optional in the calculation of emissions, it is recommended that these be taken into account. These include, among others:

- **storage of freight at hubs, such as warehousing**
- **use of information and communications technology (ICT) equipment and data servers related to hub operations**
- **(re) packaging**

7.6.3.2. Allocation level

There are different levels of detail when allocating the emissions of a hub or compound. For reporting it is recommended that the total emissions of the hub or compound are allocated to the selected intensity parameter. For example:

$$\text{Emission intensity} = \frac{\text{Total emissions (e.g. kgCO}_2\text{e)}}{\text{Intensity parameter (e.g. car)}}$$

However, for internal purposes, if the necessary data is available, a more detailed, process-related view can be chosen. To do so, the hub's emissions must be able to be assigned to the areas or processes in which they occur. Only then are they allocated to the selected intensity parameter. This results in multiple, but differentiated, emission intensities for the entire hub. For example:

$$\text{Total emissions} = \text{Emissions storage area} + \text{Emissions workshop area}$$

$$\frac{\text{Emissions storage area (e.g. kgCO}_2\text{e)}}{\text{Intensity parameter (e.g. car)}} \qquad \frac{\text{Emissions workshop area (e.g. kgCO}_2\text{e)}}{\text{Intensity parameter (e.g. car)}}$$

7.6.3.3. CO_2e intensity parameters

The following is a list of potential parameters, which may be more or less suitable depending on the specific use case. A clear recommendation on which parameter to use cannot be provided at this time.

- gCO_2e/car
- gCO_2e/move (handling step)
- gCO_2e/days of storage

7.6.3.4. Emission factors

When calculating the emissions of a hub or compound, emission factors with different levels of detail can be used. A distinction is made between the following approaches:

- Location-based approach
- Market-based approach

The difference between these two approaches lies in the source of the emission factors. In the location-based approach, the regional or national electricity mix is used to determine the electricity emission factor. This value is independent of the source of the electricity actually purchased.

The market-based approach provides more accurate results, but requires detailed information about the electricity source. The approach makes it possible to calculate the specific emission factor of the purchased electricity, taking into account green electricity certificates or emission certificates that prove that the electricity comes from renewable sources. The electricity mix of the electricity supplier actually used by the company is taken into account.

To summarise, the location-based approach leads to broader applicability, while the market-based approach increases accuracy. In order to be able to report emissions as accurately as possible, the market-based approach should be aimed for, whereby the location-based approach is recommended if data is missing.

7.6.3.5. Calculation frequency

Unlike transport operations, an annual calculation of emission intensities is recommended for hubs and compounds because some of the necessary data is only provided yearly.

8. Insetting

8.1. General introduction to topic

8.1.1. Definition

Carbon offsetting is a mechanism for companies to purchase carbon credits from projects that create a reduction in emissions of carbon dioxide or greenhouse gases (GHG) in order to compensate, or offset, their own emissions. Purchasing the credits helps to finance and support projects with a positive impact that contribute to the achievement of sustainable development goals.

As the name suggests, the term insetting derives from the concept of carbon offsetting. Carbon offsetting usually allocates the positive impact of a GHG reduction activity outside of a company's direct or indirect operations to their internal activities. Thus there is no internal emission reduction. Insetting on the other hand, refers specifically to GHG reductions that are directly related to a company's value chain, either by geography, production, or commodity. Instead of financing an existing project elsewhere through offsetting, insetting projects are developed with partners along the value chain and are tailored for the operations and impacts of the company.(Reference: International Platform for Insetting, IPI)

Insetting:
Insetting is described in this guideline as the reduction of CO_2e emissions from transports by using renewable and/or low carbon energy within a company's own transport network and allocating this reduction to a specific cargo (physical use and mass-balancing are accepted).

Book & Claim:
Book and Claim has a broader application area and therefore is described in this guideline as the reduction of CO_2e emissions from transports by using renewable and low carbon energy across the same transport sector, but in different transport networks and allocating this reduction to a specific cargo.

Transport network:
A transport network is the operational infrastructure used by a logistics service provider (LSP) to move goods or passengers. The logistics provider is responsible for managing the assets within this infrastructure and making decisions about how they are used, including fuel type, routes, and speed of transit.

8.1.2. Explanation of concept

Insetting and Book&Claim, as described in this guideline, offer methods to attribute the advantages of renewable and low-carbon energy (i.e. reduced CO_2e emissions) to transport activities. Picture the electricity grid: sustainable sources like wind and hydropower feed clean energy into the shared network. Customers can choose to pay for 'green electricity' from their supplier, supporting the overall injection of renewables. However, this doesn't guarantee that the electricity powering their home directly originates from a specific wind turbine. Instead, it ensures that an equivalent amount of renewable energy is supplied to the grid.

In the context of transport, these mechanisms allow customers to make a positive intervention in their supply chain emissions, even if the low carbon solution is not directly available within their cargo route. Such support incentivises the further rollout of alternative fuels and aids the acceleration of decarbonisation within the sector.

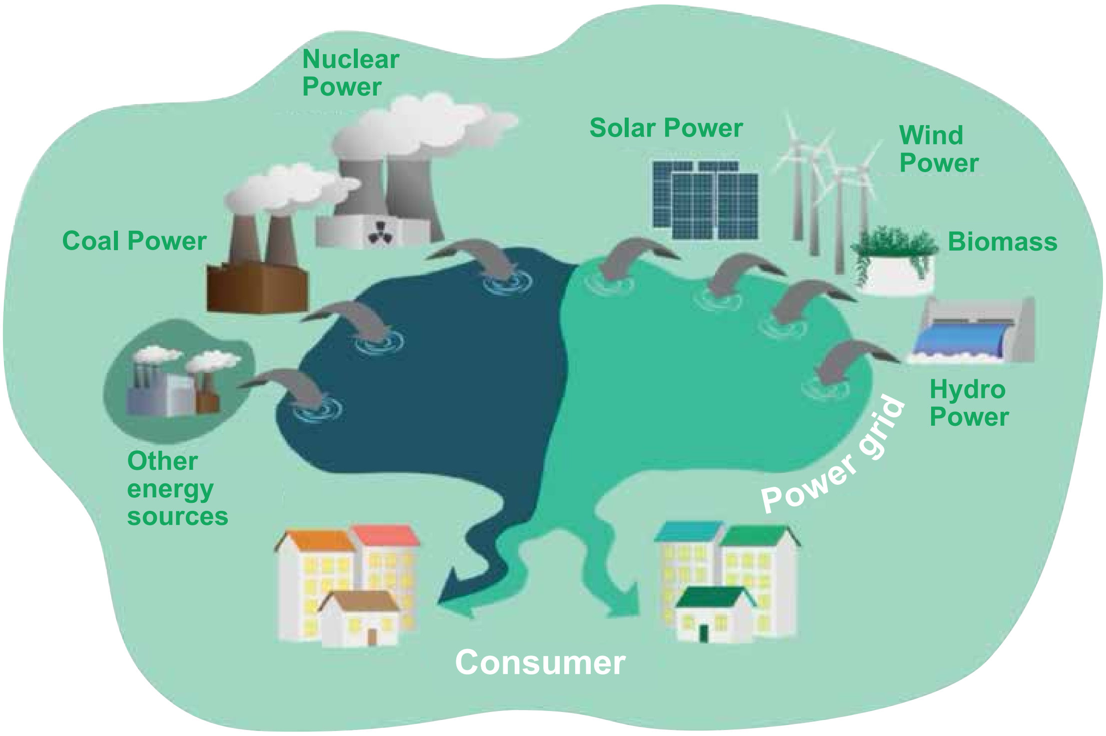

Figure 8: Explanation of concept

8.1.3. Emission Accounting within Insetting

Insetting employs various calculation methods to account for the emissions reductions achieved within a company's own transport network. Two common approaches are outlined below:

Method 1: Relative Emission Reduction Allocation

This method involves allocating the relative reduction in emissions achieved by switching from conventional fuels to renewable or low-carbon energy sources within the company's network. For example, if a company uses biofuel in a portion of its fleet, the percentage reduction in emissions compared to conventional fuel use is calculated. This reduction is then applied to specific transport operations, effectively offsetting a corresponding portion of their emissions. In certain cases, this can result in reporting transport operations with near-zero or zero gCO_2e emissions. This approach is prevalent in sectors like aviation and maritime.

