GreenTurn

Co-created KPIs and framework for impact assessment

Deliverable D3.1

Version N°2.0

Grant Agreement	101147942
Project website	green-turn.eu
Contractual deadline	30/04/2025 (M9)*
Dissemination level	PU (Public)
Nature	Deliverable
Author(s)	Julia Amaral (UAN) Joris Beckers (UAN)
Contributor(s)	-
Reviewer(s)	Vasileios Zeimpekis (UAEG) Georgios Tepteris (UAEG) Ioannis Manolis (LOGIKA) Bartosz Kożuch (LPIT)

Funded by the European Union

GreenTurn has received funding from European Union´s Horizon Europe Programme under grant agreement no°101147942. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Commission. Neither the European Union nor the granting authority can be held responsible for them.

Change Log

Version	Description of change
V0.1	Initial version preparation
V0.2	Revised draft based on internal comments
V0.3	Inclusion of the appendix
V1.0	First revision with tracked changes
V2.0	Final version

List of abbreviations

Abbreviation/Term	Description
EU	European Union
KPI	Key Performance Indicator
WP	Work Package
VKT	Vehicle Kilometers Traveled
LSP	Logistics Service Provider
TMS	Transport Management System

Disclaimer

Copyright message

THE CIVITAS INITIATIVE IS CO-FUNDED BY THE EUROPEAN UNION

GreenTurn is a project under the CIVITAS Initiative, an EU-funded programme working to make sustainable and smart mobility a reality for all. Read more - civitas.eu.

Table of contents

1 Executive Summary

This deliverable presents the development and structure of the GreenTurn Key Performance Indicator (KPI) framework, designed to robustly assess the environmental, economic, and social impacts of the innovative urban logistics pilots in the project. GreenTurn brings together diverse e-commerce stakeholders to co-create zero-emission logistics solutions that combine receiver behavioral nudging with delivery and return operations.

The KPI framework was developed through a collaborative, multi-step process based on three pillars: defining pilot objectives, establishing a rigorous impact assessment methodology across economic, environmental, and social dimensions, and ensuring comparability with existing frameworks. This process involved academic partners, pilot site leaders and external partners, guaranteeing relevance and applicability across both physical and digital pilots.

Aligned with the project's strategic objectives, the framework organizes KPIs into clearly defined impact levels reflecting the goals of sustainable logistics innovation. The GreenTurn KPIs are tailored specifically to the context of last-mile delivery and return flows, enabling meaningful impact assessment while facilitating comparability with other EU projects. This deliverable includes detailed KPI definitions, measurement units, and guidance on data collection

Internal discussions with academic partners facilitated the refinement of KPIs to ensure they directly support the project's objectives and address the specific challenges of last-mile logistics. Pilot-level workshops engaged site leaders to evaluate each KPI's practical relevance and data collection methods within their local contexts. In addition, revisiting existing frameworks from CIVITAS and the sister project ensure comparability of the results. This collaborative approach balanced conceptual rigor with operational realities, enabling a KPI list that is both meaningful and implementable.

The workshops revealed important insights into data availability and highlighted certain KPIs that required adaptation to local conditions or data constraints, ultimately helping to prioritize indicators that are both impactful and feasible to monitor. Reflections on data availability and transferability emphasize the framework's capacity to accommodate diverse pilot types—physical and digital—by leveraging both observed and modeled data sources. While some indicators depend on direct measurement, others may rely on assumptions or proxy data, particularly in digital simulations.

Overall, the GreenTurn KPI framework serves as a shared reference point for transparent and robust evaluation of urban logistics innovations, supporting the transition towards sustainable, zero-emission e-commerce delivery and return strategies.

2 Introduction

GreenTurn brings together a diverse range of stakeholders—including public authorities, logistics providers, technology partners, research institutions, and industry networks—to co-create zero-emission logistics solutions, providing sound and transparent information on logistics operations footprints, and enabling more sustainable delivery and return choices.

To effectively evaluate these solutions, this deliverable presents the development process and final structure of the GreenTurn KPI framework. The framework was co-created through an iterative and collaborative process involving academic partners and pilot leaders, ensuring it captures the multidimensional impacts of the pilots. It is designed to enable comprehensive impact assessment across environmental, economic, and social domains of urban logistics.

Aligned with established evaluation methodologies such as the CIVITAS framework and complementary EU projects (i.e., CodeZERO, GREEN-LOG), the GreenTurn KPI framework supports comparability and transferability of results. This deliverable details the methodology for KPI selection and refinement, describes the organization and content of the framework, and reflects on its applicability to both physical and digital pilots. Although the KPI framework was designed to streamline data collection by leveraging existing methods, such as reports and operational logs, a brief discussion of anticipated data-related challenges is also included in this deliverable, as data availability is closely tied to each pilot's scope and operational context.

This document is organized as follows: Section 3 covers the methodology applied in developing the KPI framework; Section 4 presents the GreenTurn KPI framework in detail, including impact categories and alignment with existing frameworks; Section 5 offers reflections on applicability and data considerations; and Section 6 concludes with key takeaways.

3 Methodology

The process of developing the KPI framework followed an iterative and collaborative approach. The goal was to create a meaningful set of indicators tailored to the specific context of the GreenTurn project—last-mile and return logistics—while maintaining conceptual alignment with the CIVITAS evaluation framework, as requested in the task description.

The development of the framework was guided by three interrelated anchors: pilot-level objectives, impact-oriented analysis, and comparability with external frameworks. As illustrated in Figure 1, these elements form a triangular foundation ensuring that the selected KPIs are locally relevant, analytically robust, and aligned with broader urban freight policy efforts.

Comparability refers to the alignment of the framework with established references, primarily the CIVITAS evaluation framework, which ensures consistency and comparability of results across European urban mobility and logistics projects. In addition, the selection of indicators was informed by insights from the sister project, as well as the academic partners' experience in both ongoing and past logistics-related projects. This makes the GreenTurn KPI framework reflective of widely adopted practices across the European research landscape.

