
**Greenhouse gases — Quantification
and reporting of greenhouse gas
emissions arising from transport
chain operations**

*Gaz à effet de serre — Quantification et déclaration des émissions de
gaz à effet de serre résultant des opérations des chaînes de transport*

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Contents

Page

Foreword.....	vii
Introduction.....	viii
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	1
3.1 Terms related to transport chain operations.....	1
3.2 Terms related to greenhouse gases and energy.....	6
3.3 Terms related to quantification.....	9
3.4 Other terms.....	11
4 General principles.....	11
4.1 General.....	11
4.2 Relevance.....	11
4.3 Completeness.....	12
4.4 Consistency.....	12
4.5 Accuracy.....	12
4.6 Transparency.....	12
4.7 Conservativeness.....	12
5 Quantification principles.....	12
5.1 General.....	12
5.2 System boundaries.....	12
5.2.1 Transport operations and hub operations included.....	12
5.2.2 Processes included.....	13
5.2.3 Application of cut-off criteria.....	14
5.2.4 Processes not included.....	14
5.2.5 Optional processes.....	14
5.2.6 Optional quantification of black carbon emissions from transport operations.....	15
5.2.7 Carbon offsetting and GHG emissions trading.....	15
5.3 Conversion of energy carrier data into GHG emissions.....	15
5.3.1 General.....	15
5.3.2 Global warming potential.....	15
5.4 Calculation of transport activity.....	15
5.4.1 Passenger transport.....	15
5.4.2 Freight transport.....	16
5.4.3 Combined transport of freight and passengers (including passenger vehicles).....	17
5.4.4 Use of distance adjustment factor.....	17
5.5 Calculation of hub activity.....	17
5.5.1 Passenger hub.....	17
5.5.2 Freight hub.....	18
5.5.3 Combined freight and passenger hub (including passenger vehicles).....	18
5.6 Allocation.....	18
5.6.1 General.....	18
5.6.2 Allocation between passengers and freight.....	19
5.6.3 Allocation between passengers of different travel classes.....	19
5.6.4 Allocation between ambient and temperature-controlled freight.....	19
6 General principles related to transport chains, transport chain elements, transport operation categories and hub operation categories.....	19
6.1 Transport chains and TCEs.....	19
6.2 Transport operations and hub operations related to TCEs.....	19
6.3 Transport operation categories and hub operation categories.....	21
6.3.1 General.....	21

6.3.2	Transport operation categories	21
6.3.3	Hub operation categories	24
7	Quantification actions	26
7.1	General	26
7.2	Establishment of GHG emission intensity of a TOC or a HOC	27
7.2.1	General	27
7.2.2	Selection of the option	27
7.2.3	Calculation with primary data (option A)	27
7.2.4	Calculation with a model (option B)	28
7.2.5	Selection of a value from a database of default values (option C)	28
7.2.6	Collection of a value from a contracted operator (option D)	28
7.3	Calculation of GHG emissions for a TCE	28
7.4	Calculation of GHG emissions for a transport chain	28
8	Quantification actions at the TOC level	28
8.1	General	28
8.2	Quantification of the GHG activity data of a TOC	29
8.3	Calculation of GHG emissions of a TOC	29
8.3.1	General	29
8.3.2	No allocation needed	29
8.3.3	Allocation needed	30
8.4	Calculation of transport activity of a TOC	31
8.4.1	General	31
8.4.2	Transport activity distance	31
8.4.3	Transport activity of a TOC of passengers — General case	31
8.4.4	Transport activity of a TOC of freight — General case	32
8.4.5	Transport activity of a TOC of passengers with multi-class vehicles	32
8.4.6	Transport activity of a TOC of freight with multi-temperature vehicles	33
8.4.7	Transport activity of a TOC with passengers and freight (whether including passenger vehicles or not)	34
8.4.8	Transport activities of a TOC with any other case	35
8.5	Calculation of GHG emission intensity for the TOC	35
8.5.1	General	35
8.5.2	General case	35
8.5.3	Case of a TOC of freight with multi-temperature vehicles	36
9	Quantification actions at the HOC level	36
9.1	General	36
9.2	Quantification of the GHG activity data of a HOC	36
9.3	Calculation of GHG emissions of a HOC	37
9.3.1	General	37
9.3.2	No allocation needed	37
9.3.3	Allocation needed	38
9.4	Quantification of hub activity of the HOC	39
9.4.1	Freight hub activity	39
9.4.2	Passenger hub activity	39
9.5	Calculation of GHG emission intensity for the HOC	39
9.5.1	General	39
9.5.2	General case	39
9.5.3	Case of a HOC of freight with multi-temperature conditions	40
10	Calculation of GHG emissions for a transport TCE	40
10.1	General	40
10.2	Calculation of transport activity	40
10.3	Selection of a GHG emission intensity	40
10.4	General case	41
10.5	Case of differentiation by passenger classes	41
10.6	Case of differentiation by cargo temperature	41
10.7	Case of transport of passengers and freight in the same vehicle	41

11	Calculation of GHG emissions for a hub TCE	41
11.1	General	41
11.2	Quantification of hub activity	42
11.3	Selection of a GHG emission intensity	42
11.4	General case	42
11.5	Case of differentiation by cargo temperature	42
11.6	Case of transfer of passengers and freight at the same hub	42
12	Results	43
12.1	For one transport chain	43
12.1.1	Calculation of GHG emissions	43
12.1.2	Calculation of transport activity	43
12.1.3	Calculation of GHG emission intensities	44
12.2	For a set of transport chains	44
12.2.1	General	44
12.2.2	Calculation of GHG emissions	44
12.2.3	Calculation of transport activity	44
12.2.4	Calculation of GHG emission intensities	45
12.3	For a transport service	45
12.4	For a set of transport services	45
12.5	For a transport mode	45
13	Reporting	45
13.1	General	45
13.2	Reporting at the organizational level	45
13.2.1	Reporting boundaries	45
13.2.2	Report	45
13.2.3	Periodicity	46
13.3	Reporting at the level of transport or hub services	46
13.3.1	Granularity	46
13.3.2	Report	46
13.4	Supporting information	47
13.4.1	General	47
13.4.2	Description of the calculation method	47
13.4.3	Transparent reporting from the use of modelled data or default GHG emission intensities	52
Annex A (normative)	Air transport	54
Annex B (normative)	Cable car transport	56
Annex C (normative)	Inland waterway transport	59
Annex D (normative)	Transport by pipeline	61
Annex E (normative)	Rail transport	63
Annex F (normative)	Road transport	66
Annex G (normative)	Sea transport	70
Annex H (normative)	Hubs	76
Annex I (normative)	Approach to account for refrigerant leakage GHG emissions from mobile air conditioning and temperature-controlled freight units during transportation operations	80
Annex J (normative)	Additional requirements and guidance for GHG emission factors	83
Annex K (informative)	GHG emission factors and sources	87
Annex L (informative)	Additional guidance for allocation to passenger according to passenger class of travel	92
Annex M (informative)	General guidance on the approach to modelling of GHG emissions of transport chains	98

Annex N (informative) Additional guidance for use of ICT equipment and data servers related to transport operations	103
Annex O (informative) Quantification of GHG emissions arising from (re)packaging processes at logistics hubs	106
Annex P (informative) Quantification of black carbon emissions from transport operations	108
Annex Q (informative) Selection of sources of default GHG emission intensities	110
Annex R (informative) Comparison of GHG emission categorization used in the GHG Protocol and this document	112
Bibliography	115

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 207, *Environmental management*, Subcommittee SC 7, *Greenhouse gas and climate change management and related activities*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 320, *Transport — Logistics and services*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition cancels and replaces IWA 16:2015, which has been technically revised throughout to expand the framework to a methodology.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides requirements and guidance for the quantification and reporting of greenhouse gas (GHG) emissions for transport chains for passengers and freight.

This document provides such a calculation with its related reporting. It specifies how to source data as input for the calculation, taking into account that transport operations vary hugely, from multinational organizations operating multiple transport modes to deliver transport services across the globe, through small local operators delivering a simple service to a single user; hence this document has adopted a structure to make it widely applicable. To ensure that values for GHG emissions that result from vehicle and hub operation and associated energy provision are considered, this document takes into account the GHG emissions associated with production and distribution of energy (including, for example, production and distribution of liquid energy carriers or grid transmission of electricity). As a result, calculation results can enable a consistent comparison of possible different energy carriers by transport service operators, users and any other interested parties. Calculation results are only directly comparable if all options chosen are internally consistent.

This document covers all modes of transport (land, water or in the air, irrespective of the means of transport, i.e. vessel, vehicle or pipeline) and includes the operational GHG emissions from hubs where they facilitate transfer of freight or passengers from one element of a transport chain to the next. It takes account of operation of empty trips required for subsequent transportation of freight or passengers. It is applicable at all stages along the entire transport chain (see also illustrative examples in [Figure 1](#) and [Figure 2](#)).

[Figure 1](#) provides an illustrative example of a freight transport chain from the point where freight leaves its last point of production or transformation (A, freight consignor) to the point where freight reaches its first non-transport related operation (B, freight consignee). This transport chain consists of five transport chain elements (TCEs), the GHG emissions of which are calculated separately. The first and last TCEs (TCE 1, TCE 5) represent road services (C) covering pre- and on-carriage; TCE 2 to TCE 4 represent a rail freight service (D) composed of road/rail terminal operations (TCE 2, TCE 4) and main carriage by rail transport (TCE 3).

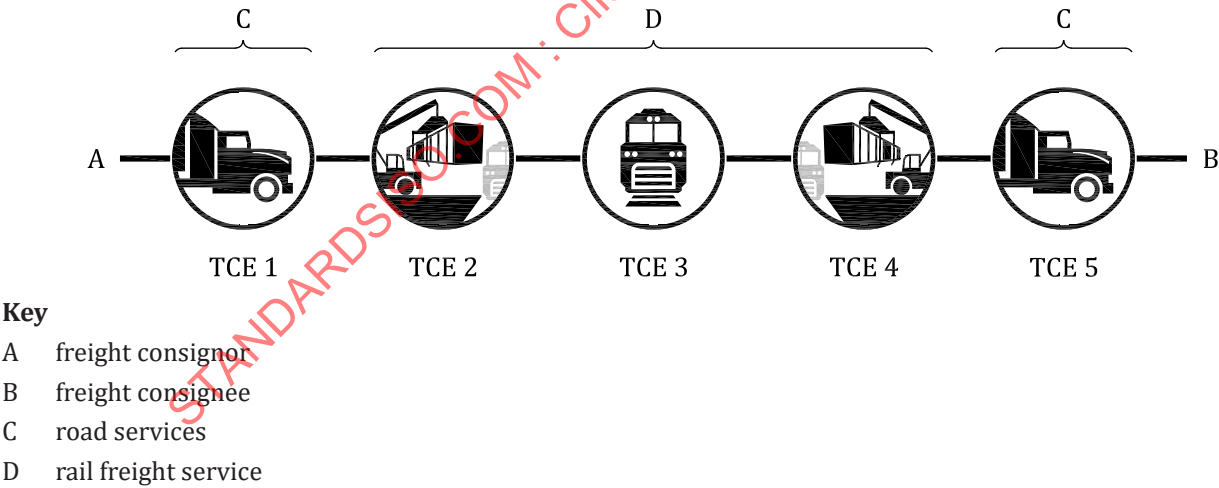
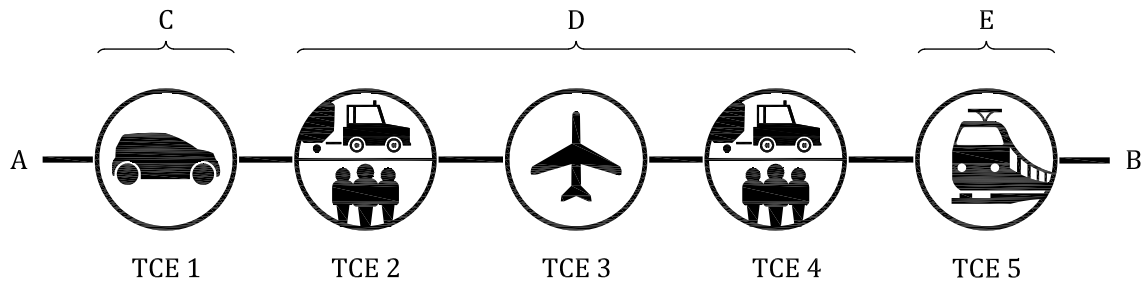


Figure 1 — Illustrative example of a multi-element freight transport chain

[Figure 2](#) provides an illustrative example of a passenger transport chain from the point where passengers leave their departure location, A, to their destination, B. This transport chain consists of TCEs, the GHG emissions of which are calculated separately. The first TCE (TCE 1) represents transport of the passenger from home to the airport by private car (C); TCE 2 to TCE 4 represent an air travel service (D) composed of passenger terminal operations for the passenger and luggage (TCE 2, TCE 4) and main carriage by plane (TCE 3). The on-carriage represented by TCE 5 shows shuttle express via rail (E).

**Key**

- A departure location
- B destination
- C private car service
- D air travel service
- E shuttle express service via rail

Figure 2 — Illustrative example of a multi-element passenger transport chain

The reporting set out in this document reflects the need to report information between the parties in a transport chain because information known to the transport or hub operator, when reported to the user of their service, helps the latter to quantify, better manage and reduce the impacts of their transport or hub activities. This is a standard for GHG emission calculation only; therefore, offsetting is not part of this document.

This document is complementary to several existing standards. It is aligned with the ISO 14064 series and ISO 14067 (see [Figure 3](#)). It contributes to the carbon footprint of products (see ISO 14067) and the life cycle assessment in accordance with the ISO 14040 family of standards and ISO 14044. [Figure 3](#) shows the relationship of this document to other International Standards of the ISO 14040 family of standards and the ISO 14060 family of standards, using the example of a freight transport chain and including possible stages within the life cycle of a product bought online as well as example topics to be covered by a company's GHG inventory.

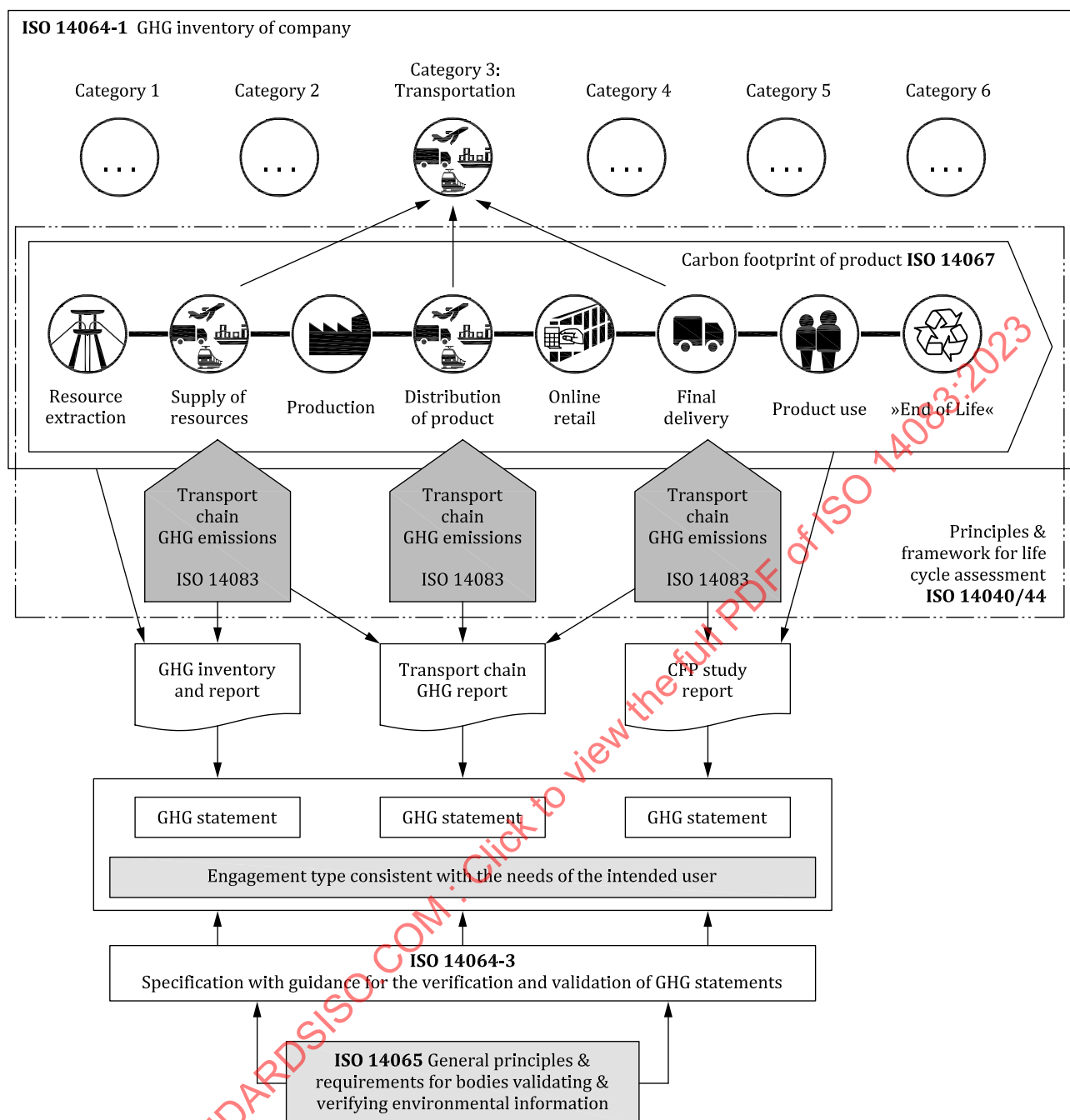


Figure 3 — Relationship between the ISO 14040 family of standards and the ISO 14060 family of standards, using the example of a freight transport chain

NOTE GHG emission intensity per tonne- or passenger-km calculated in accordance with this document can be used as primary or secondary data for GHG quantification projects in accordance with ISO 14067 and/or ISO 14064-1. These data require adaptation or modification if full life cycle based GHG-emissions are needed, e.g. vehicle manufacture or transport infrastructure provision.

The approach acknowledges, and is in line with, the valuable work conducted on GHG calculation and reporting that is documented in the aforementioned standards and by other protocols and organizations, including but not limited to, the United Nations Framework Convention on Climate Change (UNFCCC),^[37] the GHG Protocol^[16] and the Global Logistics Emissions Council (GLEC) Framework for Logistics Emissions Accounting and Reporting^[15].

Greenhouse gases — Quantification and reporting of greenhouse gas emissions arising from transport chain operations

1 Scope

This document establishes a common methodology for the quantification and reporting of greenhouse gas (GHG) emissions arising from the operation of transport chains of passengers and freight.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 Terms related to transport chain operations

3.1.1

cable car

ropeway

transport system where *vehicles* (3.1.35) are moved by at least one cable motorized by a machinery

Note 1 to entry: Vehicles circulating on cable(s) whose movement is not transmitted by at least one cable are not considered cable cars. Vertical elevators are also not considered cable cars.

3.1.2

charter

contract for the hire of a specific *vehicle* (3.1.35) from an owner for a specified period of time for the charterer's purposes subject to agreed restrictions

3.1.3

collection and delivery round

trip with the purpose to collect and/or deliver *freight* (3.1.7) at successive locations along the trip

Note 1 to entry: Typically, but not necessarily, the trip starts and ends at the same location.

3.1.4

consignment

separately identifiable amount of *freight* (3.1.7) transported from one consignor to one consignee via one or more modes of transport

Note 1 to entry: Although "consignment" and "shipment" (3.1.20) are common terms often considered as synonyms, in this document and other technical publications, a consignment is differentiated to a shipment. Indeed, a shipment refers to a grouping of freight corresponding to the shipper needs, whereas a consignment refers a grouping of freight according to a carrier or freight forwarder's transport solutions.

[SOURCE: ISO 26683-1:2013, 3.9, modified — “freight” replaced “goods items (available to be)”. “and specified in one single transport document” deleted. Note 1 to entry added.]

3.1.5

empty trip

section of the route of a *vehicle* (3.1.35) during which no *freight* (3.1.7) or *passenger* (3.1.16) is transported

EXAMPLE Vehicle (re)positioning trips, empty backhauls.

3.1.6

fleet

set of *vehicles* (3.1.35) operated by one *transport operator* (3.1.30)

3.1.7

freight

goods, materials, commodities, parcels, etc. being transported from one location to another

[SOURCE: EN 14943:2005, 3.437, modified — “materials, commodities, parcels, etc.” added.]

3.1.8

hub

DEPRECATED: node

DEPRECATED: site

DEPRECATED: station

DEPRECATED: facility

DEPRECATED: centre

DEPRECATED: depot

location where *passengers* (3.1.16) transfer and/or *freight* (3.1.7) is transferred from one *vehicle* (3.1.35) or mode of transportation to another before, after or between different elements of a *transport chain* (3.1.25)

Note 1 to entry: Hubs include, but are not limited to, rail/road terminals, cross-docking sites, airport terminals, terminals at seaports and distribution centres.

3.1.9

hub activity

parameter that quantifies the *throughput* (3.1.21) of a *hub* (3.1.8)

3.1.10

hub equipment

equipment and facilities used within a *hub* (3.1.8) to transfer *freight* (3.1.7) or *passengers* (3.1.16)

3.1.11

hub operation

operation in order to transfer *freight* (3.1.7) or *passengers* (3.1.16) through a *hub* (3.1.8)

3.1.12

hub operation category

HOC

group of *hub operations* (3.1.11) that share similar characteristics

Note 1 to entry: [Annex H](#) contains examples of HOCs.

3.1.13

hub operator

entity that carries out *hub operations* (3.1.11) involving carriage of *freight* (3.1.7) or *passengers* (3.1.16), or both

3.1.14

hub service

service provided within a *hub* (3.1.8) *transport chain element* (3.1.26)

3.1.15**load factor**

ratio of the actual load to the maximum legally authorized load of a particular *vehicle* (3.1.35)

3.1.16**passenger**

person carried by a *vehicle* (3.1.35)

Note 1 to entry: The term and its abbreviation “pax” are also used as a unit for quantity of passengers.

Note 2 to entry: Where the word “passengers” is used, it refers to one or more passengers unless specified in the context.

3.1.17**pipeline**

long continuous line of pipes, including ancillary equipment, used for transporting *freight* (3.1.7)

[SOURCE: ISO 6707-1:2020, 3.1.2.30, modified — “freight” replaced “liquids or gases”.]

3.1.18**pipeline transport**

movement of a medium (liquid, gas, liquefied gas, slurry) through a system of pipes from one location to another

3.1.19**round trip**

group of sequential journeys that start and end in the same place, whatever the intermediate routing

3.1.20**shipment**

identifiable collection of one or more *freight* (3.1.7) items (available to be) transported together from the original shipper to the ultimate consignee

Note 1 to entry: A shipment may be transported in one or a multiple number of *consignments* (3.1.4).

Note 2 to entry: A shipment can be aggregated or disaggregated to different consignments according to the requirements of the means of transportation on any one element of the *transport chain* (3.1.25), e.g. single bulk units and packages can be aggregated on a pallet and such pallet can be handed over as a unit for aggregation in a container, which in turn is treated as a consignment in a *vehicle* (3.1.35).

Note 3 to entry: Although “consignment” and “shipment” are common terms often considered as synonyms, in this document and other technical publications, a consignment is differentiated to a shipment. Indeed, a shipment refers to a grouping of freight corresponding to the shipper needs, whereas a consignment refers a grouping of freight according to a carrier or freight forwarder’s transport solutions.

[SOURCE: ISO 26683-1:2013, 3.34, modified — “freight” replaced “goods”. Notes 2 and 3 to entry added.]

3.1.21**throughput**

quantity of *passengers* (3.1.16) or *freight* (3.1.7) handled, sorted, cross-docked or transferred within and between modes at a *hub* (3.1.8)

3.1.22**transshipment**

action by which *freight* (3.1.7) is transferred from one means of transport to another during the course of one *transport chain* (3.1.25)

[SOURCE: EN 14943:2005, 3.1154, modified — “transport chain” replaced “transport operations”, and the second part of the definition deleted.]

3.1.23

transport

movement of *passengers* (3.1.16) and/or *freight* (3.1.7) from one location to another performed by modes of transport such as air, *cable car* (3.1.1), inland waterway, *pipeline* (3.1.17), rail, road and sea

[SOURCE: ISO 26683-1:2013, 3.37, modified — “passengers and/or freight” replaced “people and “goods”, “of transport” added and the following list changed, “and the field comprises the attributes of infrastructure, vehicles and operations” deleted.]

3.1.24

transport activity

parameter that quantifies *passenger* (3.1.16) or *freight* (3.1.7) *transport* (3.1.23)

3.1.25

transport chain

sequence of elements related to *freight* (3.1.7) or a (group of) *passenger(s)* (3.1.16) that, when taken together, constitutes its movement from an origin to a destination

Note 1 to entry: A passenger or a group of passengers can include their luggage and, if any, their *vehicles* (3.1.35).

Note 2 to entry: Where there are two or more elements, in the majority of cases, one of them implies that the freight or passengers use a *hub* (3.1.8).

3.1.26

transport chain element

TCE

section of a *transport chain* (3.1.25) within which the *freight* (3.1.7) or a (group of) *passenger(s)* (3.1.16) is carried by a single *vehicle* (3.1.35) or transits through a single *hub* (3.1.8)

EXAMPLE If a multimodal trip of a passenger includes taking a bus from stop “L4” to stop “L7” of bus line “L”, then one TCE is the trip of the passenger from “L4” to “L7”.

Note 1 to entry: See [Figures 4](#) and [5](#).