Method 2: Virtual Energy Exchange for Emission Reporting

This method accounts for emissions by virtually replacing the conventional fuel used in a specific transport operation with an equivalent amount of renewable or low-carbon energy used elsewhere within the company's network. This is not a physical fuel swap, but rather an accounting practice. By applying the lower emissions factor associated with the renewable or low-carbon energy source, the reported emissions for the transport operation are reduced. However, it's important to note that renewable and low-carbon energy sources typically have a well-to-wheel (WTW) emissions factor greater than zero. Therefore, this method will result in lower emissions reporting, but not necessarily zero emissions.

Customer Alignment:
The selection of a specific calculation method should be determined in close consultation with the customer, as their reporting requirements and sustainability goals will influence the most appropriate approach.

Example 1 [Relative Emission Reduction Allocation]

Parameter	Value	Unit	Source
Consumption (Diesel)	83	kg	TMS
WTW-GHG emissions factor (Diesel)	4.19	$kgCO_2e/kg$	GLEC Framework V3.1
WTW-GHG emissions factor (HVO100)	1.31	$kgCO_2e/kg$	GLEC Framework V3.1
Allocated consumption (HVO100)	120.75	kg	calculated

Table 34: Relative Emission Reduction Allocation

1. Calculating total emissions

$$83\,kg * 4.19\,\frac{kg\,CO_2e}{kg} = 347.77\,kg\,CO_2e$$

2. Calculating the reduction potential of HVO100

$$\frac{1.31\frac{kgCO_2e}{kg}}{4.19\frac{kgCO_2e}{kg}} = 0.3126$$

Reduction potential $-\,0.3126 = 0.6874 = 68.74\%$

- With the use of HVO100 compared to diesel, 68.74 % of emissions can be saved

3. Calculation of necessary amount of renewable or low carbon energy

$$\frac{83\,kg}{0.6874} = 120.75\,kg$$

- The use of 120.75 kg HVO100 saves 347.77 $kgCO_2e$ in comparison to the use of Diesel.

$$(120.75\,kg * 4.19\,\frac{kg\,CO_2e}{kg}) - (120.75\,kg * 1.31\,\frac{kg\,CO_2e}{kg}) = 347.77\,kg\,CO_2e$$

- 120.75 kg HVO100, must be allocated to this transport, that results in 0 gCO_2e emissions that can be reported to the customer.

Example 2 [Virtual Energy Exchange for Emission Reporting]

Parameter	Value	Unit	Source
Consumption (Diesel)	83	kg	TMS
WTW-GHG emissions factor (Diesel)	4.19	$kgCO_2e/kg$	GLEC Framework V3.1
WTW-GHG emissions factor (Diesel)	97.8	gCO_2e/MJ	GLEC Framework V3.1
WTW-GHG emissions factor (HVO100)	29.7	gCO_2e/MJ	GLEC Framework V3.1

Table 35: Virtual Energy Exchange for Emission Reporting

1. Calculating total emissions

$$83\,kg * 4.19\,\frac{kg\,CO_2e}{kg} = 347.77\,kg\,CO_2e$$

2. Calculating energy (MJ) used

$$\frac{347.77\,kg\,CO_2e}{0.0978\,\frac{kgCO_2e}{MJ}} = 3555.93\,MJ$$

3. Calculating emissions if renewable or low carbon energy were used for the transport operation

$$3555.93\,MJ * 0.0297\,\frac{kg\,CO_2e}{MJ} = 105.61\,kg\,CO_2e$$

→ 3555.93 MJ of HVO100 can be allocated to this transport, that results in 105.61 $kgCO_2e$ emissions that can be reported to the customer.

Negative emission intensity fuel

According to the European renewable energy directive (RED II) greenhouse gas emissions from the production and use of transport fuels, biofuels and bioliquids shall be calculated as follows:

E = eec + el + ep + etd + eu – esca – eccs – eccr

where

E	=	Total emissions from the use of the fuel;
eec	=	emissions from the extraction or cultivation of raw materials;
el	=	annualised emissions from carbon stock changes caused by land-use change;
ep	=	emissions from processing;

etd	=	emissions from transport and distribution;
eu	=	emissions from the fuel in use;
esca	=	emissions savings from soil carbon accumulation via improved agricultural management;
eccs	=	emissions savings from CO_2 capture and geological storage; and
eccr	=	emissions savings from CO_2 capture and replacement.

Table 36: Negative emission intensity fuel

The above equation contains components that produce emissions and components that save emissions. Thus, based on the absolute values of each component, **it is possible that the overall resulting greenhouse gas emissions are negative.** In detail the three factors that can lead to negative emissions are:

- **Emissions savings from soil carbon accumulation (e_{csa}),** which occur through various methods like improved crop rotation or manure management. The latter one is the most potent for which credits up to -124.4 g CO_2eq/MJ can be attributed to the overall factor.
- **Emissions savings from CO_2 capture and storage (e_{ccs})** refer to practices of capturing CO_2 from processing biomass (i. e. burning it for energy production) and storing the sequestrated carbon underground.
- **Emission savings from CO_2 capture and replacement (e_{ccr})** refer to a similar practice as the above. Just in this case the sequestrated CO_2 is used to replace fossil derived CO_2 in various processes like the carbonation of drinks or the conversion into value-added products through chemical processes (production of synthetic fuels, chemicals and materials).

To show how negative emissions come to be, we like to provide an example based on the typical values for the production of biomethane from wet manure in open digestate without off-gas combustion (see marked in table below):

EF_biomethane = 0.0 + 84.2 + 19.5 + 1.0 + 3.3 – 124.4 – 0 – 0 = -16.4 gCO_2e/MJ

Biomethane production system	Technical option		Typical Value [g CO_2eq/M]					
			Cultivation	Processing	Upgrading	Transport	Compression at filling station	Manure credits
Wet manure	Open digestate	no off-gas combustion	0,0	84,2	19,5	1,0	3,3	124,4
		off-gas combustion	0,0	84,2	4,5	1,0	3,3	124,4
	Close digestate	no off-gas combustion	0,0	3,2	19,5	0,9	3,3	111,9
		off-gas combustion	0,0	3,2	4,5	0,9	3,3	111,9

Table 37: Source: Renewable Energy Directive (EU2018/2001), 16.07.24, p.163

Note: Usually, positive biogenic emissions are out of scope when reporting fuel emissions. It is therefore debatable if biogenic emissions savings can be in scope, although it is allowed according to RED II.

