Calculating GHG transport and logistics emissions for the European Chemical Industry

Module 5 of the GLEC Framework written in partnership with Cefic

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About Smart Freight Centre
Smart Freight Centre (SFC) is a global non-profit organization dedicated to an efficient and zero emission freight sector. We cover all freight and only freight. SFC works with the Global Logistics Emissions Council (GLEC) and other stakeholders to drive transparency and industry action – contributing to Paris Climate Agreement targets and Sustainable Development Goals.

Our role is to guide companies on their journey to zero emission logistics, advocate for supportive policy and programs, and raise awareness. Our goal is that 100+ multinationals reduce at least 30% of their logistics emissions by 2030 compared to 2015 and reach net-zero emissions by 2050.

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1. Introduction

The members of Cefic, representing the majority of the chemical industry in Europe, recognize the importance of reducing the overall environmental impact of freight transport. Hence, knowledge about the GHG emissions that result from the transport of goods within their supply chain, both inbound to their production plants and outbound to their customers, is important to them. These guidelines support them in gaining this knowledge, so enabling them to take steps to reduce their impact.

Cefic and ECTA, representing the specialist transport companies who work on behalf of the chemical producers, published a first guideline for the calculation of tank to wheel GHG emissions from freight transport operations applicable to the European chemical sector in March 2011. Since then there have been many developments in the field of GHG emission accounting, both in general and specifically for freight transport operations, including the EN16258 standard published in 2012 and the GLEC Framework first published in 2016. Nonetheless, the fundamentals of the process remain the same:

- Establish the amount and type of fuel used for the transport service in question
- Convert the fuel use to a well-to-wheel GHG emission value, expressed as mass of CO_2e
- Relate the GHG emissions, including those from cleaning and warehousing, to the transport and logistics activity, expressed in tonne-kilometers, provided by the service
- Report both the total GHG emissions and the emission intensity, expressed as mass of CO_2e per tonne km

This process is set out in more detail Chapter 1-3 of the GLEC Framework.

This updated report reflects changes that have occurred in the past decade and represents an opportunity for the sector to respond to increasing pressure from investors, legislation and customers to reduce GHG emissions from freight transport activities in particular, given its classification as a ‘hard to abate’ sector. Implementing this guidance will show that the sector is adopting current best practice, adapted specifically for the chemical industry, and is preparing itself for the decarbonization challenge that will become increasingly apparent in the coming years.

The scope of the GHG emission calculation covered in this report includes the transport and logistics activities directly related to the chemical industry supply chain. The primary focus are the transport and logistics operations the companies are contractually responsible for, which are primarily the transport of finished goods to their customers. Estimates may also be made for transport operations within the supply chain that are the responsibility of other entities, for example inbound transport of raw materials, although any such estimates will inevitably be subject to greater uncertainty due to lack of knowledge of all parameters and hence greater reliance on estimation and assumptions. Therefore, it is highly recommended to request transport emission data to be included in the emission reporting of the contracting party

The activities include:

- The transport itself, including associated vehicle repositioning needed to fulfil the service
- The handling of goods and short-term storage at logistics sites, including energy use associated with movement of goods within a logistics site or warehouse and the operation of the storage or handling facility
- Tank cleaning operations required to make vehicles available for their use in chemical transport
- Temperature control (whether heating or cooling) required for conditioning of the product during the transport chain

Items specifically excluded are:

- Activities associated with intermediate processing of a product, including where its nature is fundamentally changed
- Administrative functions of the transport company, even if they are co-located at a logistics site
- Maintenance of site or vehicles
- Vehicle or transport infrastructure

Implementing the guidance in a way that informs and drives change in the industry will require a significant amount of interaction between the chemical companies and their logistics service providers (LSPs). This will include interactions between LSPs and subcontracted transport operators, warehouse operators and cleaning stations. Actions that reduce GHG emissions from chemical transportation will need to be supported by the sharing of GHG information based on primary data, rather than relying on the industry standard default values that are provided here merely as a starting point for those companies that are only now setting up their emission calculation and reporting processes.

The report is structured as follows:

- Section 2 sets out some of the specific characteristics of chemical industry logistics operations that influence the way that GHG emissions are calculated as well as the resulting impacts
- Section 3 sets out typical or representative values that may be used as default values by European chemical companies in cases where they are beginning to compute GHG emissions or where more specific carrier data is not available, for whatever reason
- Section 4 provides guidance for carriers and LSPs when it comes to interpreting these guidelines
- Section 5 provides guidance for chemical companies when it comes to implementing the GLEC Framework and the influence of these industry-specific guidelines
- Section 6 acknowledges that knowledge about GHG emission impacts and calculations is continually evolving, as is the list of potential low emission solutions that are available to companies, including those in the chemical industry. Section 6 indicates areas where updates are most likely to be needed in the relatively near future and where this would be reflected in future versions of this guidance.
- A summary table of the default GHG emission intensity values for road transport based on knowledge of load and empty running is presented in Annex 1 while Annex 2 presents additional information about intermodal transport.

2. Chemical industry specifics

This section describes specific characteristics of chemical industry transport and logistics operations that are not set out in detail in the existing GLEC Framework. The approach in terms of core methodology is unaffected, i.e., identify all the individual elements of the transport chain, including any associated empty running and then collect the information necessary to calculate the emissions.

However, some of these characteristics do influence the way in which transport operation categories are defined for use in chemical transport operations. The result is a more detailed and specific set of transport categories than the general set defined in the main body of the GLEC Framework.

2.1 Nature of the cargo transported

The cargo transported for the chemical industry is a mixture of solids, liquids and gases that are either ingredients for or the result of chemical processes managed by the chemical industry. Consignment sizes tend to be greater than in the wider transport sector, which leads to a greater incidence of bulk transportation, the potential for higher payloads, especially when expressed in terms of cargo mass, and a greater potential for use of intermodal solutions and high-capacity modes such as rail, inland waterway and sea transport.

Some cargos have very specific storage or handling requirements that impact upon the way that transport chains in the chemical industry are arranged. This may also impact on the nature of the equipment used and on the business relationship, e.g., greater reliance on tankers or equipment that can withstand high pressures. These issues are reflected in some of the following subsections.

Analysis of data collected by ECTA suggested that the nature of the cargo, when classified as dry bulk, liquid bulk or cargo packed in smaller containers, does have an impact on both average load and the extent of empty running. This has been combined with information collected from chemical companies (Cefic members) to compile the input parameters used to define the default values presented in section 3 of this report.

2.2 Shared transport – definitions and use

Terminology can vary within the freight transport sector as a whole and even within a segment such as chemical transportation. The following terms have been used to establish the chemical sector default emission intensity values:

- **Full truckload (FTL):** a chemical company has enough product for a consignment to fill a vehicle, by weight or other dimension, close to the vehicle's legal limits and that vehicle travels from a single point of origin to a single destination to deliver the single consignment.
- **Less than truckload (LTL):** a chemical company has one or more consignments that individually are not big enough to fill a vehicle, by weight or other dimension, to the vehicle's legal limits. An approximate boundary of 15 tonnes, i.e. ± 60% load by mass, has been used to differentiate full and less than truckload. LTL transport can be split into many different subcategories with widely differing characteristics. For the purposes of this document the following two categories have been used:
    - **Partial load:** a single LTL consignment, which on its own is not big enough to fill a vehicle, by weight or other dimension, is transported on its own from a single point of origin to a single destination. The reason can be timing (rush order) or incompatibility with other products.
    - **Groupage:** multiple LTL consignments, potentially originating from different chemical companies and different origins are consolidated by a logistics service provider to achieve a main haul transport with higher load factor than would otherwise be the case. The consolidated consignments may be delivered to one or several end destinations. Consignment size, operating pattern, overall load factor can all vary considerably within this broad category of transport.

The use of groupage transport is commonplace, particularly for packed goods. The nature of the cargo may require specialist transport providers who are used, or even licensed, to handle cargos with specific properties. The benefit of groupage services from a GHG emission perspective is that the transport provider should be able to achieve greater overall efficiency by carrying several consignments from different providers in one trip, so maximizing load factors and minimizing empty running. Sharing of operational information and actual GHG emission performance of groupage transport has been relatively uncommon; however, with the increased focus on transparency and reduction of GHG emissions we expect that may change in the future.

The work required of the transport company should not be any greater than for dedicated transport, because all customers would be expected to share a network average emission intensity value that reflects the overall benefit of the shared transport operation and the associated improved efficiency.

2.3 Dedicated transport

The use of dedicated transport services, where dedicated equipment is provided by the transport company for the use of a specific product (and company), is more common in the chemical sector than in general haulage, particularly due to the specialist nature of the equipment, cargos and cleaning requirements. This could lead to an increased incidence of empty running. Hence there is a trade-off between dedicated transport contracts and a lower overall system efficiency / higher GHG emissions.

This places a responsibility on chemical companies and their transport providers to investigate options to reduce the incidence of company-specific dedicated transport wherever the business model will allow it. For example, allowing transport of compatible loads or using cleaning facilities close to the point of unloading that would allow a backload would both avoid an empty return trip to base and improve overall transport system efficiency.

Data collected by ECTA suggested that there are significant variations reported in terms of average load and particularly empty running from transport operator to transport operator. Unfortunately, it has not been possible to isolate the nature of the transport operation to establish whether dedicated transport contracts were contributing to this variation. The assumption is that dedicated transport would result in higher level of empty running than for shared transport. However, it is likely that there is also a variation in the operating practices between differing transport companies which is clear reason to advocate for the use of primary data as the basis for GHG calculations.

2.4 Payloads

As mentioned previously, the cargo tends to be relatively dense and consignments are larger, leading to payloads that are typically much closer to vehicle payload limits than the overall sector average. Nonetheless, consultation with individual chemical companies did reveal significant variations from company to company, around a relatively high average payload figure.

Although high payload does slightly increase vehicle fuel consumption and emissions when expressed on a per vehicle kilometer basis, the benefit of transporting more cargo in a single trip significantly outweighs this effect and leads to a much lower emission intensity value, expressed in emissions per unit of transport activity (mass CO_2e / tonne km).

The variation from company to company emphasizes the importance of using primary data for the calculation of emissions at a company or even better at product level, and of monitoring factors such as the load factor and extent of empty running within a supply chain

1. To adhere to the basic principle of accuracy
2. To help identify where efficiency improvements and hence emission reductions can be achieved

It is through simple steps like these that short-term emission reductions can be easily achieved at relatively low cost and to the benefit of all parties involved and wider society.