3.1.27

transport distance

distance between the origin and the destination of a *passenger* (3.1.16), a *consignment* (3.1.4) or a *vehicle* (3.1.35) along a specified route

Note 1 to entry: For the use of this document, the route followed by the passenger, the *freight* (3.1.7) or the vehicle may be different from that originally planned. This leads to two categories of transport distances: *actual distances* (3.1.27.1), and distances used for calculation of *greenhouse gas emissions* (3.2.8), i.e. *transport activity distances* (3.1.27.2).

3.1.27.1

actual distance

transport distance (3.1.27) along the actual route taken by a *vehicle* (3.1.35)

EXAMPLE Distance measured by an on-board device (odometer).

3.1.27.2

great circle distance

GCD

transport distance (3.1.27) determined as the shortest distance between any two points measured along the surface of a sphere

3.1.27.3**shortest feasible distance****SFD**

DEPRECATED: planned distance

DEPRECATED: network distance

transport distance (3.1.27) determined as the distance achievable by the shortest practical route available according to the infrastructure options for a particular *vehicle* (3.1.35) type

Note 1 to entry: "Shortest practical route" implies that small detours from the shortest distance, e.g. to avoid congested city centres or rural roads unsuitable for certain vehicle sizes, can be included.

3.1.27.4**transport activity distance**

transport distance (3.1.27) related to *passengers* (3.1.16) or *freight* (3.1.7) moved, used as a parameter for calculation of *transport activity* (3.1.24)

3.1.28**transport operation**

operation of a *vehicle* (3.1.35) in order to transport *passengers* (3.1.16) and/or *freight* (3.1.7)

EXAMPLE If a multimodal trip of a passenger includes taking a bus from stop "L4" to stop "L7" of bus line "L", this requires a transport operation being the operation of this bus on line "L", from the first stop "L1" to the last stop of this bus line.

Note 1 to entry: It includes cases where the destination is the same as the origin passing through other locations on the way.

3.1.29**transport operation category****TOC**

group of *transport operations* (3.1.28) that share similar characteristics

Note 1 to entry: Annexes A to G contain recommendations for the characteristics used to specify the TOCs for each transport mode.

3.1.30**transport operator**

entity that carries out *transport operations* (3.1.28) involving carriage of *freight* (3.1.7) or *passengers* (3.1.16), or both

3.1.31**transport service**

service provided to a *transport service user* (3.1.33) for the *transport* (3.1.23) of *freight* (3.1.7) or a *passenger* (3.1.16) from an origin to a destination

Note 1 to entry: A transport service can imply multiple *transport chain elements* (3.1.26), requiring both *transport operations* (3.1.28) and *hub operations* (3.1.11), as shown in Figure 1 and Figure 2.

3.1.32**transport service organizer**

entity that provides *transport services* (3.1.31), within which the operation of some *transport chain elements* (3.1.26) are subcontracted to one or more other entities that operate them

Note 1 to entry: A transport service organizer acts as an intermediary between the *transport operator* (3.1.30) or *hub operator* (3.1.13) and the *transport service user* (3.1.33). A transport service organizer can act as the transport operator or hub operator for some of the transport chain elements that comprise the overall service.

Note 2 to entry: A transport service organizer can be, for example, a freight forwarder, an entity organizing trips/travel (e.g. travel agency, tour operator) or a local authority responsible for public passenger transport.

3.1.33

transport service user

entity that buys and/or uses a *transport service* ([3.1.31](#))

Note 1 to entry: A transport service user can be a *passenger* ([3.1.16](#)), a shipper or a *transport service organizer* ([3.1.32](#)).

3.1.34

twenty-foot equivalent unit

TEU

standard unit used to express a number of containers of various lengths and for describing the capacities of container ships or terminals

[SOURCE: EN 14943:2005, 3.1166]

3.1.35

vehicle

any means of *transport* ([3.1.23](#))

Note 1 to entry: Including, for example, vessels, drones and *pipeline* ([3.1.17](#)), whether driven by an operator or wholly (or partially) autonomous.

3.1.36

vehicle operation

deployment of a *vehicle* ([3.1.35](#)) to fully or partially provide a *transport operation* ([3.1.28](#))

3.2 Terms related to greenhouse gases and energy

3.2.1

carbon dioxide equivalent

CO₂e

unit for comparing the radiative forcing of a *greenhouse gas* (GHG) ([3.2.5](#)) to that of carbon dioxide

Note 1 to entry: The carbon dioxide equivalent is calculated using the mass of a given GHG multiplied by its *global warming potential* ([3.2.4](#)).

[SOURCE: ISO 14064-1:2018, 3.1.13]

3.2.2

energy carrier

substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes

Note 1 to entry: For the purposes of this document, energy carriers can be electricity, fuels (fossil, biofuels, synthetic and blends), steam, heat, compressed air or other similar media, which can be purchased, stored, treated or used in a piece of equipment or in a process, or recovered.

Note 2 to entry: Where required for the quantification of *greenhouse gas activities* ([3.2.6](#)), quantities of energy carriers should be expressed in a manner that is unambiguous for subsequent calculation steps. This may be in units of volume (e.g. litre, m³), mass (e.g. kg) or energy (J, kWh), or multiples thereof.

[SOURCE: ISO 52000-1:2017, 3.4.9, modified — Notes 1 and 2 to entry added.]

3.2.3

energy consumption

quantity of energy applied

Note 1 to entry: Energy consumption is a specific form of *greenhouse gas activity data* ([3.2.7](#)).

[SOURCE: ISO 50001:2018, 3.5.2, modified — Note 1 to entry added.]

3.2.4

global warming potential GWP

index, based on radiative properties of *greenhouse gas (GHG)* (3.2.5), measuring the radiative forcing following a pulse emission of a unit mass of a given GHG in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide (CO₂)

[SOURCE: ISO 14064-1:2018, 3.1.12.]

3.2.5

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

Note 1 to entry: For a list of GHGs, see the latest Intergovernmental Panel on Climate Change (IPCC) Assessment Report^[32].

Note 2 to entry: Water vapour and ozone are anthropogenic as well as natural GHGs but are not included as recognized GHGs due to difficulties, in most cases, in isolating the human-induced component of global warming attributable to their presence in the atmosphere.

[SOURCE: ISO 14064-1:2018, 3.1.1]

3.2.6

greenhouse gas activity GHG activity

activity that results in a *GHG emission* (3.2.8)

EXAMPLE Consumption of energy, refrigerant leakage, methane slip.

3.2.7

greenhouse gas activity data GHG activity data

quantitative measure of *GHG activity* (3.2.6)

[SOURCE: ISO 14064-1:2018, 3.2.1, modified — “GHG activity” replaced “activity that results in a GHG emission or GHG removal”. Example deleted.]

3.2.8

greenhouse gas emission GHG emission

release of a *GHG* (3.2.5) into the atmosphere

Note 1 to entry: It is expressed in mass of *carbon dioxide equivalent* (3.2.1).

Note 2 to entry: GHG emissions are categorized in this document according to their sources, as follows:

- *hub equipment energy provision GHG emissions* (G_{HEEP}) (3.2.8.1);
- *hub equipment operation GHG emissions* (G_{HEO}) (3.2.8.2);
- *packaging life cycle GHG emissions* (G_{PL}) (3.2.8.3);
- *vehicle energy provision GHG emissions* (G_{VEP}) (3.2.8.4);
- *vehicle operation GHG emissions* (G_{VO}) (3.2.8.5);
- *total operation GHG emissions* (G_{TO}) (3.2.8.6);
- *total energy provision GHG emissions* (G_{TEP}) (3.2.8.7);
- *total GHG emissions* (G_T) (3.2.8.8).

Note 3 to entry: The symbol notation within this document follows the following procedure: “ $G_{X,Y}$ ” refers to the GHG emissions of category X (“X” being vehicle operation, hub equipment operation, etc.) for Y, where “Y” can be a *transport operation category* (3.1.29), a *hub operation category* (3.1.12), a *transport chain* (3.1.25), a *transport chain element* (3.1.26), or any set thereof.

[SOURCE: ISO 14064-1:2018, 3.1.5, modified — Notes 1, 2 and 3 to entry added.]

3.2.8.1

hub equipment energy provision greenhouse gas emission **hub equipment energy provision GHG emission**

G_{HEEP}

release of a *GHG* (3.2.5) into the atmosphere during the process of producing, storing, processing and distributing an *energy carrier* (3.2.2) for *hub equipment* (3.1.10) operation

3.2.8.2

hub equipment operation greenhouse gas emission **hub equipment operation GHG emission**

G_{HEO}

release of a *GHG* (3.2.5) into the atmosphere as a result of *hub equipment* (3.1.10) operation

3.2.8.3

packaging life cycle greenhouse gas emission **packaging life cycle GHG emission**

G_{PL}

release of a *GHG* (3.2.5) into the atmosphere during the life cycle *processes* (3.4.3) of *packaging* (3.4.2)

3.2.8.4

vehicle energy provision greenhouse gas emission **vehicle energy provision GHG emission**

G_{VEP}

release of a *GHG* (3.2.5) into the atmosphere during the process of producing, storing, processing and distributing an *energy carrier* (3.2.2) for *vehicle operation* (3.1.36)

3.2.8.5

vehicle operation greenhouse gas emission **vehicle operation GHG emission**

G_{VO}

release of a *GHG* (3.2.5) into the atmosphere as a result of *vehicle operation* (3.1.36)

3.2.8.6

total operation greenhouse gas emission **total operation GHG emission**

G_{TO}

sum of *GHG emissions* (3.2.8) from operational *processes* (3.4.3) included in the system boundaries

3.2.8.7

total energy provision greenhouse gas emission **total energy provision GHG emission**

G_{TEP}

sum of *GHG emissions* (3.2.8) from energy provision *processes* (3.4.3) included in the system boundaries

3.2.8.8

total greenhouse gas emission **total GHG emission**

G_T

sum of *GHG emissions* (3.2.8) from all *processes* (3.4.3) included in the system boundaries

3.2.9**greenhouse gas emission factor****GHG emission factor**

coefficient relating *GHG activity data* (3.2.7) with the *GHG emission* (3.2.8)

[SOURCE: ISO 14064-1:2018, 3.1.7, modified — Note 1 to entry deleted.]

3.2.10**greenhouse gas emission intensity****GHG emission intensity**

coefficient relating specified *GHG activity data* (3.2.7) with the *GHG emission* (3.2.8)

Note 1 to entry: It can be expressed as:

- mass carbon dioxide equivalent (CO₂e) per tonne kilometre, or equivalent units, for freight transportation;
- mass CO₂e per tonne for freight hub *throughput* (3.1.21);
- mass CO₂e per passenger kilometre, or equivalent units, for passenger transport;
- mass CO₂e per passenger for passenger hub throughput.

3.2.11**greenhouse gas source****GHG source**

process (3.4.3) that releases a *GHG* (3.2.5) into the atmosphere

[SOURCE: ISO 14064-1:2018, 3.1.2]

3.3 Terms related to quantification**3.3.1****allocation**

partitioning the input or output flows of a *process* (3.4.3) or product system between the product system under study and one or more other product systems

Note 1 to entry: In this document, the definition is understood as partitioning *greenhouse gas (GHG) activity* (3.2.6) or *GHG emissions* (3.2.8) related to *transport operations* (3.1.28) and *hub operations* (3.1.11) with multiple functionalities, between groups of entities (*freight* (3.1.7) and/or *passengers* (3.1.16)) carried or transferred that benefit from the same functionality.

EXAMPLE 1 For an air transport operation with an aircraft carrying both passengers and belly freight, the total GHG emissions of the transport operation can be partitioned between freight and passengers.

EXAMPLE 2 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.

[SOURCE: ISO 14040:2006, 3.17, modified — Note 1 to entry, Example 1 and Example 2 added.]

3.3.2**class factor**

z

ratio based on a calculation, aiming to characterize a class of *passengers* (3.1.16) in comparison with the lowest class

3.3.3**primary data**

quantified value of a *process* (3.4.3) or an activity obtained from a direct measurement or a calculation based on direct measurements

Note 1 to entry: Primary data can include *greenhouse gas (GHG) emission factors* (3.2.9) and/or *GHG activity data* (3.2.7).

[SOURCE: ISO 14067:2018, 3.1.6.1, modified — Note 1 to entry deleted. Note 2 to entry renumbered as Note 1 to entry.]

3.3.4

secondary data

data which do not fulfil the requirements for *primary data* (3.3.3)

Note 1 to entry: Secondary data can include data from databases and published literature, default *greenhouse gas emission factors* (3.2.9) from national inventories, calculated data, estimates or other representative data, and data obtained from proxy processes or estimates.

Note 2 to entry: In this document, secondary data are either *modelled data* (3.3.4.1) or *default value* (3.3.4.2).

[SOURCE: ISO 14067:2018, 3.1.6.3, modified — “greenhouse gas” and “and data obtained from proxy processes or estimates” added, and “validated by competent authorities” deleted in Note 1 to entry. Note 2 to entry replaced.]

3.3.4.1

modelled data

data established by use of a model that takes into account *primary data* (3.3.3) and/or greenhouse gas (GHG) emission-relevant parameters of a *transport operation* (3.1.28) or *hub operation* (3.1.11)

Note 1 to entry: Relevant parameters can be vehicle size, *load factor* (3.1.15), fuel type and quality, topography, speed, etc., thereby reflecting a representative value of the transport operation's *GHG emissions* (3.2.8).

3.3.4.2

default value

secondary data (3.3.4) value drawn from a published source

Note 1 to entry: Such values can be established by use of a model, but they will not necessarily correspond to the greenhouse gas emission-relevant parameters of the *transport operation* (3.1.28) or *hub operation* (3.1.11) being evaluated.

Note 2 to entry: See [Annex Q](#) for examples of sources for default values.

3.3.5

distance adjustment factor

DAF

ratio between the *actual distance* (3.1.27.1) and the *transport activity distance* (3.1.27.4), related to same origin and destination locations

EXAMPLE Ratio between “actual distance” and “shortest feasible distance” (3.1.27.3).

3.3.6

cut-off criteria

specification of the amount of material or energy flow or the level of significance of *greenhouse gas (GHG) emissions* (3.2.8) associated with unit *processes* (3.4.3) or the *transport chain* (3.1.25) to be excluded from a GHG quantification

Note 1 to entry: See [5.2.3](#) for examples.

Note 2 to entry: “Energy flow” is defined in ISO 14040:2006, 3.13.

[SOURCE: ISO 14044:2006, 3.18, modified — “significance of greenhouse gas (GHG) emissions” has replaced “environmental significance”, “the transport chain” has replaced “product system”, “GHG quantification” has replaced “study”. Notes to entry added.]

3.3.7

passenger equivalent

peq

unit of quantification of *freight* (3.1.7), *passengers* (3.1.16) and passenger vehicles in the case of combined *transport* (3.1.23) of freight with passengers, for which each of these entities is compared to an average passenger

3.3.8**passenger of lowest class equivalent**

plceq

unit of quantification of *passengers* (3.1.16) in the case of passenger transport with different classes, for which passengers of each class are compared to a passenger in the lowest class

3.4 Other terms**3.4.1****offsetting**

mechanism for compensating for *greenhouse gas (GHG) emissions* (3.2.8) of a *process* (3.4.3) through the prevention of the release of, reduction in, or removal of, an equivalent amount of GHG emissions in a process outside the boundary of the process system

[SOURCE: ISO 14021:2016, 3.1.12, modified — “greenhouse gas (GHG) emissions of a process” replaced “the carbon footprint of a product” and “process system” replaced “product system”.]

3.4.2**packaging**

materials used for the containment, protection, handling, delivery and presentation of *freight* (3.1.7)

Note 1 to entry: Packaging may be further categorized into:

- primary packaging, which is designed to come into direct contact with the product;
- secondary packaging, which is designed to contain one or more products together with any primary packaging required;
- *transport packaging* (3.4.4).

3.4.3**process**

set of interrelated or interacting activities that transforms inputs into outputs

[SOURCE: ISO 14044:2006, 3.11]

3.4.4**transport packaging**

tertiary packaging

distribution packaging

protective packaging

packaging (3.4.2) designed to contain one or more articles or packages, or bulk material, for the purposes of *transport* (3.1.23), handling and/or distribution

Note 1 to entry: Transport packaging does not include road, rail, ship and air containers.

4 General principles**4.1 General**

The application of principles is fundamental to ensure that GHG-related information is a true and fair account. The principles are the basis for, and will guide the application of, the requirements in this document.

4.2 Relevance

Select the GHG sources, data and methodologies appropriate to the needs of the intended user.

4.3 Completeness

Include all relevant GHG emissions, subject to cut-off criteria, as described in [5.2.3](#).

4.4 Consistency

Enable meaningful comparisons in GHG-related information.

4.5 Accuracy

Reduce bias and uncertainties as far as is practical.

4.6 Transparency

Disclose sufficient and appropriate GHG-related information to allow intended users to make decisions with reasonable confidence.

4.7 Conservativeness

When assessing comparable alternatives, use a selection of data that is cautiously moderate.

5 Quantification principles

5.1 General

The requirements as outlined below determine the approach set out in the subsequent clauses of this document:

- The methodology for calculating GHG emissions shall be substantively similar for each transport mode or hub across passenger and freight operations.
- All GHG emissions resulting from transport chain operation shall be treated equally, irrespective of the energy carrier used.
- All GHG emissions shall be assigned across the passengers and/or freight carried or transferred.
- In cases of unavoidable divergence, the sum of calculated GHG emissions shall not be less than the total GHG emissions calculated.

In cases where national or international legislative bodies stipulate the use of a specific quantification methodology that takes precedence over this document, the processes of the legislative approach shall be clearly documented.

[Annexes A](#) to [H](#) include further specifications that shall be followed for transport modes (air, cable car, inland waterway, pipeline, rail, road, sea) and hubs, respectively. Reference values for GHG emission factors are presented in [Annex K](#) together with guidance on their production in [Annex J](#).

5.2 System boundaries

5.2.1 Transport operations and hub operations included

The quantification of GHG emissions shall include all transport operations by the following modes and means, as well as the hub operations that precede, follow or link them together (see [Figure 1](#) and [Figure 2](#) for illustrative examples):

- air transport;
- cable car transport;

- inland waterway transport;
- pipeline transport;
- rail transport;
- road transport;
- sea transport.

Transport of passengers by lift, escalator, conveyor belt, moving walkway, etc. and transport of freight by forklift, pallet truck, etc. shall be part of hub operations.

5.2.2 Processes included

The quantification of GHG emissions of a transport chain shall include the following processes, which produce GHG by combustion or by leakage, regardless which organization operates them:

- vehicle operational processes;
- hub equipment operational processes;
- vehicle energy provision processes;
- hub equipment energy provision processes;
- loaded and empty trips made by vehicle, hence including diversionary and/or out-of-route distance;
- start-up and idling of vehicles, pipelines, transshipment and (de)boarding equipment;
- cleaning/flushing operations for pipelines;
- combustion and/or leakage of energy carriers at vehicle or hub equipment level;
- leakage of refrigerants used by vehicles or hubs.

EXAMPLE 1 For the following vehicles using two different energy carriers, both energy carriers are taken into account for the calculation: road vehicle using liquefied petroleum gas (LPG) and gasoline, road vehicle using electricity (plug in) and gasoline, ship using heavy fuel oil (HFO) and marine diesel oil (MDO).

The vehicle operational processes shall include operation of all on-board vehicle systems including propulsion and auxiliary processes.

EXAMPLE 2 Main engines, auxiliary equipment used to maintain the temperature and/or functionality of the freight and/or passenger space are on-board devices used to facilitate loading or unloading of the vehicle.

NOTE Auxiliary units also include those used to power refrigerated containers when not connected to the primary vehicle energy source or grid; e.g. chassis generators.

Hub operational processes shall include operation of all handling, on-site transportation, transshipment and (dis)embarking equipment and facilities, including heating and temperature control.

Through the use of recommended or best available (e.g. national) GHG emission factors, the energy operational processes shall include the following:

- For solid, liquid and gaseous energy carriers: Production and dismantling of energy source infrastructure, e.g. power plant manufacture, extraction or cultivation of primary energy, chemical processing, transport and distribution (including pipeline) of energy at all steps of the production of the energy carrier used.
- For electricity: Extraction, processing and transport of primary energy, power generation, power generation infrastructure, e.g. solar panel or wind turbine manufacture, grid losses associated with transmission and distribution of electricity.

Where best available GHG emission factors do not include production and dismantling of energy source infrastructure this shall be noted in the reporting, (see [Clause 13](#)), in accordance with the cut-off criteria guidance in [5.2.3](#).

5.2.3 Application of cut-off criteria

In general, all processes and flows that are attributable to the analysed system shall be included.

The omission of processes, inputs or outputs from the calculation are not permitted as a general rule. Any decisions to omit processes, activities, inputs or outputs shall be clearly stated; the reasons for and implications of their omission shall be explained. Reference to the use of cut off criteria shall be made if relevant.

Application of cut-off criteria to a given transport chain can rely on the following three possible quantifications:

- a) Transport activity: inclusion in the study of all inputs that cumulatively contribute more than a defined percentage of the transport activity within the transport chain.
- b) Energy: inclusion in the study of all inputs that cumulatively contribute more than a defined percentage of the transport activity within the transport chain.
- c) Environmental significance: inclusion of all GHG sources that cumulatively contribute more than a defined percentage of the GHG emissions of the transport chain.

NOTE This percentage can be specified by national regulations.

5.2.4 Processes not included

The quantification of GHG emissions of a transport chain shall not include, in particular:

- production and supply processes of refrigerants;
- waste produced;
- processes at the administrative (overhead) level of the organizations involved in the transport services;
- processes for the construction (e.g. embedded GHG emissions associated with vehicle production), maintenance, and scrapping of vehicles or transshipment and (de)boarding equipment;
- processes of construction, service, maintenance, and dismantling of transport infrastructures used by vehicles (e.g. roads, inland waterways, rail infrastructure) or transshipment and (de)boarding infrastructure;
- businesses co-located within a hub such as retail and hospitality services, whose functions are severable and incidental to the transportation operation of the hub.

5.2.5 Optional processes

The annexes include specifications for optional elements that can be quantified in addition to the core elements of the GHG calculation. Where these optional elements are calculated, this shall be clearly stated. Guidance regarding the use of default GHG emission intensities is provided for reference purposes in [Annex Q](#).

The following processes may be included in the calculation:

- storage of freight at hubs, such as warehousing;
- use of information and communications technology (ICT) equipment and data servers related to transport and/or hub operations (see [Annex N](#));

— (re)packing (see [Annex O](#)).

5.2.6 Optional quantification of black carbon emissions from transport operations

In addition to the quantification of GHG emissions, the user may estimate black carbon emissions from transport operations (see [Annex P](#)).

5.2.7 Carbon offsetting and GHG emissions trading

Outcomes from carbon offsetting actions or GHG emissions trading (e.g. under the European Union Emissions Trading System (EU ETS)^[31]) shall not be taken into account for quantification and reporting of GHG emissions from transport operations.

5.3 Conversion of energy carrier data into GHG emissions

5.3.1 General

Quantification of the conversion of energy carriers (used to power transport operations and associated auxiliary processes or to facilitate hub operations) into GHG emissions shall be done using the corresponding GHG emission factor, expressed as the mass of CO₂ equivalent per amount of energy carrier consumed. [Annex J](#) provides requirements and guidance on GHG emission factors.

NOTE [Annex R](#) provides a table that shows the relationship between the GHG emission scopes used in the GHG Protocol^[16] and the categorization of GHG emissions as used in this document.

5.3.2 Global warming potential

For the release of GHGs to the atmosphere, the global warming potential (GWP) acts as the conversion factor from the mass of gas released to the mass of CO₂ equivalent.

The source of the GHG factors shall be clearly stated and used consistently. The IPCC's latest GWP with a 100 year perspective (not including climate-carbon feedback) should be used.^[34] Any deviation should be explained.

5.4 Calculation of transport activity

5.4.1 Passenger transport

The transport activity for passenger transportation shall be the number of passengers multiplied by the transport activity distance. The quantity of passengers shall account for all individual passengers carried per transport operation plus their baggage.

NOTE For non-commercial transport (e.g. driving an owned vehicle or self-drive hire), the driver and any persons participating in the operation of the vehicle are included in the quantity of passengers. For commercial transport (e.g. taxis, trucks, trains), these people are not included in the quantity of passengers.

The transport activity distance shall be either the shortest feasible distance (SFD) or the great circle distance (GCD). In situations where the transport activity distance travelled by each passenger is unknown, passenger transport activity can be calculated by multiplying the number of passengers by the mean actual distance travelled by passengers on journeys included within this transport operation category (TOC).

The standard unit for expressing distance shall be the kilometre (km). Where alternative systems are in use (e.g. miles or nautical miles), these units may be used.

5.4.2 Freight transport

The transport activity for freight transportation shall be the quantity of freight multiplied by the transport activity distance.

The quantity of freight shall be the actual freight mass. The standard unit for expressing units of mass (e.g. quantities of freight) shall be kg or metric tons (1 000 kg or tonnes). Where alternative systems are in use (e.g. pounds and tons) these units may be used as long as this is unambiguously signalled.

NOTE 1 The phrase “ton” is commonly and incorrectly used to denote 1 000 kg, a mistake that can lead to systematic inaccuracies in calculation and reporting. The correct phrases for 1 000 kg are tonne or metric ton.

In specific circumstances (post and parcels operations and containerized transport) alternatives to the standard units for the quantity of freight may be used. If such a choice is made, it shall be clearly documented.

NOTE 2 In these circumstances any references to tonne kilometres in the text of this document can be considered as twenty-foot equivalent unit (TEU) kilometres or item kilometres as appropriate for calculation purposes unless indicated otherwise.