Due to this debate, some customers will not claim these benefits. It is, therefore, to be agreed with the customer if negative factors shall be used for calculations and insetting or not.

If used, negative emissions factors impact the two methods of carbon insetting, that were introduced in this chapter:

- For the process of Relative Emission Reduction, because the reduction is now above 100 %, simply less energy/fuel is needed to achieve 0 g CO_2e for a transport as compared to a positive emissions factor with reductions below 100 %.
- In case one uses the Virtual Energy Exchange two outcomes are possible:

  1. A negative amount of total emissions can be reported for the transport due to the fact that a positive fuel emission factor is exchanged for a negative one.
  2. A mixture of biogenic and fossil energy compliant with the propulsion + fuel/energy types defined in this guideline can be used to achieve slightly positive emissions.

8.1.4. Guideline overview

- **Further guidelines on this topic are listed below.**
- **Roundtable on Sustainable Biomaterials:** RSB Book & Claim Manual (RSB Book & Claim Procedure)
- **Smart Freight Centre:** Voluntary Market Based Measures Framework for Logistics Emissions Accounting and Reporting
- **Smart Freight Centre and MIT Center for Transportation & Logistics:** Sustainable Aviation Fuel Greenhouse Gas Emission Accounting and Insetting Guidelines

8.2. Description of recommended insetting process

This chapter provides a structured overview of a possible way in which an insetting solution could be operated by a logistics service provider. Necessary documents are named and the additional steps for the standard emissions calculation are shown. The recommended process is based on method 2 (Virtual Energy Exchange for Emission Reporting) above.

In general, the aim of this method is to assist the LSP in realising the full value of sustainable fuels by creating a framework through which the LSP can offer emission reductions to customers across their transport network.

8.2.1. Data collection

In order to be able to fully implement the insetting process, a “Proof of Sustainability” (PoS) certificate issued by an approved certifying party[1], is required. This certificate ensures that the reduced emissions are calculated using the correct emission factor and, also, that the maximum available quantity of the fuel is not exceeded.

Important data to be collected from the certificate (PoS) are therefore:

- Fuel type
- Total quantity (in MJ)
- Emission factor (gCO_2e/MJ)

1 Certifying parties are determined, for example, by the European Commission

- Emission reduction in relation to the GLEC emission values of the fossil comparator used
- Issue date of certificates and expiry date (if applicable)
- Other qualitative characteristics if required (land-use-change, feedstock, etc.)
- Standard on which the certificate is based (e.g. RED)

8.2.2. TOC emission intensity calculation

The emission intensity is calculated in two steps. In both steps, the calculation is similar to that in chapter 7.2.4 (TOC emission intensity calculation). However, in the first step, the emission factor of standard diesel is used for the total amount of energy (MJ) consumed[2]. Note that this refers to both the consumption of diesel and the consumption of HVO, for example. The calculated emission intensity thus forms the reference value for journeys within the TOC that would have been fuelled exclusively with standard diesel. In the second step, for the same transport activity data, the emission factor of the sustainable energy is used to calculate the emission intensity. This calculated emission intensity thus forms the reference value for journeys within the TOC that would have been fuelled exclusively with sustainable energy. Note that if several Proofs of Sustainability are available, a weighted average value based on energy must be used for the emission factor of the sustainable energy (see also chapter 7.2.3.4).

To distinguish between the different types of emission intensity, they are assigned an insetting indicator in the TOC emission intensity report. This indicator can have the following values:

1. The emission intensity is based on the emission factors of the energy sources actually used for transport. These can also be average values if, for example, 80 % B7 diesel and 20 % HVO100 are fuelled.
2. The emissions intensity shown is calculated to represent the emissions of transport that would have been operated exclusively with conventional fuel.
3. The emissions intensity shown is calculated to represent the emissions from transport that would have been powered exclusively by renewable and low carbon energies.

8.2.3. Consignment GHG emission calculation

The calculation of consignment specific emissions is described in chapter 7.2.5. It should be noted that the calculated emissions intensity is used here in order to reflect the emissions from the use of sustainable fuel.

The final step is to determine the amount of renewable energy that needs to be removed (claimed) from the register for this transport/group of transports of a customer. To do this, the quantity of energy on which the previously calculated emissions are based is calculated. This is done in MJ.

Example calculation:

$$\frac{\text{Total emission } (g\,CO_2e)}{\text{Emission factor } \left(\frac{gCO_2e}{MJ}\right)} = \text{Energy } (MJ) \qquad \frac{71200\ g\,CO_2e}{29{,}7\ \frac{gCO_2e}{MJ}} = 2397{,}31\ MJ$$

8.2.4. Retrieval from register

Once the quantity of energy required for the transport has been determined, this quantity can be taken from the register. Possible data fields that should be taken into account are

2 Note that volume consumption of fuels is standardised in MJ to take into account different energy densities per litre.

- Quantity (MJ)
- Remaining quantity (MJ)
- Start (MJ) –End (MJ)(Retrieved MJ range from register)
- Start of term – end of term (Term of the retrieval)

Call-off no.	Custom-er/contract information	Qty called off	Remain-ing Qty	Start (MJ)	End (MJ)	Start of term	End of term	Date of retrieval
1	Customer1	30.000	70.000	1	30.000	01.01.2024	31.03.2024	01.04.2024
2	Customer2	45.000	25.000	30.001	75.000	01.01.2024	31.03.2024	01.04.2024
3	..	..	..	..	..	..	..	..

Table 38: Retrieval from register

Note that there should be a separate register for each PoS that digitally maps the exact quantity and properties of that energy source. Therefore, if the emission intensity was calculated using an emission factor that was determined from the weighted average of the emission factor of all available sustainable energies, the amount of energy to be retrieved must also be distributed to the existing registers in the same proportion as it was taken into account in the emission factor.

8.3. Minimum standards a LSP should meet when designing a book & claim solution

Book and claim systems are currently not standardized and the guideline presents a best practice solution with the previous insetting example. In addition, however, the minimum requirements for a book and claim system that an LSP should comply with when developing its own solution are listed below to facilitate and standardize auditing.

- Proof of sustainability (PoS) certificate should be issued by a third party
    - Quantities of the renewable or low carbon energy should be stated
    - Emission factor of the renewable or low carbon energy should be stated
- Sources for constants should be given
- Ideally, information should be exchanged via EDI messages.
- If available, the relevant emission accounting guidelines for the respective MoT should be followed

9. Annex

9.1. Automotive Industry transport scenarios

In this annex, a series of transport emission scoping and reporting examples that illustrate the various scenarios within the process landscape of the automotive industry are presented. Each example is depicted through a flow chart, showcasing the flow of materials and information, the sender and recipient, the freight payer, and the associated CO_2e emissions scope. Additionally, we provide practical examples for the respective roles to facilitate a clear understanding of the responsibilities and procedures involved.

1. **Goods Flow:** The movement of automotive components/service parts or finished vehicles. This can refer to:

- Pre-Inbound flow: Activities related to the transportation of goods prior to a reporting company's tier #1 supplier.
- Inbound flow: Movement of raw materials or components/service parts from suppliers to the manufacturing or assembly plant/warehouse.
- Outbound flow: Transport of finished vehicles and service parts from the manufacturing plant to either dealerships, warehouses, or end customers.
- Intracompany flow: Transfer of goods between different facilities or departments within the same company.

