# Emission Calculation Guideline

**October 2025**

## Disclaimer

This document is intended for informational purposes only and provides guidance on greenhouse gas (GHG) emissions calculation, primarily to assist smaller organisations that may not have in-house expertise. It aims to clarify the methodology outlined in the Global Logistics Emissions Council (GLEC) Framework, including Module 5 for the European chemical industry, and to illustrate calculations with examples while highlighting common pitfalls. The information is provided in good faith and believed to be accurate, but no warranties or guarantees are made regarding its completeness, applicability, or suitability for any specific purpose. This document is not a substitute for reviewing the official GLEC Framework, applicable standards, or regulatory requirements.

# Emission calculation guideline

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# Introduction and purpose of the document

The original Cefic/ECTA (European Chemical Industry Council / European Chemical Transport Association) Emission Measuring Guideline was published in March 2011. Since that time, much has changed in the field of emissions reporting, and a revision is therefore required to bring it up to date. The European Standard EN 16258:2012 was published in 2012, and the subsequent Global Logistics Emissions Council (GLEC) Framework was introduced around 2016.

Cefic[1] and ECTA[2] collaborated in 2021 with Smart Freight Centre[3] to develop the Module 5 of the GLEC Framework for the European chemical industry. The scope of the GHG emission calculation covered in this Module 5 included the transport and logistics activities directly related to the chemical industry supply chain. The primary focus were the transport and logistics operations the companies are contractually responsible for, which are primarily the transport of finished goods to their customers. By the inclusion of emissions reporting according to Module 5 in the 2022 revision of SQAS, everyone within our chemical industry is becoming more familiar with the calculation and reporting requirements.

Greenhouse gas emission accounting is not an end in itself and, if we agree with the phrase "what gets measured gets done", we can treat the calculations and an understanding of the current level of greenhouse gas emissions as the starting point for the reduction initiatives that are vital in achieving European climate targets.

The push for further standardisation of logistics emission accounting methodologies resulted in the new ISO standard (ISO 14083:2023) in 2023 and a corresponding revision of the GLEC framework (GLEC 3.0)[4] to bring it in line. Also, GLEC Module 5 for chemicals transport in Europe was revised accordingly. This has brought with it some changes in terminology as we now look to measure emissions from a Transport Chain within different Transport Operating Categories. A Transport Chain is defined as "the point where the freight leaves its last point of production or transformation to the point where freight reaches its first non-transport related operation".

The SQAS questionnaires have been revised and are being used in assessments from September 2025 onwards.

Initially, the scope of this guidance will focus predominantly on road freight and intermodal journeys covering both packed and bulk shipments. Subsequent versions will add more detail around rail, inland waterways and short sea journeys in line with GLEC Module 5 methodology.

The **main purpose of this guidance** is to clarify the methodology and assist smaller organisations that may not have their own in-house experts. The guidance does not replace the need to read and be familiar with the **GLEC Framework**, including **GLEC Module 5**, but it aims to illustrate the calculations with simple examples and highlight some common pitfalls in the process.

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[1] https://cefic.org/

[2] https://www.ecta.com/

[3] https://smartfreightcentre.org/

[4] https://smart-freight-centre-media.s3.amazonaws.com/documents/GLEC_FRAMEWORK_v3_UPDATED_02_04_24.pdf

# 1. Definition of terms

**1.1.** Transport Operating Category (TOC): A TOC is a group of transport operations that share similar characteristics, in a defined period, which is typically one calendar year unless specified otherwise and explained in the related reporting.

**1.2.** Transport Chain Elements (TCE): A transport chain can be split in transport chain elements of which the GHG emissions are calculated separately. In this guidance we will discuss 4 TCE's: road transport, rail transport, waterway transport and hub operations. A TCE can be defined as by freight being carried by a single vehicle or transitioning through a single hub.

**1.3.** Transport Chain: the chemical industry transport chain includes all logistics activities starting from the loading location (production site) to the final customer delivery.

**1.4.** Empty run: empty runs are all transport and hub operations performed with empty equipment, starting from the last unloading location until the next loading location. Typical empty run activities are cleaning, equipment repositioning and container depot activities. If the transport or handling of an empty container is provider as a service to another service provider (e.g. subcontracted service), then the activity is considered as a consignment in its own right (i.e. a transport chain element) and thus not as an empty run.

**1.5.** Well to tank emissions or energy provision emissions: GHG emitted from the moment of production of a transport fuel (petrol, diesel, electricity, natural gas) to the moment of fuel supply.

**1.6.** Tank to wheel/wake or transport operations activity emissions: GHG emitted from the point of transmission of transport fuel to the vehicle (at the recharging or refuelling station) to the moment of its discharge (consumption of the fuel or electricity, while on the move.)

**1.7.** Hub Operating Category (HOC): A HOC is a group of hub operations that share similar characteristics, in a defined period, which is typically one calendar year unless specified. Examples of Hub operation categories are warehouse activities, terminal activities, cleaning stations, depot activities.

**1.8.** Well to wheel/wake: refers to the full life cycle of fuel and is split in the Well to Tank and Tank to Wheel emissions. The Well to Tank (WTT) emissions are all emissions that stem from the refining and distribution of the fuel. The Tank to Wheel emissions (TTW) stem from the consumption of the fuel. Together they comprise the total emissions of a TCE.

**1.9.** CO2 equivalent: is used to quantify the emissions of multiple gases that have an impact on the climate. Carbon dioxide is not the only greenhouse gas, others include CH4 Methane; CFCs Chlorofluorocarbons; HFCs Hydrofluorocarbons and more. With GHG emissions, the guidance refers to CO2 equivalent emissions.

**1.10.** Primary data: a quantified value obtained from a direct measurement, or a calculation based on the direct measurement. Primary data is considered best when calculating GHG emissions and shall be based on the GHG sources (quantity of fuel consumed, refrigerant leaked) that are converted to GHG emissions. The outcome can be calculated into GHG emission intensity with the corresponding transport activity.

**1.11.** Secondary data: data which is not primary data, that can include default emission factors, calculated data or data from published databases. Secondary is considered inferior compared to primary data due to a lack of complete match with the transport activity. Secondary data should always be chosen based on the closest match between the classification and the TOC.

**1.12.** Absolute Emissions: Absolute emissions refer to the total logistics emissions of the reporting company expressed in metric tonnes of CO2 equivalent.

**1.13.** Emission Intensity: Emission intensity is expressed in gram or kg CO2 equivalent per tonne-kilometre (for transport) or per tonne outbound (for hub operations). It specifies the quantity of greenhouse gas emissions in relation to the specific greenhouse gas activity that caused those emissions. Emission intensity can be calculated from primary data but can also be provided via default emission factors.

# 2. GHG emission accounting process

## 2.1. Overall guidance on accounting steps

The GHG emission accounting process always consists of combining economic activity with the relevant emission intensity. GHG emission accounting makes use of Transport Chain Elements (TCE) and Transport Operating Categories (TOC) or Hub Operating Categories (HOC) to support the calculation.

**Transport Chain or TC** refers to the sequence of transport modes and logistics operations used to move the goods from their origin to their destination.

**Transport Chain Elements or TCE** refer to the individual elements or segments of a transport chain. The sum of all individual TCE emissions of a transport chain shall equal the total emissions of the transport chain. A transport chain starts at the loading place of a production site and ends with the delivery of the goods at the customer's unloading place. Therefore, a transport chain can consist of multiple modes and intermediate hub steps. In case a cleaning is required before loading or a heating before unloading, this activity will also be part of the transport chain. To provide quality GHG emission accounting, an organization should have activity information (tonnes handled or tonne-kilometre transported) at TCE level.


*Figure 1: Calculation of total GHG emissions of a transport chain. Source: Cefic and the European Chemical Transport Association (ECTA), (2025).*

**Transport Operating Categories or TOC** refer to the transport chain elements that share similar characteristics and therefore have a similar emission intensity profile. The TOC reflects the emission intensity of these groups of TCE. For logistics hubs, the equivalent definition is Hub Operating Categories or HOC. To calculate the emission of a specific TCE step in a transport chain, the TCE activity is multiplied by the corresponding TOC or HOC intensity.


*Figure 2: Calculation of TCE emissions. Source: Cefic and the European Chemical Transport Association (ECTA), (2025).*

The maturity of the organization, defined by their ability to obtain primary data at a more granular level, will result in more detail or granularity of the emission intensity. For starting organizations, TOC granularity may be limited. The guidance for the chemical industry is to have minimum TOC categorization at level 3 of the Module 5. Level 3 means detailing per type of goods (bulk/packed) <u>and</u> type of transport equipment (tank container, tanktruck, FTL, LTL…) <u>and</u> temperature (ambient, temperature-controlled). For mature organizations, the TOC may be at product level or on transport lane for their own operations.

To calculate the absolute emissions of a transport chain, as a summation of the different transport chain elements. We will need to combine the emission intensity with the respective activity information. For that, we require correct categorization through use of transport operating categories.

In the next chapter we will go through each step with examples to illustrate the action.