Impact Analysis represents the consensus-driven selection of KPIs by academic partners, ensuring that each indicator contributes meaningfully to forthcoming environmental, economic, and social assessments within the project.

Pilots' Objectives ensure that the KPI framework maintains local relevance by capturing the specific scope and goals of each pilot. To achieve this, the pilots were consulted through multiple channels, including workshops, email communications, and additional meetings scheduled as needed. This collaborative approach allowed the framework to be tailored to reflect each pilot's unique context and priorities, while still maintaining the comparability and interoperability of results.

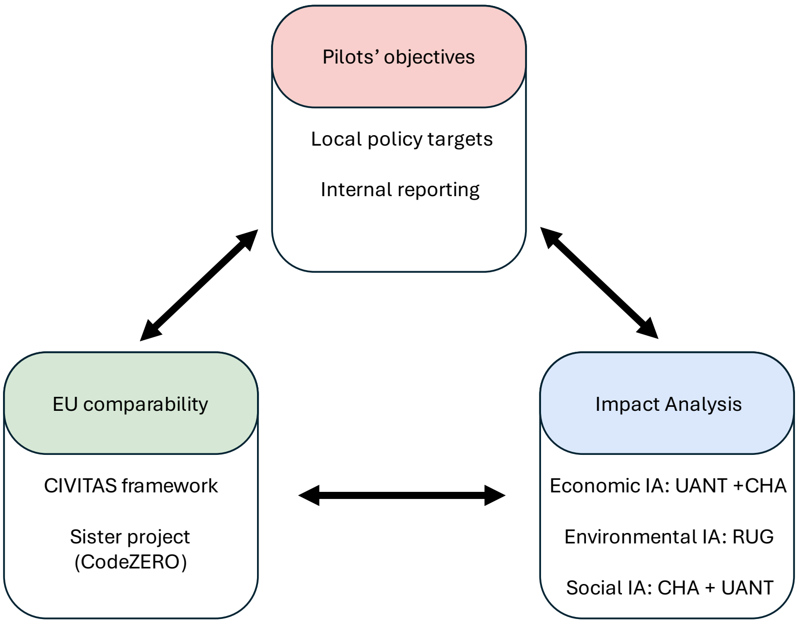

Figure 1. Foundations for KPI Framework Development

The iterative and collaborative process was marked by alternating rounds of input from different stakeholders. The process began with internal discussions among the academic partners to define a preliminary shortlist of KPIs. This was followed by consultation with representatives from the sister project, after which the academic team reconvened to further refine the selection. The revised proposal was then presented to the pilot leaders during a dedicated workshop. Feedback from this session was discussed once again among the academic partners, leading to additional adjustments. Throughout the process, further meetings were held on an as-needed basis—either with individual academic partners or specific pilot leaders—to address emerging questions or context-specific challenges. A final round of input was gathered through spreadsheets shared via email with all pilot teams, allowing them to validate and refine the proposed indicators. This back-and-forth ensured the development of a robust and coherent framework.

3.1 EU Comparability

To ensure comparability with on-going and future EU projects, the starting point was a thorough review of the CIVITAS evaluation framework (CIVITAS MUSE, 2024), which was a requirement for this task. While CIVITAS is primarily oriented toward passenger mobility, relevant indicators were identified and adapted for application in the context of urban freight and e-commerce logistics. This alignment not only provided a structured methodology for indicator selection but also ensures that the resulting KPIs are immediately comparable with those used in other CIVITAS-aligned projects, reinforcing the potential for benchmarking and replication.

In parallel, we also consulted the KPI list from the sister project CodeZERO. While both projects aim to improve urban logistics, differences in scope and project objectives made full alignment challenging. Nonetheless, several KPIs were found to overlap, and a cross-project equivalency mapping table is provided in this deliverable. In addition to reviewing CodeZERO deliverables (Fiorello et al., 2024; Fiorello et al., 2025), we discussed directly with members of the CodeZERO consortium to validate our understanding and ensure methodological coherence.

Beyond CodeZERO, the KPI selection process was also shaped by the academic partners' expertise gained through their involvement in a range of past and ongoing projects (e.g., GREEN-LOG and MoLo Hubs) focused on logistics and urban freight. These projects offer valuable precedents for defining indicators relevant to urban logistics context, ensuring that the GreenTurn KPI framework resonates with established European practices.

Together, these sources formed the foundation for the preliminary shortlist of KPIs, which was then brought forward for discussion and refinement in collaboration with the project's academic and implementation partners, as detailed in the next sections.

3.2 Impact Analysis

A series of working meetings were held with the project's partners, primarily academic institutions responsible for subsequent impact assessment tasks. These discussions went beyond the technical review of the indicators themselves. A key objective was to ensure alignment between the KPIs and the overarching goals of the project, both at the level of the local pilots and within the broader analytical scope of the GreenTurn framework.

The academic partners involved in these sessions were also tasked with leading the environmental, economic, and social impact assessments in WP4. As such, the KPI framework needed to support not only local policy monitoring and operational priorities, but also the methodological consistency required for robust and comparative impact evaluation across pilots (both physical and digital).

The collaborative process included:

- Reviewing the CIVITAS-based shortlist of indicators as a starting point;
- Refining indicator definitions to reflect the specificities of urban logistics systems;
- Assessing the feasibility of data collection for each indicator;
- Proposing new KPIs to address gaps, especially where logistics-specific challenges were underrepresented.

One example is the KPI related to the number of deliveries using reusable packaging that was introduced to fill a gap identified during these discussions. This indicator aligns with GreenTurn's focus on circular economy practices and was not present in existing frameworks. On the other hand, some indicators were refined for enhanced analytical depth. For example, the environmental impact KPIs were expanded beyond CO_2 emissions to include other pollutants like NO_x and particulate matter (PM), providing a more comprehensive environmental assessment. Additionally, the freight activity indicator evolved from simply tracking total vehicle-kilometers traveled (VKT) to including VKT per delivery, adding a layer of operational efficiency measurement that better suits the urban logistics context. The full list of GreenTurn KPIs with the equivalent CIVITAS KPI is presented on section 4.3.