The typical payloads used in generating the road transport default GHG emission intensity values for chemical transport are as follows:

Market Segment	Data Source	Value (tonnes)
Overall sector average	Inferred from more detailed segments below	18
Packed goods transport		
Packed goods average	Inferred from more detailed segments below	15
Packed goods: FTL	Cefic project member data; confirmed ECTA member survey	21
Packed goods: part load	Cefic project member data	8
Packed goods: groupage	ECTA secretariat	15
Bulk transport		
Bulk goods average	ECTA member survey; confirmed Cefic project member data	22
Bulk goods: tank truck	ECTA member survey; confirmed Cefic project member data	21
Bulk goods: hopper/silo	ECTA member survey; confirmed Cefic project member data	26
Bulk goods: tank container	ECTA member survey; confirmed Cefic project member data	24

2.5 Empty running

Minimizing the extent of empty running is a way for all parties with an interest in freight transport to improve efficiency. At the same time a certain level of empty running is inevitable, especially for FTL transport, as it is unlikely that the next consignment will always be available at the point of unloading the previous one. Groupage allows an LSP to minimize empty running within the constraints of their network and the amount of business they are able to generate. The extent of empty running is an important influencing factor on GHG emission intensity values. The following values have been used in this document:

Market Segment	Data Source	Value (% of total distance)
Overall sector average	Inferred from more detailed segments below	22
Packed goods transport		
Packed goods average	Inferred from more detailed segments below	22
Packed goods: FTL	ECTA member survey	22
Packed goods: part load	ECTA member survey	22
Packed goods: groupage	GLEC LTL average	17
Bulk transport		
Bulk goods average	Inferred from more detailed segments below	22
Bulk goods: tank truck	ECTA member survey	19
Bulk goods: hopper/silo	ECTA member survey	22
Bulk goods: tank container	ECTA member survey (assumed same as tank truck)	19

Higher values of empty running have been assumed for dedicated transport services based on discussions with Cefic members that are within the range reported in the ECTA survey.

2.6 Cleaning operations

In many cases the purity of the cargo is important to meet strict product standards. Where such a restriction applies it is essential that the transport equipment is thoroughly cleaned between the successive transport operations conducted by a vehicle to avoid cross contamination. The required cleaning operations are carried out to industry standards at facilities that may or may not be present at, or close to, the location where a particular cargo is unloaded or the next cargo is to be loaded. If no cleaning station is present the result may be additional empty running between point of unloading and the next loaded journey. In extreme cases, if a cleaning facility is not available in the locality of the unloading location, this may necessitate a return to base for cleaning before the next journey can be undertaken.

The impact of cleaning on empty running has been factored into the default values based on feedback and data received from Cefic and ECTA members.

Where a cleaning operation is known to take place the calculation of transport GHG emissions should be based on a combination of the transport emissions and the GHG emissions associated with a cleaning operation. A default value for the GHG emissions from cleaning is provided in section 3.10. However, that value depends heavily on the local electricity emission factor and the efficiency and energy source of the steam generator. This information may support emission reduction through re-evaluating options for compatible loads, potentially moving away from dedicated company transport.

Because the choice of cleaning versus dedicated transport is part of the operational model of the transport provider, and may change depending on volumes and business developments, it is important for the chemical company to ensure the service provider considers this option. Given high the variability of cleaning emissions it is recommended that the provider of the cleaning operations uses a specific value for the GHG emission per cleaning operation for their specific situation, wherever possible. Further guidance can be found at: https://www.eftco.org/safe-cleaning/professional-cleaning.

2.7 Tank container transport

From a GHG calculation methodology perspective, the use of tank containers to transport fluids is not *per se* a significant deviation from other truck body types, i.e., the standard trailer used in generic road transport calculations. What is important to note is that, as for all other transport, it is the net weight of the load that should be used when calculating the transport activity, i.e. excluding the weight of the container. If there is any uncertainty, please confirm with the carrier that the weight of the container has not been included in the calculation of the GHG emission intensity.

2.8 Pipeline transport

Pipeline transport is a form of transport that is highly specific to the chemical sector and is not currently reflected in the main body of the GLEC Framework, except in passing in the introduction. Hence, information for pipeline transport has been developed specifically for this report. This has highlighted that, although information is known to pipeline operators, until now sharing and calculation of GHG emissions from this transport mode has been limited.

Discussion among the project group suggested that there are several factors that influence the emission intensity of pipeline transport, including:

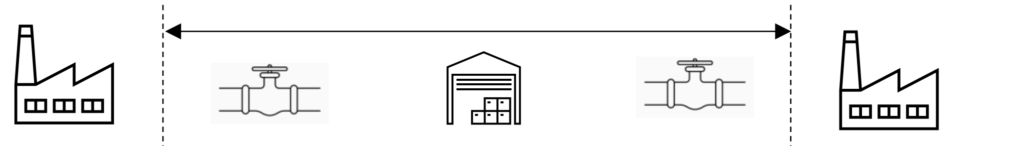
- Pipeline length
- Pipeline diameter
- Nature of the product (liquid or gas)
- Viscosity of the product

- Pressure within the pipeline system, which may be varied depending on required flow rate

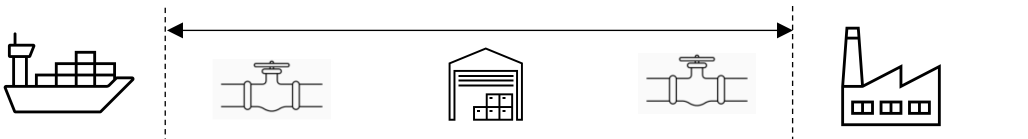
Some products, particularly gases, may come out of the production plant in a highly pressurized form. If that pressure can be captured then the product may, in some cases, flow due to the original pressurization without requiring extra energy for transportation. In order to ensure consistency with the overall project scope, and boundaries used for the emissions for production plants and logistics sites, the following boundaries were agreed:

- Do not include the energy used by pumps ‘within the boundaries of a production site’ meaning that only the energy used by pumps when the product is in transit contribute to the pipeline transport emissions
- If the product is already in transit, and being transferred from a ship or barge, any pumps on board the ship or would be accounted for by the ship, whereas any pumps linked to the pipeline would be included in the pipeline emissions

This is shown by the following diagram:



where	**factory**	**transit**	**half-way station**	**transit**	**destination**
what	pump	pump	pump	pump	pump
in/out	no	yes	yes	yes	no



where	**ship**	**transit**	**half-way station**	**transit**	**destination**
what	pump	pump	pump	pump	pump
in/out	no	yes	yes	yes	no

Given the potential variability of pipeline emission intensity it is recommended that chemical companies request emission intensity data from the operator of the pipeline expressed in GHG emissions per tonne km of product throughput, averaged on an annual basis in order to calculate representative emissions in a comparable way to other transport modes.

3. Impact of chemical industry specifics on default values

3.1 Sector-specific transport operation categories

This section presents the result of the discussions within the project group on how the individual different transport categories should be set out on a mode-by-mode basis and the resulting default GHG emission intensity values.

Similar to the presentation of default values in the main body of the GLEC Framework, defaults are presented in a hierarchy of three levels, starting from a highly generic situation where the chemical company knows little about the consignment or how it is transported, through a situation of partial knowledge through to a more detailed knowledge of the goods and the detailed means of transport. Through this progression the assumptions become more specific to the transport in question and the values more representative of the actual transport.

All emission intensity values are presented as well to wheel (WTW) values in g CO_2e/tkm.

3.2 Road transport

Following the approach taken in Module 2 of the main GLEC Framework three levels of default GHG emission intensity value are provided for road transport:

Level 1: to be used by the chemical company only in exceptional circumstances when there is no knowledge of the product type or how the transport service is organized.

Level 2: to be used by the chemical company when there is knowledge of the product type but no knowledge of how the transport service is organized.

Level 3: to be used by the chemical company when there is knowledge of the product type and the general nature of the transport service but the carrier has not provided the data required for calculation of the GHG emissions based on their primary data.

The default road transport GHG emission intensity values are calculated on the basis of using vehicles in the class "articulated truck up to 40 tonne gross vehicle weight" using "Diesel, 5% biodiesel blend", which industry data shows to be the predominant vehicle class.

Transport Operation category		**Empty running (% of total distance)**	**Typical load (tonnes)**	**GHG emission intensity value (g CO_2e/tkm)**
Level 1:				
Overall sector average		22	18	71
Packed goods – Level 2				
	Average, ambient	22	15	81
	Average, temperature controlled	22	15	91
Packed goods – Level 3				
FTL	ambient	22	21	63
	temperature controlled	22	21	71
Partial load	ambient	22	8	137
	temperature controlled	22	8	154
Groupage	ambient	17	15	78
	temperature controlled	17	15	87
Bulk goods – Level 2				
	Average, ambient	22	22	61
	Average, temperature controlled	22	22	68
Bulk goods – Level 3				
Tank truck	Ambient	19	21	62
	Temperature controlled	19	21	70
	Dedicated, ambient	50	21	90
	Dedicated, temperature controlled	50	21	101
	Ambient	22	26	55

Transport Operation category		Empty running (% of total distance)	Typical load (tonnes)	GHG emission intensity value (g CO_2e/tkm)
Hopper/ silo	Temperature controlled	22	26	62
	Dedicated, ambient	50	26	76
	Dedicated, temperature controlled	50	26	86
Tank container	Ambient	19	24	58
	Temperature controlled	19	24	65
	Dedicated, ambient	50	24	83
	Dedicated, temperature controlled	50	24	93

The values for dedicated transport are at the extreme, conservative end of the possible range with 50% empty running, assuming dedicated transport at the company level. For a more accurate value, specific to your service, please consult with your service provider

For non-dedicated transport where a cleaning operation is required to facilitate operation with a lower level of empty running as compared to returning to base for cleaning then an additional 81.5 kg CO_2e per cleaning operation should be added (see section 3.10).

3.3 Rail transport

Transport Operation category	Empty running (% of total distance)	Load factor (%)	Traction energy	GHG emission intensity value (g CO_2e/tkm)
Level 1: Overall sector average	33	40	Average	19
Level 2 : Container train (intermodal)				
Average	17	50	Average	17
Diesel train	17	50	Diesel	25
Electric train	17	50	Electric	12
Level 2 : Blocktrain (RTC)				
Average	50	100	Average	16
Diesel train	50	100	Diesel	24
Electric train	50	100	Electric	12
Level 2 : Single Wagon train (RTC)				
Average	50	100	Average	20
Diesel train	50	100	Diesel	33
Electric train	50	100	Electric	16

Notes:
Single wagon rail transport includes allowance for extra short distance transport to origin main haul site to assemble full train and from destination site for final distribution.

Electric traction energy is assumed only for main haul traction. Any shunting within site or short distance transport to/from site to assemble single wagon trains is assumed to be by diesel traction.

Electric main haul assumes EU average electricity factor of 420 g CO_2e/kWh. Use of individual country mixes may give significantly different values, especially in countries with a highly decarbonized electricity supply.

3.4 Inland waterways transport

Inland waterways transport is well-suited to the generally larger consignments that are typical of the chemical sector and so the inland waterway default intensity values in the main GLEC Framework are directly applicable to the chemical sector as follows:

Transport Operation category	Overall utilization (%)	GHG emission intensity value (g CO_2e/tkm)
Bulk tanker (average)	65	21
Tanker barge (liquid)	65	21
Tanker barge (gas)	65	21
Container vessel (average)	75	26
Container vessel 110m	75	26
Container vessel 135m	75	20
Dry barge (average)	50	19

3.5 Short and deep sea transport

The framing of international sea transport, whether deep sea or short sea (coastal) shipping is currently set by the IMO 4th GHG Study[1], which focuses on categorization of vessels by general type size categories. This approach has been used to provide short sea and deep sea shipping values for chemical tankers, gas tankers and general cargo. The values are based on the 'upper quartile' values quoted in the IMO 4th GHG Study and so are deliberately higher than average in order to adhere to the principle of taking a cautious approach to the use of default GHG emission intensity values. Although shown in the same table below it is worth noting that short sea shipping within Europe is likely to be performed by the smaller vessel sizes whereas deep sea transport will more likely use the larger vessel sizes.

