Experimental proposal

Logistic Green Label lite

a prototype to get to Logistic Green Label

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Summary and objectives of the proposal

The Logistic Green Label aims to introduce an innovative system of **environmental sustainability certification of shipments** for the logistics sector, based on a quantitative and objective analysis of the environmental impact of shipments and subsequent compensation. This approach adopts a range of criteria to assess logistics sustainability, considering key parameters such as CO_2 equivalent (CO_2e) emissions, air pollution, waste management and the social impact of logistics operations.

This document proposes the implementation of **Logistic Green Label lite**, a prototype of the certification model *Logistic Green Label* (the complete one).

The adoption of a standardized sustainability label can encourage logistics practices with a lower environmental impact, providing companies and consumers with a tool for evaluating the eco-sustainability of shipments.

The proposed model represents a starting point for further developments, including advanced parameters relating to energy management and the life cycle of packaging, with the aim of refining methods of measuring environmental impact and promoting truly sustainable logistics.

La Logistic Green Label

The project of Logistic Green Label intends to promote the concept of Green Logistics through the use of a talking shipping label, which tells the level of sustainability of the shipment itself. The concept of sustainability aims to be as broad as possible, objectively analyzing all the possible pressures that man exerts on the natural and social environment to manage logistical processes, outside and inside the warehouse: air pollution, carbon dioxide emissions, as well as the waste produced by the disposal of packaging, the exploitation of workers, discrimination and the impact on public health.

Each shipment will be able to obtain Logistic Green Label certification if it causes no negative environmental impact on the environment.

The Logistic Green Label was created to allow a complete and impartial impact measurement, to communicate to all interested parties, in a fair and transparent manner, the degree of sustainability of each shipment.

Thanks to a standard and international certification, which takes into consideration the entire logistics chain, the assessment of the level of sustainability of each shipment is more credible and can represent a real stimulus to the collective commitment to safeguarding the planet.

Interested parties:

- ➢ The natural environment requires adequate actions to safeguard it.
- ➢ Consumers must be informed with maximum transparency on the level of sustainability relating to the management of their orders.
- ➢ Logistics operators (storage and transport of goods) must be able to control the work della Green Label to ensure that the assessments concerning them are correct. Their collaboration is fundamental to obtain consistent data regarding the calculation of their emissions.
- ➢ Operators in the packaging sector, as well as manufacturers of motor vehicles and other technical equipment, must be able to advise on the most appropriate methods of evaluating the products that concern them.
- ➢ Logistics support service companies, including companies that provide management services (administrative, warehouse, WMS) that will be able to support the provision of data necessary to organize fulfillment and shipping operations.
- ➢ Finally, commercial companies (individual merchants or marketplaces) must be able to bring their own experience and recommend appropriate strategies for feasible applicability, not in conflict with commercial processes.

The organization Logistic Green Label

The Decentralized Autonomous Logistic Green Label Organization (DAO) is a non-profit organization, democratically managed by all stakeholders.

The DAO is structured as follows:

- ➢ The **Advisory teams** have the role of proposing the strategies and operating rules of the company to the decision-making body Logistic Green Label.
- ➢ The **Decision body** it is represented by the DAO itself. Voting takes place through a democratic process in which each participant expresses their preferences whose weight on the final decision is proportional to the quantity of tokens owned. Tokens are distributed based on pre-established and transparent rules.
- ➢ The **Steering committee**, made up of 9 members, coordinated by the general secretary, elected by the members of the DAO. This committee has the task of proposing the strategic vision of the DAO to the decision-making body and managing its implementation

The organization's website is www.logisticgreenlabel.org

The advisory commissions are as follows:

- ➢ *Transport Commission:*
  It has the task of defining the elements and calculation methods to quantify the environmental impact relating to goods transport, considering all the variables involved: routes, vehicles used, etc...
- ➢ *Commissione Packaging:*
  It has the task of defining the elements and calculation methods to quantify the environmental impact relating to the packaging used to manage shipments. It also defines best practices and selects recommended technological solutions to manage sustainable shipments.
- ➢ *Warehousing Commission:*
  It has the task of defining the elements and calculation methods to quantify the environmental impact relating to the activities that take place inside the warehouse and its boundaries. It also defines best practices and selects recommended technological solutions to manage sustainable warehousing activities.
- ➢ *Compensation Commission:*
  It is responsible for defining possible ways of compensating (and virtuous examples) of the environmental pressures produced by the Transport, Packaging and Warehousing areas. Each compensation must be measurable, in order to be able to be compared with pressure measurements.
- ➢ *Standard Commission:*
  It has the task of defining the standards to which the management of the Green Label must comply: the format of the labels and the correct use of the brand, the issuing procedures, the control methods, etc. This commission will work in synergy with the others, in order to be able to collect homogeneous data relating to the measurement of impacts and compensations.

- *Communication Commission:*
  It has the task of supporting internal communication processes and managing external communication activities (multilingual), consistently with the wishes expressed by the DAO. It also has the task of coordinating and controlling communication activities towards third parties carried out by individual members of the DAO, in order to enforce the wishes of the DAO itself.

The environmental pressures of transport

To measure the environmental impact of freight transportation, the GLEC Framework v3 (Global Logistics Emissions Council), developed by Smart Freight Center (SFC), provides a standardized approach for calculating greenhouse gas (GHG) emissions and other environmental pressures along the supply chain. This method is based on established metrics, such as energy consumption and CO_2e emissions per transport unit, allowing companies to quantify and reduce their environmental impact.

