Global Logistics Emissions Council Framework

for Logistics Emissions Accounting and Reporting

Version 2.0

Smart Freight Centre

GLEC
GLOBAL LOGISTICS EMISSIONS COUNCIL

Foreword

Freight transportation and logistics activities contribute 8–10% of global greenhouse gas emissions. A concerted global effort with this sector is critical to reaching our Paris Climate Agreement targets and the Sustainable Development Goals.

Multinationals hold the key, especially those with global brands and supply chains. As buyers or suppliers of freight services, they have the power to take action. They can act as leaders through reporting carbon emissions, setting climate targets and collaborating with partners to reach them.

Calculating and reporting emissions is a first step. Smart Freight Centre and a group of companies, associations and programs formed the Global Logistics Emissions Council (GLEC) and together developed the first GLEC Framework in 2016.

Since then, global companies have made significant progress in understanding and reducing greenhouse gas emissions from freight transportation. More and more companies are adopting the GLEC Framework, which has been further advanced by programs like CDP and the Science-Based Targets initiative (SBTi). We also supported numerous companies to implement the GLEC Framework, both directly and in cooperation with the EU-funded LEARN (Logistics Emissions Accounting Reporting Network) Project, taking close note of the challenges companies face and successful approaches to calculation and reporting of emissions.

While the original GLEC Framework established the foundations of the methodology, and cleared the pathway for harmonizing existing methodologies, GLEC Framework version 2.0 is what many partners have asked for – a simple explanation of the methodology with clear implementation steps, filling gaps left in v1.0 and bringing the content up to date for 2019 and beyond.

Beyond the simpler style and focus on implementation steps, other improvements include the following:

- Additional guidance on logistics sites, the mail and parcel sector, and inland waterways transport;
- Updated default emission intensity factors for transport activities;
- Data collection and assurance guidelines;
- Recommendations for standardized reporting of emissions: the GLEC Declaration.

For companies, it's valuable to get in at this early stage: to become a leader on logistics emissions reduction and make that an integrated part of your corporate identity. Getting there will require planning, collaboration, and investment. We hope the GLEC Framework will play a role in this by providing a common language to track the climate impacts of logistics.

A new era has begun, where transparency around the climate impacts of a company's supply chain becomes the norm. We are thrilled to provide you with the updated GLEC Framework and welcome the support of all stakeholders – private sector, governments, research and civil society – to expand the movement that GLEC has started across the globe.

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The Global Logistics Emissions Council

Figure 1. Global Logistics Emissions Council partners propel the GLEC Framework to success.

Acknowledgments

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About GLEC

www.smartfreightcentre.org/glec/

Led by SFC, the Global Logistics Emissions Council (GLEC) was established in 2014 as a voluntary partnership and has grown to more than 50 companies, industry associations and green freight programs, backed by experts, governments and other stakeholders. Together, we develop and implement global guidelines to calculate, report and reduce logistics emissions that work for industry.

About Smart Freight Centre

www.smartfreightcentre.org

Smart Freight Centre is a global non-profit organization dedicated to an efficient and zero-emissions freight sector. SFC brings together and works with the global logistics community to drive transparency, collaboration and industry action – contributing to Paris Climate Agreement targets and Sustainable Development Goals. Our goal is that 100+ multinationals reduce at least 30% of logistics emissions by 2030 compared to 2015 across their global logistics supply chains and decarbonize by 2050.

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Introduction to Logistics Emissions Accounting

Freight’s Climate Impact

Using the Framework

Freight's Climate Impact

The logistics sector plays a vital role in the supply chains that lie at the heart of the global economy.

The maritime and rail sectors are critical enablers of the flow of energy resources such as oil and natural gas, as well as commodities such as steel, fertilizers and containerized consumer goods. The aviation sector plays an important role in moving time-sensitive products and high value consumer goods. At the base there is road transport – the most ubiquitous form of freight transportation to point of consumption around the world.

All these modes are linked by various types of logistics sites, where goods are stored, repacked and distributed.

Logistics' climate impact is large and growing

Comprising 23% of global greenhouse gas (GHG) emissions, the transport sector is the third largest source of GHG emissions after industry and buildings.[1] Freight transportation made up 36% of transport's emissions in 2015, but is expected to be at least equivalent to passenger transport by 2050.[2] While three-quarters of freight is shipped by sea, road is by far the dominant source of global logistics emissions, with over 1,700 million tonnes of CO_2 emitted in 2015.[2,3]

Strong economic growth is creating a huge demand for freight transport. Demand is expected to triple by 2050, driven largely by Asia, Africa and Latin America.[2] The massive demand will increase the tonne-kilometers* shipped by air by 363%, inland waterways by 264%, sea by 244%, and road by nearly 200%.

As other sectors decrease their reliance on oil and gas, the fossil fuel-dependent transport sector is predicted to become the most carbon-intensive sector by 2040.[4] Without intervention, freight transport emissions will more than double by 2050.

It doesn't have to be that way

Growth in the logistics sector does not necessarily have to mean growth in emissions. Indeed, to meet global climate goals – limiting global temperatures to less than two degree increase from pre-industrial levels – governments, the logistics sector and its many customers will need to make a concerted effort to decarbonize freight transportation.

More efficient operational practices like load consolidation, modal switch and fuel-efficient driving have the potential to decrease emissions without the need for capital investments. Low emission freight technologies are also increasingly available and have strong potential for reducing carbon emissions, most notably the adoption of renewable energy for transportation and logistics sites. Ambitious decarbonization policies can enhance industry actions and drive further reductions.

If we choose the path towards more efficient freight transport, we have the opportunity to keep transport emissions at a level similar to today. How will we know if we are on track to meet this goal? We must commit to tracking and reporting our carbon emissions.

* tonne-kilometers is also written as tonne-km or t-km in tables and formulae.

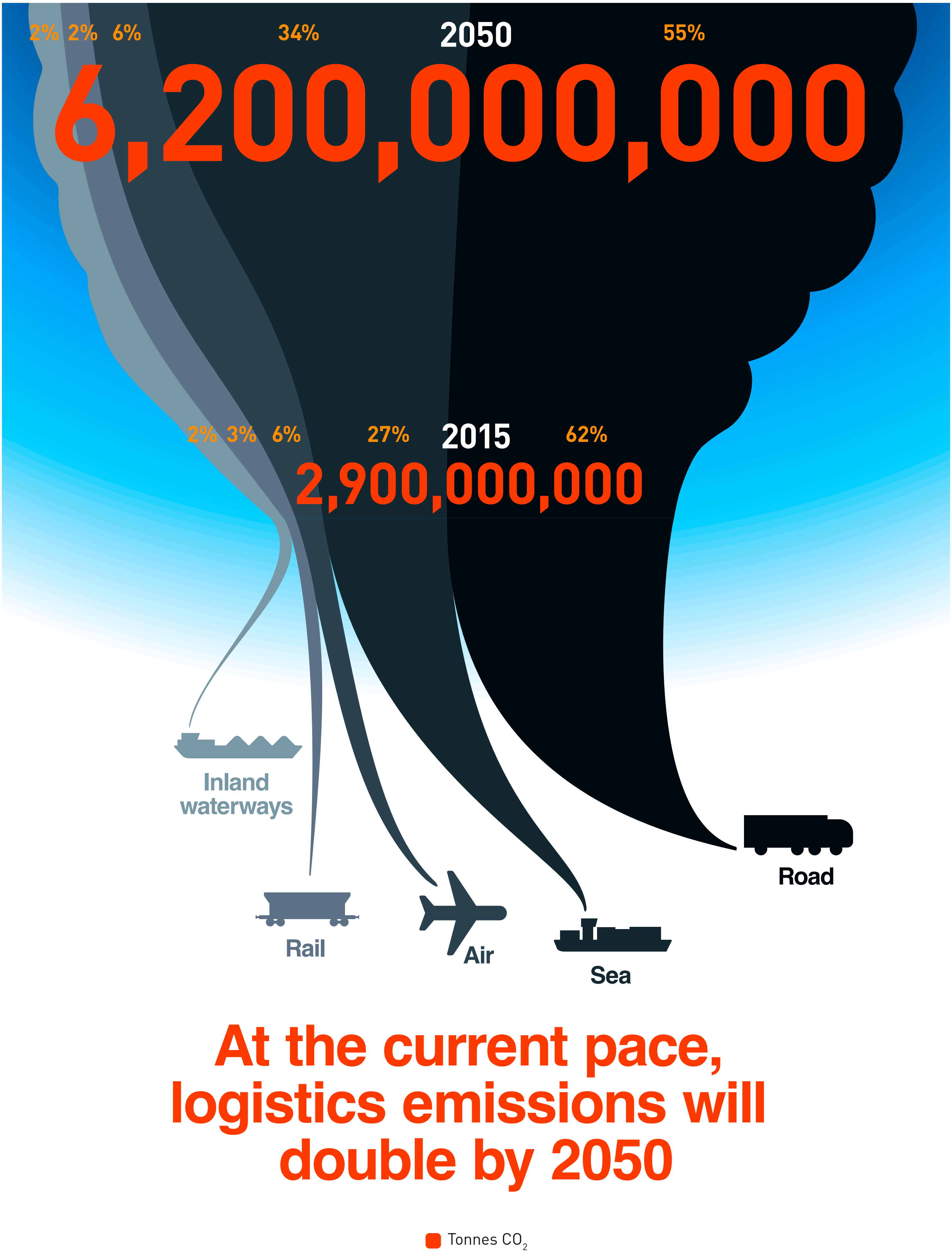


Figure 2. Each mode of transport contributes to logistics emissions, at varying degrees.
(Source: International Transport Forum Outlook 2019)

Using the Framework

Why Companies Use the GLEC Framework

Carbon emissions have become the de facto metric to communicate sustainability between buyers, suppliers, investors, customers, governments and beyond. Tracking GHG emissions over time allows companies to use both total emissions and carbon intensity as key performance indicators (KPIs) in operational and supply chain planning and target-setting.

That said, carbon accounting for logistics is still a relatively new practice. The complexity of the sector necessitates a relatively simple and practical approach that companies of all sizes and institutional capacities can apply – the GLEC Framework.

Here are some of the ways the GLEC Framework streamlines emissions accounting across supply chains and geographies:

The Framework works with industry standards
Accredited by the Greenhouse Gas Protocol, the GLEC Framework is the recommended method for reporting emissions to CDP, setting Science-Based Targets, and aligning with a growing number of other methodologies and industry standards.

The Framework works for stakeholders
Covering Scopes 1, 2 and 3, the Framework works for shippers, carriers and logistics service providers (LSPs), as well as for other end users of emissions information, such as governments, investors and green freight programs. It works for companies just beginning to account for their transport emissions, to the other extreme companies that have full visibility of emissions in their operations and supply chain – and provides a realistic pathway for the former to progress and achieve the latter.

The Framework works for decision-making
Carbon can be used in investment, procurement, and sales strategies to assess the impact of various scenarios, predict the carbon Return on Investment, and track progress towards climate goals following implementation. This leads to improved efficiency and bottom-line financial savings, alongside reduced climate and health impacts.

The Framework works with green freight programs
Green freight programs play a critical role in connecting shippers and carriers around the globe. Accounting and reporting freight activity is part of the broader process of supply chain efficiency and sustainability efforts that green freight programs help to support.

The GLEC's partnerships with global green freight programs, such as United States Environmental Protection Agency (US EPA) SmartWay, Green Freight Asia, Clean Cargo Working Group, Lean & Green, Programa de Logística Verde, are essential for streamlining carbon accounting and emission reduction on a global scale.

International Green Freight Programs

United States Environmental Protection Agency (US EPA) SmartWay, Green Freight Asia, Clean Cargo Working Group, Lean & Green, Programa de Logística Verde

How to Use the GLEC Framework

The remainder of this document includes step-by-step guidance and tailored advice for those calculating logistics emissions.

It is important to recognize that the GLEC Framework is not a formal standard that provides one, and only one, prescriptive step-by-step approach to the calculation and reporting of logistics emissions. Instead the Framework provides boundaries for the emissions to be reported, base methodologies that can be used (with or without adaptation), considerations for the reporting process, and guidance on how to deliver the best output from the information available to you.

It is therefore a decisive and necessary step towards a formal International Standards Organization (ISO) standard for the calculation of freight transport and logistics emissions (see the conclusion for more information).

The GLEC Framework also shows users where they can improve calculations in order to reduce the uncertainty of results. Doing this will, in turn, make it easier to identify where to target cost and emissions savings in your operations, whether they are carried out in-house or by contractors on your behalf.

Although there is no one-size-fits-all approach to implementing the GLEC Framework, we hope this document will give you a solid starting point for designing a program that works for you and your supply chain partners.

How the Framework is organized

This document is divided into two primary sections. Section 1 provides information on the calculations themselves. Chapter 1 provides an overview of the foundations and principles of the GLEC Framework. Chapter 2 guides you through the steps in emissions accounting for Scopes 1, 2 and 3. Chapter 3 provides additional information for each transportation mode and logistics sites.

In Section 2, information on how to use calculation results is detailed. Chapter 4 provides information on reporting and disclosure, and Chapter 5 discusses ways in which carbon emissions can be used in decision-making and target-setting.

The material contained in the appendices includes references, a glossary, abbreviations, units and conversion factors. We also include a number of real-world examples to demonstrate the variety of ways in which this Framework can be used to meet different goals.

The subsequent modules provide emission factors for fuels and refrigerants, default emission intensity values for all modes and specific advice for the mail and parcel sector.

In practice, we know logistics accounting isn't always a linear process. You may find yourself going back and forth between sections to learn more about a certain mode, check the glossary, or to find data collection guidance. As new data become available, you may return to the Framework to refine calculations.

In any case, we hope the information you are looking for is here and, if not, we encourage you to get in touch and ask questions at www.smartfreightcentre.org.

Introduction

1 Calculating logistics emissions

- 1 Foundations of the GLEC Framework
- 2 Calculation steps
- 3 Considerations for each mode

2 Using emissions results

- 4 Reporting emissions
- 5 Beyond reporting

Conclusion

Section 1

Calculating Logistics Emissions

Section 1
Calculating Logistics Emissions

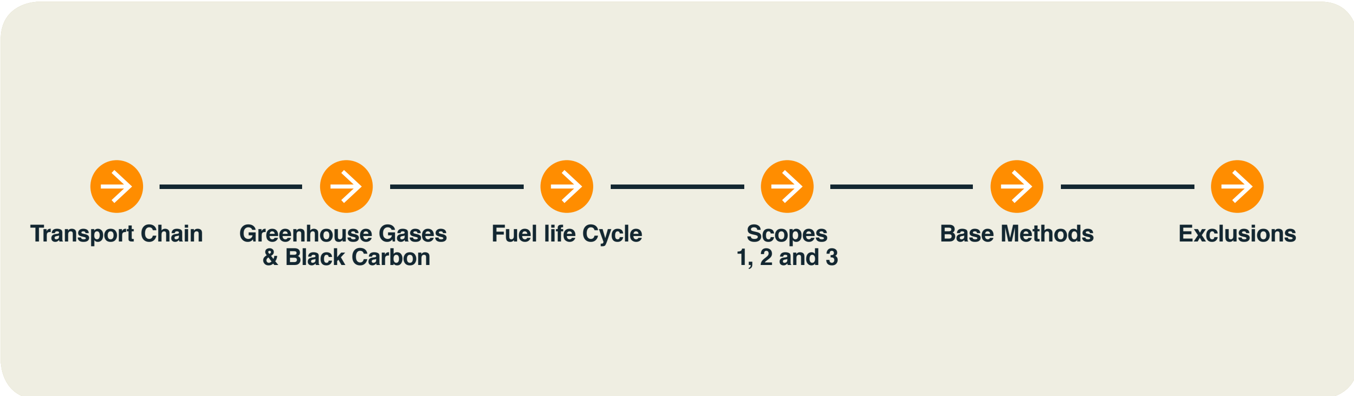
Chapter 1
Foundations of the GLEC Framework

Chapter 2
Calculation Steps

Chapter 3
Considerations for Each Mode

Chapter 1

Foundations of the GLEC Framework



Application of the GLEC Framework is comprised of two key steps – aligning with the basic foundations of logistics carbon accounting, followed by calculating emissions. The following chapter sets the foundation of the Framework, establishing the guiding principles and boundaries of the method.

The Transport Chain

The GLEC Framework aims to cover all aspects of freight transportation, designed to allow full visibility of the mobile and stationary elements within a transport network, as shown in Figure 3. All modes of freight transportation are covered, namely: air, inland waterways, rail, road and sea. Stopping points along a journey, where goods are transferred, stored or repackaged are also included, classed together as logistics sites.

Pipelines may also be considered as a mechanism of freight transport. While the Framework does not include specific guidance on pipelines at this time, the principles of the Framework apply to the calculation of pipeline emissions, e.g. converting fuel or electricity use to emissions and relating this to the movement of a product.

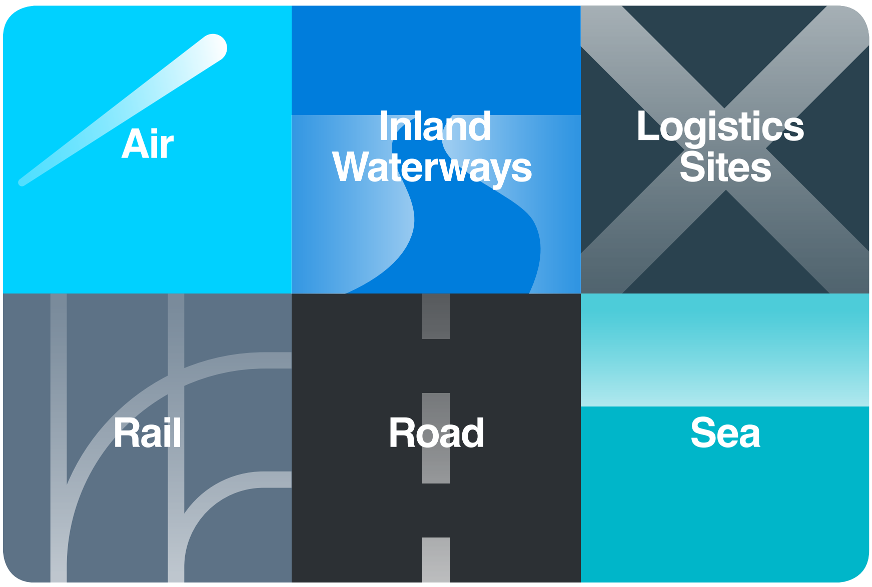


Figure 3. The GLEC Framework covers all transport modes plus logistics sites.

Greenhouse Gases and Black Carbon

The GLEC Framework includes guidance to account for all GHG emissions related to freight transport, as shown in Figure 4. Associated with fossil fuel combustion and refrigeration, the GHGs included in the Framework have been identified by the United Nations Framework Convention on Climate Change's Kyoto Protocol as significant for their role in contributing to climate change.[5]

Carbon dioxide comprises the majority of GHG emissions for logistics activities, and is thus the standard reference by which emissions are measured. CO_2-equivalent (CO_2e) is the common unit used to represent the global warming impact of the various GHGs, and is used as such throughout this document.

Black carbon, a climate and health pollutant, is also prevalent in transportation emissions, and is covered by the GLEC Framework's related publication, the Black Carbon Methodology for the Logistics Sector, described in Box 1.[6]

Climate Pollutants from Logistics Activities

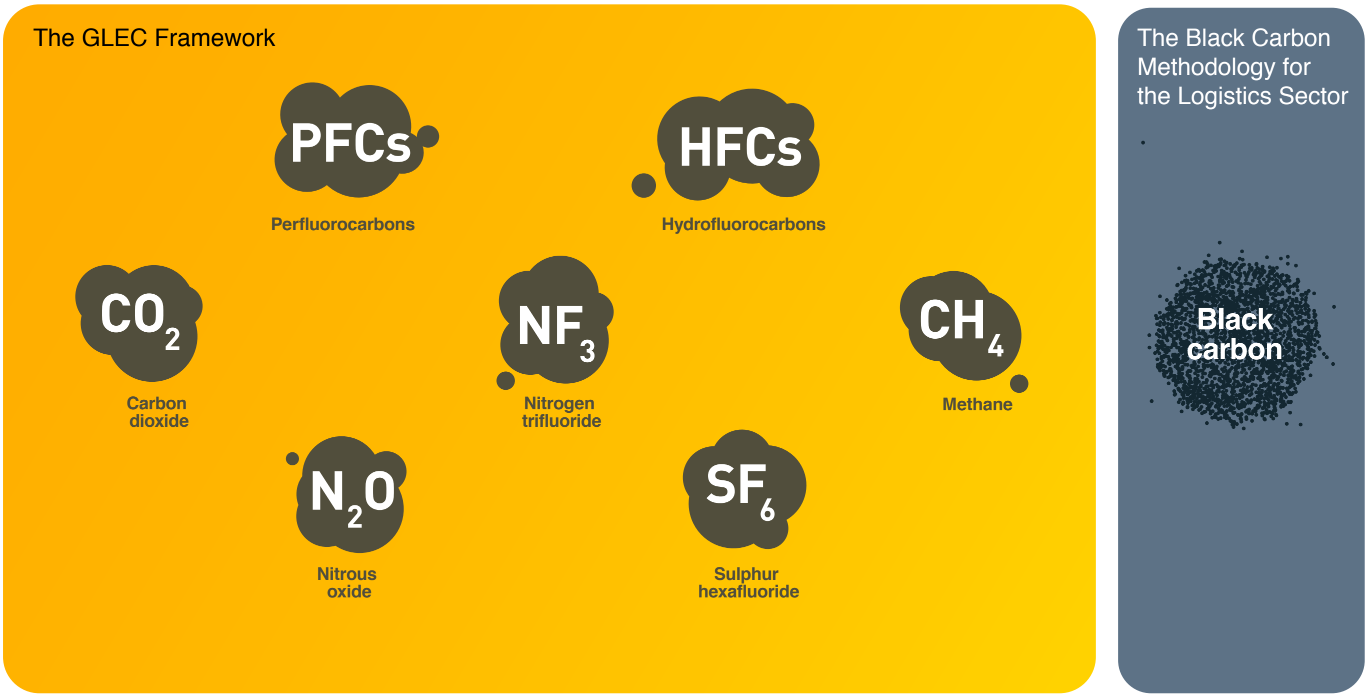


Figure 4. The GLEC Framework focuses on the Kyoto Protocol greenhouse gases; the Black Carbon Methodology for the Logistics Sector covers black carbon.

Box 1. Accounting for black carbon

Black carbon is the term used for particulate matter emitted from impartial fossil fuel combustion. Black carbon is a short-lived climate pollutant with potent global warming potential and a negative effect on human health.[7]

While GHGs are the primary focus of the GLEC Framework, in 2017 Smart Freight Centre, the UN Climate and Clean Air Coalition, the International Council on Clean Transportation and the US EPA SmartWay developed an annex to the GLEC Framework that covers black carbon emissions: The Black Carbon Methodology for the Logistics Sector.[8]

The Black Carbon Methodology provides a way to calculate black carbon following the same principles as the GLEC Framework.

Learn more about the document at https://www.ccacoalition.org/en/resources/black-carbon-methodology-logistics-sector

Base Methodologies

At the core of the GLEC Framework is alignment of global efforts on carbon accounting for logistics operations. It builds on what exists for individual modes, green freight programs and government, and harmonizes practices widely used by industry, experts and practitioners around the world. This serves to improve compatibility and comparability of results, while also streamlining data collection and reporting efforts.

This Framework is accredited as being aligned with the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard, Scope 2 Guidance, and Corporate Value Chain (Scope 3) Accounting and Reporting Standard.[9–11]

The Framework is also aligned with the Intergovernmental Panel on Climate Change Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC Guidance).[12]

Beyond the high-level accounting protocols, the GLEC Framework harmonizes numerous other existing methodologies. The methodologies that are used as the basis for the Framework can be found in Table 1.

Table 1. Carbon accounting methods used to develop the GLEC Framework

Greenhouse Gas Protocol: 1. Corporate Accounting and Reporting Standard[8] 2. Scope 2 Guidance[9] 3. Corporate Value Chain (Scope 3) Accounting and Reporting Standard[10]		✓
IPCC Guidelines for National Greenhouse Gas Inventories12		✓
Air	International Air Transport Association Recommended Practice 1678[13]	✓*
	SmartWay Air Cargo Tool[14]	✓*
Inland Waterways	SmartWay Barge Carrier Tool[15]	✓*
	GHG Emission Factors for Inland Waterways Transport[16]	✓
	International Maritime Organization Ship Energy Efficiency Operation Index[17]	✓*
Logistics Sites	Guidance for Greenhouse Gas Emissions Accounting at Logistics Sites[18]	✓
	Guidance for Greenhouse Gas Emission Footprinting for Container Terminals[19]	✓
Rail	EcoTransIT: Methodology and Data Update 2018 [20]	✓
	SmartWay Rail Carrier Tool[21]	✓*
Road	European Committee for Standardization EN 16258: Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers) [22]	✓
	SmartWay Road Carrier Tool[23]	✓*
Sea	International Maritime Organization Ship Energy Efficiency Operation Index[17]	✓*
	Clean Cargo Working Group Carbon Emissions Accounting Methodology[24] (Currently applies to container shipping only)	✓*

* Must be scaled to account for CO_2e and WTW emissions. Scaling factors are provided in Module 1.

Scopes of Accounting

The goal of the GLEC Framework is to account for all relevant logistics emissions within a company's operations and supply chain. We classify emissions into three categories following the principles of accounting put forward by the Greenhouse Gas Protocol, as shown in Figure 5.[9–11]

Scope 1 emissions include the direct emissions from assets that are owned or controlled by the reporting company. This includes the combustion of solid or liquid fuels purchased to produce energy, heat or steam for use in stationary or mobile equipment (e.g. vehicles, vessels, aircraft, locomotives, generators) and/or buildings associated with logistics sites (e.g. warehouses).

Scope 2 emissions are indirect emissions from the production and distribution of electricity, heat and steam purchased by the reporting company for use in its own logistics sites, electric vehicles or other owned asset requiring electricity.

Scope 3 emissions are indirect emissions from the reporting company's supply chain. Most notably, this includes transportation emissions required to move goods from suppliers to the reporting company and from the reporting company to the end customer. Scope 3 also covers the production and distribution of fuels burned in Scope 1, transport emissions embedded within purchased goods and services, product use and end-of-life.

In total the Greenhouse Gas Protocol specifies 15 categories of supply chain many of which, for example purchased goods and services and emissions from product use and end-of-life, also have the potential to include transportation emissions. A full description of the Scope 3 categories is included in Chapter 5.

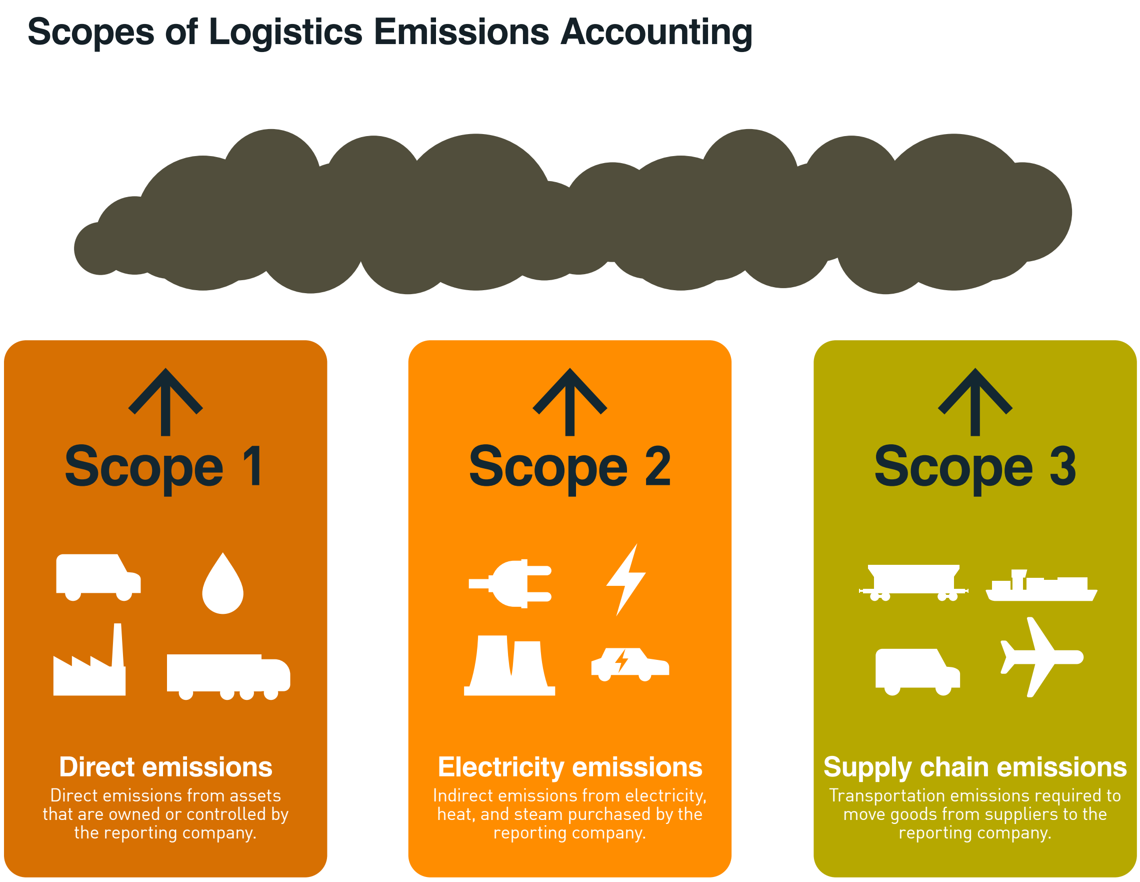


Figure 5. The three scopes of carbon accounting established by the Greenhouse Gas Protocol.

Accounting for Fuel Emissions

Fuel use is most accurately reported using mass (kg) as the unit; however, in practice liquid fuels are usually measured by volume for convenience. Unit conversions are available in Module 1.

In order to capture the full climate impact of fuel use, as required under the Greenhouse Gas Protocol, the GLEC Framework includes emissions from the full fuel life cycle, known as well-to-wheel (WTW) emission factors. WTW factors are comprised of two separate sub-categories: well-to-tank (WTT) and tank-to-wheel (TTW), described below and illustrated in Figure 6.

