ISO 14083
Guidance document for GHG platform calculators

Topsector Logistiek

Colophon

ISO 14083 guidance document for for GHG platform calculators

Disclaimer
This document provides an easy-to-use practical guidance for providers of GHG emissions calculations who seek to implement the requirements of the ISO 14083 standard on the quantification and reporting of greenhouse gas (GHG) emissions arising from transport chain operations. The guidance does not constitute a replacement of the ISO 14083 requirements but should be used in conjunction with the standard and read as an additional support to interpret requirements. Please note that the focus of this guidance is on the transport or handling of freight. Appendix B specifically addresses guidelines related to passenger transport.

Topsector Logistiek

How to read

This document is structured along five chapters and two appendices.

Chapter 1

The first chapter briefly introduces the relevance of calculating GHG emissions in the transport- and logistics sector and the role of the ISO 14083

Chapter 2 & 3

The second and third chapter provide a summary of key general principles to consider as well as considerations when defining the calculation scope.

Chapter 4

The fourth and main chapter of the guidance provides insights on how to calculate emissions in line with the standard.

Chapter 5

The fifth chapter explains which elements need to be reported on.

Appendix A

Summarizes all relevant mathematical formulas.

Appendix B

Specifically addresses guidelines related to passenger transport.

Contents

Abbreviations

Term	Abbreviation	Definition
Actual Distance	AD	Transport distance along the actual route taken by a vehicle (e.g. distance measured by an on-board device).
Allocation		Partitioning the input or output flows of a process or product system between the product system under study and one or more other product systems.
Distance Adjustment Factor	DAF	Ratio between the actual distance and the transport activity distance, related to same origin and destination locations.
Emission factor	eF	Coefficient relating GHG activity data with the GHG emission.
Energy carrier		Substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes, e.g. electricity, fuels, steam, heat, compressed air or similar media
Great circle distance	GCD	Transport distance determined as the shortest distance between any two points measured along the surface of a sphere.
Greenhouse gas	GHG	Gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds.
Hub		Location where *freight or passengers* transfer from one vehicle or mode of transportation to another before, after or between different elements of a *transport chain*.
Hub energy provision	HEP	Release of GHG into the atmosphere during the process of producing, storing, processing and distributing an energy carrier for hub operation.
Hub operator		Entity that carries out hub operations involving carriage of freight or passengers or both.
Hub operation	HO	Operation to transfer freight or passengers through a transport hub.
Hub operation category	HOC	A group of hub operations that share similar characteristics.
Passenger	pax	Person carried by a vehicle. *Note: The term and its abbreviation "pax" are also used as a unit for quantity of passengers.*
Passenger equivalent	peq	Unit of quantification of freight, passengers, and passenger vehicles in the case of combined transport of freight with passengers, for which each of these entities is compared to an average passenger.
Passenger of lowest class equivalent	plceq	Unit of quantification of passengers in the case of passenger transport with different classes, for which passengers of each class are compared to a passenger in the lowest class.
Shortest feasible distance	SFD	Transport distance determined as the distance achievable by the shortest practicable route available according to the infrastructure options for a particular vehicle.
Tank-To-Wheel	TTW	Emissions from fuels combusted to power Scope 1 activities (e.g. the wheel), i.e. direct tailpipe emissions.
Transport chain	TC	Sequence of elements related to a consignment or a passenger that, when taken together, constitutes its movement from an origin to a destination.
Transport chain element	TCE	A specific component or section within the overall transport chain within which the freight or passenger is carried by a single vehicle or transits through a single hub.
Transport hub		Location where passengers and/or goods transfer/are transferred from one vehicle or mode of transportation to another before, after or between different elements of a transport chain.
Transport operator		Entity that carries out transport operations involving carriage of freight, or passengers, or both.

Abbreviations

Term	Abbreviation	Definition
Transport operation	TO	Operation of a vehiclein order to transport passengers and/or freight.
Transport operation category	TOC	Group of transport operations that share similar characteristics.
Transport service organizer		Entity that provides transport services, within which the operation of some TCEs is subcontracted to one or more other entities that operate them (transport or hub operators).
Transport service user		Entity that buys and/or uses a transport service.
Vehicle energy provision	VEP	Release of GHG into the atmosphere during the process of producing, storing, processing and distributing an energy carrier for vehicle operation.
Vehicle operation	VO	Deployment of a vehicle to fully or partially provide a transport operation.
Well-To-Tank	WTT	All processes between the source of the energy (the well) through the energy extraction, processing, storage and delivery phases up until the point of use (the tank).
Well-To-Wheel	WTW	All emissions from the full fuel life cycle; should be equivalent to the sum of WTT and TTW.

For a full list of terms and definitions, please consult chapter 3 of the ISO 14083.

1 Introducing the ISO 14083

1.1 The importance of tracking GHG emissions

To reach the 1.5°C climate goal of the Paris Agreement and respective corporate climate-related targets, the reduction of emissions within companies' supply chains is essential. For companies relying on upstream and/or downstream transportation and distribution, so called Scope 3[1] emissions often constitute the biggest share of emissions. Globally, the transport sector accounted for about 20% of carbon dioxide (CO_2) emissions in 2021, making it the sector with the second largest share of emissions[2]. Yet, calculating the precise emissions associated with the transport of e.g. a certain shipment or per passenger is often a highly complex task. The transport and hub operations necessary may vary in distances and modes of transport, with different fuel consumption profiles and consequently different GHG emissions intensities.

Two aspects significantly impact the tracking of GHG emissions for companies. First, companies encounter different levels of complexity in their operations. There is a notable contrast between smaller First-Party-Logistics companies that autonomously handle all services, fostering a comprehensive understanding and direct access to trip data. In contrast, larger entities such as third-, fourth-, or fifth-party-logistics companies, entailing numerous suppliers and subcontractors, face the challenge of integrating and exchanging data, introducing varying levels of complexity into their operations. Second, companies have different levels of data-readiness. Some companies already have advanced data tracking systems in place, while others have not gathered GHG emissions before and are therefore less experienced in calculating emissions. At the same time, it is especially companies operating within the logistics and transport sector *(used interchangeably in the following)* who are increasingly pressured to monitor, provide data on, and reduce their GHG emissions. A big driver for this is mandatory corporate sustainability reporting such as under the EU Corporate Sustainability Reporting Directive (CSRD). The CSRD obliges companies from all industries to report Scope 3 emissions. Consequently, companies increasingly turn to transport companies for crucial information as a significant portion of Scope 3 emissions is linked to transportation.

Companies offering services and platforms for calculating GHG emissions, in the following referred to as platform calculators, face increasing demand from transport companies who need support in calculating and monitoring their carbon footprint.

1.2 Tracking transport-related GHG emissions in a harmonized way

Multiple frameworks and guidelines have been published to guide transport and logistics companies in quantifying and reporting their GHG emissions. These include, but are not limited to the:

- **EN 16258**
  A European methodology standard for the calculation and declaration of energy consumption and GHG emissions of transport services;
- **COFRET recommendations**
  Based on a review of the EN 16258;
- **IWA 16:2015**
  Defining the framework for harmonized methods for the quantification of CO_2 emissions of freight transport;
- **GLEC Framework for Logistics and Emissions Accounting and Reporting**
  Offering a comprehensive methodology and guidelines for GHG emissions calculations;
- **ISO 14064-series**
  Series, detailing requirements for quantification and reporting of GHG emissions as well as the verification of respective statements.

1 *The Scope 1, 2 and 3 break down has been established by the GHG Protocol. Scope 1 refers to companies' direct emissions, e.g. through vehicle usage. Scope 2 refers to indirect emissions through purchased electricity, steam, heating and cooling. Scope 3 emissions relate to emissions produced through upstream and downstream activities in the value chain.*

2 *Source: https://www.statista.com/statistics/1129656/global-share-of-co2-emissions-from-fossil-fuel-and-cement/*

In March 2023, the *ISO 14083* on the quantification and reporting of GHG emissions arising from transport chains was published. It represents both a consolidation and international harmonisation of existing frameworks, such as the GLEC framework or the EN 16258 into one standard. The standard provides an internationally harmonized approach to quantifying GHG emissions in the logistics sector, and if applied consistently, it can enhance comparability of GHG calculations between different actors within and across transport chains. ISO 14083 applies to all GHGs emitted in the transport sector, e.g. through the consumption of energy, refrigerant leakage, or methane slip. The majority of GHG emitted by the transport sector is CO_2, emitted from the burning of fossil fuel for cars, trucks, ships, trains, and planes[3].

It is important to note that ISO 14083 consolidates existing approaches and therefore does not introduce a radical new methodology. Yet, it does provide for a broadened scope and puts a more explicit perspective on some key elements. For example, it departs from the traditional scope 1,2 and 3 classification, instead addressing emissions through a Well-To-Tank (WTT) and Tank-To-Wheel (TTW) perspective. It puts a focus on the entire transport chain and speaks about transport chain elements (TCEs) with transport operation categories (TOCs) and hub operation categories (HOCs) rather than transport legs. Importantly, the standard applies to companies of varying sizes and to both freight and passenger transport.

Tracking GHG emissions associated with transport activities in the value chain is also relevant under other ISO standards. A company may, for example, calculate a product carbon footprint in line with ISO 14067 which is often part of a wider life cycle assessment (LCA) as specified in ISO 14040/44. Alternatively, a company may want to calculate its entire GHG inventory under ISO 14064-1, under which transportation, e.g. related to the supply of resources, distribution of a product, or final product delivery, is an own category. To calculate these transportation-related emissions, ISO 14083 becomes relevant again. Moreover, guidance from ISO 14064-3 and ISO 14065 may be used in relation to data verification and validation of GHG statements under ISO 14083, which does not provide specifications on these aspects.

1.3 Using a standardized approach for different purposes

When it comes to the quantification and calculation of GHG emissions, the scope of GHG emitting activities to focus on can differ per company. Companies are increasingly obliged by legislation to calculate their Scope 1, 2 and 3 GHG emissions, as is the case with the CSRD. At the time of writing, the implementation of the ISO 14083 is not legally binding. However, the EU Commission has proposed an EU regulation which promotes the adoption of the ISO 14083[3]. Depending on the underlying purpose, transport or hub operators (e.g. carriers) may be asked to calculate emissions associated with a particular individual transport or hub operation; transport service organizers (e.g. freight forwarder) may need to calculate emissions for multiple selected transport or hub operations, while transport service user (e.g. shipper) may need to know the emissions associated with the entire shipment of a good.