Smart Freight Center (SFC) is a global non-profit organization, headquartered in the Netherlands, that focuses on promoting sustainable transportation and logistics globally. The main objective of SFC is to reduce greenhouse gas (GHG) emissions and improve efficiency in the freight transport sector through the adoption of common practices and standards. One of the key contributions of the Smart Freight Center is the GLEC Framework, which supports companies in measuring, reducing and reporting carbon emissions related to freight transport. The GLEC V3 allows you to calculate CO_2e emissions (CO_2 equivalent) plus other pollutants (NOx, PM, etc.) across the entire supply chain. Each transport mode has a different emission factor (g CO_2e per tonne-kilometre, tkm).

The organization's website is www.smartfreightcentre.org

The basic formula according to the GLEC to calculate emissions using the data collected above is:

$$CO_2e \text{ emissions} = \text{Distance traveled} \times \text{Emission Factor} \times \text{Load Weight}$$

CO2e definition

CO_2e (CO_2 equivalent) is a unit of measurement used to quantify and compare the impact of different greenhouse gases, translating them all in terms of "carbon dioxide equivalents" (CO_2). CO_2e is used by various actors involved in managing the environment and fighting climate change, including governments and international organizations, verifiers, NGOs and environmental research groups as it facilitates the monitoring and comparison of greenhouse gas emissions.

Each greenhouse gas has a different Global Warming Potential (GWP), which represents a gas's ability to trap heat in the atmosphere compared to CO_2. CO_2 has a GWP of 1 by definition. Other greenhouse gases, such as methane (CH_4) and nitrous oxide (N_2O), have higher GWPs because they trap heat more effectively:

- Methane (CH_4): GWP approximately 28-36 times higher than CO_2.
- Nitrous oxide (N_2O): GWP approximately 298 times higher than CO_2.

- ➢ Fluorinated gases: GWP that can be thousands of times higher than CO_2.

When measuring the overall environmental impact, we convert the amount of each greenhouse gas emitted into CO_2 equivalent using its GWP. For example, an emission of 1 ton of methane is equivalent to approximately 28-36 tons of CO_2e.

The global panorama of measurements

The global panorama of environmental measurements is based on a series of standards and initiatives aimed at ensuring uniformity, transparency and comparability in the data collected. In this context, several international organizations have developed guidelines and protocols to support companies and institutions in assessing environmental impacts. One of the important references in this area is the **Global Logistics Emissions Council (GLEC)**, which provides a methodological framework for measuring and reporting emissions in the logistics and transport sector. This initiative aims to harmonize emissions calculation practices at a global level, facilitating comparison between different players in the sector.

Another significant standard is the **ISO 14084**, which provides guidelines for environmental management through performance evaluation and continuous improvement. This standard fits into the broader framework of ISO regulations dedicated to sustainability, representing a useful tool for organizations that intend to monitor and reduce their environmental impact.

These tools and methodologies constitute an important basis for companies that want to adopt sustainable practices and improve their environmental efficiency, contributing to more responsible management of resources and the reduction of emissions globally.

The environmental pressures of logistics centers

The logistics hub emissions boundary begins when the goods are unloaded from the arriving vehicle and ends when the goods are reloaded onto the departing vehicle. The GLEC Framework considers emissions from logistics hubs as those emitted from the fuel and electricity used to unload/load or move goods at the hub, and from direct leaks of refrigerants used in temperature control equipment.

To identify the emission intensity applicable to a specific TCE, it is necessary to establish which HOC (Hub Operation Chain) this TCE can be connected to. HOC is a group of hub operations that share similar characteristics, in a defined period, which is usually one calendar year, unless otherwise indicated and explained in the relevant report.

Recommended clusters for hub operation categories (HOC) are based on:

- ➢ Processes: Cargo transshipment only, Passenger transfer only, Combined passenger/cargo transfer, Cargo transshipment and storage
- ➢ Types of goods: medium/mixed, containerized or exchangeable, palletised, break bulk/piece goods, dry bulk, liquid bulk, vehicle transport, other

➢ Conditions: ambient, temperature controlled

The calculation of CO_2e emissions related to warehousing according to the GLEC Framework v3 guidelines, is based on a methodology that allows estimating greenhouse gas emissions associated with logistics activities, including warehouses and distribution centers.

Formula for calculating CO_2e emissions for warehousing

$$CO_2e \text{ emissions} =$$

$$\text{Total energy consumption of the warehouse x Emission factor x } \frac{Volume\ used}{Warehouse\ volume}$$

Packaging

Packaging represents an essential component in the logistics and distribution of goods, but its environmental impact is significant throughout its life cycle. CO_2e emissions mainly derive from the production of materials, transport and disposal phases, with substantial differences depending on whether they are plastic, paper, glass or metal. Each material has its own carbon footprint, influenced by the extraction of raw materials, industrial processes and the possibility of being recycled or reused. In addition to direct emissions, the problem of disposal further impacts the environment: non-recycled packaging often ends up in landfills or is incinerated, generating further emissions and consuming space and resources.

An even more critical aspect concerns environmental dispersion, with millions of tons of plastic and other waste accumulating in terrestrial and marine ecosystems every year, causing damage to biodiversity and human health.

The **GHG Protocol** is an international standard developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) to measure and manage greenhouse gas emissions. It is the most widely used framework in the world for calculating the carbon footprint of companies, products and services.

The organization's website is www.wri.org

With a view to calculating the carbon footprint of packaging, the GHG Protocol provides detailed guidelines on how to collect data relating to emissions throughout the entire life cycle of packaging (from production to disposal). This standard is essential to ensure a rigorous and consistent approach in quantifying CO2e emissions related to packaging.