Care should be taken when calculating emissions from sea transport that distances are converted from nautical miles to kilometers to avoid systematic errors.

Vessel category			GHG emission intensity value (g CO_2e/tkm)
Chemical tanker	0-4999	dwt	105.3
	5000-9999	dwt	33.3
	10000-19999	dwt	22.0
	20000-39999	dwt	12.9
	40000-+	dwt	9.7
General cargo	0-4999	dwt	34.7
	5000-9999	dwt	26.1
	10000-19999	dwt	23.5
	20000-+	dwt	12.4
Gas tanker	0-49999	m^3	74.7
	50000-99999	m^3	16.2

[1] The 4th GHG Study is more recent than the current version of the GLEC Framework and is the basis anticipated for the current draft of the ISO14083 sea annex and next update to the GLEC Framework.

	100000-199999	m^3	12.5
	200000-+	m^3	15.9

Dwt = deadweight tonnes

3.5.1 Sea container transport

The latest data from the Clean Cargo initiative has been used for containerized shipping. Clean Cargo provides industry average data on a tradelane basis and this has been converted to a per tonne kilometer basis using indicative payload values for ISO tank, 20' and 40' containers.

Transport Operation category		**Temperature Condition**	**GHG emission intensity value (g CO_2e/tkm)**
Level 1: Sector Average	ISO Tank	Ambient	3.2
		Temp controlled	5.8
	20'	Ambient	3.5
		Temp controlled	6.4
	40'	Ambient	5.7
		Temp controlled	10.3
Level 2:			
Intra NW Europe	ISO Tank	Ambient	6.7
		Temp controlled	10.6
	20'	Ambient	7.4
		Temp controlled	11.7
	40'	Ambient	12.0
		Temp controlled	19.1
Intra Mediterranean	ISO Tank	Ambient	6.1
		Temp controlled	10.6
	20'	Ambient	6.8
		Temp controlled	11.7
	40'	Ambient	11.1
		Temp controlled	19.0
NW Europe - Mediterranean	ISO Tank	Ambient	4.7
		Temp controlled	7.6
	20'	Ambient	5.2
		Temp controlled	8.4
	40'	Ambient	8.5
		Temp controlled	13.6
NW Europe - Asia	ISO Tank	Ambient	2.0
		Temp controlled	4.5
	20'	Ambient	2.2
		Temp controlled	4.9
	40'	Ambient	3.6
		Temp controlled	8.0
NW Europe - Africa	ISO Tank	Ambient	4.8
		Temp controlled	7.9
	20'	Ambient	5.3
		Temp controlled	8.7
	40'	Ambient	8.7
		Temp controlled	14.2

Transport Operation category		Temperature Condition	GHG emission intensity value (g CO_2e/tkm)
NW Europe – South & Central America	ISO Tank	Ambient	3.2
		Temp controlled	5.8
	20’	Ambient	3.6
		Temp controlled	6.4
	40’	Ambient	5.8
		Temp controlled	10.4
NW Europe – Middle East / India	ISO Tank	Ambient	2.7
		Temp controlled	5.2
	20’	Ambient	3.0
		Temp controlled	5.7
	40’	Ambient	4.8
		Temp controlled	9.3
NW Europe - Oceania	ISO Tank	Ambient	3.8
		Temp controlled	6.3
	20’	Ambient	4.2
		Temp controlled	6.9
	40’	Ambient	6.9
		Temp controlled	11.3
NW Europe – North America East Coast / Gulf	ISO Tank	Ambient	4.2
		Temp controlled	6.8
	20’	Ambient	4.6
		Temp controlled	7.5
	40’	Ambient	7.5
		Temp controlled	12.2
NW Europe – North America West Coast	ISO Tank	Ambient	3.1
		Temp controlled	5.6
	20’	Ambient	3.4
		Temp controlled	6.2
	40’	Ambient	5.5
		Temp controlled	10.1

3.6 Air transport

Air transport is a relatively uncommon mode of transport for the chemical sector; hence, the guidance is to use the general values specified in the GLEC Framework.

3.7 Pipeline transport

The current data available suggests that the characteristics and performance of pipelines is highly variable making it difficult to represent reliably using a default GHG emission intensity value.

As many pipelines are owned by chemical companies, it is expected that emissions can easily be calculated from the energy consumption available to the pipeline owner, as follows (see also section 2.8):

Total emissions = electricity consumption outside site boundaries x electricity emission factor (country specific, or EU average of 420 kgCO_2e/kWh).

Where the total tonne km = total tonnes transported in the latest year multiplied by the length of pipeline in km.

Most pipelines have been shown to operate in the range 1 to 50 g CO_2e/tkm, although instances of up to 360 g CO_2e/tkm have been found in extreme circumstances (e.g. combination of short distance, uphill etc.).

3.8 Intermodal transport

Intermodal transport involves the transport of a consignment by at least two transport modes, which necessarily have different operating characteristics, as well as a handling operation at a logistics site each time there is a change of mode. As such, assigning a default GHG emission intensity value to an intermodal transport is subject to a greater degree of uncertainty than to an individual transport mode - not only does it depend on the uncertainty associated with the assumptions for each individual transport element, but also the assumed length, and hence relative contribution, of each leg. Hence, the following scenarios should be seen as indicative; pre- and on- carriage are assumed to be by road transport. These values also include the default values from the GLEC Framework of 1.2 kg CO_2e / t or 30.1 kg CO_2e per container moved.

Main Carriage	**Total Distance (km)**	**% distance by main carriage**	**GHG emission intensity value (g CO_2e/tkm)**
rail	1000	85	27.3
inland waterway	110	85	47.5
short sea containerized	1100	85	16.7
deep sea containerized	7600	90	9.0

Notes:
Total distances in the above table are for Europe and based on Cefic survey data; deep sea based on transatlantic intermodal example.
Includes GHG emissions associated with 2 transhipment actions, one at each end of the main haul.

Additional information is provided in Annex 2 (Intermodal GHG emission intensity by distance) which shows the variability according to total distance, distance share as well as an equation that sets out the impact on GHG emission intensity of varying these two distance parameters, keeping all other assumptions fixed.

A worked example using different levels of information to show how a more detailed and accurate calculation can be achieved with better data and by calculating the emissions for every step in the intermodal chain including transhipment is provided in Annex 3. This would also allow the calculation of other modal combinations such as road + rail / barge + deep sea, for example in addition to the four default combinations.

3.9 Logistics Sites

Information regarding GHG emissions from logistics sites in general remains relatively limited. Hence, provision of default GHG emission values specifically for the chemical industry (including tank storage as well as transhipment and warehousing) is not possible and the guidance is to use the general values specified in module 2 of the GLEC Framework. (Efforts will continue with GLEC members and partner organizations to add depth to the data regarding GHG emissions from logistics sites with a view to revising the data in future versions of the Framework.) It is recommended that companies request a value from the operator of the logistics site that represents the GHG emission per tonne of product throughput for their specific situation.

3.10 Cleaning Operations

The following table sets out the calculation used to determine a representative value for tank cleaning. The value of 81.5 kg CO_2e per cleaning operation conducted has been used in several of the worked examples later in this document.

Indicative Tank Cleaning Calculation based on data provided by EFTCO using a conservative average European electricity emission factor (see https://www.eftco.org/safe-cleaning/co2-print).

Electricity (kg CO_2e/kWh)	Gasoil (kg CO_2e/kWh)
0.420	0.325

Per tank cleaning	Consumption	Production kg CO_2e
Energy consumption for heating tank cleaning water (kWh gasoil)	228	74.1
Electricity consumption HP Pump (kWh)	8.0	3.4
Electricity consumption WWT (kWh)	9.6	4.0
Water consumption (m^3)	2.0	0
Total per tank cleaning		**81.5**

Note: according to the transport chain boundaries, electricity consumption included only relates directly to cleaning operation
Note: the heating efficiency of the steam generator in the above example is assumed to be 90%. (For other assumptions see the EFTCO webpage above.)

4. General guidelines for transport operators and logistics service providers

This section briefly describes the steps a carrier, or LSP that operates transport equipment, must take in order to align with requirements of the GLEC Framework. The main focus is guidance to be used by transport operators in the collection and processing of operational data. Additional information is also provided for situations where operations are subcontracted, as is often the case for integrated, intermodal and specialist transport.

4.1 Operational data collection and processing

As set out in chapter 2 of the GLEC Framework, the expectation is that the operator of the transport, irrespective of mode, will have access to the energy/fuel consumption information necessary to calculate their total emissions, based on the equation:

GHG emission (mass of CO_2e) = fuel / electricity consumption (per amount of energy used)
x WTW emission factor (kg CO_2e per amount of fuel used)

So that a carrier can report information to their customer, which may be an LSP, in a way that is meaningful, it makes sense for the carrier to tailor the information to the customer's needs by following some simple steps, as outlined below. The intention is to provide transparency over the GHG emissions which the carrier produces while conducting transport on their behalf, so reducing:

- the risk of incorrect reporting;
- wasted time linked to incorrect or incomplete reports
- improved opportunity to identify emission hotspots and make joint decisions to improve efficiency / reduce emissions

Step 1: Break up your total transport into categories

For the information to be as relevant as possible it is important to break up your overall transport activities in different categories and then base your customer report on the category relevant to them. The idea is that the characteristics of the trips within one category are as similar as possible (e.g. same type of truck, lanes, distances, type of load, etc.), so that the performance is clustered around a representative value.

To perform the calculation you need to be able to identify the net tonnes of product transported and kilometers driven (both loaded and empty) associated with each category and specify the total fuel consumption for that category.

In this step it is also good practice to engage with your customer to see if the categories you intend to use match their needs. In the worst case you can combine everything together into one category for the whole business and decide how you could create more specific categories for the next reporting period.