3 For a list of GHGs, see the latest Intergovernmental Panel on Climate Change (IPCC) Assessment Report.

Mandatory or voluntary reporting	Companies face increasing demands to calculate their Scope 3 GHG emissions, including transport-related emissions, to ensure compliance with the latest regulatory reporting requirements, such as those under the EU's CSRD. Some companies calculate their GHG emissions because they want to report on their emissions performance voluntarily, or provide respective data to stakeholders, e.g. via their Annual Reports, Sustainability Reports, or through rating submissions such as the Carbon Disclosure Project (CDP) Climate Questionnaire.
Decision-making & optimization	Companies calculate their GHG emissions to analyse their past performance and identify emission-intensive operations. This allows them to identify opportunities for emissions reduction and efficiency optimization. Monitoring emissions performance in this way can also help to track progress vis-à-vis set climate goals or strategies.
Answering demand from stakeholders & enabling data exchange	Companies calculate their GHG emissions to answer to clients requesting data on emissions associated with a certain good or service, e.g. related to the shipment of their goods. Similarly, companies face demands for GHG emissions data from other transport organisations, which ship a particular good and need data to complete their own GHG emissions calculations. *For example:* Exchange of emissions data from a carrier to a shipper can take place at the level of (a) the company, i.e. GHG emissions produced by the carrier for the client, (b) the transport chain, i.e. GHG emissions of a consignment (from origin to destination), (c) a transport chain element, i.e. GHG emissions of a transport leg (at consignment level).

***Table 1** Use cases for GHG emissions calculations*

An essential and overarching element for all cases is enhancing availability and exchangeability of GHG emissions data. This can be achieved by implementing the ISO 14083, which provides a universal methodology to calculate GHG emissions across the logistics supply chain. Consequently, platform calculators should ensure that their calculation services are executed in accordance with the ISO 14083 standard.

Platform calculators can support companies in calculating their CO_2 emissions and identifying emission reduction opportunities while ensuring compliance with emission-related laws and regulations. Given the importance of being able to exchange GHG emissions data in a harmonized format, companies may want to ensure that the calculation services carried out by platform calculators follow a harmonized approach and are executed in accordance with the ISO 14083.

4 In July 2023, the EU Commission proposed a regulation on the accounting of GHG emissions of transport services. The regulation does not make GHG reporting mandatory but establishes a voluntary EU methodology for the measurement of GHG emissions for freight and passenger transport, building on ISO 14083.

2 Key principles to consider

With each GHG emissions calculation, the platform calculator needs to apply some general (quantification) principles to ensure that any GHG-related information is true and fair and follows the same harmonized approach, i.e.: relevance, completeness, consistency, accuracy, transparency, and conservativeness. First, all GHG sources, data, operations included, and methodologies selected by platform calculators shall be relevant and appropriate to meet the needs of the user of the GHG emissions data. Second, GHG emissions from all processes and flows relevant to the scope of analysis shall be included and omissions are generally not permitted. If certain processes, activities, inputs or outputs are omitted, e.g. because they are not deemed material for the emissions performance, this needs to be clearly stated, together with the reasons for and implications of such omissions. If cut-off criteria are applied, these need to be referenced accordingly. Cut-off criteria relate to thresholds, defining the inclusion (or exclusion) of inputs contributing more (or less) than a defined percentage to e.g. the transport activity or GHG emissions. As the usage of cut-off criteria can hamper comparability, it should be avoided. Third, the approaches applied need to be consistent and accurate, and provide sufficient transparency to make well-informed decisions and to avoid bias and uncertainties. When platform calculators are able to choose between different data, they should always select the option that is conservative and cautiously moderate, i.e. where GHG emissions are rather overstated than understatedd[5].

Throughout the quantification process, the platform calculator should ensure that a similar methodology is applied for each transport mode across operations. Moreover, all GHG emissions resulting from a transport chain operation shall be treated equally, irrespective of the energy carrier used. Platform calculators shall assign all GHG emissions across the freight carried or transferred from one vehicle to another in a hub[6]. In some cases, this may require allocation, e.g. if the transport includes both freight and passengers. In the context of GHG emissions calculation, allocation generally refers to the process of assigning or distributing total GHG emissions that originate from one specific activity across different products[7]. Allocation becomes necessary whenever a vehicle or hub fulfills multiple functionalities and GHG emissions need to be fairly distributed. If, for example, an airplane transports both freight and passengers, the GHG that the airplane emits needs to be distributed fairly to the passengers and freight - depending on for example how many passengers are on board, or how heavy the share of the freight is.

Yet, allocation should be avoided wherever possible by dividing the process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes. For cases where allocation is needed, the ISO 14083 specifies the different GHG emissions calculation steps necessary. For freight operations, allocation is necessary for the combined transport of freight and passengers, but also in freight operations with different temperature conditions, where GHG activity data related to every temperature condition should be collected and used for allocation, where feasible. The calculation steps described in the remainder of this guidance assume that no allocation is needed. Appendix B of this document provides further allocation guidance in relation to passenger transport.

For more details on the general principles see *Chapter 4 of ISO 14083*. For more information on the quantification principles see *Chapter 5 of ISO 14083*.

5 Conservativeness is interpreted differently depending on the circumstances. For more information on interpretations of conservativeness see e.g. ISO14064-3:2019, Annex B.9

6 Where empty containers, roll cages or pallets are transported on behalf of a purchaser of transport services for the purpose of relocation or in order to move a new load they become a consignment in their own right and GHG emissions should be assigned to them accordingly. In cases where these GHG emissions cannot be assigned to a specific purchaser or transport service, GHG emissions shall be allocated to the network.

7 For example, for a sea transport operation on a container ship carrying both dry and reefer containers, the GHG activity for temperature control of reefer containers can be allocated to reefer containers only.

3 Considerations on system boundaries

3.1 Processes included and excluded

ISO 14083 is widely applicable for a range of different transport modes and means, covering transport by air, cable car, inland waterway, pipeline, rail, road, and sea. It applies to calculating emissions associated with *transport* operations, i.e. transport of freight from point A to point B, using a certain transport mode, as well as to calculating emissions associated with *hub* operations that precede, follow, or link different transportation operations together, i.e. relating to the handling, loading or transhipment of freight. Any company calculating GHG emissions should clearly define the scope of transport and/or hub operations that are considered in the calculation. Any calculation of GHG emissions within a transport chain shall include all processes that produce GHG by either combustion or by leakage of refrigerants, regardless of which organization operates them. The GHG emissions calculation should include both loaded and empty trips[8], including diversionary and/or out-of-route distance; as well as start-up and idling of vehicles, pipelines, transhipment and (de)boarding equipment. For pipeline transport, cleaning, and flushing operations should also be included in the calculation.

The ISO 14083 does not foresee a division of GHG emissions into Scope 1, 2 or 3 emissions, but rather into operational energy use, and energy provision emissions. More concretely, the platform calculator should include vehicle and/or hub equipment related *operational* and *energy provision* processes, as well as combustion and/or leakage of energy carriers at vehicle and/or hub equipment level, and leakage or refrigerants used by vehicles or hubs[9]. The inclusion of *operational* processes requires calculating GHG emissions released as a result of a vehicle or hub equipment operation, i.e. during the deployment of a vehicle or the transfer of freight through a hub. *Vehicle operational* processes include the operation of all on-board vehicle systems including propulsion and auxiliary processes. *Hub operational* processes include the operation of all handling, on-site transportation, transhipment and (dis)embarking equipment and facilities, including heating and temperature control. The inclusion of *energy provision* processes requires calculating GHG emissions released during the process of producing, storing, processing and distributing an energy carrier for a vehicle or hub operation. These should be included by using the best available GHG emission factors.

Processes related to storage of freight, use of information and communications technology equipment, or (re)packaging can be optionally included in the calculation. Excluded from the quantification of GHG emissions are processes related to the production and supply processes of refrigerants; waste produced; processes at administrative level; and processes for the construction, maintenance and scrapping of vehicles or transhipment and (de)boarding equipment or dismantling of transport infrastructures, as well as co-located businesses within a hub. Moreover, any outcomes from carbon offsetting or GHG emissions trading shall not be included in the calculation. For more details on system boundaries, see s*ection 5.2 of ISO 14083*. For transport by pipeline *(Annex D)* and for hub operations *(Annex H)*, *ISO 14083* furthermore specifies which operations to include and exclude from the GHG emission calculation.

8 Empty trips refer to the section of the route of a vehicle during which no freight is transported, e.g. vehicle (re)positioning trips or empty backhauls. Calculating companies should in turn make sure to track, or demand from subcontracted entities, data on empty trip distances.

9 Refrigerant leakage can occur due to vibrations, loose connections or a general degradation of a refrigeration system, which is sometimes used in transport operations to maintain a specified temperature during transport. Please see Annex I of the ISO 14083 for a recommendation on how to account for refrigerant leakage GHG emissions.

3.2 Conversion of energy carrier data into GHG emissions (partial or full life-cycle perspective)

To ensure the proper conversion of a quantity of fuel or energy carrier into GHG emissions, corresponding emission factors shall be used, allowing to derive the mass of CO_2 equivalent (CO_2e) per amount of fuel or energy carrier consumed. A GHG emission factor is a coefficient relating the GHG activity data with the GHG emissions, and they are pivotal for calculating any carbon footprint. They are a standardized measure for translating the amount of fuel and energy used to power a transportation activity into GHG emission values. Importantly, they can account for variations depending on e.g. the transport mode or consumption location, as a specific type of fuel does not always consistently result in identical emissions. Emission factors and sources for them vary and should be chosen per activity type. *Annex K of ISO 14083* references some emission factors and sources for the most relevant transport energy carriers. Companies may use other emission factors, e.g. specific national emission factors such as the Dutch ones or the default emission factors as provided by the GLEC framework. Furthermore, emission factors can be derived from recognized databases such as GREET or GaBi. When choosing emission factors, companies should consider the level of granularity, i.e. whether to use global aggregated factors or location-specific factors. The choice of emission factors should always be adequate and as realistic, i.e. specific and granular, as possible. Comparing gasoline emission factors across different regions highlight this need, with a factor of 4.21 *kg* CO_2e/kg (total/WTW) from the European ecoinvent v3.9.1 database, and a value of 3.78 *kg* CO_2e/kg (total/WTW) from the North American GREET database. Where national legislation mandates the use of specific GHG emission factors, or a government provides GHG emission factors for voluntary GHG emission reporting, the use of these sources of GHG emission factors shall be clearly documented. Please see *Annex J and K of ISO 14083* for further requirements and guidance on GHG emission factors and sources.