The **ISO 14067** is an international standard that defines the requirements for the quantification and communication of the carbon footprint of products (CFP), which includes packaging. It is based on life cycle analysis (LCA) and follows the guidelines of ISO 14040 and ISO 14044 to evaluate the CO2 emissions associated with each phase of the product's life cycle.

In the context of packaging, ISO 14067 helps standardize how companies calculate and report CO2e emissions associated with packaging, ensuring transparency, accuracy and comparability between different assessments. It can be particularly useful for certifying packaging as having a low environmental impact or for communicating results to consumers and stakeholders.

Both standards provide a solid and recognized framework for establishing internal standards for calculating the carbon footprint of packaging.

The emission factors for the **disposal** they represent a measure of CO_2e emissions, associated with the different methods of waste disposal. These factors vary depending on the material, disposal method and technologies used.

The environmental impact of packaging is not limited only to correct disposal, but is aggravated by environmental phenomena **dispersion into the environment**. This dispersed waste causes severe damage to terrestrial and marine ecosystems, contributing to biodiversity loss, soil and water pollution and even climate change.

Steps to calculate CO_2e emissions of packaging

The first step to calculate CO_2 emissions of packaging is to consider the life cycle of packaging, which includes all phases from the production of raw materials to disposal. The key stages to consider are:

- *Production of raw materials* (e.g. paper, plastic, glass, metal).
- *Packaging manufacturing processes.*
- *Transportation and distribution.*
- *Use and disposal (recycling or incineration).*

For each phase of the life cycle, specific data is collected regarding energy consumption, use of raw materials and distances traveled during transport. Some tools for calculating the carbon footprint such as the GHG Protocol or LCA database (e.g. Ecoinvent, GaBi) provide information on the emission factors relating to various materials and processes.

Formula for calculating CO_2e emissions

$$CO_2e \text{ emissions} = \sum_{i=1}^{n} (m_i \times EF_i)$$

Where:

- m_i : is the quantity of each material used for packaging in kg
- EFi_i: is the CO_2e emission factor for the i-th material, expressed in kg CO_2e. This factor depends on the type of material (e.g. paper, plastic, glass) and the production and transportation processes used.

Common emission factors (indicative)

- ➢ Cardboard: approximately 0.8-1.1 kg CO2e per kg of cardboard.
- ➢ Plastic (PET): approximately 2.3-3.5 kg CO2e per kg of plastic.
- ➢ Glass: approximately 0.5-1 kg CO2e per kg of glass.
- ➢ Aluminium: approximately 9-13 kg CO2e per kg of aluminium.

Certification of the materials used

In the calculation of CO_2e emissions related to packaging, the universally recognized certifications of materials play a crucial role, as they guarantee traceability, sustainability and reduction of environmental impact throughout the entire life cycle of the packaging. Using certified materials means relying on consolidated standards that evaluate aspects such as the origin of the raw materials, energy consumption in production processes, recyclability and the possible compostability of the materials.

Certifications such as **FSC** (Forest Stewardship Council) for paper and cardboard, **PEFC** (Programme for the Endorsement of Forest Certification) for the sustainable management of forests, or **Cradle to Cradle** (C2C) for materials designed according to circular economy principles, offer guarantees on the sustainability of packaging and can significantly reduce the carbon footprint compared to non-certified materials.

Measurement and compensation

To define an emissions compensation standard, it is essential to start from the criteria we want to adopt to evaluate the effectiveness of the different strategies.

The shipment's Logistic Green Label will include all information about the chosen compensation project:

- ➢ **Type of project and certification**: details on the type of project (Nature Based Solutions, Hybrid Solutions, Engineered Solutions), on the provider and on the certifications that guarantee credit quality (for example, VCS, Gold Standard).

  NBS projects are carbon avoidance or carbon removal projects based on expansion, conservation or protection actions of natural ecosystems.

  ES solutions involve the use of man-made technologies and innovative processes to capture and store greenhouse gas emissions from the atmosphere. These solutions are more focused on directly mitigating emissions, rather than relying on natural ecosystems.

  Hybrid solutions represent an innovative approach that integrates both nature-based and engineered solutions to maximize CO removal$_2$2 from the atmosphere. The goal of hybrid removal projects is to maximize carbon removal efficiency and environmental benefits through a synergistic approach.

- **Quantity of CO_2e compensated**: quantity of emissions offset and environmental benefits, such as support for biodiversity or efficiency of carbon reabsorption.
- **Transparency of compensations**: the details of the compensation credits are recorded to offer stakeholders and customers the possibility to verify and trace the path of the compensation itself.

The principles underlying the standard require that compensation be additional, permanent and verifiable.

Offsetting emissions through NBS projects, such as reforestation (replanting trees in deforested areas) or afforestation (planting trees in areas where there have never been any), helps balance greenhouse gas emissions generated by various activities. Trees, during photosynthesis, absorb CO_2 from the atmosphere, transforming it into biomass. Each tree absorbs a variable amount of CO_2e depending on the species, age and growing conditions, but on average a tree can absorb around 20-25 kg of CO_2 per year.

Certified compensation projects

To ensure the effectiveness of Carbon Removal projects, many organizations follow international certification standards, such as **Verified Carbon Standard (VCS**), The **Gold Standard** or the United Nations criteria. These certifications ensure that the projects respect parameters of transparency, sustainability and monitoring of actual absorption capacities.