## 2.2. Visual representation of Chemical Transport Chains:

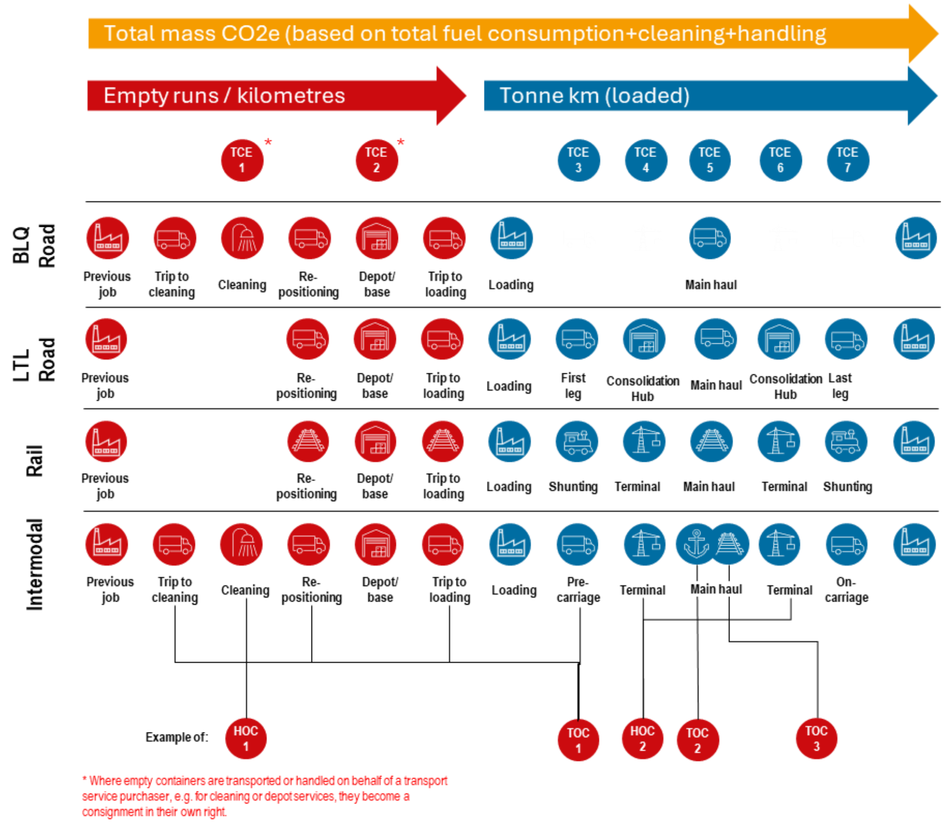


*Figure 3: Overview of typical TCE in chemical logistics. Source: Created by Cefic and the European Chemical Transport Association (ECTA), (2025). Adapted from © Smart Freight Centre from: GLEC Framework v3.1 edition, revised and updated (2024), page 150, Examples of empty running and its relation to the calculation of emissions.*

The chemical transport chain can be very complex, with multiple stakeholders and supply chain activities. To calculate transport operating categories, emissions are to be considered from a roundtrip perspective, i.e. the activities from loading location to the customer, as well as emissions from empty trips and intermediate activities. The relevant chemical supply chain activities consist out of the transport activities (main leg, pre- and on carriage) and hub operating activities (warehouse activities, container terminal activities, container depot operations, container cleaning and heating) including the trips to and from these hubs, reposition of empty equipment.

Please note that where an empty run activity is marked as TCE, it means that this activity is executed as a stand-alone service (e.g. cleaning, empty container depot by a subcontractor) with its specific HOC. Cleaning or heating activities should not be integrated in the transport operation category as they can be required or not, depending on the customer or the product. The emissions from an empty container depot could be integrated in the TOC of the corresponding transport TOC, if this is an integral part of the transport service.

### 2.3. Importance of emission intensity for comparison & evaluation:

The emission intensity of a TOC or HOC intensity is a key parameter in transport emission management. The emission intensity enables customers to compare the emission management performance of various service providers for a given supply chain activity.

The process to identify the TOC/HOC emission intensity is a multistep process clarified below:


*Figure 4: Calculation of TOC and HOC intensity. Source: © Smart Freight Centre from: GLEC Framework v3.1 edition, revised and updated (2024), page 34, Calculating GHG emission intensity of a TOC or a HOC.*

The emission intensity combines the total emissions within a certain TOC or HOC during the last year and the economic activity in tonne-kilometre within that category.

### 2.4. Introduction of fictional company

To provide a practical aid in illustrating the emission accounting steps, the guidance will make use of a fictional company that performs a tailored set of transport activities.

The transport company has performed the following orders with corresponding data in the previous calendar year and is now performing its GHG accounting calculation.

| Order | Kg | Product | bulk/packed | Temp Control | From | To | Distance km (SFD for subcontracted) | Mode | transport type | own / subcontracted operation | Cleaning of the tank ? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Order 1 | 16800 | P-12 | bulk | T°-controlled | I | L | 300 | road | tank truck | Subcontracted | no |
| Order 2 | 21700 | P-4 | bulk | Ambient | U | H | 1300 | road | silo truck | Own operation | no |
| Order 3 | 14400 | P-11 | bulk | T°-controlled | S | A | 1800 | road | tank truck | Subcontracted | no |
| Order 4 | 20100 | P-10 | bulk | Ambient | A | E | 400 | road | tank container | Own operation | no |
| Order 5 | 26800 | P-6 | bulk | Ambient | Q | X | 700 | road | tank container | Subcontracted | no |
| Order 6 | 25700 | P-10 | bulk | Ambient | N | Q | 300 | road | tank container | Own operation | yes |
| Order 7 | 25900 | P-18 | bulk | Ambient | J | A | 900 | road | tank truck | Own operation | no |
| Order 8 | 27600 | P-1 | bulk | Ambient | F | Q | 1100 | road | silo truck | Own operation | yes |
| Order 9 | 14800 | P-18 | bulk | Ambient | W | K | 1200 | road | tank truck | Own operation | yes |
| Order 10 | 22400 | P-9 | bulk | Ambient | N | X | 1000 | road | tank container | Subcontracted | yes |

*Table 1: Order overview fictional transport company. Source: Cefic and the European Chemical Transport Association (ECTA), (2025).*

# 3. Guidance to emission intensity calculations process steps

In the next section, the guidance will provide more detailed information related to each process step to complete the emission intensity calculations.

## 3.1. Step 1: Define TOC/HOC activity

### 3.1.1. Identify Transport Chain Elements (TCE) of the Transport Chain

The first step for a logistics service provider, is to segment the chemical transport chain in different logistics activities. In this step, the organization must split the Transport Chain into individual Transport Chain Elements and obtain the activity per transport order associated with each TCE for the last year.

The transport chain for each shipment starts at the loading site (the consignor) and ends at the unloading site of the customer (consignee). Along the chain, one or more transshipments can take place. A transport chain element (TCE) is a section of the transport chain which is carried by a single vehicle or transits through a single Hub.  The goods may not necessarily stay in the same loading unit along the full transport chain.

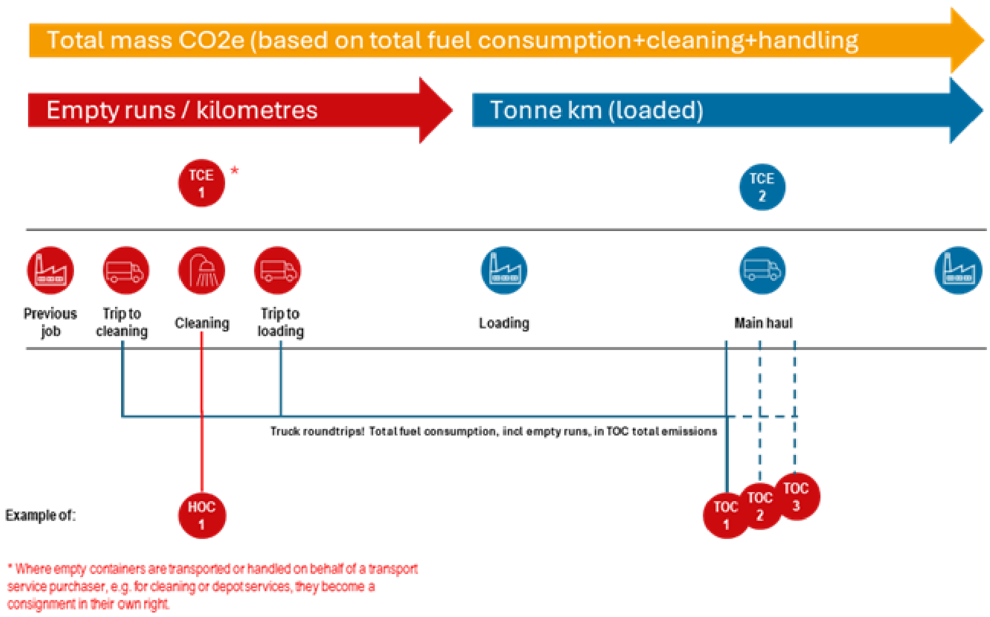


*Figure 5: TCE of bulk transport chain. Source: Cefic and the European Chemical Transport Association (ECTA), (2025).*

The TCE only considers loaded activity.  The only exception is where empty containers or pallets are transported on behalf of a transport service purchaser (i.e. as a subcontracted activity), e.g. for relocation purposes, or empty container depot services or cleaning. In that case they become a consignment in their own right.

The activity is expressed in tonne-kilometre and consists of the shipped weight (or equivalent) over a specific distance.

In the example, each order has a loaded transport trip and is a one-step process. There are 10 loaded transport TCE's performed by the fictional company

In addition to the loaded transport orders, we note that there are 4 orders that have a cleaning that takes place prior to the laden transport activity. The cleaning activity itself is captured separately as a TCE because they add emissions to the roundtrip transport but do not stem directly from transport activities.

To calculate the transport activity, we combine the weight or payload of the order with the distance.

### 3.1.2. Categorize your transport activities into Transport Operating Categories (TOC) and/or Hub Operating Categories (HOC):

To ensure the GHG emission accounting is accurate and relevant, it is important to assign similar transport activities or TCE into corresponding Transport Operating Categories (TOC).