The outcome was a refined shortlist of indicators that was both grounded in local relevance and analytically fit for supporting the project's long-term evaluation goals.

3.3 Pilot's Objectives

To assess the feasibility and contextual relevance of the proposed KPIs, a dedicated exercise was conducted during the General Assembly held in Zaragoza in March 2025. This session brought together pilot leaders and aimed to ground the KPI framework in the practical realities of implementation.

During the workshop, each pilot representative was asked to evaluate the shortlisted KPIs based on two key criteria:

- Relevance to their specific pilot context and objectives;
- Feasibility of data collection, including data availability and sources.

To support this assessment, participants were provided with a shared, online spreadsheet containing the full list of proposed KPIs. For each indicator, they were invited to input their feedback directly into the spreadsheet, using a standardized format to ensure consistency across responses.

The exercise provided valuable insights into practical considerations, such as local data constraints, institutional responsibilities, and priorities across diverse pilot environments. The workshop also included a group discussion segment, allowing participants to raise questions, clarify indicator definitions, and share concerns or suggestions in real time. The feedback gathered through this workshop played a central role in finalizing the GreenTurn KPI framework, helping to balance methodological coherence with feasibility and relevance at pilot level.

Building on the initial assessment, a follow-up was conducted in early July 2025 to gather updated inputs and begin paving the way toward implementation. In addition, this exercise served to better integrate the new logistic service provider (LSP) and pilot leader for the Polish and French pilots that joined the GreenTurn project after the initial workshop was conducted.

Partners were given access to a shared online spreadsheet, this time structured to capture more operational detail. For each KPI, pilots were asked to indicate whether it was going to be measured (yes/no), who would provide the data, and the method of data collection. This exercise aimed to maintain momentum, encourage continued reflection, and inform upcoming tasks related to monitoring and reporting. It also provided a preliminary view of how the KPI framework might be operationalized in practice.

4 GreenTurn Assessment Framework

The assessment framework was co-developed through a multi-step process described in Section 3, with the aim of enabling robust impact assessment across the environmental, economic, and social dimensions of the logistics pilots. The KPIs have been selected to reflect the specific context of last-mile delivery and return flows, encompassing both physical and digital pilots.

This section is structured as follows: Section 4.1 outlines the overall structure of the framework and the categorization of indicators across the three impact domains. Section 4.2 presents the final list of selected KPIs, including their definitions, units of measurement, and expected data sources. Section 4.3 discusses the alignment of the GreenTurn KPI framework with existing evaluation methodologies, highlighting opportunities for comparability and transferability across projects. Section 4.4 discusses the applicability of the KPI in physical vs. digital pilots. And Section 4.5 discusses in more depth the inputs received from pilot leaders concerning KPIs' adoption and data collection.

4.1 Structure and Impact Categories

The GreenTurn framework categorizes KPIs into three primary impact categories: environment, economic, and social, each reflecting a distinct dimension of sustainable urban freight systems. The categories are further subdivided into impact levels relevant to the project. The impact levels are directly aligned with the objectives of the project.

The environment category focuses on the ecological impact of freight operations, including efforts to increase the use of non-fossil fuel freight vehicles and promote sustainable packaging practices. The economic category includes KPIs that intersect economic and environmental goals, as improving delivery efficiency leads to both lower operational costs and reduced emissions. Finally, the social category emphasizes the human-centric aspects of freight systems, aiming to facilitate consumer choices for sustainable transport options, improve accessibility and inclusivity, and enhance the working conditions of logistics workers. Together, these categories and their associated KPIs provide a holistic approach to evaluating the impacts of pilot interventions, guiding the transition toward more sustainable and equitable urban logistics systems.

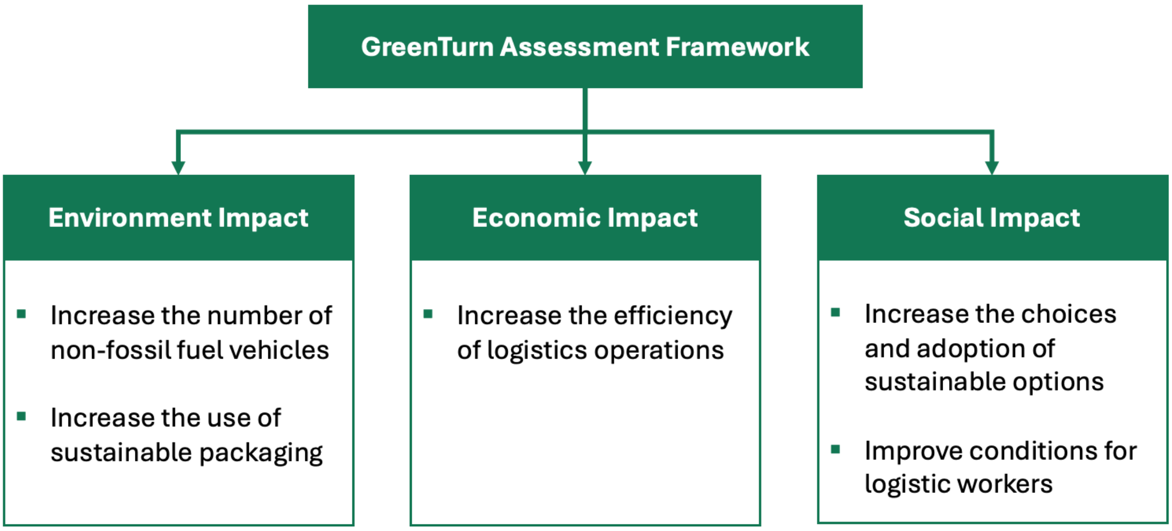

Figure 2. Categories and impact levels within the assessment framework.