Certification

The Logistic Green Label project was born with the ambition of creating a transparent and reliable system for the certification of sustainability in logistics. One of the long-term goals is the establishment of a **public register of certifications**, which could be based on blockchain technology to ensure data immutability and traceability. This would allow all interested parties - companies, consumers and institutions - to easily verify information relating to emissions and environmental impacts of logistics activities.

The idea is to develop **a recognizable label** and **brand**, which can become a reference standard for anyone who wants to demonstrate their commitment to reducing environmental impact. However, to ensure the credibility and governance of this system, a solid organizational structure will be needed. For this reason, we imagine that the management of the certification is entrusted to a body that is an emanation of the DAO (Decentralized Autonomous Organization) Logistic Green Label, thus guaranteeing a decentralized, collaborative and transparent approach.

We are aware that this is only the beginning of an ambitious journey, with many challenges to face. We don't have all the answers, but we believe that, step by step, with the contribution of those who share this vision, we can build something significant for the future of **sustainable logistics**.

La Logistic Green Label lite

The Logistic Green Label lite represents a **prototype** preliminary version of the Logistic Green Label project, implemented before the final version. This Lite version allows you to concretely test the entire system in real operating conditions, collecting essential data to optimize the certification process and ensure that it fully meets the set sustainability objectives.

To achieve the Logistic Green Label lite, we have designed a **simplified version of the system** which generates the Logistic Green Label for each shipment. This version collects specific data for each shipment, using standardized formulas to calculate emissions and determine related offset costs.

Although we are aware that the Lite version does not yet represent the final product, we consider this intermediate phase fundamental for gathering information, validating operational hypotheses and concretely starting the project. This initial phase constitutes a solid foundation from which to evolve towards a more advanced and performing version. Throughout this document we will delve into the current limitations of the system and clearly define the strategic objectives necessary to overcome them.

In summary, the Logistic Green Label lite offers a valuable opportunity to collect reliable data, refine evaluation criteria and consolidate the credibility of the Green Label before final release.

Method of calculating CO2e emissions

Starting from the basic formula for calculating CO_2e emissions **GLEC Framework v3** in freight transport, which links the distance travelled, the emission factor and the weight of the load, other parameters are considered in order to make the calculation more precise and adaptable to the operational reality of a shipment through a generalized form that is inspired by various models for calculating emissions in the transport sector developed in scientific contexts.

In fact, the initial formula does not take into account significant variables such as the volume of the shipment, the efficiency of the means of transport based on the type of load and the additional emissions deriving from other phases of the logistics process.

We thus arrive at a more complex formula, which also considers the volume, the weighting coefficients and indirect emissions:

$$CO_2e = E_f \times \left(\alpha \frac{P}{1000} + \beta V \right) \times D + E_m$$

Logistic Green Label lite parameters

- CO_2e is the total quantity of equivalent CO_2 emitted (expressed in kg CO_2e)
- E_f is the specific emission factor of the means of transport (kg CO_2e per tonne-km);
- P is the weight of the shipment (in kg);
- V shipment volume (in m^3)
- D is the distance traveled (in km);
- α is the coefficient that weighs the relative importance of weight in the fuel consumption of the means of transport (dimensional)
- β is the coefficient that weighs the relative importance of the volume in the fuel consumption of the means of transport. with dimensional unit $[\frac{ton}{m^3}]$
- E_m represents the indirect or additional emissions deriving from the parking and handling of the package in the warehouses (in kg CO_2e)

How to choose the emission factor E_f ?

The value of E_f it depends on the means of transport and its efficiency.
Some typical values collected from institutional sources (ISPRA, IPCC, GHG Protocol, MASE) are:

- ➢ Airplane: 0.5 - 1.5 kg CO_2e per tonne-km
- ➢ Truck: 0.1 - 0.15 kg CO_2e per tonne-km
- ➢ Train: 0.02 - 0.06 kg CO_2e per tonne-km
- ➢ Ship: 0.005 - 0.02 kg CO_2e per tonne-km

The choice of emission factor values for the Lite version of the Green Label follows a conservative and pragmatic criterion. To determine which value to choose for each means of transport, we adopt a conservative approach to avoid underestimating the impact the environmental impact. We assume a worst-case scenario, we opt for the upper limit of the values indicated for each means of transport.

Let's analyze why the higher values of the range are used for each transport mode:

Aircraft = 1.5 kg CO_2e per tonne-km

The plane is one of the means of transport with the greatest environmental impact. The choice of the upper limit of 1.5 kg CO_2e per tonne-km is justified by the fact that among the available values, the highest was adopted to guarantee an estimate that considers the most unfavorable scenario and does not underestimate the environmental impact.

Truck = 0.15 kg CO_2e per tonne-km

Trucks, although more efficient than airplanes, are still a major source of emissions in land transportation.

Choosing 0.15 kg CO_2e per tonne-km represents a conservative assessment, taking into account situations where the truck may be less efficient (for example, on routes with non-optimized loads or with less efficient vehicles).

Train = 0.06 kg CO_2e per tonne-km

Trains are one of the most environmentally friendly means of transport compared to others, especially if powered by renewable energy sources. However, in order not to underestimate the impact, the maximum value of 0.06 kg CO_2e per tonne-km is chosen, which takes into consideration a system that is not optimized or powered entirely by renewable sources.

Ship = 0.02 kg CO_2e per tonne-km

Ships, despite having a lower impact than other vehicles, continue to be an important source of emissions, especially if they are not optimized for efficiency.

The choice of the upper limit (0.02 kg CO_2e per tonne-km) takes into account conditions in which naval transport is not particularly efficient or in which fossil fuels are used.