ISO 14083 requires companies to convert GHG activity data into vehicle and/or hub equipment *operation* GHG emissions and *energy provision* GHG emissions. GHG emissions from *operational* processes are the direct emissions from burned and bought fuels used to carry out the operation. They are also referred to as Tank-To-Wheel (TTW) emissions. GHG emissions from *energy provision* processes are the indirect emissions from electricity and from fuels for electricity, including fuel production and transmission losses. They are also referred to as Well-To-Tank (WTT) emissions. In turn, for each activity, the direct downstream TTW and the indirect upstream WTT GHG emissions need to be calculated, using the appropriate emission factor. In sum, WTT and TTW emissions give a full life-cycle perspective, constituting the total Well-to-Wheel (WTW) emissions. WTT and TTW emissions are also included within the differentiation between Scope 1, 2 and 3 emissions in line with the GHG Protocol. For a comparison of the GHG emission categorization used in the GHG Protocol and ISO 14083, see *Annex R* of the standard.

While the calculation of direct TTW GHG emissions from operational processes is often common practice, the inclusion of all upstream processes necessary to calculate GHG emissions associated with energy operational processes, including energy source/plant infrastructure, can prove difficult in reality. Consequently, the use of clearly stated cut-off criteria for GHG emission factors of energy provision is possible, as specified in *Annex J* as well as *section 5.2.3 of the ISO 14083*. If cut-off criteria are applied, this needs to be clearly referenced.

4 Considerations for GHG emissions calculation

4.1 Preparation - understanding the underlying approach

The methodology of the ISO 14083 applies to multiple stages of a transport chain with different actors engaging in diverse GHG emitting activities. The calculation of a company's carbon footprint should cover all operations, including transport but also hub operations that connect different transport legs. Prior to running any calculation, it is important to understand and define the transport chain(s).

The transport chain refers to the entire sequence of operations carried out to move goods from point A to point B, encompassing all stages and entities involved in the process. It starts with the point of departure, i.e. where the good is leaving the sender or shipper and ends with the receiver of the good. The transport chain can be broken down into various transport chain elements (TCEs), i.e. into individual sections within which the freight is carried by a single vehicle or transits through a single hub. As illustrated in Figure 1, a TCE can encompass a transport operation, e.g. transport by truck (TCE 1) or ship (TCE 3), or a hub operation, e.g. the clearing and handling at a port (TCE 2). Each TCE always corresponds to either transport or hub operations, which is the operation of the vehicle(s) or hub(s) for this TCE. In turn, each transport or hub operation can be grouped into a transport or hub operation category (TOC/HOC). TOCs/HOCs group together all operations sharing similar characteristics, e.g. individual vessels at a certain size carrying dry bulk freight, or temperature-controlled long-distance freight transport via block train. Emission intensity is then not determined per individual trip, but per group of operations that share similar characteristics. Each TCE is linked to a TOC/HOC, to determine the emission intensity per TCE. The ISO 14083 leaves some flexibility when it comes to the level of detail for establishing TOCs or HOCs, which in turn often depends on the data available. *Annexes A to G in the ISO 14083* provide examples of characteristics per transport mode which can be used to establish a TOC/HOC.

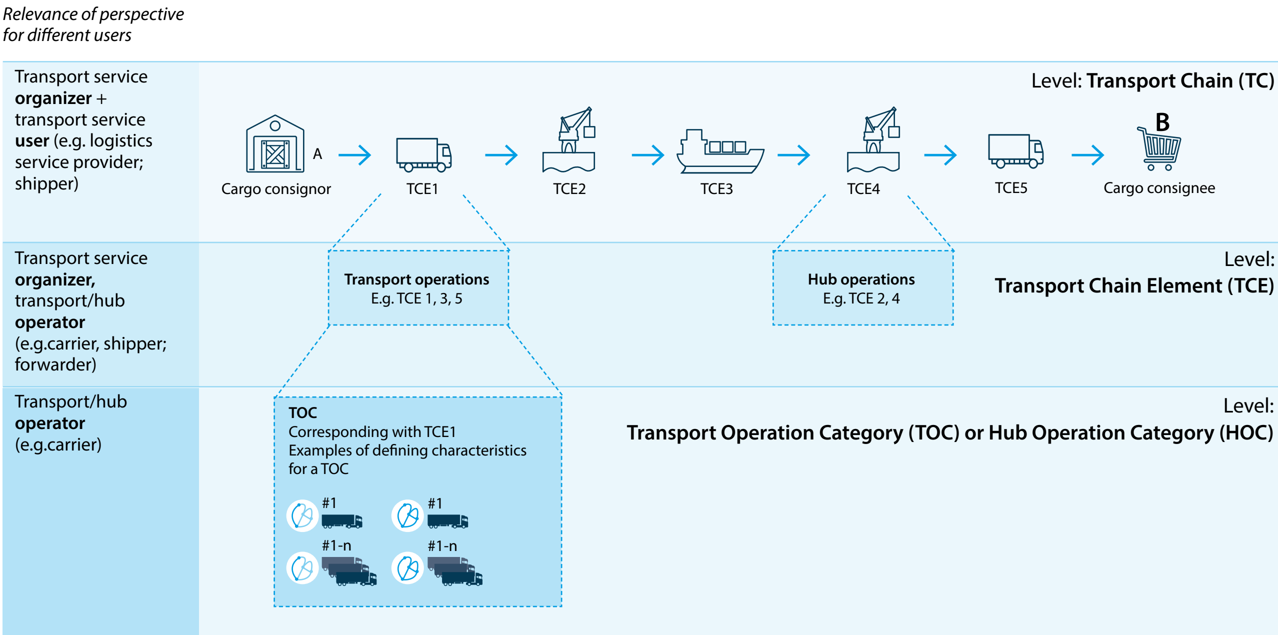

Figure 1 *Indicative characteristics for establishing TOCs and HOCs*

Companies must clearly define the scope of their calculations. Depending on the use case of the client, a platform calculator may want to calculate GHG emissions associated with a certain logistics operation and/or associated with a certain shipment, being transported from point A to B via the use of different transport and hub operations. Following the logic of ISO 14083, the platform calculator should support in assessing whether the company intends to calculate GHG emissions and GHG emission intensity for one operation within a transport chain, i.e. a TCE, or for a combination of multiple TCEs, constituting a transport chain.

As a general rule, the platform calculator should get a good overview of the company's transport chain and then dissect the transport chain into its constituting TCEs. Each TCE needs to be related to a TOC or HOC, grouping relevant transport or hub operations. Then, the TOC or HOC specific GHG emission intensities need to be calculated, allowing in turn to determine GHG emissions per TCE. At the transport chain level, the GHG emissions are then the sum of GHG emissions of each constituting TCE.

Irrespective of the level of detail, GHG emissions are calculated by multiplying the GHG activity data with a respective GHG emission factor. Emission factors quantify GHG emissions per unit of activity and indicate the relationship between the amount of energy or fuel used and the amount of pollutants produced. GHG emission intensity is then the coefficient relating the specified GHG activity data with the GHG emissions. It can be expressed as mass CO_2e per tonne kilometre, or equivalent units for freight transportation, or as mass CO_2e per tonne for freight hub throughput. Emission intensity values allow for easy comparison, as absolute emission values are not directly comparable.

Basic approach	
GHG emissions *=*	*GHG emitting activity data × GHG emission factor*
GHG emission intensity value *=*	$\dfrac{\textit{GHG emissions}}{\textit{specific transport or hub activity}}$

4.2 Preparation - data inputs and dealing with default data

4.2.1 Gathering or requesting data

The emission intensities at TOC or HOC level can be calculated with primary data, modelled data, or default values. The availability and readiness of data often depends on the complexity of the clients' transport chains. Smaller, first-party logistics companies often have direct access to all necessary data points, while larger enterprises, reliant on a network of suppliers and sub-contractors, may possess only a fraction of the required information. Platform calculators can support clients in addressing this complexity. For example, tools can model data or include features to facilitate data exchange or provide solutions for automated tracking and monitoring, ensuring a holistic approach to emission intensity calculations tailored to different levels of data availability. Wherever possible, however, primary data should be used. Only if primary data is not available, modelling is possible, with the disadvantage of a lower accuracy.

4.2.2 Data input requirements

As mentioned in section 3.2 of this guidance, ISO 14083 requires an explicit split between direct, *operational* TTW emissions and indirect *energy provision* WTT emissions. TTo calculate the GHG emission intensity value at the level of a TOC or HOC, following data are needed:

- **Fuel data**
  - Fuel type or energy carrier type used;
  - WTT and TTW emission factors for each fuel type and energy carrier used;
  - Quantity of each type of fuel consumed and energy carrier used.

- **Trip activity data**
  - Weight transported;
  - Origin and destination locations of the shipments to calculate transport distance;
  - Characteristics of the freight transported or handled at the hub, such as quantity, volume (units/amount transported);
  - For hub operations, the quantity of outbound freight. In specific circumstances, alternative units for the quantity of freight may be used in addition to the standard units, such as e.g. the number of containers or the number of TEUs.

Moreover, companies may decide to request additional transport- and/or hub-operation related data, which supports the grouping of operations into TOCs and HOCs. These may include, but are not limited to:

- Number and type of vehicles, or length and type of pipeline;
- Type of process (e.g. freight transhipment only; combined passenger and freight transfer);
- Nature of freight (e.g. average/mixed; palletized; dry bulk; vehicle bulk);
- Freight condition (e.g. ambient; temperature-controlled);
- Air conditioning or other cooling infrastructure installed and respective data on leakage of refrigerants;
- Propulsion type, such as type of electric motor or combustion engine;
- Journey type (e.g. point-to-point (long haul) or collection and delivery).

For more guidance on how to establish mode-specific TOCs and HOCs and which data points may be useful, see *section 6.1* of this guidance as well as *section 7.2 and Annexes A-H of the ISO 14083*.

4.2.3 Dealing with data gaps and different data sources

It is important to keep in mind that the type of data used influences the granularity and accuracy of any calculation results. This in turn can impact the quality and usability of the GHG emission information derived. Any GHG emissions calculation shall always rely on data specific to and representative of the processes in the transport chain or TCE analysed. Consequently, the ISO 14083 clearly prioritizes the usage of primary data as the basis for the GHG emissions quantification. Only where primary data is not available, secondary data may be used, prioritizing modelled data over default data. Platform calculators should therefore ensure to request respective primary data from clients, if they are transport or hub operators, or other users who have that data available. If clients are transport service organizers or users, it should be considered whether they can request the necessary information from their transport providers, or alternatively, whether modelled data can be used.

Secondary modelled data

Depending on each specific case, a model can perform calculations based on available primary data and filling gaps with secondary data that represents the best available approximation of the missing data. Modelled data is permitted under the condition that it provides a better representation of the actual GHG emissions in comparison to using default factors. *Annex M of the ISO 14083* provides further guidance on modelling GHG emissions, introducing two model types and the main parameters that may be used in such models. Importantly, any parameters chosen must be specified and documented in the final report of GHG emissions.