4.1.1 Environment Impact

The environment impact category focuses on minimizing the ecological footprint of logistics operations by targeting key areas such as vehicle emissions and packaging practices. This category includes indicators that measure the adoption of non-fossil fuel freight vehicles, such as cargo bikes, electric vehicles, and hydrogen-powered vehicles, which contribute to reducing greenhouse gas emissions and air pollution in urban areas. It evaluates the environmental impact of logistics operations by tracking emissions per vehicle-kilometer traveled and the share of non-motorized or zero-emissions vehicles used. The category also highlights the importance of sustainable packaging practices by monitoring the adoption and return rates of reusable and returnable packaging solutions.

Increase the number of non-fossil fuel freight vehicles:

- Emissions (CO_2, CO, NO_x, SO_x, PM_{10}, $PM_{2.5}$) per km per vehicle type
- Share of non-fossil fuel vehicles in the fleet
- Share of deliveries and returns made by non-fossil fuel vehicles
- Emissions (CO_2, CO, NO_x, SO_x, PM_{10}, $PM_{2.5}$) per delivery/return

Increase the use of sustainable packaging:

- Share of returnable and reusable packaging
- Share of reusable packaging returned

4.1.2 Economic Impact

The economic impact category captures the synergy between increasing operational efficiency and reducing environmental impacts in logistics operations. It emphasizes the dual benefit of improving logistics performance in ways that both reduce operational costs and lower ecological footprints. Key indicators in this category include improving the load factor of freight vehicles and reducing the total vehicle-kilometers traveled. Where relevant, these indicators are disaggregated by vehicle type to provide deeper insight into the performance of different fleet components. This level of detail can help identify opportunities for vehicle right-sizing or shifting to lower-impact modes—such as replacing underutilized larger vehicles with cargo bikes—supporting both economic and environmental objectives. These metrics not only enhance cost-effectiveness for logistics providers but also contribute to more efficient use of energy and natural resources. Increase the efficiency of logistic operations:

- Average load factor at the start of the tour by vehicle type
- Total VKT and VKT per delivery/return
- Avg. stops per tour
- Cost per delivery/return

4.1.3 Social Impacts

The social impact category highlights the human-centered aspects of logistics systems, focusing on two key areas: increase the choices and adoption of sustainable options and improve logistics workers' conditions. It reflects the importance of enabling consumers to make sustainable choices by promoting awareness and making them accessible. These KPIs measure the availability and adoption of sustainable delivery/returns options, considering both the infrastructure supporting sustainable logistic operations and the willingness of citizens to engage in such behaviors. It highlights the need to not only provide accessible infrastructure to support sustainable transportation options, but also to inform and nudge consumers towards making more environmentally responsible choices.

Increase the choices and adoption of sustainable options:

- Number of parcel pick-up/drop-off points per inhabitant
- Potential accessibility to logistics services
- Share of costumers ready to adopt sustainable behaviors
- Customers' expenditure with shipping and returns

At the same time, this category recognizes the critical role of logistics workers by addressing issues such as overtime and wage equity.

Improve conditions for logistic workers:

- Ratio between average wage of logistics workers and minimum income
- Share of delivery/pickup tours longer than work journey
- Coefficient of variation in route duration (std/mean of the route duration)

4.2 List of KPIs

The table below presents the finalized list of KPIs. Each KPI is linked to a GreenTurn impact category and level. The table also describes the necessary data to compute the KPI, the unit, and for which project tasks the KPI is relevant.

Table 1. List of KPIs.

	Impact Level	Key Performance Indicator	Required Data	Unit	Task
Environment	Increase the number of non-fossil fuel deliveries and returns	Emissions (CO_2, CO, NO_x, SO_x, PM_{10}, $PM_{2.5}$) per km per vehicle type	Total VKT per vehicle type or total fuel consumption per vehicle type	g of type of pollutant / km	T4.2/T4.3/T5.3
		Share of non-fossil fuel vehicles in the fleet	Number of vehicles in the fleet by type	% of non-fossil fuel vehicles	T2.1/T4.2/T4.3
		Share of deliveries and returns made by non-fossil fuel vehicles	Number of packages delivered or returned by vehicle type	% of deliveries or returns by non-fossil fuel vehicles	T2.1/T4.2/T4.3
		Emissions (CO_2, CO, NO_x, SO_x, PM_{10}, $PM_{2.5}$) per delivery/return	Number of deliveries/ returns and VKT per vehicle type or total fuel consumption per vehicle type	g of type of pollutant / delivery or return	T4.2/T4.3/T5.3
	Increase the use of sustainable packaging	Share of returnable and reusable packaging	Total number of packages delivered and number of packages in reusable packaging	% of returnable packaging	T4.2
		Share of reusable packaging returned	Total number of returns and number of returns in reusable packaging	% of returns in reusable packaging	T4.2
Economic	Increase the efficiency of logistics operations	Average load factor at the start of the tour by vehicle type	Weight or volume of packages loaded in the vehicle by vehicle type	% of used capacity in volume or weight	T2.1/T4.2/T5.2
		Total VKT and VKT per delivery/return	Total VKT and total number of packages delivered/returned	km / delivery or return	T2.1/T4.2/T4.3/T5.2
		Avg. stops per tour	Number of stops per tour	Number of stops	T2.1/T4.2/ T4.3/T5.2
		Cost per delivery/return	Operational costs per vehicle type	€ / delivery or return	T4.2/T5.2

Table 1. List of KPIs. (Continued)