The breakdown of the default GHG emission intensities follow a suggests structure for the transport operation categories as follows:

Road transport:
Level 1:
- Overall average

Level 2:
- Packed goods average, ambient
- Packed goods average, temperature controlled
- Bulk goods average, ambient
- Bulk goods average, temperature controlled

Level 3:
- Packed goods: FTL, ambient
- Packed goods: FTL, temperature controlled
- Packed goods: partial load, ambient
- Packed goods: partial load, temperature controlled
- Packed goods: groupage, ambient
- Packed goods: groupage, temperature controlled
- Bulk goods: tank truck, ambient
- Bulk goods: tank truck, temperature controlled
- Bulk goods: tank truck, dedicated, ambient
- Bulk goods: tank truck, dedicated, temperature controlled
- Bulk goods: hopper/silo, ambient
- Bulk goods: hopper/silo, temperature controlled
- Bulk goods: hopper/silo, dedicated, ambient
- Bulk goods: hopper/silo, dedicated, temperature controlled

Rail transport
Level 1: Overall sector average
Level 2:
- Track Container
- Track RTC blocktrain
- Track RTC (single wagon)

Inland waterway transport
- Bulk tanker
- Container vessel
- Tanker barge (liquid)
- Tanker barge (gas)
- Dry barge
- Container vessel 110m
- Container vessel 135m

Sea transport
- Chemical tanker
- General cargo
- Gas tanker
- RoRo
- Container transport: sector average
- Container transport: by trade lane

- Bulk goods: tank container, ambient
- Bulk goods: tank container, temperature controlled
- Bulk goods: tank container, dedicated, ambient
- Bulk goods: tank container, dedicated, temperature controlled

Intermodal transport

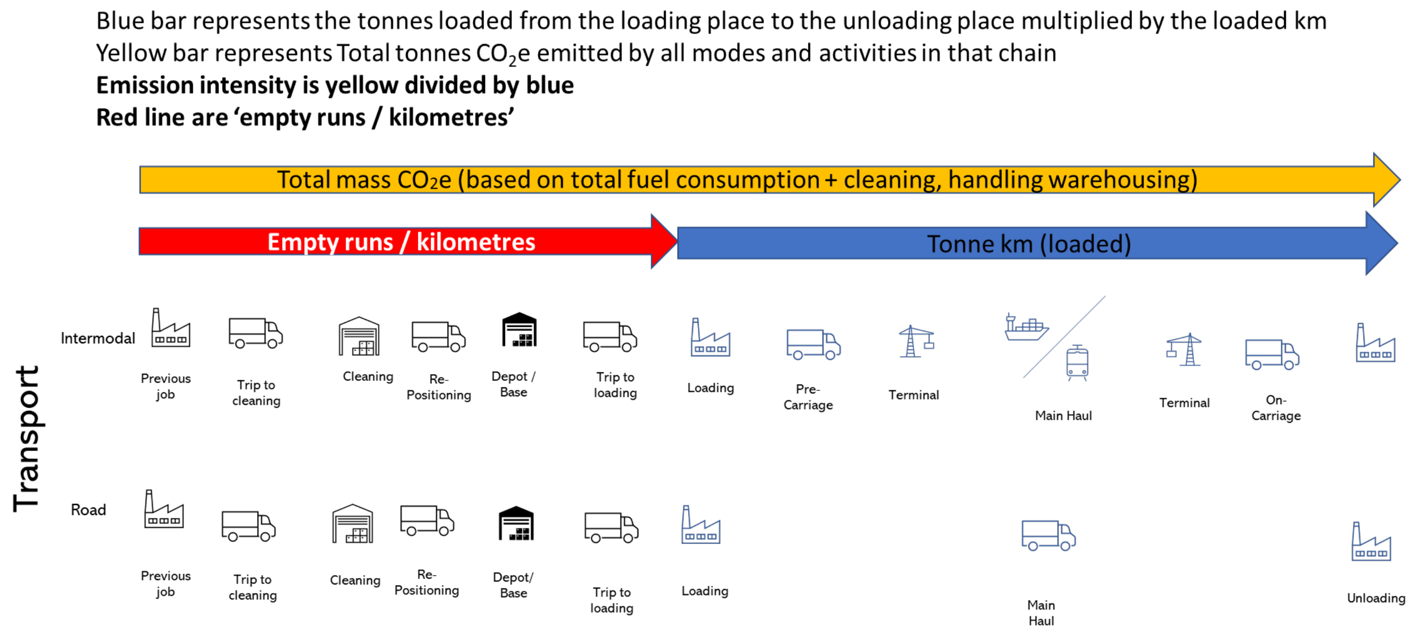
- Road + rail main carriage
- Road + inland waterway main carriage
- Road + short sea containerized main carriage
- Road + deep sea containerized main carriage

Step 2: Calculate fuel consumption by category

To determine the total GHG emissions for each category that is relevant to you and your customer, it is important that you know the fuel consumed in each category over the requested time period.

The approach taken will depend on the maturity level of your organization, which may be based on the total amount of liters purchased, the average fuel consumption by type of truck in the fleet, or actual consumption monitored through telematics systems or refueling records.

Ideally, the fuel data will be available as actual liters consumed per vehicle and it will be possible to assign the distance travelled, the amount of product transported and the associated fuel consumption by category from the bottom up. In many cases individual vehicles will only operate in one category, but where that is not the case the operations should be assigned by category according to use. Remember, you must 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.



If primary fuel data are not available at the ideal, disaggregated level then you will either have to

- work with averages of fuel consumption for the different vehicle types. In that case you need to know the actual total kilometers (empty and full) driven by the different vehicle types in each operation category. For example:

Category **Bulk truck**	total km driven per type	Avg consumption l/km	Consumption per truck type

Truck type A	10,000,000	0.26	2,600,000
Truck type B	5,000,000	0.30	1,500,000
		Total fuel consumption in category	**4,100,000**

- or make top-down assumptions; for example, it could be that you make an estimate of the share of the total fuel consumption for the different operation categories based on your knowledge of the proportions of vehicle activity within your business. For example:

Transport Category	Percentage of total fuel consumption	Liters fuel consumed
	Total company fuel consumption	**200,000,000**
Bulk truck (liquid/solid)	40%	80,000,000
Container carrying trucks	30%	60,000,000
Refrigerated trucks	30%	60,000,000

When you use either of these approximations it is important to check that when you add together the consumption of all the categories this matches the total consumption of your operation, so you are sure that all consumption has been accounted for.

You may be consuming different fuel types (e.g. diesel, biodiesel blend, LNG) within one operation category. In this case you would need to determine the consumption of the individual fuel types separately in order to calculate the emissions correctly at step 3.

Step 3: Calculate total GHG emissions

Once you know the actual fuel consumption for the operation category, you can now calculate the related GHG emissions for each fuel using the emission factor for that fuel. The emission factors will depend on the type of fuel and may vary by region. The GLEC Framework contains standard factors for most common fuels; these may be updated occasionally, so always check the latest version of the GLEC Framework (module 1). For some more innovative fuels such as high blend biofuels your fuel supplier probably has its own certified value for the emission factor linked to the fuel that they are supplying.

For example, if three different fuel grades are used within a single operation category as follows, the total GHG emissions would be calculated as:

Fuel type	Consumption (l)	Well to Wheel emission factor (**kg** CO_2e/l fuel)	Total emissions **(t)** CO_2e
Diesel	80,000,000	3.24	259,200
Diesel (5% biodiesel blend)	20,000,000	3.17	63,400
100% Biodiesel	1,000,000	1.92	1,920
		Total emissions for category	**324,520**

Step 4: Calculate the emission intensity

When sharing information with your customer you may be happy to collect and share your primary data (fuel used and resulting emissions) with them so that they can see the full calculation shown in Step 3. This is most likely to be relevant for dedicated transport contracts where their volumes can more easily be identified. Alternatively, you may prefer to share the emission intensity of the transport operation that you provide on their behalf. To calculate the emission intensity you need to know the total GHG emissions (from step 3) and the amount of transport activity expressed in tonne kilometers.

In this step you must calculate the transport activity for all the loaded trips in each category and add up the tonne kilometer values for each trip. This gives the total tkm of the category and can also accurately identify the tkm for your individual customers. More detailed guidance on calculating transport activity is presented in table 3 on page 25 of the GLEC Framework[2].

Short example of the correct approach to calculate the transport activity

Trip	Customer	Loaded weight (t) per trip	Loaded distance traveled (km) per trip	Metric ton kilometers (tkm)
1	Customer A	20	150	3000
2	Customer B	19	100	1900
3	Customer B	22	200	4400
etc				
Total tkm for this category over the requested time period				**9300**

The emission intensity is easily calculated by dividing the total emissions in a transport operation category by the tkm in that category. Using this information you can calculate emissions for each category, for example:

Category	Total emissions (kg CO_2e)	Total transport activity (tkm)	GHG intensity value kg CO_2e /tkm
Bulk truck	7680	128000	0.060
Container carrying truck	5280	60000	0.088

By assigning total emissions to a transport operation category, and dividing it by the loaded tonne km, the calculated GHG intensity factor includes emissions linked with empty runs, cleanings, repositioning, for that transport category.

Additional calculation examples are provided in Annex 3.

Step 5: Carrier reporting to direct customer

Follow the guidance in the GLEC Framework on reporting, the so called "GLEC Declaration". You should report the activities that you provide directly to each customer according to table 12 of the GLEC Framework; in this example, your Bulk truck category and your Container carrying truck category.

Item	GHG intensity value (WTW) CO_2e kg/tkm	Customer specific tkm****	WTW GHG emission (kg CO_2e)
Bulk truck category	0.060	50,000	3,000
Container carrying truck category	0.088	10,000	880
Total emissions kg CO_2e			3,880
Input data type**	100% primary data		
Mode coverage*	Road		
Data verification statement***	Data has not been independently verified by a 3rd party		
Period covered	1/1/2020 – 31/12/2020		

*) In this case the emission calculations only cover road transport.

[2] The table shows the correct approach, based on adding up the tonne kilometer values for each trip, as well as two acceptable approaches for estimation of total transport activity and two approaches that are commonly used, but incorrect. Even the acceptable approaches for estimation of total transport activity can introduce significant uncertainty and should be avoided as soon as the more detailed approach is feasible.

**) Since you used your own actual fuel consumption and tonne kilometers, this calculation is considered based on primary data. Had you received information from sub-contractors, that would need to be specified. You could then list their total emissions as a separate line item in this overview. Likewise, if you had used default values for a part of your business for which you have no actual consumption figures, you would have to state the percentage or which part of the business these defaults were used for.
***) For extra confidence you could ask an independent 3rd party to verify the data and calculations, but this is not common yet.
****) Please specify if actual or planned kms have been used

Note: if you provide a transport service with the same characteristics for multiple customers (e.g. a groupage service) it is acceptable to calculate the emission intensity for the combined service and report the same emission intensity to all customers that receive that service. See the examples provided in Annex 3 for more information.

4.2 Managing data from subcontracted services

It is often the case that for some elements of a transport service the carrier is providing the service to an intermediary that integrates the individual transport and logistics operations to provide the overall contracted service i.e. (some of) the actual operations are subcontracted. This often has an influence on the visibility of data within the contract chain and the way in which the final calculation is presented to the chemical company as the final customer. Three general situations are possible:

- the transport provider does not operate any transport services directly, instead subcontracting all aspects to one or more transport operators, possibly across different modes of transport
- the transport provider operates transport services only in one mode and subcontracts other modes where they are necessary in order to complete the full transport operation, e.g., for intermodal transport services.
- the transport provider operates transport services only in one mode but sometimes subcontracts some operations in order to manage overall fluctuations in demand or where a special vehicle is needed as part of a broader contract.

The main contractor should request the information from the transport operators in the format as set out in section 4.1 and to use this information within its own reporting. To-date this has not been common but is expected to become more so in the future as data and IT systems improve. In cases where this data is not shared then the main contractor will need to rely on either detailed modelling (section 5.3.2) or the industry defaults (section 3) for those elements of the service that are subcontracted.

For intermodal transport the main contractor is expected to report the total GHG emissions and the emission intensity of the full intermodal service, as set out in table 12 of the GLEC Framework.

LSP reporting to chemical company

Again this follows the guidance in the GLEC Framework on reporting, the so called “GLEC Declaration”. The LSP should report the activities that within the overall contract, whether provided using its own assets or those of subcontracted of transport and logistics operators. The example report below is for an intermodal transport service as set out in more detail in Annex 3.