Well-to-Tank (WTT)

WTT emissions consist of all processes between the source of the energy (the well) through the energy extraction, processing, storage and delivery phases up until the point of use (the tank).[26] WTT values can vary by energy source, region, method of production and the transportation required to move the fuel to market.

Tank-to-Wheel (TTW)

These are the emissions from fuels combusted to power Scope 1 activities (the wheel). TTW is considered to be zero for electricity, hydrogen fuel cells and biofuels – all emissions are in the WTT stages at the point of use.

Well-to-Wheel (WTW)

These are emissions from the full fuel life cycle, and should be equivalent to the sum of WTT and TTW emissions.

Reporting WTT, TTW and WTW

TTW emissions from fuels used in direct operations are reported as Scope 1; the associated WTT emissions are reported as Scope 3.

Emissions for electricity used in the company's direct operations are reported as Scope 2.

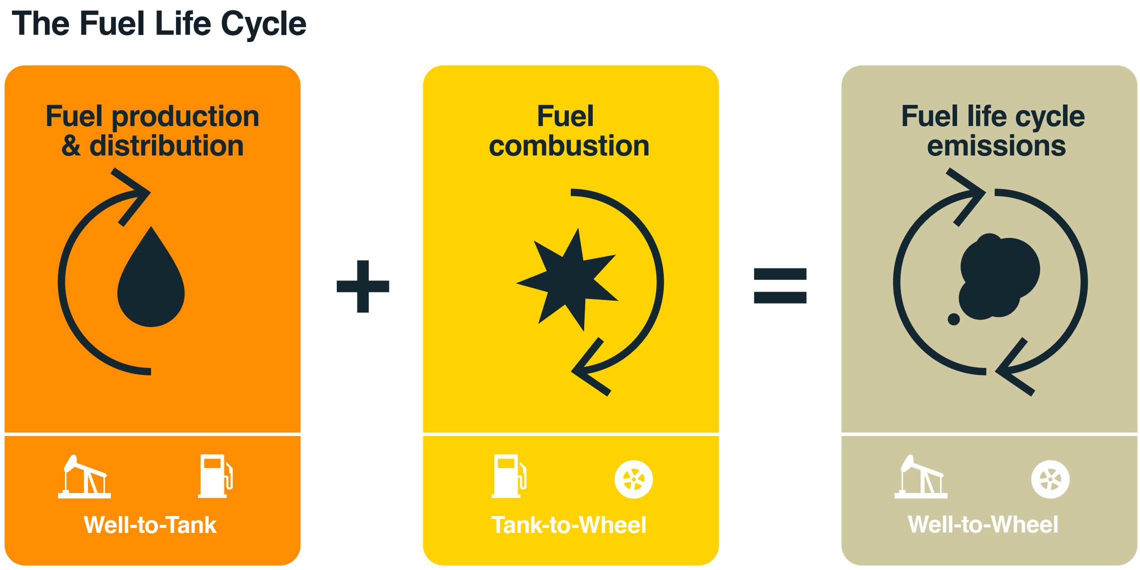


Figure 6. The GLEC Framework includes the full scope of emissions from the fuel life cycle.

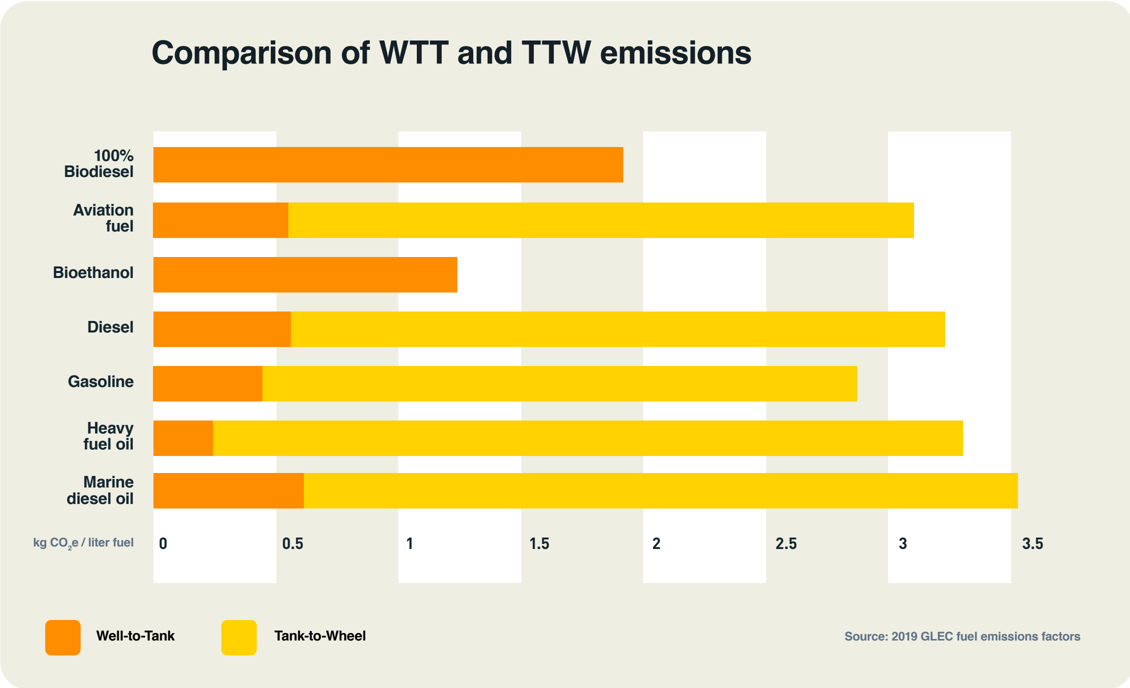


Figure 7. Emissions from each stage of the fuel life cycle varies for different fuel types.

WTW emissions for fuels burned by subcontractors are reported as Scope 3.

More detailed guidance on where such emissions should be reported within the Greenhouse Gas Protocol and CDP reporting structure is included in Chapter 5.

Fuel emission factors. The amount of fuel used can be converted to CO_2e using standard emission factors for each fuel type. Fuel emission factors are expressed as mass of CO_2e released for fuel or electricity used.

$$\text{Fuel emission factor} = \frac{\text{kg } CO_2e}{\text{kg fuel}}$$

The GLEC Framework provides CO_2e emission factors for both the well-to-tank and tank-to-wheel phases of most fuels in Module 1. High blend biofuels, hydrogen fuel cells and electricity are not included at this time (See Box 2). The GLEC fuel emission factors are based on global averages; actual emissions may vary depending how and where the fuel is produced.

The WTT factors included in the Framework are representative values that average out the differences across common fuel production and distribution supply chains and are generally accepted as reasonable estimates by practitioners.

Emission factors for fuels not listed in Module 1 can be used as long as WTW emissions are included and the source is acknowledged.

Electricity emission factors.
Electricity emission factors are used to convert electricity use to CO_2e based on the source(s) of energy used to create electricity. Fuel emission factors are expressed as mass of CO_2e released for the kilowatt-hours (kWh) of electricity used.

$$\text{Electricity emission factor} = \frac{\text{kg } CO_2e}{\text{kWh electricity}}$$

The renewable electrification of transport systems is seen as a key tactic for decarbonizing the transport sector. To track emissions from electrified operations, companies must gather electricity emission factors for countries or regions.

Growing investment in renewable energy technologies means that electricity emission factors in some countries are changing rapidly; therefore, company databases should be updated regularly.

The International Energy Agency (IEA) compiles and publishes annually-updated lists of national electricity emission factors, and we recommend companies use this as a source of information. The factors are available for purchase from the IEA website.

IEA electricity emissions factors include data for the following items:

- gCO_2/kWh for electricity generation
- Correction for transmission and distribution losses induced emissions (gCO_2/kWh)
- Correction for trade induced emissions (gCO_2/kWh)
- gCO_2e/kWh for electricity generation from CH_4
- gCO_2e/kWh for electricity generation from N_2O

To ensure a full WTW approach we recommend including all these elements in the national electricity emission values.

SFC has negotiated access to this IEA dataset during 2019 for 25 companies that adopt the GLEC Framework. Please contact SFC for more information on the data and the IEA terms of use.

Box 2. Special Considerations for Alternative Fuels

Leaving WTT emissions out of reporting can be extremely misleading. This is particularly relevant for many alternative fuels, where GHG emissions are only in the WTT phase (hydrogen and electricity) or are considered net zero due to carbon sequestration of emissions from the WTT phase (biofuels).

For this reason, as biofuels and renewable energy sources gain a larger market share, it becomes particularly important to track and reduce emissions in the WTT phase.[74] Tips on finding these emissions are below:

Biofuel
Because biofuel production methods vary more widely than conventional fuels in terms of the feedstock and associated processes, there is no single recognized standard value for WTT for each broad class of biofuel. Knowledge of the biofuel feedstock and production pathway reduces uncertainty when selecting an emission factor. Biofuel providers should be able to provide this value directly; other sources may be life cycle databases, government agencies and green freight programs.

Conventional fuels often include a small percentage of biofuel; this is reflected within the GLEC Framework emission factors with relatively low uncertainty.

Electricity
WTT emissions for electricity include the production and acquisition of fuels consumed in power generation as well as transmission and distribution (T&D) losses in the electricity grid. These values can be obtained from the IEA, life cycle databases or government agencies.

Hydrogen fuel cells
At the time of publication, there is no widely-accepted value for hydrogen fuel cell WTT emissions. Please refer to the producer for more information about hydrogen production and distribution.

Exclusions from the GLEC Framework

The following items may contribute additional climate impacts for logistics activities but are not addressed by the GLEC Framework at this time for reasons of data availability, practicality or other issues. These exclusions may be revised in future updates to the Framework as new information becomes available.

- Direct emissions of GHGs resulting from fuel spills and leakages (unless already embedded within fuel emission factors).
- Additional climate impacts from the combustion of aviation fuels in high atmosphere such as radiative forcing, contrails, cirrus, etc.
- Processes at the administrative level of organizations, such as staff commuting, business trips, computer systems, and the operation of office buildings unrelated to the moving, storage and handling of freight within a logistic site.
- Emissions from construction, maintenance and scrappage of vehicles or transport infrastructure.
- The production and maintenance of vehicles.
- The construction and maintenance of transport infrastructure.

De minimus rule

In alignment with the Greenhouse Gas Protocol, there is no hard and fast rule for excluding emissions from Scope 1, 2 and 3 activities.[9] Disclosures of emissions should reflect the 'substance and economic reality' of the reporting company and provide sufficient data to enable decision-making on the part of the company, its customers and its stakeholders.

The Greenhouse Gas Protocol states that the reporting company should not set an arbitrary threshold for excluding emissions based on the difficulty of finding information or perceived scale of the impact. Instead, companies should make a good faith effort to account for emissions, and document where emissions have not been estimated or estimated at an insufficient level of quality.

Companies often face the most difficulty accounting for Scope 3 emissions. The Greenhouse Gas Protocol offers the Scope 3 Evaluator to reduce the reporting burden.

Chapter 2
Calculation Steps

There are various steps that need to be carried out in order to generate a reliable and transparent logistics emissions calculation output. The nature of these steps and the order in which they can be carried out may vary depending on an organization's role in the supply chain, the data available, the chosen calculation approach and agreements over responsibility for the calculation with customers or LSPS.

Step 1
Set boundaries and goals

Step 2
Calculate Scope 1 & 2 emissions

Step 3
Calculate Scope 3 emissions

Step 1 Set boundaries and goals

STEP 1
Set boundaries and goals

There are various steps that need to be carried out in order to generate a reliable and transparent logistics emissions calculation output. The nature of these steps and the order in which they can be carried out may vary depending on an organization's role in the supply chain, the data available, the chosen calculation approach, and agreements over responsibility for the calculation with customers or logistics service providers.

- Set the boundary of the emissions calculation
- Consider the end goals for the emissions values – accounting can be used for annual climate disclosures, setting and tracking Science-Based Targets, analysis of activities and suppliers, product carbon footprints and more.

Set the boundaries
A successful emissions analysis begins with identifying the extent of activities included in the carbon reporting and related analysis. As a minimum, Scope 1 and 2 emissions should be quantified and careful consideration needs to be given as to the boundaries for the Scope 3 emissions.

Understanding as much as possible about transport activities for the study area, such as modes of transport, carriers, information on vehicles and fuels etc., will refine the accuracy of the final results.

Think about end goals
The end use of emissions values can drive the calculation strategy. One of the most common uses of the GLEC Framework is to calculate the total logistics emissions of a company over the course of a year, typically used for climate disclosures and Science-Based Target setting. However, the GLEC Framework can be applied at various levels of detail in order to aid with decision-making, such as in a particular country, for a particular customer's shipments or from a particular carrier or LSP.

Emission calculations can also be used to find emission intensity, where total annual emissions are allocated to an activity. To evaluate freight transport efficiency, emissions per tonne-kilometer is the most relevant KPI for many practitioners. Other emission intensity metrics may be useful as well, such as the average emissions per tonne shipped, along a certain trade lane or by a certain carrier. Emissions may also be allocated to a product, otherwise known as a product carbon footprint.

Determine data needs
Given that the type of data used has a direct influence on the accuracy of the results, and hence the degree to which results can be used to inform and track emission reduction actions, it is important to gather high quality, consistent data, and to specify the type of data and calculation approach used. Specific guidance on collecting high quality data for transportation is provided by US EPA SmartWay.[27]

The following categories are set out to clarify input data types:

- **Primary data.** Good quality primary (actual) data are what should be used by a transport or logistics site operator to calculate its Scope 1 carbon emissions, and what transport buyers should aim to collect from carriers for their Scope 3 emissions accounting. Primary data can range from highly precise information, such as from fuel receipts or annual spend, to aggregated values that reflect fuel or emission intensity for a year's worth of vehicle movements.
- **Program data.** Green freight programs play an important part in acting as a neutral platform to collect and share reliable data between transport operators and their customers in a neutral, managed environment. Program data can guide carrier selection and identify potential energy, cost and emission saving strategies.
- **Modeled data.** Companies and tool providers model fuel use and emissions using available information on goods types, consignment sizes, journey origin, destination and intermediate handling locations, and any information about the vehicles used, load factors, etc.
  The relevance of the model's outputs will depend on the level of detail that is available about the transport operation and the assumptions made, as well as the model's algorithms. In general, assumptions that are made that rely on default data, rather than primary data, will lower the validity of the output. It is important to ensure that the methods and default data embedded into tools align with the GLEC Framework.
- **Default data.** If no other data are available, the last resort is to use default data representative of average industry operating practices. Default data can provide a general indication of emissions, illuminating

hotspots and offering a structure for prioritizing further data collection to improve accuracy.

In order to help companies that are starting out on a journey to high quality logistics emissions calculations, Module 1 of the Framework presents a wide range of default data with varying levels of precision, that provide a general indication of emissions. Communication with suppliers can help to better understand the actual conditions in order to pick the most appropriate default factors. Specific information about the vehicle fleet, fuel type, temperature control, topography, etc. can improve accuracy.

The source of any default data used should be clearly specified, especially if not from the GLEC Framework default data lists.

It is important to remember that primary and modeled data are much more likely to be representative of actual conditions than default data. Using default data may lead to results that over- or underestimate emissions compared with actual conditions, as Box 3 describes in more detail.[28] Using default factors also removes the ability to use carbon emissions as a KPI to evaluate carriers, routes or other operational differences – key market mechanisms to encourage efficiency and emissions reduction.

Table 2. Overview of data sources

PRIMARY DATA	PROGRAM DATA	DETAILED MODELING	DEFAULT DATA
All Scope 1 reporting should be based on primary data. Primary data is best for Scope 3, typically expressed as an annual average	Data from green freight programs for Scope 3 reporting.	Models combine shipment data with information on vehicles and fleets in order to model fuel use and emissions	Industry average figures using standard assumptions of vehicle efficiency, load factor and empty running.
Example: Total annual emissions or average emissions per tonne-km.	**Example**: SmartWay carrier performance data; Clean Cargo Working Group carrier data	**Example**: EcoTransIT	**Example**: GLEC default emissions factors, life cycle databases, academic studies, or national legislation.

Box 3. How does the choice of factor affect Scope 3 emissions results?

Many companies have trouble finding reliable information about transport activities in their supply chain. As efforts to improve visibility of the transport chain continue to expand, a company may be able to transition from default emission intensity data to more detailed values, like primary or program data.

So, if you change default factors, will your reported emissions go up or down? The answer is that it depends.

Example where emissions would decrease

Transitioning from the average CO_2e/tonne-km factor for the road sector provided by the Greenhouse Gas Protocol to the GLEC Framework's value for a 40 tonne truck would lead to a decrease in reported emissions.

Transitioning from the GLEC Framework's factor for a 40 tonne truck to a factor provided by a carrier with a low-emission vehicle fleet would further decrease the reported value of emissions.

Example where emissions would increase

In air travel, longer flights are generally more efficient. If you learn that the routing from point of origin to point of destination actually involves multiple stopovers, then shifting to default factors that reflect the individual, shorter flight sectors, potentially with an associated increase in total distance flown, would increase the reported emissions value.

Step 2 Calculate Scope 1 & 2 emissions

Find fuel and electricity data → Convert fuel to GHGs → Convert electricity to GHGs

STEP 2
Calculate Scope 1 & 2 emissions

- For Scope 1 and 2, fuel and electricity data are converted to emissions using a standard fuel or electricity emission factor.
- Due to lack of access to the necessary primary data, Scope 3 emissions are generally based on activity data, namely tonne-kilometers, coupled with a fuel or emission intensity factor

Emissions are related to the amount of fuel and electricity burned; therefore, quantifying fuel* consumption is a fundamental step in calculating logistics emissions. Primary fuel consumption data is generally used to calculate Scope 1 and 2 emissions, whereas program, modeled or default values are often required for Scope 3.

When emissions are added together for all activities, the resulting value represents the total emissions over one year (or other study period as defined). Total emissions should equal the sum of all emissions across all transport services, logistics activities and other subdivisions used by the company.

Scope 1

Scope 1 fuel information should be gathered from fuel and refrigerant receipts, fuel management systems and/or annual spend. Fuel data should cover the full round trip; i.e. the fuel associated with full, partially-loaded and empty trips should be included.

See Chapter 3 for collecting and organizing data for each mode and logistics sites.

* The term fuel is used to represent all energy sources including solid and liquid fuels and electricity

Once fuel data are compiled, the fuel used can be converted to emissions. Different fuels emit different amounts of carbon – be sure to convert each fuel type to CO_2e separately.

$$\text{kg } CO_2e = \sum_1^n \left(\text{fuel (kg)} \times \text{fuel emission factor} \left(\frac{\text{kg } CO_2e}{\text{kg fuel}}\right)\right)$$

More detailed fuel data will improve the accuracy of GHG emission estimates, support efficiency monitoring and inform pricing structures, e.g., for cool chains. For example, recording the energy used for temperature control equipment separately allows companies to allocate these emissions only to goods that are heated, chilled or frozen.

If detailed fuel data are not available, such as when using total fuel spend, estimate the amount of each fuel burned based on the best available information about your fleet or transport operations. For example, if a fleet is made up of 70% diesel and 30% compressed natural gas (CNG) trucks, local prices can be used to estimate liters burned of each fuel starting from invoiced values.

Scope 2

Electricity bills provide the most accurate information on electricity use. Electricity is typically reported in kilowatt-hours (kWh) and should be totaled separately based on geography. The location (country, state or city) where electricity is purchased is important information to record, as the emissions are tied to the source of energy for that electric grid.

$$\text{kg } CO_2e \text{ emissions} = \sum_1^n \left(\text{electricity (kWh)} \times \text{electricity emission factor} \left(\frac{\text{kg } CO_2e}{\text{kWh electricity}}\right)\right)$$

Step 3 Calculate Scope 3 emissions

Calculate tonne-kms → Find fuel efficiency or emissions intensity factors → Convert tonne-kms to GHGs

STEP 3
Calculate Scope 3 emissions

- Scope 3 emissions can be more challenging to calculate.
- A consistent approach to calculating weight, distance and tonne-kilometers is put forth to streamline data sharing and improve accuracy of results.

Depending on the type of data available,Scope 3 emissions are calculated based on a combination of primary, modeled or default fuel or emissions data linked to the transport activity, expressed in tonne-kilometers.

Calculate tonne-kilometers

To evaluate freight transport activities, it's important to consider both the weight of the shipment and the distance it was transported. As such, the tonne-kilometer is the key unit for freight transport, representing one tonne of cargo moving for one kilometer.

The tonne-kilometer provides a useful and consistent 'common denominator' to express efficiency for freight transportation. Like a 'miles per gallon' or 'liters per 100km' figure, the amount of fuel or CO_2e used to move a certain amount of cargo for a certain distance typically calculated over a period of one year to even out seasonal variations and outlying values.

$$\text{Fuel or } CO_2e \text{ intensity factor} = \frac{\sum_1^n (\text{kg fuel or } CO_2e)}{\sum_1^n (\text{tonne-km})}$$

Capturing shipment weight and distance in an accurate and consistent manner can be surprisingly difficult to achieve. Shippers may not be able to acquire this information from their carriers, and carriers may struggle correlate their tonne-kilometers with actual fuel burn.

The following sections provide an approach to finding weight and distance.

Weight

The basis for quantifying the amount of goods being transported or processed in the GLEC Framework is the actual shipment weight (mass). Volume and density are also common attributes of freight, but weight is selected for the GLEC Framework due to its consistent application across the supply chain. Other metrics may be used by companies for analysis, and in some cases, reporting, but weight should be communicated alongside these measurements to ensure consistency along the multimodal supply chain.

Weight should include the product and the packaging provided for transport by the shipper; additional packaging or handling equipment used by the carrier or LSP should not be included in Scope 3 calculations. Weight information may be found on invoices, bills of lading, within a Transport Management System, etc. Proxies such as 'chargeable weight' should not be used.

Distance

The distance a shipment is transported is measured from the point where the shipper hands it over to the carrier and ends with the hand-over of the shipment to another carrier or the end receiver. While this may seem simple, especially in light of developments in GPS and telematics systems, finding distance is part of what makes logistics carbon accounting a complicated endeavor.

Many shipments involve multiple transport legs and modes; some are handled by multiple carriers. Sometimes there are intermediate stopovers in locations that reflect a carrier's transport network rather than the most direct route. Sometimes routes are modified due to weather, tides, construction or traffic conditions, information that may or may not be known to other parties.

This is complicated by goods traveling on shared transport assets, where shipments are consolidated to increase vehicle loading and hence efficiency, but may lead to longer distances being travelled than would be the most direct route for an individual shipment.

Distance information should be collected for each transport leg, either through direct measurement or estimation. Four common approaches to calculating distance are as follows:

- **Actual distance.** Based on odometer readings or knowledge of the actual route, the true actual distance is generally only known by the carrier. In most cases a shipper or LSP does not have access to the actual distances travelled by its subcontracted carriers.
- **Great circle distance (GCD).** Also known as direct distance or 'as the crow flies', GCD is an approach to distance measurement that is currently focused on air transport. GCD is easily standardized and doesn't

relate to actual transport network conditions. While this is a compelling option for harmonizing distance measurement across multimodal supply chains, it is currently not widely known or accepted outside of the aviation industry.

- **Shortest feasible distance (SFD).** Shortest feasible distance represents the shortest route between two places and is typically found using route planning software. SFD is not an optimal method because it does not reflect real operating conditions, such as the physical restrictions of a vehicle (e.g. weight and height), road type, topography, congestion or construction.
- **Planned distance.** Also found using route planning software, planned distance tends to be the shortest distance taking into account real operating conditions and typical operational choices such as avoiding congestion hotspots or unsuitable, restricted roads.
- **Network distance.** Effectively a variation of planned distance, network distance is used where the route options that can be taken are limited, such as rail or inland waterway networks.

Air transport uses GCD to measure distance; for most other situations, planned or network distance is recommended. Planned distance is the most consistently available and accepted approach to distance measurement for the various actors within a supply chain. Guidance for distance calculation for each mode is provided in Chapter 4.

The tonne-kilometer calculation

Tonne-kilometers bring together weight and distance as the metric for freight transport activity. To calculate tonne-kilometers for a single consignment, weight and distance are multiplied together.

$$\text{tonne-km} = \text{tonnes} \times \text{kilometers}$$

To find the total tonne-kilometers for a set of consignments, the weight and loaded distance are multiplied together for each consignment and then the individual tonne-kilometer values are added together. To improve the accuracy of emissions calculations, calculate tonne-kilometers separately for different transport services and fuel types.

$$\sum_{trip=1}^{n} \text{tkm} = \text{tonne}_{\text{trip 1}} \times \text{kilometer}_{\text{trip 1}} \; \ldots + \text{tonne} \times \text{kilometer} \ldots + \text{tonne}_{\text{trip n}} \times \text{kilometer}_{\text{trip n}}$$

If accurate tonne-kilometer data are not available, approaches to estimation are as follows:

Table 3. Demonstration of tonne-kilometer (tkm) calculation approaches

Shipment	tonnes	kilometers	tkm
1	10	1,000	10,000
2	40	400	16,000
3	400	300	120,000
4	10	700	7,000
5	60	1,200	72,000
		Correct answer: total tkm	**225,000**

ACCEPTABLE ESTIMATION APPROACHES:	
Multiply total tonnes by average km	374,400
Multiply average tonnes by total km	374,400
INCORRECT ESTIMATION APPROACHES (Do Not Use!)	
If you multiply total tonnes by total km	1,872,000
If you multiply average tonnes by average km	74,880

For Scope 1:

$$\text{tkm} = \text{vehicle capacity (tonnes)} \times \text{average load factor}\left(\frac{\text{average shipment weight (tonnes)}}{\text{vehicle capacity (tonnes)}}\right) \times \text{total distance (km)} \times \text{proportion of distance loaded}\left(\frac{\text{loaded distance (km)}}{\text{total distance (km)}}\right)$$

For Scope 3:

$$\text{tkm} = \text{total weight (tonne)} \times \text{average shipment distance (km)}$$

Find fuel efficiency or emission intensity factors

There are many different sources of data that can be used to estimate fuel and emissions for Scope 3, each with varying levels of accuracy and usefulness for different applications. Typically, the data are classified into fuel efficiency or emission intensity factors (fuel use tkm or CO_2e t-km), which are combined with activity data (tkm) to calculate a final total value. The type of data may range from primary to program, modeled, or default data, as discussed in Chapter 1.

It is recommended that independent, third party assurance of the input data and any assumptions embedded within the calculation process are carried out.

Convert activity data to emissions

The final calculation for Scope 3 emissions brings together the tonnes, kilometers and efficiency or intensity factors. The approach varies depending on the factor being adopted – fuel efficiency or CO_2e intensity.

With a fuel efficiency factor:

$$\text{kg } CO_2\text{e emissions} = \sum_1^n \left(\textit{total}\text{ tkm} \times \text{fuel efficiency factor}\left(\frac{\text{kg fuel}}{\text{tonne-km}}\right) \times \textit{fuel emission factor}\left(\frac{\text{kg } CO_2\text{e}}{\text{kg fuel}}\right)\right)$$

This step must be carried out separately for each type of fuel; fuel emission factors are available in Module 1.

With a CO_2e intensity factor:

$$\text{kg } CO_2\text{e emissions} = \sum_1^n \left(\textit{total}\text{ tkm} \times CO_2\text{e } \textit{intensity factor}\left(\frac{\text{kg } CO_2\text{e}}{\text{tonne-km}}\right)\right)$$

In this case, the fuel is already converted to CO_2e. Be sure the underlying data account for the full fuel life cycle (WTW) and all GHGs (CO_2e).

Data assurance

The GLEC Framework is intended to align methodological aspects as far as is possible. Carbon emissions calculation outputs rely not only upon a sound methodology but also good quality input data.

The type of data used can influence the accuracy of the results, and also the degree to which results can be used to inform and track emission reduction actions. Thus it is important to specify the type of data and calculation approach used, especially for Scope 3.

With this in mind, it is recommended that companies consider appointing appropriately qualified, independent third party entities to conduct assurance of the input data and any assumptions embedded within the calculation process. Though not required, third party assurance provides an independent assessment with the aim of establishing confidence or trust around a process and/or declared output.

To support this process, SFC has worked with GLEC members and consultees to develop an Assurance Guidance document that accompanies the GLEC Framework. The purpose is to provide guidance for assurance providers in the steps required to assess claims made about the adoption and implementation of and calculation outputs from the GLEC Framework.

Among other outputs, the Assurance Guidance recommends that a statement explaining the proportional breakdown of input data according to data type classifications: primary data (both aggregated and disaggregated), program data, modeled data and default data accompanies every calculation output.

Ultimate responsibility for the reported carbon emissions results rests with the reporting organization, and third party assurance should help confirm this. In order to confirm adherence with the GLEC Framework, SFC has developed an accreditation process that covers core aspects of methodological alignment with the GLEC Framework. Details are available online at www.smartfreightcentre.org.*

* SFC cannot take responsibility for the quality of the input data used or provided by third parties as an input when following the GLEC Framework or when using an SFC-accredited calculation tool or green freight program. To this end we recommend that input data is independently verified by an appropriately qualified third party, and a statement is issued where this is the case; ultimately it is the user's own responsibility to be sure that they are confident in the data that they subsequently rely on when using any calculation outputs.

Emission calculations: in summary
The preceding sections provide an overview of common considerations and actions needed for emissions accounting. Users of the Framework should feel free to apply the steps flexibly, in the order most useful for their needs. The best order for your situation may depend on what activities are being considered, what data are available and how the results will be used.

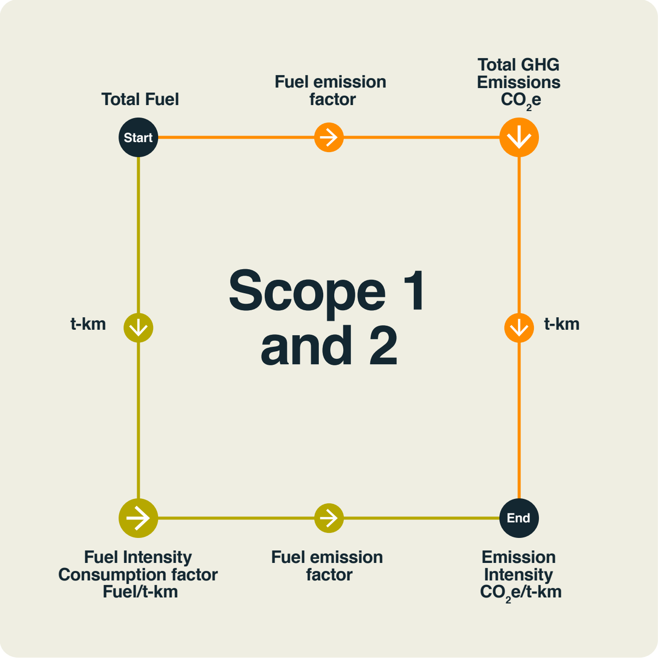
A summary of typical calculation steps is provided below. The Framework continues in Chapter 4 with additional calculation details specific to each mode of transport and logistics sites.