Secondary default data

In case primary data are not available and modelling is not possible, default data may be used. Default data relates to pre-determined estimates or assumptions of average industry operating practices. Default data can represent default values for factors such as fuel type or vehicle type, as well as for emission intensity values. When using default GHG emission intensities, it is important to choose values closely aligned with the characteristics of the TOC or HOC in question. Freight transport data can vary significantly depending on the region, influenced by factors like operating conditions and practices. Consequently, emission factors and intensities in a different location to the one they were derived should be treated cautiously. It is assumed that default values should only be used by organizations or individuals that are largely unfamiliar with the process of calculating GHG emissions. The more experienced an organization, the more it is expected to work with input data relating directly to their actual transport activity. *Annex Q of the ISO 14083* provides guidance on selecting sources of default GHG emission intensities, while *Annex K of the ISO 14083* provides a list of GHG emission factors and sources.

Note on data quality and validation

Mere access to data does not guarantee good quality. As transport chains get more complex, ensuring accurate and high-quality data can become a challenge. Reviewing data quality before any calculation is an important step, as it fosters trust in the shared information and gives transparency on any assumptions made in the calculation process. Moreover, it allows to keep track of data gaps and to regularly interrogate data records. Important to note, the ISO 14083 does not provide specific requirements or principles with respect to data quality and/or validation. However, it notes that transparency on the category of data and data quality is highly important (see *section M.4 of ISO 14083*).

4.3 Calculation - emissions per transport/hub operator (individual TCE)

The following section describes the steps necessary to calculate GHG emissions associated with transport or hub operations, related to an individual TCE. Section 4.4 of this guidance provides an overview of the steps needed to calculate emissions associated with multiple TCEs or an entire transport chain, which however builds upon the calculation at TCE level. Please note that the *ISO 14083* provides an overview of necessary quantification actions at TOC level *(section 8)*, at HOC level *(section 9)*, at transport TCE level *(section 10)*, at hub TCE level *(section 11)*, and at transport chain level *(section 12)*. The following description does not provide a 1:1 replication of those steps but rather tries to group them together where possible, to explain the overarching approach. The crucial underlying element is to calculate the emissions intensity value at TOC or HOC level. Consequently, the following basic calculations are necessary:

$$\textbf{GHG emission intensity} = \frac{\textit{GHG emissions}}{\textit{Specific transport or hub activity}}$$

GHG emissions = *GHG activity data (from emitting transport or hub operation) × GHG emission factor*

With:

Transport activity = *Actual freight mass transported × transport activity distance*

Hub activity = *Quantity of (outbound) freight*

Where:

Transport activity distance refers to either the shortest feasible distance (SFD) or great circle distance (GCD)

The calculation of the emissions intensity value at TOC or HOC level can be broken down into four steps, as displayed in Figure 2. For a mere overview of the needed formulas, see appendix A of this guidance.

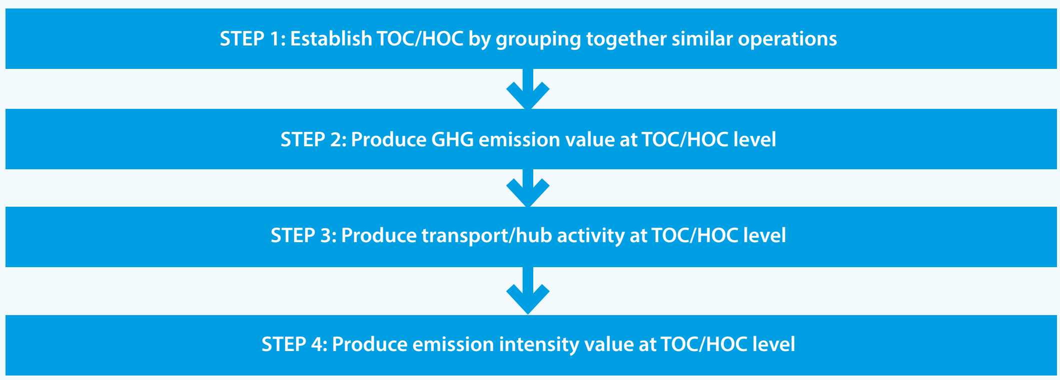

Figure 2 *Approach to calculate the emission intensity value at TOC or HOC level*

4.3.1 Step 1: Establish TOC/HOC

To establish TOCs and HOCs, it is important to first identify for which TCE, i.e. which defined section of a transport in which a movement is carried out or handled through a hub, the GHG emissions are to be calculated and to list the operations that are related to this TCE. A TCE could, for example, be defined as the transport operation necessary to transport goods via road from the shipper to the origin airport terminal *(transport operation)*. Similarly, it could refer to goods being unloaded at the destination airport terminal and loaded into a road vehicle *(hub operation)*. Importantly, a TCE always corresponds with a TOC or HOC. In turn, a TOC or HOC shall reflect the combined characteristics of the respective transport mode, hub type and freight. This allows to consider any single transport or hub operation in the context of the overall system in which it takes place, as prescribed by ISO 14083.

Once the transport and hub operations in scope of the calculation are identified, those that share similar characteristics should be grouped into TOCs and HOCs respectively. When defining the characteristics of a TOC or HOC, different factors can be considered. For an overview of such characteristics see table 3. Moreover, *Annexes A to H of ISO 14083* provide further guidance on grouping different transport or hub operations per mode. If platform calculators decide to use a different categorisation approach to establish TOCs and HOCs, this needs to be duly justified and documented.

Important to consider when establishing TOCs and/or HOCs is that these can have different levels of granularity. For example, a TOC may relate to a single vehicle on a single journey or specific schedule, or to a specified group of vehicles in multiple schedules. Similarly, a HOC may relate to a single hub or a specific hub type. Importantly, a transport or hub operation should not be split between two TOCs or HOCs. In turn, a TOC or HOC shall fully include each transport or hub operation. As an example, a TOC may be a group of similar collection and delivery rounds from the same hub; or may group transport activities by truck with ambient freight from point A to point B (the journey from A to B being the TCE). Please note that sometimes one vehicle may transport both ambient and temperature-controlled freight. Such cases shall be treated as one TOC, with GHG activity data and GHG emissions being allocated between the freight. *Annexes A to H of the ISO 14083* provide more guidance on such allocations, depending on the mode of transport.

Characteristics for establishing a TOC	Characteristics for establishing a HOC
Number and type of vehicles, or length and type of pipelines	Number and type of hub operations contributing to the HOC
Nature and consistency of the vehicle or pipeline operations included (e.g. block train, single wagon, point-to-point (long haul) journey, collection and delivery journey)	Handling of freight, (un-)loading, (de-)boarding, transport on-site
Any processes associated with maintaining the condition of the freight (e.g. temperature control)	Nature and consistency of the hub operations included (e.g. electrified or non-electrified)
Nature of the freight carried (e.g. dry bulk, liquid bulk, containerized)	Inbound and outbound transport mode to and from the hub and relevance of intermodal change
Period of activity of the vehicles or pipelines	Any processes associated with maintaining the condition of the freight (e.g. temperature control, repacking) Nature of the freight handled at the hubs (e.g. palletized, containerized, piece good)

Table 2 *Indicative characteristics for establishing TOCs and HOCs*

4.3.2 Step 2: Produce GHG emission value at TOC/HOC level

The second step requires the calculation of GHG emissions per transport / hub operation associated with a TOC or HOC. In other words, the relevant GHG activity data per TOC or HOC needs to be identified and converted into CO_2e. Important to recall, for each TOC and each HOC, the vehicle or hub equipment *operation* GHG emissions, as well as the vehicle or hub equipment *energy provision* GHG emissions need to be calculated for each GHG activity, by multiplying the quantity of the GHG activity type by the vehicle or hub equipment operation and vehicle or hub equipment energy provision GHG emission factor, respectively.

The GHG activity data for each TOC and HOC should include all GHG sources, i.e. consisting of the total consumption of each energy carrier and refrigerant used for the relevant transport or hub operations. In cases where e.g. the vehicles grouped into one TOC use different energy carriers, the emissions for each GHG activity type need to be calculated and then summed together to provide the total GHG emissions of the TOC.

4.3.3 Step 3: Produce transport/hub activity at TOC/HOC level

To be able to calculate the total emission intensity value, the transport/hub activity at the TOC/HOC level is needed next to the GHG emissions at the TOC or HOC level. The *freight transport activity* of a TOC is obtained by multiplying the mass of an individual consignment (freight) transported in the operation by the transport activity distance of the individual consignment, and then adding up all the results of the aforementioned multiplication for each shipment of the TOC (during a given period). In other words, the weight and loaded distance are multiplied together for each individual consignment in the TOC/HOC and then the individual tonne-kilometre values are added together. The ISO 14083 specifies that only one type of transport activity distance, i.e. either the shortest feasible distance (SFD) or the great circle distance (GCD) shall be used[10].

In cases where no data on the SFD or GCD is available, the actual distance and a distance adjustment factor (DAF) should be used. The DAF is used by multiplication of the actual distance by a specific DAF value and serves to increase the transport activity distance used in the calculation of GHGs to allow for systematic differences between the actual distance and the SFD or the GCD. *Annexes A to G of the ISO 14083* provide recommended values of the DAF for different modes. For the specific case of the transport activity distance for collection and delivery rounds, please see *section F.4.2 of the ISO 14083*. Please see *sections 8.4.3 to 8.4.8 of the ISO 14083* for further calculation approaches depending on the type of activity.

The *hub activity* relates to the quantity of (outbound) freight. The total hub activity of the HOC is then the sum of the quantity of (outbound) freight that is associated with the hub operations in the HOC.

***Note** that this guidance assumes a no-allocation scenario. In allocation scenarios, varying formulas adapted to the allocation scenario are needed to calculate the transport or hub activity at TOC/HOC level.*

4.3.4 Step 4: Produce emission intensity value at TOC/HOC level

The general approach for calculating the GHG emission intensity at the TOC/HOC level is to divide the total GHG emissions of the TOC/HOC, as calculated in step 2, by the total transport activity of the TOC or total hub activity of the HOC, as calculated in step 3. The emissions intensity value is then based on the average GHG emissions for a group of similar transport or hub activities and should be expressed in g CO_2e per tonne-km at TOC level, or as g CO_2e per tonne throughout at HOC level.

10 As shown by report from TNO, the GCD is considered the optimal distance metric for CO_2 allocation in freight transport (https://publications.tno.nl/publication/34638248/4PDy2A/TNO-2021-P11077.pdf). To facilitate data exchange and ensure greater comparability, this guidance document consequently recommends to use the GCD wherever possible.

4.4 Calculation - emissions per transport service organisers and transport service users (multiple TCE/entire transport chain)

This section describes the calculation process necessary when wanting to calculate GHG emissions associated with more than one TCE or for a whole transport chain. The GHG emissions and GHG emission intensity value for multiple TCEs or an entire transport chain are the sum of the GHG emissions and GHG emission intensity values per TCE. To recall, each TCE corresponds either with a TOC or HOC. Consequently, to derive an emissions value for multiple TCEs, the calculation steps at TOC or HOC level - as described in *section 4.3* - need to be carried out. See Figure 3 for a graphical illustration of the necessary calculation steps.