2. **Shipper:** The party responsible for sending goods. In the various scenarios:

- Inbound/Pre-Inbound: Often a parts manufacturer or raw material supplier.
- Outbound: Typically, the car or component manufacturer.
- Intracompany: Any department or facility within the company sending goods to another department or facility within the same company.

3. **Receiver:** The entity receiving the goods:

- Inbound/Pre-Inbound: Usually the tier 1 manufacturing supplier, the car manufacturing or assembly plant.
- Outbound: OEM from tier 1 supplier or typically the car dealerships or end customers.
- Intracompany: Any department or facility within the company receiving goods from another department or facility within the same company.

4. **Freight Payer:** The entity that pays for the transportation of goods. In most scenarios, the freight payer could be either the shipper or receiver, depending on the terms of the sale or internal company policy.
5. **CO_2e Emissions Reporting Scope:** The outline of greenhouse gas emissions resulting from transportation activities in the automotive supply chain. This includes emissions from vehicles used in inbound, outbound, and intracompany.
6. **Information Flow:** The transmission of data related to the movement of goods, such as order updates, consignment schedules, delivery confirmations, and invoices. This flow of information is essential in all transport scenarios (inbound, outbound, intracompany, and pre-inbound) to maintain efficient operations, meet delivery schedules, and ensure synchronization of supply with demand in the automotive supply chain.

After providing the necessary context in our introductory section, we now delve into our first illustrative scenario.

9.1.1. Pre-Inbound

This flowchart represents two distinct scenarios within the pre-inbound phase of the automotive supply chain, labelled as Option A and Option B. Each scenario is characterized by different freight payers and their reporting responsibilities for transportation emissions.

In Option A, Company N, is the freight payer. In this scenario, the flow of goods starts from Company N to Company A and then finally to Company B (the Car Industry Supplier or OEM). As the freight payer, Company N is responsible for reporting transportation emissions data to Company A – these will be Scope 3 Cat 4 from company A's perspective.

From Company B's perspective, these emissions fall under Scope 3, Category 1 of the Greenhouse Gas Protocol and will be reported to them by company A as part of the goods supplied.

In contrast, Option B designates Company A as the freight payer. In this scenario, Company A assumes the responsibility for reporting transportation emissions to both Company N and Company B.

As in Option A, from Company B's viewpoint, these reported emissions are also classified as Scope 3, Category 1 according to the Greenhouse Gas Protocol.

These two options represent different configurations within the pre-inbound stage of the automotive supply chain, each with unique implications for the responsibility of CO_2e reporting. They illustrate the complexity and the importance of accurate identification of the freight payer in ensuring correct emissions reporting.

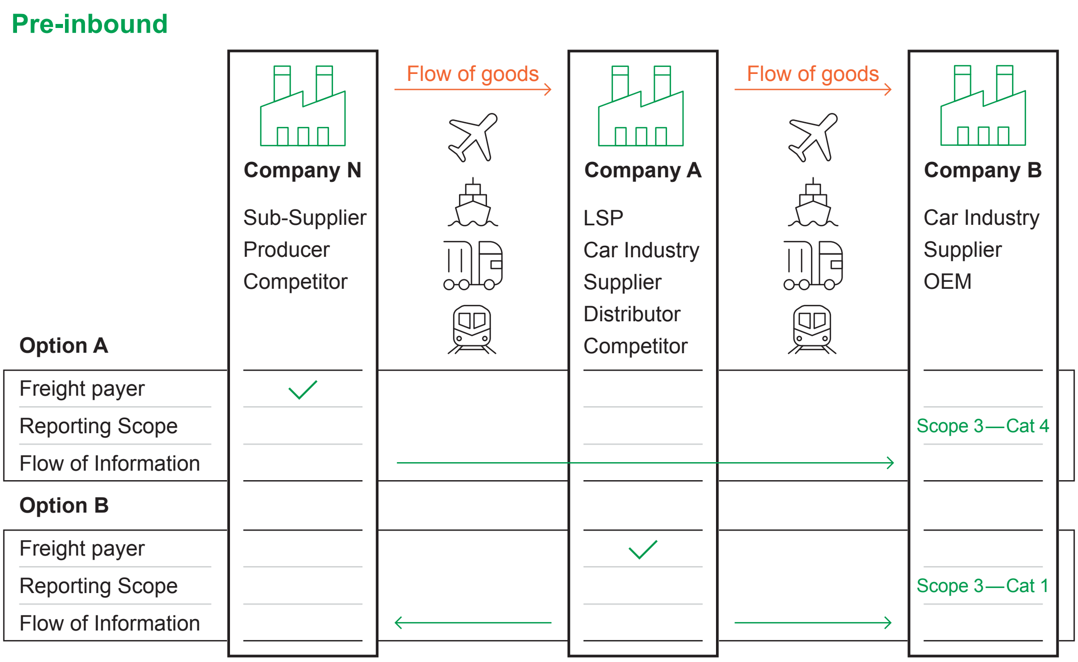

Figure 9: Pre-inbound scenario

9.1.2. Inbound

This flowchart outlines two potential scenarios within the inbound stage of the automotive supply chain, denoted as Scenario A and Scenario B. The scenarios differ based on the entity serving as the freight payer and its respective emissions reporting responsibilities.

In Scenario A, Company A, acting as a sub-supplier, producer, or competitor is the freight payer. The flow of goods extends from Company A to Company B, the Car Industry Supplier or OEM. As the freight payer, Company A bears the responsibility of reporting transportation emissions data to Company B. From Company B's perspective, these emissions are classified under Scope 3, Category 4, as per the Greenhouse Gas Protocol.

Scenario B, on the other hand, sees Company B assuming the role of the freight payer. In this setup, Company B is responsible for reporting transportation emissions to Company A. Despite the change in the freight payer, from Company B's viewpoint, these emissions remain within Scope 3, Category 4 of the Greenhouse Gas Protocol.

These scenarios serve to illustrate the varying arrangements in the inbound stage of the automotive supply chain, underscoring the critical role of identifying the freight payer in accurately assigning responsibility for CO_2e reporting.