Scope 1 and 2 emissions

The route for transport operators to calculate and report their own emissions starts with total fuel, which can be converted to emissions using fuel emission factors. Dividing by tonne-kilometer then gives the emission intensity.

From a calculation perspective, it does not matter if you convert to intensity before or after converting fuel into emissions. The key is that both total emissions and emission intensity are reported side by side as KPIs.

Figure 8. Calculation summary for scopes 1 and 2.



Scope 3 emissions

For Scope 3 emissions the customer has a range of possible options, depending on what input data are available, as follows.

1. With primary or program data
If they have access to the emission intensity data, then the conversion is via two stages and again, from a calculation perspective, the order does not matter.

Figure 9. Calculation summary for scope 3 using primary or program data.

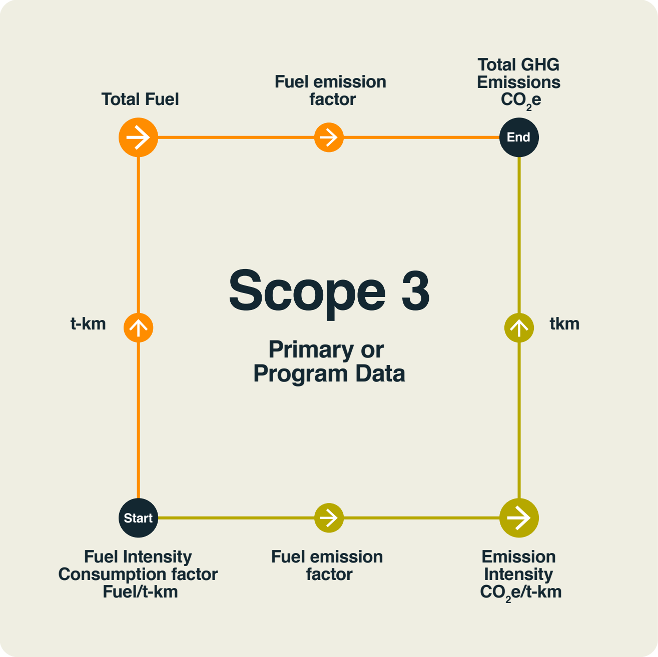
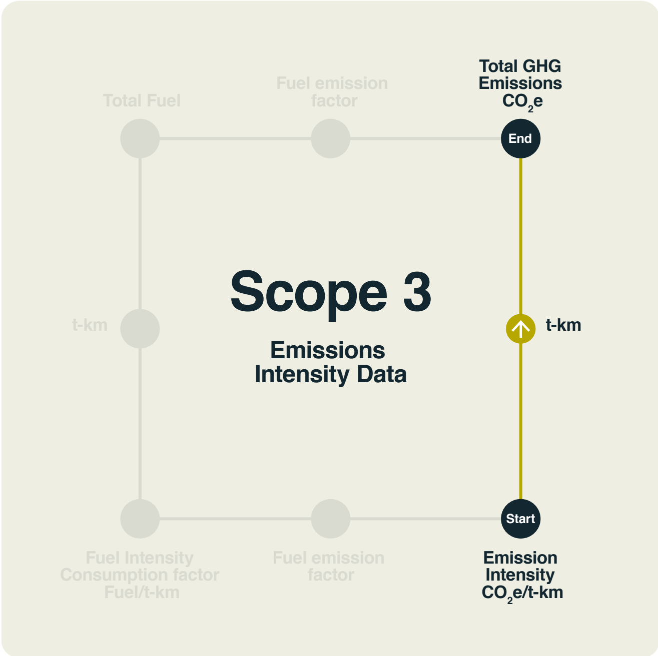


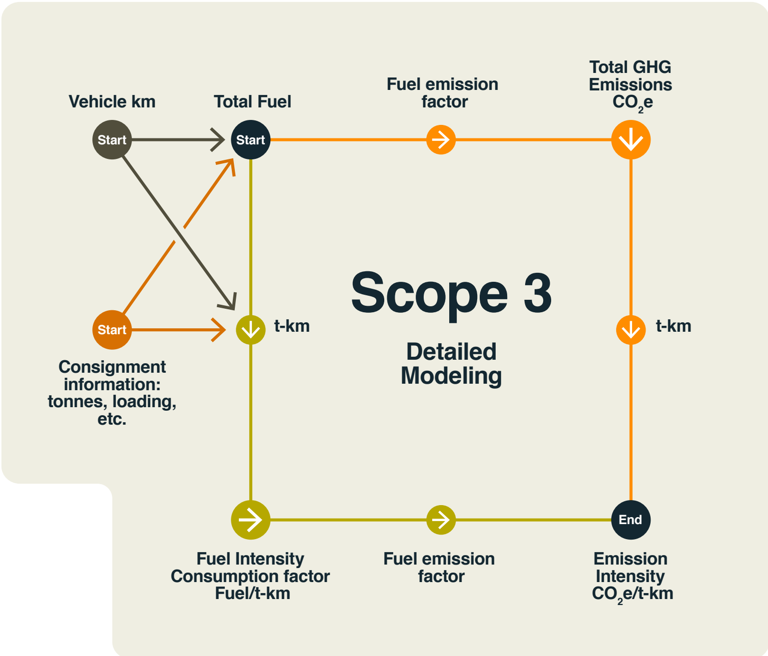
Figure 10. Calculation summary for scope 3 using emission intensity data.



2. From emission intensity data

If trustworthy information is only available in the form of emission intensity data, then the situation is simplified. Program data and default factors are often expressed this way, and users must rely on the provider to take the correct fuel emission factors.

Figure 11. Calculation summary for scope 3 using modelled data.

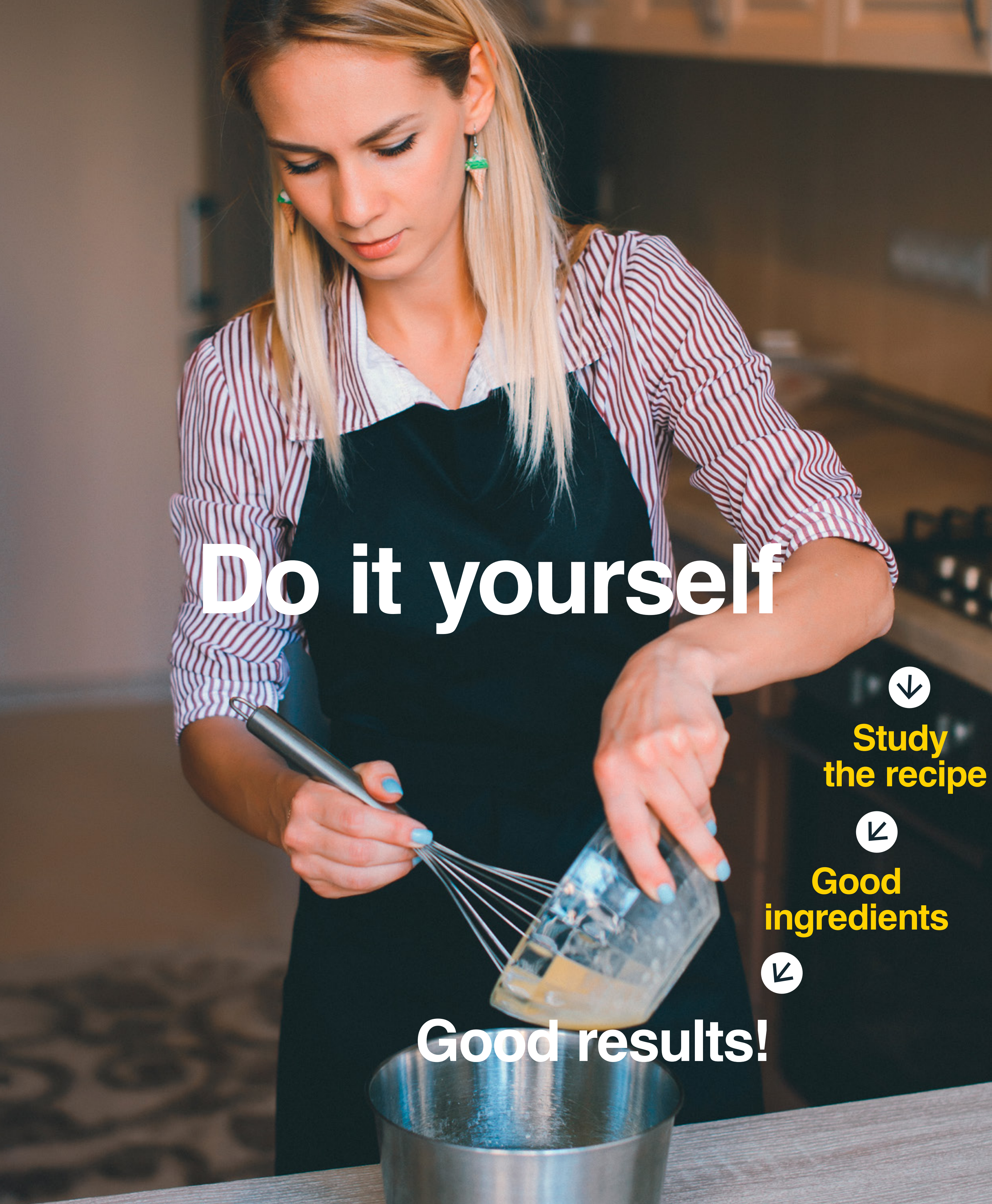


3. Using detailed modeling

If the information available from the carrier to the customer is limited then detailed modeling may be required to calculate internally consistent values of fuel and tonne-kilometers.

The better the ingredients, the better the cake

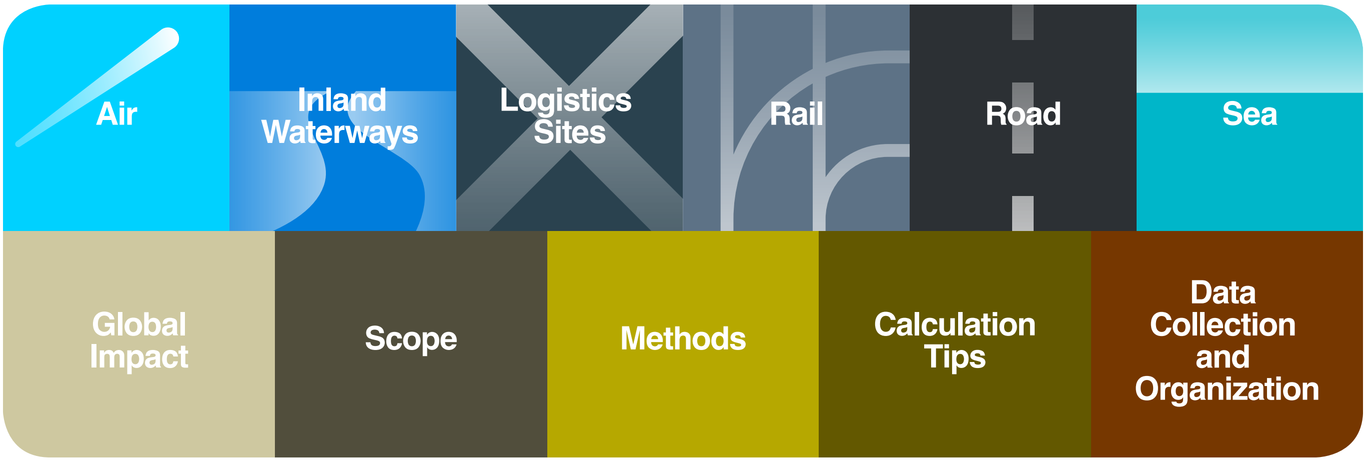
To use a culinary analogy, following the GLEC Framework should ensure that if you set out to make a birthday cake, then what you get is indeed a birthday cake.




Ask a pro
Check reviews
Study compatability
with your ingredients
Good results!

Chapter 3

Considerations for Each Mode



Accounting for emissions from freight transportation requires an understanding of a diverse set of business models, modes of transport, regions and more. Through our experience working with various stakeholders, we've compiled specific advice on calculating emissions for each mode of transport and logistics sites. In many circumstances, information for each mode would then be brought together to fully understand the impact of the complete, multimodal logistics chain.

Our collaborative work with the Universal Postal Union and companies in the mail and parcels sector is a good example of how this comes together, as set out in Module 4.

Each of the following sections includes an overview of global impact for that mode, the detail on the scope of activities included, information on base methods, and a set of tips for emissions accounting.

We welcome your tips and tricks at www.smartfreightcentre.org.

Air

Global Impact

The majority of aviation emissions come from passenger transport, with freight-related aviation comprising only around 11% of total emissions in 2017.[29] That said, aviation is the fasting growing area of freight transportation.[2] Though the proportion of freight transport activity sent by air is relatively small, aviation remains the most emissions intense mode of transportation, despite improvements in fuel efficiency.[30,31]

Air transport has a unique interaction with the climate because the majority of emissions occur at cruising altitudes of 8–12 km.[32] The IPCC notes that high altitude deposition of not only CO_2, but also NO_X, methane, water vapor and ozone, contributes a climate warming impact, and can also seed clouds that trap heat from the earth's surface (radiative forcing).[33]

More research is needed to better understand aviation's impact on the climate. The Emissions Database for Global Atmospheric Research has contributed to this mission by mapping of emissions at take-off, cruising and landing.[34]

Reductions in air freight emissions are possible through more efficient aircraft, improved air traffic management and other optimization measures.[35] However, achieving aviation decarbonization will be a challenge without a new aircraft engine and/or fuel source. The lack of ready technologies has led the International Civil Aviation Organization (ICAO) to put forth the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which uses carbon offsets to mitigate climate impacts until new technologies are available.[36]

Scope

The GLEC Framework covers freight transport by any type of aircraft, including freighters and passenger aircraft carrying cargo in their hold ('belly cargo'). Aircraft are defined as 'any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of air against the earth's surface.'[37] Neither the embedded emissions of producing the aircraft themselves, nor the emissions related to airline or airport staff, are covered by the Framework.

The full flight cycle is included: taxiing, take-off, cruising, landing, as well as any other movement related to freight loading and unloading. Any additional global warming impacts from the combustion of aviation fuels at high altitude are not included.

The services provided by the air terminal (e.g., loading, unloading, cleaning, block power) are classified under logistics sites.

Methodology

The GLEC Framework is compatible with the International Air Transport Association's (IATA) Recommended Practice (RP) 1678[14] and the US EPA's 2018 SmartWay Air Carrier Partner Tool.[15] The European Standard, EN16258,[23] incorporates an alternative approach to allocation of emissions to belly cargo which is accepted as long as a clear statement is made that this is the approach used; additional details on compatibility are listed below.

At the time of publication of the Framework, the approach to emissions calculation, reduction and impact mitigation under ICAO's CORSIA program was still under development.[36] Once the full details are published by ICAO, SFC will evaluate the method for compatibility with the GLEC Framework.

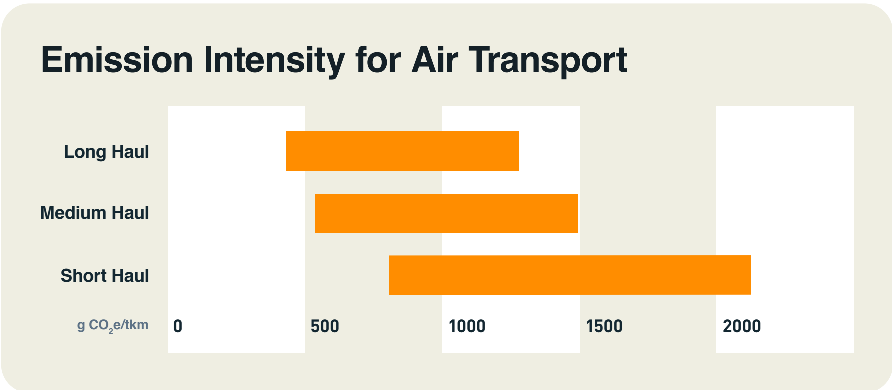


Figure 12. Examples of WTW emission intensity for air transport, based on 2019 GLEC default factors.

IATA RP1678

- IATA emissions results are expressed as TTW, CO_2; therefore, the WTT emissions must be added and the result must be scaled to a CO_2e basis for alignment with the GLEC Framework.
- IATA's network-based approach is in line with the transport service category approach.
- IATA allows emissions to be calculated on a weight or volume basis; for alignment with the GLEC Framework, weight should be used.

SmartWay Air Carrier Partner Tool

- SmartWay emissions results are expressed as TTW, CO_2; therefore, the WTT emissions must be added and the result must be scaled to a CO_2e basis for alignment with the GLEC Framework.

Tips for Air Transport Calculations

Shipment weight

- Use actual shipment weight, not proxies like chargeable weight.

Distance

- Distance is measured as the GCD between the origin and destination airport for each flight leg.
  - The EN 16258 standard requires that 95km is added to the GCD to account for maneuvering at each end of a flight; if a GLEC Framework adopting company chooses to use the EN16258 approach then use of the +95km adjustment is implied.
- The latitude and longitude of the start and end point can be taken either from aerodrome data published in the national Aeronautic Information Publication or from a source using such data (e.g. ICAO).
  - If intermediate stops are made, distance should be calculated for each leg in the overall journey and then added to find the total distance.
- For Scope 3 calculations, it can be difficult to know intermediate stops on the flight path. If distance is taken between start and end points, not including intermediate stops, this will lead to systemic underestimation of distance. The only way to know for sure is to obtain flight numbers for each journey, though this can be a complicated task. One company's experience in distance estimation is show in Box 4.

Load factor

- Ideally, representative load factors should be sourced from the aircraft operator.
- Where such data are not available a suitable starting point is shown in Table 4.

Table 4. Average load factors for freighters and passenger aircrafts, adapted by EcoTransIT from Eurocontrol Small Emitters Tool[21,38]

Trip Distance	Load Factor (based on freight capacity)
Short haul (up to 1,000km)	50%
Medium haul (1,001 – 3,700km)	70%
Long haul (3,700km+)	70%

Box 4. Case study on air distance

SFC analyzed the global air freight shipments of an anonymous LSP and found that roughly 90% of their air freight involved a routing with at least one stopover. The average deviation from GCD was an increase of about 6.5%.

However, a handful of routes showed a distance deviation of more than 40% above direct distance. These were extremely infrequent occurrences, 3% of all shipments, covering low annual throughput, indicating that most likely there were unusual circumstances involved.

Nonetheless this case demonstrates how without the tonne-kilometer data from the carrier, emissions could easily be underestimated.

Default factors

- The following GLEC Framework air transport fuel efficiency and emission intensity factors are provided (see Module 2 for more information):
  - The overall IATA Industry average.
  - A matrix showing notional short-, medium- and long-haul values for passenger planes and freighters, as well as an average value that can be used when the nature of the air transport is unknown.
  - Default values are provided for both IATA RP1678 and EN16258 methodologies, in part to show the significant difference in results for belly freight between the two methodologies due to the respective approaches to allocation of the emissions between freight and passengers.
- If flights include intermediate stops, the appropriate default factor for each flight leg's origin and destination points should be applied.

Fuel type

- Jet fuel A (kerosene) is the assumed fuel type for air transport.
  - Aviation gas is also used in some cases, such as for aircraft with piston engines.
  - If there is reason to believe another fuel type is used, i.e. through detailed knowledge of aircraft type, select the appropriate CO_2e emissions factor and document the change

Suggestions for Data Collection and Organization

Table 5. Additional information helpful to improve Scope 3 accuracy

Information about aircraft	Information about activities
o Type of plane (freighter or passenger plane) o Aircraft make/model o Capacity (freight or passenger capacity) o Engine type: turbine (typically run on jet fuel) or piston (typically run on aviation gas)	o Origin-destination for each flight leg o Trade lane (see GLEC Framework air defaults for examples) o Knowledge of intermediate stops or airports where transhipment occurs o Length of flight legs (short, medium or long)
Transport service categories recommended for categorizing carrier data	
• Origin-destination pair • Contract type: shared freighter, fully contracted freighter or belly cargo	

Inland Waterways

Global Impact

Freight transport by inland waterways comprises a relatively small share of the logistics sector, though it is seen as a beneficial option due to its relatively low carbon emission intensity and role in reducing road congestion. Despite the benefits of fuel efficiency and pollution reduction, inland waterway transport has experienced less growth and infrastructure investment than other modes, especially in developing countries.

Energy use and emissions information for inland waterway transportation is often grouped with other modes of water transport in statistical publications, making it hard to isolate trends.[3] The GLEC Framework default values suggest that, depending on the vehicle or vessel used, inland waterways can offer a low energy, low emission alternative for medium and long distance transport.

Efficiency can be gained through slow-steaming and optimized logistics operations. Fuel-efficient power and propulsion systems, streamlined hulls and superstructures, and alternative fuels like biodiesel or hydrogen present more practical near-term solutions.[39] An electrified long-distance ship is effectively off the table until the weight and volume of energy storage batteries are greatly reduced.

Scope

Inland waterways transport refers to freight movement along stretches of water that are not part of the sea, such as rivers, lakes, canals and estuaries.[40] Types of inland waterways vessel include barges, coupled convoys, pushed convoys, tankers and container vessels.[17]

All emissions related to the movement of cargo, including empty backhauls and repositioning, should be included. Emissions related to buildings and equipment used to load or unload cargo are classified under logistics sites.

Methodology

In general, inland waterway emissions accounting follows the principles developed by the maritime sector. The GLEC Framework is in alignment with the principles of the International Maritime Organization (IMO) Energy Efficiency Operation Index (EEOI) guidelines and the US EPA SmartWay Barge Carrier Tool.

IMO EEOI[18]

- IMO EEOI emission results are expressed as TTW, CO_2; therefore, the WTT emissions must be added and the result must be scaled to a CO_2e basis for alignment with the GLEC Framework.

SmartWay Barge Carrier Tool[16]

- SmartWay emission results are expressed as TTW, CO_2; therefore, the WTT emissions must be added and the result must be scaled to a CO_2e basis for alignment with the GLEC Framework.
- Carrier-specific values are available for a small set of companies operating in North America.
- SmartWay intensity values are reported as CO_2/ton-mile – the fuel consumption is already converted to CO_2 using standard fuel emission factors supplied by SmartWay.
- Conversion from US tons to metric tonnes may be needed to ensure consistency of reporting.

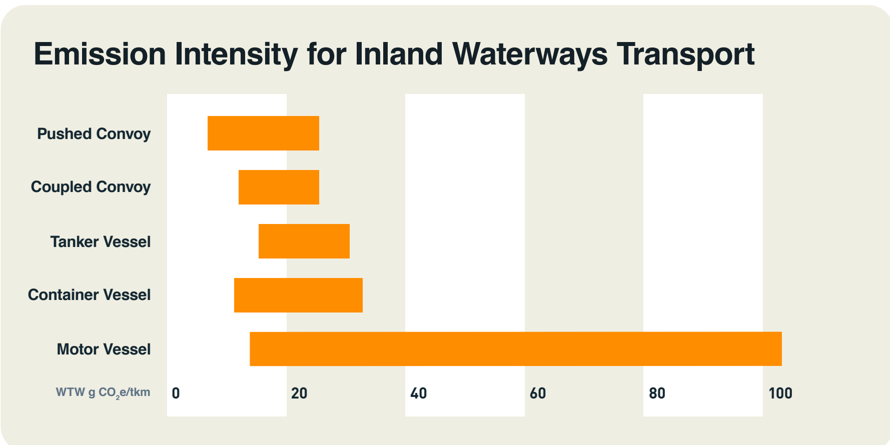


Figure 13. Examples of WTW emission intensity for inland waterway transport, based on 2019 GLEC default factors.

Tips for Inland Waterway Transport Calculations

Shipment weight

- Use actual weight or, if not available, estimated weight based on the mass of the cargo.
- Twenty foot equivalent units (TEUs) can be converted using the standard conversion factors in Appendix 4.

Distance

- Distance should be calculated using actual waterway network distance based on the start and end point of the journey.
  - Ideal distance data is from the vessel's log book.
  - Other options may include distance planning software, telematics data or other sources of network distance data.
- Convert (nautical) miles to kilometers using factors in Appendix 4.

Load factor

- Information regarding typical load factors in inland waterway transport is limited.
- Development of the GLEC Framework default factors allowed the collation of load information by vessel type that has been incorporated in the published default factors. Load factors were generally in the range 45–75%, including allowance for empty running, depending on vessel and cargo type.

Default factors

- Smart Freight Centre and STC-Nestra worked collaboratively with GLEC members to develop a new set of industry-reviewed default factors that accurately represent today's inland waterway sector.[17]
- Whilst we would always encourage carrier-specific values, the default values in Module 2 provide a significant step forward in terms of collecting and sharing consistent data for a wide range of inland waterway vessel types.

Fuel type

- Marine diesel oil is the assumed fuel type for the GLEC default factors.
  - Other potential fuel types include other diesel oils, liquified natural gas (LNG) and biodiesel.
  - If there is reason to believe another fuel type is used, i.e. through knowledge of operations, select the appropriate CO_2e emissions factor and document the deviation.

Suggestions for Data Collection and Organization

Table 6. Additional information helpful to improve Scope 3 accuracy

Information on ship	Information on activities
• Vessel type (e.g., covered cargo, barge, pushed convoy, container, tanker) • Vessel size • Payload	• Cargo type • Route taken • Temperature control • Waterway classification • For convoys, number of barges
Transport service categories recommended for categorizing carrier data	
• Cargo type: bulk, containers, pallets, mass-limited cargo and volume-limited cargo • Condition: ambient or temperature controlled • Contract type: shared or dedicated	

Logistics Sites

Global Impact

A vital backbone to supply chains, logistics sites are where goods are stored and processed, and where myriad forms of transport intersect.

Logistics sites are often close to population hubs, emphasizing the importance of both the climate and health impacts of their activities. Given their integral role in the booming logistics sector, their impact is only expected to grow in the coming years.

Logistics sites are a diverse group of facilities scattered around the globe; their collective impact is not well-understood. The World Economic Forum estimated that warehouse and sorting facilities alone can comprise up to 13% of supply chain emissions.[41]

A company's use of logistics sites, and the subsequent emissions, will vary based on the modes of transport, refrigeration needs and region. Therefore, the relative impact of emissions from logistics sites will vary by company and product and should be assessed accordingly.

Scope

Logistics sites are the nodes, hubs, centers, depots and facilities that connect transport legs or are the starting or end point of a transport chain.[19] Facilities classed as logistics sites include terminals, ports, airports, warehouses, cross-docking sites, distribution centers and more.

The boundary for emissions from logistics sites begins when the consignment is unloaded from the inbound vehicle or vessel, and ends when the goods are either handed over to the recipient or reloaded onto the outbound vehicle or vessel.

The Framework considers emissions from logistics sites as those emitted by the fuel and electricity used to store or move freight at the site, and direct losses of refrigerants used in temperature control equipment. This includes energy used for order picking, repacking, onsite vehicles, technical equipment, lighting, heating/cooling (for facilities and reefers), weigh stations, office buildings and administrative facilities related to freight movement, and other freight-related activities.

Emissions linked to energy supply for onsite vehicles and machinery such as cranes, reach stackers, fork-lift trucks, diesel generators and shore power to vessels are included. This means that inbound and outbound transport to-from the center is not included in logistics sites' emissions.

In practice, it may be difficult to split electricity and fuel burn for freight and non-freight related activities as an input to reporting to customers. In such cases, logistics site operators are encouraged to make these calculations based on the best available information and transparently record any potential anomalies when reporting.

For logistics sites that are jointly operated, allocation of emissions should be based on the throughput tonnage by each operator.

The upstream emissions related to infrastructure, vehicles and material handling equipment are not included, nor are Scope 3 emissions, such as employee commuting and business travel.

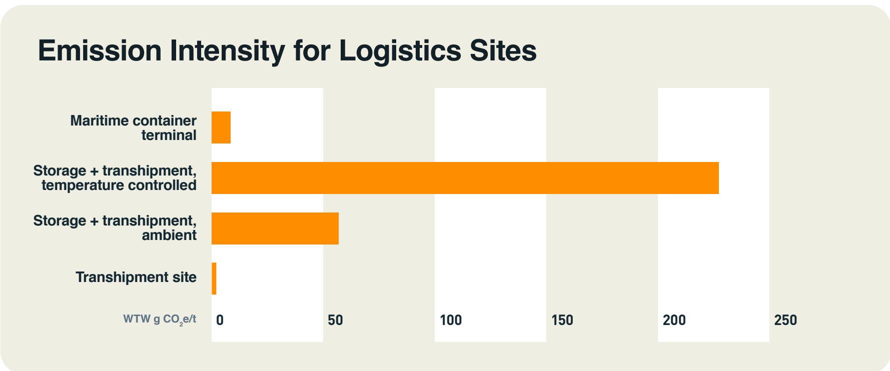


Figure 14. Examples of WTW emission intensity for logistics sites, based on 2019 GLEC default factors.

Methodology

The GLEC Framework aligns with following methodologies, with modifications as indicated.

Guidance for Greenhouse Gas Emissions Accounting at Logistics Sites[19]

- The Fraunhofer Institute for Material Flow and Logistics (IML) guidance provides detailed guidance on accounting for logistics sites.
- The method was developed jointly in collaboration with SFC and EcoTransIT, and informed this version of the Framework.

Guidance for Greenhouse Gas Emission Footprinting for Container Terminals[20]

- This Guidance was also developed in collaboration with SFC with the GLEC Framework in mind and is aligned in its principles.

Tips for Logistics Site Calculations

Shipment weight

Weights for logistics sites are calculated based on the cumulative annual weight of shipments leaving the center, i.e. outbound cargo. It may be useful to also track the number of tonnes requiring special treatment, such as requiring order picking or temperature control. This additional information allows companies to only allocate emissions caused by this special treatment to relevant goods.