Item	GHG intensity value (WTW) CO_2e kg/tkm	Customer specific tkm	WTW GHG emission (kg CO_2e)
Intermodal rail transport Dormagen to Italy	0.0188	222,000	4,170
Total emissions kg CO_2e			4,170

Input data type*	primary data for road transport; default data for rail, transhipment and tank cleaning		
Mode coverage	Road (pre- and on-carriage), transhipment, rail (main carriage) tank cleaning		
	GHG intensity value (WTW) CO_2e kg/tkm	Customer specific tkm	WTW GHG emission (kg CO_2e)
Rail	0.0120	210,900	2,531
Road	0.0718	11,100	796
Data verification statement***	Data has not been independently verified by a 3rd party		
Period covered	1/1/2020 – 31/12/2020		

* primary data for operations using owned trucks; default data used for subcontracted operations

5. Guidelines for chemical companies per mode

The intention is that the contracted transport provider will provide a report, as set out in section 4 step 5, presenting the results of GHG emission calculations aggregated for the transport they provide in each of the transport operation categories set out in section 3.

The reports provided should contain the information required for a chemical company to calculate its freight transport GHG emissions for each transport operation category by summing up the declared emissions across all carriers and all transport operation categories.

In cases where a logistics service provider fails to report, or does not report fully then the following procedures would apply:

1. No data reported: Request the data in the format set out in section 4 step 5

2. If the logistics service provider presents only the total GHG emission (i.e. total CO_2 or CO_2e) covering all TOCs:
    a. Request the data as set out in section 4 step 5, split out for each TOC;
    b. If step 2a fails, perform your own GHG emission calculation for each TOC according to 5.1.

3. If the logistics service provider presents only the total GHG emission (i.e. total CO_2 or CO_2e) for each TOC:
    a. Request the emission intensity and transport activity data for each TOC, as set out in section 4 step 5;
    b. If step 3a fails, calculate the GHG emissions according to 5.1 in order to sense-check the total GHG emission value provided by the carrier for each TOC. If in doubt, use your own calculation results and engage with the carrier to try to establish the reasons why they struggled to report fully.

4. If the logistics service provider presents only a GHG emission intensity value for each TOC:
    a. Request the emission intensity and transport activity data as set out in section 4 step 5;
    b. If step 4a fails, compare the GHG emission intensity value provided with the default emission intensity for that TOC. If you are satisfied that the GHG emission intensity value provided by the carrier is credible then calculate the GHG emissions according to 5.1 using the GHG emission intensity value provided carrier. If in doubt, calculate the GHG emissions according to 5.1 using

the default GHG emission intensity value for the TOC and engage with the carrier to try to establish the reasons why they struggled to report fully.

5.1 Chemical company calculation

In cases where the data provided by the logistics service provider is incomplete the chemical company should calculate the GHG emissions for each TOC using the following formula:

GHG emission (mass of CO_2e) = GHG emission intensity (mass of CO_2e / tonne km) x transport activity (tonne kilometers)

Use the GHG emission intensity value provided by the carrier if you have confidence in it; otherwise use the default industry emission intensity value for that TOC

If the carrier provides a GHG emission intensity value but not the associated tonne km there is a risk of underestimating the total emissions. In such cases an additional distance adjustment factor of 5% should be applied to allow for the typical extra actual distance travelled by the vehicle compared to the planned distance calculated by a route planner.

GHG emission (mass of CO_2e) = GHG emission intensity x chemical company estimate of transport activity x 1.05

The factor of 1.05 should also be applied for groupage transport to allow for the additional distance that can result from the operator's network or from diversions to pick up or drop off intermediate loads.

5.2 Data checks

Because reporting of GHG emissions between carrier and their customer is not yet common it is likely that in the early stages there will be errors in the data reported. Common errors that could impact the carrier's calculation that the customer should be aware of include:

- Incomplete reporting. This is one reason why it is useful to include the tonne km value as part of the carrier report – because the chemical company knows the amount of transport contracted it should become clear quickly if some of the transport activity has been missed out.
- Incorrect calculation of the transport activity can lead to calculation of an incorrect emission intensity value. Follow the detailed guidance in chapter 2 of the GLEC Framework

  Note: it is normal for the carrier's transport activity to be slightly higher than the chemical company's expectation, partly because actual distance travelled is almost always greater than the planned distance, even when the origin, destination and route are known; however, for groupage or LTL transport the difference may be considerably higher because the chemical company is unlikely to know precise details of the carrier's network and the position of intermediate transfer locations and depots can have a significant influence on the total distance travelled.
- Use of incorrect emission factors – most likely substituting a tank to wheel rather than a well to wheel value. This would be apparent through incorrect, probably lower, total emission and emission intensity values than expected.
- Failure to include the emissions from empty running within the calculation. This would result in a systematically lower, total emission and emission intensity values than

expected and would be more noticeable for dedicated transport where the level of empty running is higher.

- Inclusion of the weight of transport equipment, such as containers or tank containers, within the weight of the load and hence the transport activity (tonne-km). This would result in a systematically lower, total emission and emission intensity values than expected.

In the future, as this type of data sharing becomes more common it is likely that cost-effective, commercial data verification services will become available.

5.3 Alternative Calculation approaches

In addition to the use of aggregated data provided by the carrier, which is presented above as the standard approach to reporting, and the backup provided by the chemical sector default emission intensity values presented in this report, other approaches are possible.

5.3.1 Shipment level data

As noted in section 4 step 4, your carrier may be willing to share primary information with you so that you can see the full calculation. This would probably help to remove uncertainty regarding the approach taken and data used in the calculation. Access to data at this level is most likely for dedicated transport where long term contracts support a truly collaborative approach to operational efficiency. In contrast, this approach is unlikely for shared transport options where it might reveal commercially confidential information.

This level of data transparency can be useful to understand the underlying issues that influence GHG performance; however, as corporate reporting generally occurs at annual level it is more useful for proactively identifying opportunities for operational efficiency and emission reduction through gain sharing

If you do have access to shipment level data in collaboration with your carrier, it is important to resist the temptation to exclude emissions linked to empty running. For road transport the most widely accepted way to include the impact of empty running is to calculate the average level of empty running across the whole transport operation category and then apply this value to the emissions due to the loaded trips in proportion to the tonne-kms.

5.3.2 Modelled Emissions

Modelling of GHG emissions is a well-established option – Smart Freight Centre has reviewed and accredited several such calculation tools as being in conformance to the GLEC Framework – see www.smartfreightcentre.org for more current details. The use of such models may be beneficial in that it should be possible to tailor the calculated values to match the specific characteristics of the transport that is being provided, rather than relying on the default values, which are, by their very nature, only generally representative. Modelling is also useful to assess the potential of different options to reduce emissions as a first step prior to investing in actual trials.

6. Recommendations for updating the defaults.

Given the increasing focus on the severity of the global climate crisis and the importance that accurate and transparent GHG reporting has in tracking progress against sector and company emission reduction targets, the whole topic of GHG calculation and reporting is subject to ongoing technical and process updates. Therefore, future updates to the GLEC Framework and these guidelines can be expected that might affect both methodology and approach to default emission intensities.

Some examples of this may include:

- Revision of the levels of empty running and typical load factors as better access to primary data and changes to standard industry practices become apparent
- Revision of default GHG emission intensity values as updated emission factors for diesel are published, new, lower emission, fuels become more commonplace for chemicals transport in some or all modes
- More detailed reporting requirements may be put in place for carriers and / or shippers, for example to split of the well-to-tank and tank to wheel components of the overall emission values.
- Improvements in the way that baseline data for specific modes are managed by the legislative bodies. For example, the IMO is aware of some overlap between the different vessel categories, particularly regarding chemical and oil tankers which use different size classifications even though some vessels may be used interchangeably; there are also calls to move from the use of vessel size classes to a continuous relationship between vessel size and expected emissions. These issues are being reviewed at IMO level, and the outcome of the discussions may result in a revised approach to calculating default emission intensity values.

Annex 1: Road transport: Full default table

% truck kms empty	Default Emission intensity g CO_2e / tonne-km on a well to wheels basis										
	Payload (tonnes)										
	8	10	12	14	16	18	20	22	24	26	28
0%	111	92	80	71	64	59	55	52	49	46	44
2%	113	94	81	72	65	60	56	52	49	47	45
4%	115	95	82	73	66	61	56	53	50	47	45
6%	117	97	84	74	67	62	57	54	51	48	46
8%	119	99	85	76	68	63	58	54	51	49	47
10%	121	101	87	77	69	64	59	55	52	49	47
12%	124	102	88	78	71	65	60	56	53	50	48
14%	126	104	90	80	72	66	61	57	54	51	49
16%	129	106	92	81	73	67	62	58	55	52	49
18%	131	109	93	83	74	68	63	59	56	53	50
20%	134	111	95	84	76	69	64	60	56	53	51
22%	137	113	97	86	77	71	65	61	57	54	52
24%	140	116	99	88	79	72	67	62	59	55	53
26%	144	119	102	90	81	74	68	63	60	56	54
28%	147	121	104	92	82	75	69	65	61	57	55
30%	151	124	106	94	84	77	71	66	62	59	56
32%	155	127	109	96	86	79	72	67	63	60	57
34%	159	131	112	98	88	80	74	69	65	61	58
36%	163	134	115	101	91	82	76	71	66	62	59
38%	168	138	118	104	93	84	78	72	68	64	61
40%	173	142	121	106	95	87	80	74	69	65	62
42%	179	146	125	110	98	89	82	76	71	67	64
44%	184	151	129	113	101	92	84	78	73	69	65
46%	191	156	133	116	104	94	87	80	75	71	67
48%	197	161	137	120	107	97	89	83	77	73	69
50%	204	167	142	124	111	101	92	85	80	75	71