Transport Operating Category (TOC): A TOC is a group of transport operations that share similar characteristics, in a defined period, which is typically one calendar year unless specified otherwise and explained in the related reporting.  TOC are used to define emission intensity for similar type of activities using primary data. If you are not able to differentiate your TOC further, the final TOC has been identified based on your data measurement capabilities. The operational characteristics within one category should be as similar as possible. For SQAS assessments, the guidance for road transport is to have at least a distinction between packed and bulk transport and transport equipment type (level 3) in accordance with the GLEC Module 5 TOC levels (see figure 6). The definition of TOC does not differentiate between own or subcontracted operations.  Only if the customer can choose between own or subcontracted services, it can be split up in different TOC s, so the emission intensity of both services is transparent.

**Road transport TOC characteristics**

| Transport operation category | | Empty running (% of total distance) | Typical load (tonnes) | Emission intensity (g $CO_2e$/t-km) | | |
|---|---|---|---|---|---|---|
| | | | | WTT | TTW | WTW |
| **Bulk goods – Level 3** | | | | | | |
| Tank truck | Ambient | 19 | 21 | 18 | 57 | 75 |
| | Temperature controlled | 19 | 21 | 20 | 64 | 84 |
| | Dedicated, ambient | 50 | 21 | 27 | 82 | 109 |
| | Dedicated, temperature controlled | 50 | 21 | 30 | 92 | 122 |
| Hopper/silo | Ambient | 22 | 26 | 16 | 51 | 67 |
| | Temperature controlled | 22 | 26 | 18 | 57 | 75 |
| | Dedicated, ambient | 50 | 26 | 22 | 70 | 92 |
| | Dedicated, temperature controlled | 50 | 26 | 25 | 78 | 103 |
| Tank container | Ambient | 19 | 24 | 17 | 52 | 69 |
| | Temperature controlled | 19 | 24 | 19 | 58 | 77 |
| | Dedicated, ambient | 50 | 24 | 24 | 74 | 98 |
| | Dedicated, temperature controlled | 50 | 24 | 27 | 83 | 110 |

*Figure 6: Chemical bulk transport default values. Source: © Smart Freight Centre from: GLEC Framework v3.1 edition, revised and updated (2024), page 143, Road transport TOC characteristics, Bulk goods – Level 3.*

Examples of TOC might include: Packed goods (level 1), full truck load (level 2), ambient or temperature controlled (level 3); Bulk goods (level 1), tank container (level 2), temperature controlled (level 3). A TOC can be defined for a transport lane, for a customer or for a specific type of truck. This will be considered as detail level 4.

It is important to remind that the level of detail requires exact or reliable assignment of fuel consumption, km driven and tonnes handled up to that transport operating category Details should include:

1. Total fuel or electricity consumed for that TOC category during the past calculation period (1 year).
2. Payload transported and loaded kilometres (per customer order) driven or handled during the same past period.

Transport Operating Categories are intended to ensure consistency in GHG emission intensity data. In the event an organization operates all TCE's with their own assets, they might have full granularity of the required information**.** In the event that an organization does not operate its own assets, it can still calculate the transport chain emissions by using TOC intensity data received from its subcontractors or default factors from GLEC Module 5.

In the guidance example of the fictional company, we note the following TOC and HOC's:

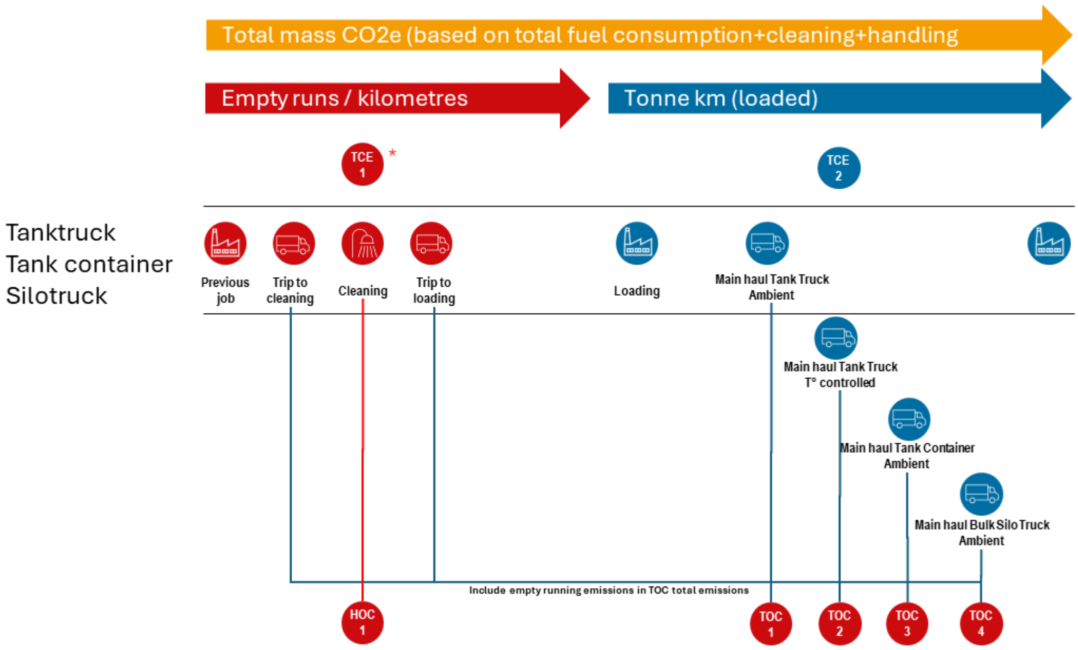


*Figure 7: TOC and HOC selection for fictional company. Source: Cefic and European Chemical Transport Association (ECTA), (2025).*

In line with the GLEC Module 5, Table 3, the TOC and HOC for this company would be:

| **Mode** | **Bulk/packed** | **Transport type** | **T° control** | **TOC** |
|---|---|---|---|---|
| Road | Bulk | Tank Truck | Ambient | TOC 1 |
| | | | T° Controlled | TOC 2 |
| | | Tank Container | Ambient | TOC 3 |
| | | Silo Truck | Ambient | TOC 4 |
| Tank cleaning | | | | HOC 1 |

*Table 2: TOC and HOC definition for fictional company. Source: Cefic and European Chemical Transport Association (ECTA), (2025).*

It is important to note that **non-laden or empty** transport activities follow a specific process with regards to obtaining TOC information.
The empty kilometres driven related to the transport **does not count** towards the total activity of the respective TOC.
The emissions of the empty transport **do count** towards the total emissions of the respective TOC.

For warehouse operations, we expect HOC to be differentiated considering their share of energy consumption in the warehouse. This can be defined by temperature conditions, type of ware operations, storage or transshipment. The following differentiation is the minimum expected:

- Transshipment (crossdocking) – ambient
- Transshipment (crossdocking) – T° controlled
- Storage (incl unloading & loading) – ambient
- Storage (incl unloading & loading) – T° controlled
- Packing & storage – ambient
- Packing & storage – T°- controlled

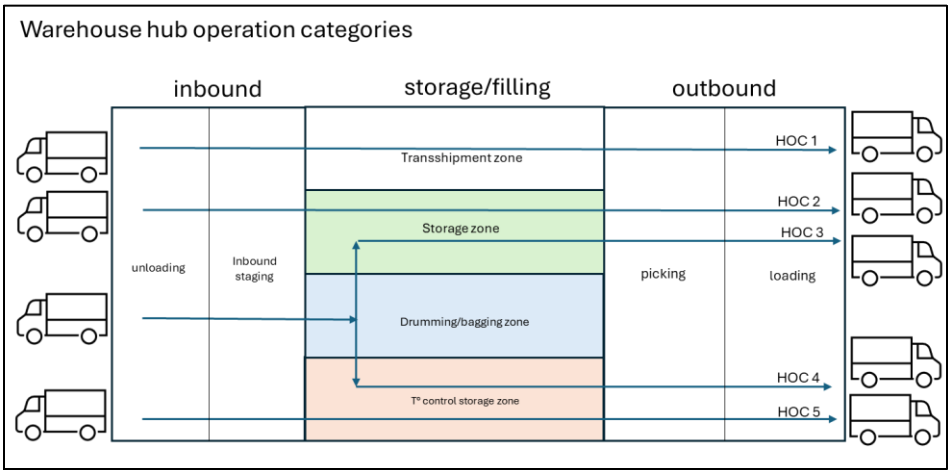


*Figure 8: Example of warehouse HOCs. Source: Cefic and European Chemical Transport Association (ECTA), (2025).*

### 3.1.3. Obtain activity information at TCE level in tonne-kilometre or equivalent

The organization has now identified Transport and Hub Operating Categories based on one or multiple TCE's. The next step is to obtain activity information at TOC level. This step should be straightforward as long as you have the TCE activity available alongside which TCE's are linked to each TOC.

To calculate the activity at TOC/HOC level, the activity of each TCE part of that TOC/HOC needs to be combined.

The activity is expressed in tonne-kilometre or tonnes and consists of the shipped weight over a specific distance.

#### 3.1.3.1. Weight

For transport operations:

Only the net weight of transported goods is taken into account (commonly referred to as payload) including the product packaging provided by the shipper but **excluding** additional packaging or handling equipment used by the operator, i.e. in the way they are presented at the loading location and are expected to be unloaded at (intermediate) destination. No additional transport packaging or equipment provided by the operator (e.g. stowage material, dunnage or container) is included.

For each transport operation, the tonnes transported are multiplied by the actual kilometres driven for that individual operation. The sum of all individual tonne-kilometre during the last year is the total TOC activity.

In the case of container transport, and when it is difficult for the transport operator to determine the payload (e.g. intermodal rail operator), TEU can be used instead of tonnes. The result of the TOC is then expressed in TEU-kilometre. The freight forwarder is then expected to multiply the TEU with the exact tonnes of the transport order.

For hub operations:

Only the net weight of transported goods is taken into account, referred to as payload including the product packaging provided by the shipper. Hub operation activity is quantified based on the tonnes throughput of shipments leaving the hub or centre, i.e. **outbound weight**. Warehouse operations are calculated in tonnes of product loaded. Cleaning activities in number of cleanings and for heating activities in number of heatings.