STEP 1: Break down transport chain into constituting TCEs and corresponding TOCs/HOCs

↓

STEP 2: Calculate GHG emission intensity at TOC/HOC level (see steps 1-4 of section 4.3)

↓

STEP 3: Calculate GHG emissions of each TCE

↓

STEP 4: Sum up the GHG emissions of all TCEs of (the part of) the transport chain

↓

STEP 5: Calculate the transport activity of (the part of) the transport chain

↓

STEP 6: Calculate the GHG emission intensity value for the (part of the) transport chain

Figure 3 *Approach to calculate emissions for multiple TCEs or an entire transport chain*

4.4.1 Step 1: Break down transport chain into its constituting TCEs and corresponding TOCs/HOCs

Clients who are transport services organisers or transport service users may be more interested in having the GHG emissions calculated which are associated with the complete transport chain of their shipments. Here, the ISO 14083 follows the logic that the total shipment-related emissions are the sumo of the emissions of all TCEs that the shipment goes through.

To calculate GHG emissions related to a certain shipment moving through a transport chain, it is necessary to dissect this transport chain into its constituting TCEs. For freight transport, a TCE is defined as the section of transport within which the movement is carried out by a single vehicle (transport operation) or handled through a single hub (hub operation). Once the TCEs have been defined, the corresponding transport and hub operations should be grouped into TOCs or HOCs, as specified in section 4.3.1 of this guidance.

4.4.2 Step 2: Calculate the GHG emission intensity at TOC/HOC level

As mentioned, a TCE always corresponds with a TOC or HOC. To be able to calculate the GHG emissions and GHG emission intensity value for multiple TCEs or an entire transport chain, first the corresponding GHG emissions, transport / hub activity and GHG emission intensity values at TOC / HOC level need to be calculated. For an explanation of these steps see section 4.3 of this guidance. The GHG emission intensity of a TCE then corresponds with the GHG emission intensity for the TOC or HOC associated with the TCE's transport or hub operation.

4.4.3 Step 3: Calculate the GHG emissions of each TCE

The GHG emissions of each TCE are calculated based on the transport or hub activity of the TCE as established throughout the previous step and as explained in section 4.3 of this guidance. The GHG emissions of a TCE are the sum of the TCE's *operation* and *energy provision* GHG emissions. To calculate these GHG emissions, the GHG emission intensity values per TOC or HOC (for operations or energy provision) are multiplied by the respective transport activity or hub activity of the TCE.

The total GHG emissions at the TCE level are then the sum of the respective vehicle or hub equipment operation and energy provision GHG emissions of the TCE. Please see *section 10.6 and 10.7 in ISO 14083* for further specifications on cases for differentiation due to cargo temperature and transport of passengers and freight in the same vehicle.

4.4.4 Step 4: Sum up the GHG emissions of all TCEs of (the part of) the transport chain

The GHG emissions of a transport chain shall be calculated by adding the corresponding GHG emissions values of all TCEs that are part of the respective transport chain.

4.4.5 Step 5: Calculate the transport activity of (the part of) the transport chain

The transport activity of a transport chain shall be calculated by adding the transport activity of all TCEs that are part of the transport chain. Please note that the transport of the TCE shall be quantified similarly to the quantification of the transport of a TOC. Hub activities are not included in this calculation.

4.4.6 Step 6: Calculate the GHG emission intensity value for the (part of the) transport chain

The GHG emissions for the transport chain can be converted into GHG emission intensities for the transport chain, by dividing the GHG emissions of the transport chain by the transport activity of the transport chain.

5 Considerations on reporting GHG emissions calculation results

Different actors may want to calculate GHG emissions for different purposes. As a general rule, the report of GHG emissions shall be either at the level of an organization, i.e. covering all transport chains operated or contracted by the company, or at the level of transport or hub services, i.e. covering only one or a set of TCEs of a transport chain. *ISO 14083* specifies the reporting requirements for both categories in *Chapter 13*.

It is not possible to omit the reporting of processes, inputs or outputs, unless clearly stating the reasons for such omission. That said, any report should always clearly state which operations are covered, noting any cut-off criteria that have been applied and noting the reasons for and implications of their use. Moreover, any report should include corresponding total emissions and emission intensity values and refer to ISO 14083. Calculations that rely on default emission intensity values shall state the source of the values used, justifying the reason for the choice if sources other than those referred to in *Annex M of ISO 14083* are used. In addition to reporting at the level of the overall organization, the transport operations operated or purchased by the organization may be disaggregated for reporting purposes as appropriate to the organizational structure, e.g. by business unit, geographical region of operation, or subsidiary.

5.1 Minimum reporting requirements at organizational level

Reporting at the level of the organisation requires an aggregation of the data from all, or selected, transport chains that the organisation is managing. The report can be a comprehensive document, or a brief report, as long as it is in a format suitable for the communication of GHG emission information.

Any report at organizational level should, as a minimum, compromise the following information:

a identification of the transport chains covered by the report, i.e all operations in scope;

b a reference to the ISO 14083:2023;

c the total GHG emissions *aggregated* for operations covered, disaggregated by mode ad hubs; and split between *operational* and *energy provision* GHG emissions, disaggregrated by energy carrier;

d the total (operational + energy provision) GHG emission intensity aggregated for operations covered, and disaggregated by transport mode and hubs, specifying the type of transport activity distance used;

e the total (operational + energy provision) GHG emissions for TCEs of each mode of transport and for hub operations;

f the total (operational + energy provision) GHG emission intensity for each TCE of each mode of transport and for hub operations, specifying the type of transport activity distance used[11];

g sources for used GHG emission factors;

h a reference to the location where supporting information is available.

When reporting total GHG emissions, the ISO 14083 requires companies to also report the share of primary and secondary data used, i.e. in percentage of reported GHG emissions per data type. Where secondary data is used, companies should also report the share of modelled vs. default data used. When using GHG emission factors, reporting organizations should provide reference and justifications for the use in accordance with provisions on *Annex J of ISO 14083*.

11 *Where alternative units for freight transport activity are used, GHG emission intensity may be disclosed in these terms (e.g. GHG emissions per item or per TEU kilometre).*

5.2 Minimum reporting requirements at the level of transport or hub services

Reporting at the level of transport or hub services serves the purpose of reporting on single TCE or to a set of TCEs that are part of a full transport chain. The aggregation of transport chains for reporting purposes can be done according to various criteria, including e.g. contractual agreements with service users and/or the period of implementation of these services. The identification of transport or hub services covered by the report may be done with an exhaustive list of these services, or by specifying the period of occurrence. The report should be in a format suitable for the communication of GHG emission information.

Any report at the level of transport or hub services should, as a minimum, compromise the following information:

a identification of the TCE(s) or transport chain(s) covered by the report, i.e. all operations in scope;
b a reference to the ISO 14083:2023;
c the total GHG emissions split by hub or transport service and split between *operational* and *energy provision* GHG emissions, disaggregrated by energy carrier;
d the total (operational + energy provision) GHG emission intensity, split by hub or transport service, and with an indication of the granularity of the TOC/HOC applied;
e a reference to the location where supporting information is available;
f the transport activity, specifying the type of distance used;
g the hub activity;
h the vehicle or hub operational GHG emissions;
i the vehicle or hub operational GHG emission intensity, specifying the type of transport activity distance used[12];
j the total GHG, transport activity and/or GHG emission intensities for each mode of transport and for hub operations, specifying the type of transport activity distance used, where appropriate;
k sources for used GHG emission factors.

When reporting total GHG emissions, the ISO 14083 requires companies to also report the share of primary and secondary data used, i.e. in percentage of reported GHG emissions per data type. Where secondary data is used, companies should also report the share of modelled vs. default data used.

The report may be complemented with corresponding GHG emission values and supporting information, which is further specified in *section 13.4 of ISO 14083*. This includes mentioning any omissions of GHG sources, transport or hub operations together with respective reasons for and implications of these omissions. *Section 13.4 of ISO 14083* provides templates for the GHG emissions report. When calculations rely on modelled data or default GHG emission intensities, calculations shall be transparent as to the model type and the parameters included in the model. For transparency, the reporting organization shall complete the table in *section 13.4.3 of ISO 14083* for each model used and share it upon request.

12 *Where alternative units for freight transport activity are used, the GHG emission intensity may be disclosed in these terms (e.g. GHG emissions per item or per TEU kilometre).*

5.3 Data verification

After having completed all steps of the GHG emissions calculation, it is equally important to have this data report verified by an independent third-party organisation. The ISO 14083 provides a universal calculation method and therefore the execution of such calculation can be verified by dedicated verification bodies. Data verification or assurance ensures reliability of data and can further foster trust by all data users. Dedicated verification or assurance bodies can establish whether the GHG emissions have been calculated and reported in accordance with the ISO 14083.

Depending on the agreed-upon scope and framework of the verification, the company should be able to provide all necessary information on the scope of the calculated carbon footprint, the data inputs used, assumptions taken and omissions made etc. The verifier will review the provided data, documents/evidence, and upon identifying potential errors, will provide the company with time to gather missing information or correct information. Upon completion of the verification, the company will receive a verification statement.

6 Appendix A - Overview of calculation formulas

6.1 Mode specific considerations

Please note that *Annexes A-H of the ISO 14083* set out further transport mode specific considerations. More precisely, they specify additional information on suitable factors for establishing a TOC or HOC; on specific calculation parameters such as the prescribed type of transport activity distance to be used; and on mode-specific aspects to consider when implementing a calculation. For transport by pipeline *(Annex D)* and hub operations *(Annex H), the ISO 14083* furthermore specifies which operations to include and exclude from the GHG emission calculation.

This additional information is provided for the following modes of transport:

Mode	Annex in ISO 14083
Air transport	Annex A
Cable car transport	Annex B
Inland waterway transport	Annex C
Transport by pipeline	Annex D
Rail transport	Annex E
Road transport	Annex F
Sea transport	Annex G
Hubs	Annex H

Table 5 *Annexes for mode-specific considerations*

6.2 Calculation formulas - emissions per transport/hub operators (individual TCE)

6.2.1 Formula related to step 2 (GHG emission value per operation within TOC/HOC and at TOC/HOC level)

For each activity, GHG activity data should be converted into both energy provision (indirect WTT) GHG emissions and vehicle operation (direct TTW) GHG emissions. Where primary data is not available, which is likely the case for the WTT emissions, GHG emissions may be calculated based on secondary data. For further requirements and guidance on GHG emission factors, see *Annexes K and J of the ISO 14083*. Where national legislation mandates the use of a database that lists specific local, regional and grid average GHG emission factors, users should use the most current official GHG emission factors and sources available.