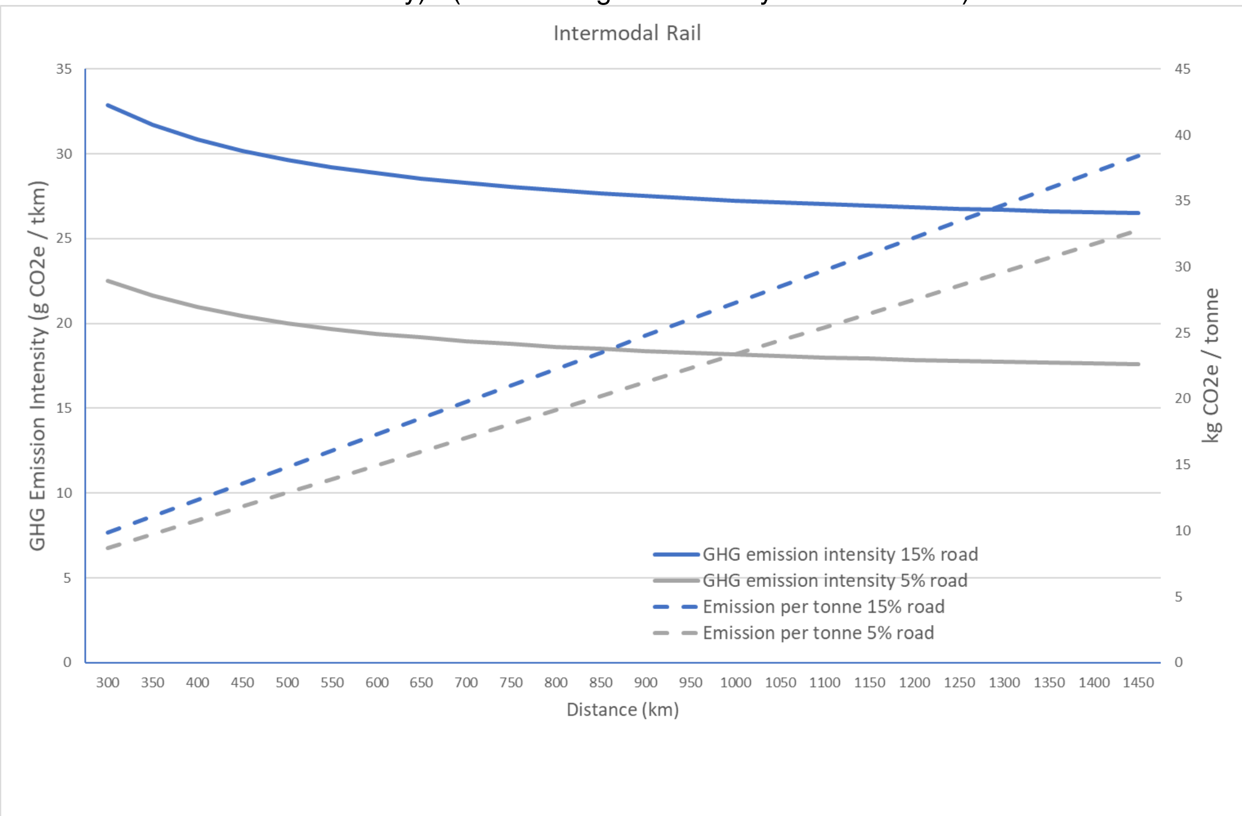
Table A1: Emission intensity values for standard articulated truck (i.e. no special equipment) with B5 diesel/biodiesel blend.

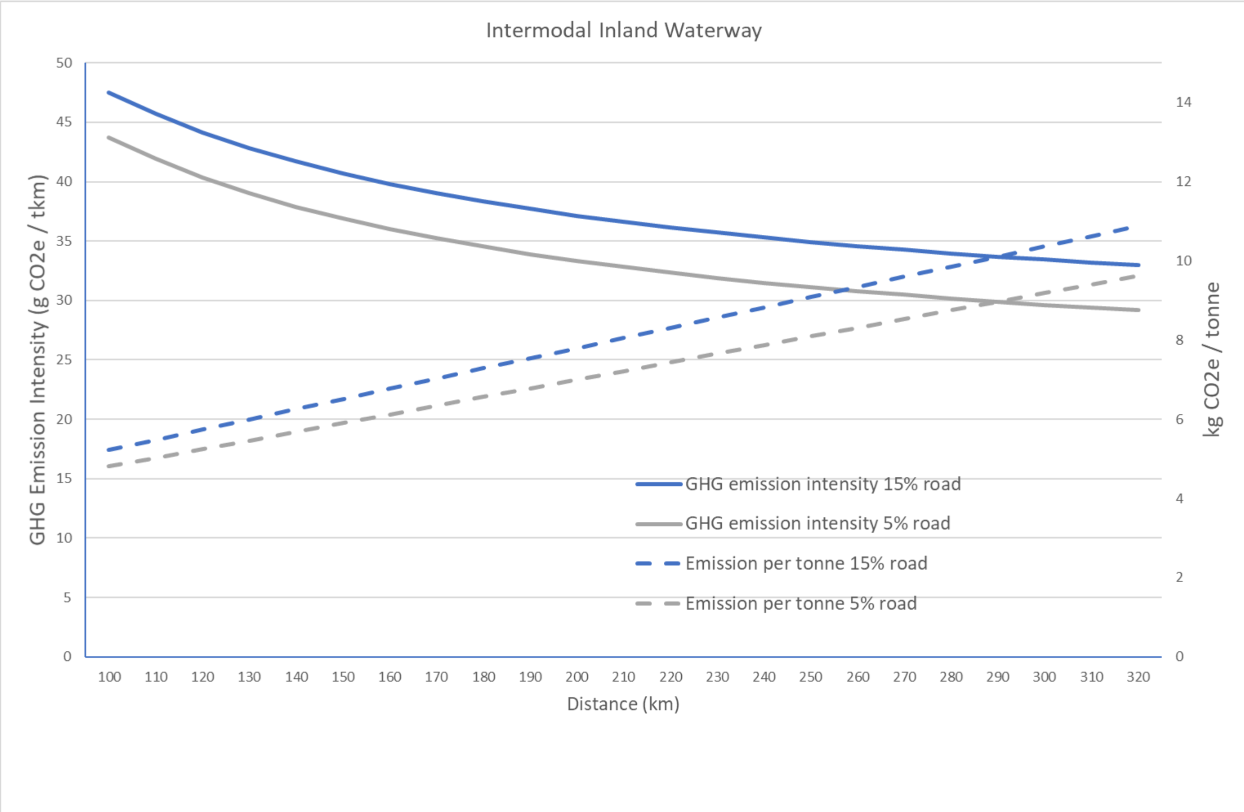
Annex 2: Intermodal GHG emission intensity by distance

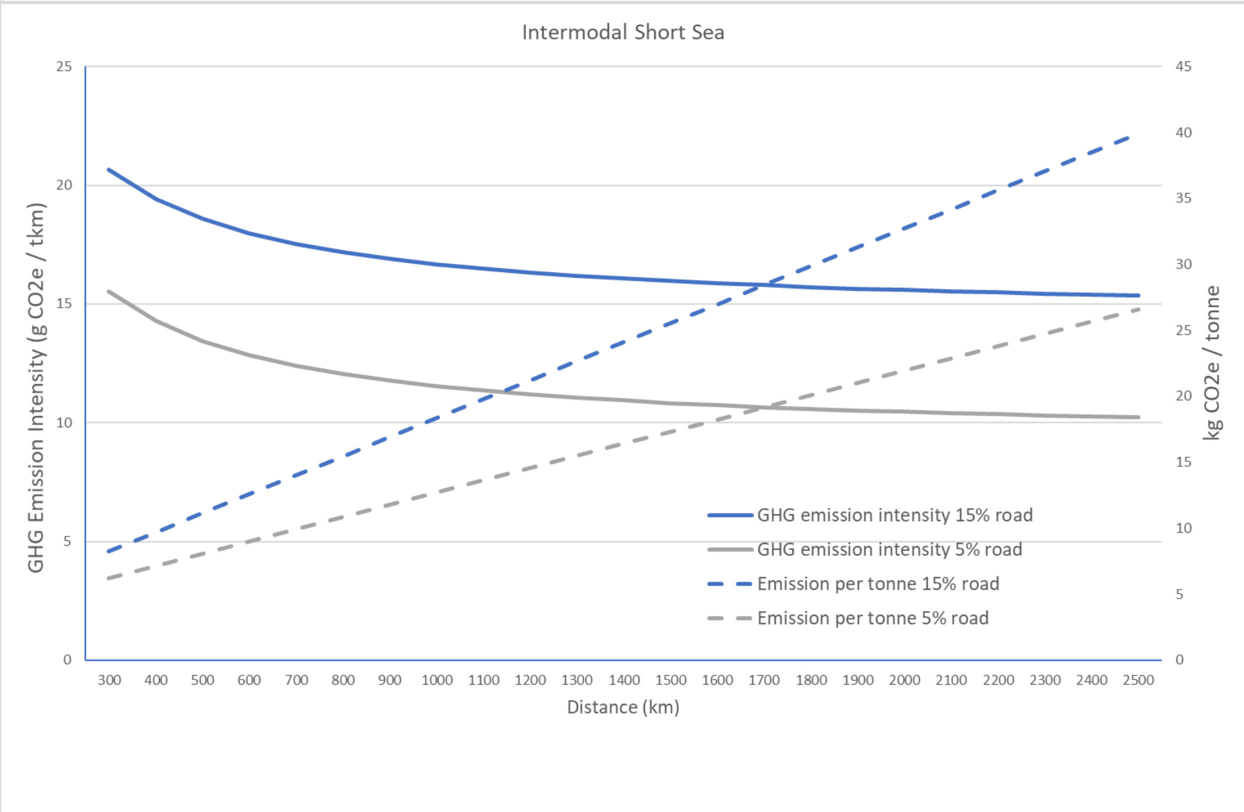
The following graphs show the relationships between GHG emission intensity and distance for the four examples of intermodal transport presented in section 3.8. As noted there, assigning a default GHG emission intensity to an intermodal transport is subject to a greater degree of uncertainty than to an individual mode due to the greater number of variables. Hence, it must be noted that the graphs show the relationship only for a combination of one example loading and empty running for each of the pre-carriage, main transport and on-carriage; however, it is instructive to show that the emission intensity does decrease marginally as the logistics site emissions are spread over a greater transport activity. At the same time the increase in total emissions per tonne of product moved has a close to linear relationship with distance, showing the impact of increasing supply chain distances on total GHG emissions, even when using an intermodal option. The graphs also show how reducing the proportion of distance by road impacts on each of these intermodal combinations.

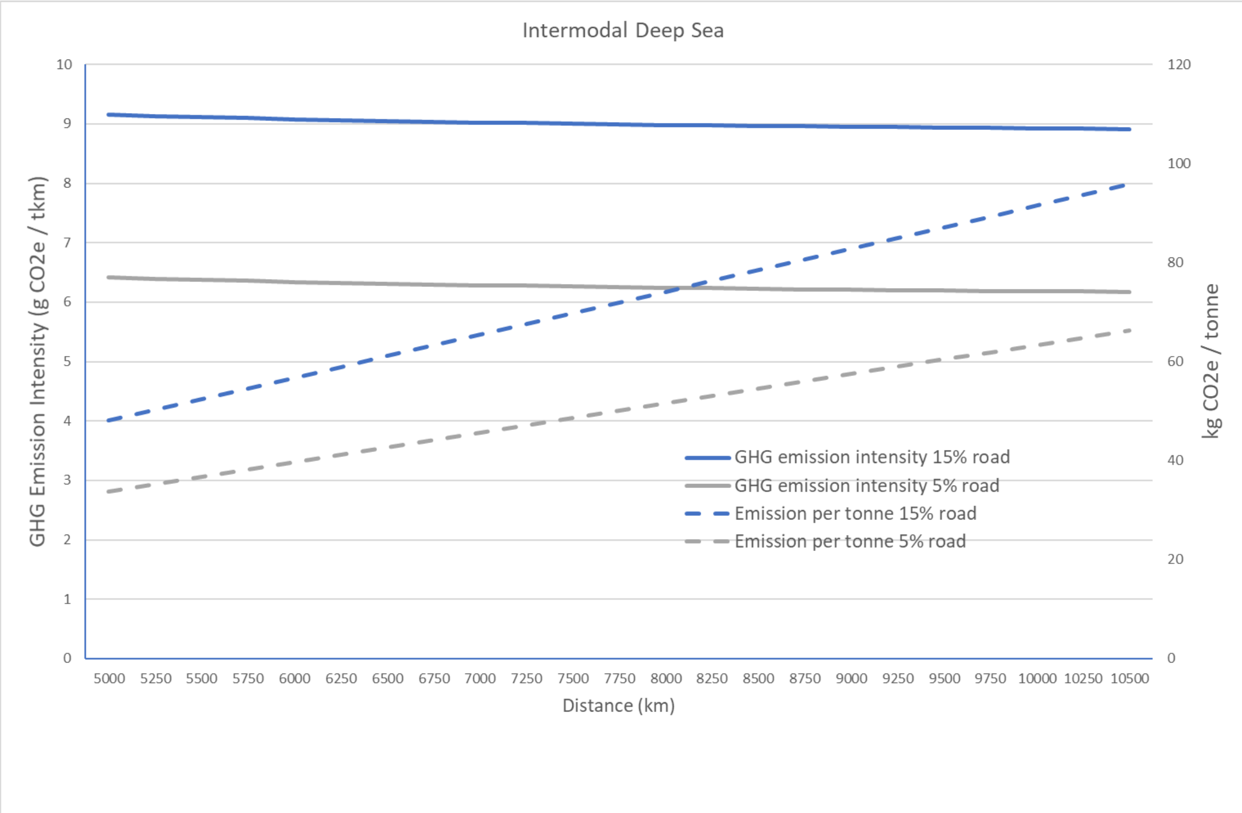
The distance ranges shown are indicative of what might be expected of each intermodal combination but could be extended in either direction in exceptional circumstances.