For mixed trips we carry out an interpolation between the previous values based on the specific characteristics of the shipping service used.

Calculation examples:

- Ef of a plane and truck trip:

  99% x 1,5 + 1% x 0.15 = **1.4865 kg CO_2e per tonne-km**

- Ef of a ship and truck trip:

  95% x 0,02 + 5% x 0.15 = **0.0265 kg CO_2e per tonne-km**

- Ef of a train and truck trip:

  95% x 0,06 + 5% x 0.15 = **0.0645 kg CO_2e per tonne-km**

Emission factors table

Means used	**Emission factor** [kg CO_2e per tonne-km]
Airplane	1,50
Truck	0,15
Train	0,06
Ship	0,02
Truck and plane (example with 1% + 99%)	1,4865
Truck and ship (example with 5% + 95%)	0,0265
Truck and train (example with 5% + 95%)	0,0645

How to choose the additional contribution E_m ?

The parameter E_m it will depend on the type of warehouse, the dwell time and the operating methods (energy used for heating, lighting, any means of handling the package). The estimate could be based on the type of facility, its size, energy management and the type of internal transportation used.

Some studies in the sector (Energy Star e l'International Energy Agency) indicate that for complex logistics operations (which include warehouses with internal handling), emissions could average approximately **0.1 - 0.3 kg CO_2e** per unit of activity (such as a pallet stop or an internal movement).

For the Logistic Green Label lite certification, we proceed with a simplification, we put ourselves in the worst case scenario and choose the negative extreme.

E_m= 0.3 kg CO_2e for each stop made in the warehouse by a single package.

E_m=0 if the route of the specific shipment is unique and direct.

What do the coefficients α and β depend on?

The coefficients α and β (which weight weight and volume respectively in the CO_2e emissions formula) depend on physical and operational factors related to transport, in particular:

- **Type of means of transport** 🚚✈️🚢

  In land and sea transport, weight tends to be more decisive than volume, so α is greater than β.

  In air transport, volume may be more influential, as space in the hold is often the limiting factor, so β may be comparable to or greater than α.

- **Load efficiency** 📦

  If a vehicle is fully loaded, weight is the main factor (α ≫ β).

  If it travels partially loaded, the volume may become more relevant, because the available payload is limited (α≈β).

- **Aerodynamic resistance and friction** 🌬️

  For trucks and trains, friction with the ground is proportional to weight.

  For airplanes, the aerodynamic drag depends on the volume and shape of the load.

It is assumed that weight and volume are the only relevant factors and that their impact on emissions is always proportionate to the use of the space available in the means of transport, for this reason → **α+β=1**

The parameters α and β can be determined in two ways:

1. Empirical estimate based on historical data 📊

- Data is collected from real shipments with different combinations of weight, volume and distance.
- One is carried out **statistical regression** (for example, with a logarithmic regression model) to find the optimal values of α and β.
- If the data shows that emissions increase more with weight than with volume, we will have α> β.

2. Use of theoretical models ⚙️

- For transport **road and rail**, studies by International Council on Clean Transportation (ICCT) show that the weight impact is approx **2-3 times greater** with respect to the volume, therefore we can assume:

$$\alpha \approx 0.7 \quad \beta \approx 0.3$$

- For transportation **airplane**, the volume is critical, therefore:

$$\alpha \approx 0.4 \quad \beta \approx 0.6$$

- For transportation **maritime**, weight dominates, therefore:

$$\alpha \approx 0.7 \quad \beta \approx 0.3$$

In the Logistic Green Label method, these theoretical models are adopted to calculate emissions, in order to have a more precise estimate of the CO_2e emitted during the transport of goods.

General formula for mixed transport

If the transport is divided into two segments (for example, part by plane and part by truck), we can calculate the coefficients α and β by combining the values for each vehicle weighted by the distance travelled.

Let's define:

- d_a = relative distance (percentage) traveled by vehicle a
- d_b = relative distance (percentage) traveled by vehicle c
- α_a, β_a = coefficients for the medium a
- α_b, β_b = coefficients for the medium b

We will therefore have:

$$\alpha_{mix} = d_a \times \alpha_a + d_b \times \alpha_b$$

$$\beta_{mix} = d_a \times \beta_a + d_b \times \beta_b$$

Table of coefficients α, β

	α	β
Airplane	0,4	0,6
Truck	0,7	0,3
Train	0,7	0,3
Ship	0,7	0,3
Truck and plane (example with 1% + 99%)	0,403	0,597
Truck and ship (example with 5% + 95%)	0,7	0,3
Truck and train (example with 5% + 95%)	0,7	0,3

Examples of application of the calculation method

In the following examples, to calculate the cost, we will consider a standard cost for compensating each Kg of CO_2 equivalent of €0.05. We based this estimate by considering an average of the absorption capacity of a tree, the relative cost (Treedom estimates) and the relative useful life of the same. We are aware that this is an illustrative estimate subject to much variability depending on the compensation method used.

Ex1: Shipping of a shoe box from Padova to Salerno by truck

Journey: 733 km entirely traveled by truck (with 2 warehouse handling opertions)

Box dimensions: 35 x 22 x 13 cm = 0.01001 cubic meters with a weight of 1 kg.

α	β	E_f [kg CO_2e per tonne-km]	E_m [kg CO_2e]
0,7	0,3	0,15	2 x 0,3 = 0,6

$$CO_2e = 0.15 \times (0,7 \frac{1}{1000} + 0.3 \times 0.01001) \times 733 + 0.6 = 1.01 \text{ kg } CO_2e$$

The compensation cost will therefore be approximately €0.05

Ex. 2: Shipping a smartphone from Shanghai to Rome by air

Journey: 9300 km by air (99% of the route) and truck (1% of the route) with 5 warehouse stops.