For post and parcel operations, where knowledge of individual items is limited, the quantity of freight may be the number of items.

For container transport, the quantity of freight may be the number of freight number of TEUs. Where such a choice is made, the mass of freight should be calculated using the actual mass of freight per TEU, if known, or otherwise using an average mass per TEU. Any such choice should be justified and documented.

NOTE 3 Alternate container types and sizes exist, e.g. one standard 40-foot ISO Series container is equivalent to two TEUs; one ISO Series 45-foot container is equivalent to 2,25 TEUs; one high cube 40-foot container is equivalent to 2,25 TEUs.

Where the actual mass of freight per TEU is not known, a standard conversion factor of 10 tonnes per TEU may be used (so 20 tonnes for a 40-foot container). Alternatively, a value of 6 tonnes may be used for lightweight cargo or 14,5 tonnes for heavyweight cargo if the use of these categories can be justified.

The quantity of freight shall include the mass of the packaging initially provided by the organization responsible for sending a consignment, and shall not include any additional transport packaging, pallets or containers used by the transport operator specific to the transport operation in question.

In cases of slurry pipelines, the mass of freight shall not include the transport medium (e.g. water).

The transport activity distance shall be either the SFD or the GCD. In cases where the transport operator does not have access to the SFD or the GCD, the actual distance and a distance adjustment factor (DAF), as described in [5.4.4](#) and [10.4](#), should be used.

The specific case of the transport activity distance for collection and delivery rounds is described in [F.4.2](#).

NOTE 4 Those who are inexperienced in calculating transport activity can easily make a mistake. The result of multiplying the total mass of all consignments by the total transport distance travelled by all the consignments is a significant over-estimate of the transport activity. The result of multiplying the average mass of all consignments by the average transport distance travelled by all the consignments can introduce a significant error in the estimation of the transport activity. See GLEC Framework,^[15] for further information.

The standard unit for expressing distance shall be the kilometre (km). Where alternative systems are in use (e.g. miles or nautical miles), these units may be used.

5.4.3 Combined transport of freight and passengers (including passenger vehicles)

The transport activity for combined transport of freight and passengers (including passenger vehicles where appropriate) shall be the quantity of freight and passengers multiplied by the transport activity distance.

Two options can be required when considering the quantity of freight and passengers for combined transport of freight and passengers. The first option can be used both for allocation and for the calculation of GHG emission intensity. The second option may only be used for allocation in situations where the data needed to apply the first option is not available.

In the first option:

- the quantity of passengers shall be the total passenger mass (as defined in [8.4.7](#));
- the quantity of passenger vehicles shall be the mass of these vehicles;
- the quantity of freight shall be the actual freight mass.

In the 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 (guidance on passenger-equivalent values for different types of passenger vehicles is provided in [Annexes E](#) and [G](#));
- the quantity of freight shall be the number of passenger equivalents (guidance on passenger-equivalent values for freight transport is provided in [Annexes E](#) and [G](#)).

The quantity of passengers shall account for all individual passengers carried per transport operation plus their baggage.

The quantity of freight shall include the mass of the packaging initially provided by the organization responsible for sending a consignment, and shall not include any additional transport packaging, pallets or containers used by the transport operator specific to the transport operation in question.

The transport activity distance shall be either the SFD or the GCD. In cases where the transport operator does not have access to the SFD or the GCD, the actual distance and a DAF, as described in [5.4.4](#) and [10.4](#), should be used.

5.4.4 Use of distance adjustment factor

A DAF shall be used each time the actual distance is used in the calculation of transport activity. The DAF is used by multiplication of the actual distance by a specific DAF value.

The DAF 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.

Recommended values of the DAF are provided for different modes in [Annexes A](#) to [G](#).

NOTE In cases where the actual distance and the transport activity distance correspond, the DAF can equal 1.

5.5 Calculation of hub activity

5.5.1 Passenger hub

The hub activity for passenger shall be the number of passengers.

5.5.2 Freight hub

The hub activity for freight shall be the quantity of freight (outbound). In specific circumstances, alternative units for the quantity of freight may be used in addition to the standard units.

EXAMPLE For maritime container hubs, the number of containers or the number of TEUs.

The quantity of freight shall include the mass of the packaging initially provided by the organization responsible for sending a consignment, and shall not include any additional transport packaging, pallets or containers used by the transport operator specific to the transport operation in question.

5.5.3 Combined freight and passenger hub (including passenger vehicles)

The hub activity for combined freight and passenger hubs (including passenger vehicles where appropriate) shall be the quantity of passengers and the quantity of freight (outbound).

The quantity of passengers shall account for all individual passengers plus their baggage. The quantity of passengers shall be the total passenger mass (first option) or the number of passenger equivalents (second option).

With the second option, each passenger is counted as one passenger equivalent.

The quantity of passenger vehicles shall be either the mass of these vehicles (first option) or the number of passenger equivalents (second option).

If a value for total mass of these vehicles is not available, the second option should be used. Passenger-equivalent values for different types of passenger vehicles are provided in [Annexes E](#) and [G](#).

The quantity of freight shall be either the actual freight mass (first option) or the number of passenger equivalents (second option). Guidance on passenger-equivalent values for freight transport is provided in [Annexes A](#), [E](#) and [G](#).

The quantity of freight shall include the mass of the packaging initially provided by the organization responsible for sending a consignment, and shall not include any additional transport packaging, pallets or containers used by the transport operator specific to the transport operation in question.

5.6 Allocation

5.6.1 General

Allocation may be implemented when multiple functionalities are fulfilled by the same vehicle or hub, and all passengers and/or freight carried do not benefit equally.

Wherever possible, allocation should be avoided 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.

In circumstances where it is required, allocation shall partition GHG sources or GHG emissions between the freight and/or passengers that benefit equally from the same functionality.

The implementation of the partitioning between these groups shall consider the different needs of GHG sources and the different GHG emissions resulting from these needs.

EXAMPLE Within a truck carrying ambient and refrigerated freight, the energy consumption for cooling and the leakage of refrigerants are partitioned between these two groups with consideration of this difference of temperature.

The transport or hub activity of each group may be used for this partitioning, but other criteria and parameters can be necessary. Once set, the allocation parameter used within a given TOC or hub operation category (HOC) shall remain constant.

5.6.2 Allocation between passengers and freight

For combined transport of passengers (including their vehicles where appropriate) and freight, the transport or hub activity should be used for allocation, in combination with the passenger-equivalent unit.

5.6.3 Allocation between passengers of different travel classes

For transport of passengers with different classes, the transport or hub activity should be used for allocation, in combination with the passenger of lowest class equivalent unit.

5.6.4 Allocation between ambient and temperature-controlled freight

For freight with different temperature conditions, the GHG activity data related to temperature control for each group of temperature conditions should be collected and used for allocation, when such association of data per group is feasible. If not, the transport or hub activity shall be used for allocation, each entity of freight being quantified with a unit of equivalence based on ambient freight.

6 General principles related to transport chains, transport chain elements, transport operation categories and hub operation categories

6.1 Transport chains and TCEs

As set out in [Clause 5](#), for the purposes of GHG quantification, the transport chain shall be broken down into the discrete, sequential TCEs that reflect the related vehicle types, pipelines or hubs that carry, handle or transfer the freight and/or the passengers as part of the whole transport chain.

EXAMPLE 1 When a passenger first travels by bus, then by metro and finally using a second bus, with the same ticket, the corresponding transport chain is composed of five elements, including the intermediate hubs such as bus or metro stations.

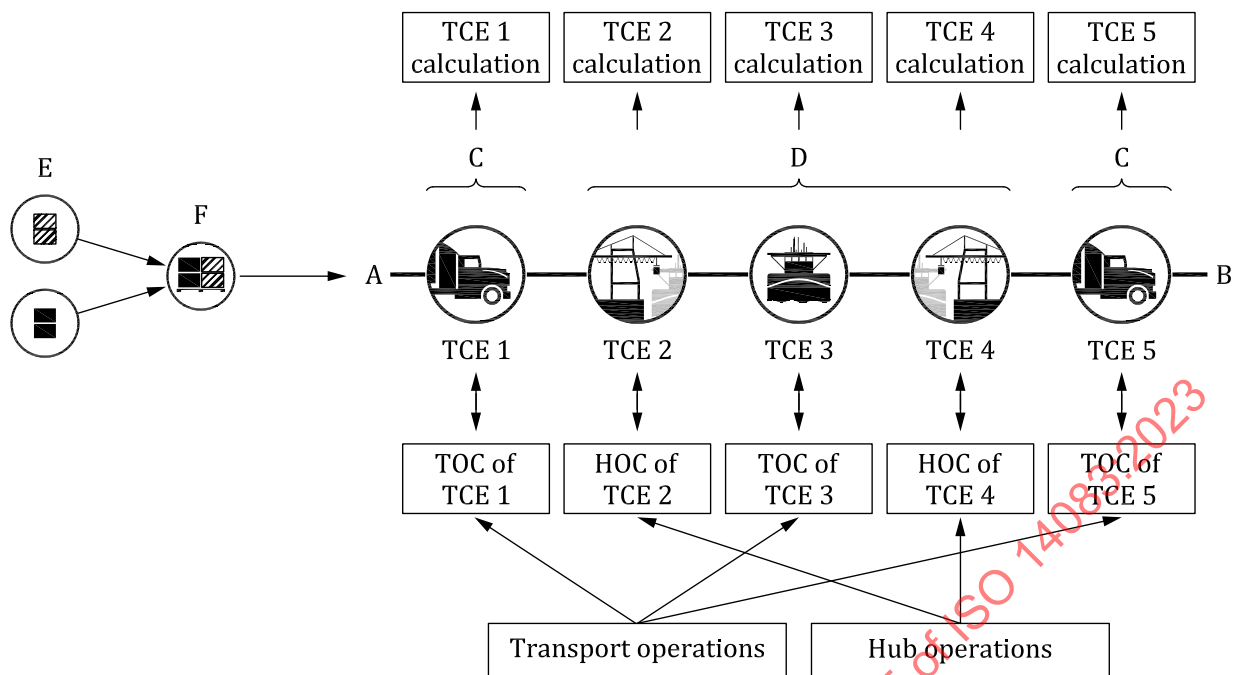
EXAMPLE 2 When a passenger first travels by local bus and then by long-distance bus, then the corresponding transport chain is composed of either two or three elements, depending on whether there is a hub (bus station) at the point of transfer between buses.

EXAMPLE 3 When a shipment first travels by truck, then is cleared and handled for export at the airport, flown to a different country, cleared and handled for import at the airport, transported by train, reloaded and handled, and finally brought by truck to its final destination, the corresponding transport chain is composed of seven elements, including the intermediate hubs such as airport handling terminals and the logistics hub at the interface rail/truck.

6.2 Transport operations and hub operations related to TCEs

Each TCE shall be related to a corresponding transport operation or hub operation, which is the operation of the vehicle(s) or the hub (s) for this TCE.

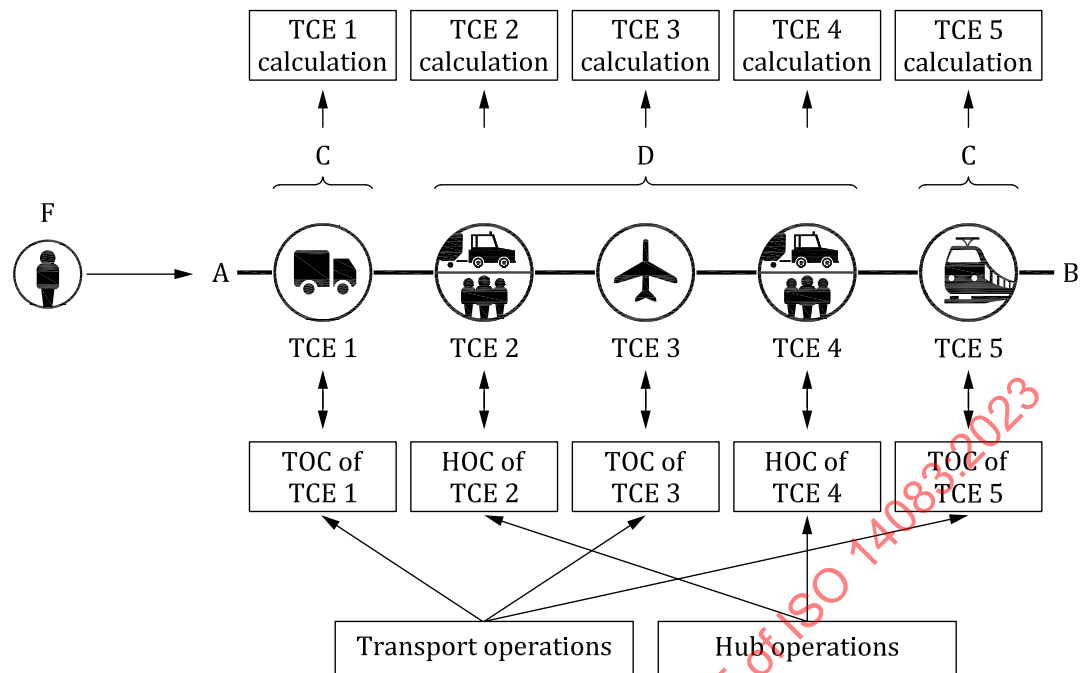
The relationship between TCEs, transport operations and hub operations is illustrated in [Figure 4](#) for freight transportation and in [Figure 5](#) for a passenger transport chain.



Key

- A cargo consignor
- B cargo consignee
- C road services
- D maritime shipping service
- E shipment
- F consignment

Figure 4 — Diagrammatic relationship between operations and TCEs for an example freight transport chain



Key

- A origin
- B destination
- C private car
- D air travel service
- F passenger

Figure 5 — Diagrammatic relationship between operations and TCEs for an example passenger transport chain

6.3 Transport operation categories and hub operation categories

6.3.1 General

Any single transport operation or hub operation shall always be considered in the context of the overall system in which it takes place. The concept of a TOC or a HOC, as a group of operations sharing similar characteristics, in a defined time period (up to one year), is the key reference point for the calculation of the GHG emissions of a TCE. The characteristics of each TOC/HOC shall reflect the combined characteristics of the transport mode, hub type and the freight/passengers, as required to meet the relevant contractual agreement.

6.3.2 Transport operation categories

6.3.2.1 Categorization of transport operations into TOCs

When defining the characteristics of a TOC, consideration shall be given to factors that affect the scale and composition of the TOC, for example:

- number and type of vehicles, or length and type (diameter) of pipeline, to be included in the TOC;
- nature and consistency of the vehicle or pipeline operations included;
- any processes associated with maintaining the condition of the freight (e.g. temperature control);
- (freight transport only) nature of the freight carried;

- period of activity of the vehicles or pipelines in the TOC.

[Annexes A](#) to [G](#) provide further examples of how such characteristics can be combined to establish TOCs.

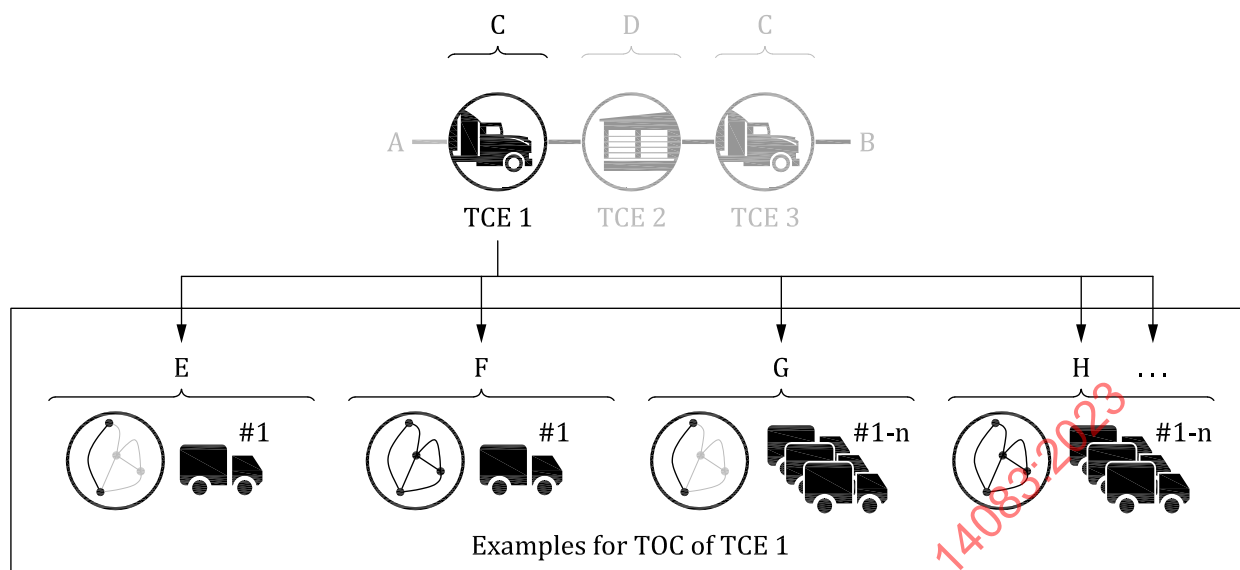
TOCs can have different levels of granularity, for example:

- TOC of a single vehicle on a single journey or specific schedule;
- TOC of a single vehicle in multiple schedules/trade lanes, based on network/trade lane characteristics;
- TOC of a specific vehicle type in a single schedule;
- TOC of a specific vehicle type in multiple schedules/trade lanes;
- TOC of a specified group of vehicles in a single schedule;
- TOC of a specified group of vehicles in multiple schedules/trade lanes.

A TOC shall fully include each transport operation, meaning that a transport operation shall not be split between two TOCs, even if this relates to two TCEs (e.g. a TCE for passengers and a TCE for freight) carried by the same vehicle.

A single TOC can include transport operations with vehicles using different energy carriers for propulsion, e.g. a container line operator uses vessels, some powered by MDO and some powered by liquefied natural gas (LNG), interchangeably on a given trade lane.

[Figure 6](#) provides examples to establish TOCs for an example transport chain of freight from the origin (A, cargo consignor) to the destination (B, consignee). The first and last transport chain element (TCE 1, 3) represent road services C, TCE 2 represents hub operation (D). In this step, the user shall establish a relevant TOC for TCE 1, e.g. a single vehicle in a single schedule E or in a multiple schedule (F), a specific vehicle type in single schedule (G) or in a multiple schedule (H), etc.



Key

- A cargo consignor
- B consignee
- C road services
- D hub operation
- E single schedule
- F multiple schedules
- G specific vehicle type in single schedule
- H specified group of vehicles in multiple schedules

Figure 6 — Diagrammatic relationship between operations and TCEs for an example freight transport chain

Transport operations which constitute a TOC should include entire round trips made by the vehicles in order to balance out GHG emissions within asymmetric transport flows. Hence, any GHG emission calculation performed by the user of a transport service cannot be performed in isolation from knowledge of the TOC. The calculation shall be based on information provided by the transport or hub operator or transport service organizer or the appropriate default values that takes into consideration all defining characteristics of the TOC.

An exception to this is when a vehicle or vessel is chartered to perform a one-way journey that can be specifically identified within both the transport operator's and transport purchaser's systems. Pipelines are another exception due to the fixed nature of the infrastructure.

NOTE 1 A roundtrip does not require an immediate return to the point of origin. It can be a group of sequential journeys that start and finish in the same place. For a train, that can be its depot at start and end of the day.

NOTE 2 Pipeline TOCs are not concerned by this recommendation, as their transport operations are not performed by moving vehicles.

For the benefit of specific investigations and analysis, the TOC can be limited to the transport operation itself and taken individually.

EXAMPLE 1 A transport user needing to quantify the effect (on load factor, energy consumption and finally GHG emissions) of different palletizations of their products, between their factory and their distribution centre, for a full-truck load.

The TOC should include loaded trips (possibly with varying loading levels) and all the empty trips related to them. Hence, the GHG emissions for a single transport or hub operation cannot be calculated

without reference to the TOC or HOC in which it takes place. This means, for example, the GHG emissions from point A to point B for a full truckload truck cannot be calculated without taking into consideration the movements and transport operations of this truck before A and after B that make a complete match to the TOC definition. It is therefore crucial to create transparency on the TOC definition and its level of granularity.

Where empty containers, roll cages or pallets are transported on behalf of a purchaser of transport services for the purpose of relocation 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.

NOTE 3 The approaches to inclusion of empty trips and round-trip characteristics depend on the level of detail used to specify the TOC.

NOTE 4 If the fleet and the operation types are homogeneous, then the whole activity of the fleet of a transport operator over one year can be the TOC for all operations performed by this fleet.

Different processes, among those listed in 5.2.2, can be distinguished within a single movement of a vehicle, in circumstances where they are dedicated to only a part of freight and/or passengers. A single TOC can include transport operations with different categories of freight or passengers in terms of requirements, such as temperature control for freight or classes for passengers.

EXAMPLE 2 If a container ship carries both ambient ("dry") containers and temperature-controlled ("reefer") containers, the operation of this container ship is included in a single TOC. Different GHG emission intensities are established within the TOC for the ambient and temperature-controlled consignments to reflect the additional energy consumption of the temperature control processes.

To implement the next steps of the calculation, each TOC shall be identified as part of one of the following types:

- TOC of passengers only (general case);
- TOC of freight only (general case);
- TOC of passengers only with multi-classes vehicles;
- TOC of freight only with multi-temperature vehicles;
- TOC of vehicles with passengers, passenger vehicles and freight;
- TOC of any other case.

6.3.2.2 Associating a TOC with a transport operation

Each transport operation shall be associated with an existing TOC.

6.3.3 Hub operation categories

6.3.3.1 Categorization of hub operations into HOCs

When defining the parameters of a HOC, consideration shall be given to factors that affect the scale and composition and characteristics of the HOC such as:

- number and type of hub operations contributing to the HOC;
- for freight: e.g. handling of freight, (un-) loading, (de-) boarding, transport on-site;
- for passenger: e.g. transfer on-site, (de-)boarding equipment, handling of luggage;
- nature and consistency of the hub operations included in the HOC (e.g. electrified or non-electrified);

- inbound and outbound transport mode and relevance of intermodal change;
- any processes essential for maintaining the condition of the freight or ensuring passenger health and safety;
- for freight: e.g. temperature control, repacking (see [Annex 0](#));
- for passenger: e.g. air conditioning;
- for freight: nature of the freight handled (e.g. palletized, containerized, piece good).

HOCs can have different levels of granularity, for example:

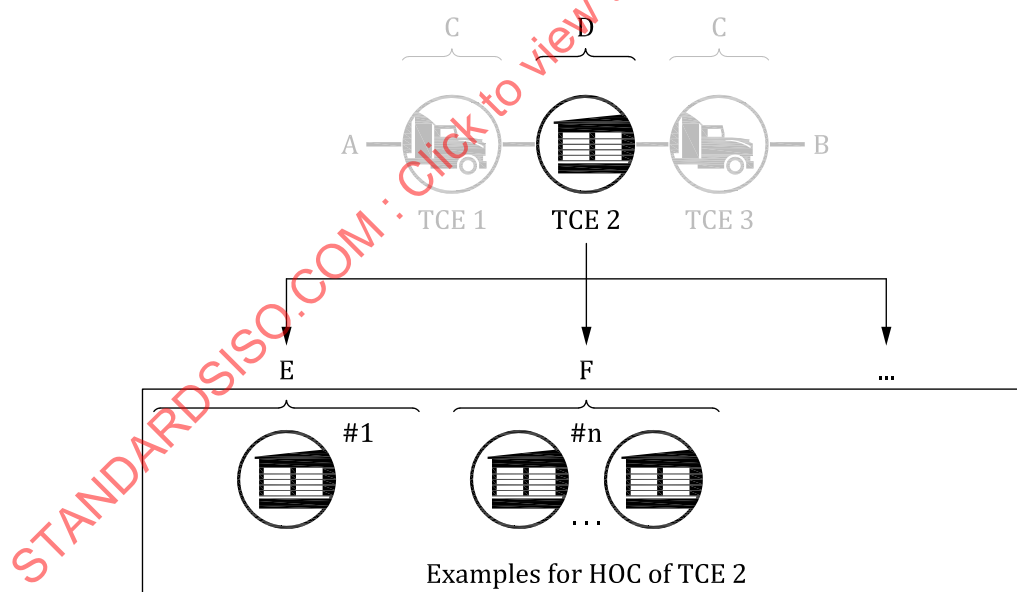
- HOC of a single hub;
- HOC of a specific hub type.

A HOC may include freight and passengers, mainly when they transit via the same hub.

A HOC shall fully include each hub operation, meaning that a hub operation shall not be split between two HOCs, even if this operation simultaneously benefits different TCEs (e.g. TCEs for passengers and freight, TCEs for ambient and temperature-controlled freight).

A hub may perform different hub operations that form part of different HOCs.

[Figure 7](#) provides examples to establish HOCs for an example transport chain of freight from the origin (A, cargo consignor) to the destination (B, consignee). The first and last transport chain element (TCE 1, 3) represent road services C, TCE 2 represents hub operation (D). In this step, the user shall establish a relevant HOC for TCE 2, e.g. a single hub E or various hubs (F) within a network, etc.



Key

- A cargo consignor
- B consignee
- C road services
- D hub operation
- E single hub
- F multiple hubs on one hub type

Figure 7 — Example transport chain of freight highlighting the potential HOC definitions

6.3.3.2 Associating a HOC with a hub operation

Each hub operation shall be associated with an existing HOC.

7 Quantification actions

7.1 General

The implementation of GHG emission quantification can rely on the involvement of different stakeholders and complementary inputs and calculations following several steps, as shown in [Figure 8](#) and then detailed in [7.2](#) to [7.4](#).