Inbound

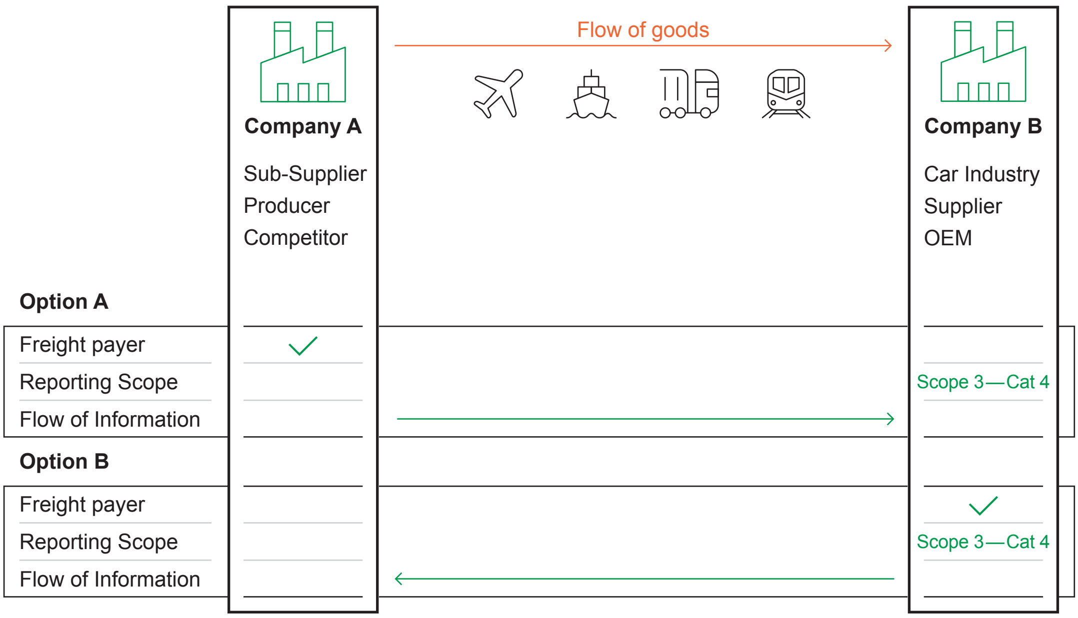

Figure 10: Inbound scenario

9.1.3. Intracompany

The Intracompany Scenario illustrates the transportation process within Company B itself, highlighting two different arrangements – Option A and Option B – each of which has distinct implications for emissions classification and reporting.

In Option A, transportation is conducted using the equipment of a third-party forwarder. As the freight payer, Company B is responsible for reporting these emissions, which are classified under Scope 3, Category 4, according to the Greenhouse Gas Protocol, reflecting emissions from transportation and distribution activities conducted by third parties.

Option B presents a different situation where transportation is carried out using Company B's own equipment. As a result, the emissions produced can fall under either Scope 1 or Scope 2 categories, depending on the sources of the energy used. Scope 1 emissions are those directly resulting from sources owned or controlled by the company, whereas Scope 2 emissions are those generated from the consumption of purchased electricity, steam, heating, and cooling.

For 3rd party transportation the company shall get emission data from the freight supplier – for company owned / operated vehicles it will be necessary to calculate your own emission levels.

These two options illustrate the importance of the nature of the transportation equipment used and its ownership in determining the appropriate emissions reporting category.

9.1.4. Outbound

The Outbound Scenario encompasses three distinctive arrangements – Scenario A, B, and C – each yielding different categories of emissions from Company B's perspective, depending on the freight payer and the transportation equipment used.

In Scenario A, Company B is the freight payer, utilizing third-party equipment for transportation. The flow of emission-related information is directed towards Company C. From an emissions reporting perspective, the emissions generated are classified as Scope 3, Category 4, as defined by the Greenhouse Gas Protocol. This category captures the emissions from transportation and distribution activities undertaken by third parties.

Scenario B involves Company B using its own equipment for transportation while also serving as the freight payer. In this setup, the emissions generated can be classified under Scope 1 or Scope 2. Scope 1 refers to direct emissions from sources that are owned or controlled by the company, such as their transportation fleet. Scope 2 encompasses emissions resulting from the consumption of purchased electricity, steam, heating, and cooling, if the vehicles used, for example, are electric and the electricity used is purchased.

Finally, in Scenario C, Company C acts as the freight payer. Here, the responsibility of reporting the emissions falls onto Company C. For Company B, these emissions are categorized under Scope 3, Category 9. This category includes emissions from the transportation and distribution of products in the downstream stages of a company's value chain when carried out by a third party.

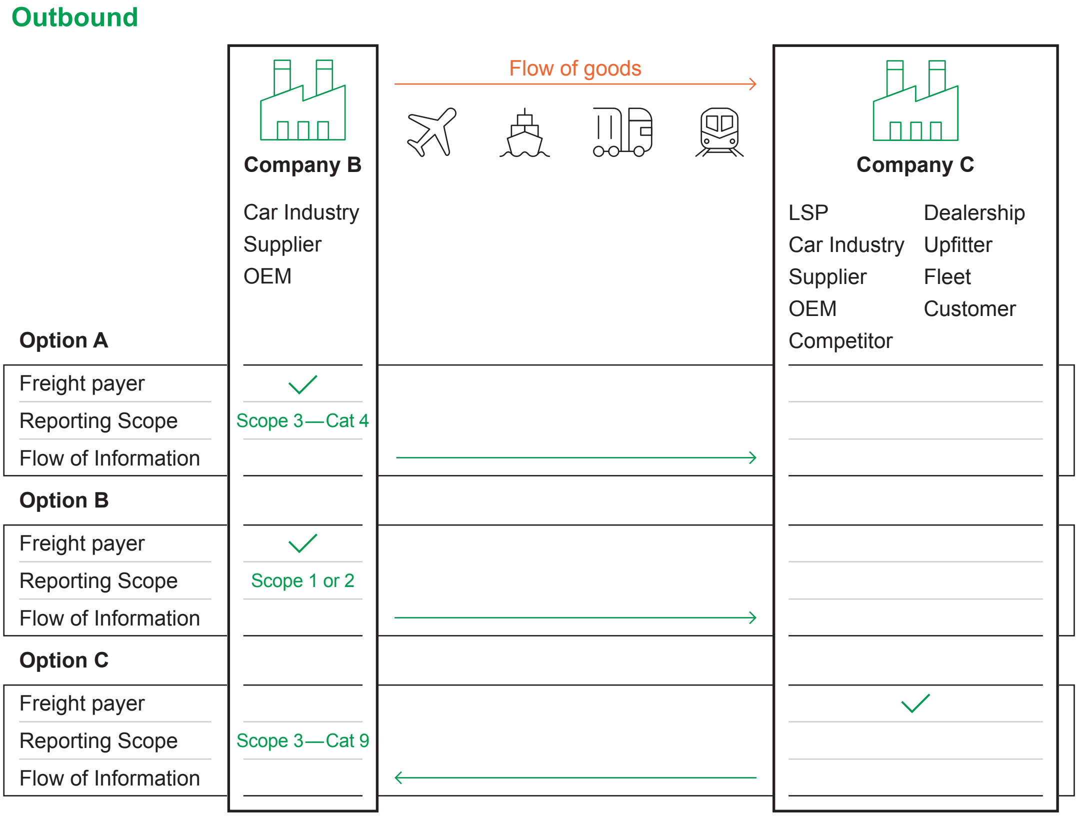

Figure 11: Outbound scenario

9.1.5. Post-Outbound

The Post-Outbound Scenario is composed of three different options—Option A, B, and C—each reflecting varying responsibility for freight payment and resulting in differing emission categories for Company B.

Option A has Company B as the freight payer. Here, the classification of emissions hinges on the nature of equipment used for transportation. If third-party equipment is used, the emissions fall into Scope 3, Category 4, capturing emissions from third-party transportation and distribution activities. On the other hand, if Company B uses its own equipment, these emissions could be classified under Scope 1 or Scope 2. Scope 1 represents direct emissions from sources owned or controlled by the company, while Scope 2 includes indirect emissions resulting from the consumption of purchased electricity, steam, heating, and cooling.