	Impact Level	Key Performance Indicator	Required Data	Unit	Task
Social	Increase the choices and adoption of sustainable options	Number of parcel pick-up/drop-off points per inhabitant	Number of pick-up/drop-off points in the study area	Number of points / inhabitant	T2.1/T5.2
		Potential accessibility to logistics services	Location of pick-up/drop-off points, population data	Number of points within x km radius	T5.4
		Share of costumers ready to adopt sustainable behaviors	Number of citizens that responded positively to adopt sustainable behaviors	% of citizens	T2.2/T2.3/T4.2/T5.4
		Costumers' expenditure with shipping and returns	Price of shipping and returns	€ / delivery or return	T2.2/T2.3/T4.2/T5.4
	Improve conditions for logistic workers	Ratio between average wage of logistics workers and minimum income	Wage of logistic workers	-	T5.4
		Share of delivery/pickup tours longer than work journey	Duration of tours	% of tours	T5.4
		Coefficient of variation in route duration (std/mean of the route duration)	Duration of tours	-	T5.4

4.3 Alignment with Existing Frameworks

To ensure the relevance and comparability of the GreenTurn KPI framework, we began by reviewing established evaluation methodologies, particularly those used in the CIVITAS framework (CIVITAS MUSE, 2024). This provided a solid foundation for indicator selection and helped ensure consistency with existing and future EU practices. Where necessary, we adapted and complemented these indicators to better reflect the specific aims and scope of GreenTurn. As discussed in the Methodology section, full alignment with CIVITAS was not feasible because the framework is primarily oriented toward passenger mobility. As a result, certain logistics-specific dimensions were not represented and required the introduction of new KPIs tailored to GreenTurn's focus.

We then compared the resulting KPI set with those used in the CodeZERO sister project (Fiorello et al., 2025) to further explore alignment and potential synergies. While full equivalence was not always possible due to differences in project focus and terminology, many GreenTurn KPIs share a common conceptual basis with these established frameworks. This alignment exercise supports knowledge transfer, facilitates cross-project learning, and strengthens the potential for future benchmarking. Alignment with CodeZERO was constrained by differences in methodology and project scope. While GreenTurn uses KPIs primarily for assessing environmental, economic, and social impacts, CodeZERO also applies KPIs to characterize operational aspects of individual deliveries, such as waiting times or vehicle types. In addition, CodeZERO includes a dedicated set of KPIs related to warehousing operations, which are outside the scope of GreenTurn.

Table 2 presents this alignment across the environmental, economic, and social impact domains, highlighting where direct or thematic correspondences exist.

Table 2. Mapping of GreenTurn KPIs to CIVITAS and CodeZERO equivalents.

GreenTurn			CIVITAS		CodeZERO	
	Impact Level	KPI	Definition	Code	Attribute Type	Definition
Environment	Increase the number of non-fossil fuel deliveries and returns	Emissions (CO_2, CO, NO_x, SO_x, PM_{10}, $PM_{2.5}$) per km per vehicle type	Average CO_2 emission per vkm of road vehicles in the fleet	ENV_DC_EF2		
Environment	Increase the number of non-fossil fuel deliveries and returns	Share of non-fossil fuel vehicles in the fleet	Share of Electric/hydrogen vehicles in the freight road vehicles fleets	ENV_DC_AFV2	Size and composition of the vehicle fleet	Delivery vehicles by type and technology
Environment	Increase the number of non-fossil fuel deliveries and returns	Share of deliveries and returns made by non-fossil fuel vehicles	Share of deliveries made by non-motorized vehicles	TRA_FR_MA2		
Environment	Increase the number of non-fossil fuel deliveries and returns	Emissions (CO_2, CO, NO_x, SO_x, PM_{10}, $PM_{2.5}$) per delivery/return			Environmental impacts	Average GHG, PM and NOx emissions per delivery
Environment	Increase use of sustainable packaging	Share of returnable and reusable packaging				
Environment	Increase use of sustainable packaging	Share of reusable packaging returned				
Economic	Increase the efficiency of logistics operations	Average load factor at the start of the tour by vehicle type	Average load factor of vehicles used for deliveries to shops by vehicle type / Average load factor of vehicles used for deliveries to households	TRA_FR_EFB / TRA_FR_EFC	Service efficiency	Vehicle load factor
Economic	Increase the efficiency of logistics operations	Total VKT and VKT per delivery/return	Road freight vehicles-km on the territory	TRA_FR_MA3	Service efficiency	Traveled distance by vehicle type
Economic	Increase the efficiency of logistics operations	Avg. stops per tour				
Economic	Increase the efficiency of logistics operations	Cost per delivery/return			Service efficiency	Delivery production cost

Table 2. Mapping of GreenTurn KPIs to CIVITAS and CodeZERO equivalents. (Continued)

GreenTurn			CIVITAS		CodeZERO	
	Impact Level	KPI	Definition	Code	Attribute Type	Definition
Social	Increase the choices and adoption of sustainable options	Number of parcel pick-up/drop-off points per inhabitant	Number of city boxes / smart lockers per inhabitant	TRA_FR_ADC2		
		Potential accessibility to services	Potential accessibility to city functions	TRA_FC_AC2		
		Share of costumers ready to adopt sustainable behaviours	Share of citizens ready to adopt sustainable mobility behaviours	SOC_AW_CP		
		Costumers' expenditure with shipping and returns	Transport expenditure of citizens	SOC_EQ_ME2	Cost	Delivery price
	Improve conditions for logistic workers	Ratio between average wage of logistics workers and minimum income	Ratio between average wage of logistics workers and average income	SOC_EQ_WC4	Labour impacts	Drivers labour conditions - wage
		Share of delivery/pickup tours longer than work journey	Share of logistic workers in the pilot area doing overtime	SOC_EQ_WC2	Labour impacts	Drivers labour conditions - working time
		Coefficient of variation in route duration (std/mean of the route duration)				

4.4 Applicability to Physical and Digital Pilots

The GreenTurn project includes both physical pilot activities and digital simulations that complement them. The digital pilots—developed as part of Task 4.3—simulate logistics interventions rooted in the same contexts and concepts as the physical pilots. They are used to explore scenarios and scalability that are not feasible to test directly on the ground or to estimate impacts where measurement is difficult.