Centers dealing primarily with containerized cargo may need to convert TEU to tonnes if shipment weights are not available. An average value of 10 tonnes per TEU can be used, but any additional information on weight can help to improve accuracy. For example, a port can adopt a site-specific average weight based on operational data.[20]

Default factors

Still a developing area, default factors for logistics sites have been historically difficult to come by. Furthermore, logistics sites are extremely diverse in their nature. Container terminals are clearly very different from warehouses, but even within each category of logistics sites there is diversity.[20] For example, some ports include warehouses, some warehouses include order picking, and so on.

Fraunhofer IML has advanced the understanding of average logistics site emission intensity values through extensive industry research and data collection.[42] This version of the Framework benefits from their research, offering a set of factors for refrigerated and ambient temperature warehouses and transhipment sites that are included in Module 1.

For these factors, fuel, electricity and refrigerants are already converted to CO_2e using European emission factors, thus it should be noted that regional variations in energy grid emissions cannot be tracked using these default factors.

Table 7. Additional information helpful to improve Scope 3 accuracy

Information on center	Information on activities
• Site type • Country/region • Grid factor	• Goods type(s) • Stock-keeping requirements (e.g. transhipment, with storage) • Temperature control (e.g. ambient, refrigerated) • Order requiring picking
Activity categories recommended for categorizing operator data	
• Stock-keeping requirements: transhipment or with storage • Site conditions: ambient and temperature control • Operations: order picking or without order picking	

Rail

Global Impact

In 2015, nearly 7% of freight tonne-kilometers were shipped by rail, resulting in the emissions of 336 million tonnes of CO_2, roughly 4% of transport sector emissions.[43] The majority of rail emissions come from China, 44%, while the US is the second biggest emitter, with 12% of global rail emissions.

While the electrification of rail lines has doubled in the last two decades, only 9% of rail transport is powered by renewable energy sources. The vast majority of freight transport by rail, 85%, relies on fossil fuels. That said, the emission intensity for freight shipped by rail has dropped by nearly one-third over the same time period.[43]

For non-electrified lines, diesel fuel is the standard energy source, although biofuels and LNG have increased their share.

Scope

Rail transport includes freight movement by a railway vehicle on a railway network between the place of loading and unloading.[37] Emissions for rail transport are those associated with the fuel and/or electricity used to move cargo under its own power (tractive vehicles) or hauled by another vehicle (coaches, railcar trailers, vans and wagons).

The GLEC Framework does not account for the embedded emissions from the production of the railway vehicle or the railway infrastructure, nor emissions from staff associated with railway operations. Emissions from rail terminals are classified as emissions from logistics sites.

Methodology

The GLEC Framework uses EcoTransIT World Methodology as the base methodology for rail transport, as recommended by the Union International de Chemins de Fer (UIC). In the US, the US EPA SmartWay Rail Carrier Tool and the information collected and published at federal level by the US Surface Transportation Board provide alternative sources of information in compatible format.

EcoTransIT World[44]

- EcoTransIT allows for emissions to be reported as both CO_2/CO_2e and TTW/WTW.
  - Be sure to use the values that include WTW and CO_2e
- Because electrification data can be difficult to find on a country level, EcoTransIT divides geographies by region in order to model the level of electrification vs diesel locomotives.

SmartWay Rail Carrier Tool[22]

- Carrier-specific CO_2e intensity factors are not available from SmartWay; however, an annual average value representing the emission intensity of North American rail companies is provided and may be useful for benchmarking.

Tips for Rail Transport Calculations

Locomotive

- The most important differentiator for rail transport is whether the locomotive uses electricity or diesel as its energy source.
- Information on train length (and hence unladen weight and capacity) can be helpful for improving accuracy.

Shipment weight

- Use actual or, if not available, estimated weight based on the mass of the cargo.

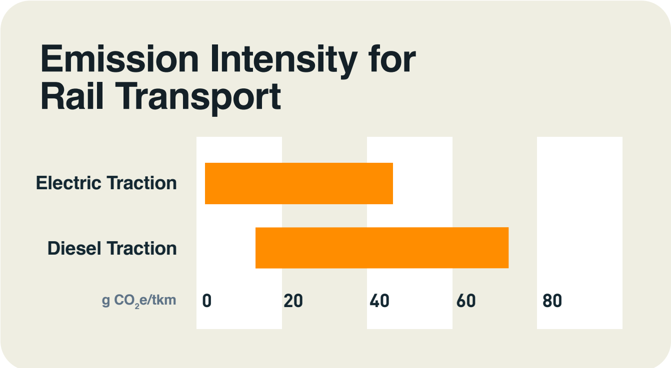


Figure 15. Examples of WTW emission intensity for rail transport, based on 2019 GLEC default factors.

Distance

- Distance should be calculated using actual rail network distance based on the start and end point of the journey.
- Rail distance can be difficult to find. Some rail carriers offer rail distance calculator to their customers. EcoTransIT's online tool can also be used to calculate rail distance at no cost.

Load factor

- Average load factors are not well-established for rail transport.
  - EcoTransIT estimates load factors based on net and gross tonne-kilometers (or revenue and non-revenue tonne-kilometers) for some cargo types, plus standard factors for wagon weights and payload capacity.[44]
  - SmartWay provides average railcar capacity data for North America.[22]

Default factors

- Limited information is available on locomotive fuel efficiency beyond Europe and North America at this time. The available information is factored into the default factors included in Module 2.
- Most US rail carriers provide an emissions calculator. Check the calculator's assumptions to be sure results align with the GLEC Framework.

Fuel type

- Diesel is the most common, and hence assumed, energy source in North America if actual conditions are unknown.
  - Other potential fuel types are electricity, diesel oils, LNG and biodiesel.
- The extent of electrification varies by region, being particularly common in mainland Europe, and can be difficult to determine if carrier data are not available.
  - Information on regional electrification can be found in RAILISA (RAIL Information System and Analyses) UIC Statistics for the rail sector.[45]
  - EcoTransIT models regional electrification values within its tool.[44]
- If the train is electrified, choose the appropriate emission factor for the original energy source (if known) and/or electricity grid factor.

Suggestions for Data Collection and Organization

Table 8. Additional information helpful to improve Scope 3 accuracy

Information on locomotive and wagons	Information on activities
• Train size • Engine class • UIC class • Share of diesel, electric or biofuel use	• Direct or hub network • Topography • Cargo type (primarily cargo density) • Temperature control equipment
Transport service categories recommended for categorizing carrier data	
• Cargo type: bulk, containers, pallets, mass-limited cargo and volume-limited cargo • Cargo density: light, medium or heavy • Journey type: domestic or international	

Road

Global Impact

In terms of global transport emissions, the road sector is by far the biggest emitter, with passenger and freight road transport contributing nearly three-quarters of overall transport emissions.[3] Freight transport by road is expected to grow in the coming years, and the majority of the growth will come from non-OECD countries.

This is significant in terms of emissions, where many older trucks remain on the road, and new vehicle technologies are more slowly adopted.[46] The vast majority of road freight transport is powered by diesel, though a widespread transition to electrified road transport is considered as essential to meet global climate targets.[47] Electrification of short-distance transport is becoming a viable option, whereas electrified long-distance transport is far from adoption at scale.

Efficiency measures show great promise for reducing emissions from road transport. Optimized fleet assignments, routing and efficient driving provide powerful levers to improve fuel efficiency.[47] Collaboration with supply chain partners can increase efficiency further through optimized ordering patterns and consolidated loads.

The road freight sector is highly fragmented; most road carriers have fewer than five trucks. Multinational shippers and LSPs may need to contract with hundreds, even thousands, of road carriers in order to meet their global logistics needs. This makes data collection especially cumbersome, though green freight programs can help to streamline the process; US EPA SmartWay, for example, collects and shares emissions data on thousands of North American road carriers, which can be used with the GLEC Framework.

Scope

Road transport refers to any freight moved using a road vehicle over a road network between a place of loading and unloading. Road vehicles are any vehicles for use on roads.[37]

Road emissions under the GLEC Framework pertain only to the fuel and/or electricity used to operate road freight vehicles and their on-board systems (e.g. for cooling). The emissions related to the production of road vehicles, logistics sites or road infrastructure are not included.

Methodology

Two methodologies have been selected as the basis for road sector calculations: EN 16258 and US EPA's SmartWay Truck Carrier Tool.

EN 16258[23]

- Both TTW and WTW emissions are calculated; be sure to use the values expressed on a WTW basis.
- Actual, SFD, planned and GCD distance measurements are all permitted under EN16258. For implementation of the GLEC Framework, the use of planned distance is recommended as a consistent approach across both Scopes 1 and 3.

SmartWay Truck Carrier Tool[24]

- SmartWay emission results are expressed as TTW, CO_2; therefore, the WTT emissions must be added and the result must be scaled to a CO_2e basis for alignment with the GLEC Framework.
- Carrier data are reported as the average CO_2/ton-mile for the carrier's fleet. Carrier emission factors can be used to calculate Scope 3 emissions with the proper conversions.
- Carrier data are reported in SmartWay using actual distance. See the tips below for information on converting actual to planned distance.

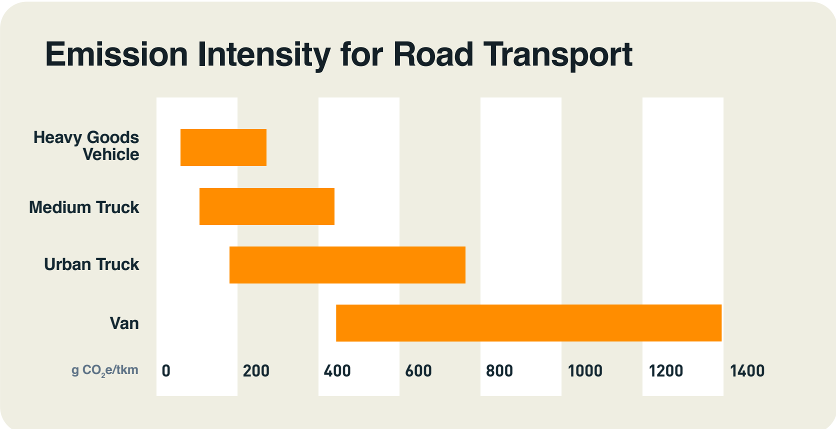


Figure 16. Examples of WTW emission intensity values for different types of EU road vehicles, based on 2019 GLEC default factors.

Tips for Road Transport Calculations

Shipment weight

- Take actual or, if not available, estimated weight based on the mass of the cargo.

Distance

- As already noted vehicle operators are the only actors in the transport chain who know the actual distance traveled. As a result planned distance is recommended for road transport.
- To avoid a systematic error between the approach to distance calculation used by vehicle operators and their customers the following factors derived from studies of operational data are recommended:
  - Actual and planned distances can be aligned using a +5% adjustment to the planned distance, which allows for minor, routine deviations from the planned route (e.g. diversions, congestion, deviation to rest points etc.).[48]
  - If a carrier routinely takes a significant deviation compared to the planned distance, for example to avoid construction, toll or mountain range, then this should be declared to the customer so that they can make a corresponding adjustment to the distance in the Scope 3 calculation. If there is a known difference but the amount is not communicated, use a +30% adjustment to the planned distance.[48]

Default factors

- Defaults factors for various types of trucks are included in Module 2.
- Standard values for empty running and load factor are embedded within the default factors.
- If the load factor is known to be different to those incorporated within the default factors, companies either need to work with the carrier to obtain a fuel efficiency or CO_2e intensity factor that represents the load factor, or model these data using a calculation tool.

Fuel type

- Diesel is the assumed fuel type for the majority of road freight transport.
- Other potential fuel types include gasoline, electricity, hydrogen, other diesel oils, CNG, LNG and biodiesel.

Collection and delivery rounds.

- For collection and delivery rounds, the total fuel and emissions should be allocated to each consignment, according to its share of the transport activity (tonne-kilometer) between the individual loading and unloading points.
- Calculations can be streamlined by using GCD or SFD as a measure of each consignment's distance, as set out in section 8.3.3.3 of the EN16258 standard and the accompanying guidance published by Clecat/DSLV.[23,49]
- For mail and parcels services, where delivery tracking is not possible, then these emissions can be allocated per item. This choice should be clearly documented.
- More information is available in Module 4 and the associated example calculation.

Suggestions for Data Collection and Organization

Table 9. Additional information helpful to improve Scope 3 accuracy

Information on vehicles	Information on activities
• Weight class • Engine class • Volume • Year • Fuel type	• Topography • Road type (urban vs rural) • Long distance vs short haul • Traffic conditions • Regular deviations from planned distance
Transport service categories recommended for categorizing carrier data	
• Cargo type: mail and parcel, bulk, containers, pallets, mass-limited cargo and volume-limited cargo • Condition: ambient or temperature controlled • Journey type: point-to-point (long haul) or multiple collection and delivery • Contract type: shared or dedicated transport	

Sea

Global Impact

Sea transport is a large and growing area of transport. Over half of global tonne-kilometers are carried by the maritime sector, with over 50,000 cargo ships in operation.[37,50] As of 2017, sea transport contributed 30% of logistics sector emissions and roughly 2–3% of global CO_2.[51,52]

International shipments comprise the vast majority of maritime emissions.[52,53] Container ships accounted for the majority of CO_2 emissions in 2012, followed by bulk carriers and oil tankers. Economies of scale lead to a relatively low emission intensity.[1]

Black carbon emissions from sea transport are a particular concern, largely due to the higher levels of particulate matter emissions associated with traditional high-sulfur heavy fuel oils.[54] While low-sulfur fuel regulations will help to address this, black carbon remains a particular concern for ocean shipping, particularly near populated areas and in the Arctic and South Asia, where black carbon can increase the melting rate of ice and glaciers.[55,56]

The IMO announced its plans to improve shipping efficiency by 50% relative to 2008 emissions by 2050, although the mechanism to achieve these reductions has not been presented in detail.[57] Electric, hydrogen fuel cell, ammonia and biofuel technologies could, over time, supplant heavy fuel oil engines, though the cost of these innovations may slow adoption.[39] Electrified long-distance shipping faces the additional challenge of finding a battery technology with energy density suitable for a ship's dimensions.

Operational practices like slow-steaming show promise for emission reduction. However, this promise needs to be reflected in commercial activities to be sure emissions are systematically reduced. For example, the IMO cautions that, while individual vessels may show improvement in efficiency, slow-steaming necessitates more ships to be in operation to satisfy demand at a slower pace.[52] This could inadvertently cancel out some of the expected emission reduction when scaling from vessel to overall fleet level.

Scope

Sea transport is the movement of goods on seagoing vessels either wholly or partly at sea.[37] Seagoing vessels include floating marine structures with one or more surface displacement hulls, such as cargo ships, tankers, Ro-Ro ships and container ships.

All fuel consumed at sea and in port are captured in emissions accounting, including empty backhauls and repositioning. This includes main and auxiliary engines, as well as fuel use for reefers, boilers and incinerators.[18] Generally, shore power is included under logistics sites unless otherwise arranged by a shipping company. Beyond fuel burn, emissions related to refrigerant and air conditioning gases should also be captured.

Methodology

The GLEC Framework aligns with following methodologies, with modifications as indicated.

IMO Energy Operational Index[18]

- The IMO covers all forms of maritime transport and cargo, and provides default factors for various ships and fuels.
- Additional detailed guidance on maritime carbon accounting can be found in the IMO's Third GHG Study.[52] IMO values must be scaled from CO_2 to CO_2e.
- IMO does not specify fuel life cycle. Determine whether WTW emissions were captured in the calculations and add WTT emissions where necessary.

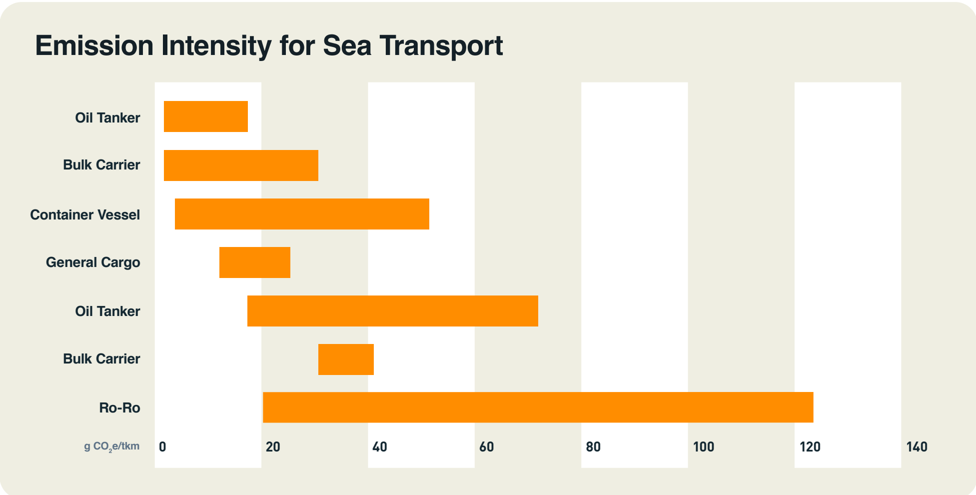


Figure 17. Examples of WTW emission intensity values for different types of oceangoing vessels, based on 2019 GLEC default factors.

Clean Cargo Working Group (CCWG) CO_2 Methodology

The CCWG is a member of the GLEC and has participated in the development of this Framework.

- At time of writing, CCWG covers only container ships though additional guidance may be offered.
- CCWG offers an open source set of industry average emission factors for maritime container transport per trade lane that are updated annually; operator-specific data per trade lane are available to CCWG members.
- CCWG emission results are expressed as TTW, CO_2; therefore, the WTT emissions must be added and the result must be scaled to CO_2e for alignment with the GLEC Framework.
- Specific guidance on calculating reefer energy consumption has been developed by CCWG and is used in the calculation of their reefer default factors.

Tips for Sea Transport Calculations

Vessel

There is a unique opportunity in sea transport to improve the accuracy of emission estimates by finding more specific vessel information. Unlike the fragmented road sector, where millions of trucks carry goods, ships are well-catalogued and public information on each vessel is available via the IMO's Global Integrated Shipping Information System.

While still a growing area, advances in digitization and data sharing within the supply chain create more visibility on the actual vessel used to carry freight. This holds the potential to improve transparency in the supply chain and could build towards improved supply chain planning for shippers and LSPs.

Refined vessel values based on carrier and/or vessel specific information will be key for tracking progress towards emissions reduction goals in the maritime sector – if a company is investing more advanced shipping technology or using low sulfur fuels and slow-steaming practices, you want your numbers to reflect it. Rightship and Clean Shipping Index provide specific vessel information and offer a diverse set of environmental data, and CCWG offers carrier-specific data for subscribing members.

Shipment weight

For containerized transport, the twenty-foot equivalent unit (TEU) is a common unit used instead of mass or weight. For example, CCWG trade lane emission intensity values are expressed as CO_2 per TEU. Conversion from TEU to tonnes is possible.

If the actual cargo weight per container is not known, EcoTransIT, CCWG and SFC have agreed to use a standard approach to average net weights for different cargo types, as shown in Appendix 4.[18,44]

- For a 40' standard container, the TEU values are multiplied by 2.
- 40' high cube containers are multiplied by 2.25.

Distance

- Actual distance can be found in ship log books, though is likely higher than SFD due to stops at intermediary ports, deviations due to weather, and other unpredictable factors.
- SFD can be estimated using online port-to-port calculators or via the Centre d'Études et de Recherches sur le Dévelopment International (CERDI) Sea Distance Database.[58]
- CCWG requires a distance adjustment factor for container ships: SFD + 15%. This factor must be used for Scope 3 calculations in cases where actual distance is not available. More research is needed to understand distance deviation for other ship types.
- Convert nautical miles to kilometers using factors in Appendix 4: Unit Conversions.

Load factor

- The CCWG trade lane factors are calculated on the basis of a fully loaded ship.
- CCWG has calculated the average utilization of container ships to be 70%, and recommends a corresponding load factor adjustment for Scope 3 calculations: dividing the CCWG trade lane factor by 70%. [59]
  - See section 3.7 of the CCWG methodology for an example calculation.

Default factors

- For non-containerized ships, generic default factors based on vessel size are included in Module 2 for bulk, general cargo, tankers and Ro-Ro vessels.
- For containerized transport, default values derived from the CCWG trade lane values are included in Module 2.
  - The GLEC default values incorporate the distance and load factor adjustments recommended in the CCWG methodology report.

Fuel Type

- Heavy fuel oil is currently assumed to be the standard fuel type; this may change as new technologies and regulations come online.
  - Other potential fuel types include marine diesel oil, LNG, electricity and biodiesel.

Suggestions for Data Collection and Organization

Table 10. Additional information helpful to improve Scope 3 accuracy

Information on ships	Information on activities
• Ship type • Vessel name/IMO number • Fuel type (including sulfur level) • Deadweight tonnage • Ship capacity	• Cargo type • Trade lane • Load factor • Speed • Fuel use + fuel split if operating within Sulphur Emissions Control Areas
Transport service categories recommended for categorizing carrier data	
• Cargo type: Bulk, container, pallets, mass-limited cargo, volume-limited cargo • Condition: ambient or temperature-control • Journey type: trade lane or other route • Contract type: shared or dedicated	

Section 2

Using Emissions Results

Section 2 Using Emissions Results

Chapter 4 Reporting Emissions

Chapter 5 Beyond Reporting

Chapter 4

Reporting Emissions

- Reporting: the Basics
- The GLEC Declaration
- Reporting Example
- Guidance for CDP

Reporting: the Basics

It's time to finalize emissions values and analyze the results. To help with this, emissions should be reported using two KPIs in conjunction with each other:

- A total emissions value, which shows the scale of the overall impact, and
- An emission intensity value, which links the emission to the transport activity or amount of product shifted.

The emissions can be reported at many different levels. Initial expectation is for annual emissions for a company or individual transport service, although further disaggregation, such as for a particular carrier, activity, vehicle or country, may be helpful for specific reporting or decision-making needs.

Each KPI is useful for reporting, goal setting and reduction tracking, but they work best when taken together.

Total emissions

Total emissions are important for reporting and tracking a company's overall emissions from year to year. Total, or absolute, emissions, are often expressed as kg or tonnes CO_2e per year, and listed separately by Scope.

	Low total emissions	High Total emissions
Low intensity	Low priority	Medium priority
High Intensity	Medium priority	High priority (emission hotspot)

Scope 1 + Scope 2 + Scope 3 = Total emissions

These figures are suitable for annual reports, CDP disclosure and other accounting platforms. More information on reporting, including the GLEC Declaration, is provided below.

It should be noted that, while carbon offsets may be purchased as part of a company's overall corporate social responsibility (CSR) strategy, they should not be deducted from a company's reported total emissions.

Emission Intensity

There is a need for a step change reduction in emission intensity if the sector is to deliver emissions reductions in line with those required by the Paris Agreement. Emissions data can be divided into emission intensity metrics, providing a numerical value to track, analyze and strategize emissions reduction. It also provides a pathway for companies to showcase efficiency in the face of business growth; for example, an expanding business might increase in total emissions while reducing emission intensity.

Reporting a tonne-kilometer-based emission intensity KPI alongside total emissions is the best way to see if this is being achieved. Intensity factors provide a numerical basis for carriers to communicate to customers and stakeholders their progress towards meeting emissions reduction targets over time. For example, if an operator invests in new electric trucks or consolidates its shipments to reduce partial loads, the fuel efficiency will go up and the CO_2e intensity factor will go down.

Results calculated using the GLEC Framework are intended to facilitate reporting, target-setting and emissions reduction strategies. This section shows the most common reporting needs, including 1) generic reporting options following the GLEC Declaration, and 2) specific guidance for CDP reporting.

Table 11. An array of metrics that can be used for further analysis of emissions results

Total Emissions	Emission intensity
kg CO_2e	**kg CO_2e per tonne-kilometer**
The total emissions over a period of time, typically one year.	Emissions divided by the logistics activity, or tonne-kilometer. Emission intensity is often reported to customers based on the total annual emissions. Emission intensity values can also be calculated for an individual customer, service type, mode, country, etc.
	Other helpful emission intensity metrics include: kg CO_2e per TEU-kilometer, tonne, kilometer, TEU, shipment, item, revenue, TEU/tonne throughput, container lifts, etc.

The GLEC Declaration

The GLEC Declaration was designed to harmonize and add transparency to the reporting process. The Declaration aims to streamline emissions reporting by increasing consistency in the information buyers request and sellers provide. This guidance covers typical freight transportation arrangements; different situations may require other types of data.

The GLEC Declaration includes two main parts:

1. A general section containing:
   - Information on the company and its activities. Brief company description, like what is on websites, e.g. mission, size, geographic coverage, services.
   - Logistics information. Brief description of how freight and logistics are organized, e.g. type of freight (bulk shipping, road, etc.) and whether transport is owned or outsourced.
   - Commitment. Brief statement of commitment to disclosure of logistics emissions in a consistent andaccurate manner aiming to make use of credible and appropriate input data from different sources.
2. Declaration of emissions data and supporting information tailored to the primary audience, which has two possibilities:
   - Business to Business (B2B), customer reporting, where the emissions reported pertain to the service provided to a specific customer, i.e. tied to a contract and associated invoice.
   - Reporting to external stakeholders, where the scope of reporting focuses on the total annual emissions and average emission intensity (e.g. in CSR or annual reports, to governments, carbon reporting initiatives such as CDP, GRI, etc.).

More detailed information on the two audiences is provided in the following sections.

A. GLEC B2B Declaration

The GLEC B2B Declaration, shown in Table 12, lays out the minimum level of information that carriers should declare to their customers, as well as an example of additional information that could be provided as a result of bilateral agreement with the customer.

Note that total emissions and tonne-kilometer data should be separated by mode. This enables customers to consider modal switch as an emission reduction strategy.

Statement of 'input data sources' provides an element of transparency as to the data sources used to calculate the reported values. Description of the data categories are provided in the early stages of Chapter 1. As the importance of understanding the basis of reported emissions increases scrutiny of the data sources used is expected to increase.

The system boundaries that determine the likely coverage of reporting at different points of the logistics chain are shown in Table 13.

B. GLEC Declaration to External Stakeholders

Stakeholder reporting typically covers the annual total of logistics emissions or annual average emission intensity for Scopes 1, 2 and 3. This type of reporting is recommended for companies with logistics emissions of 5% or more of their total carbon footprint.

Table 12. GLEC B2B Declaration

	Minimum Level of Declaration	Other Potentially Useful Information
Coverage of reporting	Total service provided to customer*	Shipment level, individual transport service, trade lane, business unit, geography, product...
Year	Reporting year	Multi-year overviews, quarterly reports, ...
Units of measurement	Total GHG emissions Tonne-km GHG emissions per tonne-km	Additional intensity factors, such as emissions per tonne, TEU, pallets, service units (if/as appropriate).
Emissions basis	WTW	Split into WTT & TTW
Scope 1, 2, 3	Total figure across all Scopes	Breakdown into individual Scopes
Reporting by mode	Customer specific: breakdown of total GHG emissions, total tonne-km and emission intensity (GHG/tonne-km) by main modes (air, sea, road, inland waterways (IWW) and rail)**	Inclusion of warehouses/logistics sites, especially if material Separate main carriage from pre-/on-carriage and provide modal breakdown of pre- and on-carriage
Input data sources (for each mode)	Identify and state main data type for each mode reported	Breakdown of data sources by mode and data category, based on tonne-kilometers: % primary data, % data from carrier programs, % modeled data, % default factor-based
Data verification	Statement whether or not input data has been independently assured	

* In this cell, the scope of reporting should be clarified. A full description of the transport service within the 'reporting system boundaries' should be provided to a B2B customer (see separate explanation). Example: 'All transport [performed for the B2B customer] including/excluding warehouses/logistics sites and pre-/on-carriage emissions'.

** Figure for each mode may include both main carriage and pre-/on-carriage irrespective of overall mode-composition (e.g. road – sea – rail – road where the sea leg dominates could be classed as 'sea' under minimum reporting).

Table 13. Considerations for a B2B GLEC Declaration for different business models.

Reporting company (service provider)	Recipient (customer)	Level of reporting	Reporting system boundaries	Details visible to the customer (minimum) per service
Carrier (or logistics site operator)	Shipper, LSP	Transport service level	• Paid (i.e. Scope 3 upstream) transport services. • Transport chain element(s) provided by the carrier. • To include pre-/on-carriage (and logistics site emissions) in case this is provided by the same carrier (or logistics site operator).	• (Shipment details) • Main transport mode • Transport activity (tonne-km) • Total of Scope 1, 2 and 3 GHG emission on WTW basis • GHG intensity (total GHGs/t-km)
LSP (or 4th party logistics service provider (4PL))	Shipper, LSP	Integrated (logistics) service level	• Paid (i.e. Scope 3 upstream) transport services. • Transport chain elements integrated into the LSP service. • To include pre-/on-carriage (and logistics site emissions)	• (Shipment details) • Main transport mode • Transport activity (tonne-km) • Total of Scope 1, 2 and 3 GHG emission on WTW basis • GHG intensity (total GHGs/t-km)

Table 14. GLEC Declaration for External Stakeholders

	Minimum Level of Declaration	Best Practice under 'Smart Freight Leadership'
Coverage of reporting	Single company figure	Disaggregated as appropriate, e.g. by: business unit, geography, subsidiary
Year	Reporting year	Past year(s)
Unit of measurement	Total GHG emissions	Emission intensity: • For the LSP or carrier: GHG per tonne-km for each mode • For shippers: GHG per tonne (or suitable unit of production)
Emissions basis	WTW	Breakdown WTT & TTW at a global level
Scope 1, 2, 3	Breakdown by Scopes 1, 2 and 3	As minimum
Reporting by mode	Split by modes/nodes that are used by the company (i.e.: air, sea, IWW, road, rail, logistics sites)	As minimum
Coverage	% coverage*	As minimum
Input data sources (for each mode)	Identify and state main data type for each mode reported	Breakdown of data sources by mode and data category • % primary data, • % data from carrier programs, • % modeled data, % default factor-based
Data verification	Statement whether input data has been independently assured	Confirmation that input data has been independently assured

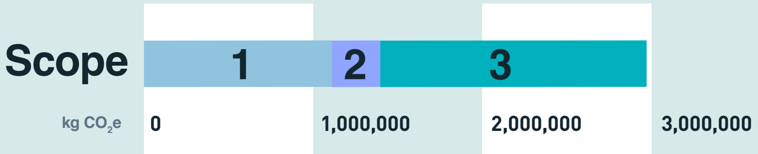
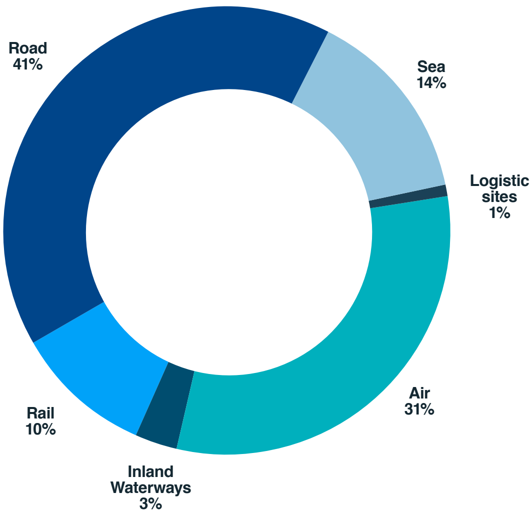
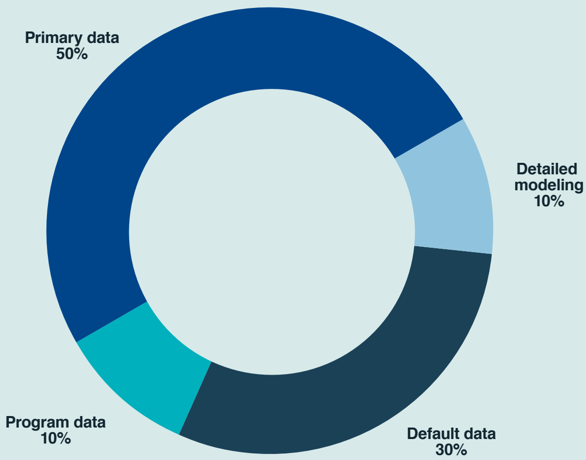
* % of the total corporate supply chain tonne-km included in the total reported emissions figure.

