

Emission intensity factors for logistics hubs

by Kerstin Dobers (Fraunhofer IML)¹, Sara Perotti (Politecnico di Milano) and Andrea Fossa (GreenRouter) – updated/extended results (10/2023) –

To overcome the data gap on operational greenhouse gas (GHG) emissions of logistics hubs, the international partners of the GILA project¹ – Fraunhofer IML, Politecnico di Milano, GreenRouter and Universidad de los Andes – organized market studies to update their initial data base on carbon emission intensity values of logistics sites. This document summarizes the approach and outcomes of the three market studies in consecutive years (2020-2023)^{2,3} with the focus on logistics sites offering storage and/or transshipment as well as liquid bulk terminals.

Data collected by each institution were processed, anonymised and finally merged into one database that allowed to elaborate the collected information. The method adopted for the first 2021 market study was replicated and further refined for the 2022 and 2023 editions. After the third market study, all sites were transferred to one anonymised consolidated database, and in case a site participated multiple surveys, the latest consumption data has been used for establishing the results described in the following.

As a result, the GILA database covers 778 logistics real estates and 65 terminals, in total 843 logistics hubs from 51 countries worldwide, 85% of them located in Europe. Their operators have provided annual information on energy consumption, refill of refrigerants, as well as throughput and logistical area indoors. The assessment scope used for calculating average emission intensity values is in accordance with the “Guide for Greenhouse Gas Emissions Accounting at Logistics Sites”⁴ and considers requirements of the ISO 14083⁵. As shown in the following process chart, the collected data was validated as regards to completeness and outliers; a detailed verification of each individual site is not included. For the elaboration of average GHG KPIs, only sites establishing a total carbon footprint calculation were considered.

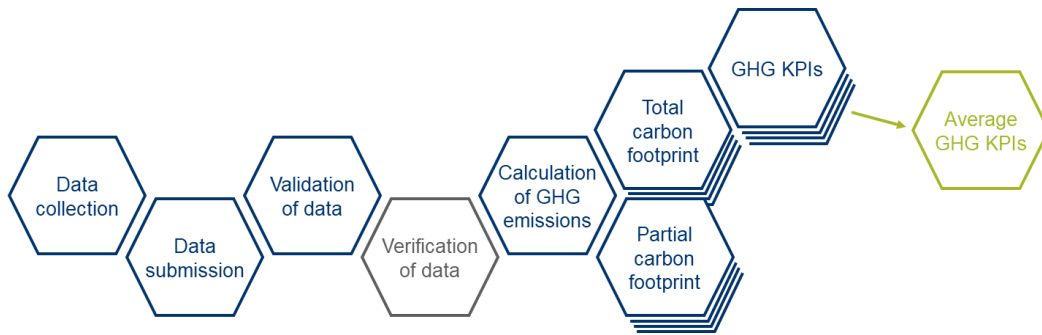
¹ Project information available at https://www.ims.fraunhofer.de/en/fields_of_activity/logistics--traffic--environment/environment_and_resource_logistics/project--gila---german--italian---latin-american-consortium-for-.html

² Dobers, K.; Fossa, A.; Perotti, S.; Jarmer, J.P.: Energy efficiency and GHG emission intensity values for logistics sites. GILA webinar. 02.02.2023. <https://reff.ims.fraunhofer.de/>

³ Dobers, K.; Fossa, A.; Perotti, S.; Jarmer, J.P.: Energy efficiency and GHG emission intensity values for logistics sites. GILA webinar. 03.02.2022.

⁴ Dobers, K.; Rüdiger, D.; Jarmer, J.P.: Guide for Greenhouse Gas Emissions Accounting at Logistics Sites. 2018. ISBN 978-3-8396-1434-1. <http://publica.fraunhofer.de/documents/N-532019.html>; currently under revision for covering ISO 14083:2023 requirements

⁵ ISO 14083:2023. Greenhouse gases – Quantification and reporting of greenhouse gas emissions arising from transport chain operations. <https://www.iso.org/standard/78864.html>



Due to varying data availability and quality (e.g. completeness of consumption data according to assessment scope, provision of base units throughput and size), a reduced number of 242 hubs has been used to calculate tonne-based emission intensity values per hub (420 hubs for m² based emission intensity values). This database differentiates four hub types, i.e.