- a) Each transport chain shall be broken down into TCEs.
- b) Each TCE shall be related to a transport or hub operation.
- c) Each transport or hub operation shall be related to a TOC or HOC. The TOC or HOC shall gather operations sharing similar characteristics, implemented over a defined period. This period should be one year or less.
- d) A GHG emission intensity (in some cases, several GHG emission intensities) shall be established or selected for each TOC or HOC.
- e) Then the GHG emissions of each TCE shall be calculated based on the corresponding GHG emission intensity and the transport or hub activity of this TCE.
- f) Finally, the GHG emissions of the transport chain shall be the sum of the GHG emissions of its TCEs.

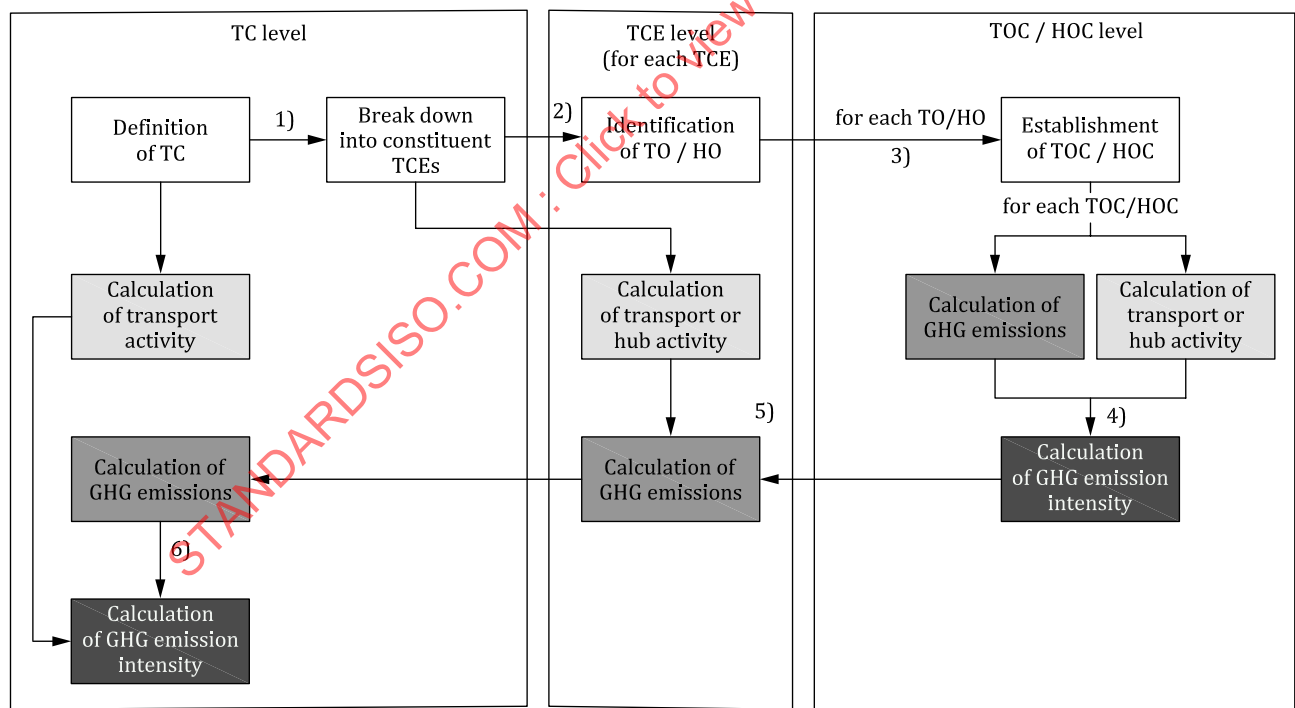


Figure 8 — GHG emission calculation steps for a transport chain

7.2 Establishment of GHG emission intensity of a TOC or a HOC

7.2.1 General

GHG emission intensities of TOCs and HOCs shall be established using one of the four following options:

- calculation with primary data (option A) (see [7.2.3](#));
- calculation with a model (option B) (see [7.2.4](#));
- selection of a value from a database of default values (option C) (see [7.2.5](#));
- collection of a value from a contracted operator that has used option A or B (option D) (see [7.2.6](#)).

NOTE GHG emission intensities can be based on a mix of data sources that combine primary data, modelled data and default values, sometimes making it difficult to clearly distinguish the categories.

7.2.2 Selection of the option

Data specific to the transport chain for which GHG emissions are being quantified shall be collected and used for the calculation. The data shall be representative of the processes for which they are collected.

A transport or hub operator should apply option A for all its transport or hub operations.

Option A may also be applied by any other user if the information and data required are available to them. If not, the user should select the option in which they are most confident regarding the accuracy of the outcome.

The values for total GHG activity, the related transport or hub activity, and derived GHG emission intensity shall be prioritized as follows to reflect the level of data access within the transport chain reporting:

- Primary data shall be used. Where this is not available, secondary data may be used. The reasons for using secondary data shall be justified and documented.
- Where secondary data are used, modelled data shall be prioritized over default data.

Commonly combinations of primary and secondary data are needed and used.

Getting the lowest possible value of GHG emission intensity shall not be a criterion for this selection.

7.2.3 Calculation with primary data (option A)

The following steps shall be followed:

- Step 1: Identify all the transport and hub operations performed and related to GHG emissions quantification needs.
- Step 2: Establish the TOCs and HOCs related to these transport and hub operations.
- Step 3, for the operations associated with each TOC and HOC:
 - Identify and quantify GHG activity data from all GHG sources (quantity of fuel consumed, refrigerant leakage, etc.) and convert them to GHG emissions.
 - Add these GHG emissions from all GHG sources to obtain GHG emissions for the TOC/HOC.
 - Calculate the corresponding transport or hub activity for the TOC/HOC.
 - Calculate the GHG emission intensity for the TOC/HOC.

NOTE These steps are detailed in [Clause 8](#) for TOCS and [Clause 9](#) for HOCs.

7.2.4 Calculation with a model (option B)

The general guidance given in [Annex M](#) may be followed for the calculation of a GHG emission intensity using a model.

7.2.5 Selection of a value from a database of default values (option C)

In cases where there is a need to use default GHG emission intensities, these should be sourced in accordance with guidance given in [Annex Q](#) using the closest match between the default GHG emission intensity classification and the characteristics of the TOC or HOC in question. If no clear match exists between the default GHG emission intensity classification and the characteristics of the TOC or HOC, then the sources used to fill this gap, and the reasons for this choice, shall be fully documented.

7.2.6 Collection of a value from a contracted operator (option D)

A GHG emission intensity may be collected from a contracted operator that has used option A or B to establish this value.

7.3 Calculation of GHG emissions for a TCE

The following steps shall be followed:

- Step 1: Identify the transport or hub operation related to this TCE.
- Step 2: Select a TOC or HOC GHG emission intensity corresponding to this operation.
- Step 3: Calculate the transport or hub activity of the TCE.
- Step 4: Calculate the GHG emissions of the TCE using transport or hub activity, the selected GHG emission intensity and, for transport, a DAF.

7.4 Calculation of GHG emissions for a transport chain

The following steps shall be followed:

- Step 1: Break down the transport chain into its constituent TCEs.
- Step 2: Calculate the sum of GHG emissions of all TCEs of the transport chain.
- Step 3: Calculate the sum of transport activity of all TCEs of the transport chain.
- Step 4: Calculate the GHG emission intensity of the transport chain, with GHG emissions (result of step 2) and transport activity (result of step 3).

8 Quantification actions at the TOC level

8.1 General

This clause sets out the quantification actions for each TOC.

The actions set out in [8.2](#), [8.3](#) and [8.4](#) shall be carried out by transport operators to quantify the GHG emissions and the transport activity related to all TOCs that comprise their overall transport operations. The results from [8.3](#) and [8.4](#) shall be combined at the TOC level to calculate the GHG emission intensity for each TOC (see [8.5](#)).

NOTE Different cases are presented, depending on the TOC being only freight or only passengers, or both, and with or without different conditions for freight (temperature) and/or for passengers (classes, accompanied vehicles).

8.2 Quantification of the GHG activity data of a TOC

GHG activity data shall encompass all GHG sources of the TOC, and therefore shall consist of the total consumption of each energy carrier and refrigerant used, as well as any other quantified GHG activity data relevant to the transport operations of the TOC.

In situations where the GHG activity data results from the use of different GHG sources (energy carriers or leakage of refrigerants), GHG activity data shall be quantified separately for each GHG source (energy carrier and refrigerant).

In situations where a GHG source is related to a specific group of passengers or freight within the TOC, the corresponding GHG activity data shall be quantified separately for this group. The sum of the GHG activity data of each GHG source and each TOC shall equal the transport GHG activity data for this GHG source for the overall operation of transport operator.

If refrigerants are refilled at hubs (e.g. refill losses at vehicle or load unit level such as reefer containers), the relevant amount of GHG activity data shall be included within the calculation of the corresponding TOC in accordance with [Annex I](#).

8.3 Calculation of GHG emissions of a TOC

8.3.1 General

This step shall distinguish the following two situations:

- No allocation needed: when each vehicle operating in the TOC does not include both passengers and freight, and provides the same functionalities to all passengers or all consignments carried, all GHG emissions within the TOC shall be added.
- Allocation needed: when the vehicles of the TOC provide different functionalities (carrying both passengers or freight, and/or providing different functionalities to different groups of passengers or freight), the corresponding GHG emissions shall be calculated for each group.

EXAMPLE Allocation can be needed in the maritime transport of containers when container ships carry both dry and reefer containers, since the use of refrigerants and energy for temperature control benefit only reefer containers, whereas propulsion of the ships benefit all containers.

8.3.2 No allocation needed

This subclause shall be applied when no allocation is needed for the calculation of GHG emissions of the TOC in accordance with [8.3.1](#).

Conversion of GHG activity data into vehicle operation and energy provision GHG emissions shall be conducted using [Formulae \(1\)](#) and [\(2\)](#) for each type of GHG activity A_i :

$$G_{VO,TOC,A_i} = Q_{TOC,A_i} \times \varepsilon_{VO,A_i} \quad (1)$$

$$G_{VEP,TOC,A_i} = Q_{TOC,A_i} \times \varepsilon_{VEP,A_i} \quad (2)$$

where

- G_{VO,TOC,A_i} is the vehicle operation GHG emissions of the TOC for GHG activity type A_i ;
- Q_{TOC,A_i} is the quantity of GHG activity type A_i for the TOC (e.g. A_i is combustion of diesel fuel and Q_{diesel} equals 12 000 kg of diesel or A_i is leakage of refrigerant R-134a and $Q_{\text{R-134a}}$ equals 100 kg of the refrigerant R-134a);

- ε_{VO,A_i} is the vehicle operation GHG emission factor for GHG activity type A_i (e.g. $\varepsilon_{VO,diesel} = 3,22 \text{ kg CO}_2\text{e/kg}$ or $\varepsilon_{VO,R-134a} = 1\,430 \text{ kg CO}_2\text{e/kg}$);
- G_{VEP,TOC,A_i} is the vehicle energy provision GHG emissions of the TOC for GHG activity type A_i ;
- ε_{VEP,A_i} is the vehicle energy provision GHG emission factor for GHG activity type A_i (e.g. $\varepsilon_{VEP,diesel} = 0,56 \text{ kg CO}_2\text{e/kg}$).

Values for GHG emission factors should be used as set out in [Annex Q](#). 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.

Where there are multiple GHG activity types (e.g. the vehicles use different energy carriers or refrigerants), the GHG emissions for each GHG activity type shall be calculated separately and then added together to provide the total GHG emissions of the TOC. [Formulae \(3\)](#), [\(4\)](#) and [\(5\)](#) shall be used:

$$G_{VO,TOC} = \sum_i G_{VO,TOC,A_i} \quad (3)$$

$$G_{VEP,TOC} = \sum_i G_{VEP,TOC,A_i} \quad (4)$$

$$G_{TOC} = G_{VO,TOC} + G_{VEP,TOC} \quad (5)$$

where

- $G_{VO,TOC}$ is the vehicle operation GHG emissions of the TOC;
- G_{VO,TOC,A_i} is the vehicle operation GHG emissions of the TOC for each GHG activity type A_i ;
- $G_{VEP,TOC}$ is the vehicle energy provision GHG emissions of the TOC;
- G_{VEP,TOC,A_i} is the vehicle energy provision GHG emissions of the TOC for each GHG activity type A_i ;
- G_{TOC} is the total GHG emissions of the TOC.

8.3.3 Allocation needed

This subclause shall be applied when allocation is needed for the calculation of GHG emissions of the TOC in accordance with [8.3.1](#).

The principles of the previous subclause shall be adapted, in order to quantify the following separately:

- $G_{TOC,all}$: GHG emissions of the TOC that result from GHG activity that benefits all passengers and/or freight equally.
- G_{TOC,sg_i} : GHG emissions of the TOC that result from GHG activity that benefits a specific group or groups of passengers and/or freight sg_i differently to other passengers or freight within the TOC (i from 1 to n , n being the number of specific groups).

This allocation of GHG emissions shall ensure that no GHG emissions are lost or double-counted, and therefore that [Formula \(6\)](#) is verified:

$$G_{TOC} = G_{TOC,all} + \sum_1^{n_{TOC}} G_{TOC,sg_i} \quad (6)$$

where

- G_{TOC} is the GHG emissions of the TOC;
- $G_{\text{TOC,all}}$ is the GHG emissions of the TOC resulting from GHG activity that is not related to any specific group of the TOC;
- $G_{\text{TOC,sg}_i}$ is the GHG emissions of the TOC resulting from GHG activity calculated for the specific group sg_i of the TOC;
- n_{TOC} is the number of specific groups of the TOC.

The chosen allocation principles shall remain consistent over time and shall be documented transparently, as appropriate.

NOTE 1 In practice, such differentiation can lead to the identification of a limited number of groups of passengers and/or freight. A common example that has been identified is the one of maritime transport of dry and reefer containers, where reefer containers constitute the only specific group of freight. A tri-temperature (ambient/fresh/frozen) transport by truck, in road transport, can lead to considering two specific groups that benefit differently from the temperature control (the fresh items and the frozen items), whereas the ambient items are not concerned.

NOTE 2 In many cases, the GHG activity within the TOC is not dedicated to each of these groups. This means that the actual GHG activity data needed for calculation of $G_{\text{TOC,sg}_i}$ (e.g. energy used for temperature control of reefer containers on a container ship) is not always measured directly. In these cases, secondary data (e.g. an estimation of energy consumption requirements) can be conducted, based on the need of energy of the temperature-controlled freight.

8.4 Calculation of transport activity of a TOC

8.4.1 General

The calculation of transport activity of a TOC shall be adapted, based on the different cases identified in [6.3.2.1](#).

NOTE In some of these cases, the calculation requires the transport activity to be calculated for the individual groups. The transport activity for the individual groups can be added, with the use of an appropriate unit (passenger-equivalent and/or passenger of lowest class equivalent), to give the total transport activity of the TOC

8.4.2 Transport activity distance

Only one type of transport activity distance (SFD or GCD) shall be used for the calculation of transport activity of a TOC.

8.4.3 Transport activity of a TOC of passengers — General case

In this general case, calculation of the passenger transport activity of a TOC shall be made using [Formula \(7\)](#):

$$T_{\text{TOC,p}} = \sum_1^{v_p} p_i \times s_{pi} \quad (7)$$

where

- $T_{\text{TOC,p}}$ is the passenger transport activity of the TOC;
- p_i 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.

NOTE In situations where the transport activity distance travelled by each passenger is unknown, passenger transport activity can be calculated by multiplying the number of passengers by the mean transport distance travelled by passengers on journeys included within this TOC.

8.4.4 Transport activity of a TOC of freight — General case

In this general case, calculation of the freight transport activity of a TOC shall be made using [Formula \(8\)](#):

$$T_{\text{TOC},f} = \sum_1^c M_i \times s_{ci} \quad (8)$$

where

$T_{\text{TOC},f}$ is the freight transport activity of the TOC;

M_i is the mass of an individual consignment i in the TOC;

s_{ci} is the transport activity distance of an individual consignment i in the TOC;

c is the number of consignments in the TOC.

NOTE 1 In situations where the transport activity distance travelled by each consignment is unknown, freight transport activity can be calculated either by multiplying the total mass of consignments by the average transport distance travelled by each consignment.

NOTE 2 In situations where an alternative option for the quantity of freight is being used, M_i can be replaced in [Formula \(8\)](#) by the appropriate unit, e.g. number of items or number of TEUs.

8.4.5 Transport activity of a TOC of passengers with multi-class vehicles

8.4.5.1 General

In the case of multi-class vehicles within the TOC, the passenger transport activity of a TOC may also be calculated using [Formula \(7\)](#), i.e. without any distinction of the passenger classes.

However, alternatively and preferably, a class differentiation should be made.

Such a differentiation may be implemented based on one or a combination of relevant criteria such as those related to the use of space, volume, GHG sources (energy carrier, refrigerant leakage), etc. In particular, the following criteria may be used:

- area per seat;
- occupancy rate per class;
- mass per seat.

8.4.5.2 Establishing class factors

The class differentiation should lead to the establishment of class factors.

The f different classes C_k (k from 1 to f) should be identified and sorted in ascending order, with C_1 being the lowest class to C_f being the highest.

The class factor z of the lowest class should be 1; i.e. $z_{C1} = 1$.

The calculation of class factors may follow the additional guidance of [Annex L](#). Class factors may also be taken from published sources.

8.4.5.3 Calculation of transport activity with class differentiation

The calculation of the passenger transport activity of the TOC with class differentiation should use [Formula \(9\)](#) for each of the f classes C_k :

$$T_{\text{TOC},C_k} = z_{C_k} \times \sum_1^{v_{p,C_k}} s_{pi,C_k} \quad (9)$$

where

- T_{TOC,C_k} is the passenger transport activity of the passengers in class C_k of the TOC
- z_{C_k} is the class factor for class C_k ;
- s_{pi,C_k} is the transport activity distance of an individual passenger i in class C_k of the TOC;
- v_{p,C_k} is the number of passengers in class C_k of the TOC.

Finally, the transport activity for the TOC should be calculated using [Formula \(10\)](#):

$$T_{\text{TOC},p} = \sum_1^f T_{\text{TOC},C_k} \quad (10)$$

where

- $T_{\text{TOC},p}$ is the passenger transport activity of the TOC;
- T_{TOC,C_k} is the passenger transport activity of the passengers in class C_k of the TOC;
- f is the number of classes.

NOTE The unit of transport activity calculated with [Formulae \(9\)](#) and [\(10\)](#) is the passenger of lowest class equivalent kilometre (plceqkm).

8.4.6 Transport activity of a TOC of freight with multi-temperature vehicles

In the case of a TOC with multi-temperature vehicles (τ different temperature conditions), a freight transport activity shall be calculated separately for each temperature condition t_k for freight, with k from 1 to τ , where t_1 is ambient, using [Formula \(11\)](#), which is similar to [Formula \(8\)](#):

$$T_{\text{TOC},k} = \sum_1^{v_{c,t_k}} M_{i,k} \times s_{pi,t_k} \quad (11)$$

where

- $T_{\text{TOC},k}$ is the freight transport activity of the consignments in temperature condition t_k of the TOC;
- $M_{i,k}$ is the mass of the individual consignments i in temperature condition t_k of the TOC;
- s_{pi,t_k} is the transport activity distance of an individual consignment i in temperature condition t_k of the TOC;
- v_{c,t_k} is the number of consignments of type t_k in the TOC.

Finally, the transport activity for the TOC should be calculated using [Formula \(12\)](#):

$$T_{\text{TOC},f} = \sum_1^{\tau} T_{\text{TOC},k} \quad (12)$$

where

- $T_{\text{TOC},f}$ is the freight transport activity of the TOC;
- $T_{\text{TOC},k}$ is the freight transport activity of the consignments in temperature condition t_k of the TOC;
- τ is the number of temperature conditions.

8.4.7 Transport activity of a TOC with passengers and freight (whether including passenger vehicles or not)

In the case of a TOC with passengers and freight (whether including passenger vehicles or not), each type of the y entities carried e_k shall be identified (k from 1 to y , e.g. e_1 is passengers with their luggage, e_2 is cars, e_3 is motorcycles, e_4 is empty trailers, e_5 is loaded trailers).

EXAMPLE Aircraft, Ro-Pax ferries for maritime transport, some intermodal trains for railway transport.

The corresponding transport activity shall be calculated separately for each type of entity e_k , using [Formula \(13\)](#):

$$T_{\text{TOC},e_k} = \sum_i^b \theta_i \times s_{i,e_k} \quad (13)$$

where

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

When using the first option set out in [5.4.3](#), if a value for the actual total passenger mass is not available, the individual passenger mass based on the typical mass of a passenger with a conventional equivalence of 100 kg per passenger (including baggage) may be used.

When using the second option set out in [5.4.3](#), i.e. for allocation between the different types of entity, θ_i shall be the passenger-equivalent value for each type of entity. [Tables E.3](#) and [G.5](#) provide passenger-equivalent values for the different types of passenger and freight vehicle.

NOTE In situations where the transport activity distance travelled by each group of entities is unknown, transport activity can be calculated by multiplying the number of entities by the average transport distance travelled by the entities on journeys included within this TOC.

Finally, the transport activity for the TOC should be calculated using [Formula \(14\)](#):

$$T_{\text{TOC}} = \sum_1^y T_{\text{TOC},e_k} \quad (14)$$

where

- T_{TOC} is the transport activity of the TOC;

T_{TOC, e_k} is the transport activity of the TOC for all entities of type e_k ;

y is the number of types of entity.

This transport activity should be expressed in either in tonne kilometre (tkm) or in passenger-equivalent kilometre (peqkm).

8.4.8 Transport activities of a TOC with any other case

When a TOC presents a different case than those presented above, especially a combination of these cases (e.g. a TOC with both freight and passengers, with different classes for passengers and different temperature conditions for freight), then the methodology for calculation of transport activities shall be adapted consistently with the cases already developed.

8.5 Calculation of GHG emission intensity for the TOC

8.5.1 General

This calculation shall consist of relating GHG emissions calculated as specified in 8.3 to transport activities calculated as specified in 8.4.

As different cases have been identified (two cases in 8.3 and six cases in 8.4), this calculation shall rely on a common approach.

8.5.2 General case

If the calculation of GHG emissions for the TOC has been implemented in accordance with 8.3.2 (no allocation), then the GHG emission intensity of the TOC shall be calculated by dividing the total GHG emissions of the TOC by the total transport activity of the TOC using Formula (15):

$$g_{j_V, \text{TOC}} = \frac{G_{j_V, \text{TOC}}}{T_{\text{TOC}}} \quad (15)$$

where

j_V is either the vehicle operation or the vehicle energy provision;

$g_{j_V, \text{TOC}}$ is the GHG emission intensity for activity type j_V for the TOC;

$G_{j_V, \text{TOC}}$ is the total GHG emissions for activity type j_V for the TOC;

T_{TOC} is the transport activity of the TOC.

The outcome shall be expressed as mass of CO₂e per transport activity.

EXAMPLE 1 GHG emission intensity: 60 g CO₂e per tonne kilometre or 60 g CO₂e/tkm.

EXAMPLE 2 GHG emission intensity: 4 g CO₂e per passenger kilometre or 4 g CO₂e/pkm.

In the case of a TOC of passengers with different classes, transport activity shall be expressed in passenger of lowest class equivalent kilometre (plceqkm).

In the case of a TOC of passengers with passenger vehicles and/or freight, transport activity shall be expressed in tonne kilometre (tkm) or in passenger-equivalent kilometre (peqkm) for allocation purposes.

8.5.3 Case of a TOC of freight with multi-temperature vehicles

In the case of a TOC of freight of multi-temperature vehicles with n_t different temperature conditions t_k (k from 1 to n_t , e.g. t_1 is ambient, t_2 is refrigerated), the calculation of GHG emissions intensities shall rely on:

- the calculation of GHG emissions in accordance with [8.3.3](#) (allocation of specific GHG activities);
- the calculation of transport activities of the TOC in accordance with [8.4.6](#).

Then, the GHG emission intensities of the freight with each temperature condition within the TOC shall be calculated using [Formula \(16\)](#):

$$g_{j_V, \text{TOC}, k} = \frac{G_{j_V, \text{TOC}, \text{all}}}{T_{\text{TOC}}} + \frac{G_{j_V, \text{TOC}, k}}{T_{\text{TOC}, k}} \quad (16)$$

where

- j_V is either the vehicle operation or the vehicle energy provision;
- $g_{j_V, \text{TOC}, k}$ is the GHG emission intensity for activity type j_V for freight of temperature condition t_k in the TOC;
- $G_{j_V, \text{TOC}, \text{all}}$ is the GHG emission for activity type j_V that is not related to control of temperature conditions (e.g. GHG emissions related to propulsion of the ship in maritime transport);
- T_{TOC} is the transport activity of the TOC;
- $G_{j_V, \text{TOC}, k}$ is the total GHG emissions for activity type j_V for freight of temperature condition t_k in the TOC;
- $T_{\text{TOC}, k}$ is the freight transport activity of the consignments in temperature condition t_k of the TOC;

NOTE Direct comparison and/or combination of GHG emission intensities calculated using SFD and GCD is not valid.

9 Quantification actions at the HOC level

9.1 General

This clause sets out the quantification actions for each HOC.

The actions set out in [9.2](#), [9.3](#) and [9.4](#) should be carried out by the hub operator to quantify the GHG emissions related to all HOCs that comprise their overall hub operations. The results from [9.3](#) and [9.4](#) shall be combined at the HOC level to calculate the GHG emission intensity for each HOC (see [9.5](#)).