* % by tonne-km

Examples of how to report following the GLEC Declaration are included in the next section and as part of the sample problems in Appendix 5.

Example of Reporting using the GLEC Declaration

For reporting platforms that are open-ended, such as an annual CSR report, an example of information that may be useful for reporting is shown as follows:

Table 15. Sample CSR Report	
Total emissions	2,682,500 kg CO_2e
Emission intensity	0.05 kg CO_2e/tonne-kilometer
CO_2e emissions by Scope Scope 1: 1,002,500 Scope 2: 250,000 Scope 3: 1,430,000	
Share of emissions from each mode or node	
Input data types	Main data type: actual data. Break down as follows 
Supply Chain Coverage	Emissions from 93% of the total tonnes shipped are covered in this report. Exclusions are for a small-scale joint venture where operational control is unclear and a new business unit in Africa.
Data verification statement	Only container shipping data and modeled data (40% of total) have been independently verified by a third party, in each case via the program tool's processes.

Guidance for CDP Reporting

- This is information specific to responding to the CDP questionnaire.
- Guidance is provided for considering transport in Scopes 1, 2 and all categories of Scope 3.

CDP is the primary reporting platform for corporate carbon emissions. In 2018, CDP released guidance on creating transportation emission intensity metrics, referencing the GLEC Framework as the baseline methodology for logistics emissions calculations.[60] Alignment of the GLEC Framework with CDP streamlines reporting and enables greater transparency between supply chain partners.

For many companies, reporting transport emissions is either a new or an evolving strategy. If underlying data or methods change significantly, the Greenhouse Gas Protocol allows for the recalculation of baseline emissions in order to reflect the new information.

Recommendations for reporting your company's transport emissions according to the CDP questionnaire are as follows.

Scope 1. Include the TTW emissions from fuels burned in the reporting company's owned and operated vehicles and logistics sites, ideally subtotaled for each type.

Scope 2. Include the WTT emissions from electricity purchased for Scope 1, ideally subtotaled for each transport mode and for logistics sites.

Scope 3. Scope 3 is divided into multiple categories, many of which can include transportation.[26] More information on how to consider transportation emissions in each category is described below.

- **Category 1: Purchased goods and services.** This includes WTW emissions from transportation embedded in goods and services purchased by the reporting company. These are cradle-to-gate emissions only; transportation from the supplier to the reporting company is included in Category 4.
- **Category 2: Capital goods.** Similar to Category 1, this category contains WTW emissions for transport embedded to capital goods purchased by the reporting company.
- **Category 3: Fuel- and energy-related emissions (not included in Scope 1 or 2).** Emissions related to the production and distribution of fuels (WTT) burned in Scope 1 are included here.
- **Category 4: Upstream transportation and distribution.** This category covers WTW emissions from outsourced logistics services used to transport or distribute products from tier 1 suppliers to company facilities, or transport between the company's own facilities. These are generally services paid for by the reporting company.
- **Category 5: Waste generated in operation.** This category includes WTW emissions related to logistics activities used in the disposal and treatment of waste from a company's waste generated in Scope 1 activities.
- **Category 6. Business travel.** While transportation is central to this category, it is pertaining to the movement of people, not freight. While still important, it is not covered by the GLEC Framework.
- **Category 7. Employee commuting.** Same as for Category 6.
- **Category 8: Upstream leased assets.** WTW emissions, from facilities or vehicles leased from the reporting company, e.g., where the reporting company is the lessee, are included here.
- **Category 9: Downstream transportation and distribution.** This category contains WTW emissions from transportation and distribution of goods from the reporting company and the end customer. In general, these are logistics services not paid for by reporting company.
- **Category 10: Processing of sold products.** WTW emissions resulting from the transport and distribution of sold products, e.g. by a stakeholder in the downstream value chain, are covered here.
- **Category 11. Use of sold products.** These include the lifetime transport emissions from the use phase of sold products. This may be particularly relevant for transport equipment manufacturers.
- **Category 12. End of life treatment for sold products.** Particularly important for the circular economy, transportation emissions from the disposal or treatment of a sold product are included here.
- **Category 13. Downstream leased assets.** WTW emissions from facilities or vehicles leased by the reporting company are included in this category.
- **Category 14. Franchises.** WTW emissions related to transportation by franchises should be considered here.
- **Category 15. Investments.** WTW logistics emissions from investments made by the reporting company should be tallied here.

Other relevant questions in the Scope 3 questionnaire include the following:

- **Evaluation status.** Determine the relevance of each category's emissions based on criteria noted in the Greenhouse Gas Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard, such as:
  - *Size of impact.* Use the GLEC Framework default factors to conduct a high-level assessment of supply chain transport required to distribute products, looking for hotspots by mode and region.
  - *Potential to influence reduction.* Examine the potential to collaborate with suppliers around emissions reduction, particularly in the identified hotspots.

  - *Demand by stakeholders.* Supply chain partners, investors and consumers are increasingly asking for transparency on environmental and social impacts on consumers and the general public, such as air quality and climate impacts from freight transport in urban areas.
  - *Risk.* Evaluate potential regulations or brand-related risks from supply chain transport emissions.
- **Emissions calculation methodology.** Let everyone know you used the GLEC Framework by listing it as the method used to calculate your freight transportation emissions.
- **Percentage of emissions calculated using data obtained from suppliers or value chain partners.** Use the guidance related to input data from the GLEC Declaration to determine percentages.
- **Explanation.** Additional useful information could be included in the explanation section, such as:
  - GLEC Framework data type
  - Sources of default data used
  - Notes on terminology, calculations, etc.

Chapter 5
Beyond Reporting

- Set Targets
- Use Carbon as a KPI
- Develop Reduction Plan
- Leverage Sales and Procurement
- Advocate for Policy

You've put in the effort to calculate and report emissions, and gained insight into emission hotspots from your freight activities; so now what?

While this document focuses on methodology, the overarching goal of this Framework is to support the logistics sector in making a stronger contribution to staying within Paris Agreement targets and to achieving Sustainable Development Goals.

Results from emissions calculations and reporting using the GLEC Framework can inform business decisions and actions that lead to emission reductions. Some suggestions follow on how to use results relate to targets, KPIs, reduction plan and policy and sector commitments.

Set Targets

More than 500 companies committed to setting ambitious emission reduction targets through the Science-Based Targets initiative (SBTi). However, many fewer include freight and logistics in their targets. The SBTi guidance for the transport sector includes freight transportation and is consistent with the GLEC Framework.[61]

A recommended first step is to use your collected data to establish a baseline and set targets in line with the Paris Agreement targets of staying within 1.5–2 degrees global warming. Develop goals based on both total emissions and emission intensity. This way, each stakeholder along the supply chain can understand their share of the transport decarbonization puzzle. Establish concrete targets not only for 2050, but also for the next 5, 10 or 15 years, so that it becomes easier to check if your company is on track.

Use Carbon as a KPI

Emission reduction targets should be supported by strong corporate policies favoring low carbon freight and logistics and KPIs at every level of the organization. With good emissions data, you can use carbon emissions as a KPI to:

- Track progress of emissions over time and against targets, and steer the management of emissions pro-actively
- Identify hot spots in your freight activities where efficiency improvements are most needed or where low-hanging fruit for emissions reduction projects exist
- Hold logistics and operations directors accountable, by using carbon emissions as a KPI alongside cost, quality, timeliness, etc. in order to understand the climate implications of new technologies, shipping routes, carriers and other metrics, or to decide upon emissions reduction strategies, carbon offsets and other mitigation measures
- Compare yourself to others and determine where you can do better, share your experiences with others, or turn your efficiencies into something marketable
- Prepare for a low-carbon world by applying a fictive price or price range to emissions and use the carbon price as a parallel KPI in decision-making.

Develop a Reduction Plan

Reliable emissions data are the basis for a sound reduction plan as they help to:

- Prioritize hot spots in your freight activities where both emissions and opportunities to reduce them are most significant
- Assess the emissions impact of solutions before and after implementation
- Determine if selected solutions collectively are sufficient to achieve corporate reduction targets.

Professor Alan McKinnon identified five solution areas covering freight demand, freight transport modes, asset utilization, fleet energy efficiency and carbon content of energy.[62] What solutions companies can implement or influence depends on whether you are a buyer or supplier of freight services, or both.

Reduce Freight Transport Demand	Optimize Freight Transport Modes	Increase Assets Utilization	Improve Fleet Energy Efficiency	Reduce Carbon Content of Energy
Supply chain restucturing	Modal shift	Load optimization	Cleaner and efficient technologies	Cleaner and lower carbon fuels
Standardized modules/ boxes	Multi-modal optimization	Load consolidation	Efficient vehicles and vessels	Electrification
3D printing	Synchromodality	Logistics centers and warehouse management	Driving behavior	Fuel management
Dematerialization			Fleet operation	
Consumer behavior			Fleet maintenance	

Figure 18.

Leverage Sales and Procurement

Two important business mechanisms to leverage carbon reduction, and where reliable emissions data are essential, are sales and procurement.

- **Sales.** If your company is making sustainable investments like electric vehicles, driver training, fuel-efficient routing, this information can be used to drive brand value as a sustainable transport provider. Emission intensity KPIs, such as CO_2e per tonne-kilometer, provide customers with qualitative information that allows your investments to be showcased and celebrated. This information, in turn, can be used as a KPI in logistics planning activities, such as choice of transport modes, routes or vehicle.
- **Procurement.** Perhaps the most powerful motivator for carriers and LSPs is the demand for carbon emissions reduction from customers. The Smart Freight Procurement Guidelines document provides practical guidance on how to integrate climate into freight transport and logistics procurement practices.[63] The Guidelines suggest several actions to reduce GHG emissions that can be undertaken in the various procurement phases – i.e. planning, tendering, contracting and contract-based supplier management – with subcontracted transport chain operators like freight forwarders, carriers and LSPs.

Advocate for Policy

A main driver for companies to take charge of logistics emissions is to avoid governments imposing mandatory requirements. Companies can use results from emissions calculations to demonstrate that reduction efforts are successful. This is best done through voluntary reporting schemes or green freight programs. US EPA SmartWay, ObjectifCO_2 in France, and Low Emissions Reduction Scheme in the United Kingdom are some examples.

A second use of emission data is to inform the development of national climate plans. Countries implementing the Paris Accords are responsible for developing and implementing an emissions reduction plan in order to collectively reach 2050 global temperature goals: ‹ 1.5–2 degree warming from pre-industrial times. As of 2016, freight transportation had been left out of all but 13% of nationally determined contributions (NDCs).[64] Of those that did include freight transport, none included international modes of transport, sea and air, which fall to international bodies to regulate.

There is a great potential to leverage industry's expertise and data on logistics emissions in order to enable more countries, regions and municipalities to better understand and reduce their logistics emissions. Through the sharing of data and aligning best practices with the principles of the GLEC Framework and GLEC Declaration, governments and industry can work together to track and meet 2050 climate goals. An example is the proposed Climate Accord of The Netherlands that covers all sectors, including mobility, and proposes measures for urban and long-distance freight. Interestingly, one policy option mentioned is to create market incentives via a certification system that allows companies to prove they have reduced the GHG emissions from freight transportation. It recommends testing this using the updated GLEC Framework and, if results are good, that this be rolled out via an international ISO standard.

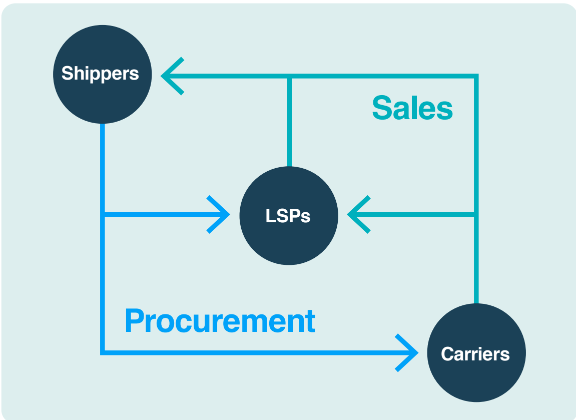


Figure 19. Sales and procurement are powerful levers for collaborative emissions reduction.

Conclusion

The Path towards Global Uptake

Conclusion

The Path towards Global Uptake

- Data Exchange
- Programs and Tools
- Sustainability Initiatives
- ISO Standard
- Policy
- Research

Companies can take three steps on the road to zero-emissions freight: report, reduce and collaborate. The GLEC Framework is the first step as it standardizes how to calculate and report emissions. We see a future where companies across all sectors calculate and report their logistics emissions. Improved access to reliable data will help both business and governments make better decisions to collectively reach climate goals.

To get there, improved data exchange and supportive programs, tools, initiatives, standards, policy and research are key.

Data Exchange

Access to good quality, preferably independently verified, data is a condition for transport operators and their customers to maximize the impact of applying the GLEC Framework. Data collection and sharing initiatives exist, such as the CCWG and SmartWay. Further efforts are needed for transport operators, particularly in the road freight sector, their customers, information technology system providers, and operators of energy efficiency and emissions data platforms to:

- Harmonize the approach to the collection of the data necessary for comprehensive and meaningful freight emissions KPIs.
- Develop consistent formats to enable data sharing between an interoperable network of platforms.
- Incorporate consistent reporting of carbon emissions, and hence the development and implementation of a widespread carbon emissions reduction strategy.

We are already in a world of big data, and with digital technologies that coordinate the complex movement of millions of tonnes of goods each day, the data are only going to get bigger. Digitization brings with it new opportunities for coordination that can be capitalized upon to collect and share the data needed to use the GLEC Framework on a global scale. Together, we can build systems that are more efficient, standardized, predictable and integrated.

Programs and Tools

The GLEC Framework is a methodology, and not a calculation tool or program. Some companies calculate emissions themselves but others make use of external calculation tools, either provided commercially or as part of Green Freight Programs.

Understanding the core characteristics of logistics emissions calculation tools available on the market helps companies to decide which of these tools best suit their needs.[65]

Green freight programs promote sustainability within the logistics sector, often by engaging both the transport supplier and buyer.[66] These programs provide a pathway for industry to collaborate, share data and benchmark performance. Incentives such as awards, ratings and labels draw attention to good performance, encouraging reluctant companies to further invest in sustainability. Programs that include emissions reporting either have their own tools, such as SmartWay, or prescribe a methodology for member companies to use, such as Green Freight Asia.

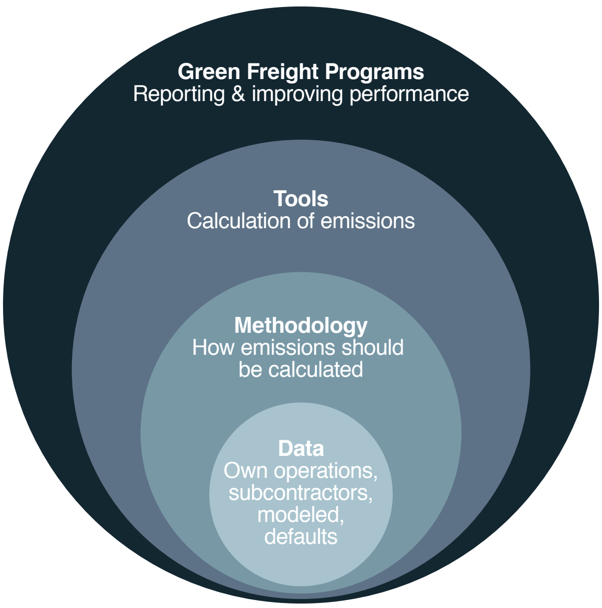


Figure 20. Data, methods, tools, and green freight programs work together to support emissions reduction.

Companies and others who make use of external tools or programs should check with their providers whether their methodology is in conformance with the GLEC Framework. Those that are in conformance can be recognized though a Smart Freight Centre accreditation label.

Sustainability Initiatives

An effective way to realize widespread uptake of the GLEC Framework is through climate and sustainability initiatives that reach beyond the freight sector.

The CDP already recommends using the GLEC Framework for companies that report logistics emissions to the scheme.[67] It is also the basis of the Science-Based Targets initiative's guidance for the transport sector, allowing companies to include logistics in their corporate targets.[61] The GLEC Framework is one of the actions of the Global Green Freight Action Plan, which is a transport initiative under the Marrakech Partnership for Global Climate Action of the United Nations Framework Convention on Climate Change.[68] All initiatives with a climate or sustainability focus, including socially responsible investment funds, are encouraged to follow suit.

The freight sector is not in control of its own destiny but merely responds to market demand. For that reason, mainstreaming the inclusion of logistics emissions in general and the GLEC Framework in particular into sectoral sustainability initiatives is key. The electronics sector is leading the charge through inclusion of the GLEC Framework in the Electronic Product Environmental Assessment Tool (EPEAT) standards of the Green Electronics Council.[69] Similarly, it has been incorporated in guidance for container port terminals.[20] The fashion sector has committed to 30% GHG emission reductions by 2030, and explicitly includes logistics – the logistics working group is coordinated by Business for Social Responsibility (BSR) and Smart Freight Centre.[70] Ideally, product labels, such as for cotton, food and forestry products, will all assess whether logistics emissions is a blind spot.

ISO Standard

During the process of developing and testing the GLEC Framework, there have been many calls for a formal standard on this topic using the structures of the ISO. It is expected that an ISO standard will ensure broader support by governments worldwide which in turn will enhance alignment between corporate and government accounting and reporting of logistics emissions.

A proposal was submitted to ISO for the development of a formal international standard for logistics emission accounting. It is likely that other documents established by the standardization community, including EN 16258 and ISO International Workshop Agreement 16,[71] will be used alongside the GLEC Framework as the baseline for standard development.

Developing an ISO is a multi-year process that includes a broader range of stakeholder types than have been involved in developing the GLEC Framework. As the process moves forward, it is important that the GLEC Framework is further implemented in order to demonstrate its role in business as the primary foundation of a formal international standard.

Policy

Supportive policy is essential to help business. A coherent set of policy recommendations was developed in consultation with government, industry and civil society representatives to ensure wide acceptability.[72] Recommendations are grouped around four 'enablers' of accounting and reporting:

- Methodology development for logistics emissions accounting
- Data collection and exchange
- Assurance of logistics emissions data and related information
- Use of results by business, government and other stakeholders

The objective is, through recommending policy priorities, to enable policy making that is aligned with both high-level targets and industry needs and activities. It can be used by national governments in countries worldwide, the European Commision and related organizations involved in setting or implementing policy agenda such as development banks and non-governmental organizations.

Methodology development
- Back GLEC Framework and support ISO development and EN16258 update
- Back single global set of fuel emission factors, including alternative fuels
- Support awareness and information campaigns for industry

Assurance
- Give companies incentives to collect high quality data and obtain assurance
- Explore assurance needs in case of mandatory reporting or carbon pricing
- Support standardized assurance guidance and reporting template

Data collection and exchange -

- Back IMO/IATA protocols and alignment
- Support development of global (or EU) data exchange protocol(s)
- Explore development of neutral platform and IT architecture with Transport Management System (TMS) link
- Take more central role in data exchange

Use of results

- Establish national Green Freight Programs
- Make government targets relevant to the sector
- Support industry surveys and recognition
- Include in NDCs /national plans: infrastructure, vehicles/vessels and their operation

Research

Supportive research is important to inform and advance action by industry. Yet it is unclear what research is most needed on emissions accounting and reporting. A research agenda was developed that recommends five areas of further research to:[73]

- Improve input data, emissions calculation and disclosure across different modes, countries and industry sectors
- Standardize the way data is exchanged between parties, using protocols and platforms, and updating transport management systems, and address trust issues between parties
- Extend emissions calculations to include ICT, infrastructure, packaging and air pollutants
- Allow for emissions calculation as part of project and infrastructure planning and organization of the logistics supply chain
- Test the implementation of the GLEC Declaration in practice, covering reporting; assurance; integration in programs, tools and indices; training and information; and standards development.

The aim is to help make informed choices when deciding what new research to carry out or fund. It can be used by national governments and the EC, as well as research institutes, industry and civil society. It is emphasized that efforts should involve industry, accompanied by pilots for testing and validation in cooperation with research institutes.

In conclusion

Society and your business need you to track and reduce carbon emissions from freight transport. We believe the GLEC Framework plays a crucial role in this by providing a common language to track climate impacts.

Adopt the GLEC Framework today!

Appendix 1
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Appendix 2
List of Abbreviations

Appendix 2. List of Abbreviations

CCWG	Clean Cargo Working Group
CDP	Carbon Disclosure Project
CH_4	Methane
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CSR	Corporate Sustainability Reporting
EEDI	Energy Efficiency Design Index
EEOI	Energy Efficiency Operation Indicator
eGRID	Emissions & Generation Resource Integrated Database
FTL	Full Truck Load
GCD	Great Circle Distance
GHG	Greenhouse Gas
GIS	Geographic Information System
GLEC	Global Logistics Emissions Council
GREET	Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model
GRI	Global Reporting Initiative
HFCs	Hydrofluoro-Carbons
HFO	Heavy Fuel Oil
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IEA	International Energy Agency
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
ITF	International Transport Forum
kg	Kilogram
KPI	Key Performance Indicator
kWh	Kilowatt-hour
LEARN	Logistics Emissions Accounting & Reduction Network
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LSP	Logistics Service Provider
LTL	Less Than Load
MDO	Marine Diesel Oil
MIT	Massachusetts Institute of Technology
N_2O	Nitrous Oxide
NDCs	Nationally Determined Contributions
NF3	Nitrogen Triflouride
NGO	Non-Government Organization
non-OECD	Non-Organization for Economic Co-operation and Development
PFCs	Perfluoro-Carbons
RAILISA	RAIL Information System and Analyses
SBTi	Science-Based Targets initiative
SF_6	Sulphur Hexafluoride
SFC	Smart Freight Centre
SFD	Shortest Feasible Distance
T&D	Transmission and Distribution
TEU	Twenty-foot Equivalent Unit
t-km	Tonne-kilometers
TSC	Transport Service Category
TTW	Tank-to-Wheel
UIC	International Union of Railways
US EPA	United States Environmental Protection Agency
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute
WTT	Well-to-Tank
WTW	Well-to-Wheel
WWF	World Wildlife Fund for Nature

Appendix 3
Glossary

Appendix 3. Glossary

Activity-based approach	Methodology that provides measurement of activity, such as vehicle miles traveled or tonne-kilometers moved, which is multiplied by an emission factor to estimate total emissions. Well-suited for planning situations and Scope 3 calculations.
Actual distance	The actual distance traveled by a shipment based on odometer readings or knowledge of the actual route.
Aerodrome	Location from which aircraft flight operations take place, regardless of whether they involve cargo, passengers or maintenance purposes.
Belly cargo	Cargo transported in a passenger aircraft.
Calendar year	A period consisting of twelve consecutive months.
Cargo	A collection or quantity of goods carried on a means of transport from one place to another; cargo can consist of either liquid or solid materials or substances, without any packaging (e.g. bulk cargo), or of loss items of unpacked goods, packages, unitized goods (on pallets or in containers) or goods loaded on transport units and carried on active means of transport.
Carrier	An entity that operates a vehicle or vehicles with the purpose of transporting goods. Vehicle could refer to any form of transport, e.g. truck, train, aircraft, waterborne vessel.
CO_2e	Carbon dioxide equivalent is a unit that describes the impact of different greenhouse gases as a single measure related to the global warming potential of carbon dioxide.
CO_2e intensity factors	A way to express the CO_2e intensity of freight transport; expressed as the total CO_2e emissions divided by the total work done, expressed in tonne-kilometers.
Fuel efficiency factor	A way to express the fuel efficiency of the useful work done when moving goods; expressed as the total fuel consumption divided by the total work done, expressed in tonne-kilometers.
Embedded emissions	The emissions related to the manufacturing and production of a product or structure. Also known as embodied emissions.
Empty running	Empty running is calculated as the percentage of total vehicle-kilometers that are run empty.
Energy	Electricity, fuels, steam, heat, compressed air and other like media.
Freight transport demand	A measure of the volume of freight transport, typically expressed by tonne-kilometer.
Freighter	An aircraft carrying solely cargo (no passengers).
Fuel-based approach	Methodologies that use actual fuel consumption data to estimate emissions, based on the content of the fuel and assumptions regarding its combustion.
Fuel life cycle	The various stages from the production to the use phase of fossil and alternative fuels.
Fugitive or evaporative emissions	Pollutant released into air from leaks in equipment, pipelines, seals, valves, power conversion stations, etc.
Great circle distance (GCD)	GCD is defined as the shortest distance between any two points on the surface of the earth, using the Vincenty distance formula associated with the World Geodesic System.
Greenhouse gas (GHG)	Greenhouse gases, defined as those indicated by the Kyoto Protocol (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) plus nitrogen-trifluoride (NF_3).
Intermodal freight transport	Multimodal transport of goods, in one and the same intermodal transport unit, by successive modes of transport without handling of the goods themselves when changing modes. The intermodal transport unit can be a container, swap body or a road or rail vehicle or a vessel.
Load factor	Load factor is the ratio of the shipment weight to the payload capacity of a vehicle or vessel.
Logistics site	A logistics site is the area where shipping goods are stored and/or handled at an intermediate destination prior to reaching their ultimate end-use (e.g. terminal, port, airport, warehouse, distribution center). In the previous version of the Framework, the term transhipment center was used for logistics sites.
Marginal accounting	Method of allocation based on assigning only the additional emissions to an extra load rather than its full, proportional share.
Materiality	Materiality is a concept that is used throughout an assurance engagement. When determining the extent of the assurance procedures to be carried out, the concept will be used to determine the sample size. Information is material if omitting, misstating or obscuring it could reasonably be expected to influence decisions of primary users of the report containing that information.
Modes	Means of transport or type of transport (e.g. rail, sea, road, etc.).
Modeled data	Tools combine available carrier and customer data about shipments; start, end and intermediate locations (logistics sites); modes; and vehicles, blended with assumptions about e.g. routing to model fuel use and emissions (e.g. EcoTransIT).
Multimodal freight transport	Transport of goods by at least two different modes of transport. Intermodal transport is a particular type of multimodal transport, often based on a contract regulating the full multimodal transport.
Network average	Average of all vehicle movements undertaken by a particular transport network.
Network distance	Effectively a variation of planned distance, network distance is used where the route options that can be taken are limited, for example rail or inland waterway networks.

Appendix 3. Glossary

Nodes	Another word for logistics sites – a connection point for redistribution of shipments (e.g. warehouse, cross-docking, etc.).
Nominal	Best available industry average applicable to a TSC.
On-carriage	Any inland movement that takes place after the container is picked up from the port/terminal.
One way trip	Travel without a return trip.
Planned distance	Goods are traveling on shared transport assets, where shipments are consolidated to increase vehicle loading and hence efficiency, but may lead to longer distances being traveled than the most direct route for an individual shipment. Also found using route planning software, planned distance tends to be the shortest distance taking into account real operating conditions and typical operational choices such as avoiding congestion hotspots or unsuitable, restricted roads.
Pre-carriage	An inland movement that takes place prior to the container being delivered to the port/terminal.
Primary data	Otherwise known as actual data, data specific to a particular organization's operations (e.g. carriers or operator of logistics site) for a particular shipment or time period.
Program data	Data from e.g. green freight programs such as SmartWay or CCWG carrier data.
Ro-Ro	Roll-on/Roll-off (Ro-Ro) ships are vessels designed to carry wheeled cargo.
Round trip	A group of sequential journeys that start and end in the same place.
Scope 1	Emissions from sources that are owned or controlled by the reporting company.
Scope 2	Indirect emissions from the generation of purchased electricity, steam, cooling or heating consumed by the reporting company.
Scope 3	Indirect or supply chain emissions resulting from a company's products or activities.
Service average	Average taken over a group of vehicle movements undertaken by a particular vehicle operator for a particular client or group of similar trips.
Shipment	Refers to the goods in a commercial transaction between a seller and a buyer; hence the shipment Identification Key exists as a common element throughout the movement of the goods throughout the transport chain from original point of supply to ultimate point of demand.
Shipper	Individual or entity that sends goods for transport.
Shortest feasible distance (SFD)	Shortest feasible distance represents the shortest route between two places and is typically found using route planning software. SFD is not an optimal method because it does not reflect real operating conditions, such as the physical restrictions of a vehicle (e.g. weight and height), road type, topography, likely congestion or construction.
Source	A physical unit or process that releases GHGs into the atmosphere.
Specific trip	A vehicle journey made at a specific time & date combination between specific locations by a specific mode of transport.
Subcontractors	Company or individual that carries out the transportation service for the contractor.
Supply chain	A system of organizations, people, activities, information and resources involved in moving a product or service from supplier to customer, often involving the transformation of raw materials to an end product.
System boundary	Definition of the limits of coverage of a calculation – in the case of the GLEC Framework limited to an assessment of which phases of the transport supply chain are and are not included in a particular transport system.
Twenty-foot equivalent unit (TEU)	The standard capacity of a 20 ft (6.10 m) container.
Tonne	Metric unit of mass equal to 1000 kilograms.
Tonne-kilometer	The unit of measure for freight transport, representing the transport of one tonne of goods over a distance of one kilometer.
Trade lanes	Heavily trafficked transport corridors where vehicle movements are heavily concentrated between multiple locations at the start and end point.
Transport Service Categories (TSCs)	Groups of similar roundtrip journeys that are considered over a 12-month period to represent the way that freight transport services are procured and provided.
Transport chain	Sequence of transport modes used to move the goods from their origin to their destination. Along the chain, one or more transhipments take place. The goods may not necessarily stay in the same loading unit along the full transport chain.
Transport system	The full set of transport-related activities, when all transport chains are aggregated.
Upstream emissions	Emissions linked to energy operational processes such as extraction or cultivation of primary energy, refining, transformation, transport and distribution of energy.
Value chain	While supply chains refer to systems that move a resource or products to a consumer, the value chain refers to the manner in which value is added to a product along the chain.