Option B has Company C as the freight payer. In this arrangement, Company C transfers emission-related information to Companies B and D. For Company B, the emissions are classified under Scope 3, Category 9. This category accounts for emissions from the transportation and distribution of products in the downstream stages of the value chain when performed by a third party.

Lastly, Option C assigns the role of freight payer to Company D. In this setup, Company D transfers information to Company C – Company C shall pass this information to Company B. Similar to Option B, from Company B's perspective, the emissions fall into Scope 3, Category 9.

Post-outbound

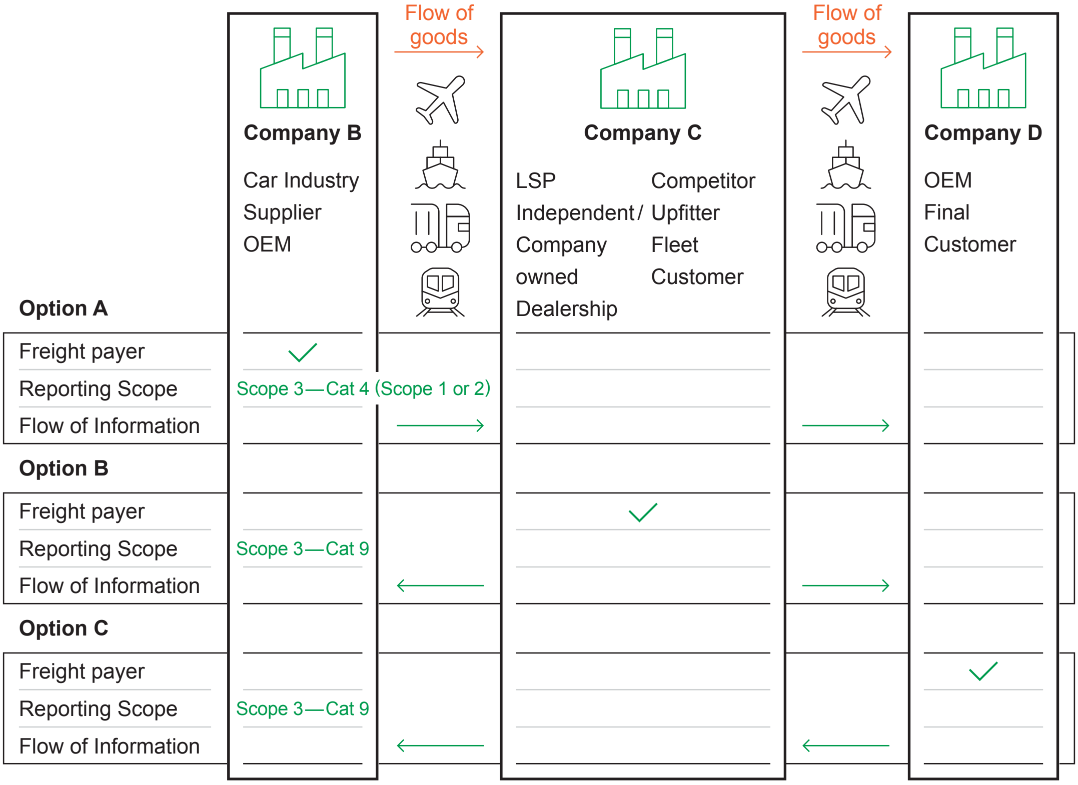

Figure 12: Post-outbound scenario

9.2. Reporting Parameter Definitions

XML files for all the reports described below (Master Data Report, Emission Intensity Report, Transport TCE GHG Emission Report and Hub TCE GHG Emission Report) can be down-loaded online at the following link: https://www.odette.org/repository/VDA_ECG_ODETTE_CO_2_Reporting_V1R1.zip

9.2.1. Master Data Report

Parameter	Definition	Requirement
ID	An identification code uniquely per LSP assigned to each TOC for easy recognition and differentiation purposes	Mandatory
Name	A textual description or name representing the TOC, providing a clearer understanding or distinction for the category in question	Optional
BusinessEntityID	Can be the DUNS Number or the Business Entity ID according to ISO 15459 associated with the re-porting entity or organization under a specific TOC, adhering to the IFTSTA standard. Example format: NAD+CA+123456789:: 16	Mandatory

Parameter	Definition	Requirement
AutomotiveIndicator	A classification indicating the standardization of the TOC by the VDA/ECG automotive guideline, either 'yes' or 'no'	Mandatory
AssetType	Cargo classification – see attached code list: Road_FV, Road_EV_Batteries, Road_General, Rail_FV, Rail_EV_Batteries, Rail_Steel, Rail_General, Rail_Intermodal, Sea_FV, Sea_General, Hub_FV, Hub_FV+HH, Hub_General	Mandatory
The definition of the parameters, which are different for each MoT, can be found in the respective chapters of the MoT and its appendix.		

9.2.2. Emission Intensity Report

Parameter	Definition	Requirement
EIID	The unique identification code assigned to the emission intensity dataset of a specific TOC	Mandatory
BusinessEntityID	Can be the DUNS Number or Odette ID or the Business Entity ID according to ISO 15459 associated with the reporting entity or organization.	Mandatory
InsettingType	Specifies whether the reported emission intensity represents the actual fuel used, a baseline (calculated with conventional fuel) or the modelled use of renewable or low carbon energies.	Mandatory
ValidFromDate	Specifies the starting date from which the TOC Emission Intensity ID can be legitimately utilized	Mandatory
ValidToDate	Specifies the ending date up to which the EIID remains valid for usage	Mandatory
ID	An identification key uniquely assigned to each TOC for easy recognition and differentiation purposes. This key is unique per LSP and shall follow a structure defined in VDA/ECG recommendation.	Mandatory
DataSource	Indicates the nature of the data source utilized – whether it's primary or secondary.	Mandatory
SampleSize	Represents the proportion of the data sample, used for primary-data based emission intensity calculation, to all transports (in tkm) of the TOC type during the reported period, expressed in percentages	mandatory (if DataSource = primary)

Parameter	Definition	Requirement
SampleSpecificity	Provides information regarding the specificity of the input data used for the emission intensity calculation – whether it's customer-specific or not	optional (if Data-Source = primary or modelled)
VerificationIndicator	Indicates if the input data has been verified by a third party compliant with ISO14083 standards	Mandatory
AccreditationIndicator	Specifies if the methodology used for calculation has been accredited by a third party in adherence to ISO14083 standards.	Mandatory
WTWEmissionFactor	A certified emission factor, expressed in kg of CO_2 equivalent per energy consumption unit, which encompasses both the direct emissions (WTT) and the emissions from combustion (TTW)	Mandatory
WTWEmissionIntensity	Represents the WTW emission intensity, measured in grams of CO_2 equivalent per tkm, where tonnes can be the actual mass or the adjusted mass	Mandatory
WTWAlternativeEmissionIntesnity	Measures the WTW emission intensity in an alternative unit of measure, such as TEU-km (Twenty-foot Equiva-lent Unit-kilometre) or parcel-km	Optional

Table 39: Master Data Report

9.2.3. Transport TCE GHG Emission Report

Parameter	Definition	Requirement
Primary identifiers according to the defined reporting level of the consignment		
ConsignmentID	Identifier for a specific consignment within a transport chain, aligned with the IFTSTA standard segment Example: CNI++ConsignmentID+9'	Mandatory
OtherReference	Reference number of a consignment within the transport chain, usually provided by the Logistic Service Provider (LSP) and aligned with IFTSTA standard segment Example: RFF+AVU: 12345'	Optional
Additional identifiers for reference		
TransportOrder	Order number for a specific transport action within the transport chain, in line with IFTSTA standard segment Example: RFF+TIN: TransportOrderNumber	Optional