#### 3.1.3.2. Distance:

The distance is measured from the point where the shipper hands goods over to the carrier, so when leaving the consignor, and ends with the hand-over of the shipment to another carrier or consignee.

For calculating total activity within a category, SQAS requires actual distance, meaning real km driven for each order.

However, if actual kms are not available, e.g. when a subcontractor is not able to provide this data, the shortest feasible distance (SFD) can be used, multiplied with a distance adjustment factor (DAF).

**Shortest feasible distance (SFD):** shortest practical route between two places, taking into account the real operating conditions, such as the physical restrictions of a vehicle, road type and topography. It is typically found using route planning software.

**Distance Adjustment Factor (DAF):** The DAF is specific to different transport modes and is based on the likelihood the TCE will have a deviation from the original routing. This can be due to roadworks, congestion or routing changes throughout the reporting period. For road transport, the DAF is 1,05 (5% additional distance). For rail and inland waterways, the DAF equals 1 (SFD is considered also close to actual distance).

#### 3.1.3.3. Subcontracting:

When utilizing subcontracting the emission accounting process follows the same steps as with internal data. However, the data is likely to differ from the internal data of the reporting company. Additional steps are needed to ensure the required data is reported by the subcontractor. Subcontractors can influence the result because of their TOC (transport activities) or HOC contributions. For TOC activity, if the subcontractor is responsible for laden transports, activity data is needed.

Special caution should be given to the granularity of the subcontracted data as well as the accuracy as it will influence the reportable TOC. If the subcontractor cannot provide primary data, distance information is likely to be modelled data using SFD (short feasible distance), corrected with a DAF (distance adjustment factor).

In the guidance example, we use the report from the previous calendar year to calculate the activity. For example, for Order 1 we combine the payload transported (in tonnes) with the corresponding distance travelled (in kilometres) to obtain the tonne-kilometre (tkm) total. Note that order 1 is a subcontracted order and no primary data was shared on actual distances or fuel consumption. Therefore, we should make use of SFD distance calculation.

So, the calculation for order 1 is : 16.8 x (300 x 1.05) = 5,292 tkms

| Order | Kg | Product | bulk/packed | Temp Control | From | To | Distance km (SFD for subcontracted) | Mode | transport type | own / subcontracted operation | Cleaning of the tank ? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Order 1 | 16800 | P-12 | bulk | T°-controlled | I | L | 300 | road | tank truck | Subcontracted | no |
| Order 2 | 21700 | P-4 | bulk | Ambient | U | H | 1300 | road | silo truck | Own operation | no |
| Order 3 | 14400 | P-11 | bulk | T°-controlled | S | A | 1800 | road | tank truck | Subcontracted | no |
| Order 4 | 20100 | P-10 | bulk | Ambient | A | E | 400 | road | tank container | Own operation | no |
| Order 5 | 26800 | P-6 | bulk | Ambient | Q | X | 700 | road | tank container | Subcontracted | no |
| Order 6 | 25700 | P-10 | bulk | Ambient | N | Q | 300 | road | tank container | Own operation | yes |
| Order 7 | 25900 | P-18 | bulk | Ambient | J | A | 900 | road | tank truck | Own operation | no |
| Order 8 | 27600 | P-1 | bulk | Ambient | F | Q | 1100 | road | silo truck | Own operation | yes |
| Order 9 | 14800 | P-18 | bulk | Ambient | W | K | 1200 | road | tank truck | Own operation | yes |
| Order 10 | 22400 | P-9 | bulk | Ambient | N | X | 1000 | road | tank container | Subcontracted | yes |

*Table 3: Calculating activity for fictional company. Source: Cefic and European Chemical Transport Association (ECTA), (2025).*

### 3.2. Step 2: Calculate the GHG emissions by TOC/HOC

In this step, the organization will calculate the total GHG emissions of a specific TOC.

The guidance is to calculate the emissions over a representative past period of time to reduce volatility of seasonality or other influencing factors.  For SQAS assessments we assume a period of 1 year, so past variations in weather, driver and traffic effects are sufficiently smoothed out.

The approach taken to this will depend on the maturity level of your organisation. It could be based on the total litres of fuel purchased, the average fuel consumption by type of truck in the fleet or actual consumption monitored through telematics systems or refuelling records.

The reporting company should aim to have the fuel available as actual litres consumed per vehicle and per TOC, e.g. packed or bulk transport and ambient or temperature-controlled transport, or HOC such as cleaning and heating.

Remember to include fuel used when the vehicle is empty and returning to base, transporting empty containers, travelling to cleaning or to its next place of loading.

***Empty running is a critical component of GHG emission accounting and a high priority reduction lever.***

The reporting company should make necessary agreements with subcontractors to obtain an emission report at TOC/HOC level and preferably based on primary data. In case of subcontracted activities where no emission report is provided by the subcontractor, you calculate the emission based on default factors by the relevant TOC activities from GLEC Module 5 using Short Feasible Distance and amount of product transported.

Once the actual fuel consumption for the transport operating category (TOC) or hub operating category (HOC) is known, you can then calculate the related GHG emissions for each fuel using the emission factor for that fuel. You should know that emission factors can change over time and may vary by region so always check that you are using the most up to date emissions factors. Links to the emissions factors contained in the GLEC framework are included in section 8 of this guidance.

Total (or absolute) emissions are normally reported in tonnes or kg of CO2e.

### 3.2.1. Assign fuel and energy consumption to the corresponding TOC/HOC

In this step, we will combine all fuel and energy consumption by emission source. The objective is to establish a correlation between the emission source to the corresponding TCE and therefore the corresponding TOC.

In the guidance example the fictional company was able to obtain fuel and energy consumption by type of transport. The ideal is to obtain consumption information at a more granular level, for example at asset or truck level. This will allow the reporting company to have a more accurate correlation between the order, the TCE, the TOC and the emission source. In reality, combinations of different methods are possible within a single TOC.

For own operations, we establish the following information by type of transport

| Own Trucks – Fuel Consumption | | |
|---|---|---|
| **Type of Transport** | **Fuel Type** | **Total Last Year** |
| Tank Truck | Diesel biofuel blend 7% | 750 litres |
| Silo Truck | LNG | 600 kg |
| Tank Container | Diesel biofuel blend 7% | 300 litres |

*Table 4: Fuel consumption by the fictional company (own assets). Source: Cefic and European Chemical Transport Association (ECTA), (2025).*

This means that the fuel consumption for own operations can be assigned to the TOCs as follows

- TOC1: road bulk tanktruck ambient: 750 litres Diesel B7
- TOC3: road bulk tank container ambient (own ops): 300-litres Diesel B7
- TOC4: road bulk silo truck ambient: 600 kg LNG

TOC2, road bulk tanktruck T°-controlled is fully subcontracted and the emission calculation is explained in 4.2.3. TOC3 is also partially subcontracted. To calculate TOC3 total emissions, emissions from own operations will be added up to the emissions from the subcontracted services.

### 3.2.2. Calculate emissions from own operations.

Emissions from own operations are calculated by multiplying fuel and energy consumed per TOC or HOC by the corresponding energy emission intensity factor.

The energy emission intensity factors for most common fuels, including bio fuel blends, can be found in the GLEC framework Chapter 3. Always validate the latest GLEC publication as energy emission intensity factors are updated frequently based on Ecoinvent and other leading databases.

In the guidance example, this would lead to the following emissions.

TOC1: 750l DieselB7 x 0,836 (density) x 3,96 kg $CO_{2e}$/kg = 2483 kg $CO_{2e}$

| Energy carrier | Lower heating value *MJ/kg* | Density *kg/l* | Volumetric energy density *MJ/l* | GHG emission (energy provision / WTT) *g $CO_2$e/MJ* | GHG emission (operational/ TTW) *g $CO_2$e /MJ* | GHG emission (total/WTW) *g $CO_2$e/MJ* | GHG emission (energy provision/ WTT) *kg $CO_2$e/kg* | GHG emission (operational/ TTW) *kg $CO_2$e/kg* | GHG emission (total/WTW) *kg $CO_2$e/kg* |
|---|---|---|---|---|---|---|---|---|---|
| **Diesel-Biofuel Blends Emission factors: Europe** | | | | | | | | | |
| 100% Diesel | 42.8 | 0.832 | 35.6 | 22.6 | 75.3 | 97.8 | 0.97 | 3.22 | 4.19 |
| 99% Diesel, 1% Biodiesel | 42.7 | 0.833 | 35.6 | 22.7 | 74.5 | 97.2 | 0.97 | 3.19 | 4.15 |
| 98% Diesel, 2% Biodiesel | 42.7 | 0.833 | 35.6 | 22.8 | 73.8 | 96.6 | 0.97 | 3.15 | 4.12 |
| 95% Diesel, 5% Biodiesel | 42.5 | 0.835 | 35.5 | 23.1 | 71.6 | 94.7 | 0.98 | 3.04 | 4.03 |
| 93% Diesel, 7% Biodiesel | 42.4 | 0.836 | 35.4 | 23.4 | 70.1 | 93.4 | 0.99 | 2.97 | 3.96 |
| 90% Diesel, 10% Biodiesel | 42.2 | 0.838 | 35.4 | 23.7 | 67.9 | 91.6 | 1.00 | 2.86 | 3.87 |
| 80% Diesel, 20% Biodiesel | 41.6 | 0.844 | 35.1 | 24.9 | 60.4 | 85.3 | 1.04 | 2.52 | 3.55 |
| 50% Diesel, 50% Biodiesel | 39.9 | 0.862 | 34.4 | 28.4 | 38.2 | 66.6 | 1.13 | 1.52 | 2.66 |
| 100% Biodiesel (50 % rapeseed, 40 % used cooking oil, 10 % soybean) | 37.0 | 0.892 | 33.0 | 34.2 | 1.2 | 35.4 | 1.27 | 0.0429 | 1.31 |