While the KPI framework was primarily validated through workshops with the physical pilot leaders, it was designed to apply consistently across both real-world and simulated implementations. This supports the project's broader goal of enabling meaningful and comparable impact assessment across all pilots.

Differences in data quality and reliability arise between the two pilot types. Physical pilots rely on operational data collected directly from LSPs or observed on site, which generally ensures a high degree of accuracy and contextual specificity. In contrast, digital pilots rely on modeled assumptions and simulated behaviors, which—although grounded in real-world parameters—may introduce higher uncertainty or variability, especially when estimating behavioral or context-dependent outcomes.

Certain KPIs are particularly challenging to measure in digital pilots. These include indicators related to:

- Working conditions
- Behavioral compliance (e.g., adherence to sustainable return practices)

These rely on human interactions, subjective perceptions, or site-specific dynamics that cannot be reliably captured through simulation alone.

Whenever possible, digital pilots draw on shared data sources to populate KPIs in a manner consistent with physical pilots. In such cases, transparency about assumptions and limitations is essential.

For example:

- Indicators such as "CO_2 emissions" can be estimated by modeling vehicle activity and deriving VKT and applying emission factors observed from pilot sites.
- User-centered indicators, such as "willingness to adopt sustainable return options," may be used as inputs to digital pilots, informed by survey results conducted at physical sites.

To that end, we recommend distinguishing between: (i) observed KPI values based on physical pilot data, and (ii) modeled KPI estimates derived from digital simulations, while maintaining a unified framework to support cross-pilot comparability and integration into overall project evaluation.

4.5 Data Collection and Availability

The initial feedback from the GreenTurn pilot sites indicates a strong foundation for monitoring the agreed set of KPIs. In general, the data required for environmental and operational indicators—such as VKT, fuel or electricity consumption, vehicle type, etc.—is already collected by logistics service providers using logs or fleet management systems tools. This allows pilots to report on KPIs without relying on additional data collection infrastructure such as GPS devices.

Operational indicators such as VKT per delivery, stop density, or load factor are widely measurable and often integrated into daily performance reporting. Still, some pilots flagged current data gaps that may be addressed during the pilot implementation phase.

Environmental indicators, including emissions of various pollutants per kilometer or per delivery, can typically be calculated using existing operational records such as odometer readings and fuel logs. For diesel vehicles, pollutant emissions like CO_2, NO_x, SO_x, and PM can be derived with relative accuracy using standard emission factors—since these pollutants result directly from the combustion process, their quantities can be estimated based on the volume of fuel consumed. In contrast, for electric vehicles, there are no tailpipe emissions; therefore, pollutants such as NO_x and PM are not emitted during vehicle operation. If one wishes to account for the emissions associated with electricity production (e.g., upstream or well-to-wheel emissions), the calculation becomes significantly more complex and depends on country-specific energy mixes and grid emission factors. In practice, most logistics operators only report CO_2 emissions from electric vehicles, based on energy consumption data (e.g., kWh), and do not account for other pollutants. This was the case in Athens, where the LSP indicated they could only provide CO_2 estimates, due to the nature of their electric fleet and the lack of tailpipe emissions data for other pollutants.

Packaging- and socially focused indicators revealed more variability in relevance and adoption. For instance, in pilots with a B2B logistics model, KPIs related to consumer behavior, such as the number of pick-up/drop-off points, are not applicable. This highlights the need for flexibility in the framework, particularly in relation to differences in each pilot's scope and objectives.

Importantly, not reporting on every KPI does not diminish the value or relevance of a given pilot. The comprehensive KPI framework was intentionally designed to accommodate these contextual differences. It allows each pilot to focus on the indicators most aligned with their operational model and local goals, while still contributing meaningfully to the overall assessment. Even when data limitations prevent full reporting robust evaluation remains possible as long as a core subset of KPIs is collected and analyzed.

Despite these differences, pilots expressed willingness to align with the common KPI list. This shared yet adaptable framework balances comparability across sites with responsiveness to local constraints. While the pilot leader for the French and Polish pilots joined the project at a later stage and were not present at the initial KPI workshop, their subsequent input confirmed the continued relevance and applicability of the proposed indicators. Their positive engagement with the framework further reinforces its coherence and operational feasibility across diverse urban logistics contexts. Detailed responses on each KPI—including whether it is planned to be measured, data sources, and collection methods—are included in the appendix. This information will serve as the reference for targeted follow-up, data validation, and refinement of the monitoring process as the pilots move forward.

5 Conclusion

This deliverable has outlined the collaborative process behind the development of the GreenTurn KPI framework, ensuring it reflects both the operational realities of pilot sites and the broader strategic objectives of the project. The framework is grounded in established evaluation methodologies while being tailored to the specific context of sustainable last-mile delivery and return flows.

In addition to supporting internal alignment across physical and digital pilots, the framework was also designed with comparability in mind, drawing from and mapping to existing approaches such as the CIVITAS evaluation framework and CodeZERO indicators. This strengthens opportunities for knowledge exchange and wider applicability beyond the project itself.

Overall, the GreenTurn KPI framework serves as a shared reference point to guide data collection, evaluation, and learning throughout the next phases of the project.

References

CIVITAS MUSE. (2024). CIVITAS MUSE Evaluation – List of impacts and indicators [Unpublished internal document].