Parameter	Definition	Requirement
TransportID	Identifier for a specific transport action within the transport chain as per IFTSTA standard segment Example: RFF+AAO: 12345	Optional
TransportIDLSP	Transport action identifier given by the Logistics Service Provider (LSP) within the transport chain, aligned with IFT-STA standard segment Example: RFF+AFC: Transport number (LSP)	Optional
TransportChain-Reference	Reference linked to the entirety of the transport chain, in line with IFTSTA standard segment Example: RFF+AKI: Transport ID	Optional
TOCEmissionIntensityID	Specific ID associated with the TOC emission intensity dataset being referenced in the transport chain.(i. e. the EmissionIntensityID of the relevant TOC Emission Intensity Report)	Mandatory
BusinessEntityID	Can be the DUNS Number or Odette ID or the Business Entity ID according to ISO 15459 associated with the reporting entity or organization.	Mandatory
ArrivalDate	Denotes when the transport action within the transport chain arrived at its destination, as per IFTSTA standard segment Example: DTM+136: 20131201: 102	Mandatory
ShippingLocation	The shipping location or source where the transport chain element starts, as defined in the IFTSTA standard segment Example: LOC+60+Place of Shipping ID: 10: Place of Shipping as Text+52.515738,13.393085	Mandatory
PlaceofArrival	The location or destination where the transport chain element concludes, as defined in the IFTSTA standard segment Example: LOC+60+Place of Arrival ID: 10: Place of Arrival as Text+52.515738,13.393085	Mandatory
DistanceData-Source	The type of data source used to determine the distance covered in the transport chain element. Options: ‘default’: Standard or preset data source. ‘secondary’: Data source derived from modelling	Mandatory

Parameter	Definition	Requirement
MassDataSource	Description: The data source used to derive the mass of the consignment in the transport chain element. Options: 'secondary': Mass determined through modelling. 'primary': Directly measured or primary data.	Mandatory
AccreditationIndicator	Specifies if the methodology used for calculation has been accredited by a third party in adherence to ISO14083 standards.	Mandatory
Distance	The measurable distance between the origin and destination used for emission calculations in the transport chain element	Mandatory
OriginalMass	The unadjusted gross mass of the consignment without any modifications or applications of conversion and equivalent factors – in kg	Mandatory
AdjustedMass	The mass of the consignment used for emission calculations, which might be adjusted based on certain conversion or equivalence factors – in kg	Mandatory
WTWCO_2e	WTW GHG emissions associated with the consignment, measured in kilograms of CO_2e	Mandatory
TTWCO_2e	TTW GHG emissions associated with the consignment, also measured in kilograms of CO_2e	Mandatory

Table 40: Transport TCE GHG Emission Report

9.2.4. Hub TCE GHG Emission Report

Parameter	Definition	Requirement
Primary identifiers according to the defined reporting level of the consignment		
ConsignmentID	Identifier for a specific consignment within a transport chain, aligned with the IFTSTA standard segment Example: CNI++ConsignmentID+9'	Mandatory
OtherReference	Reference number of a consignment within the transport chain, usually provided by the Logistic Service Provider (LSP) and aligned with IFTSTA standard segment Example: RFF+AVU: 12345'	Optional
Additional identifiers for reference		

Parameter	Definition	Requirement
TransportOrder	Order number for a specific transport action within the transport chain, in line with IFTSTA standard segment Example: RFF+TIN: TransportOrderNumber	Optional
TransportID	Identifier for a specific transport action within the transport chain as per IFTSTA standard segment Example: RFF+AAO: 12345	Optional
TransportIDLSP	Transport action identifier given by the Logistics Service Provider (LSP) within the transport chain, aligned with IFT-STA standard segment Example: RFF+AFC: Transport number (LSP)	Optional
TransportChain-Reference	Reference linked to the entirety of the transport chain, in line with IFTSTA standard segment Example: RFF+AKI: Transport ID	Optional
HOCEmissionIn-tensityID	Specific ID associated with the HOC emission intensity dataset being referenced in the transport chain.(i. e. the EmissionIntensityID of the relevant HOC Emission Intensity Report)	Mandatory
BusinessEntityID	Can be the DUNS Number or Odette ID or the Business Entity ID according to ISO 15459 associated with the reporting entity or organization.	Mandatory
ArrivalDate	Denotes when the consignment within the transport chain arrived at the specific location, such as a hub or compound as per IFTSTA standard segment Example: DTM+136: 20131201: 102	Mandatory
DispatchDate	Denotes when the consignment within the transport chain leaves the specific location, such as a hub or compound as per IFTSTA standard segment Example: DTM+136: 20131201: 102	Mandatory
MassDataSource	Description: The data source used to derive the mass of the consignment in the transport chain element. Options: ‘secondary’: Mass determined through modelling. ‘primary’: Directly measured or primary data.	Mandatory
AccreditationIndi-cator	Specifies if the methodology used for calculation has been accredited by a third party in adherence to ISO14083 standards.	Mandatory

Parameter	Definition	Requirement
OriginalMass	The unadjusted gross mass of the consignment without any modifications or applications of conversion and equivalent factors	Mandatory
WTWCO$_2$e	WTW GHG emissions associated with the consignment, measured in kilograms of CO$_2$e	Mandatory
TTWCO$_2$e	TTW GHG emissions associated with the consignment, also measured in kilograms of CO$_2$e	Mandatory

Table 41: Hub TCE GHG Emission Report

9.3. Road Transport

9.3.1. TOC Table

Digit	Parameter	Number	Value
1	Asset	1	Finished Vehicles
		2	Electric Vehicle Battery
		3	General Cargo
2	Journey type	1	FTL
		2	LTL
		3	Point-to-Point
		4	Multi-stop
3	Distance class	1	Short-haul
		2	Long-haul
4	Vehicle type	1	Van
		2	Up to 18 t truck
		3	Up to 24 t truck
		4	Up to 40 / 44 t truck
		5	EMS truck
		6	Up to 18 t Small Car Carrier
		7	Up to 40 t Car Carrier

Digit	Parameter	Number	Value
		8	EMS Car Carrier
5	Empty	0	
6+7	Propulsion type + fuel type	01	ICE – Diesel, B0
		02	ICE – Diesel, B7 (7 % Bio-Diesel-share)
		03	ICE – Diesel, B20 (20 % Bio-Diesel-share)
		04	ICE – Diesel, B50 (50 % Bio-Diesel-share)
		05	ICE – Diesel, B100 (100 % Bio-Diesel-share)
		06	ICE – HVO10
		07	ICE – HVO20
		08	ICE – HVO50
		09	ICE – HVO100
		10	ICE – Ethanol
		11	ICE – LNG
		12	ICE – BIO LNG
		13	ICE – CNG
		14	ICE – BIO CNG
		15	ICE – LPG
		16	BEV – conventional (not green)
		17	BEV – green
		18	PHEV – conventional (not green)
		19	PHEV – green
		20	Hydrogen – conventional (not green)
		21	Hydrogen – green

Table 42: TOC table Road Transport

9.3.2. Ranking of recommended data sources for modelling emissions

This table presents a ranking of different sources for the modelled calculation of CO_2e emissions. The ranking is based on user experiences regarding the quality and completeness of the mentioned sources.