The relationship in each case is:
Overall emission intensity = (% main mode distance x main mode emission intensity) + (% road distance x road emission intensity) +(2 x handling site intensity / total distance)

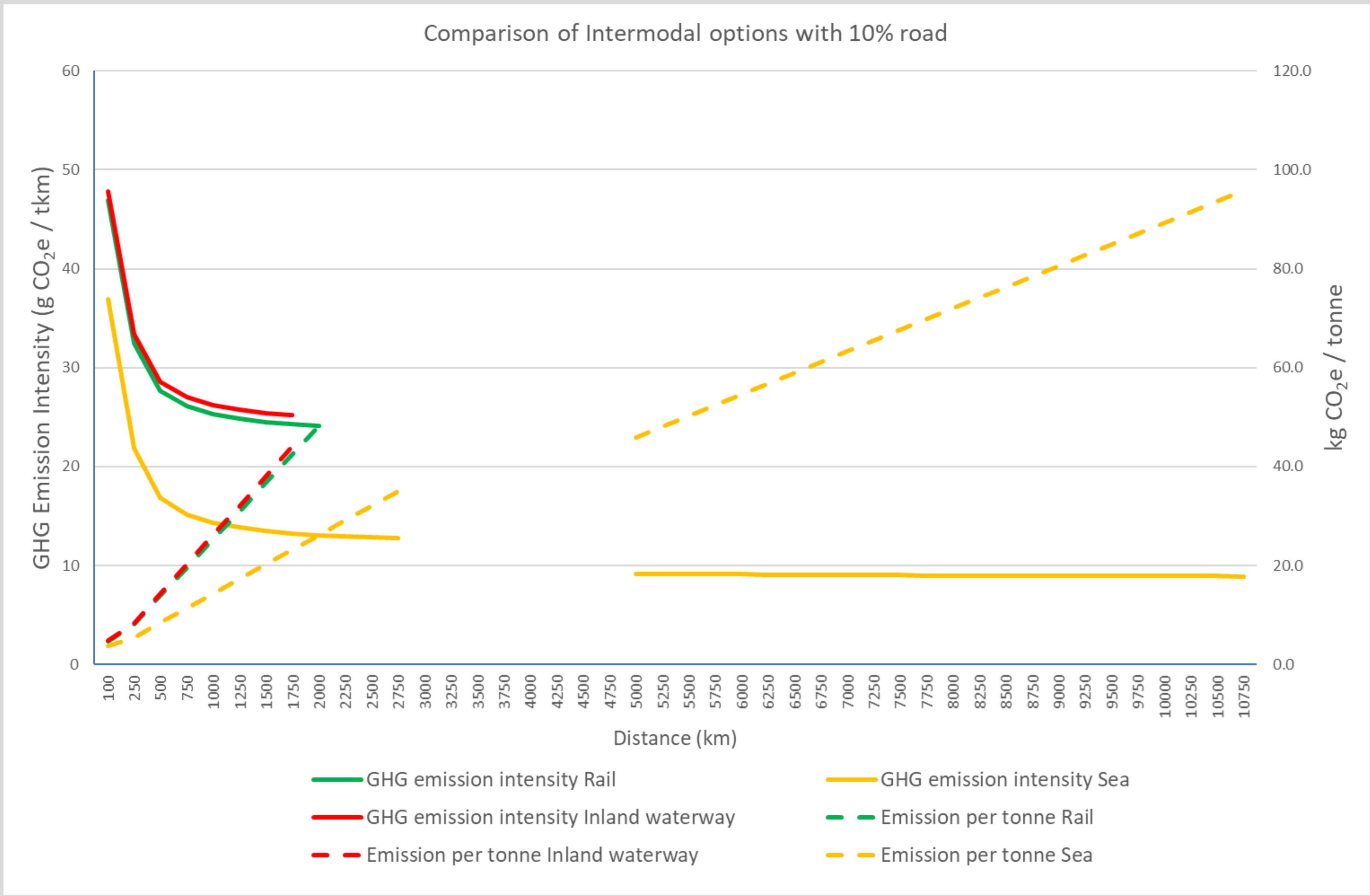



Intermodal Inland Waterway
GHG Emission Intensity (g CO2e / tkm)
kg CO2e / tonne
Distance (km)
GHG emission intensity 15% road
GHG emission intensity 5% road
Emission per tonne 15% road
Emission per tonne 5% road


Intermodal Short Sea
GHG Emission Intensity (g CO2e / tkm)
kg CO2e / tonne
Distance (km)
GHG emission intensity 15% road
GHG emission intensity 5% road
Emission per tonne 15% road
Emission per tonne 5% road



The following graph then shows how the modes compare with each other for a standard 10% pre- and on-carriage element by road. It is worth noting that short sea distances can be considerably longer than rail or inland waterway depending on the exact route meaning that it is important to consider the exact options rather than relying solely on general emission intensity values.



Comparison of Intermodal options with 10% road
GHG Emission Intensity (g CO2e / tkm)
kg CO2e / tonne
60
50
40
30
20
10
0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
100
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
3250
3500
3750
4000
4250
4500
4750
5000
5250
5500
5750
6000
6250
6500
6750
7000
7250
7500
7750
8000
8250
8500
8750
9000
9250
9500
9750
10000
10250
10500
10750
Distance (km)
GHG emission intensity Rail
GHG emission intensity Sea
GHG emission intensity Inland waterway
Emission per tonne Rail
Emission per tonne Inland waterway
Emission per tonne Sea

Annex 3: Example Calculations

Road Transport

Chemical Company Calculations

Road Example 1

Level 3 Calculation

Calculation of GHG emissions for groupage transport to move 10 tonnes of packed goods between two points that are 250 km apart according to the shortest feasible distance by road.

Given that the customer knows that the goods are being transported via a groupage transport then the starting point is the level 3 GHG emission intensity value of 78 g CO_2e/tkm from the table in section 3.2.

Using the equation from section 5.1 the GHG emissions can be estimated to be:

GHG emission (mass of CO_2e) = GHG emission intensity x customer estimate of transport activity x 1.05

(The distance adjustment factor is applied due to the lack of information about the actual distance that the goods are transported for this groupage transport.)

GHG emission = 78 g CO_2e/tkm x 10 t x 250 km x 1.05 = 204.75 kg CO_2e

Calculation using information provided by the carrier / LSP

The transport service provider has been able to provide the following information that relates to this transport:

Item	GHG intensity value (WTW) CO_2e kg/tkm	Customer specific tkm	WTW GHG emission (kg CO_2e)
Ambient groupage transport	0.0617	28,600	1764.62
Total emissions kg CO_2e			1764.62
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		

The report covers the whole of the month's operations for its groupage operations for all customers. The transport activity value is the amount of transport activity for this particular customer. Without confirmation of the tonne km linked to this specific consignment the calculation would be:

GHG emission = 61.7 g CO_2e/tkm x 10 t x 250 km x 1.05 = 161.96 kg CO_2e

(The distance adjustment factor of 1.05 is applied as the provided GHG intensity value is assumed to be based on actual distances if not stated otherwise)

However, if the transport operator confirms that the actual transport activity of this consignment was 2600 tkm then the calculation can be refined to be:

GHG emission = 61.7 g CO_2e/tkm x 2600 tkm = 160.42 kg CO_2e

Road Example 2

Level 3 Calculation

Calculation of GHG emissions for groupage transport to move 8 tonnes of packed goods between two points that are 510 km apart according to the shortest feasible distance by road.

Given that the customer knows that the goods are being transported via a groupage transport then the starting point is again the level 3 GHG emission intensity value of 78 g CO_2e/tkm from the table in section 3.2.

Using the equation from section 5.1 the GHG emissions can be estimated to be:

GHG emission (mass of CO_2e) = GHG emission intensity x customer estimate of transport activity x 1.05

(The distance adjustment factor is applied due to the lack of information about the actual distance that the goods are transported for this groupage transport.)

GHG emission = 78 g CO_2e/tkm x 8 t x 510 km x 1.05 = 334.15 kg CO_2e

Calculation using information provided by the carrier / LSP

The transport service provider has been able to provide the following information that relates to this transport:

Item	GHG intensity value (WTW) CO_2e kg/tkm	Customer specific tkm	WTW GHG emission (kg CO_2e)
Ambient groupage transport	0.0549	300,000	16,470
Total emissions kg CO_2e			16,470
Input data type	100% primary data		
Mode coverage*	Road		
Data verification statement	Data has not been independently verified by a 3rd party		
Period covered	Q1 2021		

The report covers the whole of the quarter's operations for its groupage operations for all customers. The transport activity value is the amount of transport activity for this particular customer. Without confirmation of the tonne km linked to this specific consignment the calculation would be:

GHG emission = 54.9 **g** CO_2e/tkm x 8 t x 510 km x 1.05 = 235.19 **kg** CO_2e

If the transport operator is unable to confirm the actual transport activity of this consignment then the above is the best calculation available to the customer.

Transport Company Calculations

Road Example 1

This provides a simplified worked example of the procedure for a transport company to calculate its GHG emission intensity for its groupage operations. It is recognized that a full, real-life network calculation would include a lot more data and hence may need a specialist software solution.

Vehicle operations included for each element of the transport chain:

Start point	End point	Load (t)	Distance (km)	Activity (tkm)	Fuel (l)
Depot	A	0	30	0	8
A	B	10	20	200	6
B	C	23	240	5520	79
C	Depot	0	260	0	65
Depot	A	0	30	0	8
A	B	10	20	200	6
B	C	23	240	5520	79
C	Depot	18	260	4680	83
Depot	E	18	40	720	13
E	Depot	12	40	480	12
Depot	A	12	30	360	9
A	C	25	255	6375	87
C	Depot	18	260	4680	83
Depot	E	18	40	720	13
E	Depot	0	40	0	10
Total				**29455**	**561**
Overall fuel intensity				**0.0190 l/tkm**	
Overall GHG emission intensity (based on Diesel fuel emission factor of 3,24 Kg CO_2e /liter)				**61.7 g CO_2e / tkm**	

Transport activity for a 10t consignment from A to C via B = 10 t x (20 + 240) km = 2600 tkm

Transport activity for a 18t consignment from C to E via depot = 18 t x (260 + 40) km = 5400 tkm

Road Example 2

This provides a simplified worked example of the procedure for a transport company to calculate its GHG emission intensity from hub and spoke groupage operations. It is recognized that a full, real-life network calculation would include a lot more data and hence may need a specialist software solution.