*Figure 9: TOC1 emission calculation for fictional company. Source: © Smart Freight Centre from: GLEC Framework v3.1 edition, revised and updated (2024), page 87, Biofuel Blend.*

TOC4: 600kg LNG x 3,99 kg $CO_{2e}$/kg = 2394 kg $CO_{2e}$

**Emission factors: European sources**

| Energy carrier | Example application | Lower heating value *MJ/kg* | Density *kg/l* | GHG emission (operational/TTW) *g $CO_2$e/MJ* | GHG emission (total/WTW) *g $CO_2$e/MJ* | GHG emission (operational/TTW) *kg $CO_2$e/kg* | GHG emission (total/WTW) *kg $CO_2$e/kg* | Non-$CO_2$ GHG emissions (operational/TTW) *g $CO_2$e/MJ* | Biogenic GHG emissions (operational/TTW) in g $CO_2$e/g | Source |
|---|---|---|---|---|---|---|---|---|---|---|
| Liquefied Natural Gas (LNG) | Europe spark ignition truck | 48.0 | n.a. | 57.4 | 83.1 | 2.75 | 3.99 | 0.93 | n.a. | ifeu. infras & Fraunhofer IML, 2024[16] |
| Bio-CNG (40% maize, 40% manure, 20% biowaste) | Europe spark ignition truck | 50.0 | n.a. | 0.9 | 25.7 | 0.05 | 1.28 | 0.93 | 2.86 | ifeu. infras & Fraunhofer IML, 2024[16] |
| Bio-LNG (40% maize, 40% manure, 20% biowaste) | Europe spark ignition truck | 50.0 | n.a. | 0.9 | 29.8 | 0.05 | 1.49 | 0.93 | 2.86 | ifeu. infras & Fraunhofer IML. 2024[16] |
| Liquefied Natural Gas (LNG) | otto duel fuel ship (medium speed) | 48.0 | n.a. | 77.6 | 96.1 | 3.73 | 4.61 | 20.33 | n.a. | IMO MEPC 81[27] |
| Liquefied Natural Gas (LNG) | otto duel fuel ship (slow speed) | 48.0 | n.a. | 67.5 | 86.0 | 3.24 | 4.13 | 10.20 | n.a. | IMO MEPC 81[27] |

^ Factors based on long distance/heavy duty road transport only, as LNG is not recommended for light duty/urban distribution.

- GHG emission factors for biofuels can vary considerably according to feedstock mix and process. Certified waste stream feedstocks can lead to low or even negative emission factors under certain circumstances; emission factors need to be carefully checked in such circumstances to avoid unintended consequences and overstatement of emission reduction benefits.
- Bio-LNG and bio-CNG based on GHG reduction threshold to qualify under the Renewable Energy Directive II (RED II.)[4]
- Emission factors sourced from ecoinvent v3.9.1 and the European electricity emission factor above are the only ones confirmed to include fuel and energy production infrastructure in the WTT element as this is a new requirement.
- Electricity emission factor above is from a different source to that used to calculate EU rail default emission intensities as we are unable to quote the IEA values here.

*Figure 10: TOC4 emission calculation for fictional company. Source: © Smart Freight Centre from: GLEC Framework v3.1 edition, revised and updated (2024), page 78, Emission factors: European sources.*

### 3.2.3. Subcontracting:

When utilizing subcontracting, the emission accounting process follows the same steps as with internal data. However, the data likely differs from the internal data of the reporting company. Additional steps are needed to ensure the required data is reported by the subcontractor. Subcontractors can influence the result because of their TOC (transport activities) or HOC contributions. For TOC: if the subcontractor is responsible for empty running and/or laden transport, emission data is needed. Special caution should be given to the granularity of the subcontracted data as well as the accuracy as it will influence the reportable TOC.

If reliable emission intensity data fails, emissions from subcontracting can be calculated based on the default values from the GLEC Framework Module 5. It is important to note, that if default values are used, the distance in the TOC activity should be based on SFD distance.

In our guideline example, this leads to the following emissions for subcontracted services:

TOC2 (road bulk tank truck T° controlled):
84 g $CO_{2e}$/tonne-km (GLEC M5) x 30.960 tonne-km = 2.601 kg $CO_{2e}$

TOC 3 (road bulk tank container ambient – subcontracted):
69 g CO2e/tonne-km (GLEC M5) x 41.160 tonne-km = 2.840 kg $CO_{2e}$

### 3.3. Step 3: Calculate the TOC/HOC intensity

The TOC emission intensity is calculated by dividing the total emissions in a transport operation category by the total tonne-kilometres in that category.

By assigning total emissions to a transport operation category (TOC) and dividing it by the loaded tonne-kilometres, the calculated GHG intensity factor includes emissions linked with empty runs, repositioning etc. for that transport category.

In case of own operations, the calculation is based on actual data from fuel emissions and from actual activity (actual kms driven). In case of subcontracted operations, the data is similar to own operations in case of fully integrated subcontractors. In case of non-integrated subcontractors, the emissions intensity equals the TOC intensity value provided by the subcontractor, or the default value from GLEC Module 5.

In case of mixed services, both own operations and subcontracted operations, total emissions are the sum of total emissions from own operations (see 4.2.2) and subcontracted operations (see 4.2.3). Total activity is the sum of own activity from own operations and from subcontracted operations (corrected with DAF in case of SFD).

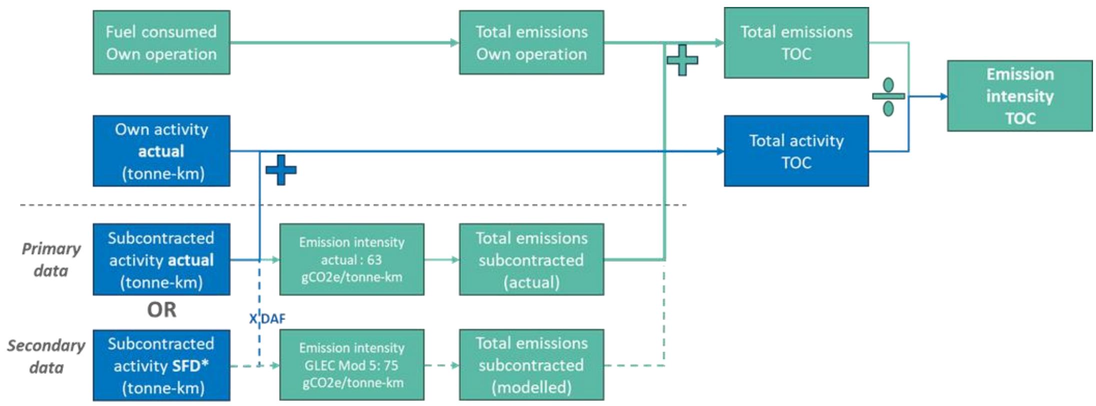


*Figure 11: Calculating TOC intensity from combined own and subcontracted services. Source: Cefic and the European Chemical Transport Association (ECTA), (2025).*

The HOC emission intensity is calculated by dividing the total emissions in a hub operation category by the units of activity in that category.

Emission intensity is normally reported in grammes of $CO_2e$ per tonnes or units outbound.

In our example, the TOC emission intensities are calculated as follows

TOC1 – road bulk tanktruck ambient (own)

- Total emissions: 2.483 kg $CO_2e$
- Total activity: 41.070 tonne-km
- TOC1 intensity: 60,46 g $CO_2e$/tonne-km

| TOC1 : road bulk tanktruck ambient | | | |
|---|---|---|---|
| own activity | 41070 | tonne-km | |
| emissions own | 750 | *0,836*3,96 | 2483 kg CO2e |
| TOC 1 intensity | 60,46 | g CO2e/tonne-km | =(2483/41070)*1000 |

| Own trucks - fuel consumption | | |
|---|---|---|
| Type of transport | fuel type | total last year |
| Tank truck | diesel biofuel blend 7% | 750 liter |
| silo truck | LNG | 600 kg |
| Tank container | diesel biofuel blend 7% | 300 liter |

| Row Labels | Sum of tonkm | Sum of tonkm act |
|---|---|---|
| **silo truck** | **58570** | **58570** |
| **Ambient** | **58570** | **58570** |
| Own operation | 58570 | 58570 |
| Order 2 | 28210 | 28210 |
| Order 8 | 30360 | 30360 |
| **tank container** | **56910** | **58968** |
| **Ambient** | **56910** | **58968** |
| Own operation | 15750 | 15750 |
| Order 4 | 8040 | 8040 |
| Order 6 | 7710 | 7710 |
| Subcontracted | 41160 | 43218 |
| Order 10 | 22400 | 23520 |
| Order 5 | 18760 | 19698 |
| **tank truck** | **72030** | **73578** |
| **Ambient** | **41070** | **41070** |
| Own operation | 41070 | 41070 |
| Order 7 | 23310 | 23310 |
| Order 9 | 17760 | 17760 |
| **T°-controlled** | **30960** | **32508** |
| Subcontracted | 30960 | 32508 |
| Order 1 | 5040 | 5292 |
| Order 3 | 25920 | 27216 |