Appendix 4
Unit Conversions

Table 16. Distance		
To convert from	**To**	**Multiply By**
Foot (ft)	Meter (m)	0.304 8
Yard (yd)	m	0.914 4
International Mile (mi)	m	1.609 344
Nautical Mile (nmi)	Kilometer (km)	1.852

Table 17. Weight		
To convert from	**To**	**Multiply By**
Short ton (2000 lb)	Metric tonne (t)	0.907 184 74
Long or imperial ton (2240 lb)	t	1.016 047
US pound (lb)	t	0.000 453 592
Kilogram (kg)	t	0.001
US Gallon	Liter (l)	3.785 411 784
Short ton-mile (ton-mi)	t-km	1.46

Conversions specific to container shipping

These figures are adopted from IMO and EcoTransIT to represent common TEU weights.

Table 18. TEU average weights	
Cargo type	**Tonnes per TEU**
Lightweight cargo	6
Average cargo	10
Heavyweight cargo	14.5
Empty container	2

Table 19. Alternative container types	
Container size	**TEU conversion factor (TEU equivalents)**
20' standard and high cube container	1.0
40' standard	2.0
40' high cube	2.25

Appendix 5
Sample Problems

The following sample calculations are provided as examples of how to apply the Framework in specific circumstances and are for guidance only. In particular the fuel consumption values are not based on real situations and should not be considered as reliable indications of likely fuel consumption in any particular circumstances.

1. Road Transport Operator Calculations: Calculating Central Paris Equipment Movers Fleet Emissions

Mr. Kane, the Director of Operations for Central Paris Equipment Movers (CPEM) has been asked by its largest client, the City of Paris, to calculate and report the emissions associated with CPEM's movement of equipment purchased by the City last year.

Step 1. Set the boundaries and goals

As a transport operator CPEM's emissions' focus will relate to the operation of vehicles and any additional logistics sites; although primarily scope 1 emissions, transport operators may also need to declare scope 2 emissions from the use of electricity and scope 3 for the WTT emissions linked to the fuels that they use. If they subcontract any operations then this should be considered as part of their scope 3.

Step 2. Calculate Scope 1 + 2

CPEM operates a fleet of 115 vehicles, including 54 electric vans, 30 diesel vans, 17 gasoline vans, 20 older, less efficient 7.5 t* diesel trucks, 6 newer, more efficient 12 t diesel trucks, and 2 older, less efficient 40 t/Class 8 trucks. CPEM does not operate any storage facilities or warehouses, nor do they subcontract any operations.

For its electric vehicles, electricity bills show that CPEM purchased 706,155 kWh of electricity. Mr. Kane reviewed his fuel receipts for the last year and determined that CPEM purchased the following amounts of fuel over the last year: 85,364 liters gasoline/ethanol 95/5 blend and 374,285 liters diesel-biodiesel blend 95/5.

Mr. Kane also estimates that 48% of his diesel fuel is used by the diesel vans, 34% by the 7.5 t diesel trucks, 16% by the 12 t trucks, and 2% by the 40 t trucks. CPEM also knows the tonnage of goods moved, the exact distance each truck traveled, and estimates an average load factor of 40%.

Data collected by the movers are tabulated for each vehicle type as follows.

Table 20. Central Paris Equipment Movers road fleet information

Vehicle Type	Fuel Type	# of Vehicles	Total Distance Per Vehicle Type (km)	Avg. Trips Taken Per Vehicle Per Year	Total Tonnage of Goods Per Year (t)
Electric Van	Electricity	54	2,567,837	476	16,738
Gasoline Van	Gasoline/Ethanol 95/5 Blend	17	845,364	278	4,366
Diesel Van	Diesel/Biodiesel Blend 95/5	30	1,474,285	385	11,845
7.5 t Diesel Truck		20	495,827	312	21,375
12 t Diesel Truck		6	174,364	204	6,865
40 t/Class 8 Truck		2	17,478	145	4,890

* xxt refers to gross vehicle weight of xx tonnes.

Total Scope 1 Emissions

Table 21. Gasoline/Diesel Vehicle CO_2e Calculation

To convert from	To	Multiply By	
Fuel Type	Liters Used	TTW Emissions Factor (kg CO_2e/liter fuel)	GHG Emissions (kg CO_2e)
Diesel/Biodiesel Blend	374,285	2.54	950,683
Gasoline/Ethanol Blend	85,364	2.30	196,337

Emission Intensity calculation

Table 22. Gasoline/Diesel Vehicle CO_2e Calculation

Vehicle Type:	Ave. km per trip	Ave. t per trip	Total tonne-km	km/l	Liters fuel used *	CO_2e /l	kg CO_2e	kg CO_2e/ tkm
Electric Van	100	0.65	668,852	n/a	n/a	n/a	67,085	0.10
Diesel Van	128	1.03	604,776	8.2	179,657	3.17	569,512	0.94
Gasoline Van	179	0.92	312,388	9.9	85,364	2.80	239,019	0.77
7.5 t Diesel Truck	79	3.43	679,378	3.9	127,257	3.17	403,404	0.59
12 t Diesel Truck	142	5.61	391,179	2.9	59,886	3.17	189,837	0.49
40 t/Class 8 Truck	60	16.86	117,886	2.3	7,486	3.17	23,730	0.20
Overall			**2,774,459**				**1,492,587**	**0.54**

* Liters fuel used is estimated using the share of each fuel indicated by the spend data.

Total Scope 2 Emissions

Table 23. Electric Vehicle CO_2e Calculation

Fuel Type	kWh Purchased	Emissions Factor (kg CO_2e/kWh)	GHG Emissions (kg CO_2e)
Electricity	706,155	0.095*	67,085

* Value provided by CPEM's electricity provider

Step 3. Calculate Scope 3 Emissions

Table 24. Gasoline/Diesel Vehicle CO_2e Calculation

Fuel Type	Liters Used	WTT Emissions Factor (kg CO_2e/liter fuel)	GHG Emissions (kg CO_2e)
Diesel/Biodiesel Blend	374,285	0.63	235,800
Gasoline/Ethanol Blend	85,364	0.50	42,682

Using emissions results

Reporting according to GLEC Declaration:

B2B report (for the client contract):

Total WTW GHG emissions: 1,492,587 kg CO_2e

WTW GHG emission intensity: 0.54 kg CO_2e/t-km

Input data type: 100% own, actual data*

Mode coverage: 100% road transport operations

Data verification statement: Data has not been independently verified by a third party

* i.e. no estimation, modeling or defaults

Public report (if this were also the total emissions of the warehouse for the year):

Total GHG emissions:

Scope 1: 1,147,021 kg CO_2e

Scope 2: 67,085 kg CO_2e

Scope 3: 278,482 kg CO_2e

WTW GHG emission intensity: 0.54 kg CO_2e/tkm

Input data type: 100% own, actual data*

Coverage: full coverage of logistics site for 12 months**

Mode coverage: 100% road transport operations

Data verification statement: Data has not been independently verified by a third party

* i.e. no estimation, modeling or defaults
**no exclusions

2. Logistics Site Calculations: James Olson's Beer Distribution and Warehousing

James Olson operates a beer distribution and warehousing operation outside of Boston, Massachusetts. The James Olson warehouse is almost 7,000 square feet and does not have any refrigeration systems installed, only space heating. He has several vehicles used within the confines of the warehouse and equipment used in day-to-day operations of the warehouse that use gasoline and diesel.

One of his major contracts asked for the emissions associated with his warehouse and delivery services over the last year. Throughput was 21,189 tonnes.

Step 1. Set boundaries and goals

As a warehouse operator James Olson logistics emissions' focus will relate to the operation of the warehouse, including any vehicle operations within the confines of the warehouse. If they operate any distribution vehicles of their own (as compared to relying on suppliers and customers to arrange the inbound and outbound transportation) then the emissions from these vehicles should also be included; the emissions are likely to be a mix of Scope 1 emissions linked to direct use of fuel, Scope 2 emissions from the use of electricity and Scope 3 for the WTT emissions linked to the fuels that they use. If they subcontract any operations then this should be considered as part of their Scope 3.

Due to severe storms that caused significant delays in power restoration over the last year, he also has two 400 kW diesel generators for use on-site. Overall, the operation purchased 141,467 kWh of electricity*, 51.25 million British Thermal Units (BTUs) of natural gas**, 1,982 US gallons of gasoline, 4,451 US gallons of 95/5 diesel/biodiesel blend, and 3,275 US gallons of diesel for his generators.

* The United States' electricity emissions factor is 0.69 kg CO_2e/kWh

**Per the EIA (https://www.eia.gov/environment/emissions/CO2_vol_mass.php), the emissions factor of natural gas is 53.07 kg CO2/million BTU.

For the purpose of this example, conversion of units is a helpful interim step to align the presentation of the emission factors for liquid transport fuels using the same units as the other sample problems.

1982 US gallons gasoline = 7503 liters

3275 US gallons diesel = 12397 liters

4451 US gallons 95/5 diesel/biodiesel blend = 16849 liters

Step 2. Calculate Scopes 1, 2 & 3

Table 25. Calculate Scopes 1, 2 & 3

Fuel Source	Amount Used	Scope 1 (kg CO_2e/unit)	Scope 2 (kg CO_2e/unit)	Scope 3 (kg CO_2e/unit)
Electricity (kWh)	141,467	-	0.69 /kWh	
Natural Gas (million BTU)	51.25	53.07/million BTU	-	8.02/million BTU
Gasoline (liters)	7,503	2.13/l		0.47/l
Diesel Oil Fuel (liters)	12,397	2.43/l		0.54/l
95/5 Diesel (liters)	16,849	2.31/l		0.60/l

Fuel Source	Scope 1 (kg CO_2e)	Scope 2 (kg CO_2e)	Scope 3 (kg CO_2e)	Total GHG Emissions (kg CO_2e)
Electricity (kWh)		97612		97,612
Natural Gas (million BTU)	2,720		411	3,131
Gasoline (liters)	15,981		3,562	19,507
Diesel Oil Fuel (liters)	30,125		6,694	36,820
95/5 Diesel (liters)	38,921		10,1009	49,030
Total GHG Emissions (kg CO_2e)	87,746	97,612	20,741	206,100

Using emissions results

Reporting according to GLEC Declaration:

B2B report (for the client contract):

Total WTW GHG emissions: 206,100 kg CO_2e

WTW GHG emission intensity: 9.73 kg CO_2e/t

Input data type: 100% own, actual data*

Mode coverage: 100% logistics site (warehouse) operations**

Data verification statement: Data has not been independently verified by a third party

* i.e. no estimation, modeling or defaults
**i.e. no external transportation by road, rail, barge, sea or air

Public report (if this were also the total emissions of the warehouse for the year):

Total GHG emissions:

Scope 1: 87,746 kg CO_2e

Scope 2: 97,612 kg CO_2e

Scope 3: 20,741 kg CO_2e

WTW GHG emission intensity: 9.73 kg CO_2e/t

Input data type: 100% own, actual data*

Coverage: full coverage of logistics site for 12 months**

Mode coverage: 100% logistics site (warehouse) operations***

Data verification statement: Data has not been independently verified by a third party

* i.e. no estimation, modeling or defaults
** no exclusions
*** i.e. no external transportation by road, rail, barge, sea or air

3. Multimodal Calculations and Product Supply Chain Calculations for a Single Product: Chocolate Azucarado's Flagship Chocolate Bar

Alejandro owns and operates a premier, artisan chocolate factory named Chocolate Azucarado based in Mexico City. Chocolate Azucarado sources its organic materials from the best producers around the globe. These include raw cacao from Mexico (Vallolid) and Cote d'Ivoire (Abidjan), cream from local Mexican dairies (Morelia), sugar from Brazil (Santos), coffee from Colombia (Bogota), and chili peppers from local Mexican farms (Delicias). Alejandro was recently approached by a major, high-end international store that wishes to distribute his most popular chocolate bar, consisting of a slightly spicy, coffee-flavored milk chocolate. As a part of the negotiations, the international store has asked him to conduct a full analysis of his flagship product's logistics chain emissions.

Step 1. Set boundaries and goals

As a manufacturer, the main elements of the logistics emissions associated with Chocolate Azucarado supply chain will be associated with inbound supply of raw materials and distribution of final product. Inbound transportation is likely to be Scope 3 emissions associated with third party transportation. Distribution of final product could be operated by Chocolate Azucarado who have a small fleet of their own vehicles resulting in Scope 1 emissions, as well as being performed by third party transportation contracted either by Chocolate Azucarado or the customer, depending on the Incoterms, either of which would be classed as Scope 3.

Step 2. Calculation Scope 1 & 2 emissions

Chocolate Azucarado also operates its own internal delivery and distribution fleet that moves goods from the main storage facility to the factory and from the factory to external distributors. These vehicles are powered by gasoline using approximately 25,764 liters of gasoline in the last year.

Step 3. Calculate Scope 3 emissions

Calculation of the emissions impact of the full supply chain involves processing input data from several different sources for the various elements of the logistics chain. For the third party transport, in spite of contacting the suppliers, Alejandro has had to use default emission intensity values for the upstream supply chain emissions.

Below is a table detailing the mass or units of goods shipped to Chocolate Azucarado, the method of shipping, the distances the products traveled and the number of shipments received per year. All road and rail freight were transported using diesel oil.

Table 26. In-House Fleet Emissions

Energy Source	Amount (liters)	Scope 1 (TTW) Emission Factor (kg CO_2e /l)	Scope 1 emissions (kg CO2e)	Scope 3 (WTT) Emission Factor (kg CO_2e /l)	Scope 3 (kg CO2e)
Gasoline	25,764	2.42	62,349	0.46	11,851

Table 27. Subcontracted transport emissions (scope 3)

Product	Mode	Emission intensity (kg CO_2e/tkm)	t-km	Total WTW emissions (kg CO_2e)
Chocolate	Rail, Diesel Oil	0.018	72,000	1,296
Cream	Truck, Diesel	0.025	5,198	130
Chili Peppers	Van, Petrol	0.26	884	230
Coffee	Air, Jet Fuel A	0.702	1,301	913
		kg CO2e/TEU km	**TEU km (main haul)**	
Raw cacao	Sea	0.130	30,630	3,982
Sugar	Sea	0.110	10,242	1,127

Chocolate Azucarado asked its ingredient-warehousing partner how much electricity was used for the cold storage of its product, which was estimated to be 167,192 kWh of electricity for the cooled warehouse.

Table 28. Logistics Site Emissions			
Energy Source	**Amount (kWh)**	**Emission Factor**	**kg CO_2e**
Electricity (Scope 2)	167,192	0.879 kg CO2e/kWh*	146,962
Handling of containers in port (Scope 3)			
Energy Source	**Amount (containers handled)**	**Emission Factor**	**kg CO_2e**
Mixed	4 x 2 = 8	30.1	240
	Total Logistics Site Emissions		147,202 kg CO_2e

* Mexico's electricity grid factor was quoted to be 0.879 kg CO_2e/kWh by their supplier.

Each bar of Chocolate Azucarado flagship chocolate weighs 0.1kg and they produced a total of 88.5 tonnes of finished chocolate. What is the emission factor for each bar of chocolate (kg CO_2e/bar)?

Table 29. Emissions per product output	
Weight of Chocolate Produced (tonnes):	88.5
Bars of Chocolate per kg:	10
Number of Chocolate Bars Produced	885,000
WTW logistics emissions chocolate:	0.26 kg CO_2e/bar

Using emissions results

Reporting according to GLEC Declaration:

B2B report (for the client contract):

Total WTW GHG emissions: 1,492,587 kg CO_2e

WTW GHG emission intensity: 0.54 kg CO_2e/t

Input data type: 100% own, actual data*

Mode coverage: 100% road transport) operations

Data verification statement: Data has not been independently verified by a third party

* i.e. no estimation, modeling or defaults

Public report (if this were also the total emissions of the warehouse for the year):

Total GHG emissions:

Scope 1: 1,147,021 kg CO2e

Scope 2: 67,085 kg CO2e

Scope 3: 278,482 kg CO2e

WTW GHG emission intensity: 0.54 kg CO2e/tkm

Input data type: 100% own, actual data#

Coverage: full coverage of logistics site for 12 months~

Mode coverage: 100% road transport operations

Data verification statement: Data has not been independently verified by a 3rd party

* i.e. no estimation, modeling or defaults

** no exclusions

Modal Switch Comparison: Chang's Dumpling House Supply Chain

Li Wei Chang operates an extremely popular dumpling chain called Chang's Dumpling House in Shanghai, China. In his seven restaurants, he serves a mix of high-end vegetarian, seafood and meat dumplings using the freshest of ingredients sourced from across Asia. His clientele, mostly from the rapidly growing Shanghai upper class and expatriate community, are becoming more concerned about greenhouse gases. As such, Li Wei has decided to explore the impact of different methods of sourcing two of his ingredients on the emissions associated with his operations.

Step 1. Set boundaries and goals

Li Wei Chang understands that he needs to examine the supply chain for his ingredients to understand the GHG emissions that result in their transportation to his restaurant. The main ingredients he is interested in optimizing sourcing to reduce emissions are as follows:

- Soy Sauce – Currently sourced from Hong Kong (Rail). Opportunity to source from Jiaxing Shanghai (Small Van)
- Shrimp – Currently sourced from Thailand (Truck). Opportunity to source from Tokyo (Air)

Li Wei Chang's suppliers were not used to this sort of request, but after some investigation were able to provide him with the information in table 30.

Step 2. Calculate Scope 1 & 2 emissions

No Scope 1 and 2 emissions were considered in this supply chain-focused calculation.

Step 3. Calculate Scope 3 emissions

This investigation will require comparison of the supply chain emissions for the two sourcing options of each product, meaning that the full supply chain needs to be established in each case.

It may be that the use of default values as a first step is sufficient to establish that there is a significant difference between the emissions of the two comparable options. Where the difference is small then further, more detailed investigation or detailed modeling may be required to provide a clear answer.

Soy sauce option 1: Long distance rail transport

Although rail is a more efficient mode of transport than road in terms of emission intensity, sourcing product from a distant supplier adds considerably to the amount of transport activity that needs to be accounted for in this option.

A suitable GLEC Framework default consumption factor for a diesel train with mixed cargo is 0.028 kg CO_2e/t-km.

Delivery over 1991 km gives a WTW logistics GHG emission for delivery of soy sauce from the existing, remote supplier of 55.7 kg CO_2e/t

Table 30. Chang's Dumpling House's supply chain

Ingredient	Origination	Shipping Method	Distance
Soy Sauce	Hong Kong	Ambient Temperature Rail (Diesel)	1991 km
Soy Sauce	Shanghai	Small Van(Diesel)	95.8 km
Shrimp (Frozen)	Thailand	Temperature controlled Diesel Truck (Diesel)	3661 km
Shrimp (Fresh)	Tokyo	Refrigerated Air Freight (Jet Fuel 1A)	1740 km

Soy sauce option 2: Local road transport

This is known to be a direct delivery from a supplier based 95.8 km away from Li Wei Chang, so there is no intermediate handling. The GLEC Framework CO_2e intensity factor for a small diesel van is:

0.68 kg CO_2e/t-km, uplifted by 13% for local conditions*, giving a value of 0.768 kg CO_2e/t-km

Delivery over 95.8 km gives a WTW logistics GHG emission for delivery of soy sauce from the local supplier of 73.6 kg CO_2e/t

Shrimp option 1: Temperature controlled road transport

Although there will be emissions from local goods handling and last mile delivery the majority of the emissions will come from the main haul, by temperature controlled large truck. The GLEC Framework CO_2e intensity factor for a large, temperature controlled, diesel truck with mixed cargo is:

0.080 kg CO_2e /tkm, uplifted by 13% for local conditions and 12% for the temperature control, giving a value of 0.101 kg CO_2e /tkm

Delivery over 3661 km gives a WTW logistics GHG emission for delivery of shrimp by truck from Thailand of 371 kg CO_2e/t

Shrimp option 2: Refrigerated air freight

Although coming from a closer location, air transport has a relatively high emission intensity which adds considerably to the emissions for this option.

The GLEC Framework CO_2e intensity factor for regional air cargo by generic aircraft type is 0.702 kg CO_2e /tkm

Delivery over 1740 km gives a WTW logistics GHG emission for delivery of shrimp from the local supplier of 1221 kg CO_2e/t

* See road defaults section for an explanation

Using emissions results

Shrimp: Conclusion

The emissions associated with road transportation of shrimps from Thailand to Chang's Dumpling House are considerably lower than the air freight alternative from Japan, meaning that a decision can be made on environmental grounds at this point.

Soy sauce: Initial conclusion

Based on the initial calculation the existing rail alternative appears favorable. However, it is worth noting the rail calculation is incomplete; there will be additional emissions generated by local transportation at each end of the product's journey and handling at the rail terminals which have not been included in the above calculation.

Also, the use of default factor for both the rail and road transportation add uncertainty to both calculations that could influence this outcome considerably. As a result, Li Wei Chang may wish to conduct a more detailed assessment given this is an important factor for the restaurant.

Module 1

Fuel Emission Factors

Module 1: Fuel Emission Factors

Fuel emission factors play an important role in the calculation of transport emissions. They are used to convert the fuel and energy used to power freight transportation into greenhouse gas emissions. Emission factors are a key part of any carbon footprinting exercise, and allow a consistent metric for considering fuel emissions that can be adopted by any party.
The emissions factor associated with fuel purchased on any particular day at a particular location has a natural variability associated with it, depending upon factors such as the nature of the original feedstock, the locations of production and consumption and the distribution mechanisms used, the energy inputs to and the nature of the production processes used, etc.
In general, conventional fuels tend to be blends that originate from a mix of sources and processes developed to ensure that they fit within the tolerances of the prevailing local fuel quality standards.

As a result, it is not standard practice to try to put an exact figure on every batch of fuel. Instead it is accepted practice to use representative values with the understanding that emissions will, over time, average out and match the representative value (assuming that it is well calculated). Variation in national fuel standards and local industrial energy efficiency can be identified in the official figures quoted in some national emission factor sources. The potential feedstocks and production processes for conventional fuels are relatively well known and as a result there tends to be a relatively low variation in values quoted for these fuels.

In contrast 'new fuels', including some renewable fuels and fuels quoted as having low GHG emissions, tend to have a less well-established production process, with greater variability over the full life-cycle and a wider range of possible feedstocks.

Although it is commonplace to blend relatively low percentages (5–10%) of biofuels into conventional fuels, it is more common than for conventional fuels that higher blend or pure biofuel products are segregated and supplied as single source product. This means that generalization of emission factors is less appropriate and could lead to greater uncertainties, at least under current market conditions; as a result, a full consideration of emission factors for 'new fuels' could be a time-consuming and costly process.

About these fuel emission factors
It is vital that emission factors are based on the most credible sources and are developed by specialists. The development of emission factors is outside the technical scope of the GLEC; thus in 2015, SFC commissioned the VTT Technical Research Centre of Finland to conduct a detailed review of the sources of emission factors used in the main international carbon footprinting standards, databases and methodologies, with a particular focus on those commonly applied or referenced in the logistics sector.

The emission factors are divided into two phases: 1) production of all fuels and energy sources (WTT phase), and 2) the emissions at point of use (TTW phase). In order to ensure a true comparison, the two phases need to be combined together into a WTW figure.

The recommended emission factors should be reviewed on a regular basis to ensure:

- They are updated in line with latest updates to the chosen sources
- As more and better information becomes available for new, low carbon fuels this information is presented alongside information for conventional fuels

As a result, the emission factors quoted in this module to the GLEC Framework should be considered as advisory. We have taken all possible steps to provide a detailed starting point for companies wishing to calculate emissions in a harmonized and representative way. Wherever possible the emission factors have been chosen with the aim of maximizing overlap with nationally published values, existing transportation standards and values used by the representative UN bodies for air and water transportation.

However, in spite of these precautions, for the reasons stated previously, the values cannot be guaranteed; in particular, the use of specific emission factors may even be mandated in certain national legislation and, in such cases, it is not the role of the GLEC Framework to advise companies to act against the locally prevailing law.

Values are presented in the following tables that show CO2e emissions for the WTT, TTW and full WTW phases of the fuel cycle. Values are also shown by volume and mass of fuel where appropriate. (Scientifically the most accurate presentation is by mass, although conventional liquid fuels are generally sold by volume and so in practice these values may be more useful.)

Table 31. International Values

Global	WTT	TTW	WTW	WTT	TTW	WTW
	kg CO_2e/kg fuel			kg CO_2e/l fuel		
Heavy fuel oil	0.26	3.15	3.41	0.25	3.06	3.31
Aviation fuel	0.70	3.18	3.88	0.56	2.55	3.10

Values are derived from IMO, CCWG and ICAO. All sources present only CO_2 emission values; CO_2e has been derived according to a scaling factor, described in more detail below.

Table 32. European Values						
Global	WTT	TTW	WTW	WTT	TTW	WTW
	kg CO_2e/kg fuel			kg CO_2e/l fuel		
Marine diesel oil	0.68	3.24	3.92	0.61	2.92	3.53
Marine gas oil	0.68	3.24	3.92	0.61	2.88	3.49
Gasoline	0.61	3.25	3.86	0.45	2.42	2.88
Bioethanol	1.56	0.00	1.56	1.24	0.00	1.24
Gasoline, 5% bioethanol blend	0.66	3.08	3.74	0.50	2.30	2.80
Diesel	0.69	3.21	3.90	0.57	2.67	3.24
100% biodiesel (B100)	2.16	0.00	2.16	1.92	0.00	1.92
Diesel, 5% bio-diesel blend (B5)	0.76	3.04	3.80	0.63	2.54	3.17
Liquefied petroleum gas	0.36	3.10	3.46	0.20	1.70	1.90
Compressed natural gas	0.39	2.68	3.07	N/A	N/A	N/A
Liquefied natural gas	0.94	2.68	3.62	N/A	N/A	N/A
Biomethane	0.49	0.00	0.49	N/A	N/A	N/A
Bio-liquefied natural gas	1.04	0.00	1.04	N/A	N/A	N/A

Table 33. North American Values						
Global	WTT	TTW	WTW	WTT	TTW	WTW
	kg CO_2e/kg fuel			kg CO_2e/l fuel		
Marine diesel oil	0.65	2.86	3.51	0.54	2.40	2.94
Conventional gasoline	0.71	2.86	3.56	0.53	2.13	2.65
California gaso-line	0.64	2.86	3.49	0.47	2.13	2.60
Gasoline 10% bioethanol blend	0.68	2.74	3.42	0.51	2.05	2.56
Bioethanol 85%	-0.20	1.89	1.69	-0.15	1.48	1.33
Methanol 90%	0.49	1.40	1.89	0.39	1.10	1.49
Diesel	0.65	2.91	3.56	0.54	2.43	2.98
Liquefied petroleum gas	0.67	2.99	3.66	0.37	1.64	2.01
Compressed natural gas	0.80	2.69	3.49	N/A	N/A	N/A
Liquefied natural gas	0.93	2.71	3.64	N/A	N/A	N/A

Notes about sources: EN16258/JEC

The majority of European values are drawn from the European standard EN16258, which itself draws heavily on the JEC report 'Well-to-Wheels Analysis of Future Automotive Fuels and Power Trains in the European Context - Reports Version 3c 2011, JEC (European Commission Joint Research Centre, Institute for Energy; EUCAR; CONCAWE)'. It is acknowledged that these values are potentially outdated given that JEC produced an updated report in 2014. However this information was used, in order not to create confusion through a proliferation of reference data, taking into account that EN16258 is due for update and a new JEC report was expected in Q1 of 2019, but has not yet been published. It is likely that the values in EN16258 would be reviewed as part of the production of an ISO taking into account any updated JEC report and the other sources refereed to here.

GREET

The vast majority of the North American values are derived from the 2018 GREET model published by Argonne National Laboratory (https://greet.es.anl.gov/). The values in GREET are presented in terms of emissions per BTU for the various phases of fuel production and use for a wide range of vehicle types and so have required conversion to the above values using standard fuel properties (physical and energy density).

BEIS

Many international companies refer to the 'UK Government GHG Conversion Factors for Company Reporting' published by the UK Government (formerly Defra, but now BEIS – Department for Business, Energy and Industrial Strategy). One of the attractions of this database is that it not only provides information about fuel and energy use but also combines this with operating data for different vehicle types to give indicative values in terms of emissions and energy use per tonne-kilometer which are extremely useful for Scope 3 emission calculation. However, the values have been derived from a UK national perspective and transferability, and hence its suitability as the basis for international guidance, must be questioned.

Country-specific values and other global regions

Several other countries including France, Australia and Canada have published national emission factors. It is likely that as increasing emphasis is placed on GHG emissions, not only but including from transport, further effort will be placed on developing a coherent and comprehensive set of GHG emission factors that can be used to enable consistent reporting from the global logistics sector, rather than causing confusion and uncertainty as to which value to use. Until that point, if national legislation mandates the use of certain values then they should be used and the values stated clearly in the explanatory notes.

For countries where there is no clearly stated emission factor then we recommend using the higher of the values quoted for the fuel in question in the North America and Europe tables above, in order to avoid accidental understatement of the results.