Box dimensions: 20 x 10 x 5 cm = 0.00100 cubic meters with a weight of 0.6 kg.

α	**β**	$\mathbf{E_f}$ [kg CO_2e per tonne-km]	$\mathbf{E_m}$ [kg CO_2e]
99%*0,4+1%*0,7 = 0,4	99%*0,6+1%*0,3 = 0,6	99%*1,5+1%*0,15 = 1,487	5 x 0,3 = 1,5

$$CO_2e = 1.487 \times (0{,}4 \frac{0{,}6}{1000} + 0.6 \times 0.00100) \times 9300 + 1.5 = 13.10 \text{ kg } CO_2e$$

The compensation cost will therefore be approximately €0.65

Ex. 3: Shipping a container from Lisbon to Funchal (Madeira) by sea

Journey: 1150 km by ship (99.5% of the route) and truck (0.5% of the route) with 2 warehouse handling opertions.

20' container dimensions: 6.058 x 2.438 x 2.591 m = 38.2675 cubic meters with a weight of 10,000 kg

α	**β**	$\mathbf{E_f}$ [kg CO_2e per tonne-km]	$\mathbf{E_m}$ [kg CO_2e]
99,5%*0,7+0,5%*0,7 = 0,7	99,5%*0,3+0,5%*0,3 = 0,3	99,5%*0,02+0,5%*0,15 = 0,021	2 x 0,3 = 0,6

$$CO_2e = 0.021 \times (0{,}7 \frac{10.000}{1000} + 0.3 \times 38.2675) \times 1150 + 0.6 = 371.53 \text{ kg } CO_2e$$

The compensation cost will therefore be approximately €18.58

Ex. 4: Shipping of a pallet from Turin to Paris by truck

Journey: 775 km by truck (100% of the route) without warehouse processing.

Pallet dimensions: 80 x 120 x 150 cm = 1.44 cubic meters with a weight of 300 kg

α	**β**	$\mathbf{E_f}$ [kg CO_2e per tonne-km]	$\mathbf{E_m}$ [kg CO_2e]
0,7	0,3	0,15	0 x 0,3 = 0,0

$$CO_2e = 0.15 \times (0{,}7 \frac{300}{1000} + 0.3 \times 1.44) \times 775 + 0 = 74.63 \text{ kg } CO_2e$$

The compensation cost will therefore be approximately €3.73

Ex. 5: Shipping of 50 refrigerators from Hamburg to Milan via train and truck

Journey: 1150 km via train (90% of the route) and truck (10% of the route) with 2 warehouse handling opertions.

Dimension of each refrigerator: 72 x 66 x 176 cm = 0.836352 cubic meters with a weight of 80 kg each.

Note: we will not calculate the total volume and weight as each refrigerator (package) will be labeled separately and each will be issued an independent Logistic Green Label.

α	**β**	**E_f** [kg CO_2e per tonne-km]	**E_m** [kg CO_2e]
90%*0,7+10%*0,7 = 0,7	90%*0,3+10%*0,3 = 0,3	90%*0,06+10%*0,15 = 0,069	2 x 0,3 = 0,6

$$CO_2e = 0.069 \times (0,7 \frac{80}{1000} + 0.3 \times 0.836352) \times 1150 + 0.6 = 24.06 \text{ kg } CO_2e$$

The compensation cost for each refrigerator will therefore be approximately €1.20

The compensation cost for the transport of the 50 refrigerators will be approximately € 60,00

Packaging

Emissions from packaging are not considered in this Lite version of the Logistic Green Label mainly due to the difficulty of finding accurate and complete data. Evaluating packaging-related emissions requires collecting detailed information regarding the materials used, production processes, transportation, recycling and waste management, and this data is not always easily accessible or standardized. In many cases, specific information on packaging suppliers or material life cycles is not publicly available or requires direct cooperation with the companies involved.

Furthermore, the different variables such as the **type of material** (plastic, paper, glass, etc.), its **origin** (recycled or virgin), and the method of **end-of-life management** (landfill, incineration, recycling) further complicate the process of estimating emissions. Since the Lite version aims to simplify the process and reduce it complexity, we have chosen not to include this variable to maintain the focus on more easily measurable aspects, such as emissions deriving from logistics and transport.

In the full version, however, packaging will be considered with greater precision, using more advanced models and more specific data, to provide a more accurate and complete analysis of overall emissions.

Label format

One of the key aspects of the Logistic Green Label lite project is the format of the labels, which must be designed to ensure clarity, readability and integrity of the data, as well as offering simple and secure access to verify information via QR code.

The Green Label Lite label is designed to guarantee the authenticity and verifiability of **certified shipments**, providing detailed information on the associated CO_2e emissions and the related compensation measures adopted.

A description of the relevant factors follows.

Proportions and format

In this prototype phase, the standard does not want to impose precise rules regarding the size and position of the elements on the label, which can be affixed alongside or in addition to the normal shipping label containing the tracking data and the recipient's address.

Logo Logistic Green Label lite

The logo of Logistic Green Label lite is an elaboration of the company logo Logistic Green Label (complete), with the addition of the word “lite”.

The logo must be clearly visible on the label, clearly distinguishable from other company symbols or logos. This logo communicates that the shipment has obtained Logistic Green Label lite certification.

Logistic Green Label lite Unique Code

The unique code identifying the certification must be printed on the label.