*Figure 12: calculating TOC1 (road bulk tanktruck ambient) emission intensity for fictional company. Source: Cefic and the European Chemical Transport Association (ECTA), (2025).*

| Energy carrier | Lower heating value MJ/kg | Density kg/l | Volumetric energy density MJ/l | GHG emission (energy provision / WTT) g $CO_2e$/MJ | GHG emission (operational/ TTW) g $CO_2e$ /MJ | GHG emission (total/WTW) g $CO_2e$/MJ | GHG emission (energy provision/ WTT) kg $CO_2e$/kg | GHG emission (operational/ TTW) kg $CO_2e$/kg | GHG emission (total/WTW) kg $CO_2e$/kg |
|---|---|---|---|---|---|---|---|---|---|
| **Diesel-Biofuel Blends Emission factors: Europe** | | | | | | | | | |
| 100% Diesel | 42.8 | 0.832 | 35.6 | 22.6 | 75.3 | 97.8 | 0.97 | 3.22 | 4.19 |
| 99% Diesel, 1% Biodiesel | 42.7 | 0.833 | 35.6 | 22.7 | 74.5 | 97.2 | 0.97 | 3.19 | 4.15 |
| 98% Diesel, 2% Biodiesel | 42.7 | 0.833 | 35.6 | 22.8 | 73.8 | 96.6 | 0.97 | 3.15 | 4.12 |
| 95% Diesel, 5% Biodiesel | 42.5 | 0.835 | 35.5 | 23.1 | 71.6 | 94.7 | 0.98 | 3.04 | 4.03 |
| 93% Diesel, 7% Biodiesel | 42.4 | 0.836 | 35.4 | 23.4 | 70.1 | 93.4 | 0.99 | 2.97 | 3.96 |
| 90% Diesel, 10% Biodiesel | 42.2 | 0.838 | 35.4 | 23.7 | 67.9 | 91.6 | 1.00 | 2.86 | 3.87 |
| 80% Diesel, 20% Biodiesel | 41.6 | 0.844 | 35.1 | 24.9 | 60.4 | 85.3 | 1.04 | 2.52 | 3.55 |
| 50% Diesel, 50% Biodiesel | 39.9 | 0.862 | 34.4 | 28.4 | 38.2 | 66.6 | 1.13 | 1.52 | 2.66 |
| 100% Biodiesel (50 % rapeseed, 40 % used cooking oil, 10 % soybean) | 37.0 | 0.892 | 33.0 | 34.2 | 1.2 | 35.4 | 1.27 | 0.0429 | 1.31 |

*Figure 13: calculating TOC1 (road bulk tanktruck ambient) emission intensity for fictional company. Source: © Smart Freight Centre from: GLEC Framework v3.1 edition, revised and updated (2024), page 87, Biofuel Blends*

TOC3 – road bulk tank container ambient (own+subc)

- Total emissions: 993 kg $CO_{2e}$ (own) + 2.840,04 kg $CO_{2e}$ (subc) = 3.833 kg $CO_{2e}$
- Total activity: 15.750 tonne-km (own) + 43.218 tonne-km (subc with DAF) = 58968 tonne-km
- TOC3 intensity: 65 g $CO_{2e}$ / tonne-km

| TOC3: road bulk tankcontainer ambient | | | |
|---|---|---|---|
| own activity | 15750 | tonne-km (act.) | |
| subc act | 41160 | * 1,05 (DAF) | 43218 tonne-km |
| total activity | 58968 | tonne-km | =15750 +43218 |
| emissions own | 300 | *0,836*3,96 | 993 kg CO2e |
| emissions subc | 41160 | *69 gCO2e/tonne-km | 2840,04 kg CO2e |
| total emissions | 3833 | kg CO2e | =993+2840,04 |
| TOC3 intensity | 65,00 | g CO2e/tonne-km | |

| Row Labels | Sum of tonkm | Sum of tonkm act |
|---|---|---|
| silo truck | 58570 | 58570 |
| Ambient | 58570 | 58570 |
| Own operation | 58570 | 58570 |
| Order 2 | 28210 | 28210 |
| Order 8 | 30360 | 30360 |
| tank container | 56910 | 58968 |
| Ambient | 56910 | 58968 |
| Own operation | 15750 | 15750 |
| Order 4 | 8040 | 8040 |
| Order 6 | 7710 | 7710 |
| Subcontracted | 41160 | 43218 |
| Order 10 | 22400 | 23520 |
| Order 5 | 18760 | 19698 |
| tank truck | 72030 | 73578 |
| Ambient | 41070 | 41070 |
| Own operation | 41070 | 41070 |
| Order 7 | 23310 | 23310 |
| Order 9 | 17760 | 17760 |
| T°-controlled | 30960 | 32508 |
| Subcontracted | 30960 | 32508 |
| Order 1 | 5040 | 5292 |
| Order 3 | 25920 | 27216 |

| Own trucks - fuel consumption | | |
|---|---|---|
| Type of transport | fuel type | total last year |
| Tank truck | diesel biofuel blend 7% | 750 liter |
| silo truck | LNG | 600 kg |
| Tank container | diesel biofuel blend 7% | 300 liter |

*Figure 14: Calculating TOC3 (road truck ambient) emission intensity for fictional company. Source: Cefic and the European Chemical Transport Association (ECTA), (2025).*

| Energy carrier | Lower heating value MJ/kg | Density kg/l | Volumetric energy density MJ/l | GHG emission (energy provision / WTT) g $CO_2e$/MJ | GHG emission (operational/ TTW) g $CO_2e$ /MJ | GHG emission (total/WTW) g $CO_2e$/MJ | GHG emission (energy provision/ WTT) kg $CO_2e$/kg | GHG emission (operational/ TTW) kg $CO_2e$/kg | GHG emission (total/WTW) kg $CO_2e$/kg |
|---|---|---|---|---|---|---|---|---|---|
| **Diesel-Biofuel Blends Emission factors: Europe** | | | | | | | | | |
| 100% Diesel | 42.8 | 0.832 | 35.6 | 22.6 | 75.3 | 97.8 | 0.97 | 3.22 | 4.19 |
| 99% Diesel, 1% Biodiesel | 42.7 | 0.833 | 35.6 | 22.7 | 74.5 | 97.2 | 0.97 | 3.19 | 4.15 |
| 98% Diesel, 2% Biodiesel | 42.7 | 0.833 | 35.6 | 22.8 | 73.8 | 96.6 | 0.97 | 3.15 | 4.12 |
| 95% Diesel, 5% Biodiesel | 42.5 | 0.835 | 35.5 | 23.1 | 71.6 | 94.7 | 0.98 | 3.04 | 4.03 |
| 93% Diesel, 7% Biodiesel | 42.4 | 0.836 | 35.4 | 23.4 | 70.1 | 93.4 | 0.99 | 2.97 | 3.96 |
| 90% Diesel, 10% Biodiesel | 42.2 | 0.838 | 35.4 | 23.7 | 67.9 | 91.6 | 1.00 | 2.86 | 3.87 |
| 80% Diesel, 20% Biodiesel | 41.6 | 0.844 | 35.1 | 24.9 | 60.4 | 85.3 | 1.04 | 2.52 | 3.55 |
| 50% Diesel, 50% Biodiesel | 39.9 | 0.862 | 34.4 | 28.4 | 38.2 | 66.6 | 1.13 | 1.52 | 2.66 |
| 100% Biodiesel (50 % rapeseed, 40 % used cooking oil, 10 % soybean) | 37.0 | 0.892 | 33.0 | 34.2 | 1.2 | 35.4 | 1.27 | 0.0429 | 1.31 |

*Figure 15: Calculating TOC3 (road truck ambient) emission intensity for fictional company. Source: © Smart Freight Centre from: GLEC Framework v3.1 edition, revised and updated (2024), page 87, Biofuel Blends.*

TOC4 – road bulk tanktruck ambient (own)

- Total emissions: 2.394 kg $CO_{2e}$
- Total activity: 58.570 tonne-km
- TOC3 intensity: 40,87 g $CO_{2e}$/tonne-km

| TOC4: road bulk silo truck ambient | | | |
|---|---|---|---|
| own activity | 58570 tonne-km | | |
| emissions own | 600 *3,99 kg CO2e/kg | 2394 kg CO2e | |
| TOC4 intensity | 40,87 g CO2e/tonne-km | =(2394/58570)*1000 | |

| Own trucks - fuel consumption | | |
|---|---|---|
| Type of transport | fuel type | total last year |
| Tank truck | diesel biofuel blend 7% | 750 liter |
| silo truck | LNG | 600 kg |
| Tank container | diesel biofuel blend 7% | 300 liter |

| Row Labels | Sum of tonkm | Sum of tonkm act |
|---|---|---|
| **silo truck** | **58570** | **58570** |
| **Ambient** | **58570** | **58570** |
| Own operation | 58570 | 58570 |
| Order 2 | 28210 | 28210 |
| Order 8 | 30360 | 30360 |
| **tank container** | **56910** | **58968** |
| **Ambient** | **56910** | **58968** |
| Own operation | 15750 | 15750 |
| Order 4 | 8040 | 8040 |
| Order 6 | 7710 | 7710 |
| Subcontracted | 41160 | 43218 |
| Order 10 | 22400 | 23520 |
| Order 5 | 18760 | 19698 |
| **tank truck** | **72030** | **73578** |
| **Ambient** | **41070** | **41070** |
| Own operation | 41070 | 41070 |
| Order 7 | 23310 | 23310 |
| Order 9 | 17760 | 17760 |
| **T°-controlled** | **30960** | **32508** |
| Subcontracted | 30960 | 32508 |
| Order 1 | 5040 | 5292 |
| Order 3 | 25920 | 27216 |

*Figure 16: Calculating TOC4 (road bulk silotruck ambient) emission intensity for fictional company. Source: Cefic and the European Chemical*