- (1) Hubs where transshipment is the main service (>80 % of goods handled)
- (2) Hubs where both transshipment and warehousing are relevant services
- (3) Hubs where warehousing is the main service (>80 % of goods handled), and
- (4) Liquid bulk terminals.

As an additional categorization, the hub conditions have been used by differentiation between ambient, chilled, frozen, or mixed temperature hubs.

The hub sizes vary from a few tonnes to more than 1 million tonnes outbound, with 52 000 tonnes as median value for storage and transshipment sites and 250 to 170 million tonnes with a median value of 800 000 tonnes for liquid bulk terminals. 40% of the operators specified that they use a hub-specific electricity mix. However, only an average national emission factor for the relevant year was used for calculating the average emission intensity value as specified in the table below. Natural gas is the main heating energy source, although liquid bulk terminals also use steam for heating purposes. Energy sources for non-electrified material handling are diesel, biodiesel, LNG, or LPG. The refrigerant types R-717, R-404A and R-410A are the most frequently used ones as specified by the participating hubs.

The following tables summarize the results of average GHG emission intensity values of the sample size, allocated to one of the defined hub types. The relevant sample size per hub type is outlined in brackets.

Logistics hub emission intensity values for different types (tonne-based)

	Ambient	Mixed
Transshipment	0.6 kg CO ₂ e / t (56)	2.2 kg CO ₂ e / t (6)
Storage + transshipment	2.1 kg CO ₂ e / t (58)	4.0 kg CO ₂ e / t (9)
Warehouse	17.5 kg CO ₂ e / t (49)	33.0 kg CO ₂ e / t (3)
Liquid bulk terminals	3.1 kg CO ₂ e / t (22)	8.1 kg CO ₂ e / t (29)

Logistics hub emission intensity values for different types (square meter-based)

	Ambient		Mixed	
Transshipment	16.7 kg CO ₂ e / m ²	(61)	19.5 kg CO ₂ e / m ²	(7)
Storage + transshipment	28.0 kg CO ₂ e / m ²	(124)	64.4 kg CO ₂ e / m ²	(43)
Warehouse	23.6 kg CO ₂ e / m ²	(138)	22.8 kg CO ₂ e / m ²	(21)

	Chilled		Frozen	
Storage + transshipment	68.0 kg CO ₂ e / m ²	(12)	103.3 kg CO ₂ e / m ²	(9)

Considering the constrained sample size, further interpreting the data at this point looks inappropriate. Still, it is crucial to emphasize the relevance for further research to establish useful average emission intensity values for logistics sites in the future, instead. For example, next to extending the database and its global coverage, we plan to link the hubs' performance indicators with their status of implementation of green measures, such as investments in energy efficiency technology and strategies. For this, the market study also covers a list of around measures, companies can select as implemented or the relevant degree of priority.

In spring **2024** there will be the **next market study** for extending the sample size. Interested companies can participate in the future market studies by using the REff Tool® or as participant in the Osservatorio Contract Logistics "Gino Marchet" of Politecnico di Milano. A consolidated analysis and elaboration of annually updated KPIs is planned, which combines all data sets from the international market studies performed until then.

For participating in this work, please contact us!
 Updates are published on <https://reff.Impl.fraunhofer.de/>.

Data requirements for participating in annual market study

Data collection of the market study is realised by using e.g. the REff Tool[®]. Here, each company receives its own database, so that confidentiality is guaranteed.

Information required for participation covers the following:

- Specification of hub (name, location, country)
- Classification of hub (warehouse, transshipment, storage & transshipment, terminal types: container, liquid bulk, dry bulk, roll on/roll off)
- Temperature requirement(s) (ambient, chilled, frozen, heated)
- Reporting year (12 months)
- Annual consumption of resources:
 - Electricity,
 - Heating energy (natural gas, biogas, heating oil, district heating, LPG, geothermal energy, wood chips, wood pellets, steam, diesel),
 - Other energy used for e.g., material handling (diesel, biodiesel, petrol, ethanol, LPG, LNG, CNG, hydrogen)
 - Refrigerants
- Annual throughput.

This information is needed to realise the quantification of greenhouse gas emissions and emission intensity values as required by the ISO 14083:2023.

We also ask for additional information (e.g. size of logistics buildings), so that we can analyse and classify participating hubs in more detail.

Please support this research by

- Participating with your own hubs (one or more hubs),
- Involving your sub-contractors in these activities.