9.2 Quantification of the GHG activity data of a HOC

GHG activity data shall encompass all GHG sources of the HOC, and therefore shall consist of the total consumption of each energy carrier and refrigerant used, as well as any other quantified GHG activity relevant to the hub operations.

In situations where the GHG activity data results from the use of different GHG sources (energy carriers or leakage of refrigerants), GHG activity data shall be quantified separately for each GHG source (energy carrier and refrigerant).

In situations where a GHG source is related to a specific group of passengers or freight within the HOC, the corresponding GHG activity data shall be quantified separately for this group.

[Annex H](#) gives examples of allocation principles of GHG activity data for the HOC.

If refrigerants are used to refill losses at vehicle or load unit level (e.g. reefer containers), the relevant amount of GHG activity data shall be included within the calculation of the corresponding TOC, see [Annex I](#).

9.3 Calculation of GHG emissions of a HOC

9.3.1 General

This step shall distinguish the following two situations:

- No allocation needed: when each hub in the HOC does not include both passengers and freight, and provides the same functionalities to all passengers or all consignments carried, all GHG emissions within the HOC shall be added.
- Allocation needed: when the hub(s) of the HOC provides different functionalities (carrying both passengers or freight, and/or providing different functionalities due to different temperature conditions of freight), the corresponding GHG emissions shall be calculated for each group.

9.3.2 No allocation needed

This subclause shall be applied when no allocation is needed for the calculation of GHG emissions of the HOC in accordance with [9.3.1](#)

Conversion of GHG activity data into hub equipment operation and energy provision GHG emissions shall be conducted using [Formulae \(17\)](#) and [\(18\)](#) for each type of GHG activity A_i :

$$G_{\text{HEO,HOC},A_i} = Q_{\text{HOC},A_i} \times \varepsilon_{\text{HEO},A_i} \quad (17)$$

$$G_{\text{HEEP,HOC},A_i} = Q_{\text{HOC},A_i} \times \varepsilon_{\text{HEEP},A_i} \quad (18)$$

where

$G_{\text{HEO,HOC},A_i}$	is the hub equipment operation GHG emissions of the HOC for GHG activity type A_i ;
Q_{HOC,A_i}	is the total quantity of GHG activity type A_i for the HOC (e.g. A_i is combustion of diesel fuel and Q_{diesel} equals 12 000 kg of diesel or A_i is leakage of refrigerant R134a and $Q_{\text{R-134a}}$ equals 100 kg of the refrigerant R-134a);
$\varepsilon_{\text{HEO},A_i}$	is the hub equipment operation GHG emission factor for GHG activity type A_i (e.g. $\varepsilon_{\text{HEO,diesel}} = 3,22 \text{ kg CO}_2\text{e/kg}$ or $\varepsilon_{\text{HEO,R-134a}} = 1\,430 \text{ kg CO}_2\text{e/kg}$);
$G_{\text{HEEP,HOC},A_i}$	is the total hub equipment energy provision GHG emissions of the HOC for GHG activity type A_i ;
$\varepsilon_{\text{HEEP},A_i}$	is the hub equipment energy provision GHG emission factor for GHG activity type A_i (e.g. $\varepsilon_{\text{HEEP,diesel}} = 0,56 \text{ kg CO}_2\text{e/kg}$).

Values for GHG emission factors shall be used as set out in [Annex J](#). Where national legislation mandates 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.

Where there are multiple GHG activity types (e.g. the equipment and facilities use different energy carriers or refrigerants), the GHG emissions for each GHG activity type shall be calculated separately

and then added together to provide the total GHG emissions of the HOC. [Formulae \(19\)](#), [\(20\)](#) and [\(21\)](#) shall be used:

$$G_{\text{HEO,HOC}} = \sum_i G_{\text{HEO,HOC},A_i} \quad (19)$$

$$G_{\text{HEEP,HOC}} = \sum_i G_{\text{HEEP,HOC},A_i} \quad (20)$$

$$G_{\text{HOC}} = G_{\text{HEO,HOC}} + G_{\text{HEEP,HOC}} \quad (21)$$

where

- $G_{\text{HEO,HOC}}$ is the hub equipment operation GHG emissions of the HOC;
- $G_{\text{HEO,HOC},A_i}$ is the hub equipment operation GHG emissions of the HOC for each GHG activity type A_i ;
- $G_{\text{HEEP,HOC}}$ is the hub equipment energy provision GHG emissions of the HOC;
- $G_{\text{HEEP,HOC},A_i}$ is the hub equipment energy provision GHG emissions of the HOC for each GHG activity type A_i ;
- G_{HOC} is the total GHG emissions of the HOC.

9.3.3 Allocation needed

This subclause shall be applied when allocation is needed for the calculation of GHG emissions of the HOC in accordance with [9.3.1](#).

The principles of the previous subclause shall be adapted, in order to quantify the following separately:

- $G_{\text{HOC,all}}$: GHG emissions of the HOC that result from GHG activity that benefits all passengers and/or freight equally.
- $G_{\text{HOC,sg}_i}$: GHG emissions of the HOC that result from GHG activity that benefits a specific group or groups of passengers and/or freight sg_i differently to other passengers or freight within the HOC (i from 1 to n , n being the number of specific groups).

This allocation of GHG emissions shall ensure that no GHG emissions are lost or double-counted, and therefore that [Formula \(22\)](#) is verified:

$$G_{\text{HOC}} = G_{\text{HOC,all}} + \sum_1^{n_{\text{HOC}}} G_{\text{HOC,sg}_i} \quad (22)$$

where

- G_{HOC} is the GHG emissions of the HOC;
- $G_{\text{HOC,all}}$ is the GHG emissions of the HOC resulting from GHG activity that is not related to any specific group of the HOC;
- $G_{\text{HOC,sg}_i}$ is the GHG emissions of the HOC resulting from GHG activity calculated for the specific group sg_i of the HOC;
- n_{HOC} is the number of specific groups of the HOC.

The chosen allocation principles shall remain consistent over time and shall be documented transparently, as appropriate.

NOTE 1 In practice, such differentiation can lead to the identification of a limited number of groups of passengers and/or freight. A common example that has been identified is the one of maritime container terminal for the transshipment of dry and reefer containers, where reefer containers constitute the only specific group of freight. A tri-temperature (ambient/fresh/frozen) transshipment in a distribution centre, can lead to considering two specific groups that benefit differently from the temperature control (the fresh items and the frozen items), whereas the ambient items are not concerned.

NOTE 2 In many cases, the GHG activity within the HOC is not dedicated to each of these groups. This means that the actual GHG activity data needed for calculation of G_{HOC,sg_i} (e.g. energy used for temperature control of reefer containers at a container terminal) is not always measured directly. In these cases, secondary data (e.g. an estimation of energy consumption requirements) can be conducted, based on the need of energy of the temperature-controlled freight.

9.4 Quantification of hub activity of the HOC

9.4.1 Freight hub activity

The hub activity shall be quantified by the quantity of freight (outbound) relevant for the HOC.

The user shall choose the most appropriate unit for the quantity of the hub activity. The choice shall remain consistent over time for each hub (and its HOCs) and shall be documented transparently, as appropriate.

NOTE In cases where the chosen unit of the quantity of freight differs to that of the inbound/outbound transport legs, a conversion can be made.

9.4.2 Passenger hub activity

The hub activity shall be quantified by the number of passengers relevant to the HOC.

9.5 Calculation of GHG emission intensity for the HOC

9.5.1 General

This calculation shall consist of relating GHG emissions calculated as specified in 9.3 to hub activity as specified in 9.4.

As different cases have been identified in 9.3, this calculation shall rely on a common approach.

9.5.2 General case

If the calculation of GHG emissions for the HOC has been implemented in accordance with 9.3.2 (no allocation), then the GHG emission intensity of the HOC shall be calculated by dividing the total GHG emissions of the HOC by the total hub activity of the HOC using [Formula \(23\)](#):

$$g_{j_H, \text{HOC}} = \frac{G_{j_H, \text{HOC}}}{H_{\text{HOC}}} \quad (23)$$

where

j_H is either the hub equipment operation or the hub equipment energy provision;

$g_{j_H, \text{HOC}}$ is the GHG emission intensity for activity type j_H for the HOC;

$G_{j_H, \text{HOC}}$ is the total GHG emissions for activity type j_H for the HOC;

H_{HOC} is the hub activity of the HOC.

The outcome shall be expressed as mass of CO₂e per hub activity.

EXAMPLE 1 GHG emission intensity: 17 g CO₂e per tonne or 17 g CO₂e/t.

EXAMPLE 2 GHG emission intensity: 4 g CO₂e per passenger or 4 g CO₂e/passenger.

9.5.3 Case of a HOC of freight with multi-temperature conditions

In the case of a HOC of freight with n_t different temperature conditions t_k (k from 1 to n_t , e.g. t_1 is ambient, t_2 is refrigerated), the calculation of GHG emissions intensities shall rely on the calculation of GHG emissions in accordance with 9.3.3 (allocation of specific GHG activities).

Then, the GHG emission intensities of the freight with each temperature condition within the HOC shall be calculated using Formula (24):

$$g_{j_H, \text{HOC}, k} = \frac{G_{j_H, \text{HOC}, \text{all}}}{H_{\text{HOC}}} + \frac{G_{j_H, \text{HOC}, k}}{H_{\text{HOC}, k}} \quad (24)$$

where

j_H is either the hub equipment operation or the hub equipment energy provision;

$g_{j_H, \text{HOC}, k}$ is the GHG emission intensity for activity type j_H for freight of temperature condition t_k in the HOC;

$G_{j_H, \text{HOC}, \text{all}}$ is the GHG emission intensity for activity type j_H that is not related to control of temperature conditions (e.g. GHG emissions related to yard lighting);

H_{HOC} is the hub activity of the HOC;

$G_{j_H, \text{HOC}, k}$ is the total GHG emissions for activity type j_H for freight of temperature condition t_k in the HOC;

$H_{\text{HOC}, k}$ is the hub activity of the HOC for freight with temperature condition t_k .

10 Calculation of GHG emissions for a transport TCE

10.1 General

This clause sets out the step of calculation of GHG emissions for one TCE of a transport chain, taking place within a TO.

10.2 Calculation of transport activity

The transport activity of the TCE shall be calculated similarly to the calculation of transport activity of a TOC (detailed in Clause 8).

10.3 Selection of a GHG emission intensity

The GHG emission intensity for the TOC associated with the transport operation related to the TCE shall be selected.

10.4 General case

The GHG emissions of a TCE shall be calculated using [Formulae \(25\)](#) and [\(26\)](#):

$$G_{j_V, TCE} = g_{j_V, TOC} \times T_{TCE} \times \delta \quad (25)$$

where

j_V is either the vehicle operation or the vehicle energy provision;

$G_{j_V, TCE}$ is the total GHG emissions for activity type j_V for the TCE;

$g_{j_V, TOC}$ is the GHG emission intensity for activity type j_V for the TOC;

T_{TCE} is the transport activity for the TCE;

δ is the DAF between the transport distance type used for the transport activity of the TCE and the transport distance type used for the GHG emission intensity of the TOC.

NOTE Use of a DAF is only required in cases where the actual distance is used for calculation of the GHG emission intensity of the TOC. Otherwise, the DAF = 1 and [Formula \(25\)](#) is simplified.

$$G_{TCE} = G_{VO, TCE} + G_{VEP, TCE} \quad (26)$$

where

G_{TCE} is the GHG emissions of the TCE;

$G_{VO, TCE}$ is the vehicle operation GHG emissions of the TCE;

$G_{VEP, TCE}$ is the vehicle energy provision GHG emissions of the TCE.

10.5 Case of differentiation by passenger classes

In the case of passengers with different classes, transport activity and GHG emission intensity should be expressed using the passenger of lowest class equivalent kilometre (plceqkm) unit, and [Formulae \(25\)](#) and [\(26\)](#) shall be applied.

10.6 Case of differentiation by cargo temperature

In the case of freight with a specific temperature condition, [Formulae \(25\)](#) and [\(26\)](#) shall be applied, using the specific GHG emission intensity for each temperature-controlled freight type.

10.7 Case of transport of passengers and freight in the same vehicle

In the case where passengers and freight are transported in the same vehicle, transport activity and GHG emission intensity may be expressed in tonne kilometre (tkm) calculated using either the actual mass or notional masses based on passenger equivalents. The chosen allocation principles shall remain consistent over time and shall be documented transparently, as appropriate. [Formulae \(25\)](#) and [\(26\)](#) shall be applied.

11 Calculation of GHG emissions for a hub TCE

11.1 General

This clause sets out the step of calculation of GHG emissions for one TCE of a transport chain, taking place within a hub operation.

11.2 Quantification of hub activity

The hub activity of the TCE shall be quantified similarly to the quantification of hub activity of a HOC (detailed in [Clause 9](#)).

11.3 Selection of a GHG emission intensity

The GHG emission intensity for the HOC associated with the hub operation related to the TCE shall be selected.

11.4 General case

The GHG emissions of a hub TCE shall be calculated using [Formulae \(27\)](#) and [\(28\)](#):

$$G_{j_H, TCE} = g_{j_H, HOC} \times H_{TCE} \quad (27)$$

where

j_H is either the hub equipment operation or the hub equipment energy provision;

$G_{j_H, TCE}$ is the total GHG emissions for activity type j_H for the TCE;

$g_{j_H, HOC}$ is the GHG emission intensity for activity type j_H for the HOC;

H_{TCE} is the hub activity for the TCE.

$$G_{TCE} = G_{HCO, TCE} + G_{HEEP, TCE} \quad (28)$$

where

G_{TCE} is the GHG emissions of the TCE;

$G_{HCO, TCE}$ is the hub equipment operation GHG emissions of the TCE;

$G_{HEEP, TCE}$ is the hub equipment energy provision GHG emissions of the TCE.

11.5 Case of differentiation by cargo temperature

In the case of freight with a specific temperature condition, [Formulae \(27\)](#) and [\(28\)](#) shall be applied, using the specific GHG emission intensity for each temperature-controlled freight type.

11.6 Case of transfer of passengers and freight at the same hub

In the case where passengers and freight are transferred at the same hub, hub activity and GHG emission intensity may be expressed either using passenger equivalents (peq) or in tonnes. The chosen allocation principles shall remain consistent over time and shall be documented transparently, as appropriate. [Formulae \(27\)](#) and [\(28\)](#) shall be applied.

12 Results

12.1 For one transport chain

12.1.1 Calculation of GHG emissions

The GHG emissions of a transport chain shall be calculated by adding the corresponding values calculated in accordance with [Clauses 7](#) to [11](#) for all TCEs that compose this transport chain, using [Formulae \(29\)](#) to [\(34\)](#):

$$G_{VO,TC} = \sum_i G_{VO,TCE_i} \quad (29)$$

$$G_{HEO,TC} = \sum_i G_{HEO,TCE_i} \quad (30)$$

$$G_{VEP,TC} = \sum_i G_{VEP,TCE_i} \quad (31)$$

$$G_{HEEP,TC} = \sum_i G_{HEEP,TCE_i} \quad (32)$$

$$G_{T,TC} = G_{VO,TC} + G_{HEO,TC} + G_{VEP,TC} + G_{HEEP,TC} \quad (33)$$

$$G_{O,TC} = G_{VO,TC} + G_{HEO,TC} \quad (34)$$

where

- $G_{VO,TC}$ is the vehicle operation GHG emissions of the transport chain;
- G_{VO,TCE_i} is the vehicle operation GHG emissions allocated to each relevant TCE_i;
- $G_{HEO,TC}$ is the hub equipment operation GHG emissions of the transport chain;
- G_{HEO,TCE_i} is the hub equipment operation GHG emissions allocated to each relevant TCE_i;
- $G_{VEP,TC}$ is the vehicle energy provision GHG emissions of the transport chain;
- G_{VEP,TCE_i} is the vehicle energy provision GHG emissions allocated to each TCE_i;
- $G_{HEEP,TC}$ is the hub equipment energy provision GHG emissions of the transport chain;
- G_{HEEP,TCE_i} is the hub equipment energy provision GHG emissions allocated to each TCE_i;
- $G_{T,TC}$ is the total (i.e. operation and energy provision) GHG emissions of the transport chain;
- $G_{O,TC}$ is the operation GHG emissions of the transport chain.

The above results may be obtained from a mix of GHG activity data of different categories (primary data, modelled data and default values).

12.1.2 Calculation of transport activity

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.

The unit of transport activity shall be the same for all TCEs within the transport chain. For freight transport, this shall be the tonne kilometre, unless one of the specific alternatives outlined in [5.4.2](#) is used (item, TEU, etc.), in which case this shall be documented. For passenger transport, this shall be the passenger kilometre. Where allocation for combined transport of passengers and freight has been

conducted using the total passenger mass, this shall be converted to the number of passengers using the standard mass for a passenger with luggage.

For this calculation, the transport activity of all TCEs within each mode of the transport chain should be established using the same type of transport activity distance (SFD or GCD).

NOTE The hub activities are not included in this calculation.

12.1.3 Calculation of GHG emission intensities

The GHG emissions for the transport chain can be converted into GHG emission intensities (g_T or g_O) for this transport chain, by dividing the GHG emissions calculated in 12.1.1 ($G_{T,TC}$ or $G_{O,TC}$) by the transport activity calculated in 12.1.2 (T_{TC}).

NOTE The hub activities are not included in this calculation, whereas the GHG emissions cover all TCEs, including hubs.

12.2 For a set of transport chains

12.2.1 General

Aggregated values can be calculated for sets of transport chains (e.g. this can be for an organization as a whole to allow overall corporate reporting or for defined subset of its business).

12.2.2 Calculation of GHG emissions

The GHG emissions of a set of transport chains shall be calculated by adding the GHG emissions for all transport chains that compose this set, using Formulae (35) and (36):

$$G_{T,S} = \sum_i G_{T,TC_i} \quad (35)$$

$$G_{O,S} = \sum_i G_{O,TC_i} \quad (36)$$

where

$G_{T,S}$ is the total GHG emissions for the set of transport chains;

G_{T,TC_i} is the total (i.e. operation and energy provision) GHG emissions of each TC_i ;

$G_{O,S}$ is the operation GHG emissions for the set of transport chains.

G_{O,TC_i} is the operation GHG emissions of each transport chain TC_i ;

12.2.3 Calculation of transport activity

The transport activity of a set of transport chains shall be calculated by adding the transport activity of all transport chains that compose this set.

For this calculation, the transport activity of all TCEs within each mode of the set of transport chains should be established with the same type of transport activity distance (SFD or GCD).

NOTE The hub activities are not included in this calculation.

12.2.4 Calculation of GHG emission intensities

The GHG emissions for the set of transport chains can be converted into GHG emission intensities (g_T or g_O) for this set, by dividing the GHG emissions calculated in 12.2.2 (G_T or G_O) by the transport activity calculated in 12.2.3 (T_S).

NOTE The hub activities are not included in this calculation, whereas the total GHG emissions of all hub TCEs are included.

12.3 For a transport service

Calculations for one transport service shall be done as specified for a transport chain (see 12.1), considering only the TCEs that form part of this transport service.

12.4 For a set of transport services

Calculations for a set of transport services shall be done as specified for a set of transport chains (see 12.2), considering only the TCEs that form part of this set of transport services.

12.5 For a transport mode

Values can be calculated that consider only the TCEs carried out by one mode of transport for an organization's business or a defined subset thereof. Calculations for one mode of transport shall be done by combining the provisions of 12.1 and 12.2 but considering only the TCEs that are carried out by a single mode of transport.

13 Reporting

13.1 General

The implementation of this document shall lead to the establishment of a report.

This report shall be either at the level of an organization (for GHG emissions of all or a part of transport chains operated and/or purchased by the organization), or at the level of transport or hub services (for GHG emissions of a set of transport or hub services, reported by a service provider to a service user).

Depending on practical issues, the report shall take the form of either a single long report, or a short report complemented with other information made available separately.

13.2 Reporting at the organizational level

13.2.1 Reporting boundaries

Reporting shall cover either all transport chains operated or purchased by the organization, or only a part of them. The reporting may be split as appropriate to the organizational structure (e.g. by business unit, geographical region of operation, subsidiary or any other relevant criteria).

13.2.2 Report

The report shall comprise, as a minimum, the following information:

- a) identification of the transport chains covered by this report;
- b) a reference to this document, i.e. ISO 14083:2023;
- c) the total (operational plus energy provision) GHG emissions (G_T);

- d) the total (operational plus energy provision) GHG emission intensity (g_T), specifying the type of transport activity distance used;
- e) the total (operational plus energy provision) GHG emissions for TCEs of each mode of transport and for hub operations;
- f) the total (operational plus energy provision) GHG emission intensity for TCEs of each mode of transport and for hub operations, specifying the type of transport activity distance used; where alternative units for freight transport activity are used (e.g. number of items, TEUs), the GHG emission intensity may be reported expressed in these terms (e.g. GHG emissions per item or per TEU kilometre);
- g) a reference to the location where information as specified in [13.4](#) is available.

The report may be complemented with corresponding operational GHG emission values.

The report shall be complemented with the supporting information specified in [13.4](#).

The reporting organization may use any medium appropriate to organizational GHG reporting such as annual corporate reports or reporting to voluntary corporate GHG disclosure programmes.

As specified in [13.1](#), the report may be divided in two parts, the complementary elements being presented in the second part.

13.2.3 Periodicity

The reporting organization should produce at least an annual report including all operations performed or purchased during a period of 12 consecutive months. In addition, a report over shorter periods, or for specific journeys, can be appropriate.

13.3 Reporting at the level of transport or hub services

13.3.1 Granularity

This report may apply either to a single TCE or to a set of TCEs that comprise a part of or a full transport chain.

The aggregation of transport chains for reporting purposes may be done using various criteria in accordance with contractual agreements with service users and/or 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.

13.3.2 Report

The report shall comprise, as a minimum, the following information:

- a) identification of the TCE(s) or transport chain(s) covered by this report;
- b) a reference to this document, i.e. ISO 14083:2023;
- c) the total (operational plus energy provision) GHG emissions (G_T);
- d) the total (operational plus energy provision) GHG emission intensity (g_T), specifying the type of transport activity distance used;
- e) a reference to the location where information as specified in [13.4](#) is available;
- f) the transport activity, specifying the type of distance used;

- g) the hub activity;
- h) the operational GHG emissions ($G_{VO,T}$ or $G_{HEO,T}$);
- i) the operational GHG emission intensity (g_{VO} or g_{HEO}), specifying the type of transport activity distance used; where alternative units for freight transport activity are used (e.g. number of items, TEUs), the GHG emission intensity may be reported expressed in these terms (e.g. GHG emissions per item or per TEU kilometre);
- 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.

The report shall be complemented with the supporting information specified in [13.4](#).

The reporting organization may use any medium that gives the clearest results and associated basis for calculations to its service user(s), including pages on websites. In cases of reporting by transport service providers to transport service users, the reports shall be effectively communicated to the transport service users.

As specified in [13.1](#), the report may be divided in two parts, the complementary elements being presented in the second part.

13.4 Supporting information

13.4.1 General

Supporting information shall ensure transparency and a clear understanding of the reporting by the full potential group of users of this document.

The following statement shall be communicated: “These calculation results have been established in accordance with ISO 14083:2023.”

The report shall be easy to access, clearly structured and transparent in its data sourcing and calculation. Additional mode-specific statements may be communicated.

13.4.2 Description of the calculation method

The report shall mention any omissions of GHG sources, transport or hub operations in accordance with [5.2.3](#). The reasons for and implications of their omissions shall be explained. The description may include, in particular:

- an explicit description of the operational implementation of the transport and hub operations;
- any other general information necessary for the understanding of the method, e.g. noting that the impact of contrails and other non-GHG climate impacts are not included in the calculation for air transport.

The report may follow the templates given in [Tables 1](#) and [2](#). The tables may be simplified according to the transport chain they refer to, providing the report conforms to the stated requirements.

Table 1 — Examples of reporting details for freight transport

Report elements	Details to be provided	Breakdown
Operations in scope (covered by data)	Indicate what is in and what is out of the report.	All transport services in the system or indicate coverage (e.g. % of total transport activity or production output); all hub GHG emissions.
Total GHG emissions of transport and hubs (CO ₂ e)	Reporting at organizational level — Aggregated across all transport chains. — Also disaggregated by mode and hubs. — Share of primary and secondary data (for secondary data, distinguish the share of modelled and default): — in cases where the share differs for TOC parameters (e.g. vehicle size category, filling rate, street category/topography), indicate per parameter — Split total operational GHG emissions and energy provision GHG emissions: — disaggregate by energy carrier.	Examples for reporting at organizational level Mode (air/sea/inland waterway/rail/road/cable car/pipeline transport) and hubs: — X tonnes CO₂e by mode across all operations in scope and cumulative at the organization level; — % of reported GHG emissions sourced from each data type (or indicate the main source if details not available): — split into TOC parameters regarding the data source; — routing/street category and topography: 100 % modelled; — load factor: primary data from own operations; — fleet composition: primary data from subcontractors. — Operational GHG emissions split into own assets and third-party assets: — total GHG emissions from, for example, diesel, LPG, sustainable aviation fuel (SAF), electricity. — Energy provision GHG emissions expressed as total GHG emissions.
	Reporting at level of transport or hub service — Split by hub or transport service. — Share of primary and secondary data (for secondary data, distinguish share of modelled and default).	Examples for reporting at level of transport or hub service From a specific hub service or a specific transport service: — X tonnes CO₂e; — % of reported GHG emissions sourced from each data type (or indicate the main source if details not available); — details to be provided, for example:

Table 1 (continued)

Report elements	Details to be provided	Breakdown
	— Split total operational GHG emissions and energy provision GHG emissions: — disaggregate by energy carrier.	— air: (modelled/flight number and routing); — road: (primary/fleet data and load factor; default/routing and topography and reference to data source); — rail: (modelled/traction type, engine size, cargo); — hub: (primary/energy consumption metered). Operational GHG emissions split into own assets and third-party assets; expressed in total GHG emissions: — total GHG emissions from, for example, diesel, LPG, SAF, electricity. Energy provision GHG emissions expressed in total GHG emissions.
GHG intensity	Reporting at organizational level — Average across modes for the overall organization. — Also disaggregate by mode and hubs.	Examples for reporting at organizational level Overall: g CO₂e/tonne kilometre (tkm) or per tonne of freight for transport service users (aggregated across all operations in scope): — mode (air/ocean/inland waterway/rail/road/cable car/pipeline transport) and hubs.
	Reporting at level of transport or hub service — Split by hub or transport service. — Indicate granularity of TOC/HOC applied per mode and hub type (as indicated in 6.3).	Examples for reporting at level of transport or hub service From a specific hub service or a specific transport service: — overall: g CO₂e/tonne kilometre (tkm); — air: X g CO₂e/tkm, TOC distance classes and freighter versus belly (or aircraft type); — ocean: Y g CO₂e/tkm, TOC: trade lane specific; — inland waterway: x g CO₂e/tkm, load factor, vessel type; — rail: x g CO₂e/tkm, load factor, GHG emissions factors; — road: Z g CO₂e/tkm, TOC: pick-up/delivery versus line haul; — hub: X g CO₂e/tonne of freight; HOC – type of hub.
Sources for GHG emission factors	Provide reference and justification for the use of GHG emission factors in accordance with provisions of Annex I .	Refer to Annex I . Indicate where national and own factors are used for electricity and or other fuels (if certified) including deviation for all factors related to operation and/or energy provision.