**Emission factors: European sources**

| Energy carrier | Example application | Lower heating value MJ/kg | Density kg/l | GHG emission (operational/TTW) g $CO_2e$/MJ | GHG emission (total/WTW) g $CO_2e$/MJ | GHG emission (operational/TTW) kg $CO_2e$/kg | GHG emission (total/WTW) kg $CO_2e$/kg | Non-$CO_2$ GHG emissions (operational/TTW) g $CO_2e$/MJ | Biogenic GHG emissions (operational/TTW) in g $CO_2e$/g | Source |
|---|---|---|---|---|---|---|---|---|---|---|
| Liquefied Natural Gas (LNG) | Europe spark ignition truck | 48.0 | n.a. | 57.4 | 83.1 | 2.75 | 3.99 | 0.93 | n.a. | ifeu, infras & Fraunhofer IML, 2024[18] |
| Bio-CNG (40% maize, 40% manure, 20% biowaste) | Europe spark ignition truck | 50.0 | n.a. | 0.9 | 25.7 | 0.05 | 1.28 | 0.93 | 2.86 | ifeu, infras & Fraunhofer IML, 2024[18] |
| Bio-LNG (40% maize, 40% manure, 20% biowaste) | Europe spark ignition truck | 50.0 | n.a. | 0.9 | 29.8 | 0.05 | 1.49 | 0.93 | 2.86 | ifeu, infras & Fraunhofer IML, 2024[18] |
| Liquefied Natural Gas (LNG) | otto duel fuel ship (medium speed) | 48.0 | n.a. | 77.6 | 96.1 | 3.73 | 4.61 | 20.33 | n.a. | IMO MEPC 81[28] |

*Figure 17: Calculating TOC4 (road bulk silotruck ambient) emission intensity for fictional company. Source: © Smart Freight Centre from: GLEC Framework v3.1 edition, revised and updated (2024), page 78, Emission factors: European sources.*

### 3.4. Step 4: Calculate the total Transport Chain emissions

The organization has now established the emissions intensities for each individual TCE at transport and hub activity level.

**For the reporting company:**
To calculate the total emissions of the transport chain or organization, the sum will be made of each individual transport chain element.

| TOC | Operator | CO2e | TKM | Emission Intensity |
|---|---|---|---|---|
| TOC 1 | Owned | 2,483.00 | 41070 | 60.46 |
| TOC 2 | Sub | 2,601.00 | 32508 | 80.01 |
| TOC 3 | Sub | 2,840.00 | | |
| TOC 3 | Owned | 993.17 | | |
| TOC 3 | Combined | 3,476.17 | 58968 | 58.95 |
| TOC 4 | Owned | 2,394.00 | 58570 | 40.87 |
| **Grand Total** | **Combined** | **14,787.34** | **191116** | **77.37** |

The accounting steps result in 2 critical metrics: emission intensity of the company operations and the total absolute emissions of the company during the previous calendar year.

**For a specific customer:**
To calculate the total emissions of the transport chain for a specific customer, the sum will be made of each individual transport chain element related to the transport orders of that customer. In our example, we assume that order 2, 4 and 5 are performed on behalf of that customer.

| Order | TOC | TKM | Emission Intensity | CO2e |
|---|---|---|---|---|
| Order 2 | TOC 4 | 28210 | 40.87 | 1,153.06 |
| Order 4 | TOC 3 | 8040 | 58.95 | 473.96 |
| Order 5 | TOC 3 | 19698 | 58.95 | 1,161.20 |

| | | | | |
|---|---|---|---|---|
| **Grand Total** | **Combined** | **14,787.34** | **191116** | **77.37** |

The accounting steps result in 2 critical metrics: emission intensity of the company operations and the total absolute emissions of the company during the previous calendar year.

# 4. Common pitfalls in calculation and reporting to be avoided

## 4.1. Data considerations

Companies are encouraged to gather operational data systematically from their operations. The more granular the data is, the more precise and reliable their emissions calculations will be. Primary data is therefore always preferable, and companies should work on improving data availability to this end. For SQAS assessments we assume a calculation period of 1 year, so past weather, driver and traffic effects are sufficiently included.

Primary data means actual km driven for a specific TOC or HOC, actual tonnes of payload shipped, actual fuel consumed in litres. It does not mean averages or aggregated consumption across multiple TOC categories.

## 4.2. TOC selection

TOC intensity is one of the most critical steps as incorrectly selecting a TOC will result in inaccurate emission accounting, often overstating the emissions.

The most common pitfalls lie in the TOC being too high level and not granular enough. The guidance is to reach at minimum level 3 of the Module 5 TOC's. This will ensure an appropriate granularity is used.

## 4.3. Activity calculation

To calculate tonne-kilometres correctly, you need to multiply the weight of each individual shipment (in tonnes) by the distance that shipment travelled (in kilometres). This must be done per shipment, and then the results are summed to get the total tonne-kilometres.

The common mistake people make is to sum all the weights and all the distances first and then multiply those totals together. For instance, summing 10 tonnes and 5 tonnes gives 15 tonnes, and summing 100 kilometres and 200 kilometre's gives 300 kilometres. Multiplying 15 tonnes by 300 kilometres gives 4,500 tonne-kilometres, which is incorrect and significantly overstates the actual transport activity.

This mistake assumes that every tonne was transported across the full combined distance, which is not true unless all shipments followed the exact same route. To avoid this error, always calculate tonne-kilometres for each shipment separately and then add them together.

### 4.4. Subcontracting

For subcontracted operations, considerations need to be made when combining activity data with intensity. For calculating total emissions based on a default value, the activity should be expressed in SFD (no use of DAF). For calculating total activity of mixed services (own + subcontracted activity), the subcontracted activity will be adjusted with the DAF:

- Actual distance x actual intensity = OK
- SFD x default factor = OK
- SFD x DAF x actual intensity = OK
- SFD x actual intensity = Not OK

### 4.5. Historical reporting using a standard format

Reporting can be done at TOC/HOC level executed within a transport chain element (TCE) for the intended shipper, differentiated by source of the data: primary data vs default factors. The reporting should include all emissions from own (TOC or HOC) activities and subcontracted activities.

To calculate the shipper associated emissions, the absolute emissions and economic activity should be calculated apportioned to that specific shipper by TOC/HOC. If no granular level data is available a structural ratio should be made by economic activity, distance driven, payload shipped or other variable.

An example of the ISO compliant reporting format is shown below:

**Example of road transport reporting**

| Item | GHG intensity (WTW) $CO_2e$ kg/tkm | Customer specific tkm | WTW GHG emission (kg $CO_2e$) |
|---|---|---|---|
| Ambient groupage transport | 0.0617 | 28,600 | 160.42 |
| Total emissions kg $CO_2e$ | | | 160.42 |
| Input data type | 100% primary data | | |
| Mode coverage | Road | | |
| Data verification statement | Data has not been independently verified by a 3rd party | | |
| Period covered | March 2021 | | |

*Figure 18: Example of ISO compliant reporting format. Source: GLEC Framework. Source: © Smart Freight Centre from: GLEC Framework v3.1 edition, revised and updated (2024), page 158, Example of road transport reporting, Table 19.*

### 4.6. Transport emissions per consignment:

For TOC's that include multiple consignments, transport emissions per consignment should be calculated using the economic activity only for that shipper, it should not be calculated using the total economic activity.

### 4.7. Payload definition:

Payload is considered the product and product packaging as provided by the shipper, it should not include the equipment such as container, trailer, dunnage or other provided by the operator.

### 4.8. Empty running:

Empty running is not included in the standard transport chain. The economic activity is therefore not included in the TOC activity calculation, the fuel consumed and thereby impact on the final emission intensity is included in the calculation of the TOC emission intensity.

## 5. GHG emission accounting in value chain

### 5.1. Reporting GHG emissions:

GHG emissions can be reported in several ways, depending on the intent of the reporting and the reporting company. To differentiate direct emissions from indirect emissions or scope 1, 2 and 3, the GLEC framework divides the overall GHG emissions into emissions related to the energy use for the operation of transport or hub activities and the emissions related to the provision of this energy.

The emissions of the transport operations constitute the tank to wheel (TTW), the energy provision emissions for energy used for transport activity make up the well to tank (WTT). The detailed breakdown by fuel for European sources can be found in GLEC 3.0, page 77.

For a transport company, the tank to wheel/wake emissions are considered direct emissions or scope 1 and the well to tank emissions are considered indirect or scope 3 emissions.

For a shipping company that does not own any of the assets the well to wheel/wake emissions are considered indirect emissions or scope 3 emissions.

Complete emissions reports should include emission intensity, total emissions, source of data, use of primary data or default factors and the reporting time period.

### 5.2. Attributing GHG emissions to a single scope or customer

Once the reporting company has completed the calculation of the total GHG emissions for a specific time period and reported in the standardized format, the emissions can be attributed to a single scope or customer. To complete this step, it is critical to have a consistent methodology throughout the report and complete the calculation on the most detailed data level available.

The emissions share of the desired scope or customer is calculated by multiplying the relative share of distance, weight or tonne-kilometre of the desired scope or customer with the total company emissions at the TCE or TOC detail level. The reporting can be done at TCE or TOC level or at aggregated level for total GHG emissions. The option chosen as methodology will be used for all attribution and cannot be changed to avoid double accounting.

To convert the attributed absolute emissions to an intensity value, the tonne-kilometre of the desired scope or customer must be known for all TCE or TOC data points.

### 5.3. Modelling GHG emissions

Once GHG emission accounting is completed for a historical period, a forward-looking view can be modelled at TCE or TOC level. When completing this exercise, one must consider that any changes from the historical activities in the future activities will not be captured in the model. Modelling can be used to understand future GHG emission footprint. For shippers this can be used to evaluate alternative options, for transport operators this can be used to submit value propositions.

Modelling is done using the GHG emission intensity values at TOC level of a historical report. The TOC should be specific and detailed to the modelling activity to ensure adequate accuracy. The GHG emission intensity figures used should be of a significant time period extending to at least a full calendar year. Default factors are available but are not company or business specific. GHG emission intensity figures based on primary data are considered best.