QR Code

Each label must include a QR code to allow immediate and unambiguous verification of the Logistic Green certification.

The content of the QR code is the URL of the verification page, which in this prototype phase will be managed directly by the provider.

This page must state:

- ➢ confirmation of **authenticity** of certification;
- ➢ all information relating to **calculation of the environmental impact** (including all input data) and the measures adopted for the **compensation.**

Correlation code

If the Green Label is additional to the standard one, to guarantee the **correlation** between the two, it will be necessary to include one or more codes that uniquely link the two documents, for example:

- ➢ *Shipping number (tracking number).*
- ➢ *Container identifier for multi-piece shipments*
- ➢ *Order number.*

Issuance procedures

The certification process follows a series of standardized activities ranging from the collection of shipment data to the calculation of CO_2e emissions, up to the compensation process and recording of results. This chapter describes in detail all the steps necessary for issuing the Logistic Green Label lite, specifying the operational steps and monitoring methods.

At every shipping certified will be awarded a **unique certification code,** which must be registered e protected to ensure traceability. This code represents the Green Label itself and is associated with the shipping data and the level of sustainability obtained and the relative **compensation**.

1. Shipment data collection

The first step to obtain the Logistic Green Label lite consists of the accurate collection of data relating to the shipment. The data to be collected are the following:

- **Distance** traveled by the shipment, expressed in km.
- **Number of packages** included in the shipment
- **Weight of each package that makes up the shipment**, expressed in kg
- **Volume of the single package that makes up the shipment**, expressed in m^3
- **The type of vehicle(s) used** (e.g., truck, ship, plane, train) and the division of the route between these vehicles

2. Calculation of environmental impacts

Once the necessary data has been collected, the provider is required to **calculate CO_2e emissions** for each package of the shipments considered, following the instructions given in the chapter "Method of calculating CO2e emissions".

3. Choice and payment of the clearing service

The company ordering the shipment who intends to obtain the Logistic Green Label, can choose one of the **compensation methods** made available by the Green Label provider.

Each compensation will correspond to a price, often made up of 2 parts:

- The **actual compensation cost** (which must be entirely conveyed to the organization that manages the compensation itself)
- The **cost of managing the process**, intended to remunerate the provider

It is necessary that the presentation of the 2 cost components is clear and transparent towards the payer, with wording that leaves no doubt regarding the destination of the funds.

Example: *The compensation cost for this shipment is €0.08 of which €0.07 is for CO_2 compensation and which will be donated to the Greentree International association and €0.01 to repay the cost of managing the process, which will be retained by the provider, CompensGreen srl.*

The provider will be able to choose the methods and times it deems most appropriate to collect the compensation costs from the orderers.

The provider's payments to the organizations that manage the compensation must instead be made within certain deadlines: the provider will not be able to retain funds exceeding €300.00 for a period exceeding 30 days.

4. Registration and traceability of the certification code

For each package that qualifies for the issuance of the Logistic Green Label lite, the provider will have to generate a **unique certification code** (lglid = Logistic Green Label ID), which will act as an identifier for the green label itself.

This code is composed of a concatenation of 3 parameters separated by the character: (colon). Here are the parameters:

- ➢ **Unique identifier of the provider**: 8-character alphanumeric code assigned by the DAO Logistic Green Label organization. This code may contain the name of the provider itself. For example, the organization Manage expeditions s.r.l. the code GESTSPED may be assigned
- ➢ **Identifier of the ordering organization** at the provider (alphanumeric, max 12 characters)
- ➢ **Shipment/package identifier** (alphanumeric, max 18 characters)

It follows that each code will be a maximum of 40 characters long

Example lglid: GESTSPED:t1000000060:1F

The code will be registered in the management system of the Green Label provider and all the data relating to that Green Label must be visible through the in-depth link in the system managed by the provider.

5. Generation of the certification label

Once the emissions calculation process and shipment registration are completed, the system will generate the **certification label** which will be made available for printing.

It is important to note that when the label is printed, the link corresponding to the QR code for further information on the certification must already be available for consultation.

Providers Logistic Green Label lite

As specified in the introduction, experimentation *Logistic Green Label lite* aims to test a new approach to improve the environmental sustainability of shipping. The objective is to start an innovative technical and organizational project, starting from a prototype that can evolve rapidly according to future decisions of the DAO Logistic Green Label.

Identification of providers

In this initial phase, too broad participation of providers is not useful and could even prove counterproductive.

It is therefore proposed to limit the initial participation to a small number of providers, preferably between 1 and 3. This choice will allow us to more effectively monitor the implementation of the **technical and organizational prototype**, simplifying operational management and guaranteeing direct control over the quality and effectiveness of the tested solutions.

The objective is to immediately establish a close and targeted collaboration with a small number of providers, selected on the basis of their ability to actively contribute to the innovation process. This approach will also facilitate the collection and analysis of the data necessary to quickly validate and refine the project, before involving additional operators in the next expansion phase.

Proposals for participation in the trial

The **DAO** will carefully evaluate every proposal coming from aspiring providers interested in participating in the testing of the Logistic Green Label lite.

Half-yearly report and operational transparency

Each provider authorized to issue the Logistic Green Label lite is required to submit to the DAO (Decentralized Autonomous Organization) a **half-yearly report** detailed on the activities carried out. The report must include precise information on certified shipments, offset CO_2 emissions and amounts paid to environmental compensation bodies.

Transparency represents a fundamental principle of this initiative. Therefore, each provider will need to ensure that information relating to the offsetting process is accurate, clear and easily accessible via a dedicated website, allowing customers to monitor the emissions offsetting journey in real time.