Fiorello, D., Gulizia, A., Repetto, E., de Stasio, C., Galli, G., Martino, A., Kin, B., & Winkelmann, F. (2024). Delivery options analysis framework (CodeZERO Project Deliverable 1.1, Version 0.3, 30/11/2024)

Fiorello, D., de Stasio, C., Gulizia, A., Galli, G., & Martino, A. (2025). Assessment framework for zero-emission delivery options (CodeZERO Project Deliverable D3.1, Version 1, 28/02/2025)

Appendix

Table 3. KPI Assessment – Zaragoza Pilot

	Impact Level	KPI	Is this KPI going to be measured?	Who is providing the data?	What are the data collection methods?
Environment	Increase the number of non-fossil fuel deliveries and returns	Emissions (CO_2, CO, NOx, SOx, PM10, PM2.5) per km per vehicle type	YES	CITYLOGIN OR OTHER LSP	Traffic applications / databases
		Share of non-fossil fuel vehicles in the fleet	YES	CITYLOGIN OR OTHER LSP	Traffic applications / databases
		Share of deliveries and returns made by non-fossil fuel vehicles	YES	CITYLOGIN OR OTHER LSP	Traffic applications / databases
		Emissions (CO_2, CO, NOx, SOx, PM10, PM2.5) per delivery/return	YES	CITYLOGIN OR OTHER LSP	Traffic applications / databases
	Increase use of sustainable packaging	Share of returnable and reusable packaging	YES	CITYLOGIN OR OTHER LSP	Computer applications / databases
		Share of reusable packaging returned	N/A	N/A	N/A
Economic	Increase the efficiency of logistics operations	Average load factor at the start of the tour by vehicle type	YES	CITYLOGIN OR OTHER LSP	NOT AVAILABLE AT THE MOMENT
		Total VKT and VKT per delivery/return	YES	CITYLOGIN OR OTHER LSP	Computer applications / databases
		Avg. stops per tour	YES	CITYLOGIN OR OTHER LSP	Computer applications / databases
		Cost per delivery/return	NO	N/A	N/A
Social	Increase the choices and adoption of sustainable options	Number of parcel pick-up/drop-off points per inhabitant	YES	Zaragoza City Council	NOT AVAILABLE AT THE MOMENT
		Potential accessibility to logistics services	YES	Zaragoza City Council	NOT AVAILABLE AT THE MOMENT
		Share of costumers ready to adopt sustainable behaviours	YES	Zaragoza City Council	SURVEYS BEFORE AND AFTER THE PILOT
		Costumers' expenditure with shipping and returns	YES	Zaragoza City Council	Mobile / computer app
	Improve conditions for logistic workers	Ratio between average wage of logistics workers and minimum income	YES	CITYLOGIN OR OTHER LSP	NOT AVAILABLE AT THE MOMENT
		Share of delivery/pickup tours longer than work journey	YES	CITYLOGIN OR OTHER LSP	NOT AVAILABLE AT THE MOMENT
		Coefficient of variation in route duration (std/mean of the route duration)	YES	CITYLOGIN OR OTHER LSP	NOT AVAILABLE AT THE MOMENT

Table 4. KPI Assessment – Athens Pilot

	Impact Level	KPI	Is this KPI going to be measured?	Who is providing the data?	What are the data collection methods?
Environment	Increase the number of non-fossil fuel deliveries and returns	Emissions (CO_2, CO, NOx, SOx, PM10, PM2.5) per km per vehicle type	YES	"LOGIKA may calculate CO2 emissions only LOGIKA | kWh (consumption from e-vans) and liters of fuel (consumption of vans)"	Extraction of primary data (distance traveled in km, fuel consumption in liters) from vehicle telematics for electric/diesel vans; fuel logs and odometer readings; aggregated via fleet management system.
		Share of non-fossil fuel vehicles in the fleet	YES	LOGIKA has both diesel & electric vans	Direct inventory of fleet composition, updated quarterly in the fleet database.
		Share of deliveries and returns made by non-fossil fuel vehicles	YES	LOGIKA may provide the data	Last mile orchestration platform: tag delivery/return records by vehicle ID/type, then aggregate in periodic reports.
		Emissions (CO_2, CO, NOx, SOx, PM10, PM2.5) per delivery/return	PARTIALY	"LOGIKA may calculate CO2 emissions only LOGIKA | kWh (consumption from e-vans) and liters of fuel (consumption of vans) per delivery/return "	Calculation using delivery logs, odometer data, and fuel/electricity consumption per tour (manual or automated reporting).
	Increase use of sustainable packaging	Share of returnable and reusable packaging	NO		
		Share of reusable packaging returned	NO		
Economic	Increase the efficiency of logistics operations	Average load factor at the start of the tour by vehicle type	YES	LOGIKA may calculate the loading factor of each e-van	Warehouse management system records at dispatch; vehicle loading factor reported in daily basis.
		Total VKT and VKT per delivery/return	YES	"LOGIKA may calculate CO2 emissions only LOGIKA | kWh (consumption from e-vans) and liters of fuel (consumption of vans)"	Extraction of primary data (distance traveled in km, fuel consumption in liters) from vehicle telematics for electric/diesel vans; fuel logs and odometer readings; aggregated via fleet management system.
		Avg. stops per tour	YES	LOGIKA has both diesel & electric vans	Direct inventory of fleet composition, updated quarterly in the fleet database.
		Cost per delivery/return	YES	LOGIKA may provide the data	Last mile orchestration platform: tag delivery/return records by vehicle ID/type, then aggregate in periodic reports.

Table 4. KPI Assessment – Athens Pilot (Continued)

	Impact Level	KPI	Is this KPI going to be measured?	Who is providing the data?	What are the data collection methods?
Social	Increase the choices and adoption of sustainable options	Number of parcel pick-up/drop-off points per inhabitant	NO	LOGIKA will serve B2B deliveries/returns of products	
		Potential accessibility to logistics services	NO	LOGIKA will serve B2B deliveries/returns of products	
		Share of costumers ready to adopt sustainable behaviours	NO	LOGIKA will serve B2B deliveries/returns of products	
		Costumers' expenditure with shipping and returns	YES	LOGIKA may provide the necessary primary data	Primary data can be extracted by Sales/billing software
	Improve conditions for logistic workers	Ratio between average wage of logistics workers and minimum income	YES	LOGIKA may provide the necessary primary data	HR payroll database for wage data; national statistics for minimum income reference.
		Share of delivery/pickup tours longer than work journey	NO		
		Coefficient of variation in route duration (std/mean of the route duration)	YES		Route duration data extracted from last mile orchestration platform; calculated in spreadsheet or analytics tool.