	GHG emissions per **transport activity**	GHG emissions per **hub activity**
Vehicle/hub **operation** (direct TTW) emissions	$G_{VO,A} = Q_A \times ef_{VO,A}$	$G_{HO,A} = Q_A \times ef_{HO,A}$
Vehicle/hub **energy provision** (indirect WTT) emissions	$G_{VEPA} = Q_A \times ef_{VEP,A}$	$G_{HEP,A} = Q_A \times ef_{HEP,A}$

Where:

$G_{VO,A}$	is total vehicle operation (direct TTW) GHG emissions for GHG activity type A;
Q_A	is total quantity of each GHG activity type A (example: (example: Q_{diesel} equals 12.000 kg of diesel; or $Q_{R\text{-}134a}$ equals 100 kg of the refrigerant R-134a);
$ef_{VO,A}$	is the vehicle operation GHG emission factor for the GHG activity type A (example: for diesel, $ef_{VO,diesel}$=3,22 kg CO_2e/kg or efVO,R-134a=1 430 kg CO_2e/kg);
$G_{VEP,A}$	is the total vehicle energy provision (indirect WTT) GHG emissions for the GHG activity type A;
$ef_{VEP,A}$	is the vehicle energy provision GHG emission factor for the GHG activity type A;
$G_{HO,A}$	is the total hub operation GHG emission for the GHG hub activity type A;
$G_{HEP,A}$	is the total hub energy provision GHG emission for the GHG hub activity type A

Where there are multiple GHG activity types, for example the vehicles use different energy carriers or refrigerants, the GHG emission values for each GHG activity type should be separately converted into GHG emission values and then added together to provide the total GHG emission values.

The total GHG emissions at TOC or HOC level shall then be calculated as follows:

	GHG emissions at **TOC level**	GHG emissions at **HOC level**
Vehicle/hub **operation** (direct TTW) emissions	$G_{VO,TOC} = \Sigma G_{VO,TOC,Ai}$	$G_{HO,HOC} = \Sigma G_{HO,TOC,Ai}$
Vehicle/hub **energy provision** (indirect WTT) emissions	$G_{VEP,TOC} = \Sigma G_{VEP,HOC,Ai}$	$G_{HEP,HOC} = \Sigma G_{HEP,HOC,Ai}$

Where:

$G_{VO,TOC}$	is total vehicle operation (direct TTW) GHG emissions of the specific TOC;
$G_{VO,TOC,Ai}$	is total vehicle operation (direct TTW) GHG emissions of the specific TOC for each GHG activity type A_i;
$G_{VEP,TOC}$	is the total vehicle energy provision (indirect WTT) GHG emission of the specific TOC;
$G_{VEP,TOC,Ai}$	is total vehicle energy provision (indirect WTT) GHG emissions for each GHG activity type A_i;
$G_{HO,HOC}$	is total hub operation GHG emissions of the specific HOC;
$G_{HO,HOC,Ai}$	is total hub operation GHG emissions of the specific HOC for each GHG activity type A_i;
$G_{HEP,HOC}$	is total hub energy provision GHG emissions of the specific HOC;
$G_{HEP,HOC,Ai}$	is total hub energy provision GHG emissions of the specific HOC for each GHG activity type A_i.

6.2.2 Formula for step 3 (total transport / hub activity at TOC / HOC level)

Please note that the calculation of a transport activity of a TOC shall be adapted, based on the different cases and factors used to establish the TOC. Only one type of transport activity distance (SFD or GGCD) shall be used for the calculation of the transport activity of a TOC. Please note that in situations where an alternative option for the quantity of freight is being used, Mi can be replaced in the formula by the appropriate unit, e.g. number of items or number of TEUs. For hub activity, only the transported mass is taken into account.

Transportactivity on **TOC level**	Hub activity on **HOC level**
$T_{TOC} = \Sigma M j \times S_{ci}$	$H_{HOC} = \Sigma_j \times M_j$

Where:

T_{TOC}	total transport activity of the TOC;
M_i	mass of an individual consignment *i* in the TOC;
S_{ci}	is the transport activity distance of an individual *i* in the TOC;
c	is the number of consignments in the TOC;
H_{HOC}	total hub activity of the HOC;
M_j	freight mass *j* handled at the hub

6.2.3 Formula for step 4 (GHG emission intensity value at TOC/HOC level)

For each TOC/HOC, the emission intensity value is calculated by dividing the total GHG emissions of the TOC/HOC by the total transport/hub activity of the TOC/HOC. The GHG emission intensity value at TOC level should be calculated as follows:

	GHG emission intensity at **TOC level**	GHG emission intensity at **HOC level**
Vehicle/hub **operation** (direct TTW) emissions	$g_{VO,TOC} = \frac{G_{VO,TOC}}{T_{TOC}}$	$g_{HO,HOC} = \frac{G_{HO,HOC}}{H_{HOC}}$
Vehicle/hub **energy provision** (indirect WTT) emissions	$g_{VEP,TOC} = \frac{G_{VEP,TOC}}{T_{TOC}}$	$g_{HEP,HOC} = \frac{G_{HEP.CHA}}{H_{HOC}}$
Total	$g_{TOC} = g_{VO,TOC} + g_{HEP,HOC}$	$g_{HOC} = g_{HO,HOC} + g_{HEP,HOC}$

Where:

$g_{VO,TOC}$	is vehicle operation (direct TTW) GHG emission intensity value for the selected TOC;
$G_{VO,TOC}$	is total vehicle operation (direct TTW) GHG emissions for the selected TOC;
$g_{VEP,TOC}$	is vehicle energy provision (indirect WTT) GHG emission intensity value for the selected TOC;
$G_{VEP,TOC}$	is total vehicle energy provision (indirect WTT) GHG emissions for the selected TOC;
T_{TOC}	is total transport activity of the TOC;
g_{TOC}	is total GHG emission intensity value for a specific TOC (sum of TTW and WTT emission intensity values);
$g_{HO,HOC}$	is hub operation (direct TTW) GHG emission intensity value for the selected HOC;
$G_{HO,HOC}$	is total hub operation (direct TTW) GHG emissions for the selected HOC;
$g_{HEP,HOC}$	is hub energy provision (indirect WTT) GHG emission intensity value for the selected HOC;
$G_{HEP,HOC}$	is total hub operation (indirect WTT) GHG emissions for the selected HOC;
H_{HOC}	is total hub activity of the HOC;
g_{HOC}	is total GHG emission intensity value for a specific HOC (sum of TTW and WTT emission intensity values).

6.3 Calculation formulas - emissions per transport service organisers and transport service users (multiple TCE/entire transport chain)

6.3.1 Formula for step 2 (GHG emission intensity value at TOC/HOC level)

Please see formulas as outlined in 6.2.1-6.2.3.

6.3.2 Formula for step 3 (GHG emissions of each TCE)

The GHG emissions of a TCE shall be calculated using the following formulas.

	GHG emissions of a **transport TCE**	GHG emissions of a **hub TCE**
Vehicle/hub **operation** (direct TTW) emissions	$G_{VO,TCE} = g_{VO,TOC} \times T_{TCE}$	$G_{HO,TCE} = g_{HO,HOC} \times H_{TCE}$
Vehicle/hub **energy provision** (indirect WTT) emissions	$G_{VEP,TCE} = g_{VEP,TOC} \times T_{TCE}$	$G_{HEP,TCE} = g_{HEB,HOC} \times H_{TCE}$
Total	$G_{V,TCE} = G_{VO,TEC} + G_{VEP,TEC}$	$G_{H,TCE} = G_{HO,TCE} + G_{HEB,TCE}$

Where:

$G_{VO,TCE}$	is total vehicle operation (direct TTW) GHG emissions for the TCE;
$g_{VO,TOC}$	is the vehicle operation (direct TTW) GHG emission intensity value for the TOC;
T_{TCE}	is total transport activity of the TCE;
$G_{VEP,TCE}$	is total vehicle energy provision (indirect WTT) GHG emissions for the TCE;
$g_{VEP,TCE}$	is the vehicle energy provision (indirect WTT) GHG emission intensity value for the TCE;
$G_{V,TCE}$	is total (WTW) vehicle GHG emissions for the TCE
$G_{HO,TCE}$	is total hub operation (direct TTW) GHG emissions for the TCE;
$g_{HO,HOC}$	is hub operation (direct TTW) GHG emission intensity value for the HOC;
H_{TCE}	is total hub activity of the TCE;
$G_{HEP,TCE}$	is total hub energy provision (indirect WTT) GHG emissions for the TCE;
$g_{HEP,HOC}$	is hub energy provision (indirect WTT) GHG emission intensity value for the HOC;
$G_{H,TCE}$	is total (WTW) hub GHG emissions for the TCE

Please note that this formula is simplified, assuming a DAF = 1. The use of a DAF is only required in cases where the actual distance is used for the calculation of the GHG emission intensity of the TOC.

Please note that ISO 14083 provides further specifications for cases of differentiation such as cargo temperature and transport of passengers and freight in the same vehicle (see *sections 10.5 to 10.7, and 11.5 to 11.6 in the ISO 14083*).

6.3.3 Formula for step 4 (GHG emissions of all TCEs of (the part of) the transport chain)

The total GHG emissions for a transport chain are calculated by adding the values calculated for all individual TCEs.

	GHG emissions of a **vehicle transport chain**	GHG emissions of a **hub transport chain**
Vehicle/hub **operation** (direct TTW) emissions	$G_{VO,TCE} = \Sigma_{i,} G_{VO,\ TCE,i}$	$G_{HO,TC} = \Sigma_{i,\ GHO,\ TCE,i}$
Vehicle/hub **energy provision** (indirect WTT) emissions	$G_{VEP,TC} = \Sigma_{i,}\ G_{VEP,\ TCE,i}$	$G_{HEP,TCE} = \Sigma_{i,\ GHEP,\ TCE,i}$
Total	$G_{TC} = G_{VO,TC} + G_{HO,TC} + G_{VEP,TC} + G_{HEP,TC}$	

Where:

$G_{VO,TC}$	is vehicle operation (total direct TTW) GHG emissions of the transport chain;
$G_{VO,TCE,i}$	is vehicle operation (total direct TTW) GHG emissions allocated to each relevant TCE_i;
$G_{VEP,TC}$	is vehicle energy provision (total indirect WTT) GHG emissions of the transport chain;
$G_{VEP,TCE,i}$	is vehicle energy provision (total indirect WTT) GHG emissions allocated to each relevant TCE_i;
GHO_{TC}	is hub operation (total direct TTW) GHG emissions of the transport chain;
$G_{HO,TCE,i}$	is hub operation (total direct TTW) GHG emissions allocated to each relevant TCE_i;
$GHEP_{,TC}$	is hub energy provision (total indirect WTT) GHG emissions of the transport chain;
$G_{HEP,TC}$	is hub energy provision (total indirect WTT) GHG emissions for each relevant TCE_i;
G_{TC}	is total WTW GHG emissions of the transport chain.