### 5.4. Data exchange of GHG emission accounting

Exchange of data is encouraged to identify joint GHG emission reduction opportunities. Data exchange should follow a standard formatting to ensure transport or hub emissions are included in a product GHG emission footprint. Some examples include iLeap and the Exchange Network. More information can be found on the website of Smart Freight Centre.

## 6. Suggested GHG emission reduction initiatives

| Opportunities | Description | Considerations for implementation | Parties involved |
|---|---|---|---|
| **A. Modal shift** | **Shift to 'greener' transport modes** | | |
| 1. Shift from Bulk Road to Single Wagon (SW) Rail Transport | Bulk road transport is replaced by transport in single wagon rail tank cars. | Availability of a direct rail connection at dispatching and receiving location.<br>Availability of sufficient storage capacity at dispatching and receiving location.<br>Willingness of customer to receive bigger quantities. Frequency and reliability of SW rail service.<br>Transit time.<br>Cost. | - Shipper<br>- Consignee<br>- LSP |

| | | | |
|---|---|---|---|
| | | Product constraints. | |
| 2. Switch from road to intermodal short sea transport (SS) | Road transport is replaced by intermodal short sea/road transport (road-SS-road) whereby the goods are transported over the major part of the distance by sea in ro-ro ferries or container ships. The transfer from road to SS and vice-versa is carried out at intermodal sea terminals. If a rail connection is available, the first and last mile can also be done by rail instead of road. | Availability of an intermodal sea terminal close to the point of origin and the point of destination.<br>Frequency and reliability of intermodal SS service. Availability of sufficient intermodal SS capacity.<br>Transit time.<br>Cost.<br>Product constraints | - Shipper<br>- Consignee<br>- LSP |
| 3. Switch from road to intermodal barge/road transport | Road transport is replaced by intermodal barge/ road transport (road-barge-road) whereby the goods are transported over the major part of the distance by barge in containers. The transfer from road to barge and vice-versa is carried out at intermodal barge/road terminals. | Availability of intermodal barge/road terminals sufficiently close to the point of origin and the point of destination.<br>Frequency and reliability of intermodal barge service.<br>Availability of sufficient intermodal barge capacity.<br>Transit time.<br>Cost.<br>Product constraints. | - Shipper<br>- Consignee<br>- LSP |
| 4. Switch from road to intermodal short sea transport (SS) | Road transport is replaced by intermodal short sea/road transport (road-SS-road) whereby the goods are transported over the major part of the distance by sea in ro-ro ferries or container ships. The transfer from road to SS and vice-versa is carried out at intermodal sea terminals. If a rail connection is available, the first and last mile can also be done by rail instead of road. | Availability of an intermodal sea terminal close to the point of origin and the point of destination.<br>Frequency and reliability of intermodal SS service. Availability of sufficient intermodal SS capacity.<br>Transit time.<br>Cost.<br>Product constraints. | - Shipper<br>- Consignee<br>- LSP |
| **B. Supply Chain Management** | **Reduce total tonne-kms through improved supply chain management** | | |

| | | | |
|---|---|---|---|
| 5. Product swap arrangements | Manufacturers of the same product agree to deliver the product to each other's customers located in the area close to the respective manufacturing sites to avoid the need for long-distance transport. | Willingness of commercial parties to engage in products swaps.<br>Need for standardization of product specifications and grades.<br>Ability to demonstrate cost savings. Compliance with competition rules. | - Shipper<br>- Consignee |
| 6. Relax monthly order-invoice cycles | Most chemical companies invoice at the end of each month, giving their customers an incentive to order at the start of the month. This induces wide variations in the volume of product flows, making it difficult for carriers to manage their vehicle capacity efficiently. By moving to a system of rolling credits, the average utilisation of logistics assets would be improved. | Need for a fundamental change in corporate culture and a relaxation of long-established traditions in sales and finance departments in both the chemical industry and its customer base. | - Shipper<br>- Consignee |
| 7. Maximize direct deliveries | Allow larger consignments to bypass warehouses of distributors and external warehouses, to travel directly from production plant to customers.<br>This eliminates a link in the supply chain, reducing handling and cutting the total tonne-kms. | High vehicle load factors need to be maintained. Agreement with distributor when the sale is handled by the distributor. | - Shipper<br>- Distributor |
| 8. Improved routing | Sub-optimal routing of products, both at a supply chain level via intermodal terminals, warehouses and tank cleaning stations, and on the road and rail networks can generate unnecessary tonne-kms. | Use more advanced logistics planning and vehicle routing tools.<br>In the case of hazardous chemicals, more careful routing also reduces the risk of accidents.<br>Transit time.<br>Cost implications | - Shipper<br>- LSP |

| **C. Increase vehicle utilisation by decreasing the proportion of empty running** | **Avoid empty returns or long repositioning journeys by increasing the proportion of vehicles with a back load** | | |
|---|---|---|---|
| 9. Flexibilization of loading and unloading time windows | Vertical collaboration between shippers and their LSPs to streamline loading and unloading operations and optimize transport planning in order to reduce empty running. | Optimization of plant opening hours (e.g. 16 hours). Implementation of flexible time slot booking systems. Allow driver self-loading/unloading. | - Shipper<br>- LSP |
| 10. Flexibility of delivery dates | Exploiting opportunities to load or deliver x days earlier or later, in order to reduce empty running (provided the characteristics of the supply chain allow such operation). | Requires sufficient inventory at both loading point and discharge point. | - Shipper<br>- LSP<br>- Consignee |
| 11. Increase availability of tank cleaning stations at key locations | By improving the geographical spreading of SQAS assessed tank cleaning stations, it will be easier for carriers to clean their vehicles in the vicinity of the unloading point and find backloads close to the unloading point. In this way the empty running of vehicles will be reduced. | Investment in cleaning stations to fill gaps in the geographical coverage. | - Tank cleaning stations<br>- Carrier |
| 12. Reduce black lists of previously loaded products | For some products chemical companies do not accept certain products as previous tank load, in order to minimize the risk of product contamination. | Chemical companies should keep their black lists of previous loads as short as possible and only maintain it for products with high contamination risk. The need to forbid certain previous loads may be prevented by upgrading the tank cleaning requirements. | - Shipper |

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| 13. Horizontal cooperation between logistics service providers | Horizontal cooperation amongst logistics service providers to increase the possibility to exploit back-loading opportunities. | Willingness of LSP's to cooperate. Cost incentive for cooperation.<br>Trust of shippers that cooperation will not have an impact on the quality of the service.<br>Compatibility of equipment. | - LSP |
| 14. Shared use of dedicated fleets (tank & silo transport) | Horizontal cooperation between chemical shippers to establish product dedicated shared use of tank fleets in order to minimize empty positioning. | Agreement between shippers on product compatibility. | - Shipper<br>- LSP |
| **D. Increase vehicle utilisation by increasing the payloads** | | | |
| 15. Increase maximum authorised vehicle weights | In some countries maximum road vehicle weights are restricted to 40 T, whereas in other countries there are national derogations allowing 44T or more. | National derogations for 44T should be introduced in all European countries. The maximum vehicle weight should be harmonised of 44T at European level. | - National & European authorities |
| 16. Expand storage capacity at delivery points | Optimal vehicle loading is partly constrained by the storage capacity of silos and tanks at customers' premises. | Available infrastructure to increase storage capacity. Investment by customers in building additional storage capacity.<br>Need to obtain permits for extending storage capacity. Increased working capital (inventory) for customers. | - Shipper<br>- Consignee |
| 17. Vendor Managed Inventory (VMI) or Haulier Managed Inventory (HMI) | In a system of VMI or HMI the supplier/haulier is responsible for replenishing the customers' stocks within certain agreed limits. This gives the producer/ haulier more control on the supply chain, allowing to manage the transport capacity more efficiently | Customers and suppliers / hauliers need to agree on systems and detailed arrangements.<br>Availability of experience, equipment and systems (telemetric) to manage this. | - Shipper<br>- Consignee<br>- LSP |

| | | | |
|---|---|---|---|
| **E. Fuel efficiency of vehicles** | **Reducing the amount of fuel consumed per km driven** | | |
| 18. Improve vehicle design | The fuel efficiency of vehicles can be increased considerably by improving the vehicle design which includes the fuel efficiency of the engine, the vehicle tare weight, the aerodynamic profiling of the vehicle and the use of low resistance tyres. | Cost - benefit of equipment improvements. Life-time of current vehicle park.<br>Incentives to change and invest. | - LSP<br>- Vehicle manufacturer |
| 19. Improve vehicle maintenance | Technical defects can prevent a lorry from operating at optimum fuel efficiency: these include under-inflated tyres, miss-alignment of axles and poo engine tuning.<br>More regular and thorough maintenance will reduce fuel consumption. | Cost-benefit of improved maintenance. Impact of more regular maintenance on availability of equipment. | - LSP |
| 20. Improve vehicle operation (eco-efficient driving) | The operation of a vehicle can be improved by driver training, reduced speeds, driver incentive schemes etc. Driver training can be supported by intelligent electronic systems that monitor driving behaviour and fuel-consumption. | Cost-benefit of different measures. Potential impact on service levels. | - LSP |
| **F. carbon intensity of fuel** | | | |
| 21. Make use of energy sources with a lower carbon intensity | Increase use of alternative fuels with lower carbon intensity (e.g. bio-fuel). | Sufficient cost advantage.<br>Availability of technology and suitable equipment. | - LSP<br>- Shipper |

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- Figure 3: Overview of typical TCE in chemical logistics. Source: Created by Cefic and the European Chemical Transport Association (ECTA), (2025). Adapted from © Smart Freight Centre from: GLEC Framework v3.1 edition, revised and updated (2024), page 150, Examples of empty running and its relation to the calculation of emissions.
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**Access to the GLEC Framework can be found here:**

**https://www.smartfreightcentre.org/en/our-programs/emissions-accounting/global-logistics-emissions-council/calculate-report-glec-framework/**

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