Table 2 — Examples of reporting details for passenger transport

Report elements	Details to be provided	Breakdown
Operations in scope (covered by data)	Indicate what is in and what is out of the report.	All transport services in the system or indicate coverage (e.g. % of total transport activity or production output); all hub GHG emissions.
Total GHG emissions of transport and hubs (CO ₂ e)	Reporting at organizational level — Aggregated across all transport chains. — Also disaggregated by mode and hubs. — Share of primary and secondary data (for secondary data, distinguish the share of modelled and default): — in cases where the share differs for TOC parameters (e.g. vehicle size category, filling rate, street category/topography), indicate per parameter — Split total operational GHG emissions and energy provision GHG emissions: — disaggregate by energy carrier.	Examples for reporting at organizational level Mode (air/sea/inland waterway/rail/road/cable car) and hubs: — X tonnes CO₂e by mode across all operations in scope and cumulative at the organization level; — % of reported GHG emissions sourced from each data type (or indicate the main source if details not available): — split into TOC parameters regarding the data source; — routing/street category and topography: 100 % modelled; — load factor: primary data from own operations; — fleet composition: primary data from subcontractors. — Operational GHG emissions split into own assets and third-party assets: — total GHG emissions from, for example, diesel, LPG, SAF, electricity. — Energy provision GHG emissions expressed as total GHG emissions.
	Reporting at level of transport or hub service — Split by hub or transport service. — Share of primary and secondary data (for secondary data, distinguish share of modelled and default).	Examples for reporting at level of transport or hub service From a specific hub service or a specific transport service: — X tonnes CO₂e; — % of reported GHG emissions sourced from each data type (or indicate the main source if details not available); — details to be provided, for example:

Table 2 (continued)

Report elements	Details to be provided	Breakdown
	— Split total operational GHG emissions and energy provision GHG emissions: — disaggregate by energy carrier.	— air: (modelled/flight number and routing); — road: (primary/fleet data and load factor; default/routing and topography and reference to data source); — rail: (modelled/traction type, service type); — hub: (primary/energy consumption metered). Operational GHG emissions split into own assets and third-party assets; expressed in total GHG emissions: — total GHG emissions from, for example, diesel, LPG, SAF, electricity. Energy provision GHG emissions expressed in total GHG emissions.
GHG intensity	Reporting at organizational level — Average across modes for the overall organization. — Also disaggregate by mode and hubs.	Examples for reporting at organizational level Overall: g CO₂e/passenger kilometre (pkm) or per passenger for transport service users (aggregated across all operations in scope): — mode (air/ocean/inland waterway/rail/road/cable car) and hubs.
	Reporting at level of transport or hub service — Split by hub or transport service. — Indicate granularity of TOC/HOC applied per mode and hub type (as indicated in 6.3).	Examples for reporting at level of transport or hub service From a specific hub service or a specific transport service: — overall: g CO₂e/passenger kilometre (pkm); — air: X g CO₂e/pkm, TOC distance classes and aircraft type; — sea: Y g CO₂e/pkm, TOC: trade lane specific; — inland waterway: x g CO₂e/pkm, TOC, vessel type; — rail: x g CO₂e/pkm, TOC, train operation type; — road: Z g CO₂e/pkm, means of transport; — hub: X g CO₂e/passenger; HOC: type of hub.
Sources for GHG emission factors	Provide reference and justification for the use of GHG emission factors in accordance with provisions of Annex I .	Refer to Annex I . Indicate where national and own factors are used for electricity and or other fuels (if certified) including deviation for all factors related to operation and/or energy provision.

13.4.3 Transparent reporting from the use of modelled data or default GHG emission intensities

As set out further in [Annex M](#), the parameters used for the calculation of modelled data, and the underlying assumptions behind default GHG emission intensities, have a strong influence on the calculation outputs.

In order to provide transparency, calculations that rely on modelled data shall be transparent as to the model type (see [Annex M](#)) and the parameters included in the model, while calculations that rely on default GHG emission intensities shall state the source of the values used, justifying the reason for the choice if sources other than those referred to in [Annex Q](#) are used.

To help with transparency, the reporting organization shall complete [Table 3](#) for each model used and share it upon request. The table is based on the list of example parameters contained in [Annex M](#), and also provides the option to list any other relevant input parameters used.

The model output and its unit of measure shall be specified.

Table 3 — List of input parameters required to accompany reporting to ensure transparency of outputs from modelling and use of deviating default GHG emission intensities

Model type		
Energy based	Yes/No	
Activity based	Yes/No	

Parameter	Included Yes/No	Additional information If included, state predominant input data type
Vehicle fleet related		
Vehicle class/fleet profile	Yes/No/Not applicable	Primary/modelled/default
Energy consumption profile	Yes/No/Not applicable	Primary/modelled/default
Vehicle configuration	Yes/No/Not applicable	Primary/modelled/default
Body type/empty vehicle mass	Yes/No/Not applicable	Primary/modelled/default
Engine type	Yes/No/Not applicable	Primary/modelled/default
Engine emission class	Yes/No/Not applicable	Primary/modelled/default
Energy carrier(s) used in vehicle (electric, liquid fuel, etc.)	Yes/No/Not applicable	Primary/modelled/default
Share of energy carrier	Yes/No/Not applicable	Primary/modelled/default
Operational		
Freight type	Yes/No/Not applicable	Primary/modelled/default
Freight requirements (e.g. temperature control/hazardous)	Yes/No/Not applicable	Primary/modelled/default
Use of specific container types	Yes/No/Not applicable	Primary/modelled/default
Load factor or average load expressed in tonnes	Yes/No/Not applicable	Primary/modelled/default
Service type (e.g. full truckload/less than truckload, full container load/ less than container load)	Yes/No/Not applicable	Primary/modelled/default
Extent of empty trips	Yes/No/Not applicable	Primary/modelled/default

Table 3 (continued)

Parameter	Included Yes/No	Additional information If included, state predominant input data type
Journey characteristics		
Routing, including location of intermediate stops	Yes/No/Not applicable	Primary/modelled/default
Route characteristics	Yes/No/Not applicable	Primary/modelled/default
Location parameters	Yes/No/Not applicable	Primary/modelled/default
Direct/via locations/multiple collection and delivery	Yes/No/Not applicable	Primary/modelled/default
Drive cycle	Yes/No/Not applicable	Primary/modelled/default
Road type/channel type	Yes/No/Not applicable	Primary/modelled/default
Urban/mixed/long-haul	Yes/No/Not applicable	Primary/modelled/default
Frequency of stops	Yes/No/Not applicable	Primary/modelled/default
Speed profile	Yes/No/Not applicable	Primary/modelled/default
Topography	Yes/No/Not applicable	Primary/modelled/default
Geographic region of applicability	Yes/No/Not applicable	Primary/modelled/default
Currents/flow rate/head, cross or tail wind and windspeed	Yes/No/Not applicable	Primary/modelled/default
Additional items...		
...		
...		

Annex A (normative)

Air transport

A.1 Air transport specific boundary

This annex shall be applied to any energy-consuming solution of air transportation, manned or unmanned, the principal purpose of which is to transport passengers or freight, or both.

A.2 Recommended approach for defining air TOCs

TOCs for air transport should be structured based on a suitable combination of the influencing factors given in [Table A.1](#).

Table A.1 — Air TOC characteristics

Journey length	Plane configuration
Short (e.g. < 1 500 km)	Passenger aircraft without freight
Long (> 1 500 km)	Dedicated freight aircraft
	Passenger aircraft with belly freight

A.3 Calculation parameters

A.3.1 Transport activity distance

Transport activity distance for air transport shall be the GCD.

A.3.2 Distance adjustment factor

In accordance with [10.4](#) and [Formula \(25\)](#), if GHG emission intensities calculated using the actual distance are reported, a DAF shall be applied. This DAF should be calculated based on the best available information regarding manoeuvring and other deviations from the GCD. This should be noted alongside the value provided. The DAF should be relevant to the context in which the transportation occurs. If information specific to the transport chain is not available, a DAF calculated using the ratio GCD plus 95 km divided by the GCD shall be used, where 95 km represents the difference between the actual distance and the transport activity distance due to manoeuvring and other deviations from the GCD.

A.4 Mode-specific considerations

A.4.1 General

Practice regarding the process of allocation of GHG emissions between passengers and freight has been split in recent times. Previous industry guidance to include a 50 kg allowance per seat, representing the mass of passenger infrastructure (e.g. seat, galley equipment) in allocation calculations is being withdrawn. This does not preclude future research into possible alternative allocation principles for freight travelling on passenger aircraft that would support the goal of real-world GHG emission reduction through the use of spare belly cargo capacity.

A.4.2 Transport activity for passenger aircraft with belly freight

In the case of TOCs in which the main function is passenger transportation with belly freight, the provisions of [5.4.3](#) and [8.4.7](#) shall be applied for calculation of transport activity.

Two options are provided in [5.4.3](#) for the general case of combined transport of passengers and freight. In this instance, the first option should be used, based on either the actual mass of passengers or a standard equivalence of 100 kg for a passenger and their baggage.

Then, the unit of transport activity shall be the tonne kilometre (preferred) or the passenger-equivalent kilometre (peqkm).

A.5 Transport activity for passenger with different classes of travel

In the case of TOCs in which passenger aircraft offers different classes of travel, [8.4.5](#) shall be applied for calculation of transport activity. Then, the unit of transport activities for passengers shall be the “passenger of lowest class equivalent kilometre” (plceqkm).

NOTE Air transport is probably the mode where allocation according to classes is the most relevant, as GHG emissions per trip are relatively high (due to distances travelled and energy carriers being fossil fuels), and differences in area per seat between the lowest and the highest class are significant (ratio 4:1 or even more). This issue is introduced in [8.4.5](#) and expanded in [Annex L](#). Examples for flights with four and two classes are presented in [L.3.2](#) and [L.3.3](#), respectively.

Annex B (normative)

Cable car transport

B.1 Cable car transport specific boundary

This annex shall be applied to any energy-consuming cable car system, the principal purpose of which is to transport passengers or freight, or both.

Any cable car system, even if designed with several vehicles, should be considered as an indivisible transport system, including its dedicated infrastructure.

B.2 Recommended approach for defining cable car TOCs

TOCs for cable car transport should be structured based on a suitable combination of the influencing factors given in [Table B.1](#) for cable car freight transport and [Table B.2](#) for cable car passenger transport.

Table B.1 — Freight cable car TOC characteristics

Operation type	Configuration	Technology	System
Industrial transport	Aerial cable car	Unidirectional monocable	Fixed-grip buckets Detachable buckets
		Unidirectional bi-cable	Material 2S Material 3S
		Reversible bi-cable (jigback)	Material cable car Cable crane
	Surface cable car	Material train drawn by rope(s)	Bucket train
		Funicular	Material funicular

Table B.2 — Passenger cable car TOC characteristics

Operation type	Configuration	Technology	System
Urban transport Mountain transport Touristic site transport	Aerial cable car	Unidirectional monocable	Fixed-grip chair lift
			Fixed-grip gondola
		Detachable chair-lift	Detachable chair-lift
			Detachable gondola
	Surface cable car	Reversible monocable (jigback)	Jigback gondola
		Unidirectional bi-cable	2S
			3S
		Detachable 2S	Detachable 2S
			Detachable 3S
		Reversible bi-cable (jigback)	Cable car
			Aerial tramways
		Train drawn by rope(s)	Horizontal train
		Automated people movers (APMs)	Automated people movers (APMs)
			Funicular
		Inclined elevators	Inclined elevators
			Draglift with rod
		Draglift with springbox	Draglift with springbox
		Low level ski-tows	Low level ski-tows

B.3 Calculation parameters

B.3.1 Transport activity distance

The transport activity distance for cable car transport should be the cable car length corresponding to the longest distance one vehicle can travel in one direction, moved by one piece of machinery, considering the cable car network (the SFD) or the GCD. If two or more cable cars are interconnected, allowing a vehicle to travel along different sections moved by different pieces of machinery, each section shall be considered as one cable car.

B.3.2 Distance adjustment factor

In accordance with [10.4](#) and [Formula \(25\)](#), if GHG emission intensities calculated using the actual distance are reported, a DAF shall be applied. The limited number of route options available within the cable car network leads to little opportunity for deviation between the actual distance and the SFD, meaning that a DAF is not required in the majority of cases. However, where there is an unplanned deviation, the DAF is likely to be specific to the individual circumstances of the deviation and can be developed on a case-by-case basis.

B.4 Mode-specific considerations

For some passenger cable car networks, detailed data on passenger journeys that allow specific passenger journey distances to be derived are not always available. In such circumstances, the average distance per journey derived from a combination of passenger surveys and network modelling may be used.

Assessing GHG emissions for cable cars can be based on primary measured data or secondary (modelled) data. Commonly, combinations of the two are needed and used.

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Annex C (normative)

Inland waterway transport

C.1 Inland waterway transport specific boundary

This annex shall be applied to any energy-consuming mode of inland waterway transportation, the principal purpose of which is to transport passengers or freight, or both. The provisions of this annex apply to energy-related GHG emissions linked to the consumption of energy for the propulsion of the vessel as well as maintenance of freight in the condition required by the owner of the goods and passengers at the required conditions for comfortable passage. When in port, or at other locations where transfer of freight or passengers takes place, GHG emissions related to the vessel's GHG activity data shall be calculated and reported as part of the inland waterway TOC. This implies that any energy supplied from shore that is stored and subsequently used for propulsion or used to maintain goods or passengers that remain part of the ship's freight, particularly electrical energy, shall be included as part of the vessel operator's GHG activity data. Similarly, refrigerant GHG emissions related to the maintenance of freight or passengers at required temperatures shall be considered as part of the inland waterway TOC, even when replenishment of the refrigerants occurs during a port call.

C.2 Recommended approach for defining inland waterway TOCs

TOCs for inland waterway transport should be structured based on a suitable combination of the influencing factors given in [Table C.1](#) for inland waterway freight transport and [Table C.2](#) for inland waterway passenger transport.

Table C.1 — Inland waterway freight TOC characteristics

Freight type	Vessel size category	Vessel configuration	Condition	Waterway type
Dry bulk	< 50 m	Individual vessel	Ambient	Canal
Liquid bulk	50 m to 80 m	Pushed convoy	Temperature-controlled	River
Containerized	80 m to 110 m			Lake
Mass-limited, general freight	110 m to 135 m			
Volume-limited, general freight	> 135 m			

Table C.2 — Inland waterway passenger TOC characteristics

Vessel operation type	Vessel size category	Condition	Waterway type
River cruise	Varies by vessel type	Transport only	Canal
Ro-Pax river ferry		Transport plus other services (restaurant, accommodation, etc.)	River
Waterbus			Lake
Water taxi			

C.3 Calculation parameters

C.3.1 Transport activity distance

Transport activity distance for inland waterway transport should be either the SFD, taking into account the inland waterway network, or the GCD.

NOTE Appropriate distance calculators can be used to help identify inland waterway distances as accurately as possible.

C.3.2 Distance adjustment factor

In accordance with [10.4](#) and [Formula \(25\)](#), if GHG emission intensities calculated using the actual distance are reported, a DAF shall be applied. This DAF should be calculated based on the best available information regarding deviations from the transport activity distance. The limited number of route options available within the inland waterway network leads to little opportunity for deviation between the actual distance and the SFD. In such circumstances, any difference in transport activity used by the transport operator to calculate the GHG emission intensity and the transport activity used by their service users is not likely to be significant and a DAF is not required at the calculation stage.

C.3.3 Alternatives to mass-based calculation

The TEU may be used as an alternative parameter to mass of freight for containerized transport.

C.4 Identification of water current effects for inland waterway modes

For inland waterway transport operations, water direction (e.g. whether with or against the current) can have an important impact on energy consumption. Any calculation of GHG emissions shall be applied on a round-trip basis to average this impact across the transport operations and conform with the provisions of [6.3.2](#).

Annex D (normative)

Transport by pipeline

D.1 Pipeline transport specific boundary

D.1.1 General

Pipeline transport refers to freight transport only, and no passenger transport is considered within pipeline transport.

D.1.2 Pipeline operations to be included in GHG emission calculation

Pipeline operations that should be included in the GHG emission calculation are limited to the energy needed by equipment located within the pipeline network to move the product through the pipeline, i.e. transport, and to keep the relevant pressure level.

See ISO 14064-1:2018, Annex B, for pipeline activities and associated emissions or removals that are not covered in this document. ISO 14064-1:2018, Annex B, provides examples of subcategorization and identification of associated sources and sinks, including direct process emissions and removals from industrial processes which include upstream (extraction) and downstream activities (oil and gas processing/refining).

NOTE Direct fugitive GHG emissions can come from systems that deliver fossil fuels (e.g. flanges, valves, unions, threaded connections).

When comparing pipeline transport with other modes, the user shall consider the fact that the commodity can be transported at different pressures or temperature levels. The relevant differential compression, cooling or heating processes with their energy use and related GHG emissions shall be covered in such a comparison.

D.1.3 Operations to be excluded from GHG emission calculation

Excluded from the GHG emissions calculation of pipeline transport is the initial compression of the medium (e.g. liquefied gas) or pumping needed for feeding the pipeline, located at the production site (start of the transport chain) or at transshipment point/terminal (within the transport chain). The latter shall be allocated to hubs (see [Annex H](#)).

D.2 Recommended approach for defining pipeline TOCs

If the TCE comprises pipeline transport, the TOC related to this TCE can be the activity of a relevant pipeline section or network over one year for all operations and medium transported by this pipeline section or network.

D.3 Calculation parameters

D.3.1 Transport activity distance

Transport activity distance for pipeline transport should be either the SFD, taking into account the pipeline network, or the GCD.

D.3.2 Distance adjustment factor

In accordance with [10.4](#) and [Formula \(25\)](#), if GHG emission intensities calculated using the actual distance are reported, a DAF shall be applied. The limited number of route options available within the pipeline network leads to little opportunity for deviation between the actual distance and the SFD. In such circumstances, any difference in transport activity used by the transport operator to calculate the GHG emission intensity and the transport activity used by their service users is not likely to be significant and a DAF is not required at the calculation stage.

D.3.3 Alternatives to mass-based calculation

In addition to the quantity of freight expressed in mass, other parameters can be used, e.g. volume.

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Annex E (normative)

Rail transport

E.1 Rail transport specific boundary

This annex shall be applied to any energy-consuming mode of rail transportation, the principal purpose of which is to transport passengers or freight, or both.

The following exclusions apply:

- any internal moves that are entirely contained within the boundaries of a hub and hence are accounted for as part of the HOC;
- any movements by vehicles whose primary purpose is not for the carriage of freight and/or passengers.

For the avoidance of doubt, the following are taken into account as part of the train TCE in accordance with the general provisions of this document:

- electricity transmission losses (included as part of the electricity GHG emission factor);
- energy re-injected to the grid as a result of brake regeneration of electricity;
- energy used for train propulsion even if using energy supplied from a system provided by a hub operator.

E.2 Recommended approach for defining rail TOCs

TOCs for rail transport should be structured based on a suitable combination of the influencing factors given in [Table E.1](#) for rail freight transport and [Table E.2](#) for rail passenger transport.

Table E.1 — Rail freight TOC characteristics

Operation type	Freight type	Condition	Propulsion
Long-distance freight transport: block train	Average/mixed	Ambient	Electric motor: fixed electricity supply system (catenary, third rail)
Long-distance freight transport: single wagon	Containerized/swap bodies	Temperature-controlled	Electric motor: on train battery energy storage
Long-distance freight transport: intermodal wagon	Dry bulk		Electric motor: fuel cell energy storage
	liquid bulk		Combustion engine
Short-distance freight transport (feeder services)	Vehicle transport		Other
	Semi-trailers		
	Other		

Table E.2 — Rail passenger TOC characteristics

Train operation type	Passenger experience	Propulsion
Long-distance passenger trains	Night trains (slow trains)	Electric motor: fixed electricity supply system (catenary, third rail)
Short-distance passenger regional trains	Vehicle trains (slow trains)	Electric motor: on train battery energy storage
Urban passenger: suburban trains	Luxury trains (slow trains)	Electric motor: fuel cell energy storage
Urban passenger: tram (streetcar)	High-speed trains	Combustion engine
Urban passenger: underground (subway, metro)	Other	Other

E.3 Calculation parameters

E.3.1 Transport activity distance

Transport activity distance for rail transport should be either the SFD, taking into account the rail network, or the GCD.

NOTE To help identify rail distances, some rail carriers and GHG emission calculation tools offer a rail distance calculator to their users or make one publicly available.

E.3.2 Distance adjustment factor

In accordance with [10.4](#) and [Formula \(25\)](#), if GHG emission intensities calculated using the actual distance are reported, a DAF shall be applied. The limited number of route options available within the rail network leads to little opportunity for deviation between the actual distance and the SFD, meaning that a DAF is not required in the majority of cases. However, where there is an unplanned deviation, the DAF is likely to be specific to the individual circumstances of the deviation and can be developed on a case-by-case basis.

E.3.3 Alternatives to mass-based calculation

The TEU may be used as an alternative parameter to mass for the quantity of freight for containerized transport.

Area for passengers may be a better allocation basis where the galley, restaurants, sleeping wagon, accompanying cars and class can be embedded (see [Clause E.5](#) on class of travel).

E.4 Mode-specific considerations

E.4.1 Consideration of data availability and rail networks

For some rail transport operations, particularly urban rail systems (e.g. streetcar/tram), detailed data on passenger journeys that allow specific passenger journey distances to be derived are not always available. In such circumstances, the average distance per journey derived from a combination of passenger surveys and network modelling may be used.

The full transport chain for cargo wagon load transport by rail can involve a network that comprises pickup/delivery, feeder and long-distance transport, each with their own characteristics, as shown in [Figure E.1](#).

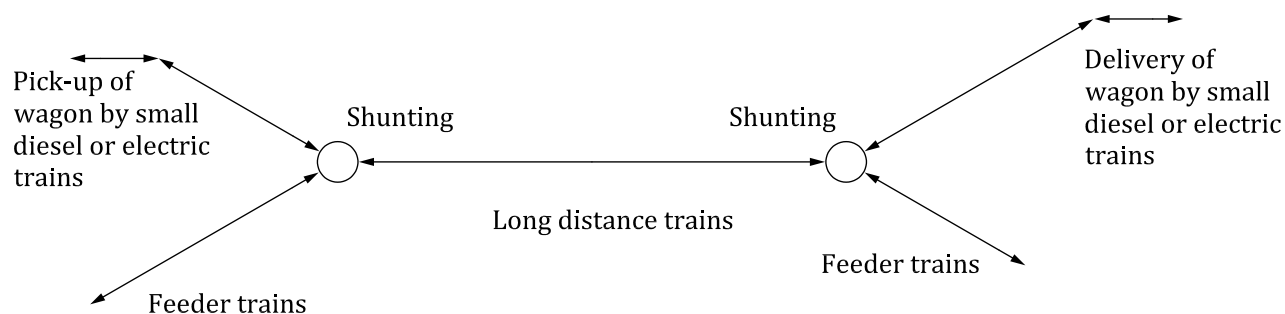


Figure E.1 — Schematic illustration of the possible elements of a cargo wagon load freight transport chain

E.4.2 Allocation for mixed passenger and freight operations in rail transport

For calculation purposes, this shall be treated as a single TOC.

Two options are provided in 5.4.3 for the general case of combined transport of passengers and freight. In this instance, the second option, based on the use of passenger equivalents, should be used.

Table E.3 provides standard values for the number of passenger equivalents that should be used in this calculation.

Table E.3 — Standard passenger-equivalent values for rail transport

Passenger transport		Freight transport	
	peq		peq
Individual passenger (including luggage)	1,0	Small van	1,3
Passenger car	1,3	Large van	3,5
Bus/coach	10,0	Rigid truck	10
Caravan, small	1,1	Articulated truck	18
Caravan, medium	2,3	Unaccompanied trailer	14
Caravan, large	3,5		
Mobile home	3,5		
Motorcycle	0,3		
NOTE The passenger-equivalent values are based on a combination of mass-based and volume-based equivalence. Using these two inputs appears to provide a balanced outcome that does not unduly favour either passengers or freight at the allocation stage.			