Vehicle operations included for each element of the transport chain:

Start point	End point	Load (t)	Distance (km)	Activity (tkm)	Fuel (l)
Hub A	O	24	20	480	8
O	P	18	4	72	1
P	Q	6	15	90	4
Q	R	14	20	280	6
R	S	8	4	32	1

S	T	12	18	216	5
T	U	18	16	288	5
U	Hub A	22	9	198	3
Handling emissions at Hub A: 1.2 kg CO_2e /t = 1.2 x 22 = 26.4 kg					
Hub A	Hub B	22	485	10670	160
Handling emissions at Hub B: 1.2 kg CO_2e /t = 1.2 x 22 = 26.4 kg					
Hub B	C	22	12	264	4
C	D	14	16	224	5
D	E	17	5	85	1
E	F	11	14	154	4
F	G	16	23	368	7
G	H	8	8	64	2
H	I	12	20	240	2
I	Hub B	20	8	160	3
Hub B	Hub A	20	485	9700	158
Total				**23585**	**383**
Overall fuel intensity			**0.0162 l/tkm**		
Overall transport emissions			383 x 3.24 = **1240.92 kg CO_2e**		
Total emissions			1240.92 + 2 x 26.4 = **1293.72 kg CO_2e**		
Overall GHG emission intensity			1293.72 / 23585 = **54.9 g CO_2e / tkm**		

The optimal calculation for a hub and spoke groupage operation is to separate the calculation of the collection and delivery element from the trunking element and for the collection and delivery element use the direct distances between each of the collection and delivery points and the hub to allocate the emissions to each consignment. This removes the variability of the detailed emission calculation depending on where the consignment happens to be within the order of a particular round.

In practice the above network value can be used to communicate the overall GHG emission intensity from the transport provider to their customer, with the customer using the 5% distance adjustment factor to allow for this variation.

Intermodal Transport

Calculation of GHG emissions for ISO container on road / rail intermodal combination from Dormagen to Italy with a total distance of 1850 km. The order consists of 7 consignments totalling 120 tonnes.

Chemical Company Calculations

The chemical company has various options. These follow the levels introduced along with the default values in section 3 and reflect the amount of information available to them.

<u>Level 1: limited information</u>

With the bare minimum of information the chemical company should consult the table in section 3.8 and combine the generic default value for intermodal rail transport of 27.3 g CO_2e/tkm (based on 15% road transport by distance) with the total transport activity of the 7 consignments which is 120 x 1850 = 222000 tkm.

Additionally 7 lots of tank cleaning emissions should be added using the standard factor of 81.5 kg CO_2e

Hence the level 1 total GHG emission is estimated to be 27.3 g CO_2e/tkm x 222000 tkm + 7 tank cleaning lots x 81500 g CO_2e/tank cleaning = 6631100 g CO_2e or **6.63 t CO_2e**.

Level 2: intermediate information

With additional information the chemical company may be able to refine the calculation and use the equation from Annex 2 with some of the modal default values from section 3. For example:

- The chemical company may know that road transport is only 5% of the total distance.
- The chemical company may choose to use the average value for an ambient tank container of 58 g CO_2e/tkm for the road legs
- The chemical company may choose to use the average GHG emission intensity value for a track container of 17 g CO_2e/tkm for the rail leg
- The chemical company can use the average transhipment emission intensity of 1200 g/t from the GLEC Framework for the transfer between road and rail at each end of the main haul.

With these parameters the overall emission intensity = 0.95 x 17 + 0.05 x 58 intensity +(2 x 1200 / 1850) = 20.3 g CO_2e/tkm

Additionally 7 lots of tank cleaning emissions should be added using the standard factor of 80.8 kg CO_2e

Hence the level 2 total GHG emission is estimated to be 20.3 x 222000 + 7 x 81500 = 5087600 g CO_2e or **5.09 t CO_2e**.

Level 3: detailed information

The chemical company may be able to use more detailed information regarding each leg to further refine the calculation as follows:

Road leg 1 (pre-carriage)
Distance is known to be 40 km
Total product mass is 120 t across 7 consignments, so average consignment weight is 17.1 t
Tailored emission intensity for a payload of 17.1 t and an average tank container empty running value of 19% is between these 4 values from the table in annex 1:

74	68
76	69

Leading to an approximate emission intensity of 71.8 g CO_2e/tkm

Total transport GHG emissions for road leg 1 = 120 t x 40 km x 71.8 g CO_2e/tkm = 344640 g CO_2e

Transhipment 1
The average transhipment emission intensity for the transfer between road and rail is 1200 g/t

Emissions between road leg 1 and rail transport = 1200 g/t x 120 t = 144000 g CO_2e

Rail leg (main carriage)
Distance is known to be 1757.5 km
Main carriage traction is known to be electric

From the table in section 3.3 the GHG emission intensity value for a track container with electric traction is 12 g CO_2e/tkm

Total transport GHG emissions for rail leg 1 = 120 t x 1757.5 km x 12 g CO_2e/tkm = 2530800 g CO_2e

Transhipment 2
The emissions for transhipment 2 are estimated to be the same as for transhipment 1.

Road leg 2 (on-carriage)
Distance is known to be 52.5 km
In the absence of carrier specific data the emission intensity for road leg 2 is taken to be the same as for road leg 1, i.e. 71.8 g CO_2e/tkm

Total transport GHG emissions for road leg 2 = 120 t x 52.5 km x 71.8 g CO_2e/tkm = 452340 g CO_2e

Total for the Intermodal Journey
The level 3 total GHG emission is the sum of the emissions from the individual journey legs.

Journey Leg	Total GHG emission (t CO_2e)
Road Leg 1	0.34
Transhipment 1	0.14
Rail leg	2.53
Transhipment 2	0.14
Road Leg 2	0.45
Tank cleaning	0.57
Total	**4.17**

<u>With Data input from the Logistics Service Provider</u>

The LSP report for the above example would be (as shown in section 4.2):

Item	GHG intensity value (WTW) CO_2e kg/tkm	Customer specific tkm	WTW GHG emission (kg CO_2e)
Intermodal rail transport Dormagen to Italy	0.0188	222,000	4,170
Total emissions kg CO_2e			4,170
Input data type	primary data for road transport; default data for rail, transhipment and tank cleaning		
Mode coverage	Road (pre- and on-carriage), transhipment, rail (main carriage) tank cleaning		
	GHG intensity value (WTW) CO_2e kg/tkm	Customer specific tkm	WTW GHG emission (kg CO_2e)
Rail	0.0120	210,900	2,531
Road	0.0718	11,100	796

Data verification statement	Data has not been independently verified by a 3rd party
Period covered	1/1/2020 – 31/12/2020

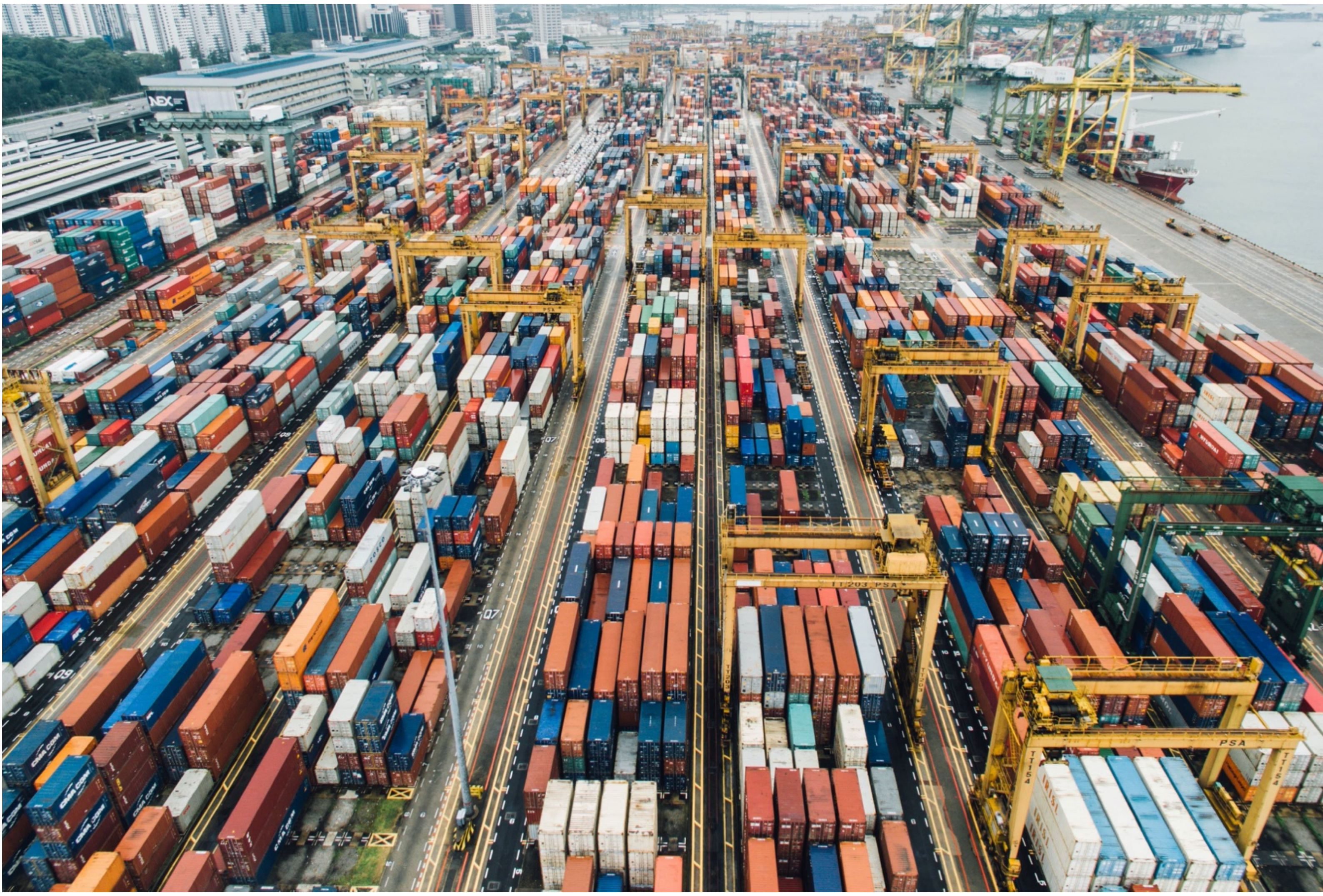
Annex 4: Partners

EUROPEAN CHEMICAL TRANSPORT ASSOCIATION

European IWT Platform

EFTCO

Join our journey towards efficient and zero-emission global freight and logistics



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