Financial transparency

The provider will also have to produce a detailed financial report that clearly highlights the total amount collected for the **emissions compensation**, and the amount actually transferred to **responsible bodies** of environmental compensation activities.

These financial reports, accompanied by documentation proving the payments made to the bodies responsible for compensation, must be published and made accessible to all interested parties.

Future objectives for the evolution towards the complete solution

The Lite version of the Green Label does not represent a point of arrival, but rather a starting point towards an increasingly precise and complete certification system. The calculation of CO_2e emissions adopted in this initial phase constitutes the basis on which more detailed and integrated analysis methods will be developed, with the aim of making the measurement of environmental impact more accurate.

Over time, the model will be expanded to include other key factors in assessing environmental pressure. We will no longer be limited only to the calculation of direct emissions, but crucial aspects such as waste disposal, the impact of packaging and the sustainability of packaging solutions, as well as the energy used in the storage and logistics management phases, will also be taken into consideration. These elements will allow us to have a more complete vision of the environmental impact of each shipment, surpassing an analysis based exclusively on CO_2e emissions.

At the same time, the calculation method itself will also be refined. The formula used in the Lite version will be progressively enriched, integrating new parameters and more in-depth data, so as to improve the accuracy of estimates and guarantee greater transparency. The ultimate goal is to make the Logistic Green Label is an increasingly effective tool, capable of precisely measuring the environmental impact along the entire supply chain and guiding companies and consumers towards truly sustainable choices.

Towards a more complete assessment of environmental impact

One of the main objectives of the evolution of the Green Label is to move beyond the current focus on direct CO_2e emissions to include a broader set of environmental factors. For example, it is essential to consider:

- ➢ Waste disposal and the environmental impact of packaging.
- ➢ The sustainability of the packaging solutions adopted.
- ➢ Energy consumption during the storage and logistics management phases.

The integration of these aspects poses significant methodological challenges. Each added variable requires reliable and standardized data, not always easily available, and harmonization between different measurement systems.

The improvement of the calculation method

The formula used in the Lite version is a starting point, but for the Green Label to become a truly effective tool, continuous refinement of the calculation method will be necessary.

Some of the key pain points to address include:

- ➢ The integration of new parameters to refine estimates.

- ➢ Continuous updating of databases on emission factors.
- ➢ Harmonization with international guidelines on sustainability.

Currently, the method of calculating emissions for mixed trips is based on a weighted average of the different routes, but this approach has limitations. For example, it may not fully take into account the differences in efficiency between different means of transport or the indirect effects linked to stopovers and waiting times. Furthermore, some parameters such as the chemical composition of fuels or the efficiency of emission reduction technologies need to be updated to reflect technological advances.

The complexity of logistics and the role of the warehouse

Another aspect to improve is the estimate of emissions related to storage in the warehouse. This intermediate step is often overlooked, but can have a significant impact on the overall environmental footprint. The main challenges to be faced concern:

- ➢ The diversity of energy sources used in warehouses.
- ➢ The efficiency of logistics structures.
- ➢ The variability of the goods' residence time.

Currently, the calculation of warehouse emissions takes into account the estimated average value of the energy consumption of the structure and the internal movement of goods. However, the heterogeneity of warehouses and their operating methods makes the application of a single standardized model complex.

Beyond the weight and volume constraint: towards more accurate modeling

The basic hypothesis of Logistic Green Label lite assumes that the available load on a vehicle is limited by the maximum transportable weight or available volume. This simplifies the calculation of emissions, but does not always reflect the operational reality of logistics.

Several factors may make more sophisticated modeling necessary:

- ➢ The efficiency of the means of transport, which can vary based on the load and operating conditions.
- ➢ Load distribution, which affects fuel consumption in ways that are not always predictable.
- ➢ Logistical constraints, such as loading/unloading restrictions and infrastructure availability.

To address these challenges, it will be necessary to develop more flexible models that take into account a greater number of variables and continually refine the coefficients used in the calculations.

Evolution of estimation methods of α and β

In the context of transport-related emissions, regression models could be employed to refine the values of the coefficients α and β, which represent the relative influence of weight and volume on fuel consumption and, therefore, emissions.

By using a regression approach based on real data from shipments, the estimates of α and β could be more accurate and specific for a particular operational context, such as the type of means of transport, climatic conditions, cargo efficiency, etc.

Regression models, especially advanced ones (such as multivariate ones), could integrate other variables, such as transportation speed, geographic area, or peak demand periods. These additional variables could influence efficiency and therefore CO_2 emissions, further improving the precision of the estimates. Regression models can also be used to make more accurate predictions about the impact of transportation choices on future emissions, allowing companies to optimize their logistics strategies and reduce emissions more effectively.

In conclusion, the adoption of regression models to calculate and optimize the coefficients α and β would represent an important step towards a more complete and dynamic solution, improving the accuracy of forecasts on CO_2e emissions in the transport sector. In the future, the use of historical data and machine learning techniques could make these calculations even more precise and adaptable, with positive impacts on sustainability policies.

Towards a more transparent and accessible system

Another fundamental step to improve the Green Label is to ensure transparency and accessibility to data. The integration of a QR code on the label will allow the certification to be connected to a shared platform, offering users the possibility of verifying the information immediately. However, for this tool to be effective, it will be essential:

- ➢ Guarantee the quality and traceability of the data used.
- ➢ Standardize the format of information to make it easier to understand.
- ➢ Ensure that the verification platform is accessible and constantly updated.