The number of passenger equivalents of a passenger vehicle shown in Table E.3 excludes the passengers transported, meaning that the total number of passenger equivalents for a car carrying three passengers is 4,3, i.e. 1,3 for the car itself plus three for the passengers.

The GHG activity data, and hence the GHG emissions, shall subsequently be calculated at the level of an individual passenger for a passenger transport chain, or a consignment for a freight transport chain, in accordance with the standard rules for passenger or freight transport, respectively.

E.5 Allocation of GHG emissions to passenger by class of rail travel

Rail transport is a mode where allocation according to classes can be relevant for regional and long-distance TOCs, as differences in area per seat between the lowest and the highest class are clear. This issue is developed in 5.4.3 and 8.4.5 and expanded in Annex L. Examples for rail journeys with two and three classes are presented in L.4.2, L.4.3 and L.4.4.

Annex F (normative)

Road transport

F.1 Road transport specific boundary

This annex shall be applied to any energy-consuming form of road transportation, the principal purpose of which is to transport passengers or freight, or both.

In some business models, a shift from transportation that uses energy to transportation that does not use any energy is feasible (e.g. replacing vans/trucks in mail and parcel delivery with foot and bicycle delivery). In these cases, the transport activity distance shall be taken into account in the calculation of the transport chain transport activity, although zero GHGs are emitted in this TCE.

Transportation operations with a principal purpose to serve as medically-assistive personal mobility aids shall be excluded (e.g. motorized wheelchairs, ambulance transport).

F.2 Recommended approach for defining road TOCs

TOCs for road transport should be structured based on a suitable combination of the influencing factors given in [Table F.1](#) for road freight transport and [Table F.2](#) for road passenger transport.

Table F.1 — Road freight TOC characteristics

Freight type	Condition	Journey type	Contract type
Dry bulk	Ambient	Point-to-point (long haul)	Shared transport
Liquid bulk	Temperature-controlled	collection and delivery	Dedicated contract (charter)
Containerized			
Palletized			
Vehicle transport			
Mass-limited, general freight (heavy cargo)			
Volume-limited, general freight (light cargo)			

Table F.2 — Road passenger TOC characteristics

Means of transport	Journey type	Level of passenger loading
Shared public transport (e.g. bus, coach, trolleybus)	Urban	Discrete number of individuals (1, 2, 3, etc.)
Shared private transport (taxi)	Suburban	
Private transport (e.g. own car, bicycle, scooter, motorbike)	Regional	Average occupancy rate
	Long-distance	
	Dedicated lines (e.g. school bus)	

Additional factors can be relevant for defining a highly specific TOC, e.g. topography, road type (highway versus urban versus rural), vehicle mass category, wagon/trailer body type.

EXAMPLE 1 If the TCE is part of a collection and/or delivery round, the TOC can be a group of similar collection and delivery rounds, e.g. from the same hub.

EXAMPLE 2 If the TCE is a trip of a passenger in a public transport bus, the TOC can be the whole bus line from starting point to the ending point. It is also possible to choose the whole bus network if the network is considered to be sufficiently homogeneous.

F.3 Calculation parameters

F.3.1 Transport activity distance

Transport activity distance for road transport should be either the SFD, taking into account the road network, or the GCD. Examples of SFD values include SFD estimates as calculated by distance/route, planning software or maps. For more accurate results, use the most specific and recent information.

F.3.2 Distance adjustment factor

In accordance with [10.4](#) and [Formula \(25\)](#), in cases where transport distance type used for transport activity differs from transport distance type used for GHG emission intensity, a DAF shall be applied. This DAF should be calculated based on the best available information regarding deviations from the transport activity distance. The DAF should be relevant to the context in which the transportation occurs. If no specific operational DAF is available, an estimated global value can be used.

In the case of the SFD being used as the transport activity distance and actual distance being used to calculate the GHG emission intensity, a DAF shall be applied. The GLEC Framework^[15] recommends using a DAF of 1,05 to increase the SFD by 5 % in order to allow for any incidental transport distance travelled that is not part of the planned route. The impact of any additional detours will already be accounted for in the measured energy consumption value.

If an alternative to the shortest feasible route serves in practice as the primary route (e.g. to avoid tolls, congestion, sharp inclines), then the transport operator should notify the transport user of this alternate route so that a more accurate transport activity distance is used in GHG emission calculations.

F.3.3 Alternatives to mass-based calculation

Calculations on a per-item basis or a per-TEU basis are likely to be common for mail and parcel collection and delivery rounds, and containerized road transport, respectively.

F.4 Mode-specific considerations

F.4.1 Specific case of calculation of transport activity for collection and delivery rounds

Many road transport operations, particularly in urban areas, fall into the TOC “collection and delivery rounds”. These are shared transports which include various stops where parts of the load are discharged and an additional load is picked up, thereby changing the load factor from stop to stop. The start and end point of a collection and delivery round can be the same location, e.g. a hub that forms part of a bigger hub and spoke network, or at different locations.

For collection and delivery rounds with multiple stops, the total energy and GHG emissions for each consignment should be calculated according to its share of the transport activity, based on the loading and unloading points of each individual consignment. In accordance with [5.4](#), the transport activity should be the quantity of freight multiplied by the transport activity distance (tkm).

F.4.2 Transport activity distance for collection and delivery rounds

In accordance with [5.4](#), the transport activity distance should be either SFD or GCD between the loading and unloading points. This may bear no resemblance to the route or actual distance between the loading and unloading points.

For post and parcel services only, where knowledge of individual consignments is limited and delivery tracking is not viable, the total GHG emissions may be calculated on a per-item basis or by share of

freight mass. In such circumstances, the transport activity in tonne kilometres between the individual loading and unloading points may be estimated rather than precisely calculated to maintain consistency throughout the full transport chain. This estimation may rely on modelling the collection and delivery rounds, and establishing average values for distances of rounds, distances travelled by consignments and consignment masses in order to fulfil the conditions of 5.4. Linked to this, a GHG emission intensity based on an alternative metric to tonne kilometres may be reported across all TCEs of the transport chain. Any such choices shall be clearly documented.

F.4.3 Hub and spoke networks

Hub and spoke networks usually consist of multiple primary hubs/distribution centres where cargo is collected and delivered via collection and delivery rounds for a relatively short-distance journey and transferred onto one or more different vehicles to be conveyed long distances (line haul) through a series of hubs of varying sizes. When considering a calculation for a hub and spoke network, the principles of establishing a series of TOCs should be applied as per Clause 6 so that the GHG emissions of each TCE within a transport chain of the hub and spoke network can correspond to a different TOC.

Figure F.1 shows a schematic of a less-than-truckload network with its different elements.

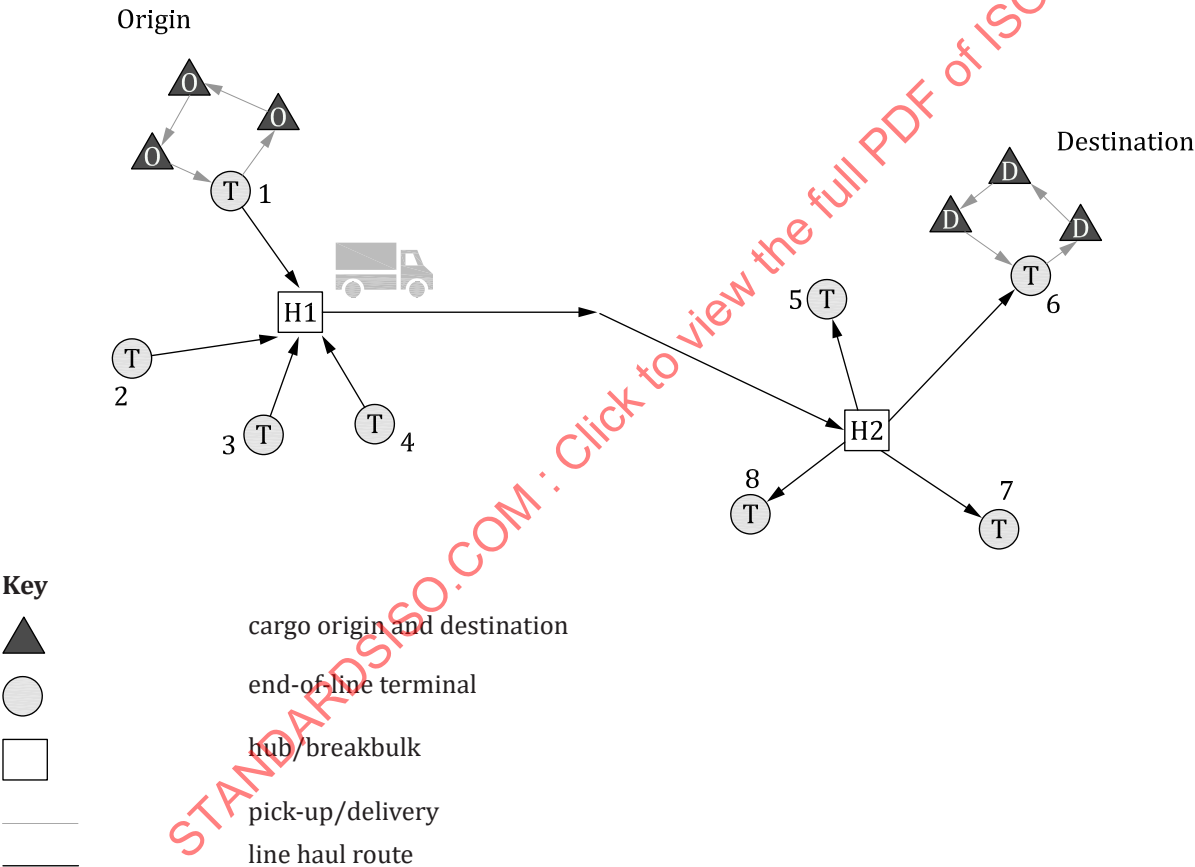


Figure F.1 — Schematic diagram showing a selection of the different elements that comprise a less-than-truckload network

F.4.4 Calculation time period

The operational data for regular transport operations should be aggregated over periods of up to one year (calendar year) to remove seasonal fluctuations or any transient impact on long-term trends. Other time aggregations are permitted under the condition that deviations from the general rule of yearly aggregation are noted and reported. In particular, the short duration and high frequency of some road transport operations makes the use of aggregation periods shorter than one year more relevant than

for other modes. An example of where an alternative time period can be appropriate is when a coach service only operates between an airport and a ski resort during the winter months.

F.4.5 General passenger transport

For some road transport passenger TOCs (e.g. bus), detailed data on passenger journeys that allow specific passenger journey distances are not always available. In such circumstances, the average journey distance per journey derived from a combination of passenger surveys and network modelling may be used.

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Annex G (normative)

Sea transport

G.1 Sea transport specific boundary

This annex shall be applied to any energy-consuming mode of sea transportation, the principal purpose of which is to transport passengers or freight, or both.

The provisions of this annex apply to energy-related GHG emissions linked to the consumption of energy for the propulsion of the vessel as well as the maintenance of freight in the condition required by the owner of the freight and passengers at the required conditions for comfortable passage.

When in port, or at other locations where transfer of freight or passengers takes place, GHG emissions related to the vessel's GHG activity data shall be calculated and reported as part of the sea TCE.

This implies that any energy supplied from shore that is stored and subsequently used for propulsion or used to maintain goods or passengers that remain part of the ship's freight, particularly electrical energy, shall be included as part of the vessel operator's GHG activity data. Similarly, refrigerant GHG emissions related to the maintenance of freight or passengers at required temperatures shall be considered as part of the sea TOC, even when replenishment of the refrigerants occurs during a port call.

G.2 Recommended approach for defining sea TOCs

G.2.1 General

TOCs for sea transport should be structured based on a suitable combination of the influencing factors given in [Table G.1](#) for sea freight transport, [Table G.2](#) for sea passenger transport and [Table G.3](#) for combined sea transport of passengers and freight.

Table G.1 — Sea freight TOC characteristics

Vessel type	Freight condition	Service type
Bulk carrier	Ambient	Scheduled (by origin and destination pairs)
Chemical tanker	Temperature-controlled	Tramp
General cargo	Mixed ambient and temperature-controlled	
Ro-Ro		
Liquefied gas tanker		
Oil tanker		
Other liquid tanker		
Container		
Vehicle carrier		
Key		
Ro-Ro: roll-on roll-off freight		

Table G.2 — Sea passenger TOC characteristics

Vessel type	Vessel size	Service type
Passenger ferry	Varies by vessel type (see Table G.4)	Scheduled (by origin and destination pairs)
Cruise ship		Chartered

Table G.3 — Mixed sea freight/passenger TOC characteristics

Vessel type	Vessel size	Service type
Ro-Pax ferry	Varies by vessel type (see Table G.4)	Scheduled (by origin and destination pairs) Chartered
Key		
Ro-Pax: mixture of roll-on roll-off freight and passengers		

G.2.2 Vessel-based categorization

The list of ship types set out in the International Maritime Organization (IMO) Fourth GHG Study,^[38] and presented in [Table G.4](#), combines freight type, vessel type, vessel size categories and freight condition (for fully temperature-controlled ships), into a commonly applicable set of TOCs for use where a vessel-based categorization is helpful. (For further detail of the process of developing the list of ship types, see section 2.2.1 of the IMO study.^[38]) This is particularly the case for charter services where the individual vessel is known to both parties in the charter agreement. In such circumstances, the use of primary data is preferred, meaning that the TOC categorization is merely for information. However, if primary data are not available then the TOC parameters become relevant to specify modelling or choice of default values.

Table G.4 — List of ship types set out in the IMO Fourth GHG study^[38]

Ship type	Size category	Unit
Bulk carrier	0 to 9 999	dwt
	10 000 to 34 999	dwt
	35 000 to 59 999	dwt
	60 000 to 99 999	dwt
	100 000 to 199 999	dwt
	200 000+	dwt
Refrigerated bulk	0 to 1 999	dwt
	2 000 to 5 999	dwt
	6 000 to 9 999	dwt
	10 000+	dwt
Chemical tanker	0 to 4 999	dwt
	5 000 to 9 999	dwt
	10 000 to 19 999	dwt
	20 000 to 39 999	dwt
	40 000+	dwt
General freight	0 to 4 999	dwt
Key		
dwt: deadweight tonnes		
cbm: cubic metres		
GT: gross tonnes		

Table G.4 (continued)

Ship type	Size category	Unit
	5 000 to 9 999	dwt
	10 000 to 19 999	dwt
	20 000+	dwt
Liquefied gas tanker	0 to 49 999	cbm
	50 000 to 99 999	cbm
	100 000 to 199 999	cbm
	200 000+	cbm
Oil tanker	0 to 4 999	dwt
	5 000 to 9 999	dwt
	10 000 to 19 999	dwt
	20 000 to 59 999	dwt
	60 000 to 79 999	dwt
	80 000 to 119 999	dwt
	120 000 to 199 999	dwt
	200 000+	dwt
Other liquids tankers	0 to 999	dwt
	1 000+	dwt
Container	0 to 999	TEU
	1 000 to 1 999	TEU
	2 000 to 2 999	TEU
	3 000 to 4 999	TEU
	5 000 to 7 999	TEU
	8 000 to 11 999	TEU
	12 000 to 14 499	TEU
	14 500 to 19 999	TEU
	20 000+	TEU
Ferry: Pax only	0 to 299	GT
	300 to 999	GT
	1 000 to 1 999	GT
	2 000+	GT
Cruise	0 to 1 999	GT
	2 000 to 9 999	GT
	10 000 to 59 999	GT
	60 000 to 99 999	GT
	100 000 to 149 999	GT
	150 000+	GT
Ferry: Ro-Pax	0 to 1 999	GT
	2 000 to 4 999	GT
	5 000 to 9 999	GT
	10 000 to 19 999	GT
Key dwt: deadweight tonnes cbm: cubic metres GT: gross tonnes		

Table G.4 (continued)

Ship type	Size category	Unit
	20 000+	GT
Ro-Ro	0 to 4 999	dwt
	5 000 to 9 999	dwt
	10 000 to 14 999	dwt
	15 000+	dwt
Vehicle	0 to 29 999	GT
	30 000 to 49 999	GT
	50 000+	GT
Key dwt: deadweight tonnes cbm: cubic metres GT: gross tonnes		

G.2.3 Service-based categorization

Service-based categorization provides a useful basis for defining the TOCs where the transport service user purchases transport for freight or passengers between the origin and the destination without knowing, or being able to choose, the specific vessel they or their freight will travel on. This is often the case for container, Ro-Ro, Ro-Pax or Pax only ferry lines.

In such cases, the transport operator is sometimes able to provide aggregated values that are representative for the overall operation based on the schedules that are in place.

G.3 Calculation parameters

G.3.1 Transport activity distance

Transport activity distance for sea transport should be either the SFD, taking into account the overall route and specific channels available to the vessel in question, or the GCD. Several specific sea transport distance calculators are available. For more accurate results, use the most specific and recent information.

G.3.2 Distance adjustment factor

In accordance with [10.4](#) and [Formula \(25\)](#), if the transport distance type used for transport activity differs from the transport distance type used for GHG emission intensity, a DAF shall be applied. This DAF should be calculated based on the best available information regarding deviations from the transport activity distance. The DAF should be relevant to the context in which the transportation occurs. If no specific operational DAF is available, a default global value can be used, e.g. Clean Cargo recommends using a DAF of 1,15 to increase the SFD by 15 %. ^[15] This is based on actual sea transport distances being, on average, 15 % greater than the shortest feasible port-to-port route.

G.3.3 Alternatives to mass-based calculation

For containerized shipping, the number of TEU slots available onboard is both the primary limiting characteristic and the mechanism by which bookings are made. As such, the TEU is the unit established within the industry for calculation and is recommended as the unit to be combined with the transport activity distance when calculating transport activity in this specific subsector.

G.4 Mode-specific considerations

G.4.1 Calculation time period

This methodology can be applied over a defined period during which multiple journeys occur, provided that all input values represent transportation operations that occur during the same time period. For journeys with multiple elements, GHG emissions for each element shall be calculated individually over the same time period according to the manner described for individual journey legs and chartered routes before aggregation.

In practice, for high frequency, regular, repeatable or short duration transport (e.g. container shipping operations), it is common for the operator to aggregate a year's worth of operational data for transportation operations that occur during that time period. This has the benefit of removing seasonal fluctuations from the reported results that can obscure more significant long-term trends.

The charter operations that are common within bulk shipping represent an example of where it is appropriate to deviate from the use of annual data aggregation and instead perform journey-specific quantification and reporting because they are often one-off, non-repeating journeys, with specific characteristics and for which the data are identifiable for the individual journeys in the systems of both the transport operator and the transport service user. The opportunity still exists for both the transport operator and the service user to subsequently aggregate journey data into annual reporting.

G.4.2 Allocation for mixed temperature-controlled consignments

In some circumstances, it is necessary to transport freight that needs to be kept under specific conditions (e.g. within a defined temperature range) on the same vessel as freight that is at ambient conditions.

For calculation purposes, this shall be treated as a single TOC. The GHG activity data and hence the GHG emissions shall subsequently be allocated between the ambient and temperature-controlled consignments based on the share of energy required to move the freight, applicable to all consignments, and the energy used specifically to maintain the temperature-controlled freight within the required temperature range.

G.4.3 Allocation for mixed passenger and freight operations — Ro-Pax ferries

For calculation purposes, this shall be treated as a single TOC.

For sea transport, the main instance of combined transport of passengers and freight is the case of Ro-Pax ferries, which are identified within the IMO classification as a ship type with 5 size subcategories (see [Table G.4](#)). Two options are provided in [5.4.3](#) for the general case of combined transport of passengers and freight. In this instance, the second option, based on the use of passenger equivalents, should be used.

[Table G.5](#) gives standard values for the number of passenger equivalents that should be used in this calculation.

Table G.5 — Standard passenger-equivalent values for Ro-Pax ferries

Passenger transport		Freight transport	
	peq		peq
Individual passenger (including luggage)	1,0	Small van	1,3
Passenger car	1,3	Large van	3,5
Bus/coach	10,0	Rigid truck	10
Caravan, small	1,1	Articulated truck	18
Caravan, medium	2,3	Unaccompanied trailer	14
Caravan, large	3,5		
Mobile home	3,5		
Motorcycle	0,3		
NOTE The passenger-equivalent values contained are based on a combination of mass-based (including the mass of passenger decks) and volume-based equivalence. Using these two inputs appears to provide a balanced outcome that does not unduly favour either passengers or freight at the allocation stage.			

The number of passenger equivalents of a passenger vehicle shown in [Table G.5](#) excludes the passengers transported meaning that the total number of passenger equivalents for a car carrying three passengers is 4,3, i.e. 1,3 for the car itself plus three for the passengers.

The GHG activity data and hence the GHG emissions shall subsequently be calculated at the level of an individual passenger for a passenger transport chain, or a consignment for a freight transport chain, in accordance with the standard rules for passenger or freight transport, respectively.

Annex H (normative)

Hubs

H.1 Hub-specific boundary

H.1.1 General

This annex shall be applied to any hub enabling the transport chain from:

- the shipper to the consignee (for freight);
- the origin of a journey to the final destination of the journey (for passengers).

Hubs include, but are not limited to, rail/road terminals, cross-docking sites, airport terminals, terminals at sea ports and distribution centres. Hubs for freight, also known as “logistics hubs”, are self-contained facilities for handling freight, including freight acceptance and release, security and documentation that connects freight within or to other modes of transport. The equivalent for passengers is self-contained facilities for the connection of passenger transport within or to other modes of transport, such as ferry terminals, airport terminals and railway stations.

H.1.2 Hub operations to be included in hub GHG emission calculation

All hub operations (enabling the transport chain from the originator of a consignment to the consignee or the origin of a journey to the final destination of the journey) that consume energy or cause refrigerant leakage are included.

GHG emissions resulting from energy use by dedicated vehicles or other equipment that move vehicles/vessels, trailers or containers (e.g. shunting, push boats, aircraft pushers) within a hub, or shuttles that transport employees who steer self-driving vehicles within a roll on/roll off terminal, or relating to air conditioning of these vehicles/vessels, shall be included in hub operation calculations, regardless of whether outdoor or indoor, as are e.g. pilot boats or tug vessels.

GHG emissions related to electricity used to cool refrigerated containers or vehicles, whether indirect GHG emissions from purchased electricity or direct GHG emissions resulting from on-site electricity generation shall be allocated to hub operations.

GHG emissions resulting from energy use for handling luggage accompanying passengers shall be included and allocated to hub operations for passenger transfer; GHG emissions resulting from energy use for handling pre-shipping luggage shall be allocated to hub operation for freight transshipment as they refer to package freight.

GHG emissions resulting from processes for storage of goods at hubs, such as warehousing, may be calculated as described for transshipment processes.

H.1.3 Operations to be excluded from the hub GHG emission calculation

Inbound or outbound transport operations of the previous or subsequent TCE (e.g. vehicles or vessels entering or leaving the hub) are not part of the calculation. Any related GHG emissions caused by energy consumption or refrigerant leakage shall be accounted within the relevant TCE. As is any grid electricity used to charge electric vehicles leaving the hub (e.g. electric vans or cars).

GHG emissions related to energy used by vehicles or vessels while temporarily at a hub should be allocated to the transport operation. Examples include energy used by auxiliary or main engine of a

vehicle/vessel/aircraft or provided by ground power units (airports) or shore power (in ports). Users may, alternatively, assign such GHG emissions to hub operations but shall do this in a consistent manner in order to ensure all GHG emissions are allocated and documented transparently.

Refill of refrigerants into refrigerated containers or vehicles shall be allocated to transport operations of respective inbound or outbound TCE (in accordance with [Annex I](#)).

Hosting of people for the purpose of staying (e.g. hotels, restaurants) is excluded, as is the parking of cars for previous or subsequent passenger transport legs (e.g. car parks, including car rental facilities), commuting of hub employees and shopping malls.

Energy consumption needed for ICT services purchased by external server providers shall be excluded from the hub GHG emission calculation, see [Annex N](#). GHG emissions resulting from self-driving cargo (e.g. in roll on, roll off terminals) are also excluded.

H.2 Recommended approach for describing HOCs

The choice of HOC should reflect the needs of the user of this document, taking into account GHG activity data availability and relevance to the particular transport chain under consideration. HOCs should be structured based on a suitable combination of the influencing factors given in [Table H.1](#).

Main stations and regional stations within a national rail network may be grouped separately to reflect the different characteristics of each.

Table H.1 — HOC characteristics

Processes	Freight type	Condition
Freight transshipment only	Average/mixed	Ambient
Passenger transfer only	Containerized/swap bodies	Temperature-controlled
Combined passenger and freight transfer	Palletized	
Freight transshipment and storage	Piece goods/break bulk	
	Dry bulk	
	Liquid bulk	
	Vehicle transport	
	Other	

H.3 Calculation parameter

For freight the calculation parameter “tonnes throughput” shall be used.

NOTE In addition to the mass other relevant allocation units, e.g. m^2 , m^3 , TEU, number of containers, number of vehicles can be used.

For passengers the allocation parameter “passenger throughput” shall be used.

H.4 Hub-specific considerations

H.4.1 Transport nodes covering a number of hubs

Transport nodes, such as maritime and inland ports, railway stations and airports, may need to be broken down into a number of hubs directly enabling the transport chains. When defining the individual hubs located at a transport node, approaches may be used such as:

- control approach, e.g. operational or financial control;

— geographical boundaries.

The chosen approach shall be consistent for all hubs at one transport node.

The hub boundaries specify the processes and related GHG activity data to be included in the quantification of GHG emissions of each hub. On-site transport between different hubs of a transport node shall be allocated in its entirety, i.e. either to one or other of the hubs or divided between the hubs.