6.3.4 Formula for step 5 (transport activity of selected transport chain)

The transport activity of a transport chain (T_{TC}) shall be calculated by adding the transport activity of all transport TCEs that compose this transport chain. Please note that the transport activity of the TCE shall be quantified similarly to the quantification of the transport activity of a TOC *(see section 6.2.2)*. Please note that hub activities are not included in this calculation.

To calculate the total transport of the TC, the following formula may be used:

Total **transport activity** of TC

$$T_{TC} = T_{TCE1} + T_{TCEn}$$

6.3.5 Formula for step 6 (GHG emission intensity value for selected transport chain)

The GHG emissions for the transport chain can be converted into GHG emission intensities for this transport chain, by dividing the GHG emissions calculated in *6.3.3* by the transport activity calculated in *6.3.4.* The ISO 14083 notes that the hub activities are not included in this calculation, whereas the total GHG emissions of all hub TCEs are included.

GHG emission **intensity** of TC

$$g_T = \frac{G_{TC}}{T_{TC}}$$

Where:

g_T	is GHG emission intensity of the transport chain
G_{TC}	is total (i.e. operation and energy provision) GHG emissions of the complete transport chain;
T_{TC}	is the total transport activity of a transport chain.

Please see s*ection 12.2 within the ISO 14083* for further supporting formulas when calculating GHG emissions and emissions intensity for a set of transport chains or transport services.

7 Appendix B - Passenger transport

7.1 Purpose of this appendix

The main ISO 14083 guidance document for supply chain partners and platform calculators provides guidance on how to calculate greenhouse gas (GHG) emissions associated with *freight* transport activities. Yet, some transport companies may also offer the transport of passengers. The ISO 14083 applies a common methodology to both *freight* and *passenger* transport chains. While key principles, system boundaries, and the underlying GHG emissions calculation approach remain the same, data inputs and the definition of a transport or hub activity can vary, depending on whether the calculation relates to the transport of freight or passengers. In addition, an allocation of GHG emissions is required when both *freight* and *passengers* are transported, or when passengers are transported with different travel classes[13]. This appendix illustrates what a passenger transport chain looks like and provides guidance on the passenger-specific data inputs and other considerations to keep in mind when calculating GHG emissions associated with *passenger* transport and combined freight-passenger transport activities.

Please note that this guidance appendix does not constitute a replacement of the ISO 14083 requirements, but should be used in conjunction with the standard, and read as additional support to interpret requirements.

7.2 Introduction to transport of passengers

The transport of *passengers*, as compared to freight, generally relates to any activities that involve the movement of people from one location to another. As people move, they can use different modes of transport, such as buses, trains, or planes. The vehicles used can vary in how many passengers they can transport, and the level of occupancy may vary, depending on the time of travel or frequentation of the route. Traveling passengers may also need to pass through a hub, if switching from one mode of transport to another, for example at a railway station.

Different modes of passenger transport can have varying emission intensities. Air travel, for example, generally has higher emissions per passenger-kilometre compared to train or bus travel. While the fuel efficiency of the vehicle is crucial, so is its capacity to transport passengers. The occupancy rate is a determinant for passenger transport, similar to the load factor in the transport of freight. Higher occupancy rates, i.e. more passengers being transported per vehicle, generally result in lower emissions per passenger.

7.3 Passenger-specific data to gather

When wanting to calculate GHG emission intensity values, companies need to make sure to gather data on all GHG emitting sources that are relevant for the scope of (passenger) transport and/or hub activities, for which they want to calculate emissions. Just as in freight transport, factors such as travel distance, changes in the mode of transport, type of vehicle, and the accuracy of emission factors used play a crucial role in calculating GHG emissions associated with passenger transport operations.

13 *Please note that allocation is not only required in the context of passenger transport. It may also be required for freight transport, in cases where, for example, freight with different temperature needs is transported, or when GHG emissions need to be allocated client-specific to individual shares of a total freight load.*

To calculate the GHG emission intensity value associated with passenger transport and/or hub operations, the following key data is needed - either from the reporting company itself related to own operations carried out or requested from subcontracted entities that carry out relevant operations:

Fuel data

- Fuel type or energy carrier type used (e.g. diesel, gasoline, electricity).
- Quantity of each type of fuel consumed and energy carrier used.
- WTT and TTW emission factors for each fuel type and energy carrier used.

Trip activity data

- Quantity of passengers (number of passengers or passenger mass) and/or freight, i.e.:
  - For passengers traveling in a vehicle: the mass of the vehicle plus the mass of the passengers and any accompanying luggage.
  - For passengers traveling by foot: the mass of the passengers and their luggage.
  - For quantity of freight: actual freight mass.
- Distance travelled between origin and destination.
- Information on vehicle type, including passenger and/or freight capacity.

Moreover, companies may decide to gather additional transport- and/or hub-operation related data, which supports the grouping of operations into transport operation categories and hub operation categories.

These may include, but are not limited to:

- Air conditioning or other cooling infrastructure installed and respective data on leakage of refrigerants;
- Level of passenger loading, such as occupancy rate in cases where class factors need to be calculated for multi-class vehicles;
- Freight condition, e.g. ambient vs. temperature controlled;
- Propulsion type, such as type of electric motor or combustion engine
- Operation types, e.g. for trains: passenger long distance trains, regional trains, trams, metro

Any calculation of GHG emissions within a transport chain shall include all processes that emit GHG by either combustion or by leakage of refrigerants, regardless of which organization operates them. More concretely, it should include vehicle and/or hub equipment related *operational* and *energy provision* processes, as well as combustion and/or leakage of energy carriers at vehicle and/or hub equipment level, and leakage or refrigerants used by vehicles or hubs. Put simply, it needs to cover operational processes, but also how vehicles and hubs get energy and should account for any leaks from refrigerants used. Section 3.1 of ISO 14083 guidance document provides an overview of the operational and energy provision processes that need to be included in the GHG emissions calculation.

In practice, this can require gathering data on processes and activities that may not seem to be 'passenger transport' operations in the first place, but nevertheless contribute to the movement or transfer of passengers. As an example, processes to consider in the case of hub operations include, amongst others, all energy consumed by transfer equipment such as de-/boarding equipment, shuttles, luggage handling, restrooms or waiting areas, as well as respective air-conditioning installed in these operations.

14 Passenger mass = number of passengers x standard mass for a passenger with luggage. If the total weight of all passengers is unknown, an estimate can be used assuming an average weight of 100kg per passenger, including their baggage.

15 Freight mass refers to the total weight or mass of goods, cargo, materials etc. being transported in the context of the freight transport.

Regarding temperature control processes such as air-conditioning, both the energy consumption as well as the leakage of refrigerants need to be accounted for, while the production and supply processes of refrigerants can be neglected. As stated in *ISO 14083 Annex H.1.2*, this may even include energy consumption and refrigerant leakage of vehicles such as push boats, aircraft pushers, or shuttles for employees that operate other vehicles at a hub. Attention should also be paid to the allocation of these emissions. For example, energy and refrigerants used by vehicles/vessels operating permanently at a hub should be allocated to hub operations accordingly, while energy and refrigerants used by inbound or outbound transport vehicles shall be allocated to transport operations of respective inbound or outbound transport chain elements (TCE). *Annex I of ISO 14083* details how to account for refrigerant leakage GHG emissions.

As ISO 14083 does not include specifics on gathering primary or secondary data for passenger transport, handling is assumed to be the same as for freight transport. The ISO 14083 prioritizes primary data for GHG emissions quantification. Only where primary data is not available, secondary data may be used, prioritizing modelled data over default data.

It is very important to carefully document the scope of the calculation and which data has been used respectively.

7.4 Dissecting a passenger transport chain into its constituting elements

As with freight transport, a passenger transport chain needs to be dissected into its individual TCEs and underlying transport operation categories (TOC) and hub operation categories (HOC), in order to be able to calculate GHG emissions in a standardized manner. As illustrated by Figure 4, a passenger transport chain can encompass the transport of passengers by different transport modes, e.g. by bus (TCE 1) or train (TCE 5), or through a hub, e.g. via an airport transfer (TCE 2 and 4). Consequently, as with freight transport, a passenger transport chain can include *transport* operations, as well as *hub* operations. In addition, some TCEs may combine both freight and passenger transport, e.g. an air travel service (TCE 3).

A passenger *transport* operation is defined as the operation of a vehicle in order to transport passengers. Different transport operations may reflect a similar category of transport operations. Defining such TOCs/HOCs is important to effectively measure and manage emissions, as they group all operations sharing similar characteristics. TOCs/HOCs are the key reference point to calculate GHG emissions of a TCE and they shall reflect the combined characteristics of the transport mode and hub type. When defining the characteristics of a TOC, similar aspects should be considered for passenger transport as for freight transport. Characteristics for grouping transport operations may include for example the number and type of vehicles or the journey length.

A passenger *hub* operation is defined as any operation necessary to transfer a passenger through a hub. While hub operations for transport of *freight* include transportation by forklift, pallet trucks or similar vehicles, transport of *passengers* includes lifts, escalators, conveyor belts, moving walkways and similar means[16]. To categorize hub operations into HOCs for passenger transport, one can consider factors that affect the scale and composition of the HOC, such as transfer on-site, (de-)boarding equipment, or handling of luggage.

16 ISO 14083, Annex H.1.2 states: "all hub operations […] that consume energy or cause refrigerant leakage are included. […] GHG emissions resulting from energy use for handling luggage accompanying passengers shall be included and allocated to hub operations for passenger transfer."

The transport of passengers may occur via different modes of transport, such as air transport, inland waterway transport, or rail transport. *Annexes A to G of ISO 14083* provide further guidance and give examples of grouping together different transport or hub operations into TOCs and HOCs for different modes of transport. For instance, *Annex A* suggests structuring air transport along a suitable combination of the journey length (<1.500km or >1.500km) and the plane configuration (passenger aircraft without freight, dedicated freight aircraft, passenger aircraft with belly freight).