Table 5. KPI Assessment – Pozan Pilot

	Impact Level	KPI	Is this KPI going to be measured?	Who is providing the data?	What are the data collection methods?
Environment	Increase the number of non-fossil fuel deliveries and returns	Emissions (CO2, CO, NOx, SOx, PM10, PM2.5) per km per vehicle type	YES	SmilePickup	Distances are known, datas of the constructor also. We have a TMS who gives us the data we need
		Share of non-fossil fuel vehicles in the fleet	YES	SmilePickup	Inventory of the fleet
		Share of deliveries and returns made by non-fossil fuel vehicles	Yes	SmilePickup	our TMS
		Emissions (CO2, CO, NOx, SOx, PM10, PM2.5) per delivery/return	Yes	SmilePickup	our TMS
	Increase use of sustainable packaging	Share of returnable and reusable packaging	if the pilot is done with IKEA all the suppors are already reusables		
		Share of reusable packaging returned			
Economic	Increase the efficiency of logistics operations	Average load factor at the start of the tour by vehicle type	Yes	SmilePickup	our TMS
		Total VKT and VKT per delivery/return	Yes	SmilePickup	our TMS
		Avg. stops per tour	Yes	SmilePickup	our TMS
		Cost per delivery/return	Yes	SmilePickup	our TMS
Social	Increase the choices and adoption of sustainable options	Number of parcel pick-up/drop-off points per inhabitant	Not in the pilot		
		Potential accessibility to logistics services	Not in the pilot		
		Share of costumers ready to adopt sustainable behaviours	Not in the pilot		
		Costumers' expenditure with shipping and returns	Not in the pilot		
	Improve conditions for logistic workers	Ratio between average wage of logistics workers and minimum income	Yes	SmilePickup	accounting documents
		Share of delivery/pickup tours longer than work journey	YES	SmilePickup	Distances are known, datas of the constructor also. We have a TMS who gives us the data we need
		Coefficient of variation in route duration (std/mean of the route duration)	YES	SmilePickup	Inventory of the fleet

Table 6. KPI Assessment – Lyon Pilot

	Impact Level	KPI	Is this KPI going to be measured?	Who is providing the data?	What are the data collection methods?
Environment	Increase the number of non-fossil fuel deliveries and returns	Emissions (CO2, CO, NOx, SOx, PM10, PM2.5) per km per vehicle type	YES	SmilePickup	Distances are known, datas of the constructor also. We have a TMS who gives us the data we need
		Share of non-fossil fuel vehicles in the fleet	YES	SmilePickup	Inventory of the fleet
		Share of deliveries and returns made by non-fossil fuel vehicles	Yes	SmilePickup	our TMS
		Emissions (CO2, CO, NOx, SOx, PM10, PM2.5) per delivery/return	Yes	SmilePickup	our TMS
	Increase use of sustainable packaging	Share of returnable and reusable packaging	Yes	SmilePickup	our TMS
		Share of reusable packaging returned			
Economic	Increase the efficiency of logistics operations	Average load factor at the start of the tour by vehicle type	Yes	SmilePickup	our TMS
		Total VKT and VKT per delivery/return	Yes	SmilePickup	our TMS
		Avg. stops per tour	Yes	SmilePickup	our TMS
		Cost per delivery/return	Yes	SmilePickup	our TMS
Social	Increase the choices and adoption of sustainable options	Number of parcel pick-up/drop-off points per inhabitant	YES	SmilePickup	But only one in the pilot
		Potential accessibility to logistics services	YES	SmilePickup	our TMS
		Share of costumers ready to adopt sustainable behaviours	YES	SmilePickup	our TMS
		Costumers' expenditure with shipping and returns	YES	SmilePickup	our TMS
	Improve conditions for logistic workers	Ratio between average wage of logistics workers and minimum income	YES	SmilePickup	Distances are known, datas of the constructor also. We have a TMS who gives us the data we need
		Share of delivery/pickup tours longer than work journey	YES	SmilePickup	Inventory of the fleet
		Coefficient of variation in route duration (std/mean of the route duration)	Yes	SmilePickup	our TMS

Table 7. KPI Assessment – Vienna Pilot

	Impact Level	KPI	Is this KPI going to be measured?	Who is providing the data?	What are the data collection methods?
Environment	Increase the number of non-fossil fuel deliveries and returns	Emissions (CO_2, CO, NOx, SOx, PM10, PM2.5) per km per vehicle type	YES	ECON/ LOGP	transportation partners/ databases of deliveries
		Share of non-fossil fuel vehicles in the fleet	TBD		
		Share of deliveries and returns made by non-fossil fuel vehicles	TBD		
		Emissions (CO_2, CO, NOx, SOx, PM10, PM2.5) per delivery/return	TBD		
	Increase use of sustainable packaging	Share of returnable and reusable packaging	Yes	LogPOINT	transportation partners
		Share of reusable packaging returned	Yes	LogPOINT	transportation partners
Economic	Increase the efficiency of logistics operations	Average load factor at the start of the tour by vehicle type	Yes	LogPOINT	transportation partners
		Total VKT and VKT per delivery/return	Yes	LogPOINT	transportation partners
		Avg. stops per tour	Yes	ECON/ LOGP	Survey/ data collection chamber of commerce
		Cost per delivery/return	Yes	ECON/ LOGP	Survey/ data collection chamber of commerce
Social	Increase the choices and adoption of sustainable options	Number of parcel pick-up/drop-off points per inhabitant	NO		
		Potential accessibility to logistics services	NO		
		Share of costumers ready to adopt sustainable behaviours	NO		
		Costumers' expenditure with shipping and returns	NO		
	Improve conditions for logistic workers	Ratio between average wage of logistics workers and minimum income	NO		
		Share of delivery/pickup tours longer than work journey	YES	ECON/ LOGP	transportation partners/ databases of deliveries
		Coefficient of variation in route duration (std/mean of the route duration)	TBD		

List of tables

List of figures