EXAMPLE 1 A port facilitates the loading and unloading of passengers or freight from ships, ferries and other commercial vessels. Activities associated with ports include the operation of vessels, freight handling equipment, locomotives, trucks, and storage and warehousing facilities related to the transportation of freight or passengers as well as the development and maintenance of supporting infrastructure. Ports typically have multiple terminals which are designated areas used for the transfer of freight and/or passengers from marine transport to road or rail transport and vice versa. Terminals can consist of multiple hub types, such as wharves and/or bulk freight loading and/or unloading structures, landings and receiving stations. GHG emission sources at terminals include freight handling equipment (e.g. gantry cranes, forklifts) as well as the electricity used by the terminals for purposes of lighting and temperature control (heating and cooling) of the building.

GHG emissions produced within the port boundary from mobile sources that travel beyond the geographic boundary, such as ocean-going vessels, locomotives and trucks, are included in transport TCE calculations.

EXAMPLE 2 An airport enables the transshipment of freight from air transport to road and vice versa as well as the transfer of passengers from air transport to road or rail transport and vice versa. For this airport, three different hubs can be identified: the air freight handling terminal (departure and arrival), the passenger terminal (departure and arrival) and the railway station.

EXAMPLE 3 A railway station enables passenger transfer from rail to road and local public transport and vice versa. Depending on materiality, this railway station can be used as one hub or subdivided into two hubs using geographical boundaries: rail hub and local public transport hub.

H.4.2 Allocation of GHG emissions of the HOC level

Allocation of GHG emissions is needed when the hub(s) of the HOC provide(s) different functionalities and the corresponding GHG emissions shall be calculated for each group (as set out in [Clause 9](#)). This is eased by separate data collection (e.g. metering) at the equipment level; however, this separate data collection is rarely possible in practice. Therefore, if GHG activity data are not available for the selected group, the user shall allocate the GHG activity data following the principles of extrapolation and proportionality (see the examples in [Table H.2](#)). The chosen allocation principles shall remain consistent over time for each hub related to the HOC and shall be documented transparently, as appropriate.

This allocation shall follow the relevant requirements of the freight or passengers as set in [9.3.3](#).

Table H.2 — Example allocation principles and areas of application within hubs

Operational area	GHG activity	Example allocation principles
Material handling equipment	Energy	— Regarding activities (e.g. transshipment, shunting) and the respective quantity of freight requiring these activities. — Including the consideration of basic processes used for all shipments, where energy consumption is difficult and/or time consuming to allocate (e.g. freight receipt, dispatch, IT infrastructure, offices). These may be summarized in one general group, the GHG emissions of which are allocated evenly to all shipments.
Transfer equipment	Energy	— Regarding zones or activities (e.g. de-/boarding, shuttles, restrooms, waiting areas) and the respective quantity of passengers requiring these activities. — Including the consideration of basic processes used for all passengers, where energy consumption is difficult and/or time consuming to allocate (e.g. luggage handling, rest rooms, IT infrastructure, offices). These may be summarized in one general group, the GHG emissions of which are allocated evenly to all passengers.
Lighting	Electricity	— By the use of functional areas which are defined zones of the hub in which specific operations take place and the respective amount of freight or number of passengers passing through these functional areas.
Temperature requirements	Energy	— By the energy consumption of the relevant temperature control equipment and the quantity of ambient and refrigerated freight.
	Refrigerants	— By the quantity of refrigerants refilled and the quantity of refrigerated freight.

Annex I (normative)

Approach to account for refrigerant leakage GHG emissions from mobile air conditioning and temperature-controlled freight units during transportation operations

I.1 General

The function of a transportation refrigeration system is to maintain a specified temperature during transport. All transport refrigeration systems must be robust and sturdy so that they can perform properly while withstanding movements and accelerations during transportation. However, leaks within the refrigeration system still occur due to vibrations, loose connections and general degradation of the refrigeration system.

This annex shall be applied to any transportation refrigeration system, the principal purpose of which is to maintain temperature control of passenger spaces or freight, or both, linked to an energy-consuming form of transportation.

I.2 Refrigerant leakage in operations to be included in GHG emission calculation

As introduced in 6.2, the quantification of GHG emissions from any transport operation within a transport chain shall start with the selection of a TOC related to this TCE. This TOC shall be a consistent group of transport operations relevant to the TCE.

When establishing a TOC, consideration should be given to characteristics that affect the scale and composition of the TOC and the needs of the users of this document (i.e. both transport operator and the transport service user).

I.3 Recommended approach for calculating refrigerant leakage GHG emission

NOTE Sources and methods consulted: Reference [34] Chapter 7, Volume 3, Table 7.9: "Emissions of Fluorinated Substitutes for Ozone Depleting Substances". Also referenced: various industry sources for capacity volumes for temperature-controlled mobile freight units for freight trucks.

I.3.1 Step 1: Determine the refrigerated transport application type as part of the TOC

For example:

- automobile type;
- commercial truck type.

When the vehicle type is unknown, or no factors exist, consider using factors for the "most-similar" type of vehicle to the one that would be likely to be used in that transportation operation.

I.3.2 Step 2: Determine a charge capacity quantity of refrigerant for the TOC

For example:

- for automobiles, where charge capacity is unknown, use a default charge capacity range of 0,500 kg to 0,750 kg refrigerant for mobile air conditioning units, with a middle point of 0,625 kg;

- for commercial trucks, where charge capacity is unknown, use a default charge capacity of 1,5 kg refrigerant for mobile air conditioning units;
- for commercial trucks, where charge capacity is unknown, use a default charge capacity range of 3 kg to 8 kg refrigerant for temperature-controlled mobile freight units (e.g. a trailer with a transportation refrigeration unit), with a middle point of 5,5 kg.

I.3.3 Step 3: Determine an annual leakage rate of refrigerant for the TOC

For example:

- for automobiles, where annual leakage rate is unknown, use a default leakage rate of 10 % to 20 % of refrigerant capacity for mobile air conditioning units, with a middle point of 15 %;
- for commercial trucks, where annual leakage rate is unknown, use a default leakage rate of 10 % to 20 % of refrigerant capacity for mobile air conditioning units, with a middle point of 15 %;
- for commercial trucks, where annual leakage rate is unknown, use a default leakage rate of 15 % to 50 % of refrigerant capacity for temperature-controlled mobile freight units (e.g. a trailer with a transportation refrigeration unit), with a middle point of 32,5 %

I.3.4 Step 4: Multiply to derive an annual leakage mass for the TOC

For example:

- for automobile mobile air conditioning units: $(0,625 \times 0,15) = 0,093\ 75$ kg annual refrigerant leakage;
- for commercial truck mobile air conditioning units: $(1,5 \times 0,15) = 0,225$ kg annual refrigerant leakage;
- for commercial truck temperature-controlled mobile freight units: $(5,5 \times 0,325) = 1,787\ 5$ kg annual refrigerant leakage.

I.3.5 Step 5: Multiply the annual refrigerant leakage by the GHG emission factor of the refrigerant used

If the refrigerant used is not known, consider using a default GHG emission factor that represents either:

- the refrigerant most commonly used in a given region for that type of transportation operation;
- a default GHG emission factor representing a weighted average of the values for refrigerants commonly used in a given region for that type of transportation operation.

For example:

- for automobile mobile air conditioning units, using GHG emission factor of 1 430 kg CO₂e/kg for R-134a: $0,093\ 75$ kg annual refrigerant leakage $\times$ 1 430 = 134,1 kg CO₂e from leakage for the example air-conditioned automobile transportation TOC;
- for commercial truck mobile air conditioning units, using GHG emission factor of 1 430 kg CO₂e/kg for R-134a: $0,225$ kg annual refrigerant leakage $\times$ 1 430 = 321,75 kg CO₂e from leakage for the example air-conditioned commercial truck transportation TOC;
- for commercial truck temperature-controlled mobile freight units, using GHG emission factor of 1 430 kg CO₂e/kg for R-134a: $1,787\ 5$ kg annual refrigerant leakage $\times$ 1 430 = 2 556 kg CO₂e from leakage for the example temperature-controlled commercial truck TOC.

I.3.6 Step 6: Assign to transport activity of the TOC to derive GHG emission intensity

Divide by the appropriate transport activity value for the TOC to derive a mass of CO₂e/passenger km or CO₂e/tonne km as an input to the overall GHG emission intensity factor for the TOC.

This approach can overestimate leakage for very short trips of less than one-day duration. However, it is more likely that the methodology is conservative, and underestimates total hydrofluorocarbon GHG emissions attributed to the transportation operation, as it does not account for pro-rating of GHG emissions from recharges and eventual disposal (less any refrigerant reclamation). Additionally, the wide range of specific circumstances can lead to a wide range of variability in outcomes. Thus, the approach is intended to primarily establish a marker using a conservative approach which can be refined over time. If the operator has more specific comprehensive information about annual refrigerant purchase records that encompass all the operations within the calculation, using that approach (as outlined in above IPPC reference) is preferable, as it would lead to more accurate outcomes.

I.4 Calculation time period

This methodology can be applied over a defined period during which multiple journeys occur, provided that all input values represent transportation operations that occur during the same time period. For journeys with multiple elements, GHG emissions for each element shall be calculated individually over the same time period according to the manner described for individual journey legs and chartered routes before aggregation.

In practice, for high frequency, regular, short duration transport, it is common to aggregate a year's worth of operational data for transportation operations that occur during that time period. This has the benefit of removing seasonal fluctuations from the reported results than can obscure more significant long-term trends. When estimating refrigerant leakage GHG emissions on an annual basis, results should be pro-rated by the number of days per year that the transport refrigeration units are in operation.

Annex J (normative)

Additional requirements and guidance for GHG emission factors

J.1 General

As stated in [5.2.2](#), the extent of GHG emissions to be calculated and reported for transport operations consists of the sum of the GHG emissions arising from vehicle and hub operation as well as the GHG emissions associated with the provision of the energy used. The total operational GHG emissions and total energy provision GHG emissions are reported separately as well as a total GHG emission value. In each case, the GHG emissions are quantified as mass of CO₂ equivalent, through the application of appropriate GHG emission factors which include the full energy carrier life cycle.

Comparability of calculation output relies on the use of robust and consistent GHG emission factors. For many traditional and new energy carriers, there is a wide range of possible feedstocks, production processes, regions of production and interdependencies (e.g. refinery efficiency, crude oil quality or feedstock production for biofuels). For this reason, [Annex K](#) provides GHG emission factors for the most relevant transport energy carriers which can only be seen as a starting point where sufficient information on the GHG emissions associated with the energy production and usage were available at time of writing.

Since the inclusion of all upstream processes (including plant infrastructure) can prove difficult in reality, the use of clearly stated cut-off criteria for GHG emission factors of energy provision in accordance with [5.2.3](#) is possible.

J.2 Biofuels

GHG emission factors for biofuels shall include the following:

- GHG emissions from the extraction or cultivation of raw materials;
- annual GHG emissions from carbon stock changes caused by land-use change (20-year perspective);
- GHG emissions from processing;
- GHG emissions from transport and distribution;
- GHG emissions from the fuel in use.

Removal of atmospheric CO₂ during cultivation of raw materials shall be excluded based on the assumption that this removal matches the subsequent GHG emission due to combustion in the operational phase. Hence, CO₂ emissions of the fuel in the operational phase are zero for biofuels but all GHG emissions of other GHGs (e.g. N₂O and CH₄) of the fuel in the operational phase shall be included in the GHG emission factor for biofuels.

Where a fuel production process produces, in combination, the fuel for which GHG emissions are being calculated and one or more other products (co-products), GHG emissions shall be divided between the fuel, or its intermediate product, and the co-products in proportion to their energy content (determined by lower heating value in cases of co-products other than electricity and heat). A co-product is any of two or more products coming from the same unit process or product system. The detailed application of these rules can vary in different certification schemes, particularly the way in which broader sustainability criteria are related to the individual co-products. For example, whether a certain process output is considered a co-product or a waste can be determined by the provisions of the certification scheme.

Waste wood, straw, husks, cobs and nutshells as well as residues from biomass processing, including crude glycerine and bagasse, may be considered to have zero life cycle GHG emissions up to the process of collection of those materials. According to local legislation, this can be subject to prior screening against wider sustainability criteria, e.g. requirements to meet sustainable land use criteria.

Indirect land use change (iLUC) can play a major role for crop-based biofuels, although iLUC GHG emission factors need further collaborative work and agreement. Separate reporting of iLUC GHG emissions is recommended along with clear, accompanying documentation of the sources and assumptions used. Further information about iLUC can be found in References [24] and [25].

Fuels derived from oil crops such as palm oil or certain other food or feed crops should be considered high risk due to the likelihood of there being a significant associated iLUC impact which can negate any GHG emission savings from the biofuel usage. This should be assessed on a case-by-case basis through an established, accredited fuel certification scheme.

For all renewable liquid and gaseous fuels of non-biological origin (commonly also referred to as “e-fuels”), the electricity used for the fuel production shall be included (in accordance with [Clause J.3](#)).

Energy and GHG emission factors for biofuel blends shall be calculated using the factors of the fuels blended, taking into account their relative share in the blend based on fuel volume or fuel energy content.

J.3 Electricity

GHG emissions from electricity consumed by transport shall be quantified using the location-based approach by applying the GHG emission factor that best characterizes the pertinent grid, i.e. dedicated transmission line, or local, regional or national grid-average GHG emission factor.

Where national and sub-national GHG emission factors are not available, global or regional GHG emission factors can be applied.

NOTE 1 The location-based approach is a method to quantify GHG emissions from energy, based on average energy generation GHG emission factors for defined geographic locations, including local, subnational or national boundaries.

Grid-average GHG emission factors should be from the relevant reporting year, if available, or from the most recent year(s) if not. Grid-average GHG emission factors for imported consumed electricity should be based on the average consumption mix of the grid from which the electricity is consumed.

To ensure comparability of calculations carried out in accordance with this document:

- 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;
- the source of the GHG emission factor used shall be documented.

Energy provision GHG emission factors shall include all relevant GHG emissions associated with generation of electricity, such as:

- transmission and distribution losses;
- other life cycle processes used in generating the electricity such as extracting, transporting and processing the energy carrier, and the processes used in producing the capital equipment for generating the electricity.

The GHG emissions from energy generation infrastructure may be quantified, documented and reported separately.

If a TCE involves means of transport using electricity and crossing multiple regions, each electricity grid GHG emission factor shall be used. For means of transport using batteries, an apportioning of

the electricity use associated with each recharge to the specific electricity grid region(s) should be conducted.

The GHG emission factors shall include all applicable covered GHGs.

NOTE 2 National electricity GHG emission factors can be purchased from the International Energy Agency^[39] and can be available via life cycle databases or government publications/agencies.

In addition to using the location-based approach, a transport provider may report using their own electricity mix using the market-based approach, provided the contractual instruments conform to the following quality criteria:

- convey the information associated with the unit of electricity delivered together with the characteristics of the generator;
- are ensured with a unique claim;
- are tracked and redeemed, retired or cancelled by or on behalf of the reporting entity;
- are as close as possible to the period to which the contractual instrument is applied and comprises a corresponding timespan;
- are produced within the country, or within the market boundaries where consumption occurs if the grid is interconnected.

When the organization uses contractual instruments for GHG emission attributes, including renewable energy certificates, these transactions shall be documented and reported separately.

NOTE 3 Contractual instruments are any type of contract between two parties for the sale and purchase of energy bundled with attributes about the energy generation, or for unbundled attribute claims.

EXAMPLE Contractual instruments can include energy attribute certificates, renewable energy certificates, guarantees of origin, power purchase agreements, green energy certificates, supplier-specific GHG emission rates, etc.

NOTE 4 The market-based approach is a method to quantify the indirect GHG emissions from energy of a reporting organization based on GHG emissions emitted by the generators from which the reporting organization contractually purchases.

If the results are used for a product carbon footprint in accordance with ISO 14067, then the market-based electricity mix shall be reported in addition.

J.4 General provision for GHG emission factors and sources

The user shall use GHG emission factors for fuels which conform with the provisions in this document. The GHG emission factors shall be listed and the following properties shall be given:

- fuel type;
- lower heating value (MJ/kg);
- density (kg/l) (for liquid fuels);
- operational GHG emissions (g CO₂e/MJ);
- total GHG emissions (g CO₂e/MJ);
- biofuel blend (in % energy content) (if applicable).

The user shall clearly state the source of all GHG emission factors for fuels.

The potential for leakage of methane, itself a potent GHG, shall be taken into account when calculating the GHG emissions resulting from the provision and use of methane-containing fuels such as compressed

natural gas (CNG), LNG and their biogenic equivalents. Upstream venting of methane from the tank or at various points further up the supply chain shall be considered in the energy provision component of the overall GHG emission factor.

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Annex K (informative)

GHG emission factors and sources

To provide a starting point for suitable sources and GHG emission factors for fuels, the major fuels used in Europe are given in [Tables K.1](#) and [K.2](#) and in the United States (US) in [Tables K.3](#) and [K.4](#).

To ensure comparability of calculations carried out in accordance with this document, where national legislation mandates the use of specific GHG emission factors, users should use the most current official GHG emission factors and sources available. For locations outside Europe and the US where no nationally mandated values apply, users can identify an alternate source, including from [Tables K.1](#), [K.2](#), [K.3](#) and [K.4](#) or their own values, if in accordance with this document.

Users should also check whether official sources have updated their values, so the most current values for an official data source can be applied.

NOTE 1 The factors from the GREET®¹⁾ database^[22] are recognized as an official source by the US government.

NOTE 2 In [Tables K.1](#), [K.2](#), [K.3](#) and [K.4](#), diesel and gasoline refers to 100 % mineral diesel and gasoline not bioblends, synthetic or other boutique fuels.

NOTE 3 All the GHG emission factors in [Tables K.1](#), [K.2](#), [K.3](#) and [K.4](#) were calculated using the GWP 100a (without climate-carbon feedback) in accordance with IPCC 2013^[44].

The operational GHG emissions from gaseous fuels should be considered in a different way than for other fuels. The extent of the methane slip varies according to the engine technology, the way the engine is run and any GHG emission abatement technology that is fitted. The legislation that applies to engines used in different situations also varies, with different limits on methane emissions applying by location and mode.

1) GREET® is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Table K.1 — European GHG emission factors for liquid fuels and electricity

Energy carrier	Lower heating value in MJ/ kg	Density in kg/l	GHG emission (operational) in g CO _{2e} /MJ	GHG emission (total) in g CO _{2e} /MJ (total)	GHG emission (operational) in kg CO _{2e} /kg	GHG emission (total) in kg CO _{2e} /kg (total)	Source
Gasoline	42,5	0,743	75,1	90,1	3,19	3,83	[17]
Ethanol (40 % maize, 35 % sugar beet, 25 % wheat)	27	0,78	0,3	48,2	0,01	1,30	[21]
Diesel	42,8	0,832	74,1	87,3	3,17	3,74	[17]
Biodiesel (50 % rapeseed, 40 % used cooking oil, 10 % soybean)	37	0,892	4,1	38,3	0,15	1,42	[21]
LPG	45,5	0,55	67,1	81,6	3,05	3,71	[17]
Jet kerosene (Jet A1 and Jet A)	43	0,8	73,5	84,7	3,16	3,64	[17][20]
HFO (2,5 % sulfur)	41,2	0,97	76,8	85,4	3,17	3,52	[17]
Light fuel oil (LFO) (0,1 % sulfur)	42,6	0,86	75,3	86,5	3,21	3,69	[17]
Hydrogen from steam reforming of natural gas	120	not applicable	0	114,4	0	13,73	[18]
HVO ^a /HEFA (SAF) (50 % rapeseed, 50 % used cooking oil)	44	0,77	0,1	28,6	0	1,26	[21]
Electricity European average (EU 28, 2019, including average losses)	not applicable	not applicable	0	97	not applicable	not applicable	[21]

^a HVO (hydrotreated vegetable oil) may also be used as a marine biofuel.

Table K.2 — European GHG emission factors for gaseous fuels including methane slip

Energy carrier	Example application	Lower heating value in MJ/ kg	Density in kg/l	GHG emission (operational) in g CO ₂ e/MJ	GHG emission (total) in g CO ₂ e/MJ (total)	GHG emission (operational) in kg CO ₂ e/kg	GHG emission (total) in kg CO ₂ e/kg (total)	Source
CNG	Europe spark ignition truck	49,2	not applicable	56,6	72,7	2,79	3,58	[18]
LNG	Europe spark ignition truck	49,1	not applicable	57,9	75,5	2,84	3,71	[18]
Bio-CNG (40 % maize, 40 % manure, 20 % biowaste)		50	not applicable	1,5	26,2	0,08	1,31	[18][21]
Bio-LNG (40 % maize, 40 % manure, 20 % biowaste)		50	not applicable	1,5	30,4	0,08	1,52	[18][21]
LNG	Otto dual fuel ship (medium speed)	49,1	not applicable	73,6	91,2	3,61	4,48	[18][19]
LNG	Otto dual fuel ship (slow speed)	49,1	not applicable	66,0	83,6	3,24	4,10	[18][19]
NOTE 1 GHG emission factors can differ to the ones shown in this table when using other types of feedstock (e.g. waste) for producing the fuel.								
NOTE 2 GHG emission factors from Reference [18] were updated to reflect the GWP 100a (without climate carbon feedback) in accordance with IPCC 2013.								
NOTE 3 Operational non-CO ₂ GHG emissions are taken from Reference [22]. Their actual values can vary between different vehicles/engine types and after treatment systems.								

Table K.3 — North American GHG emission factors for liquid fuels and electricity

Energy carrier	Lower heat- ing value in MJ/ kg	Density in kg/l	GHG emission (operational) in g CO ₂ e/MJ	GHG emission (total) in g CO ₂ e/MJ	GHG emission (operational) in kg CO ₂ e/kg	GHG emission (total) in kg CO ₂ e/kg	Source
Gasoline	41,7	0,749	73,0	90,2	3,04	3,76	[22]
Ethanol (corn)	27,0	0,789	0,3	55,6	0,01	1,49	[22]
Diesel	42,6	0,847	75,0	90,5	3,20	3,86	[22]
Biodiesel (soybean)	37,7	0,881	4,1	20,6	0,15	0,78	[22]
HVO (tallow)	44,0	0,779	0,05	17,7	0,002	0,78	[22]
LPG	46,6	0,508	64,8	78,5	3,02	3,66	[22]
Jet kerosene (Jet A1 and Jet A)	43,2	0,802	73,2	84,6	3,16	3,65	[22]
HFO (2,7 % sulfur)	39,5	0,991	81,7	94,3	3,23	3,72	[22]
Very low sulfur fuel oil (VLSFO) (0,5 % sulfur)	39,5	0,991	81,7	95,6	3,23	3,78	[22]
Ultra low sulfur fuel oil (ULSFO) (0,1 % sulfur)	39,5	0,991	81,7	95,9	3,23	3,79	[22]
MDO (0,5 % sulfur)	41,0	0,914	78,6	92,1	3,22	3,78	[22]
Marine gas oil (MGO) (1,0 % sulfur)	42,8	0,837	75,2	87,8	3,22	3,76	[22]
Electricity US (2019) (including average losses)	not applicable	not applicable	0	118	not applicable	not applicable	[23]

Table K.4 — North American GHG emission factors for gaseous fuels

Energy carrier	Example application	Lower heating value in MJ/ kg	Density in kg/l	GHG emission (operational) in g CO ₂ e/MJ (operational)	GHG emission (total) in g CO ₂ e/MJ (total)	GHG emission (operational) in kg CO ₂ e/kg (operational)	GHG emission (total) in kg CO ₂ e/kg (total)	Source
CNG	North America spark ignition truck	47,1	not applicable	56,8	73,7	2,67	3,47	[22]
LNG	North America spark ignition truck	48,6	not applicable	57,0	76,7	2,77	3,72	[22]
NOTE Operational non-CO ₂ GHG emissions can vary between different vehicles/engine types and after treatment systems.								

Annex L (informative)

Additional guidance for allocation to passenger according to passenger class of travel

L.1 Guidance for the calculation of class factors based on area per seat and occupancy rate per class

L.1.1 General case

The calculation of the class factor considering both the area per seat and the occupancy rate per class may be implemented using the following steps, within a given TOC:

- Step 1: The f different classes C_k (k from 1 to f) should be identified and sorted in ascending order, from C_1 being the lowest to C_f being the highest.
- Step 2: The u different vehicle configurations L_i (i from 1 to u) should be identified, based on the different areas for each class for each vehicle configuration and data regarding these areas should be collected.
- Step 3: The average area per passenger for each class C_k may be calculated, using [Formula \(L.1\)](#):

$$\Phi_{C_k} = \frac{\sum_{i=1}^u A_{C_k, L_i} \times s_{L_i}}{\sum_{i=1}^u T_{C_k, L_i}} \quad (\text{L.1})$$

where

Φ_{C_k} is the average area per passenger for class C_k ;

A_{C_k, L_i} is the area for class C_k within vehicle configuration L_i ;

s_{L_i} is the transport activity distance, in kilometres, of vehicle configuration L_i ;

T_{C_k, L_i} is the transport activity, in passenger kilometres, for class C_k within vehicle configuration L_i ;

u is the number of vehicle configurations L_i .

- Step 4: a class factor for each class C_k that characterizes the average area per passenger for each class C_k , compared to C_1 , may be calculated, using [Formula \(L.2\)](#):

$$z_{C_k} = \frac{\Phi_{C_k}}{\Phi_{C_1}} \quad (\text{L.2})$$

where

z_{C_k} is the class factor for class C_k ;

Φ_{C_k} is the average area per passenger for class C_k .

NOTE By definition, $z_{C_1} = 1$.