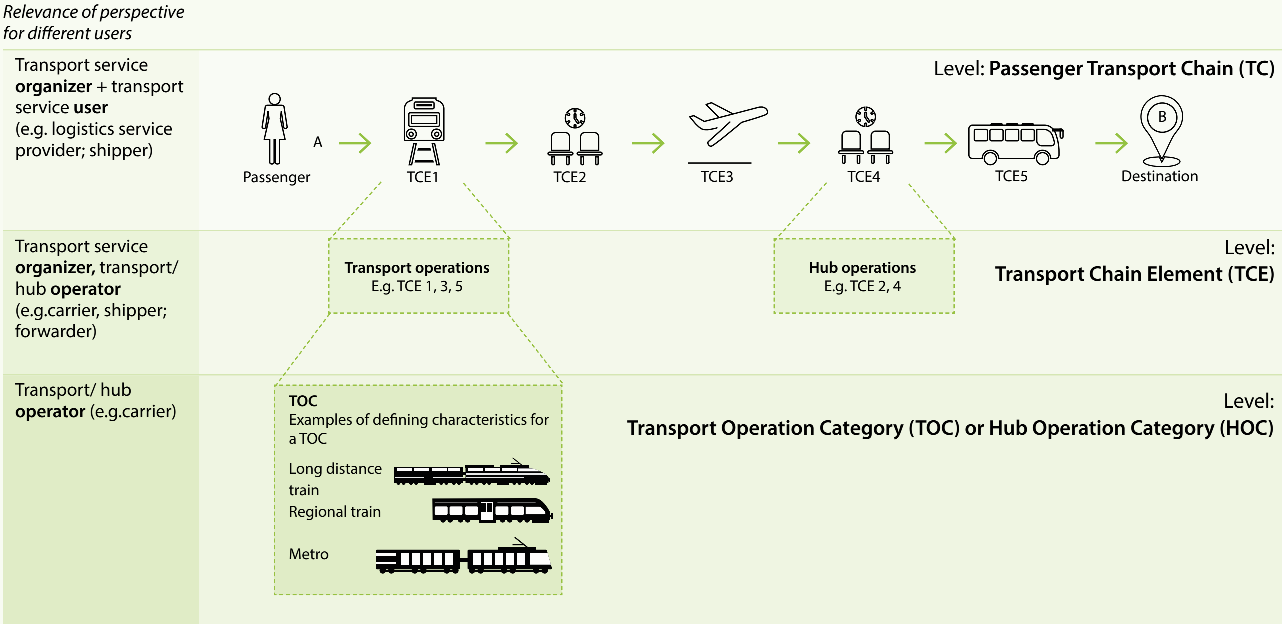

Figure 4 *Illustration of transport chain elements for passenger transport*

Once the TOC or HOC has been defined, the GHG emission value at the TOC or HOC level needs to be calculated. This is done by identifying and converting the relevant GHG activity data per TOC or HOC into CO_2e. To recall, just as with freight transport, ISO 14083 also requires that GHG activity data for passenger transport be converted into vehicle and/or hub equipment *operation* GHG emissions and *energy provision* GHG emissions.

7.5 Calculating the passenger transport and/or passenger hub activity

The underlying approach for calculating GHG emissions remains the same for both freight and passenger transport. To be able to calculate the total emission intensity value at the TOC or HOC level, the transport or hub activity is needed. Here, the data input for calculating the *passenger* transport or hub activity differs from that of the freight transport. The approach to calculating the emission intensity value at the TOC or HOC level is illustrated in Figure 2 of this Guidance Document.

The *transport activity* for passenger transport (only passengers) is calculated by multiplying the number of passengers, plus their baggage, with the transport activity distance[17]. The transport activity shall either be the shortest feasible distance (SFD) or the greater circle distance (GCD)[18]. Where the transport activity distance per passenger is unknown, the passenger transport activity can be calculated by multiplying the number of passengers by the mean actual distance travelled by passengers within this TOC.

17 While transport activity for freight looks at the actual freight mass, the transport activity for passengers looks at the number of passengers.

18 To facilitate data exchange and ensure greater comparability, this guidance document recommends to use the GCD wherever possible.

In cases of *combined transport* of freight and passengers, for example via a ferry, the transport activity shall be the quantity of freight and passengers multiplied by the transport activity distance. The quantity of passengers then refers to the total passenger mass[19], the quantity of passenger vehicles (if applicable) to the mass of the vehicles, and the quantity of freight to the actual freight mass.

The *hub activity* for *passenger* transport shall be quantified by the number of all individual passengers relevant to the HOC[20]. For *combined* freight and passenger hubs, the hub activity shall be the quantity of passengers and the quantity of freight (outbound).

The option described above for calculating the transport activity for combined transport of freight and passengers can be used both for allocation and for calculation of GHG emission intensity. In some cases, however, data needed to apply this option - i.e. data to quantify passenger, vehicles used and freight - may not be available. For these situations, the ISO 14083 prescribes a second option which can be used for allocation. In this second option, companies should rely on passenger equivalency values to replace the missing data. Passenger-equivalent values (peq) provide standard values to express the volume of different modes of transportation. These equivalency values are based on a combination of mass-based and volume-based equivalence, as these two inputs provide a balanced outcome that does not unduly favour either passengers or freight at the allocation stage. In this second option, each passenger is counted as one passenger equivalent, the quantity of passenger vehicles shall be the number of passenger equivalents of these vehicles, and the quantity of freight shall be the number of passenger equivalents for freight[21].

For more information on standard passenger-equivalent values for different types of passenger vehicles and freight transport, please see *Annexes E and G of ISO 14083*.

Transport activity

Passenger transport activity
= *number of all individual passengers (plus their luggage)× transport activity distance*

Transport activity for combined transport of freight and passengers
= *quantity of freight*
+ *quantity of passengers (+ quantity of passengers vehicles where applicable)*
× *transport activity distance*

Where:
Transport activity distance refers to either the shortest feasible distance (SFD) or great circle distance (GCD)

Hub activity

Passenger hub activity
= *number of all individual passengers*

19 Passenger mass refers to the number of passengers multiplied by the mass for a passenger with luggage. If the total weight of all passengers is unknown, an estimate can be used assuming an average weight of 100kg per passenger, including their baggage.
20 While hub activity for freight looks at the quantity of outbound freight, the hub activity for passengers looks at the number of passengers.
21 For example, and in accordance with Table E.3 in Annex E of the ISO 14083, the peq of an individual passenger (including luggage) is 1,0. The peq of a passenger car is 1,3. Two passengers travelling in a passenger car would total a peq of 3,3.

The general approach to then calculate the GHG emission intensity at the TOC/HOC level is to divide the total GHG emissions of the TOC/HOC by the total transport/hub activity of the TOC/HOC. The emission intensity value is then based on the average GHG emissions for a group of similar transport or hub activities. For passenger transport at the TOC level, GHG emission intensity can be expressed as mass CO_2e per passenger kilometre, or equivalent units, or for passenger hub throughput at the HOC level as mass CO_2e per passenger.

7.6 Key aspects on allocation (passenger vs. freight)

An allocation of GHG emissions is required when both freight and passengers are transported, or when passengers are transported with different travel classes[22]. In the context of GHG emissions calculation, allocation generally refers to the process of assigning or distributing total GHG emissions that originate from one specific activity across different products. Especially in the transport sector, individual vehicles often transport various types of freight or passengers simultaneously. As the ISO 14083 specifies, allocation is necessary when multiple functionalities are fulfilled by the same vehicle or hub, and the GHG emission cannot be allocated equally to all passengers and/or freight. The ultimate goal is to provide a fair and representative distribution of emissions among different outputs. However, ISO 14083 mentions that allocation should be avoided wherever possible. Allocation can best be avoided by splitting the corresponding activities or processes to be allocated into different sub-processes and collecting the input and output data for each sub-process. Where allocation cannot be avoided, GHG sources or GHG emissions shall be partitioned, i.e. distributed, between freight and/or passengers that benefit equally from the same functionality, taking into account the different needs of GHG sources and resulting GHG emissions.
For partitioning, the transport/hub activity may be used, but other criteria such as the ones mentioned in the next paragraph may be necessary as well. Once defined, the allocation parameter within a TOC/HOC shall remain the same. *Annexes A to H of the ISO 14083* provide more guidance on allocation, depending on the mode of transport.

When having to allocate GHG emissions, the formulas for calculating the GHG emissions at the TOC/HOC level must be adapted to the allocation scenarios. ISO 14083 discloses various allocation scenarios, including calculations being performed for a TOC of passengers with multi-class vehicles or for a TOC with freight and passengers. When allocating emissions to passengers in different travel classes, the transport/hub activity should be used for allocation, in combination with the passenger of the lowest class equivalent unit. See *Chapter 8.4.5 of ISO 14083* for calculating the transport activity of a TOC with multi-class vehicles. When allocating between passengers and freight, the transport/hub activity should be used for allocation, in combination with the passenger-equivalent unit. See *Chapter 8.4.7 of ISO 14083* for calculating the transport activity of a TOC with passengers and freight.

22 *Please note that allocation is not only required in the context of passenger transport. It may also be required for freight transport, in cases where for example freight with different temperature needs is transported, or when GHG emissions need to be allocated client-specific to individual shares of a total freight load.*

7.7 Calculation formulas

Transport activity of a TOC of passengers - General case *(related to 6.2.2 Formula for step 3 in Appendix A)*:

Passenger transport activity at **TOC level**	Passenger transport activity at **HOC level**
$T_{TOCp} = \Sigma_1^{vp} Pi \times s_{pi}$	$H_{HOCp} = v_p$

Where:

T_{TOCp}	is the passenger transport activity of the TOC;
Pi	is an individual passenger *i* in the TOC;
s_{pi}	is the transport activity distance of an individual passenger *i* in the TOC;
v_p	is the number of passengers in the TOC/HOC;
H_{HOCp}	is the total passenger hub activity of the HOC.

Transport activity of a TOC for combined transport of passengers and freight *(related to 6.2.2 Formula for step 3 in Appendix A)*:

First, calculate the transport activity separately for each type of entity e_k, (*k* from 1 to *y*, e.g. in the case of a mixed-use train: e_1 passengers with their luggage, e_2 cars, e_3 motorcycles, e_4 freight)

$$T_{TOC,e_k} = \int_i^b \theta_i \times s_{i,e_k}$$

Where:

T_{TOC,e_k}	is the transport activity of the TOC for all entities of type *ek*;
θ_i	is the quantity of each entity *i* of type *ek* in the TOC;
s_{i,e_k}	is the transport activity distance of each entity *i* of type *ek* in the TOC;
b	is the number of entities of type *ek* in the TOC.

Second, the transport activity for the TOC should be calculated:

$$T_{TOC} = \int_1^y T_{TOC,e_k}$$

Where:

TTOC	is the transport activity of the TOC;
T_{TOC,e_k}	is the transport activity of the TOC for all entities of type *ek;*
y	is the number of types of entity.

Topsector Logistiek
Ezelsveldlaan 59 2611 RV Delft | +31(0)15 251 65 65 | info@topsectorlogistiek.nl | www.topsectorlogistiek.nl

Topsector Logistiek