Data	Source	Rank
Fuel/energy economy (e.g., l/100 km)	Handbook of emission factors (DACH, France, Sweden, Norway)	1
	DEFRA (applied in the UK)	1
	EcoTransIT	2
Distance travelled	Tailored route calculation tools for truck transportation	1
	EcoTransIT for SFD	2
	Transport Management System (TMS)	2
Mass (t)	Part mass/vehicle mass from customer	1
	LSP – if weighing facility is available	2
Empty run %	Transport Management System (TMS)	1
	EcoTransIT	2
	GLEC Framework	2
Utilisation %	Transport Management System (TMS)	1
	EcoTransIT	2
	GLEC Framework	2
GHG emission factor	GLEC Framework/ISO14083	1
Lower heating value	GLEC Framework/ISO 14083	1

Table 43: Ranking of recommended data sources for modelling emissions

9.3.3. Default values

This table presents a ranking of different sources for the modelled calculation of CO_2e emissions. The ranking is based on user experiences regarding the quality and completeness of the mentioned sources.

Data	Source	Rank
Fuel/energy economy (e.g., l/100 km)	Handbook of emission factors (DACH, France, Sweden, Norway)	1

Data	Source	Rank
	DEFRA (applied in the UK)	1
	EcoTransIT	2
Distance travelled	Tailored route calculation tools for truck transportation	1
	EcoTransIT for SFD	2
	Transport Management System (TMS)	2
Mass (t)	Part mass / vehicle mass from customer	1
	ECG Vehicle mass and dimension catalogue	2
	LSP – if weighing facility is available	2
Empty run %	Transport Management System (TMS)	1
	EcoTransIT	2
Utilisation %	Transport Management System (TMS)	1
	EcoTransIT	2

Table 44: Modelling data source ranking List

9.3.4. Default values

These tables display default values based on actual data analyses from the participating logistics service providers and OEMs / suppliers. This data serve as a foundation to give a more differentiated view on the average transport characteristics in the automotive industry.

Asset	Utilization rate	Empty trip
General Cargo	60 %	33 %
Electric Vehicle Batteries	75 %	38 %

Table 45: General Cargo / Battery transport default values (no further differentiation of journey types)

Finished Vehicle Transport default values per journey type	Utilization rate	Empty trip
Point-to-Point	80 %	30 %
Multi-stop		

Table 46: Finished Vehicle transport default values per journey type

9.4. Rail Transport

9.4.1. TOC Table

Digit	Parameter	Number	Value
1	Asset	1	Finished Vehicles
		2	Electric Vehicle Battery
		3	General Cargo
		4	Steel
		5	Intermodal transport
2	Transport concept	1	Single wagon
		2	Block train
3	Train configuration	1	<500 m length
		2	<600 m length
		3	<700 m length
		4	≥ 700 m length
4	Wagon type	1	Double deck
		2	Flat wagon
		3	Regular
		4	Multimodal
		5	Steel
5	Operating mode	1	Shuttle full-full
		2	Shuttle full-empty
		3	Triangle
		4	Network
6+7	Propulsion type and source of electric energy	01	Electric-powered, energy mix
		02	Electric-powered, 100 % renewable energy
		03	Diesel-powered

Table 47: TOC Table Rail Transport

9.4.2. Ranking of recommended Data sources for modelling emissions

This table presents a ranking of different sources for the modelled calculation of CO_2e emissions. The ranking is based on user experiences regarding the quality and completeness of the mentioned sources.

Data	Source	Rank
energy consumption	EcoTransIT World – Methodology report 2023	1
Distance travelled	DIUM (Distancier international uniforme marchandises) directory by UIC (Union internationale des chemins de fer)	1
	EcoTransIT	2
Mass (t)	Part mass/vehicle mass from customer	1
Empty run %	Transport Management System (TMS)	1
Utilisation %	Transport Management System (TMS)	1

Table 48: Ranking of recommended Data sources for modelling emissions

9.4.3. Default values

This table displays default values based on actual data analyses from the participating logistics service providers and OEMs/suppliers. These data serve as a foundation to give a more differentiated view on the average transport characteristics in the automotive industry.

Asset Type	Finished vehicles	Batteries	General cargo	Intermodal transport	Steel
Transport Concept	Block train	Single wagon	Variation too large for default value	Block train	Single wagon
Train Configuration	>=700 m	Number x length of wagons	Number x length of wagons	<600 m	Number x length of wagons
Wagon Type	Double deck	Multimodal	Variation too large for default value	Multimodal	Steel
Operating Mode	Shuttle full-empty	Network	Variation too large for default value	Shuttle full-full	Network
Propulsion Type and source of electricity	Electric; Energy Mix	Electric; Energy Mix	Electric; Energy Mix	Electric; Energy Mix	Electric; Energy Mix

Asset Type	Finished vehicles	Batteries	General cargo	Intermodal transport	Steel
Train mass	600 t–1,200 t	Number x length of wagons	Number x length of wagons	1,000–1,500 t	Number x length of wagons
Utilization rate	85 %	75 %	60 %	60–80 %	100 %

Table 49: Default values

Operating Mode	Shuttle full-full	Shuttle full-empty	Triangle	Network
Empty trip factor	5 %	100 %	20–60 %	60 %

Table 50: Operating Mode

9.5. RoRo Transport

9.5.1. TOC Table

Digit	Parameter	Number	Value
1	Asset	1	Finished vehicles
		2	General Cargo
2	Transport concept	1	Deep sea
		2	Short sea
		3	Inland waterway
3	Empty	0	
4	Ship type	1	Vehicle carrier (PCC/PCTC)
		2	Ro-pax ship
		3	Ro-Ro ship
		4	Container/Ro-Ro Cargo Ship (Con-Ro)
		5	Container ship
5	Empty	0	
6+7	Empty	00	

Table 51: TOC table RoRo Transport

9.6. Hubs and Compounds

9.6.1. HOC Table

Digit	Parameter	Number	Value
1	Asset type	1	Finished vehicles
		2	Finished vehicles + High&Heavy
		3	General Cargo
2	Compound type	1	Inland compound
		2	Port terminal
3+4	Connection types	01	Road
		02	Rail
		03	Road + Rail
		04	Road + Maritime
		05	Road + Inland waterway
		06	Rail + Maritime
		07	Rail + Inland waterway
		08	Maritime + Inland waterway
		09	Road + Rail + Maritime
		10	Road + Rail + Inland waterway
		11	Road + Maritime + Inland waterway
		12	Rail + Maritime + Inland waterway
		13	Road + Rail + Maritime + Inland waterway
5	Service spectrum	1	Handling (basic)
		2	Additional “low impact” service
		3	Additional “high impact” service

Digit	Parameter	Number	Value
6	Size	1	Small hubs and ports (2.000 storage places)
		2	Medium hubs and ports (2.000 – 20.000 storage places)
		3	Large hubs and ports (20.000 storage places)
7	Geographical location	1	Northern Europe
		2	Central Europe
		3	Southern Europe

Table 52: HOC Table Hubs and Compounds

10. Literature

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