Scaling emission factors: CO_2 to CO_2e and TTW to WTW

As part of the GLEC study conducted in 2015 we found that many of the sources of emission factors available at that time did not quote a full set of emission factors covering all of CO_2 and CO_2e, WTT, TTW and WTW emission factor combinations. However, for those sources that did provide a full set there was a striking level of consistency in the ratio of CO_2e to CO_2 (CO_2e = 101–102% of CO_2) and WTW to TTW (WTW = 120% of TTW) values. Where necessary and applicable we have used these ratios to convert certain values where critical gaps remained in the data. We hope that future published data, as in the case of the latest GREET model, include a full dataset making such scaling unnecessary.

See below for examples of actual uplift scaling values from TTW to WTW based on the EN16258 values.

Table 34. TTW to WTW scaling factors for different fuel types

	Region	WTT (kgCO_2e/kg)	TTW (kgCO_2e/kg)	WTW (kgCO_2e/kg)	WTT as % of TTW
Heavy fuel oil	Global	0.26	3.15	3.41	8%
Aviation fuel	Global	0.7	3.18	3.88	22%
Marine diesel oil	Europe	0.68	3.24	3.92	21%
Gasoline	Europe	0.61	3.25	3.86	19%
Gasoline, 5% bioethanol blend	Europe	0.66	3.08	3.74	21%
Diesel	Europe	0.69	3.21	3.9	21%
Diesel, 5% biodiesel blend	Europe	0.76	3.04	3.8	25%

Module 2

Default Fuel Efficiency and CO_2e Intensity Factors

Module 2: Default Fuel Efficiency and CO_2e Intensity Factors

Introduction

As explained in the main body of the GLEC Framework, there remains a clear need for default factors as a 'fall back' option in cases when knowledge about the details of subcontracted transport services, or access to primary data, is limited or unavailable. For some transport services there is a choice between many sources of reference data and default factors which can lead to comparability issues, whereas for other services there are limited data available, leading to very high-level assumptions being made, this time leading to uncertainty and potentially unrepresentative outputs being generated.

As a result, the members decided that the GLEC Framework should be linked to an appendix containing a set of GLEC Default Factors that draws together, in one place, a set of default factors across all modes, to support consistent and comparable reporting. The information provided is intended to inform reporting by shippers or logistics service providers who want to start estimating and reducing their Scope 3 GHG emissions from transporting cargo as part of their inbound or outbound supply chains before progressing to using more accurate approaches.

The results are presented as a set of tiered levels of detail, designed to match the level of understanding of potential users of the information. Up to three levels of detail have been provided for each mode.

1. A single, conservative value where the user's knowledge is highly limited, often to the mode of transport used with little, if any, additional information.
2. A basic level of disaggregation where a service type is known, but detailed information of the vehicle or operational characteristics, which could help refine the value used, remain unknown.
3. A more granular set of values, for use where some knowledge about the vehicle type, vehicle size and fuel exists.

Technically it would be possible to provide a very detailed set of default values that takes into consideration a wide variation in load factors, cargo types, fuel mixes, regional variations etc. However, we believe that producing such a list would be misleading, because it would imply a level of precision that is inappropriate to its likely subsequent use, as default values can only provide an indication of emissions and this could discourage companies from progressing toward use of better quality data in the form of detailed modeling or the use of good quality primary data which would better suited to detailed emission reduction decision-making.

To phrase this in a different way, we hope that, in-time, the default values provided will not be needed because, increasingly, companies will have enough information to use high quality emissions modeling or verified primary data sources to support precise reporting and better-informed emission reduction decisions.

The GLEC default factors have been produced with certain constraints in mind, particularly:

- The default values quoted are, to the best of our knowledge, conservative: in most cases they are likely to give a higher value than if actual data are used in a calculation. The reasoning behind this is that there should not be a penalty in terms of an increase in reported emissions when a company progresses to the use of more precise input data.
- Variations in the approach taken or the data available for emission calculation by global geographic region.
- Among the many sets of default values that have been published over the years there are some that carry legal weight; for example the Base Carbone data in France and the 'Guideline for Shipper Energy Conservation Action' in Japan contain energy intensity values that are embedded within national emission reporting legislation, and as such are required to be used for estimation of emissions from domestic transportation by companies based in those countries.
- The values are generally quoted to 2 significant figures in order to emphasize that they only provide estimates of Scope 3 GHG emissions. As stated in the main body of the Framework, Scope 1 emissions in particular, or attempts to calculate accurate Scope 3 emission values, should be based on a more sophisticated approach, for example using verified primary data and/or an accredited calculation tool.
- Justification as to data sources, operational assumptions and choices made has been provided to a level considered appropriate for an industry-led initiative. The GLEC default factors are not intended as a peer-reviewed scientific publication for the very reason that they are all about estimation as a first step on a company's journey to inclusive, good quality GHG emissions reporting. That said, this appendix can be updated when new data sets become available for inclusion, as harmonization or standards are adopted, and as understanding improves over time.

Taking this approach also allows a comparison of representative values across and within modes at a general level. The following graph shows a high level comparison of the possible range of emission intensities associated with each mode. The values are drawn from the broader database that informs the values presented for each mode on the subsequent pages and should only be considered as indicative.

It is clear that there is a very wide range possible within each mode, depending on the particular operational and technical characteristics of the transport, although general trends are also clearly visible. Four more specific examples have been added for road transport to show how, even within sub-classes, wide variations are still possible, which again emphasizes the need to define the specific nature of the transport as closely as possible to obtain an accurate output.

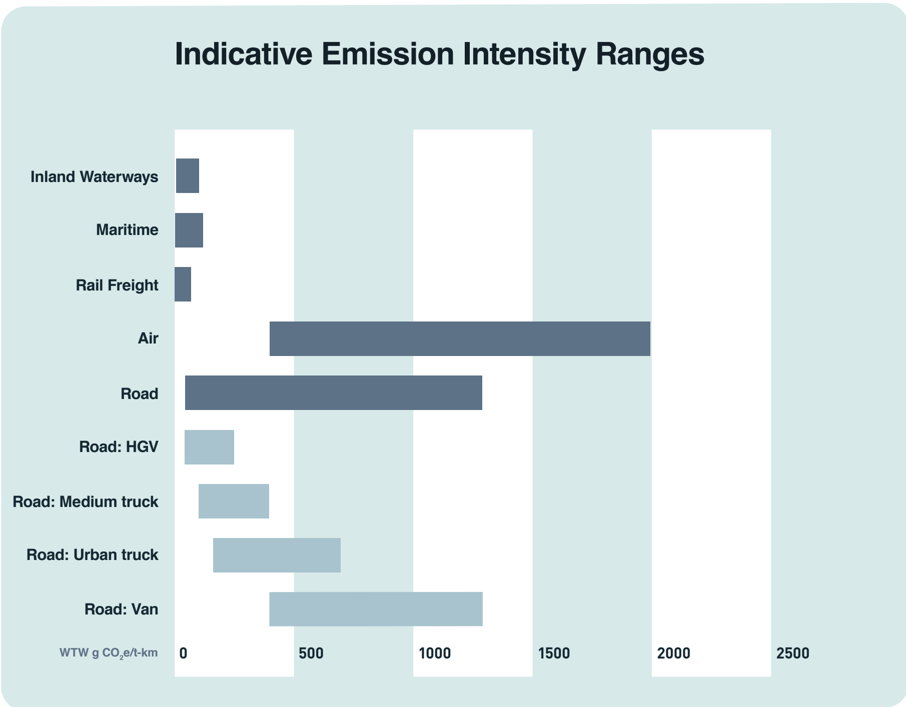

Figure 21. Examples of WTW emission intensity values for different types of freight transport, based on 2019 GLEC default factors.

Air Transport

As noted in the main body of the GLEC Framework, many factors influence the emissions from air transportation, not least the aircraft type and detailed routing which may not be immediately apparent.

The following default emission intensity values have been produced for air freight transport to provide LSPs and shippers with indicative values for their reporting of Scope 3 emissions where primary data are not available from the airline, or there is insufficient information (e.g. specific aircraft type or load factor are unknown) to allow detailed modeling of the emissions.

At time of publication the situation for air freight is complicated by the existence of two established methodologies for airfreight calculations. As explained in the main body of the GLEC Framework, whilst there is a current preference for use of the IATA RP1678 due to its adoption at global level by ICAO, the methodology set out in EN16258 has gained wide traction among some users, and so both methodologies are accepted as long as a clear statement is made as to which is used.

Emissions are quoted on a WTW, CO_2e basis, using the fuel emission factor for jet fuel quoted in Module 1 of the Framework.

Overall mode average

Based on the latest overall value for aviation fuel intensity compiled by IATA, 34.22 l/100 'revenue tonne-km', across all operation and aircraft types then the overall average value for airfreight GHG emission intensity would be 1060 g CO_2e/t-km.

Additional Detail
Naturally, as for other modes, this single figure does not capture the detail or range of possibilities for actual operational characteristics.

In compiling the following air freight default values a number of possible data sources were identified which produced or quoted widely varying values. Based on discussion with various stakeholders the following sources have been used:

- For belly freight, or hybrid aircraft, where freight and passengers are transported in the same aircraft indicative data has been sourced
  1. indirectly from the Eurocontrol Small Emitters Tool, based on values supplied by EcoTransIT
  2. based on values calculated using information provided in the ICAO Carbon Emissions Calculator Methodology Version 10.

  Values for indicative routes were calculated from both sources and then combined to give an average value.
- For freighter, where only freight is transported indicative data has been
  1. sourced indirectly from the Eurocontrol Small Emitters Tool, based on values supplied by EcoTransIT
  2. validated through private communications with GLEC member companies that operate their own aircraft fleets.
- Finally, a set of values is provided for companies that are unable to determine whether their air freight has been transported as belly freight or on a freighter. This has been calculated as a weighted average of the belly freight and freighter values in the ratio 55% belly freight, 45% freighter.

In each case, values are presented for both IATA RP1678 and EN16258. Significant differences can be seen for belly freight as the allocation of total emissions between freight and passengers is the primary difference between the two methodologies. Smaller differences are apparent even for freight-only aircraft due to the difference in approach in calculating distances between the two methodologies.

Finally the data are presented for short, medium and long haul. We understand that this is in itself a simplification because overall fuel, and hence emission intensity, varies steadily with distance for any particular aircraft and loading condition. We also recognize that there is not a single definition of the terms, short, medium and long haul. These are all indications as to why it would be better to rely on either verified airline data or detailed modeling from a reputable source than these default data.

Bearing in mind all these caveats the proposed air sector defaults are as follows:

Table 35. Air transport emission intensity factors

	ICAO/IATA RP1678			EN16258		
	WTW g CO_2e/t-km			WTW g CO_2e/t-km		
	unknown	**belly freight**	**freighter**	**unknown**	**belly freight**	**freighter**
Short haul (< 1000 km)	1130	920	1390	1430	1490	1340
Medium haul (1000–3700 km)	700	690	710	920	1110	700
Long haul (> 3700 km)	630	680	560	800	990	560

Load factors used as input by EcoTransIT in the Small Emitters Tool are:

- Freight load factor: short haul 50%; medium and long haul 70%
- Passenger load factor: short haul 65%; medium haul 70%; long haul 80%

Inland Waterway Transport

Region: Global

Although the following intensity factors are proposed as global factors, the data are primarily based on European operational information on major waterways and combined according to weighted averages for common vessel categories.

Table 36. Inland waterways transport emissions intensity factors

Vehicle characteristics and size	Loading Basis	Fuel	Consumption factor (kg/t-km)	Consumption factor (l/t-km)	Emission intensity (g CO_2e/t-km)		
	Combined Load Factor & Empty Running				WTT	TTW	WTW
Motor vessels < 80 m (< 1000 t)	55%	Diesel	0.0076	0.0091	5.2	24	30
Motor vessels 85–110 m (1000–2000 t)	52%	Diesel	0.0048	0.0058	3.3	15	19
Motor vessels 135 m (2000–3000 t)	50%	Diesel	0.0049	0.0059	3.4	16	19
Coupled convoys (163–185 m)	61%	Diesel	0.0044	0.0052	3.0	14	17
Pushed convoy – push boat + 2 barges	70%	Diesel	0.0044	0.0053	3.1	14	17
Pushed convoy – push boat + 4/5 barges	70%	Diesel	0.0025	0.0030	1.7	8.0	10
Pushed convoy – push boat + 6 barges	70%	Diesel	0.0019	0.0023	1.3	6.1	7.4
Tanker vessels	65%	Diesel	0.0055	0.0066	3.8	18	21
Container vessels 110 m	75%	Diesel	0.0065	0.0079	4.5	21	26
Container vessels 135 m	75%	Diesel	0.0051	0.0061	3.5	16	20
Container vessels – Coupled convoys	68%	Diesel	0.0051	0.0061	3.5	16	20

Pushed convoy data applicable to US operations.

It is well known that the nature of the waterway system can have a significant impact both on the type and size of vessel that can navigate it and the ease of transit due to the prevalence of locks, underwater clearance and speed of flow. In the context of the European data this has been specifically highlighted for France where the Base Carbone database contains values generated from national operational data that suggest a much higher energy and emission intensity than the values above. This is another indication that it can be misleading to rely on generic information, and good quality primary data, or failing that directly applicable, in-country data should be sought wherever possible.

Logistics Sites

Region: Global

The development of default emission intensity factors for logistics sites is still at a relatively early stage. In part this is because these emission sources have been perceived as making a relatively small contribution to overall supply chain and product lifecycle emissions. However, that in itself is not a reason to exclude these emissions from an overall logistics emissions assessment and consider how emissions can be reduced in such locations. In addition inventories for some businesses have shown that emissions from logistics sites comprise around 10% of the company total, which is not negligible.

The development of sound guidance for calculating logistics sites (Fraunhofer IML's Guide for GHG Assessment for Logistics Sites) has also provided an opportunity to expand on the previous work done for maritime container ports by FEPORT in conjunction with SFC and the GLEC.[19,20]

In the course of the work to develop the logistics site guidance Fraunhofer IML conducted initial data gathering activities that led to the following initial set of defaults for ambient transhipment sites and both ambient and temperature controlled logistics sites that offered both storage and transhipment facilities. The sample size that these values are based on is relatively small; the values will be updated over time assuming that more and better data become available and are shared with Fraunhofer IML. We expect this to improve accuracy and also to broaden the range of defaults offered, e.g. additional definitions and size categorization of logistics sites or values for specific regions where ambient climate conditions can have a strong influence on the amount of heating or cooling required.

As is the case for all default values, the figures below should be used as a last resort when primary data are not available, or as a starting point that can lead on to future calculations based on primary data. We consider the values to be slightly conservative in nature (i.e. on the high side). If you, as a logistics site operator, are not happy for your customers to use the values quoted then the onus is on you to provide them with more accurate information based on primary data and calculations that follow the guidance documents mentioned above.

Table 37. Logistics site emission intensity factors

	Ambient	Temperature controlled/mixed
Transhipment site	1.2 $kgCO_2e/t$	n/a
Storage + transhipment	5.4 $kgCO_2e/t$	11.7 $kgCO_2e/t$
Maritime container terminal	30.1 $kgCO_2e$/container moved	n/a

The above values for transhipment/storage + transhipment are based on input data from European logistics sites only. Sample sizes: ambient transhipment sites n = 4; ambient storage + transhipment n = 34; temperature controlled/mixed storage + transhipment n = 15.

Values quoted are the median value from each sample which was considered to be more representative than the mean for small sample sizes with large variations and some apparent outliers.
Almost all sites use natural gas as heating energy source, 7 sites use heating oil; the use of district heating and geothermal or wood-based energy is rare.

Electricity emissions based on the latest (year 2016) data for OECD Europe, published by the IEA, as IEA global electricity emission factors (2018). The values show significant sensitivity to electricity GHG emissions and are likely to be much higher in regions of the world where coal-fired electricity generation is commonplace.

Refrigerated sites refilled the following refrigerants: R-410A, R-404A or R-134a. For sites where no average weight of pallets handled was specified an average conversion factor of 450 kg per pallet was assumed, which was relevant for 10 sites.

Value for maritime container terminals was taken from UN ECLAC, 2015, with notional 1% uplift from CO_2 to CO_2e.

Future Development

Fraunhofer IML is working in partnership with SFC to attempt to build a broader database of terminal emissions, from which better knowledge of emission reduction opportunities and a wider range of default values will become available. This is achieved through application of the REff tool, which is provided online via https://s.fhg.de/reff. To participate in this work, please contact either contact-reff@iml.fraunhofer.de or SFC to discuss how to provide logistics sites activity data to help grow this knowledge base.

Rail Transport

Region: Europe

EU average (where traction energy type unknown*): 17 g CO_2e/t-km (WTW)

EU average (diesel traction): 28 g CO_2e/t-km (WTW)

EU average (electric traction): 10 g CO_2e/t-km (at the average 2016 EU electricity generating mix**)

* UIC Railway Handbook 2017: 62% of EU rail tracks are electrified. This does not necessarily refer to relative flows, but is used as a proxy for the default value.

** Average 2016 EU electricity generating mix sourced from IEA global electricity emission factors (2018)

Region: North America

For North America Tier 1 railroads are required to report information to the Surface Transportation Board in a specified format. Information is collected, aggregated and published through the American Association of Railroads in the form of revenue ton-mile output per gallon of fuel used, following the Eastern Regional Technical Advisory Committee (ERTAC) methodology. Conversion to the common units used in the GLEC Framework, and conversion using the latest GREET fuel emission factors, gives the following average emission intensity value.

US average (diesel): 16 g CO_2e/t-km (WTW)

Many of the North American railroads have their own calculators which calculate according to the ERTAC approach and can be accessed online.

European Diesel Traction

The EcoTransIT 2018 Methodology Update includes information about typical train, wagon and operating characteristics for different commodity types that can be used to provide more disaggregated default factors.

Table 38. European rail diesel traction emission intensity factors

Load characteristics	Basis		Consumption factor (kg/t-km)	Consumption factor (l/t-km)	Emission intensity (g CO_2e/t-km)		
	Load Factor	Empty Running			WTT	TTW	WTW
Average/mixed	60%	33%	0.0073	0.0087	5.6	22	28
Container	50%	17%	0.0067	0.0080	5.1	20	25
Cars	85%	33%	0.016	0.019	12	48	60
Chemicals	100%	50%	0.0063	0.0075	4.8	19	24
Coal & Steel	100%	50%	0.0049	0.0058	3.7	15	19
Building Materials	100%	50%	0.0061	0.0073	4.6	19	23
Manufactured Products	75%	38%	0.0064	0.0077	4.9	20	24
Cereals	100%	38%	0.0048	0.0058	3.7	15	18
Truck + trailer on train	85%	33%	0.035	0.042	27	110	130
Trailer only on train	85%	33%	0.029	0.024	18	70	90

Load factors, empty running and train characteristics sourced from EcoTransIT World Methodology and Data Update, December 2018

Truck + trailer and trailer only on train provide derived average values, including allowance for return trips where there is zero return load. Based on 34–40 t articulated truck/truck trailer combination, including average truck loading and empty running characteristics. Tonne-kilometer in these circumstances refers to the net load within the truck.

European Electric Traction

EcoTransIT 2018 Methodology Update provides additional information about typical train, wagon and operating characteristics for different commodity types that can be used to provide a more disaggregated default factors.

Table 39. European rail electric traction emission intensity factors

Load characteristics	Basis		Emission intensity (g CO_2e/t-km) @ average 2016 EU electricity generating mix
	Load Factor	Empty Running	
Average/mixed	60%	33%	10
Container	50%	17%	9.1
Cars	85%	33%	22
Chemicals	100%	50%	8.6
Coal & Steel	100%	50%	6.7
Building Materials	100%	50%	8.3
Manufactured Products	75%	38%	8.8
Cereals	100%	38%	6.6
Truck + trailer on train	85%	33%	48
Trailer only on train	85%	33%	33

Load factors, empty running and train characteristics sourced from EcoTransIT World Methodology and Data Update, December 2018

Truck + trailer and trailer only on train provide derived average values, including allowance for return trips where there is zero return load. Based on 34–40 t articulated truck/truck trailer combination, including average truck loading and empty running characteristics. Tonne-kilometer in these circumstances refers to the net load within the truck.

Average 2016 EU electricity generating mix sourced from IEA global electricity emission factors (2018)

Road Transport

This section sets out the current GLEC Default Values for road transport. The main datasets presented are for North America and Europe. These datasets are presented separately because the data in the primary inputs are arranged in a different way.

The primary inputs used are:

1. SmartWay truck data 2018 for North America
2. Handbook of Emission Factors (HBEFA) database values processed by intermediaries such as EcoTransIT, and others
3. UK BEIS (formerly Defra)
4. Base Carbone, as used in application of article L. 1431-3 of the French Transport code (September 2018)
5. Network for Transport Measures (NTM)

Region: North America

Table 40. North American road emission intensity factors

SmartWay Category*	Consumption factor (kg/t-km)	Consumption factor (l/t-km)	Emission intensity (g CO_2e/t-km)		
			WTT	TTW	WTW
Van (<3.5 t)	0.22	0.26	140	630	780
General	0.030	0.036	19.7	88	108
Auto Carrier	0.032	0.038	20.8	93	114
Dray	0.022	0.026	14.3	64	78
Expedited	0.127	0.152	82.4	369	451
Flatbed	0.022	0.027	14.6	65	80
Heavy Bulk	0.020	0.024	13.3	59	73
LTL/Dry Van	0.039	0.047	25.6	114	140
Mixed	0.026	0.031	16.9	76	93
Moving	0.088	0.105	57.4	257	314
Package	0.144	0.172	93.8	420	514
Refrigerated	0.022	0.027	14.6	65	80
Specialized	0.026	0.031	16.8	75	92
Tanker	0.018	0.022	11.9	53	65
TL/Dry Van	0.026	0.031	17.0	76	93

* The SmartWay Category designation for each fleet is based on the Operation and Body Type options selected by the carrier when entering data into the SmartWay database.

Data from US EPA SmartWay, except van which is sourced from NTM. Fleets are characterized by:

1. Business type: for-hire and private fleets. There are relatively few private fleets compared to for-hire fleets; generally the private fleets are well utilized and so not detrimental to the overall value if included with the for-hire fleets; hence, for simplicity, no differentiation is made.
2. Operational type: Full Truckload (FTL), Less than Truckload (LTL), dray, expedited or package
3. Equipment type, relating to the type of cargo carried: dry truck (or van), temperature controlled truck (or van), flat bed, chassis (container), heavy/ bulk, auto carrier, moving and specialized (e.g. hopper, livestock). Fleets can be classified as 'mixed' if they have more than a set percentage of its operational mileage outside of one particular service or equipment category.
4. Current year averages for empty running and load factor based on primary data inputted by carriers into the SmartWay tool, and hence implicitly included in the calculations, are not publicly available.

The dry truck category and chassis (or intermodal container) category are combined in SmartWay as similar operational characteristics exist.

Most temperature-controlled fleets are FTL with relatively fewer LTL so this category is also combined.

Region: Europe and South America

For users who have little knowledge other than a basic vehicle type then the starting points for vehicles without temperature control would be:

Van (<3.5 t Gross vehicle weight (GVW)): 680 g CO_2e/t-km (WTW)

Urban truck (3.5-7.5 t GVW): 370 g CO_2e/t-km (WTW)

MGV (7.5-20 t GVW): 200 g CO_2e/t-km (WTW)

HGV: (>20 t GVW): 92 g CO_2e/t-km (WTW)

Each these values is based on a particular set of assumptions and chosen from the much larger set of possibilities available in the full dataset.
As explained in the introduction the choice is highly unlikely to be 'right' (i.e. highly accurate) for the majority of applications, but can be considered suitable as a starting point where there is little detailed knowledge.

Where there is a greater level of knowledge about the vehicle and fuel type then the following, disaggregated values can be used. An even broader range of values, adjusted by operational characteristics (heavy and low density cargo, specific levels of loading and empty running) from which this list was selected is also available (on enquiry to SFC).

Table 41. Europe and South America road emission intensity factors

Mode	Vehicle characteristics and size	Combined Load Factor & Empty Running	Fuel	Consumption factor (kg/t-km)	Consumption factor (l/t-km)	Emission intensity (g CO_2e/t-km)		
						WTT	TTW	WTW
Road	Van ≤ 3.5 t	36%	Diesel, 5% biodiesel blend	0.180	0.215	140	550	680
		24%	Petrol	0.281	0.353	160	850	1000
		36%	CNG	0.176	-	80	540	620
		36%	LPG	0.193	0.345	70	590	660

Table 42. Europe and South America road emission intensity factors

Vehicle characteristics and size	Load characteristics	Basis		Fuel	Consumption factor (kg/t-km)	Consumption factor (l/t-km)	Emission intensity (g CO_2e/t-km)		
		Load Factor	Empty Running				WTT	TTW	WTW
Rigid truck 3.5–7.5 t GVW	Average/ mixed	60%	17%	Diesel, 5% biodiesel blend	0.098	0.118	74	300	370
				CNG	0.079	-	45	310	360
Rigid truck 7.5–12 t GVW	Average/ mixed	60%	17%	Diesel, 5% biodiesel blend	0.062	0.074	47	190	240
				CNG	0.062	-	28	190	220
Rigid truck 12–20 t GVW	Average/ mixed	60%	17%	Diesel, 5% biodiesel blend	0.040	0.048	30	120	150
				CNG	0.040	-	15	130	150
				LNG	0.039	-	46	130	180
Rigid truck 20–26 t GVW	Average/ mixed	60%	17%	Diesel, 5% biodiesel blend	0.033	0.039	26	99	130
				CNG	0.030	-	15	100	120
				LNG	0.030	-	36	100	140
Rigid truck 26–32 t GVW	Average/ mixed	60%	17%	Diesel, 5% biodiesel blend	0.026	0.031	20	78	98
	Container	72%	30%		0.023	0.027	18	69	87
Artic truck up to 34 t GVW	Average/ mixed	60%	17%	Diesel, 5% biodiesel blend	0.024	0.029	18	74	92
	Container	72%	30%		0.027	0.033	21	83	100
Artic truck up to 40 t GVW	Average/ mixed	60%	17%	Diesel, 5% biodiesel blend	0.021	0.025	16	64	80
	Container	72%	30%		0.020	0.024	15	60	75
Artic truck up to 40 t GVW	Average/ mixed	60%	17%	CNG	0.023	-	10	66	75
	Container	72%	30%		0.023	-	10	65	75
	Average/ mixed	60%	17%	LNG	0.023	-	23	65	88
	Container	72%	30%		0.023	-	23	64	87
	Average/ mixed	60%	17%	LNG with 20% bio content	0.023	-	23	52	75
	Container	72%	30%		0.023	-	23	51	75
Artic truck 40 t GVW, inc lightweight trailer	Heavy	100%	38%	Diesel, 5% biodiesel	0.016	0.019	12	48	60
Artic truck up to 44 t GVW	Light	30%	9%	Diesel, 5% biodiesel blend	0.029	0.034	23	87	110
	Average/ mixed	60%	17%		0.018	0.021	14	54	68
	Heavy	100%	38%		0.015	0.018	12	46	58
	Container	72%	30%		0.018	0.021	14	54	67
Artic truck up to 60 t GVW	Average/ mixed	60%	17%	Diesel, 5% biodiesel blend	0.017	0.020	12	51	63
	Heavy	100%	38%		0.014	0.017	11	44	55
	Container	72%	30%		0.017	0.020	13	50	63
Artic truck up to 72 t GVW	Heavy	100%	38%	Diesel, 5% biodiesel blend	0.013	0.014	10	38	48
	Container	72%	30%		0.014	0.017	11	43	54

Table 43. Europe and South America road emission intensity factors

Vehicle characteristics and size	Combined Load Factor & Empty Running	Fuel	Consumption factor (kWh/tkm)
Van ≤ 3.5 t	31%	Electricity	1.1

Table 44. Europe and South America road emission intensity factors

Vehicle characteristics and size	Load characteristics	Basis		Fuel	Consumption factor (kWh/tkm)
		Load Factor	Empty Running		
Rigid truck 3.5–7.5 t GVW	Light	30%	9%	Electricity	0.90
	Average/mixed	60%	17%		0.51
Rigid truck 7.5–12 t GVW	Light	30%	9%		0.68
	Average/mixed	60%	17%		0.39

Region: Asia and Africa*

For vans (up to 3.5 t GVW) apply a 13% uplift to the regional values for Europe and South America.

For heavier vehicles (> 3.5 t GVW) apply a 22% uplift to the regional values for Europe and South America.

Temperature controlled Road Freight**

For vans (up to 3.5 t GVW) apply a 15% uplift to the regional values for Europe, South America, Asia and Africa.

For heavier vehicles (> 3.5 t GVW) apply a 12% uplift to the regional values for Europe, South America, Asia and Africa.

* Based on extrapolation analysis by NTM of data from https://www.theicct.org/publications/literature-review-real-world-fuel-consumption-heavy-duty-vehicles-united-states-china

**Private Communication from TK'Blue, validated using USEPA 2019 SmartWay Truck Carrier Partner Tool Technical Documentation

Sea Transport

Table 45. Sea transport emission intensity factors

Vehicle characteristics and size	Load characteristics	Basis		Fuel	Consumption factor (kg/t-km)	Consumption factor (l/t-km)	Emission intensity (g CO_2e/t-km)		
		Load Factor	Empty Running				WTT	TTW	WTW
Oil tanker <5 dwkt*	Heavy	89%	25%	HFO	0.0178	0.0183	4.6	56	61
	Heavy	89%	25%	MGO	0.0168	0.0186	11	54	66
Oil tanker 5–60 dwkt	Heavy	82%	25%	HFO	0.0062	0.0063	1.6	19	21
	Heavy	82%	25%	MGO	0.0058	0.0064	3.9	19	23
Oil tanker 60–200 dwkt	Heavy	79%	56%	HFO	0.0026	0.0027	0.70	8.1	8.8
	Heavy	79%	56%	MGO	0.0024	0.0027	1.6	7.9	9.5
Oil tanker >200 dwkt	Heavy	89%	52%	HFO	0.0008	0.0008	0.20	2.4	2.6
	Heavy	89%	52%	MGO	0.0007	0.0008	0.50	2.3	2.8
	Heavy	89%	52%	LNG	0.0007	-	0.7	1.9	2.6
General Cargo <10 dwkt	Average/ mixed	85%	31%	HFO	0.0056	0.0057	1.4	17.5	19
	Average/ mixed	85%	31%	MGO	0.0052	0.0058	3.6	16.9	21
General Cargo 10–20 dwkt	Average/ mixed	83%	37%	HFO	0.0039	0.0041	1.0	12	13
	Average/ mixed	83%	37%	MGO	0.0037	0.0041	2.6	12	15
Bulk carrier <10 dwkt	Average	86%	25%	HFO	0.0096	0.0099	2.5	30	33
	Average	86%	25%	MGO	0.0091	0.0101	6.2	29	36
Bulk carrier 10–100 dwkt	Average	85%	43%	HFO	0.0022	0.0022	0.5	6.9	7.4
	Heavy	88%	43%		0.0022	0.0021	0.5	6.7	7.2
	Average	85%	43%	MGO	0.0021	0.0023	1.3	6.7	8.0
	Heavy	88%	43%		0.0020	0.0022	1.4	6.4	7.8
Bulk carrier >100 dwkt	Average	86%	43%	HFO	0.0009	0.0008	0.2	2.7	2.9
	Heavy	90%	43%		0.0008	0.0008	0.2	2.6	2.8
	Average	86%	43%	MGO	0.0008	0.0009	0.5	2.6	3.1
	Heavy	90%	43%		0.0008	0.0009	0.5	2.5	3.0
	Average	86%	43%	LNG	0.0008	-	0.7	2.0	2.7
	Heavy	90%	43%		0.0007	-	0.6	2.0	2.6
Ro-Ro fleet average	Average, freight only	40%	0%	HFO	0.0132	0.0136	3.4	42	45
		40%	0%	MGO	0.0124	0.0140	8.4	40	49
	Truck + Trailer, ave load factor	40%	0%	HFO	0.0295	0.0304	7.6	93	100
		40%	0%	MGO	0.0280	0.0316	19	90	110
	Trailer only, ave load factor	40%	0%	HFO	0.0198	0.0204	5.2	63	68
		40%	0%	MGO	0.0192	0.0217	13	61	74
Ro-Pax	Average	40%	0%	HFO	0.0613	0.0632	16	190	210
		40%	0%	MGO	0.0578	0.0649	39	190	230

* dwkt = 1000 deadweight tonnage (DWT)

Tanker, General cargo and Bulk carrier derived from IMO 3rd GHG study and STREAM (CE Delft)

Ro-Ro 'Average, freight only': Clean Shipping Index Fleet Average

Ro-Ro 'Truck + Trailer' and 'Trailer only' represent derived average values, including allowance for return trips where there is zero return load. Based on 34–40 t articulated truck/truck trailer combination, including average truck loading and empty running characteristics. Tonne-kilometer in these circumstances refers to the net load within the truck.

Ro-Pax derived using fleet modeling data provided by EcoTransIT World on a weight-based allocation basis.

Container Shipping

All the end user factors for containerized shipping are calculated according to the stages presented in the Clean Cargo Working Group methodology [25] (to allow for a 70% industry average load factor and use of a 15% distance conversion, conversion from CO_2 to CO_2e and the inclusion of well-to-tank as well as tank-to-wheel (propeller) emissions.

Default maritime container end user factors are derived from the latest (2017) Clean Cargo trade lane CO_2 emission factors. Three levels of information are presented depending on the level of information about origin and destination known to the user:

- The overall CCWG industry average
- Five sets of aggregated data for major trade lane groupings (see figure below) based on a weighted average of flows on the detailed trade lanes included within each grouping.
- The full set of CCWG trade lanes

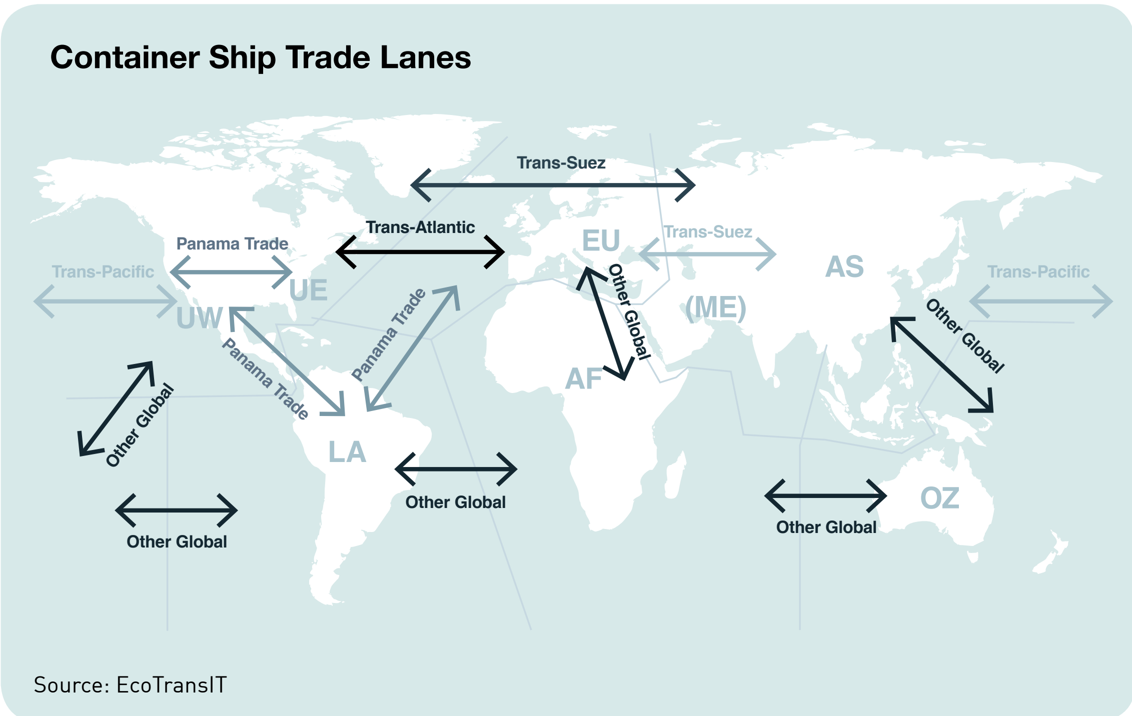

Figure 22. Common trade lanes for sea transport.

For greatest accuracy use the values that correspond to the fullest level of information you know.

Separate factors for temperature controlled (reefer) and ambient (dry) containers are presented at each level.

Table 46. Container ship emission intensity factors

Trade lane		Aggregate average trade lane emission factor	End user factors		
		g CO_2/TEU -km	WTT g CO_2e/TEU-km	TTW g CO_2e/TEU-km	WTW g CO_2e/TEU-km
Industry Average (to be used in cases where the origin-destination pair is unknown)	Dry	47.2	6.7	78	85
	Reefer	80.1	11	130	140
Aggregated Major Trade Lanes					
Panama Trade	Dry	56.8	8.1	94	100
	Reefer	92.7	13	150	170
Trans-Atlantic	Dry	59.3	8.5	98	110
	Reefer	92.1	13	150	170
Trans-Suez	Dry	40.9	5.8	68	74
	Reefer	78.8	11	130	142
Trans-Pacific	Dry	45.8	6.5	76	83
	Reefer	75.6	11	130	140
Other Global	Dry	53.0	7.6	88	95
	Reefer	87.0	12	140	160
Detailed Trade Lanes					
Asia to-from Africa	Dry	48.9	7.0	81	88
	Reefer	83.8	12	140	150
Asia to-from Mediterranean/ Black Sea	Dry	38.8	5.5	64	70
	Reefer	71.4	10	120	130
Asia to-from Middle East/ India	Dry	46.8	6.7	78	84
	Reefer	79.3	11	130	140
Asia to-from North America EC / Gulf	Dry	44.7	6.4	74	81
	Reefer	74.1	11	120	130
Asia to-from North America WC	Dry	46.7	6.7	78	84
	Reefer	76.8	11	130	140
Asia to-from North Europe	Dry	30.5	4.4	51	55
	Reefer	61	8.7	100	110
Asia to-from Oceania	Dry	58.9	8.4	98	110
	Reefer	91.3	13	150	160
Asia to-from South America (incl. Central America)	Dry	41.3	5.9	69	74
	Reefer	71.6	10	120	130
Europe (North & Med) to-from Africa	Dry	61.3	8.7	100	110
	Reefer	101.5	15	170	180
Europe (North & Med) to-from South America (incl. Central America)	Dry	48.6	6.9	81	88
	Reefer	83.4	12	140	150
Europe (North & Med) to-from Middle East/India	Dry	40	5.7	66	72
	Reefer	72.5	10	120	130
Europe (North & Med) to-from Oceania (via Suez / via Panama)	Dry	66.4	9.5	110	120
	Reefer	99.3	14	160	180

Table 46 continued					
Trade lane		**Aggregate average trade lane emission factor**	**End user factors**		
		g CO_2/TEU -km	**WTT g CO_2e/TEU-km**	**TTW g CO_2e/TEU-km**	**WTW g CO_2e/TEU-km**
Detailed Trade Lanes					
Mediterranean/Black Sea to-from North America EC/Gulf	Dry	61.4	8.8	100	110
	Reefer	96.2	14	160	170
Mediterranean/Black Sea to-from North America WC	Dry	51.8	7.4	86	93
	Reefer	84.2	12	140	150
North America EC/Gulf/WC to-from Africa	Dry	71.2	10	120	130
	Reefer	104.7	15	170	190
North America EC/Gulf/WC to-from Oceania	Dry	67.2	9.6	110	120
	Reefer	96.7	14	160	170
North America EC/Gulf/WC to-from South America (incl. Central America)	Dry	63.4	9.0	110	110
	Reefer	99.1	14	160	180
North America EC/Gulf/WC to-from Middle East/India	Dry	53.1	7.6	88	96
	Reefer	84.8	12	140	150
North Europe to-from North America EC/Gulf	Dry	60.4	8.6	100	110
	Reefer	92.6	13	150	170
North Europe to-from North America WC	Dry	58.4	8.3	97	100
	Reefer	88.7	13	150	160
South America (incl. Central America) to-from Africa	Dry	45	6.4	75	81
	Reefer	77.1	11	130	140
Intra Africa	Dry	79.7	11	130	140
	Reefer	130.3	19	220	230
Intra North America EC/Gulf/WC	Dry	117.2	17	190	210
Intra South America	Dry	72.4	10	120	130
	Reefer	114.6	16	190	210
SE Asia to-from NE Asia	Dry	60.2	8.6	100	110
	Reefer	95.1	14	160	170
Intra NE Asia	Dry	58.1	8.3	96	100
	Reefer	102.7	15	170	190
Intra SE Asia	Dry	74.3	11	120	130
	Reefer	118.5	17	200	210
North Europe to-from Mediterranean/Black Sea	Dry	63.1	9.0	100	110
	Reefer	99.7	14	170	180
Intra Mediterranean/Black Sea	Dry	88.6	13	150	160
	Reefer	148	21	250	270
Intra North Europe	Dry	87.1	12	140	160
	Reefer	133.9	19	220	240
Intra Middle East/India	Dry	59.7	8.5	99	110
	Reefer	105.3	15	170	190
Other	Dry	75.2	11	120	140
	Reefer	114.5	16	190	210

Module 3

Refrigerant Emission Factors

Module 3: Refrigerant Emission Factors

From Fraunhofer IML's Guidance for GHG accounting at Logistics Sites.

Table 47. Refrigerant emission factors

Type	Chemical formula	Alternative name	[g CO_2e/g] (EU 517/2014, IPCC 2007)
R-717	NH_3	Ammonia	0.00
R-290	C_3H_8	Propane	3.00
R-600	C_4H_{10}	Butane	4.00
R-744	CO_2	Carbon dioxide	1.00
R-22	$CHClF_2$	Chlorodifluoromethane	1,810.00
R-32	CH_2F_2	Difluoromethane	675.00
R-115	$CClF_2CF_3$	Chloropentafluoroethane	7,360.00
R-125	CHF_2CF_3	Pentafluoroethane	3,500.00
R-134a	CH_2FCF_3	1,1,1,2-Tetrafluorethan	1,430.00
R-143a	CH_3CF_3	1,1,1-Trifluorethan	4,470.00
R-404A	Mixture: (own calculation)	44.0% R-125 4.0% R-134a 52.0% R-143a	3,921.60
R-407C	Mixture: (own calculation)	23.0% R-32 25.0% R-125 52.0% R-134a	1,773.85
R-410A	Mixture: (own calculation)	50.0% R-32 50.0% R-125	2,087.50
R-417C	Mixture: (own calculation)	19.5% R-125 78.8% R-134a 1.7% R-600	1,809.41
R-504	Mixture: (own calculation)	48.2% R-32 51.8% R-115	4,137.83

Module 4

Application of the GLEC Framework for the Mail and Parcel Sector

Module 4: Application of the GLEC Framework for the Mail and Parcel Sector

Individual industry and business sectors often have specific cargo or operational characteristics. This in turn means that there may be a benefit in developing additional guidance or providing specific examples in order to respond to these characteristics, in order to clarify how the GLEC Framework can be implemented to maximize harmonization in approach within a sector.

The mail and parcels sector was identified as an area where an additional review of existing industry practices and guidance would be beneficial.

A summary of the discussions held jointly between SFC, Universal Postal Union (UPU) and a number of postal, parcel, courier companies and freight forwarders* about how the sector operates and assesses its emissions is presented below, followed by a recommendation on approach.

* Input has also been sought from other GLEC members and consultees on specific points.

1. Assessment of the Mail and Parcels Sector

In order to understand the status quo, this project began with an assessment of the sector's activities today, including the following:

- Documenting and aligning existing approaches within the sector and with the GLEC Framework
  - Providing input to the revised GLEC Framework
  - Identifying any areas in need of further research

The project included

1. collecting information about transportation network structures, and
2. comparing the approaches of the UPU's Online Solution for Carbon Analysis and Reporting (OSCAR) tool, the GLEC Framework and the participating companies.

1a. Types of Service

There was a clear differentiation between express and standard services for businesses classed as parcel carriers and between mail and parcel deliveries for more traditional postal companies. Linking these together suggests differentiating up to four service types:

- Mail
- Parcels
- Express
- Palletized deliveries

1b. Network Structure

The logistics activities in this sector can, at high level, be differentiated into three elements:

1. Sorting of the consignments at logistics sites.
2. The trunking (long distance transport) activities whereby individual items are consolidated and transported between the initial and final logistics sites. (This in itself could involve multiple journey segments by different modes; for example an international item may initially be received at a specialized center and sorted before continuing onwards to a local delivery center.)
3. The collection and delivery rounds which involve relatively localized transport activities with multiple collections and deliveries within a single journey that starts and ends at a logistics site.

The calculation of logistics emissions conducted by companies operating in this sector reflects the above operating elements.

2. Emission Calculation in the Mail and Parcels Sector

The presence of three elements requires that calculations of a full mail and parcels transport chain needs to be split into these three elements and then subsequently drawn together.

2a. Logistics Sites

Emissions from the logistics sites were generally not included in calculations due to data availability limitations from third party sites. When they were included, the approach of participating companies followed the GLEC Framework, whereby the total emissions were calculated based on total energy use and appropriate emission factors. Emission intensity values tended to be calculated by allocation according to the throughput of the logistics hub; total weight and the total number of items were the most common metrics, although other metrics are also used.

The inclusion of emissions from logistics sites was most common for hubs operated by the postal operator/logistics service provider themselves (i.e. Scope 1 emissions). Emissions from third party operations, such as at an airport freight handling centre, (i.e. Scope 3 emissions), were also reported albeit it less frequently.

2b. Trunking (Long Distance) Transport

In cases where long distance transport was conducted by a company's own vehicles, Scope 1 emissions were calculated according to actual fuel use, and intensity KPIs were subsequently calculated from a knowledge of the quantity of freight transported. This was most likely to be the case for road transportation, where postal operators in particular have their own fleet of trunking vehicles.

However, the majority of long distance transport, particularly international transport by sea and air, but also much ground transportation by rail and road, is contracted to independent transport providers. For these trunking activities, an activity-based approach following the GLEC Framework was used, where knowledge of the tonne-kilometer transported was combined with an emission intensity value to calculate the total emissions. In general, emissions from trunking activities tended to make up the majority of emissions for items requiring long distance transportation.

2c. Collection and Delivery Rounds

Collection and delivery rounds were the most complex element for this sector when it comes to emissions calculation, with the widest current variation in approach used and associated KPIs.

For mail operations, and some express/courier companies, collection and delivery rounds were conducted by the company's own vehicles (i.e. result in Scope 1 emissions); in such circumstances the total GHG value was generally based on actual fuel information and, as a result, considered reliable. Otherwise, where the collection and delivery rounds were subcontracted, the calculations required either reports of the amount of fuel used by the contractor, or use of activity data for modeling/estimation of the fuel used by the contractors by the customer.

The question of what is the best intensity metric to use to express efficiency and to allocate emissions to each consignment for onward reporting was the most complex to resolve among the group. A contributing factor to the complexity is that, for a dense urban delivery network, the route may be fixed, as is typical for mail services, or dynamic responding to daily demand for other consignment types (e.g. parcels, express, pallets).

The type and typical use of each intensity KPI is summarized in the following table.

Table 48. Transport Phase

Service type	Logistics site	Trunking	Collection & Delivery
Mail	Items processed Weight throughput	(for international) Tonne-km for domestic: Per item average weight average volume	Item average weight average volume
Parcels	Items processed Weight throughput	(for international) Tonne-km for domestic: Per item (average) weight (average) volume	Item (average) weight (average) volume
Express	Items processed Weight throughput	Tonne-km	Item weight Item volume
Pallet	Items processed Pallets dispatched Weight throughput	Tonne-km Pallets transported	Tonne-km Pallet weight No of pallets

The first version of the GLEC Framework deferred to the EN16258 standard for the approach recommended for (multi-stop) collection and delivery rounds. This detailed approach is still included in the Framework's road sector guidance. However, it requires information about the location of every collection and delivery location in order to determine a fair allocation per consignment according to the share of tonne-kilometer out of total tonne-kilometer, based on each origin/destination pair.

This level of detailed information is sometimes collected for high value items that pass through an express network, or for general freight services where a small number of larger items are transported in a shared distribution network; however, for low value and/or small items, where potentially hundreds of items may be distributed in a very dense network, neither the business case for collecting such information nor the increase in accuracy warrant the necessary IT investment to capture the necessary level of detail. Hence, for general mail where delivery densities are generally high, a less data intense per-item approach may be the most practical option.

3. Recommendations

A mix of approaches may be needed due to the divide between Scopes 1 and 3 and the nature of the 3 separate elements of the mail and parcels chain (i.e. logistics site, trunking, and collection and delivery). Always document the approach taken.

Scope 1

Logistics Sites

Set boundaries and goals

- Establish the boundaries of each logistics site from an emission calculation perspective; open discussions with the local management as they will be the ones most likely to know where to find the necessary energy use information; and establish the site throughput in the appropriate units (tonnes preferred for consistency with the overall Framework, although items accepted for mail and parcels services where this is the metric that will be used for the overall system)

Calculating emissions

- Identify annual use per energy type based on available information
- Convert to GHG emissions using relevant emission factor for each energy type as per standard GLEC Framework guidance

Using results

- Total emissions for each site
- Emission intensity per tonne throughput and/or per item

Trunking

Set boundaries and goals

- Identify the full trunking network so that all individual activities (and handling operations) can be included and confirm whether under own operation or subcontracted

Calculating emissions

- For each own operation establish the annual fuel consumption and transport activity in tonne-kilometer
- Convert to GHG emissions using relevant emission factor for each energy type as per standard GLEC Framework guidance

Using results

- Total emissions for each trunking activity
- Emission intensity per tonne-kilometer for each trunking activity

Collection and Delivery

Set boundaries and goals

- Identify the nature of local collection and delivery activities at each logistics site
- Establish if different services operate from the same locations and the extent to which different service levels are integrated/kept separate. (This may have a bearing on whether separate calculations need to be conducted for a single site.)
- Determine the need for a detailed or overview calculation, and whether location data are collected to support a detailed calculation
- Establish if there is a mix of own operation and subcontracting which would also add a level of complexity to the calculation

Calculate emissions

- Identify annual use per energy type based on available information
- Convert to GHG emissions using relevant emission factor for each energy type as per standard GLEC Framework guidance

Using emissions results

- Total emissions for each collection and delivery service at each location
- Emission intensity per tonne km and/or per item

Scope 3

Logistics Sites

Set boundaries and goals

- Find contact details or public reports for each third party logistics site on the network

Calculate emissions

- Engage with identified third party logistics sites to see if they currently calculate emissions, and if so whether they follow the GLEC Framework
- If not, encourage them to start calculating and reporting
- If they follow the GLEC Framework combine reported emission intensity values with known throughput to calculate total emissions
- If not, identify a suitable default emission intensity value as a proxy until better information is available

Using emissions results

- Total emissions for each site
- Emission intensity per tonne throughput and/or per item (for third party operations this is most likely a restatement of the information provided)

Trunking

Set boundaries and goals

- Identify each third party trunking operation on the network

Calculate emissions

- Engage with identified third party transport operator to see if they currently calculate emissions, and if so whether they follow the GLEC Framework
- If not, encourage them to start calculating and reporting
- If they follow the GLEC Framework combine reported emission intensity values with known throughput to calculate total emissions
- If not, identify a suitable default emission intensity value as a proxy until better information is available

Using emissions results

- Total emissions for each trunking activity
- Emission intensity per tonne-kilometer for each trunking activity (for third party operations this is most likely a restatement of the information provided)

Collection and Delivery

Set boundaries and goals

- Identify the nature of local collection and delivery activities at each logistics site and the extent of any subcontracted operations
- Establish whether or not actual fuel data is available for the subcontracted operations

Calculate emissions

- Collect fuel and activity data from the contracted operator or estimate total fuel according to a best knowledge of the vehicle operations conducted
- Convert to GHG emissions using relevant emission factor for each energy type as per standard GLEC Framework guidance

Using emissions results

- Total emissions for each collection and delivery service at each location
- Emission intensity per tonne-km and/or per item

Example

The following example is designed to show how the elements can be combined to calculate the emissions for an item across its full journey. The approach to logistics sites and trunking elements follow the GLEC Framework and are not shown in detail below (although values for logistics sites and trunking elements are quoted in order to show the basis for calculation and reporting of the overall chain), whereas the collection and delivery element benefits from a more detailed explanation of possible approaches.

For collection and delivery rounds the Framework recommends allocating emissions using one of either the detailed EN16258 approach or a simplified per item approach. Use the former when the business case and/or an imperative for accuracy make collecting large amounts of data worthwhile. The use of other KPIs alongside one of the two core KPIs is of course not precluded.

The example considers a hypothetical situation where a 250 gram package is collected from the sender as part of a tracked collection round, inserted into a consolidated, international mail and parcels network and delivered as part of a general, untracked delivery network. The purpose is to show the overall approach and the difference in application at each end of the transport chain. Readers are requested not to debate whether or not this is not a realistic commercial service.

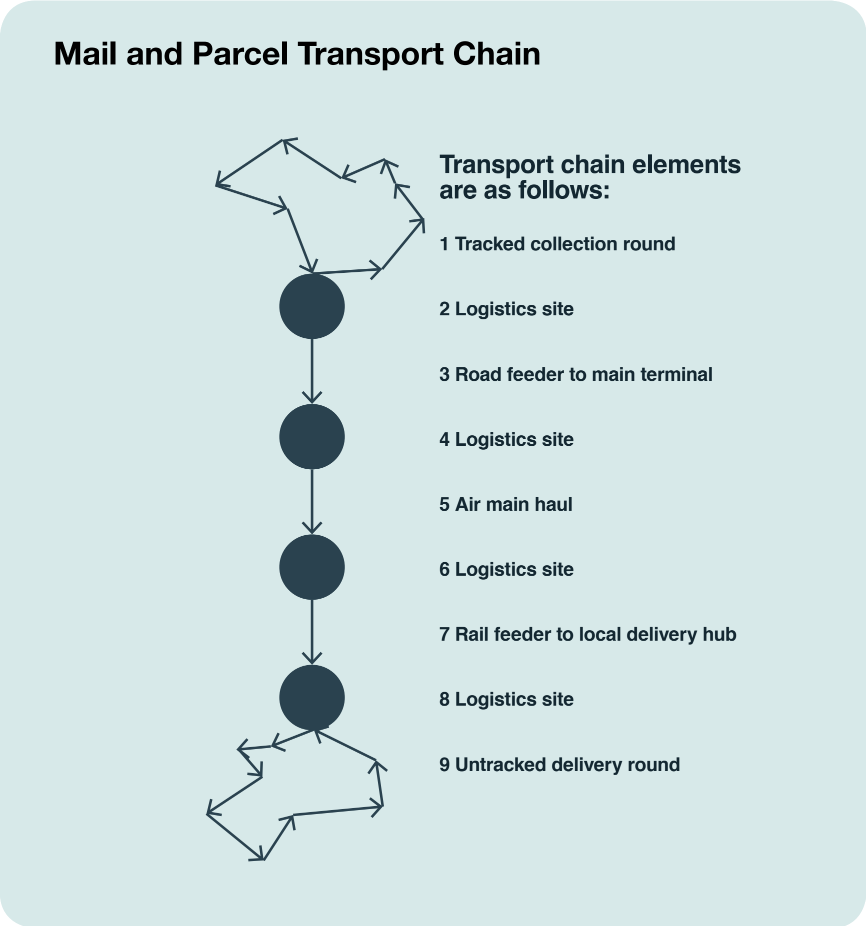

Figure 23. The different elements within a mail and parcel transport chain.

Overall calculation framework from point of collection to delivery. Starting information presented below from logistics site 2 where the collections are processed to logistics site 8 where the deliveries are organized.

Table 49. Sample mail and parcel sector data table

			Emission intensity factor	Unit	Data category	Distance (km)	t-km	Emission kg CO2e
1	Tracked collection round	own transport			Primary		-	A
2	Logistics site	own site	4.1	kg CO_2e/t	Primary	-	-	0.0010
3	Road feeder to main terminal	own transport	0.066	kg CO_2e/ t-km	Primary	120	0.030	0.0020
4	Logistics site	own site	4.6	kg CO_2e/t	Primary	-	-	0.0012
5	Air main haul	own plane	0.563	kg CO_2e/ t-km	Primary	4800	1.200	0.6756
6	Logistics site	shared site	1.2	kg CO_2e/t	Default*	-	-	0.0003
7	Rail feeder to local delivery hub	third party service	0.028	kg CO_2e/ t-km	Default**	400	0.100	0.0028
8	Logistics site	shared site	1.2	kg CO_2e/t	Default*	-	-	0.0003
9	Untracked delivery round	own transport			Primary		-	B

Data category primary implies data sourced from internal company systems. Data category default implies data sourced from GLEC Framework defaults:

* logistics site default, ambient transhipment centre

** European diesel rail default for general cargo

The above information would apply irrespective of the approach used for the collection and delivery rounds.

The remaining task is to calculate the values A and B.

Scenario 1: Tracked collection round

For the tracked collection round the assumption is that information exists or can be calculated relating to the following items:

- total fuel for the collection round
- direct distance between the logistics site and each individual collection point
- weight of each individual item, including packaging
- emission factor to convert fuel to emissions

In the example below 14 collections are shown. The 250 g item that is the focus of this example is collection number 7.

Table 50. Sample mail and parcel sector emissions calculations

14 collections	Distance driven point to point (km)	Direct distance collection location to hub (km)	Item weight (kg)	Total fuel (l)	Direct tkm	Allocation (%)	Emission (kg CO_2e)
Hub							
1	8	7	4		0.0280	7.7%	1.10308
2	2	7.2	1		0.0072	2.0%	0.28365
3	4	9	0.25		0.0023	0.6%	0.08864
4	0.5	8.9	2		0.0178	4.9%	0.70124
5	3	8.6	20		0.1720	47.4%	6.77607
6	1	9	2		0.0180	5.0%	0.70912
7	**2**	**9.5**	**0.25**		**0.0024**	**0.7%**	**0.09356**
8	0.5	9.5	3		0.0285	7.8%	1.12278
9	4	7	0.1		0.0007	0.2%	0.02758
10	2	6	7		0.0420	11.6%	1.65462
11	6	8	2		0.0160	4.4%	0.63033
12	1	7.7	3		0.0231	6.4%	0.91004
13	2	8.3	0.2		0.0017	0.5%	0.06540
14	4	7	0.5		0.0035	1.0%	0.13789
Hub	**4**	**3.5**					
Total	**44**			**4.8**	**0.3631**		**14.304**

Allocation of emissions is based on percentage share of the direct tonne-kilometer for each collected item.

Fuel emission factor used to convert 4.8 liters to 14.304 kg CO_2e is the US WTW value for diesel fuel.

Scenario 2: Untracked collection round

For the untracked delivery round the data requirement is less and relates to the following items:

- total fuel for the delivery round,
- number of items delivered
- emission factor to convert fuel to emissions

For the example the 250 g item is one of 275 items delivered as part of a general mail delivery round.

Total fuel is measured to be 7.3 liters

Fuel per item is 0.0265 l/item

Emission per item is 0.086 kg CO_2e/item, using the EU average WTW value for diesel fuel

The information is now available to insert values A and B into the overall calculation framework:

Table 51. Sample mail and parcel sector calculation results

			Emission intensity factor	Unit	Data category	Distance (km)	t-km	Emission	%
1	Tracked collection round	own transport			Primary		-	0.0936	10.8%
2	Logistics site	own site	4.1	kg CO_2e/t	Primary	-	-	0.0010	0.1%
3	Road feeder to main terminal	own transport	0.066	kg CO_2e/ t-km	Primary	120	0.030	0.0020	0.2%
4	Logistics site	own site	4.6	kg CO_2e/t	Primary	-	-	0.0012	0.1%
5	Air main haul	own plane	0.563	kg CO_2e/ t-km	Primary	4800	1.200	0.6756	78.3%
6	Logistics site	shared site	1.2	kg CO_2e/t	Default*	-	-	0.0003	0.0%
7	Rail feeder to local delivery hub	3rd party service	0.028	kg CO_2e/ t-km	Default**	400	0.100	0.0028	0.3%
8	Logistics site	shared site	1.2	kg CO_2e/t	Default*	-	-	0.0003	0.0%
9	Untracked delivery round	own transport			Primary		-	0.0860	10.0%
	Total							**0.8627**	

* logistics site default, ambient transhipment centre

** European diesel rail default for general cargo